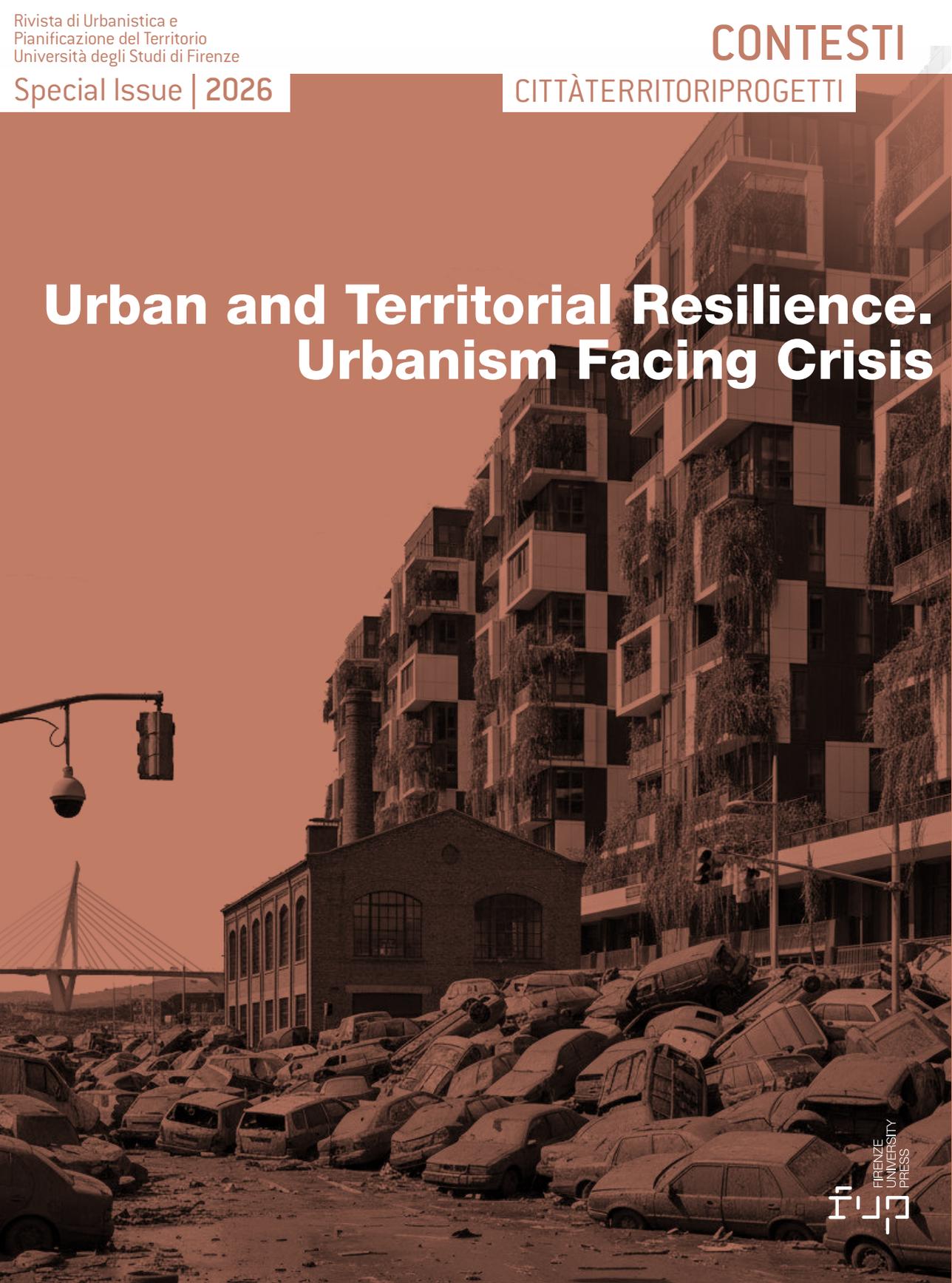


# Urban and Territorial Resilience. Urbanism Facing Crisis





# CONTESTI

## CITTÀ TERRITORI PROGETTI

Rivista di Urbanistica e  
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### keywords

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landscapes  
urban and regional sustainability

## 1. Urbanism Facing Crises and Multi-Risks

Cities and landscapes are undergoing an ever increasing number of often intertwined crises, which urbanism and territorial governance are called to fully understand and to timely and effectively address, in order to

protect – in advance and/or in the midst of an emergency – the health and the sound operation of the spatial systems in which human and non-human societies can only live and flourish, i.e. the ecosystems upon which everything

*Cities and landscapes are undergoing an ever increasing number of often intertwined crises, which urbanism and territorial governance are called to fully understand and to timely and effectively address, in order to protect – in advance and/or in the midst of an emergency – the health and the sound operation*

*of the spatial systems in which human and non-human societies can only live and flourish, i.e. the ecosystems upon which everything depends: the ecological, the social, and the economic spheres, and with them the cultural, the political, etcetera. Spatial multi-risk has been the core of the scientific activities taking place within the Spoke number 5 “Urban and metropolitan settlements” of the extended partnership project “RETURN – multi-Risk sciEnce for resilienT commUnities undeR a chaNging climate”. This special issue brings together studies and perspectives from those scientific activities, connected projects, and topic-relevant parallel studies, expanding much beyond the original idea to collect the proceedings of the special session “Urban and territorial resilience: from measuring to building planning solutions”, organised by most of this issue’s Guest Editors (Amenta, Cazzola, Cristiano, Giudice, Trabucco, & Vingelli) within the 63rd Congress of the European Regional Science Association (Terceira, Portugal, 26–30 August 2024).*

depends: the ecological, the social, and the economic spheres, and with them the cultural, the political, etcetera. Spatial systems can be seen as the hybrid constellation of infra-structural, ecological and socio-political that sustains human-habitability on Earth; yet, non-human life often adapts and reorganises itself even when such systems fail (cfr. Ahern, 2011, and Holling, 1973). Revealing this asymmetry, calls for a humbler stance towards spatial governance and practice – one that looks at ecosystems not just as support to humans and their activities (however apparently not even so widespread) but also sees urban processes as connected and unavoidably dependent on ecological systems and their processes. More catastrophic events were recorded in the first twenty years of the 21st century compared to the previous two decades (UNDRR, 2020). Matched with problematic spatial choices over time, the ongoing climate crisis is bringing more and more disasters, with other existing crises (ecological, energy, resources, socio-economic, geo-political, etc.) standing out as relevant while trying to anticipate and handle them (Cristiano, 2022a; 2022b), both as additional causes and as crucial factors in addressing them over time (Trabucco & Cristiano, in this issue). The “problematic spatial choices” are those planning decisions, land-use policies, design decisions that tend to amplify hazards by constraining the adaptive capacities of the landscapes and ecosystems wherein they are enacted. Resilience (Holling, 1973, and espe-

cially its spatial declination (Davoudi, 2013), is conceived as a useful concept for dealing with the current crises, such as the climate one (Davoudi *et al.*, 2013), but not limited to that, and the related exposure to risks. However, too often resilience is still used as a vague concept, and requires a deep understanding of its spatial implications by framing it as a dynamic and transformative process that requires (much more than just technical) innovation and adaptability, especially in an uncertain century of interconnected crises. This special issue of *CONTESTI. Città, territori, progetti* was originally aimed at collecting the outcomes of the special session “Urban and territorial resilience: from measuring to building planning solutions”, organised and chaired by some of the Guest Editors of this special issue on the occasion of the 63rd Congress of the European Regional Science Association (ERSA), held in Terceira, Portugal, in 26–30 August 2024. The entire special issue was conceived and developed within the Extended Partnership project funded by the European Union’s *Next-GenerationEU* “RETURN – multi-Risk sciEnce for resilientT commUnities undeR a chaNging climate”, Spoke TS1 “Urban and Metropolitan Settlements”, whose research agenda focuses on the integration of Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) within spatial planning and design, where Disaster Risk Management (DRM) is interpreted as a circular, systemic process linking prevention, preparedness, response, and recovery,

and requiring multi-level governance as well as place-based and multi-risk approaches. The original idea of elaborating the ERSA special session proceedings was actually expanded while getting to this publication, by refining the works, submitting them to anonymous peers, and also bringing together researches and perspectives from other scientific activities within RETURN and connected projects, as well as topic-relevant parallel studies. From its conceptualisation through to its , the present special issue has aimed at contributing to a more comprehensive understanding of spatial resilience and at providing valuable insights for developing practical solutions in the current climate crisis. In particular, the issue has sought to explore methods and tools to evaluate the effectiveness of adaptation and mitigation strategies in enhancing territorial resilience in multi-risk contexts and to define a better quality of life for local communities; to clarify the concept of urban and territorial resilience, deepening the mutual influences between resilience and other concepts; to showcase case studies attempting to build resilient territorial systems; to identify and test metrics to provide a comprehensive understanding of strengths and weaknesses within the territorial system through the research and collection of progress, response, and efficiency indicators capable of measuring resilience while facing multiple crises and multiple risks. As a matter of fact, on top of climate-related threats, the collected papers show how spatial resilience

must contend with intertwined risks – environmental, technological, metabolic, and socio-spatial ones, thus highlighting the plurality of critical conditions that shape contemporary territories (i.e. case studies such as Terra dei Fuochi, Bagnoli-Coroglio, the Campi Flegrei cultural landscapes, Ostiense’s energy poverty conditions, or the brownfield palingenesis analysed in this issue). Finally, this special issue confirms that long-sighted urban, metropolitan, and regional resilience is undergoing a profound epistemological shift, moving away from engineering-based and sectoral interpretations toward ecological, socio-technical and metabolic frameworks (see e.g. contributions by Brunetta *et al.*, Amenta *et al.*, De Martino *et al.*). This shift calls for new ontologies of urban systems, and related adequate cautious urban planning and design choices, capable of engaging with cycles, thresholds, uncertainties, and the non-linear dynamics of socio-ecological assemblages, so as to consciously avoid spatial collapse and timely prevent and mitigate disasters here and now.

## 2. Urban and Territorial Resilience: theoretical contributions

The theoretical contributions collected in the “Essay” section of this special issue delineate the complex and evolving landscape of urban and territorial resilience, a field marked by continuous conceptual and operational transformation. The special issue investigates the increasingly necessary convergence between

Disaster Risk Reduction and Climate Change Adaptation, a nexus that demands innovative policy frameworks and territorially situated forms of intervention. Collectively, the contributions reveal a discipline undergoing a profound epistemological reconfiguration, one that questions established paradigms and advances a more ecological, systemic, and situated understanding of resilience (Brunetta & Voghera, 2023).

The opening contribution, the review by **Tra-bucco and Cristiano**, underscores that many contemporary approaches to spatial resilience are still constrained by sectoral and engineering-oriented models that struggle to engage with socio-spatial dynamics and the complexity of planning practices. These approaches often rely heavily on technical performance metrics that lead to a fragmented and reductionist understanding of resilience. Against this backdrop, **Ranzato** advocates for a radical shift in perspective by inviting us to “embrace disruption”. In this interpretation, disruption and infrastructural anomalies (such as the urban lakes and connected spontaneous ecosystems produced by technical errors in Brussels and Rome) become epistemic openings that reveal latent dimensions of the contemporary city, such as non-human agencies and neglected ecological relations. From this viewpoint, resilience becomes the ability to coexist with uncertainty and to recognise the generative potential embedded in conditions that are usually considered marginal or problematic.

The community dimension, developed in **Daniel's** contribution, emerges as a second critical axis. Her work on citizen science shows how practices such as citizen-generated data, participatory risk perception, and collaborative adaptation enable communities to operate as genuine social infrastructures of resilience. These processes challenge top-down governance models and counter the technocratic fragmentation identified earlier, demonstrating the democratic and transformative potential of co-produced knowledge. Despite the persistent limitations in participation, Daniel proves that co-produced and situated knowledge, rooted in everyday practices, are essential to resilient spatial systems. In this way, her contribution challenges top-down governance models and counters the technocratic fragmentation identified by Trabucco and Cristiano.

A third strand concerns methodological innovation. **Ridolfi et al.** reconceptualise risk as an opportunity for design, presenting the “L methodology”, which integrates multi-level strategic frameworks with multi-risk territorial diagnoses. Their work shows how risk can function as an interpretative matrix capable of revealing vulnerabilities, orienting decisions, and structuring adaptive strategies. This approach displaces the notion of territory as a passive support, instead positioning it as a dynamic assemblage whose hydrological, ecological, and metabolic processes actively shape risks and opportunities. Building on this perspective, **Amenta et al.** introduce the concept of metabolic risk. Their framework shows how

marginal, abandoned or contaminated spaces act as metabolic agents, accumulating fragilities while also embedding latent regenerative potential. Using multidimensional indicators and co-creation processes, they demonstrate how these “waste” territories can become laboratories for circular and resilience-oriented transformations. A related contribution by **De Martino et al.** centres water as an active territorial agent. Their framework for multi-risk territories proposes water-adaptive (amphibious) approaches that require new design languages capable of engaging with cycles, thresholds, and instability. Their urban laboratories demonstrate how adaptive scenarios, perceptual mapping, and co-design practices can generate innovative territorialities.

Temporal framings of risk are elaborated by **Clemente and Puzone**, who insist that resilience be articulated across all phases of the risk cycle: prevention, preparedness, response, and recovery. While this orientation on structured temporal strategies may appear in contrast with Ranzato's valorisation of unpredictability and disruption, both ultimately converge on a processual understanding of resilience: crises are neither interruptions nor isolated events, but rather components of iterative and open-ended trajectories that demand both openness to contingency and the construction of tools to steer it over time. Finally, **Pisano** emphasises the epistemic role of design. Drawing on the experiences of the “Prato Ready” Laboratories, he argues that design should be understood not merely as a means

for producing spatial or technical solutions, but as a cognitive and reflective device capable of generating knowledge, surfacing tacit processes, and interrogating complex spatial dynamics. Pisano's perspective, emerging out of the educational approaches by a wider team of Florence's faculty members, resonates with the experimental, iterative, and speculative logics that recur across the special issue – from Ranzato's revalorisation of disruptions to De Martino *et al.*'s water-responsive approaches, from Ridolfi *et al.*'s multi-risk reading to Daniel's co-production of knowledge.

Taken together, these contributions articulate a significant paradigm shift. Urban and overall spatial resilience emerges not as a linear or technocratic response to risk, but rather as an open, iterative, transdisciplinary, and deeply territorial process (Brunetta *et al.*, 2019). It weaves together ecological dynamics, socio-spatial practices, and heterogeneous epistemologies, transforming crises from objects of mitigation into generative conditions for reimagining how territories are inhabited, designed, and governed amidst ongoing transformations – be the latter chosen or not.

### **3. Urban and Territorial Resilience: case-based contributions**

Building upon the critical reconceptualisation of resilience articulated in the “Essays” section, the Research section stands as its methodological and empirical testing ground. This section gathers contributions that shift the focus of the debate from the conceptual framing

of resilience to its effective measurement and implementation, proposing and testing methodologies, tools, and planning solutions within real territorial contexts and ongoing research. The selection of the articles presented in this section has been guided by the search for rigorous case studies that, far from being limited to a mere description of risk scenarios, could offer operational approaches for building resilience in contemporary territories.

The gathered contributions investigate and test a diversity of territorial conditions, using diverse and appropriate scales of study. Cases range from dense, historic centres, such as Rome or Turin, to peri-urban and coastal areas, and large former industrial areas. Indeed, the section contributes to the aim of the special issue – providing insights for practical solutions in the current risk condition – specifically by understanding and measuring impacts on the territorial and communities' metabolism and form (Wachsmuth, 2012; Bahers, 2022). While shared threats, such as climate change and natural hazards, affect all examined territories; nonetheless, their specific manifestation is highly context-specific, demanding a multi-scalar and systemic perspective for comprehensive understanding. At the local scale of historic centres, the focus sharpens on climate justice impacts among vulnerable populations, suggesting the development of more effective participatory approaches. Conversely, at the territorial scale, strategic development opportunities clearly emerge, linked to multi-level governance and the closure of urban metabolic

cycles in a circular perspective (Amenta *et al.*, 2022). This framing elevates the significance of landscape, “green and blue infrastructure”, and natural cycles, generating a necessary dialectic that places human and non-human communities in tension, mediating between emergency risk regimes and the pursuit of everyday comfort in contemporary cities (Wu, 2013).

The methodological and operational focus of this section converges into three principal research streams. These streams not only help harmonise the current body of work but can also pave the way for future advancements in territorial resilience, providing a robust framework for multi-risk and context-based studies:

**1. Developing methodologies and indicators for planning:** a first portion of these contributions concentrates on the measurement and mapping of resilience, providing analytical tools that effectively translate the concept into actionable territorial governance. Foremost, the work by **Vingelli *et al.*** addresses the need for a more inclusive approach, moving beyond purely economic metrics. They propose a methodological framework for the identification and evaluation of Non-Economic Loss and Damage (NELD). This research extends the NELD concept typically tied solely to climate risk, offering critical instruments to recognise the intangible dimensions of loss within multi-risk urban regeneration contexts. Consistent with the goal of operationalising resilience, **Cazzola *et al.*** develop a spatial indicator approach to map urban resilience re-

sponses across five key dimensions in Turin, delivering a holistic and multi-dimensional assessment. Complementarily, **Brunetta *et al.*** propose a methodological framework that defines Local Resilience Units based on urban proximity. This offers a practical and scalable planning tool that overcomes operational limitations, firmly anchoring resilience to a defined and local scale of intervention.

**2. Governance, Spatial Justice, and socio-climatic vulnerability:** while methodologically grounded in the study of urban form and space, these papers primarily address the political and social dimension of risk, highlighting how interconnected crises translate into socio-spatial inequalities that severely stress the adaptive capacity of communities. **Del Duca *et al.*** conduct a climate risk analysis focused on Urban Heat Islands, specifically addressing the impact on Urban Health in the Florence Plain. Similarly, **Panella** explores the relationship between adaptive climates and energy poverty (Ostiense, Rome), critiquing the technological rationalism of comfort and demonstrating how climate risk translates into socio-economic inequality at both the domestic and urban scales. Managing such complexity necessitates a paradigm shift in governance and design processes. **Bruno *et al.*** examine the integration of spatial analysis and participatory processes to enhance climate change resilience emphasising the crucial role of local action and robust governance. Finally, **Guida and Bocchino** tackle

the management of areas exposed to latent and declared risks such as environmental contamination and social disruption. Their work introduces the concept of “Malleable Territories” and proposes regenerative solutions that demand adaptive and innovative planning capable of embracing contextual uncertainty and dynamism in metropolitan areas.

**3. Environmental Regeneration, Design, and Landscapes at Risk:** the final set of contributions concentrates on the active and transformative role of design and landscape as a tangible response to risk. **Isola et al.** analyse the function of Urban Green Infrastructures and the provision of ecosystem services (e.g., flood control) in Cagliari, providing a methodology to quantify the benefits of Nature-Based Solutions in risk mitigation. A complementary perspective is offered by **Piccirillo et al.**, who reflect on the potential for spontaneous regeneration - rewilding (Pereira & Navarro, 2015) - of brownfields, framing these sites as experimental laboratories for environmental justice and community engagement in transformation processes. The concept of risk is also extended to cultural heritage: **Castigliano et al.** employ resilience as a unifying concept to connect cultural heritage preservation with landscape ecology. They invite a rethinking of cultural landscapes not as static “silent ruins,” but as dynamic systems capable of adaptation. Concluding the section, **Di Palma et al.** bring the focus

back to the central role of architectural and urban design within “landscapes at risk,” suggesting a form of design that acts as a mediator between the built environment and environmental dynamics, promoting new forms of spatial equilibrium as a tangible response to crises.

The contributions in the Research section clearly suggest that building urban and territorial resilience cannot be reduced to a mere technical-quantitative exercise. The commitment to identify and measure the socio-spatial dimension of risk – from quantifying intangible loss to mapping vulnerability differentials (such as Urban Heat Islands and energy poverty) – reveals a strong and necessary orientation toward spatial justice as the fundamental prerequisite for an effective crisis response.

In this framework, the essential role of public space, landscape, and the environment emerges forcefully. Nature-Based Solutions are consequently presented not as mere allusive procedures, but are grounded in concrete significance through innovative and pertinent design approaches. Design is thus reframed not simply as a technical exercise, but as a critical lever for developing universally accessible solutions capable of strengthening both social cohesion and ecosystem relationships within the urban metabolism. The selection of complex case studies validates this critical stance. The empirical evidence collected casts a powerful bridge toward the next section, underscoring the necessity for policies, design

and evaluation instruments that fully grasp the utility and the transformative force in this context-based and multi-risk perspective.

#### **4. The significance of this special issue in operationally pursue Urban and Territorial Resilience**

Beyond the specific contexts and methodologies explored, this issue points toward a broader research and action agenda. The (re) conceptualisation of resilience as a spatial, socio-ecological and more-than-human process, demands experimental frameworks capable of linking disaster risk reduction, climate adaptation, spatial-climate justice and ecological regeneration in situated and diacronic manners. Several research trajectories – including those developed within the RETURN project and by the Guest Editors – are already developing and testing such approaches. Rather than offering definitive answers, the gathered contributions suggest that operationalising urban and territorial resilience means working with living territories, multispecies assemblages, where urbanism – facing crisis (and hopefully not *contributing to* those crises) – is called to sustain those living environments and entities that populate them within changing and uncertain times. In this sense, this issue is not an endpoint, but an invitation to further experimentation and testing across territories, scales, and disciplinary boundaries. The contributions that are part of the present special

issue will hopefully serve as theoretical and practical examples and sources of inspiration for scientists, professional practitioners, and public administrations genuinely seeking to enhance spatial resilience in their respective contexts. The next operational editorial, in Italian, strives to link the contents, learnings, and meta-learning associated with this special issue starting from a critical reading and interpretation of an ongoing urban transformation debate in Rome, Italy, exhibiting multiple risk and resilience dilemmas.

#### **Attributions**

Concept and structure: S.C & I.T.; section 1: first draft by S.C., editing by D.V. & I.T., review by I.T., C.P. & S.C.; section 2: first draft by I.C., editing and review by I.T., B.G., S.C. & A.V.; section 3: first draft by F.V., editing and review by I.T., L.A. & M.R.; section 4: I.T. & S.C.; overall coordination, editing, and review: S.C.; fund acquisition: S.C., B.G., C.P., M.R., A.V.

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# L'urbanistica, le crisi, l'urbanistica in crisi: dall'acquiescenza nei collassi urbani alla cura del territorio.

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**Trasformazioni e futuro: resilienza, urbanistica e crisi a partire da un caso romano**

*Il tema è politico, sostiene Veronica Dini, avvocatessa che si occupa di diritto ambientale e che ha avviato alcune delle cause sui cantieri sotto inchiesta a Milano: "Le amministrazioni pubbliche hanno tutti gli strumenti per difendere il valore ecologico dei loro territori dal rischio cementificazione, soprattutto in tempi di crisi climatica" (Gainsforth, 2025)*

*Ecco il monito costante a chi governa questa città: di essere custode e portavoce di un testimone di libertà e resistenza, per le generazioni che verranno*

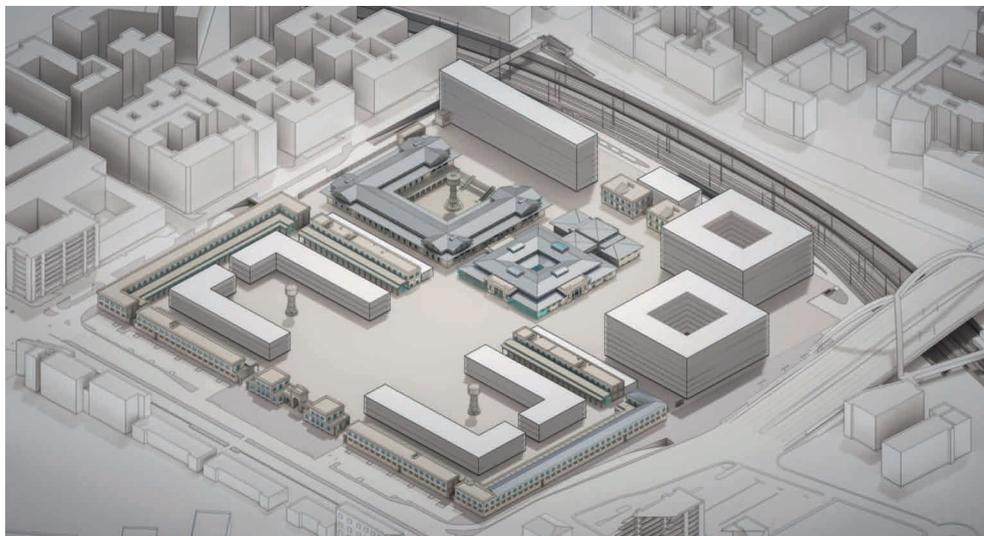
(un amministratore pubblico chiamato oggi a difendere il valore ecologico del suo municipio dalla cementificazione, in tempi di crisi climatica, per le generazioni presenti e per le generazioni che verranno, 2021)

ROMA, 26 novembre 2025 – Centro sociale per anziani "Ostiense Ex Mercati Generali". Da sinistra a destra della cattedra, senza ordine apparente, siedono l'assessora ai lavori pubblici e alle infrastrutture<sup>1</sup>, la capogruppo del partito di maggioranza in consiglio comunale<sup>2</sup> e il presidente<sup>3</sup> di un municipio interessato da un enne-

simo mega-progetto di “rigenerazione” urbana<sup>4</sup>. In disparte e in silenzio, l’assessore all’urbanistica, «ingegnere elettronico ed esperto di sistemi informativi e di comunicazione»<sup>5</sup>. L’incontro “Il futuro degli Ex Mercati Generali e la Trasformazione del Quadrante Ostiense” è stato convocato in seguito a una sollevazione popolare nei quartieri limitrofi, con assemblee, manifestazioni e la costituzione di un comitato civico per la tutela dell’area<sup>6</sup>, in risposta al fatto che il comune avesse deliberato prima un rinnovato interesse pubblico<sup>7</sup> e poi nuove cubature per l’area di 9 ettari a meno di un chilometro a sud delle Mura Aureliane e a circa 250 metri dalla Stazione Ostiense. Si tratta di una convenzione integrativa rispetto a quella sottoscritta nel 2006, che per sessant’anni vorrebbe dare l’uso del complesso in concessione a uno dei maggiori fondi di investimento immobiliare al mondo, texano, in cambio di un canone di 165.000 euro l’anno<sup>8,9</sup>. Il progetto prevede «un investimento totalmente privato di circa 380 milioni di euro» (Comune di Roma, 2025), con quasi 4 ettari per piazze e non meglio specificate aree “verdi”, quasi 4 ettari di parcheggi pubblici<sup>10</sup> e quasi 3 ettari di parcheggi privati, per un totale di circa 2600 posti auto interrati. Il comunicato stampa del comune non affronta la questione delle nuove cubature, d’interesse urbanistico: parla soltanto di superfici: mq (nemmeno m<sup>2</sup>), come negli annunci immobiliari<sup>11</sup>. Il progetto per gli Ex Mercati Generali prevede che oltre 5 ettari<sup>12</sup> siano destinati a quello che – nonostante i prez-

zi annunciati – viene presentato come uno studentato. Nella maggior parte degli strumenti urbanistici uno studentato è considerato parte della destinazione d’uso residenziale. Nell’ambito del PNRR, i nuovi studentati<sup>13</sup> avevano ottenuto una serie di agevolazioni fiscali, economiche, edilizie e urbanistiche, tra cui il cambio della destinazione d’uso in deroga agli strumenti urbanistici e alle leggi regionali o statali, la detassazione della maggiore rendita catastale risultante da detto cambio, aumenti di cubatura e, in assenza di questi, la possibilità di costruire anche in aree soggette a vincolo paesaggistico<sup>14</sup>. L’art. 40 della legge 182/2025 modifica il Testo Unico dell’Edilizia, introducendo ora la possibilità del silenzio-assenso per qualsiasi intervento su qualsiasi immobile<sup>15</sup> soggetto a «vincoli idrogeologici, ambientali (ad esempio: di Parco), paesaggistici o culturali (tra cui quelli storico-artistici, archeologici)» per i quali era invece prevista una Conferenza dei Servizi<sup>16</sup>.

Da convenzione<sup>17</sup>, il *wanna-be* studentato dell’Ostiense dovrebbe avere stanze singole che si prevedono affittabili a prezzi compresi tra 1159 € e 1281 € al mese e posti letto in stanza doppia a 763 €; circa un quinto delle superfici<sup>18</sup> dovrebbe essere destinato all’affitto di *posti letto* a 610 €, prezzo quest’ultimo definito come *calmierato*, ossia inferiore ai prezzi di mercato, ma in città certe cifre sono ben superiori al prezzo di una stanza *singola* in un appartamento condiviso, mentre un posto letto in zona si può trovare a 250 € al mese<sup>19</sup>; quel ben più economico libe-



ro mercato è già un ostacolo per molte studenti; non saranno simili strutture a risolvere il problema del diritto allo studio, anzi. Ciononostante, i documenti e le varie esternazioni del comune si concentrano sul fatto che il canone spacciato come calmierato ammonti al 25% dei posti letto, tralasciando (oltre al fatto che, costando oltre il doppio della media di zona, non è affatto calmierato) il dettaglio che questi occupino solo il 20% delle superfici, dunque, i posti a canone ridotto hanno superfici ridotte ed esattamente lo stesso prezzo al metro quadrato: le proporzioni confermano che  $25 : 20 = 763 : 610$ ; di nuovo, un'ontologia immobiliare). Non solo i prezzi calmierati non sono davvero calmierati, ma lo studentato rischia di non essere nemmeno uno studentato – da un lato, per ragioni di mercato: nelle zone semi-centrali dell'Ostiense e dell'attualmente più economica Garbatella, con 1281 € al mese si possono prendere in affitto appartamenti da 75 fino a oltre 110 metri quadrati, mentre nominalmente 610 € potrebbero dare accesso a tagli dai 35 ai 54 metri quadrati<sup>20</sup>; dall'altro lato, perché questo tipo di operazioni immobiliari, non residuali nell'urbanistica contrattata di mezza Europa, la-

sciano spesso ampio spazio alle locazioni di tipo turistico (anche quando realizzate in edifici pubblici<sup>21</sup>), come avviene ad esempio per le catene *The Social Hub*<sup>22</sup> e *Camplus*<sup>23</sup>, presenti su piattaforme quali *Booking.com*<sup>24</sup> e pubblicizzate come *student hotel* o più esplicitamente alberghi per “viaggiatori” e studenti<sup>25</sup>. Non sembrano esserci garanzie che la destinazione d'uso dello studentato, residenziale, non sia invece usata per creare delle strutture ricettive; il progetto dovrebbe essere rimodulabile dopo 7 anni<sup>26</sup>. Già oggi, poi, i diffusi soggiorni a pagamento da Oltreoceano (si parla di oltre 20.000 \$ per tre mesi e mezzo di permanenza)<sup>27</sup>, laddove anche per qualche studente con una più umile borsa Erasmus l'esperienza all'estero può essere vissuta come una vacanza estesa (Teichler, 2015), non aiutano la distinzione tra studenti e turisti (per quel *target*, sembra se non altro assente la distinzione per censo o almeno per capacità di spesa), ma di sicuro mostrano la differenza che c'è tra uno *student hotel* e le residenze universitarie a canoni davvero calmierati, dunque necessarie per assicurare il diritto allo studio.

Si scriveva che non sembrano al momento di-

## Prospetto volumetrico del progetto per l'area degli Ex Mercati Generali di Roma, vista da sud-ovest

Fonte: documenti progettuali del Comune di Roma  
Fig. 1

sponibili i dati sulle volumetrie deliberate: se nel 2015 si parlava di 343.000 metri cubi, le nuove immagini rese disponibili dal comune mostrano la ristrutturazione delle strutture storiche e la costruzione di otto nuovi fabbricati (in **Figura 1**, illustrati con le superfici orizzontali bianche e quelle verticali in grigio); sommando le superfici annunciate per le varie funzioni al coperto<sup>28</sup> e ipotizzando cautelativamente un'altezza media lorda di 3 metri per piano<sup>29</sup>, ora parrebbero in ballo oltre 453.000 m<sup>3</sup>, con un indice di fabbricabilità (IF) che, su 9 ettari, sembrerebbe toccare, se non superare, il massimo (5 m<sup>3</sup>/m<sup>2</sup>) previsto fin dal 2003 per le nuove costruzioni dalle Norme Tecniche di Attuazione del Piano Regolatore Generale; tali stime comprendono le preesistenze, ma queste ultime appaiono minoritarie sia in termini di superficie che di volumetrie; ci si può quindi aspettare che l'IF relativo alle sole nuove costruzioni (più m<sup>3</sup> su meno m<sup>2</sup>) possa risultare ancora maggiore.

### Come nulla fosse

Ecco, numeri e regole a parte, per un'urbanistica capace di proiettarsi nel presente e nel futuro, i vent'anni che ci separano dall'adozione del piano regolatore e dall'*iter* che portò al primo bando e alle varie concessioni risultano cruciali – e ciò non vale solo per il caso romano. La storia degli Ex Mercati Generali può rappresentare un esempio emblematico e quasi didascalico del cambiamento di paradigma richiesto alle scelte urbanistiche nel ventunesimo secolo: i sem-

pre peggiori sconquassamenti climatici, l'innalzamento delle temperature, i fenomeni di siccità, le alluvioni, le sempre più aspre crisi ecologiche e sociali, le disuguaglianze crescenti, l'incessante consumo di suolo, i riassetti geopolitici e geoeconomici, le prossime pandemie attese sono soltanto alcuni dei rischi interconnessi (o delle forzanti che vari rischi poi generano) che non possono essere affrontati se si continuano ad alimentare quei rischi e quelle forzanti. Inseguendo la crisi economica del 2007-09 in una prospettiva biofisica, Brown e Ulgiati (2011) concludevano che il problema non è tanto quello della scarsità delle risorse o di trovare nuovi fonti energetiche, quanto piuttosto il perseverare con il *business as usual*, continuare cioè a fare (affari) come se nulla fosse, con tutte le forme di degradazione del patrimonio ecologico e umano che ciò comporta – un patrimonio che è anche sociale ed economico, un patrimonio che è anche territoriale e urbano.

Se guardiamo all'urbanistica come all'interfaccia tra i sistemi ecologici e i (sotto-)sistemi socio-economici, ogni scelta dovrebbe essere orientata all'interesse pubblico, cioè a una mediazione tra i diversi interessi di chi compone quei sottosistemi sociali ed economici. I sistemi economici sono dei sottosistemi dei sistemi sociali (non possono cioè esistere al di fuori di essi) e i sistemi sociali sono a loro volta dei sottosistemi ecologici (v. ad es. Cristiano, 2021), sono inseriti cioè in un sistema di relazioni con un ambiente circostante necessariamente non



## Panoramica attuale dell'area degli Ex Mercati Generali di Roma, vista da nord-est

Fonte: Google Earth; questa mappa include dati di: Vexcel Imaging US, Inc. Data SIO, NOAA, U.S. Navy, NGA, GEBCO Landsat / Copernicus. Date: 01/01/2004 - 04/10/2025

Fig. 2a

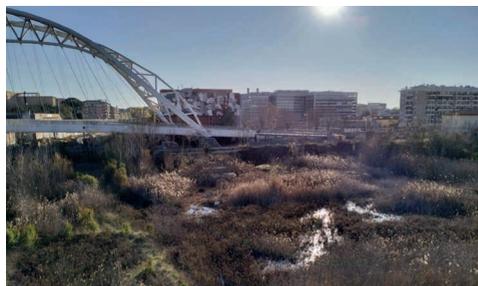
umano; fare i conti con la sfera ecologica non è quindi un vezzo da ambientalismo borghese, ma una condizione *sine qua non* per continuare a immaginare un **futuro** non distopico ma auspicabilmente prospero<sup>30</sup> per le società e le economie umane: prima di mediare tra interessi che a oggi portano spesso a una distruzione ecologica, il punto cruciale è capire come salvaguardare – in modo più lungimirante – non l'interesse pubblico (distorto di senso), ma il *bene collettivo*, che solo può emergere dal preservare condizioni favorevoli alla vita. Anche quando affronta la sostenibilità e la resilienza, il paradigma attuale dominante (*mainstream*) ragiona al contrario di come funziona il mondo di cui troppo spesso ci si dimentica di far parte, invertendo le gerarchie: regna l'economia (in forme peraltro molto poco variegate – e la poca diversità indebolisce ogni sistema), erodendo le sue stesse basi sociali ed ecologiche. Per provare a scampare gli effetti più deleteri dell'insostenibilità strutturale che ne deriva, «le dimensioni ecologiche e sociali [...] dovrebbero assumere un ruolo primario,

non essere puri orpelli dei *desiderata* economici; la domanda», cioè qualsiasi attività economica, trasformazioni urbane incluse, «andrebbe quindi calibrata su ciò che socio-ecologicamente ci si può permettere» (Cristiano, 2021).

### Urbanistica, biodiversità e futuro

Adattando i discorsi di Brown e Ulgiati all'urbanistica e al giorno d'oggi, non è difficile vedere come una illimitata crescita anche urbana stia creando e creerà problemi sempre più seri – ecologico-climatici e quindi anche ulteriori problemi sociali ed economici. L'urgenza di agire c'è. Come farlo? Il caso degli Ex Mercati Generali mostra che *non fare* (errori) può essere già un ottimo punto di partenza. Nel frattempo, infatti, in quell'area è risorto un ecosistema, con tanto di aree umide e specchi d'acqua (**Fig. 2**), un'**oasi ecologica urbana**: «migliaia di salici, pioppi bianchi e cannuce palustri. I nove ettari di suolo pubblico nel cuore della città sono diventati un'area di grande biodiversità» (Gainsforth, 2025).

Proprio in tema di biodiversità e di futuri non di-



**Dettagli della rigenerazione ecologica spontanea nell'area degli Ex Mercati Generali a Roma; in un immaginario sociale colonizzato (v. Latouche, 2013), è verosimile mettere in atto dei "riflessi pavloviani" quali "un pieno è meglio di un vuoto", "nuovo è meglio che vecchio", "più è meglio che meno", "messo a profitto è meglio che abbandonato", "moderno è meglio di selvatico" e così via. In questo e nei prossimi paragrafi sono offerti dei ragionamenti utili anche a decolonizzarlo, quell'immaginario; sarà allora forse più facile ricordarsi che un vuoto tra il cemento può essere pieno delle basi biofisiche per vivere nelle città del XXI secolo, che più inquinamento, più "traffico", più alluvioni, più "emergenze caldo" non sono affatto meglio che averne meno, che un'area "verde" può rappresentare un "foglio bianco" per immaginare e prepararsi a un futuro meno "nero"**

Fonte: Google Earth; questa mappa include dati di: Vexcel Imaging US, Inc. Data SIO, NOAA, U.S. Navy, NGA, GEBCO Landsat / Copernicus. Date: 01/01/2004 - 04/10/2025  
Figg. 2b-2c-2d-2e-2f

stopici, il PNRR ha finanziato con 320 milioni di euro la costituzione del *National Biodiversity Future Centre*<sup>31</sup>, una rete di ricerca che mette insieme 48 enti e università, per un totale di 1300 ricercatrici e ricercatori, sotto il coordinamento del Consiglio Nazionale delle Ricerche. Sempre a proposito di biodiversità, la giurista ambientale Dini ricorda che «la riforma della costituzione del 2022 ha inserito la tutela dell'ambiente, della biodiversità e degli ecosistemi per le future generazioni tra i principi costituzionali, specificando che l'iniziativa economica privata è libera, ma non può danneggiare la dignità umana, la salute o l'ambiente» (*ibid.*). D'altra parte, come ben sa ogni urbanista, la stessa Carta pone dei limiti alla proprietà privata «allo scopo di assicurarne la funzione sociale e di renderla accessibile a tutti» (art. 42). Oggi più che mai, in un'epoca in cui le conseguenze ecologico-climatiche di scellerate scelte economiche mettono a repentaglio la società tutta, economia compresa, occorre interrogarsi su quali siano le scelte in grado di perseguire la funzione sociale e il bene collettivo e quali quelle che invece rimangono loro contro.

Nell'abbandono pluridecennale, i sistemi ecologici dell'area degli Ex Mercati Generali si sono rigenerati (loro sì, e davvero)<sup>32</sup> da soli, non tornando, naturalmente, alle condizioni precedenti, ma operando una trasformazione spontanea iniziata a partire dall'evoluzione di un sito completamente artificializzato: costruito, dismesso, scavato; nell'ultimo articolo di questo numero speciale, Piccirillo *et al.* chiamano questo processo

*palingenesi*, "rinascita". I sistemi ecologici si sono sviluppati de-mineralizzando l'area, "rimangiando" il cemento non più necessario<sup>33</sup>, anzi, come vedremo tra poco, sempre più problematico. In alcuni contesti lo si fa per scelta; in italiano, Broggin e Ranzato (2023) affrontano i casi di Parigi e di Francoforte; è di recente pubblicazione un manuale tecnico, scientifico e progettuale (Bortolotti e Geroldi, 2025) dedicato proprio alla desigillazione<sup>34</sup> del suolo. All'Ostiense, il rinselvatichimento ha offerto e offre una **letterale boccata d'aria** a una città e a un quadrante urbano che stanno conoscendo in questi anni un forte aumento delle cubature edificate (e di conseguenza del traffico, dell'insicurezza stradale, del rischio di allagamenti, dei condizionatori d'aria accesi, delle temperature, dell'inquinamento e della relativa possibilità di ammalarsi, del costo della vita, etc.), anche grazie alle recenti modifiche alle Norme Tecniche di Attuazione del Piano Regolatore del 2003 – una sua rivisitazione sottotraccia, dunque senza tutti gli *iter*, senza una discussione politica aperta, prevista invece da una modifica al Piano, e senza una armonizzazione col Piano stesso: gli *standard* urbanistici prevedono per ogni metro quadrato costruito una certa superficie di servizi, compresi gli spazi non costruiti, "verdi"; costruendo, ovviamente, questi spazi non fanno che diminuire (e a poco servono delle aree "verdi" o "vuote" lontane), mentre strutture e infrastrutture cruciali restano le stesse e diventano quindi inadeguate. Non fare un ragionamento sugli impat-

ti urbani di certe scelte va a scapito del sistema-città tutto, investitori immobiliari compresi.

### **Partecipazione, ordine del discorso e pubblico interesse**

*Io vorrei rispondere ad alcune domande però faccio una premessa rispetto a quello che abbiamo detto all'inizio, cioè questo è un immobile su cui l'amministrazione non può metterci dei soldi sopra, ma è un immobile su cui AMA s.p.a. deve patronalizzarlo, ok!?! perché questo.. perché questa.. è una scelta, cioè... [- Politica?!], (voce fuori campo)] ...una scelta politica! ...che rivendico! Assolutamente sì, ... assolutamente sì (un assessore all'urbanistica in altre occasioni taciturno, 2025)<sup>35</sup>*

*Ma n[on] è un interrogatorio, la partecipazione! (un "custode e portavoce di un testimone di libertà e di resistenza", di fronte a una platea del quartiere romano della Montagnola che non trovava risposta alle proprie domande, in carenza di informazioni e consapevolezza riguardo nuove edificazioni previste in un ex deposito della municipalizzata che si occupa di rifiuti solidi urbani e nettezza urbana, 2025)<sup>36</sup>*

Tornando all'incontro sugli Ex Mercati Generali, questo era stato pubblicizzato come un'assemblea pubblica, ma già la prossemica non aiuta: chi parla e controlla i tempi e gli interventi da

un lato, il pubblico dall'altro; non basta il pubblico per fare un'assemblea. Ma non finisce qui. La maggior parte delle centinaia di persone coinvolte è stata costretta a seguire il tutto con la leggera differita di qualche diretta *streaming* ar-rabattata nel corridoio o per strada; la sala scelta all'interno del centro anziani "Ostiense ex Mercati Generali" di via Negri era infatti così piccola (35 sedie) che il più delle partecipanti non ha potuto veramente partecipare all'incontro, ostinatamente ripetuto come *partecipativo*. Dall'inizio alla fine – oltre a decidere chi, se, quando e per quanto tempo poteva parlare – il pulpito ha dettato l'**ordine del discorso** (Foucault, 1971), ha cioè reiterato visioni dominanti e forme di controllo e di selezione di ciò di cui discutere, peraltro in modo ben meno nascosto di quanto descritto nei saggi del filosofo francofono. Di nuovo, se in ambito scientifico è ormai consolidata la consapevolezza del fatto che la resilienza<sup>37</sup> (la capacità di adattarsi in modo positivo a un contesto mutato) beneficia dalla diversità, restringere il campo del discorso non pare parte di alcuna soluzione di pubblico interesse. Nell'incontro in questione, l'ordine del discorso è stato dettato con questioni tecniche (dal dire di avere intenzione di recepire qualche piccola modifica al progetto già deliberato allo sciorinare frasi ipnotiche da Azzecagarbugli dell'urbanistica); lo ha fatto con questioni storiche (richiamando concessioni date oltre vent'anni fa, colpe di giunte precedenti, anche se dello stesso colore politico e anche se l'interesse pubblico è stato de-

liberato quest'anno). In un simile dirottamento dell'attenzione, però, per quasi l'intero incontro *con pubblico* si sono evitate le questioni fondamentali. Foucault analizzava l'ordine del discorso per *liberarsi* dalle sue forme di potere, non per replicarle. Se ci liberiamo da simili distrazioni – e la libertà passa anche dalla consapevolezza, che spesso manca per decapacitazione culturale, disinteresse sociale<sup>38</sup> e insufficiente informazione pubblica sui rischi e sulle poste in gioco – la questione non è tanto quella di **indorare la pillola** contrattando un certo numero di metri quadrati di servizi pubblici – questi, peraltro, non per forza sessantennali – e nemmeno con la messa in scena di assemblee che non sono assemblee ma momenti diversi, convocati a giochi fatti e non per capire come vede la città il bene collettivo: secondo la scala di Arnstein (1969), che misura i vari livelli con cui è presentata la partecipazione, solo i pioli più alti capacitano la cittadinanza; gli altri placano gli animi, informano circa decisioni già prese, rabboniscono o manipolano, ricercando quindi approvazione, al limite in cambio di piccole concessioni come in questo caso un'area per i cani. In questo modo ci si distoglie però dal problema principale, la madre di tutti gli altri: come si sta usando la delega a perseguire il pubblico interesse. Ecco, è la concezione del pubblico interesse il problema non affrontato – anzi, come spiegato poco fa, del **bene collettivo**. A destra o a sinistra, per chi governa non sembra essere facile liberarsi dal pensiero unico per cui se si favorisce l'interesse privato poi ne beneficia la

società tutta e, al limite, si ottiene qualche piccola concessione ritenuta o venduta come pubblica; si chiama “effetto *trickle down*” o, meno elegantemente, la politica della **redistribuzione delle briciole**, a volte considerata un motore buono (ma ben sappiamo non privo di problematiche) per gli anni '50 e '60; a torto o a ragione è considerato tale per un'economia in forte accelerazione (il Brasile? l'India?); ingranare quella marcia qui e ora rischia di far male domani, a chi la città la vive, a chi la amministra e pure a chi ci vuole fare affari. Nei prossimi paragrafi provo a spiegare il perché. Come visto poco fa (quarta nota) per le espressioni “sviluppo *sostenibile*” e “*rigenerazione urbana*”, che contengono parole rassicuranti, ma fuorvianti, e quindi viziano la comprensione di ciò che viene fatto in realtà, neutralizzando in partenza le critiche, il problema sistemico di questo distogliere l'attenzione dalla questione del bene collettivo, “decorando” invece interessi particolari, alimenta l'illusione di modificare qualcosa e di “migliorarla”, ma serve solo a mandare avanti una macchina che sta andando a sbattere senza mettere in dubbio la direzione: nell'immagine della “leva” della Meadows (1999), non cambia il paradigma e quindi non si cambia granché, anzi si rafforza il problema, continuando come nulla fosse.

### **Collassi urbani deliberati**

In operazioni che causino una sostituzione su base censuaria di chi vive e frequenta un quartiere (un processo meglio noto come “gentrifica-

zione”) e che prevedano nuova cementificazione e ulteriore consumo di suolo – quando i rapporti dell’ISPRA in materia sono ogni anno più allarmanti e disperati (2023; 2025) – anche in presenza di vincoli idrogeologici e in un’epoca in cui il maltempo associato al *malterritorio* (v. Wu Ming, 2023) causa sempre più alluvioni, la tendenza della pratica edilizia e urbanistica, accompagnata da una generale deregolamentazione normativa, da delibere politiche e silenzi-assensi a ogni livello, sembra sempre più spesso **progettare deliberatamente un collasso urbano**, capace di rendere vano ogni studio tecnico e scientifico, come quelli offerti all’interno di questo numero speciale. E simili scelte non sono tecniche: sono scelte politiche. *Responsabilità* politiche. Nell’esempio degli Ex Mercati Generali, non è chiaro dove sia l’interesse pubblico se non ci sono assicurazioni che non si determini nei prossimi anni un **collasso sociale e commerciale**. Con l’aumento che ci si può attendere nei prezzi dei canoni di affitto di aree “riqualificate”, rischia di acuirsi l’emergenza abitativa già in atto, accentuando la già citata gentrificazione. Se il quartiere diventa destinato a gente facoltosa, come certi cosiddetti studenti (che magari vengono dall’estero per qualche mese di vacanza-studio; v. Teichler, 2015), se non proprio turisti (come abbiamo visto accadere in contesti analoghi venduti per studentati<sup>39</sup>), è difficile pensare che – oltre al costo della vita in generale – i negozi e i quartieri restino gli stessi: sempre a Roma, si guardi a Trastevere o al Pi-

gneto negli anni scorsi, si vedano le trasformazioni in corso a Sanlorenzo. Con la conversione di negozi per il quartiere in bar e ristoranti l’economia locale diventa più vulnerabile: in Cristiano e Gonella (2020), studiando Venezia durante la pandemia da covid-19, abbiamo mostrato che i rischi di una monocultura economica di quel tipo sono per la città tutta, esercenti incluse, e che l’interesse pubblico e il bene collettivo passano per la gestione dei beni pubblici, in cui ricade la concessione in questione. Con qualche esempio più semplice, non appare fugato il rischio che in prospettiva chi vive all’Ostiense debba cambiare quartiere per trovare un parrucchiere dai prezzi accessibili – e già una più periferica Tormarancio<sup>40</sup>, con tutte le cementificazioni in corso, rischia di trasformarsi rapidamente anch’essa!) o che un’esercente non veda rinnovato il contratto di locazione del negozio (con l’aumento dei prezzi, per via di qualcuno disposto a pagare di più) o che la sua attività sia scalzata dalla concorrenza (in un nuovo polo commerciale, per un fattore di scala, le attività economiche rischiano di essere più efficienti e attrattive dei negozi di vicinato esistenti; sarebbero poi ulteriormente avvantaggiate dai parcheggi dedicati in un quartiere dove i maggiori flussi comporterebbero maggiore congestione delle strade e maggiore difficoltà a trovare un parcheggio, in assenza di una strategia per delle forme di mobilità dolce *anche* a favore del commercio). In occasione del giubileo del 2025, l’aumento dei canoni di affitto, le locazioni abitative non rinnovate per favorire la ri-



cettività turistica o anche solo la maggiore fila al bar probabilmente non sono passate inosservate in zona. E la situazione abitativa rischia solo di peggiorare; ci sono numerosi studi sugli impatti di progetti simili e la gentrificazione non è minore in caso di processi partecipativi (Bortolotti e Grassi, 2025). Per evitare simili problemi non saranno utili gli spazi messi oggi a disposizione di qualche associazione da un privato sulla già gentrificata via del Porto Fluviale o in un ipotetico domani agli Ex Mercati Generali!

È difficile non pensare a un **collasso della mobilità**: si parla di nuovi parcheggi nell'area in questione, ma non del fatto che queste cubature rischiano di acuire i problemi di strade già selvagge e sempre più violente e pericolose, non solo per cicliste e pedoni, e di creare sempre più congestione ("traffico"). Una rapida stima della capacità stradale (TRB, 2010) suggerisce che la via Ostiense è in grado di lasciar defluire un ordine di grandezza di 4000 automobili l'ora nei due sensi di marcia; la circonvallazione Ostiense, con le soste quasi costanti in doppia fila, la metà; con i 2600 nuovi posti auto e a tutti i nuovi veicoli a motore direttamente collegati al mega-progetto degli Ex Mercati Generali (quelli a servizio dei 52.000 m<sup>2</sup> di *student hotel* e quelli

attratti da tutti gli uffici, le palestre, i ristoranti, etc. previsti negli altri 33.000 m<sup>2</sup>), non è difficile immaginare una saturazione delle arterie stradali, con tempi di percorrenza più lunghi, senza contare le centinaia di nuove abitanti in arrivo nel '26 giusto al di là della ferrovia<sup>41</sup> (e tralasciando l'inquinamento e il surriscaldamento, trattati tra poco). Le forme di mobilità dolce sono plurali: tra queste, quelle ciclabili vanno distinte da quelle pedonali; unirle in spesso mal progettate piste "ciclo-pedonali" da una parte ostacola e rende rischiose entrambe le forme di spostamento, dall'altra rivela il predominio culturale dell'automobile e della religione della velocità (ravvisabile, ad esempio, anche nel nome del progetto ciclabile romano del "*grande raccordo anulare delle biciclette*"<sup>42</sup>). Le forme di mobilità per continuare a vivere nelle città mediterranee hanno bisogno di temperature adeguate, dunque anche di acqua e di ombra, di corridoi ecologici urbani.

Non sembra al momento essere stata fornita alcuna rassicurazione tecnico-scientifica circa il fatto che siano scongiurati dei **collassi geologici, idraulici e idrogeologici**. L'intera area della bassa valle dell'Almone, entro la quale ricade anche il sito degli Ex Mercati Generali, rappre-

## I diversi percorsi finali dell'Almone (fonte: Autorità di bacino del fiume Tevere, Piano di Stralcio Funzionale n. 5, op. cit. in Parco Regionale dell'Appia Antica, 2021)

Fig. 3a

senta una zona ad alta pericolosità «connessa a processi di subsidenza» (Amanti *et al.*, 2013, elaborando Campolunghi *et al.*, 2008), con spostamenti verticali dovuti «alla presenza di sedimenti sotto-consolidati e con scarse caratteristiche geotecniche» (Amanti *et al.*, 2013). La «mancanza di un adeguato approfondimento della “storia geologica” [...] nelle fasi esecutive di un piano di sviluppo urbanistico» rischia di determinare degli sprofondamenti, come d'altronde ha già fatto anche in zona (*ibid.*). Contrariamente a quanto dichiarato dall'assessora ai lavori pubblici e alle infrastrutture in occasione dell'incontro con la cittadinanza, il sito è direttamente interessato dal fiume Almone: sono qui offerte nuove evidenze. Secondo l'unica opera in italiano reperita, il fiume sembra essere stato tombinato nel 1937 sotto la circonvallazione Ostiense (Parco Regionale dell'Appia Antica, 2021), come evidenziato in verde nella **Fig. 3/a**. Nei decenni, però, l'afflusso di acque miste fluviali e fognarie avrebbe messo in difficoltà il depuratore della Magliana, dove confluiva il collettore in cui erano state convogliate anche le acque dell'Almone, dando così il via a un progetto per dedicare il condotto sotto la Circonvallazione Ostiense «esclusivamente al trasporto delle acque nere, mentre le acque del fiume, dopo una complessa opera di risanamento lungo tutto il suo percorso, sarebbero state sollevate con un sistema di pompe e immesse in una nuova condotta parallela, da collocare a una quota superiore», lavori che però si sarebbero interrotti,

«sia per l'abbandono dell'impresa appaltatrice (fallita subito dopo l'assegnazione), sia per sovrappiù difficoltà attinenti autorizzazioni da parte del Parco dell'Appia Antica» – questo è ciò che riferisce un articolo pubblicato a inizio anni 2000 sul periodico locale *Cara Garbatella*<sup>43</sup>, con informazioni attribuite all'azienda che gestisce le infrastrutture idrauliche romane [purtroppo, non sembrano reperibili fonti dirette, ma l'esperienza della *public history* (solitamente tradotta come “storia orale”) mostra come la memoria dei luoghi possa rivelarsi utile in questioni come quella della protezione in materia ambientale (v. Hayden, 1997)]. L'acqua riaffiorata all'interno del sito degli Ex Mercati Generali è stata attribuita alla falda del fiume Almone (Giovannini, 2025); non è chiaro se ciò possa essere dovuto a eventuali perdite di uno o più condotti in cui il corpo idrico sarebbe stato costretto, allo scorrimento di acque sotterranee libere legate ai lavori idraulici interrotti oppure a delle risorgive. La ricostruzione storico-idrografica di Rinne (2021), in lingua inglese, colloca in zona una serie di sorgenti e, proprio nei pressi di quelle che diventeranno i mercati generali (**Fig. 3/b**), di un antico *balneum* (terme private); Rinne localizza anche un ponte sull'Almone usato fino all'epoca alto-medievale, facendo attraversare al fiume l'intera area in questione, come mostrato in rosso nella stessa figura. Per quanto spostati verso nord il percorso suggerito dall'Autorità di bacino del Tevere, questo sembrerebbe coerente con la posizione del ponte e della foce dell'Almone nel Tevere e con la



presenza di un pozzetto d'ispezione (**Fig. 3/c**) di fronte al padiglione centrale degli Ex Mercati Generali, nel quale si può sentire scorrere abbondante un presumibile corso d'acqua tombinato. Queste informazioni aggiungono testimonianze idriche oltre a quanto già suggerito, aggiungendo nuovi elementi di dubbio (e dunque di necessaria precauzione) ma non fornendo un quadro completo dei percorsi delle acque sotterranee nell'area. D'altronde, all'Ostiense come altrove, è difficile immaginare di riuscire a comprendere e governare completamente i deflussi idrici (tanto più in presenza di uno dei principali fiumi della penisola, il Tevere, tanto più in pre-

senza di azioni correttive abbandonate in seguito a degli errori tecnici, tanto più se davvero si scavassero grosse buche per le fondazioni di nuovi edifici nello storico alveo finale di un fiume, dove c'è tutt'ora acqua sia nel sottosuolo che in superficie – persino nelle poche aree ancora pavimentate, sebbene anch'esse in corso di rinaturalizzazione: **Fig. 3/d** – e tanto più se vi si prevedesse di costruire dei livelli interrati). La presenza di aree non cementificate appare oggi salvifica: l'acqua presente nel suolo può “respirare”, mentre quella che piove si infila e non allaga il circondario<sup>44</sup>. Anche certi ingegneri hanno iniziato a mettere in discussione l'approccio tec-

## L'asse del percorso del fiume Almona (in rosso) e la storia idrica del sito (in giallo) secondo Rinne (2021); rielaborazione originale.

Fonte: Google Maps; Airbus, Maxar Technologies, Vexcel Imaging US, inc. Dati cartografici 2026

Fig. 3b

## Pozzetto d'ispezione alle acque di un corso d'acqua tombinato in prossimità dell'ex Mercato Ittico, padiglione al centro dell'area degli Ex Mercati Generali

Fig. 3c

## Ristagni idrici e vegetazione nella porzione ancora pavimentata degli Ex Mercati Generali

Fig. 3d

nocentrico ai fiumi, trattati come oggetti in un «ultimo sussulto di un paradigma morente»<sup>45</sup>, anziché come interlocutori, come ad esempio nelle esperienze dei contratti di fiume (v. Caruso *et al.*, 2020). Nel caso affrontato siamo in prossimità di un'area che, nonostante la rinnovata permeabilità dopo la dismissione dei Mercati, già quasi vent'anni fa risultava attenzionata all'interno della *Carta della pericolosità e della vulnerabilità geologica del territorio comunale*: una «zona a rischio idraulico R2 per la quale è necessaria la gestione attraverso i piani di protezione civile» (Comune di Roma, 2008); al 2008, nel raggio di un chilometro, erano censite 13 aree «interessate da allagamenti e dissesti [...] per deflusso non regimentato di acque meteoriche connesse con eventi pluviometrici critici». Con il progressivo inasprimento degli eventi meteorici estremi e il maggiore consumo di suolo autorizzato nel tempo nel quadrante e a monte dei fiumi Almona e Tevere, la pericolosità (ossia la probabilità di accadimento di un fenomeno, in questo caso alluvionale) che ci si possa aspettare oggi e nel futuro è verosimilmente maggiore; all'aumentare della sigillazione del suolo, a cui contribuisce anche il progetto in questione, au-

menta anche la vulnerabilità della zona; aumentando nel tempo anche il numero di persone e di beni (fabbricati, infrastrutture, etc.), aumenta anche l'esposizione – sono dunque già prevedibili come crescenti tutti e tre i fattori che costituiscono il rischio<sup>46</sup>. Più cemento, più rischio. Già gli strumenti a disposizione – come le carte del rischio idraulico e idrogeologico o l'invarianza idraulica, con i suoi tempi di ritorno basati su serie storiche diverse dagli eventi sempre più aspri attesi in futuro – risultano dunque non più adeguati: è ovvio che le alluvioni che si susseguono in Europa sempre più rapidamente non colpiscono solo zone a rischio idraulico massimo, R3! Al momento, come visto in precedenza, sembra in atto una sempre più marcata deregolamentazione delle costruzioni anche in aree a rischio idrogeologico; se si ha a cuore la sicurezza dei territori, quei pochi strumenti che gli enti locali hanno ancora a disposizione andrebbero dunque usati nell'ambito di una strategia preventiva ispirata a un principio di precauzione volto al bene collettivo. Mentre una città costruita sull'acqua, come Venezia, riesce a non far sgorgare acqua dai gabinetti dei piani terreni grazie alla tecnica – finché dura – in casi come quello



che si è qui preso ad esempio sono paradossalmente delle scelte *politiche* a rischiare di trasformare i territori oggetto di certe trasformazioni nella prossima Toscana e nella prossima Emilia Romagna: serve per caso ricordare che impermeabilizzando il territorio, le piogge intense sempre più frequenti non riescono a essere assorbite e creano fiumi di morte e distruzione?! Non pare bastare l'esempio iberico, che l'anno scorso ha mietuto centinaia di vittime, con le potenti immagini di ammassi di macchine spazzate dal fango a Valencia (**Fig. 4**) durante un fenomeno di maltempo sempre meno eccezionale. [Mentre questo articolo viene impaginato, proprio a Roma è esondato l'altro affluente principale del Tevere: l'Aniene, con «gravi allagamenti»<sup>47</sup> e oltre mille interventi dei vigili del fuoco<sup>48</sup>]. Sfortunatamente, il *malterritorio*, la mala-urbanistica à la *Ischia*, non sortisce i suoi effetti solo con le piogge.

Non sembrano scongiurati dei **collapsi climatico-ecologici, energetici e sanitari**: maggiore traffico e maggiori cubature portano anche maggiori emissioni veicolari e per riscaldare e raffrescare le stanze (e non stupisce se una studente che paga milletrecento euro al mese per una stanza o un turista che si ferma per qualche giorno vuole in estate le temperature da cui rifugge d'inverno, o viceversa!); maggiori emissioni portano maggiore inquinamento, minore biodiversità, maggiore surriscaldamento climatico (a seconda che si usino dei termini scientifici o giornalistici, con le sue *isole* o le sue *ondate* di calore) – una “emergenza caldo” in realtà prevedibile e quindi *prevenibile*: non paiono affrontati gli impatti a tutto questo correlati, anche mortali, che ci si può attendere sulle persone anziane, sulle persone malate anche da giovani, sugli animali domestici, sugli animali selvatici che compongono quella poca biodiversità ecologica

## Danni a Paiporta (Comunitat Valenciana, Spagna), ottobre 2024

Fig. 4

che rimane e che sola ci può far sopravvivere in climi sempre più ostili. Non sembra affrontato il problema energetico già manifesto d'estate con i frequenti *blackout* legati ai picchi di domanda per raffrescare gli edifici. Al contrario, dalle rive del fiume Tevere<sup>49</sup> alla Tenuta di Tormarancia<sup>50</sup>, i sempre meno numerosi sistemi ecologici ancora in salute vengono erosi, disboscati e pavimentati per farne delle attrezzature urbane laddove il primo bisogno dei quartieri è la loro messa in sicurezza da tutti i rischi fin qui elencati, cui simili interventi non giovano affatto; lo stesso vale per gli ecosistemi presenti nell'area degli Ex Mercati Generali: in estate le aree vegetate (non "tinte di verde" con aiuole o alberelli) contribuiscono a ridurre le temperature fino a 6 °C (Comune di Zurigo, 2023); le aree umide, come quella che si è sviluppata all'Ostiense, sono infine tra i più importanti ecosistemi per il sequestro dell'anidride carbonica (Were *et al.*, 2019) – altro che le vernici industriali che, anche in zona, pretenderebbero di "mangiare lo smog"<sup>51,52,53</sup>!

Se non si intravedono, non si comprendono e non si prevengono questi e altri tipi di rischi urbani, mentre si perde la diversità culturale, quando i disastri poi si manifestano è difficile pensare di avere le capacità per comprenderli e affrontarli. Nelle emergenze – già dall'antica Grecia dei tiranni – si acuisce l'autoritarismo (e con esso, in un circolo vizioso, diminuisce la diversità e si acuisce la vulnerabilità). In un'epoca di pericoli vecchi e nuovi e fragilità multiple, si sta prevenendo o si sta *predisponendo* un **collasso anche politico**?

### Dall'acquiescenza nei collassi urbani alla prevenzione territoriale multi-rischio: pianificare oggi la sicurezza di domani

*Quando l'ultimo albero sarà abbattuto,  
l'ultimo pesce mangiato,  
e l'ultimo fiume avvelenato, vi renderete  
conto che non si può mangiare il denaro*  
(Toro Seduto, 1876)

*Questa è la storia di un uomo che cade da un  
palazzo di cinquanta piani.  
Mano a mano che cadendo passa da un piano  
all'altro, il tizio per farsi coraggio si ripete  
«Fino a qui, tutto bene. Fino a qui, tutto bene.  
Fino a qui, tutto bene».  
Il problema non è la caduta,  
ma l'atterraggio.  
(Vince, ne *L'Odio*, Kassoviz, 1995)*

L'abbandono, il ritardo nello slancio suicida di un modello di città che sembra ricalcare il noto "modello Milano", può offrire invece qui e ora un'opportunità. Tutto pulsa (Odum *et al.*, 1995): come il sole che è alla base di tutto quello che abbiamo intorno, tutto ha alti e bassi. Le città stanno pulsando pericolosamente verso il muro economico, climatico-ecologico e sociale. Per un governo del territorio resiliente non solo a parole serve quindi lasciare delle zone-cuscinetto (*buffer*, v. Cristiano, 2024), dei margini di sicurezza che consentano di rimbalzare, e di rimbalzare bene – come per la teoria di Darwin, che consen-

tano di **sopravvivere adattandosi a ciò che serve oggi e domani**, capendo cosa persegua davvero **l'interesse pubblico e il bene collettivo necessari oggi, necessariamente diversi da quelli di un quarto di secolo fa**. Si è già spiegato che non esiste alcun sistema economico al di fuori dei sistemi sociali e che non esistono sistemi sociali al di fuori dei sistemi ecologici. All'Ostiense come negli altri casi presentati in alcuni degli articoli che seguono, il margine di sicurezza consiste ad esempio negli ecosistemi palustri e arborei e nella cassa di espansione naturale che si sono create spontaneamente nel sito abbandonato (la natura tutto cura; si è allenata grazie a prove ed errori millenari; parafrasando Commoner, 1972, ne sa molto di più di noi); questo può evitare o lenire, tra i vari, dei danni alluvionali. Si era in ritardo nell'errore di cementificare e privatizzare – come se fossimo ancora nei decenni del *boom* economico! – un'area ereditata dal passato, vista come un vuoto da un punto di vista dell'estrazione del valore oggi dominante ma alla base delle crisi: quello del denaro che non si mangia; si può correre nella direzione della macchina che sta per andare a sbattere, come si sta facendo, oppure si può sfruttare il vantaggio e riconoscere l'esistenza di valori *altri* (v. Cristiano, 2023) e assecondare il più antico, il più longevo, il più importante: quello della vita. Un ecosistema come quello sviluppatosi negli Ex Mercati Generali ci può suggerire, se siamo lungimiranti, che certe zone non sono “buche”, ma piuttosto margini di sicurezza, cuscinetti per affronta-

re i molteplici bisogni socio-ecologici (quindi anche economici) presenti e futuri, e questa è una necessità sempre più urgente.

Viviamo in un'epoca in cui **i bisogni sociali cambiano all'istante**. Sembra alquanto anacronistico pensare oggi di congelare un'idea di interesse pubblico per sessant'anni, come prevedono le concessioni fatte all'Ostiense. Cambia ferocemente il clima, cambia la geopolitica, etc.; le mobilitazioni per la Palestina – buoni o cattivi – hanno portato rapidi cambiamenti. Dopo un quarto di secolo, cambierà pure la concezione di bene collettivo, di pubblica utilità, che oggi e domani non sembrano più poter essere le briciole dei grossi capitali, stranieri o meno, ma il porsi all'avanguardia di una città che guarda al futuro attivamente, che si fa capofila della resilienza forte, climatica e non solo: una capacità territoriale di resistere ai nuovi rischi *più forte* dei lavori di ingegneria del PNRR. Il ritardo nel fare errori in quell'area “vuota” può portare a immaginare una città che già guarda avanti e ci protegge davvero con quelle premure sociali ed ecologiche che varie amministrazioni già discutono nei vari “*hub* culturali”, senza apparenti conseguenze – anzi spesso facendo poi l'opposto – nelle politiche per la città. Nel recente Piano per il Clima di Roma, pur se solo in una manciata di occorrenze su quasi 200 pagine, è ricordato che il consumo di suolo ha effetti diretti sia sulle isole di calore che sulle alluvioni; mentre anche nel nome di progetti PNRR si continuano a tagliare albe-

ri<sup>54</sup> (Loy, 2025), cruciali per continuare a vivere in città a queste latitudini<sup>55</sup>, il caso degli Ex Mercati Generali può dire qualcosa, può rendere quel municipio capofila del piano climatico romano e Roma capofila di una nuova idea di città mediterranea a prova di questo ventunesimo secolo. Una parte del lavoro l'ha già fatta gratuitamente la "natura"; di fronte a simili questioni è difficile pensare di potersi nascondere dietro al dito di un problema legale o economico; il PNRR ha mostrato che di fronte a un'emergenza si può fare una scelta eccezionale per quello che viene ritenuto un bene collettivo: qui anche delle ricerche finanziate in quell'ambito ammoniscono in tal senso.

Ripensare i bisogni può significare creare i primi "quartieri spugna" (v. Haase, 2025) o i primi **ri-fugi climatici** (Pede, 2024) d'Italia, anzi lasciarli diventare foresta urbana là dove c'è ancora chi vorrebbe lasciar imporre cemento che sigilla il suolo, che si arroventa, che fa installare motori per l'aria condizionata di gente abituata magari a stare a trenta gradi d'inverno e a diciotto d'estate. Ripensare i bisogni significa non seguire nello schianto un paradigma, un modello di sviluppo datato, in prospettiva sempre già dannoso per chiunque. Per *chiunque*. Come cercare invece un atterraggio morbido (Odum e Odum, 2006)? Come evitare di lasciarci trascinare da questo fango culturale? Se si sbaglia, si può ammettere, ci si può perdonare, le responsabilità sono spesso condivise, anche nella de-

lega col voto, per chi ancora la dà. Se ci si rende conto che il bene pubblico non passa più per operazioni finanziarie, ma - in un'ottica di sistema-città - anche gli investimenti privati sono anzi in prospettiva protetti da scelte più assennate e al passo coi tempi, oggi la **pubblica utilità** rischia di essere quella di poter innanzitutto **continuare a vivere** in una città - pure a continuare a fare soldi, perché nessun imprenditore può guadagnare da una città morta, nessuna economia prospera con le zone arancioni o rosse alluvionali, le ordinanze che bloccano le normali attività, con le distruzioni, con lo *smog* irrespirabile e col sovraffollamento durante una pandemia; perché i soldi non si mangiano (da un punto di vista geobiofisico - quello alla base del macrosistema di cui le società e le economie fanno tutte parte - nemmeno esistono).

Ci si può chiedere se, a Roma Sud e altrove, sia impossibile pensare che il costo-opportunità di rivedere (e valutare stavolta in modo accurato e trasparente) l'interesse pubblico passi anche dalle conoscenze create e da tutto quel denaro pubblico già speso per le ricerche del progetto in cui si inserisce questo numero speciale<sup>56</sup>, di quello sulla biodiversità per il futuro<sup>57</sup> o quant'altro. Ci si può chiedere se possa passare da una stima dei danni attesi da certi progetti e da una generale rinuncia a fare urbanistica oggi. Ci si può chiedere se sia impensabile un piano di investimenti straordinari per ripagare le eventuali penali di ritiro delle concessioni - se mai

dovute, sia in termini contrattuali<sup>58</sup>, sia in termini politico-amministrativi: **se il Piano di Roma per il Clima persegue il pubblico interesse, e se il piano per il clima riconosce, come ricordato, che il consumo di suolo ha effetti su alluvioni e isole di calore, allora non pare poterci essere pubblico interesse laddove ci sia del consumo di suolo.** Ci si può chiedere, a prescindere, se sia impensabile un'idea di città – *urbs, civitas et polis* – pronta a resistere e a reagire bene alla prossima alluvione, alla prossima pandemia, alla prossima guerra<sup>59</sup>, alla prossima ondata di calore, al prossimo lungo *inferno* che rischia di durare presto da marzo a settembre, etc. La “natura”, si diceva, ha già fatto un po’ di lavoro e mostrato la strada; con fondi nazionali e internazionali, migliaia di ricercatrici e ricercatori hanno lavorato su questi temi e hanno pubblicato e pubblicheranno articoli, libri, numeri speciali di riviste scientifiche; se davvero partecipata (ai pioli più alti della scala di Arnstein, 1969), la co-progettazione di un'idea altra di città può essere davvero a costo zero e magari più diversificata e quindi più capace di resistere e di ben adattarsi ai cambiamenti vari, a quelli che oggi possiamo già prevedere e a quelli che la complessità degli ecosistemi da cui troppo a lungo ci si è creduti estranei, con i suoi effetti a catena, ci impedisce di intravedere (v. Lenton *et al.*, 2019). Di fronte a tante crisi, non possiamo permetterci anche quella dell'urbanistica, un'urbanistica che «non può essere pratica acquiescente», ma deve «rimanere continuo esercizio di radicale critica so-

ciale» (Secchi, 2005). Il problema non è finanziario, non è tecnico, non è nemmeno soltanto scientifico. Si tratta di una scelta politica: coprirsi gli occhi e concepire il “pubblico interesse” come un *pro forma* da ratificare, nel nome di un'unica ragione economica (che, in prospettiva, come visto, si promette peraltro anti-economica), rendendosi quindi condiscendenti nei confronti di collassi già prevedibili ora, o interrogarsi sul bene collettivo nei prossimi decenni, continuamente mutevoli, e pianificare subito la sicurezza urbana e territoriale?

### **Contributi scientifici per mitigare e prevenire le prossime catastrofi<sup>60</sup>**

La crisi dell'urbanistica nell'affrontare la mitigazione e l'adattamento alla crisi climatica e la riduzione dei rischi di catastrofi emerge già nel primo contributo della sezione dedicata ai Saggi (**Trabucco e Cristiano**): sono poche le pubblicazioni in cui questi temi sono trattati organicamente negli ambiti della pianificazione, della progettazione e del governo della città e del territorio; quando ciò avviene, il discorso è viziato da uno stampo tecnico, difficilmente capace di comprendere e navigare la complessità del *continuum* ecologico, sociale, economico. Il “fare come nulla fosse” davanti alle varie crisi può essere interrotto tramite una serie di scelte consapevoli o può ineluttabilmente accadere lo stesso, come notavano i già citati Brown e Ulgiati (2011). Il *business as usual* può essere interrotto da fenomeni di rottura: durante dei lavori di scavo

funzionali a operazioni immobiliari simili a quella introdotta nelle pagine scorse, le ruspe bucano la falda freatica: a Bruxelles e a Roma Est nascono così, spontanei e non progettati, due nuovi laghi urbani, due oasi di biodiversità. Questi due casi sono presentati e discussi da **Ranzato** in un più ampio contributo scientifico agli studi sulla resilienza evolutiva dei sistemi urbani, sulla scia di Davoudi *et al.* (2013), che mette insieme l'analisi della complessità delle infrastrutture urbane contemporanee, il controllo sociale degli ecosistemi grazie alla tecnologia e i possibili apprendimenti sociali in seguito a fenomeni imprevisi. Con Debord (1967), «il vero è un momento del falso». La sospensione della “normalità” può mostrare la strada per uscire dal pantano<sup>61</sup>. I vari rischi che incombono sulle città e sui territori nei prossimi decenni richiedono forme forti di resilienza, dunque anche diversificazione nella loro comprensione e nelle risposte da studiare e mettere in pratica. In questo senso, **Daniel** affronta un approccio complesso e sotto-esplorato come quello della promozione della resilienza di comunità; lo fa valutando il ruolo che può giocare in questo la scienza partecipata (*citizen science*), ossia – in una collaborazione tra università, comunità e amministrazioni locali – il coinvolgimento attivo della cittadinanza, che diventa scienziata non professionista e contribuisce a generare nuovi saperi utili a un'efficace protezione dai rischi, compresa l'identificazione di rischi prima non affrontati. In un quadro di crisi ecologiche e una serie di vulnerabilità in-

terdipendenti, **Ridolfi et al.** presentano un approccio innovativo per una pianificazione urbana e territoriale capace di collocarsi in un'ottica di prevenzione di fronte ai molteplici rischi (*multi-risk transition*). Il contributo propone un metodo innovativo che mette insieme la valutazione multi-rischio e la coerenza delle politiche (*governance coherence*), così da consentire a chi si occupa di pianificazione di interpretare le vulnerabilità del sistema territoriale in cui operano e di allineare le strategie di adattamento ai vari livelli. Il metodo è applicato alla Riserva di Biosfera del Delta del Po, parte del programma MaB<sup>62</sup> dell'UNESCO. I bisogni, i saperi e le percezioni delle comunità locali – alla base del contributo di Daniel sulla resilienza di comunità tramite la scienza partecipata – rappresentano un punto di partenza anche per il contributo di **De Martino et al.**, che prendono atto di come la pianificazione tradizionale, fondata su logiche terrestri e vincolata a rigidi confini amministrativi, mal si relaziona con la complessità dei rischi legati all'acqua; nel loro contributo è mostrato come, in un territorio come quello della penisola e delle isole italiane, l'interazione tra terra e mare si manifesta con una crescita insostenibile che porta a sovra-edificare le coste, impermeabilizzandole e interrompendo così i cicli naturali dell'acqua; sempre in relazione all'acqua sono affrontate le disuguaglianze sociali che emergono dall'accesso iniquo a spazi pubblici sicuri e resilienti lungo le aree interessate dai corpi idrici. Per convivere con l'acqua, De Martino *et al.* presentano

un formato di laboratori urbani come piattaforme per la resilienza, articolati in una fase di analisi dei vari rischi, in una mappatura partecipata e percettiva e in una di costruzione di scenari. La co-creazione insieme alle comunità locali (*living lab*) è parte anche del contributo di **Amenta et al.**, che studia possibili forme di resilienza per i paesaggi dei rifiuti (*wastescape*) quali ex aree industriali, aree portuali dismesse e siti contaminati, proponendo per i rischi associati agli scarti metabolici territoriali un quadro interpretativo e un supporto alle decisioni in materia di strategie (qui, sì) di rigenerazione di siti dismessi. Le catastrofi urbane, e in particolare quelle dovute agli sconvolgimenti climatici, sono alla base del contributo di **Clemente e Puzone**, che – guardando alla città e ai suoi rischi da una prospettiva di progettazione tecnologica e ambientale dell'architettura – propongono un quadro concettuale e operativo che tiene insieme la valutazione delle strategie e delle soluzioni di risposta climatica nelle quattro fasi previste dal protocollo per la riduzione dei rischi di catastrofe: preparazione, evento, risposta/ripresa, adattamento di lungo periodo. Ecco, in questo contributo diventa protagonista proprio la dimensione temporale, mentre si sottolinea il bisogno di approcci progettuali dinamici, multi-scalari e sistemici per far sì che gli insediamenti urbani riescano a prevenire, sopportare e riprendersi dagli impatti climatici. A cavallo tra l'urbanistica, l'architettura del paesaggio, la composizione architettonica e la progettazione tecnologica e ambien-

tale dell'architettura, **Pisano** presenta i risultati di un sistema integrato di laboratori didattici portato avanti nell'a.a. 2024/25 all'interno della Scuola di Architettura di Firenze, nei canali in italiano e in inglese dei corsi di laurea magistrale in Architettura e in Pianificazione e Progettazione Urbana e Territoriale per la Sostenibilità, valutando le risposte dei gruppi di studenti, sollecitate – da un corpo docenti eterogeneo e allargato – a misurarsi con una progettazione multi-rischio intorno ai temi della sostenibilità, della crisi climatica, delle risorse energetiche e della risposta alle catastrofi.

I contributi successivi sono dedicati alle Ricerche – hanno cioè una postura più orientata all'applicazione in casi di studio, pur mantenendo apprendimenti teorici utili in altri contesti. **Piccirillo et al.** propongono una riflessione critica sul potenziale rigenerativo delle aree dismesse, grazie al rinselvaticamento spontaneo, guardando a esse come laboratori sperimentali capaci di aprire forme alternative e adattive di (vera) rigenerazione urbana. Ispirato ai concetti della palingenesi, delle ecologie spontanee e dei beni comuni, il loro contributo esamina come i casi di prolungato abbandono possono causare inaspettate rinascite ecologiche e attivazioni civiche. Offrono un'analisi comparata di tre casi emblematici: Canvey Wick, nel Regno Unito, La Goccia, a Milano e il lago Bullicante, a Roma. **Bruno et al.** trattano la partecipazione delle comunità locali e l'analisi territoriale per affronta-

re la crisi climatica, partendo da un'applicazione nel centro storico di Genova. L'obiettivo della loro ricerca è quello di testare e rendere replicabile un approccio innovativo, anche attraverso l'identificazione e la messa a sistema di informazioni già reperibili in basi di dati ufficiali esistenti. In **Del Duca et al.** è affrontato il rischio legato alle isole di calore nella Piana fiorentina; nella parte analitica è proposta una variante alla formulazione del rischio urbano, per dare priorità all'intervento in risposta alla maggiore vulnerabilità di alcune fasce di popolazione; nella parte progettuale, invece, è illustrata una serie di proposte per la mitigazione dei rischi associati, legando quindi urbanistica, clima e salute. **Isola et al.** affrontano le infrastrutture verdi urbane nella città di Cagliari: la ricerca pone un accento sulle aree naturali e semi-naturali, gli spazi aperti e i corpi idrici, trattando il tutto nell'ottica dei servizi ecosistemici, ossia dei benefici che le città traggono da una simile qualità urbana, al fine di soddisfare i vari bisogni della popolazione, di perseguire il benessere urbano, di preservare la biodiversità e di fornire risposte a questioni come la prevenzione delle alluvioni, la regolazione del clima, la cattura di anidride carbonica e la qualità degli habitat. Partendo dalla constatazione che il perseguimento pratico della sostenibilità e della resilienza territoriale è inscatolato in diversi programmi e in diverse strategie settoriali, per fare un passo oltre **Brunetta et al.** introducono una cornice operativa per tradurre le teorie sulla resilienza urbana in azioni adatte ai

singoli contesti. La chiamano Unità di Resilienza Locale. Ricorrendo a una piattaforma libera di informazione territoriale (qgis) e alla compilazione di un inventario di punti di interesse alla scala del quartiere, ogni unità mette insieme l'analisi territoriale e la co-progettazione con le comunità con lo scopo di rafforzare la capacità delle città e dei municipi di far fronte agli *shock* e allo stesso tempo preservare il proprio benessere e la propria qualità della vita. L'adattamento della resilienza urbana ai singoli contesti è anche alla base del lavoro di **Cazzola et al.**, che propongono e testano, a Torino, un approccio quali-quantitativo in grado di combinare l'analisi territoriale con alcuni indicatori sensibili alla realtà in cui intervenire. Mappando gli elementi di risposta legati alle vulnerabilità naturali insieme alle dinamiche socio-istituzionali, il loro metodo consente un'integrazione tra vari settori che mostrano come cruciali per implementare strategie efficaci di pianificazione territoriale resiliente. **Guida e Bocchino** pongono l'attenzione sul fatto che i rischi territoriali non sono sempre evidenti, ma anche latenti, e ciò richiede una radicale trasformazione e un significativo adattamento nel modo in cui si pianifica. Impiegando il concetto di malleabilità territoriale, affrontano la complessità della Terra dei Fuochi e restituiscono qui gli esiti di un laboratorio progettuale portato avanti presso l'Università della Campania "Luigi Vanvitelli". **Vingelli et al.** esplorano le dimensioni delle perdite e dei danni immateriali che colpiscono quei contesti urbani esposti

a molteplici fattori di rischio in fase di bonifica e recupero. Impiegano le lenti dell'ecologia politica urbana, conducono una rassegna sistematica della letteratura scientifica sulle perdite e i danni non monetari e applicano il tutto nel sito di interesse nazionale di Bagnoli-Coroglio, a Napoli, al fine di ampliare la concezione istituzionale delle perdite e dei danni e di ampliare il ventaglio dei rischi urbani contemplati dai metodi oltre ai soli rischi climatici. La crisi climatica è invece oggetto dello studio di **Di Palma et al.**, che – analizzando quattro casi: a Roma, a Bordeaux, a Charneca (Portogallo) e a Car de Salou (Spagna) – esplorano i significati umanistici, fisici e sociologici della resilienza, declinando la progettazione architettonica e urbana in quattro scale: quella del dispositivo temporaneo, quella del manufatto architettonico, quella del paesaggio urbano e quella del paesaggio a bassa densità insediativa. Il lavoro di **Panella** ci riporta a Roma, proprio all'Ostiense, trattando la territorializzazione dei discorsi più attuali sui consumi di energia, l'efficienza energetica e le isole di calore urbane, andando oltre il convenzionale tecno-funzionalismo e le mode dei *Positive Energy Districts*<sup>63</sup> e dei *Near Zero Energy Buildings*, facendo invece i conti con la realtà esistente, fatta di un patrimonio immobiliare datato, povertà energetica e disagio abitativo e sociale. Il caso dell'Ostiense è solo un punto di partenza che esplora, dalle singole abitazioni ai quartieri interi, le possibilità offerte dalla progettazione nell'adattarsi alle condizioni imposte dalla crisi climatica e nel

consentire un risparmio energetico – il che passa attraverso i parchi fluviali, i parchi esistenti e i lotti da lasciare non edificati. **Castigliano et al.** esplorano le interazioni tra i paesaggi culturali e i più ampi sistemi ecologici in cui questi si inseriscono, adottando la resilienza come un concetto in grado di unire la conservazione del patrimonio esistente e le trasformazioni urbane, scegliendo l'area dei Campi Flegrei, con la sua natura vulcanica, le sue rovine archeologiche e altri fattori che contribuiscono a un degrado e a un abbandono territoriale.

## Conclusioni e prospettive

*In politica abbiamo una fede così ferma in un avvenire manifestamente inconoscibile che siamo pronte a sacrificare milioni di vite a quel sogno da fumatore d'oppio che è l'Utopia o il dominio del mondo o la sicurezza perpetua.*

*Ma quando sono in ballo le risorse naturali, sacrifichiamo all'avidità di oggi un futuro prevedibile in modo alquanto accurato.*

*Sappiamo, ad esempio, che se abusiamo del suolo questo perderà la sua fertilità; che, se massacrano i boschi e le foreste, alle prossime generazioni mancherà il legname, i versanti delle montagne e delle colline si eroderanno e le valli saranno spazzate via dalle alluvioni. Ciononostante, continuiamo ad abusare del suolo e a massacrare i boschi e le foreste.*

*In una parola, immoliamo il presente all'av-*

*venire in quelle questioni umane complesse in cui ogni previsione è impossibile; ma nelle questioni relativamente semplici della natura, in cui conosciamo benissimo ciò che è probabile che accadrà, immoliamo l'avvenire al presente (Huxley, 1944)*<sup>64</sup>

Nella crisi dell'urbanistica in una realtà fatta di crisi multiple e interconnesse, appare assai frequente considerare *realista* l'accettazione dello *status quo* e, con esso, la ricerca di un ipotetico vantaggio per sé e per la propria parte di società, bollando invece come *utopica* ogni alternativa che si proietti dal continuare a perpetrare il problema verso una qualche soluzione – che si proietti, dunque, verso il futuro (o, meglio, da un presente presentato come eterno, ma sempre più fragile, verso un futuro da rendere meno fosco). Guardando la stessa realtà ma mettendo a fuoco sia lo sfondo adombrato dei prossimi decenni, sia questioni ben illuminate ma normalmente taciute già oggi, la prospettiva può cambiare. Lo *status quo* produce, come qui ricordato, una serie di disastri: è dunque utopico, piuttosto, credere che lo *status quo* possa durare *ad libitum*. Per le prevedibili conseguenze solo in parte già in atto, è anzi *distopica*, oltre che complice, la sua passiva accettazione, credendo o facendo credere di poterne redistribuire le briciole. Erodendo le basi della vita e minando con esse la sicurezza territoriale, l'incolumità di persone e beni – tutte pre-condizioni per qualsiasi beneficio sociale ed economico, pre-condizioni tanto

imprescindibili quanto rimosse dal discorso – è distopica e complice ogni trasformazione urbana e territoriale che non si misuri seriamente con i molteplici rischi di questo 21° secolo e che non dimostri accuratamente di scongiurare di contribuire ai vari (e spesso interrelati) collassi climatico, ecologico, energetico, sanitario, idrogeologico, sociale, economico, commerciale, alimentare, della mobilità – collassi, in una parola, *urbani* – collassi urbani a diversi dei quali contribuisce ogni singolo metro quadrato di ulteriori costruzioni, *green* o meno; in Italia si consumano oltre 20 ettari al giorno, cioè più di un campo da calcio ogni 45 minuti: una «trasformazione del territorio agricolo e naturale in aree artificiali» che incede al ritmo di oltre 2 metri quadrati al secondo (ISPRA, 2025). Uno dei realismi più crudi, anche se spesso taciuto, è quello dell'incremento delle catastrofi urbane e territoriali legate ad esempio alla crisi climatica in corso, con le sempre più frequenti “emergenze” del caldo estremo e delle alluvioni. A cosa servono “redistribuzioni” come ad esempio un asilo nido o un'area cani in delle città invivibili per il caldo estremo, per i relativi *blackout*, in città spazzate via dal fango, in quartieri gentrificati e turistificati senza più abitanti, etc.? Si è qui visto come ogni economia – in quanto sottosistema della sfera sociale, a sua volta sottosistema della sfera ecologica – abbia bisogno di solide basi ecologiche e solide basi sociali per resistere, adattarsi e continuare a prosperare in un'epoca per forza di cose nuova. Le varie versioni dell'opera satiri-

ca *La nave dei folli*, le prime delle quali più che cinquecentennali, narrano di una nave a bordo della quale c'è chi si dedica a un vizio e chi a un altro, o chi si adopera per cambiare qualcosa alla luce di magari condivisibili questioni economiche, etiche o sociali, ma nessuno o quasi si cura della nave sulla quale tutto ciò accade e può accadere, quasi nessuno si cura della navigazione suicida che si sta operando e – prevedibile *spoiler* – alla fine l'imbarcazione cola sempre a picco. Tornando ai dibattiti sulle trasformazioni urbane<sup>65</sup>, per proiettarsi nel futuro servono visioni e strumenti di “accompagnamento del territorio”: le sfere ecologica e sociale non derivano dall'iniziativa economica – anzi, ne sono spesso danneggiate – ma piuttosto la nutrono: eroderle è un'altra rotta suicida; sarebbe come tagliare il ramo su cui poggiamo; e quando, grazie al nostro abbandono e alla nostra incuria, spuntasse per caso qualche nuovo ramoscello, affrettarci a scacciarlo, chi d'imperio, chi con una supervisione pubblica, chi con un processo partecipativo per decidere insieme come recidere quel raro appiglio e cosa farci di socio-economicamente utile con quel poco di materiale asportato. L'urbanistica, che gestisce l'interfaccia tra le attività socio-economiche umane e i sistemi ecologici in cui esse sono necessariamente collocate, non può essere più la mera somma di interventi edilizi<sup>66</sup> privati che strutturalmente non possono curarsi dei più ampi sistemi ecologico e sociale: utopico è pensare di poter continuare a racimolare per sempre le briciole di un pasto che sta

scomparendo; dentro e fuor di metafora, è il tempo di salvare il suolo rimasto, rifertilizzarne altro, e seminare. In risposta alla necessità di sviluppare visioni territoriali capaci di proiettarsi in un futuro di crisi multiple (Fabbro, 2024; Fabbro e Cristiano, 2024; Cristiano, 2024a), Moccia<sup>67</sup> nota come gli strumenti disciplinari dell'urbanistica siano ancora orientati a un certo funzionalismo. Come ricorda Bianchetti (2016), l'approccio funzionalista è riduzionista – dunque sempre meno adatto alla complessità – e gli elementi per una sua critica sono già tutti maturi fin dagli anni Settanta, mentre anche nel secondo decennio del ventunesimo secolo «il progetto urbanistico rischia di finire entro le maglie di un nuovo funzionalismo» che appiattisce lo spazio e la società. Dal funzionalismo urbanistico a quello sociale, come fa il concetto di metabolismo sociale (e urbano) con i flussi che nutrono una società (o una città) e che ne vengono espulsi, il funzionalismo considera la società come un organismo vivente, concentrandosi invece sulla natura appunto funzionale delle relazioni tra le parti che compongono la società (o la città); in alcune sue varianti, il funzionalismo è adattivo e legato alla teoria dei sistemi (v. Franceschini, 1985). Portando le scienze biologiche e l'ecologia dei sistemi anche nella comprensione del territorio, occorrerebbe ricordarsi che le funzioni delle società umane (insediamenti compresi) sono garantite soltanto dalla vita: dalla riproduzione della società e dalla salute degli ecosistemi non umani. Il funzionalismo non può essere più ap-

piattito, dunque, su una sfera squisitamente economica (*funzionale* alla sola espansione del capitale), ma serve che riconsideri la sfera sociale, sempre più spesso negletta, e quella ecologica, strutturalmente esclusa. Che lo si voglia superare o meno, occorre “sbloccare” funzioni dimenticate, spente e/o non ancora attivate, perché nessun sistema funziona senza delle condizioni al contorno favorevoli e un’organizzazione interna plurale e sana. Come l’inverno con l’estate, come la notte con il giorno, come il sonno con la veglia, come l’ozio fa da necessario contraltare al *negotium*. In un’epoca di *burnout*, dimenticarsene è tanto insostenibile al livello personale quanto al livello territoriale, dove il selvatico fa da necessario contraltare all’ambiente costruito. Già nella Roma antica, come ricordato da Romito<sup>68</sup>, esisteva la consapevolezza del limite<sup>69</sup>, della necessità di contrattare lo spazio urbano con il *Latium*, con quell’insieme di flora, fauna e corpi idrici che può essere qui tradotto con le aree di supporto, con gli ecosistemi e con i cuscinetti, i margini di sicurezza da cui l’*Urbe* – e come essa ogni città – necessariamente dipende. In un’epoca viziata dal predominio dell’automobile e dalla religione della velocità, come richiamato poco fa, pretendere di riuscire a prescindere da certe zone-cuscinetto, cementificandole, è come non lasciare la distanza di sicurezza in macchina quando si corre veloci (e stiamo correndo veloci); in un’urbanistica viziata dall’edilizia, è come trasformare cucine e bagni in camere da letto: queste ultime avranno pure dei valori di

mercato più alti, ma servono dei margini per la riproduzione della vita, per il “metabolismo” dei flussi in ingresso, dei flussi in uscita, delle “digestioni” e di altre trasformazioni. In un’epoca viziata da bilanci di impresa e mandati elettorali, una visione, **un’idea di città e di territorio a medio e lungo termine**, troppo spesso manca; in un secolo nuovo, come visto, una visione appare invece sempre più urgente. Le funzioni ecosistemiche vitali sono relegate ai margini non urbanizzati (o ai “vuoti abbandonati”), mentre diventa sempre più ristretto e più generico il concetto di “verde urbano”, in cui gli uffici tecnici inseriscono spesso anche l’arredo urbano (pali, panchine, recinzioni, etc.), quando non campi da calcio, da tennis, spogliatoi, bar, ristoranti e così via. Il verde non è altro che un colore privo di significato ecosistemico, buono appunto per indorare, o *inverdire*, le pillole dell’inerziale *status quo*: un’aiuola, un prato, un terrazzo “verde” non forniscono alcun beneficio ecosistemico, rappresentano invece un appiattimento della biodiversità, hanno bisogno di flussi di risorse e relativi impatti per essere mantenuti e, al contrario degli ecosistemi, sono vulnerabili a ciò che Ranzato chiama più avanti *rottture*, tra cui possiamo qui inserire, oltre ai guasti infrastrutturali, siccità, pandemie e altri “imprevisti” in realtà ben prevedibili in questo secolo inedito. In termini di mitigazione e adattamento alla crisi climatica, gli effetti di raffrescamento delle aree vegetate dipendono dalle dimensioni dei parchi e dalla vitalità degli ecosistemi che li costituiscono



(Chang e Li, 2014): solo così il “verde” può offrire dei benefici termici alle aree urbane circostanti ben oltre i confini del parco, controbilanciando le isole di calore (*ibid.*). Se in un’altra epoca all’Ostiense il fiume Almona è stato interrato sotto la Circonvallazione, proprio a fini climatici la Seul del XXI secolo fa l’opposto: il fiume Cheonggyecheon è stato riportato alla luce: da un’autostrada urbana ne è nato un parco fluviale lungo 11 km (Jeon e Kang, 2019). Sempre dall’Asia, dopo un’alluvione costata la vita a oltre trecento persone e la casa a ben oltre un milione di cinesi<sup>70</sup>, è stato realizzato il parco fluviale di Yongning, a Zhengzhou (Stokman e Ruff, 2005), ispirato al già citato concetto di “**città spugna**”, utile a creare ciò che è stato qui definito un margine di sicurezza per prevenire altri disastri. Un’altra area-spugna è stata realizzata a Bangkok sul sito di un’ex fabbrica di tabacco: il parco forestale di Benjakitti (**Fig. 5**) aumenta la biodiversità e la capacità di mitigare i rischi climatici-ecologici a

fronte di poca manutenzione (Yu e Wang, 2024). Esistono numerose funzioni – forse le più indispensabili per la città del futuro – che sono attualmente escluse dagli strumenti urbanistici votati al “funzionalismo”. Con un parallelo intenzionalmente specista e utilitaristico, guardiamo all’approccio predatorio delle degenerazioni urbanistiche in atto (cosiddette rigenerazioni urbane incluse) come a una macelleria: si compra, si taglia, si vende carne; in un’epoca di tramontata abbondanza ci si rende conto, però, che la carne va anche allevata, che esistono dei territori al di fuori del laboratorio di squartamento esistono dei territori in cui la vita si riproduce e che il negozio dipende da essi: solo dalla vita il mercato può estrarre valore: l’allevamento è un’attività imprescindibile anche per chi volesse vendere la carne, pena non averne più. Ecco, così come i coltelli da macelleria non sono buoni per l’indispensabile allevamento, gli strumenti urbanistici ereditati da una fase di storicamente

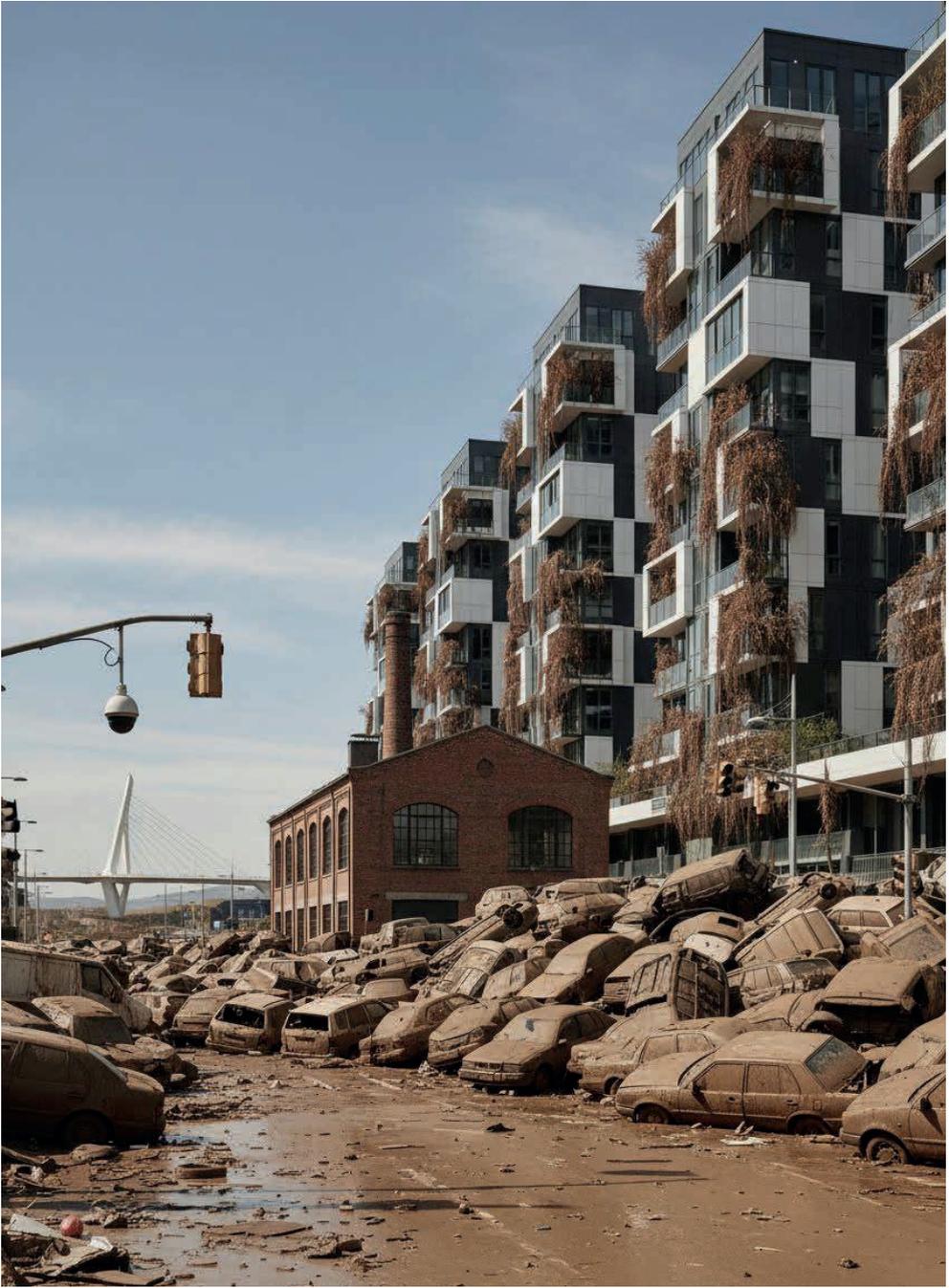
## Il parco fluviale di Benjakitti a Bangkok

Fonte: Supanut Arunoprayote, CC BY-NC-SA

Fig. 5

tramontato *boom* economico non sono buoni per preservare le indispensabili forme di riproduzione ecologica e sociale che pure sono alla base di ogni attività economica. C'è bisogno di un'ottica, di un'ontologia transcalare e di strumenti anche, soprattutto e sempre più alle madri dimenticate di ogni funzione urbana: quella ecologica e quella sociale, che quando sono in salute si sviluppano in *reti* (e in quest'epoca chiamiamo "reti sociali" principalmente il loro opposto: i *social network*). Di tutti i rischi qui menzionati<sup>71</sup>, solo uno ha dei propri strumenti urbanistici: quello idraulico, con le relative carte del rischio e col principio di invarianza idraulica, per rispettare il quale le nuove costruzioni dovrebbero dimostrare di non alterare l'afflusso delle acque meteoriche nei corpi idrici, ossia fiumi, ruscelli, canali (in un'ottica tecno-utilitaristica e dimentica della realtà ecologica, chiamati "ricettori"); la probabilità di accadimento di eventi meteorici estremi si basa però su delle serie storiche, ossia su ciò che è successo nel passato (fino a duecento anni addietro), e non su cosa ci si attende in un futuro fatto ahinoi di eventi estremi senza precedenti; e, negli anni, con una impermeabilizzazione del suolo (cioè una cementificazione) anch'essa crescente, nonostante i già citati moniti dell'ISPRA e grazie i giochi di parole per continuare a consumarlo (v. Cristiano, 2024b). Per intenderci, non ci aspettiamo che siano identificati come a rischio massimo (R3) tutti i territori che in questi anni stanno cadendo vittime delle varie alluvioni! Dun-

que, solo il rischio idraulico ha degli strumenti... e si promettono sempre meno adeguati! Per molti altri, non esistono nemmeno strumenti vetusti! Possibili soluzioni possono essere modulari. Servono quindi nuovi strumenti adeguati per i rischi vecchi e nuovi, in attesa dei quali parrebbe assennato usare un sano **principio di precauzione territoriale** e di buone pratiche reali, non soltanto definite come tali. Con l'immagine di poco fa, servono nuovi strumenti per la filiera della carne, non solo per l'ultimo miglio; in assenza nuovi paradigmi, o per svilupparne, appare indispensabile includere tra le funzioni urbane anche quelle ecologiche e sociali, che garantiscono ogni altra funzione, non limitandosi agli elementi più patentemente insediativi ma estendendosi a tutto ciò di cui gli insediamenti hanno bisogno e che, se ci si limita a un'ottica meramente economicistica ed estrattiva, non si può che continuare pericolosamente a erodere. Mentre si chiamano al momento "rigenerazione" i coltelli del macellaio, servono nuovi strumenti che siano davvero rigenerativi, nuovi strumenti che non sono ancora appunto urbanistici, ma di cui il governo – o forse meglio la *cura* – del territorio può, deve dotarsi, pena continuare a scomparire. In un'urbanistica che tende a lasciar costruire fino a dove è *consentito* (e ad allargare, con la deregolamentazione, le maglie di ciò che lo è), serve invece agire fin dove è *opportuno*, fin dove è *prudente*; in un'epoca di sigillazione del suolo estrema e di consumo di altre risorse non rinnovabili, la vera questione non può essere



## Città mediterranea del 21° secolo cresciuta a dismisura senza cura del territorio

Fonte: CC BY-NC-SA

Fig. 6

l'alternativa tra costruire in orizzontale o in verticale (aumentando cioè le cubature), ma ricucire gli strappi con le basi ecologiche e sociali per garantire – tanto in lungo quanto in largo – che la città esistente continui a vivere e a prosperare: non costruire finché è lecito e oltre, ma – al rovescio – contenere le espansioni laddove non ci sia un sostegno biofisico sufficiente, una solida copertura *ecologica*, non solo finanziaria, perché l'insolvenza verso un debito ecologico o è in prospettiva ben peggiore di quella verso un debito *economico* (Cristiano, 2018), che biofisicamente nemmeno esiste. Si tratta della responsabilità di garantire non un'area per i cani o un asilo nido, ma una **sicurezza territoriale** su cui queste e qualsiasi altra funzione urbana si possono innestare. Servono nuovi *standard* urbanistici<sup>72</sup> capaci di rispondere alle **mutate esigenze urbane** e, in prospettiva, a molteplici rischi. La resilienza esige dei cambiamenti e i cambiamenti esigono del caos generativo: Sennet e Sendra (2020) parlano di progettare il disordine; quest'ultimo, «tradizionalmente considerato un aspetto negativo nella pianificazione urbana» diventa una «componente essenziale dell'esperienza urbana» e «svolge un ruolo vitale nel buon funzionamento degli aspetti sociali, culturali, estetici ed economici delle città» (Pisano e De Luca, 2024); prima degli strumenti urbanistici formali, quelli *informali* «stimolano le dimensioni costitutive del piano e incidono sulla forma stesso del piano, sollecitandone una mutazione» (*ibid.*). La resilienza esige diversità: serve un

“investimento urbano” per accompagnare il fiorire di tutti i cuscinetti, di tutti i margini di sicurezza necessari; un investimento nei vivai di domani: lasciar crescere la biodiversità ecologica, le “biodiversità” sociale, artistica, culturale, politica, economica: diversificarne i relativi “investimenti” ecologici, sociali, culturali, etc., perché una città senza gli ecosistemi che la sostengono non può essere né *urbs*, né *civitas*, né *polis*, perché una società schiacciata non produce nulla di culturale, perché una cultura economicizzata, una “industria culturale”, rischia di non coltivare la materia prima così come il macellaio non può allevare le vacche. Nel sito degli Ex Mercati Generali la biodiversità ecologica ha cominciato a fiorire, manca quindi darle spazio e dar lo spazio che resta alla diversità sociale, culturale, economica, etc. L'urbanistica – ricorda De Luca (2018) – è fatta di scelte politiche tecnicamente assistite. Nella sua degenerazione, l'assistenza appare troppo spesso quasi esclusivamente finanziaria, quando è invece sempre più necessario che le scelte politiche siano *scientificamente* assistite. Come dimostrano alcune delle ricerche pubblicate in questo numero speciale e molte altre già pubblicate da diversi gruppi di ricerca internazionali e molto spesso interdisciplinari, saperi e competenze non mancano. La pandemia del 2020-2022 ha insegnato che l'economia sa già riconvertirsi rapidamente. Sull'importanza di dare a un insediamento umano un sostegno ecologico affidabile può offrire un esempio Calvino (1972) ne *Le città invisibili*: Isaura, coi suoi

mille pozzi, sorge sopra un lago sotterraneo e non si estende oltre di esso; qui e ora, il lago è acqua, l'acqua è vita: qualsiasi insediamento può nascere soltanto sulle sue basi biologiche, sui propri presupposti metabolici. **L'urbanistica per il futuro, la cura del territorio**, deve capire i limiti e garantire le fondamenta ecologiche e sociali per ogni città, per ogni insediamento umano. Ogni scelta che se ne dimentica diventa necropolitica. Si ha la possibilità di deliberare distruzione o vera rigenerazione. Se si mettono a fuoco i possibili prossimi decenni con una visione territoriale orientata alla sicurezza della popolazione, all'incolumità, allo sviluppo – *sostenibile* davvero – della diversità di vita umana e non umana e alla salvaguardia di queste ultime dalle oggi prevedibili e imprevedibili minacce, allora si saprà forse cogliere l'opportunità di trovare, mostrare e intraprendere per prime la via d'uscita dal problema, che dà sul vasto mondo delle soluzioni.

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## Note

<sup>1</sup> «laureata in Architettura, è dirigente generale in quiescenza del ministero delle Infrastrutture e Mobilità Sostenibili e lo scorso 16 aprile è stata nominata commissario straordinario di Governo per il completamento della diga di Pietrarossa in Sicilia. Al Ministero ha guidato la direzione generale Infrastrutture Stradali. Dal 2010 al 2013 ha presieduto la V sezione del Consiglio superiore dei Lavori pubblici, occupandosi di strade, gallerie stradali e ferrovie» (comune.roma.it/web/it/ornella-segnalini.page; accesso alla pagina: 8 dicembre 2025)

<sup>2</sup> laureata in Economia e commercio, quadro alle Poste con funzioni di relazioni istituzionali, consigliera comunale dal 2016 ([https://www.comune.roma.it/web-resources/cms/documents/BAGLIO\\_Curriculum\\_Vitae.pdf](https://www.comune.roma.it/web-resources/cms/documents/BAGLIO_Curriculum_Vitae.pdf); accesso alla pagina: 8 dicembre 2025)

<sup>3</sup> maturità classica, militanza nel centro sociale della Garbatella, La Strada, dove si è «dedicato con cura al progetto della Scuola Popolare Piero Bruno, oggi diventata un modello [...] di contrasto alla dispersione scolastica»; consigliere municipale dal 2013, presidente dal 2018; «elementi distintivi» della sua formazione politica sono state le mobilitazioni contro la riforma scolastica della Moratti e l'Onda universitaria, le grandi manifestazioni contro la guerra e soprattutto i diversi percorsi per declinare materialmente il tema del diritto allo studio»; [comune.roma.it/web-resources/cms/documents/Amedeo\\_Ciaccheri\\_Bografia.pdf](https://comune.roma.it/web-resources/cms/documents/Amedeo_Ciaccheri_Bografia.pdf) (accesso alla pagina: 8 dicembre 2025)

<sup>4</sup> “rigenerazione urbana” che nella comunicazione web del comune compare sia nel titolo, come complemento di specificazione di detto progetto, sia tra le lunghe esperienze maturate dalla società immobiliare beneficiaria della convenzione, appunto «in progetti complessi di rigenerazione urbana e valorizzazione del patrimonio pubblico e privato» <https://www.comune.roma.it/web/it/notizia/ex-mercati-general-firma-ta-convenzione-integrativa-al-via-progetto-di-rigenerazione.page> (accesso più recente: 8 dicembre 2025); come ad esempio per l'espressione “sviluppo sostenibile”, anche “rigenerazione urbana” contiene parole che viziano la comprensione di ciò che viene fatto in suo nome, rendono difficili le critiche (solo un folle potrebbe scagliarsi contro un'operazione chiamata sostenibile o rigenerativa) – in altre parole, come vedremo nelle prossime pagine, inquinano il discorso

<sup>5</sup> e secondo candidato più votato alle elezioni comunali più recenti tra le fila del primo partito di maggioranza comune.roma.it/web/it/maurizio-veloccia.page (accesso alla pagina: 8 dicembre 2025)

<sup>6</sup> il comitato ha organizzato la Prima Conferenza Urbanistica Civica dell'VIII Municipio di Roma, tenutasi il 13 dicembre 2025

<sup>7</sup> <https://www.comune.roma.it/web/it/notizia/ex-mercati-general-ok-assemblea-pubblico-interesse.page>

<sup>8</sup> <https://www.rainews.it/tgr/lazio/articoli/2025/11/ex-mercati-general-firmata-la-convenzione-9c8c0f9e-6df1-4d3e-a098-307b4233344a.html> (sui canali ufficiali del Comune di Roma non pare al momento reperibile il testo della convenzione; nell'incontro del 26/11/2025 è stato dichiarato che i documenti relativi alla convenzione sono pubblici ma non pubblicati...)

<sup>9</sup> – ogni mese circa 15 centesimi al metro quadrato, venti volte in meno dell'attuale prezzo per l'affitto di un monolocale in zona

<sup>10</sup> di fronte a una domanda specifica in occasione dell'incontro pubblico, non è stato chiarito se per la sosta libera o a pagamento

<sup>11</sup> durante la stesura di questo articolo, l'11 dicembre 2025 la stampa dà notizia del sequestro, da parte della magistratura, di due edifici di lusso in costruzione, i cui progetti omettevano le cubature, parlando solo di superfici “lorde”: a quanto pare, «a Milano si usa il termine volumetria per indicare la superficie lorda di pavimento»: «un trucco sulle parole per aggirare le regole» e far passare una nuova costruzione per una semplice

ristrutturazione avviabile con una Segnalazione Certificata di Inizio Attività (SCIA), ossia una semplice comunicazione; fonte: [https://milano.corriere.it/notizie/cronaca/25\\_dicembre\\_11/milano-inchieste-sull-urbanistica-la-procura-sequestra-la-torre-in-costruzione-unico-brera-27-indagati-1ffc153-7cec-4e18-9f73-fbfa-cao21xk.shtml?refresh\\_ce](https://milano.corriere.it/notizie/cronaca/25_dicembre_11/milano-inchieste-sull-urbanistica-la-procura-sequestra-la-torre-in-costruzione-unico-brera-27-indagati-1ffc153-7cec-4e18-9f73-fbfa-cao21xk.shtml?refresh_ce) (accesso alla pagina: 11 dicembre 2025)

<sup>12</sup> cinquantamila metri quadrati

<sup>13</sup> non questo in oggetto

<sup>14</sup> Come ricorda e ben illustra l'ANCE (2025), il decreto-legge 19/2024 (poi convertito nella legge 56/2024) riprende alcune sue proposte e prevede una serie di misure per agevolare la trasformazione di immobili in studentati. Per agevolare ulteriormente questi processi il PNRR ha stanziato 1,198 miliardi di euro, con gli oneri relativi ai primi tre anni di gestione delle strutture interessate pagati dal Ministero dell'Università, con la non tassazione dell'aumento del valore della rendita catastale derivante dal cambio della destinazione d'uso e con la deroga dall'obbligo di reperire e cedere al comune ulteriori aree per servizi di interesse generale (gli standard urbanistici). Le agevolazioni urbanistiche: (a) per gli studentati, è sempre ammesso il cambio di destinazione d'uso degli immobili, anche in deroga agli strumenti urbanistici e alle normativi regionali e statali; (b) per gli interventi edilizi connessi al cambio della destinazione d'uso basta una semplice SCIA (Segnalazione Certificata di Inizio Attività: una comunicazione agli uffici comunali o municipali); (c) gli interventi di ristrutturazione edilizia possono aumentare le cubature fino al 35% in più rispetto alla volumetria originaria, legittima o legittimata; (d) in assenza di aumenti di cubature, gli interventi sono autorizzati anche in aree sottoposte a vincoli paesaggistici; (e) gli alloggi e le residenze per studenti finanziati dal PNRR non sono assoggettati al reperimento di ulteriori aree a standard ai sensi del DM 1444/1968 e delle disposizioni regionali, né all'obbligo della dotazione minima dei parcheggi ai sensi della Legge 1150/1942 (art. 1-quater, comma 4).

<sup>15</sup> non più solo per studentati o presunti tali

<sup>16</sup> <https://portale.assimpredilance.it/articoli/legge-per-la-semplificazione-2025-novita-in-tema-di-edilizia> (accesso: 11 dicembre 2025)

<sup>17</sup> non visionata perché appunto - al 23 dicembre 2025 - non risulta pubblicata; oltre al comunicato stampa, sono però circolati alcuni documenti (v. nota sotto.)

<sup>18</sup> diapositive comunali, datate 28/01 e 02/07/2025, proiettate in occasione di una serie di incontri pubblici e circolate in formato pdf

<sup>19</sup> <https://www.immobiliare.it/annunci/120336076/> («posto letto in doppia ampia e luminosa», via Pellegrino Matteucci, Roma, «7° piano con ascensore in condominio tranquillo e ben abitato»; annuncio consultato l'8 dicembre 2025)

<sup>20</sup> elaborazioni dalla Banca dati delle quotazioni immobiliari dell'Agenzia delle Entrate, periodo di riferimento: primo semestre del 2025; <https://www1.agenziaentrate.gov.it/servizi/Consultazione/ricerca.htm>; trattandosi di medie, gli appartamenti più piccoli potrebbero costare di più rispetto al prezzo al metro quadrato ufficiale

<sup>21</sup> come avviene, è avvenuto o potrebbe avvenire ancora a Venezia, per la Residenza "Ai Crociferi" (<https://thisiscombo.com/it/camere/venezias>) e per il Camplus S. Marta ([https://corriereedelveneto.corriere.it/notizie/venezias-mestre/cronaca/24\\_agosto\\_28/venezias-le-camere-per-gli-studenti-affittate-ai-turisti-su-airbnb-multa-a-camplus-ed-esu-73609a6f-65d1-4e49-a53a-bd0fd696d1k.shtml](https://corriereedelveneto.corriere.it/notizie/venezias-mestre/cronaca/24_agosto_28/venezias-le-camere-per-gli-studenti-affittate-ai-turisti-su-airbnb-multa-a-camplus-ed-esu-73609a6f-65d1-4e49-a53a-bd0fd696d1k.shtml)), strutture sorte rispettivamente all'interno di proprietà delle università Luav e Ca' Foscari

<sup>22</sup> precedentemente conosciuto come The Student Hotel e già presente in Italia con cinque strutture a Roma, Firenze (2), Bologna e Torino

<sup>23</sup> attualmente presente in 17 città italiane, v. <https://www.camplus.it/> (accesso più recente: 7 dicembre 2025)

<sup>24</sup> Booking.com: Camplus Living Bononia; Booking.com: The Social Hub Amsterdam; Booking.com: The Social Hub Rome (accessi più recenti: 7 dicembre 2025)

<sup>25</sup> <https://www.thesocialhub.co/it/bologna/> (accesso più recente: 7 dicembre 2025)

<sup>26</sup> delibera di attribuzione del "pubblico interesse" al progetto (protocollo n. 20571 del 11/07/2025)

<sup>27</sup> v. ad esempio i listini offerti alla pagina <https://www.iesabroad.org/destinations/italy> (accesso: 18 dicembre 2025)

<sup>28</sup> oltre alle già affrontate funzioni ricettiva (52.242 m<sup>2</sup>) e dei parcheggi sotterranei (65.998 m<sup>2</sup>), già illustrate, le informazioni proiettate pubblicamente e lasciate circolare parlano di: ristorazione (2.000 m<sup>2</sup>), negozi (1.000 m<sup>2</sup>), uffici (5.074 m<sup>2</sup>), mediateca (3.413 m<sup>2</sup>), libreria (1.100 m<sup>2</sup>), palestra e spa (1.900 m<sup>2</sup>), biblioteca

(1.047 m<sup>2</sup>), uffici (1.475 m<sup>2</sup>), centro anziani (478,3 m<sup>2</sup>), sala conferenze (405,3 m<sup>2</sup>), intrattenimento e spettacolo (1.320,5 m<sup>2</sup>), start-up innovative (10.000 m<sup>2</sup>), promozione eno-gastronomica (4.000 m<sup>2</sup>)

<sup>29</sup> gli ambienti abitabili devono avere una superficie netta di 2,70 m, i parcheggi interrati 2,40 m, ma ci sono da aggiungere gli spessori delle strutture (solai, impianti, etc.) e la sala conferenze e gli altri locali aperti al pubblico potrebbero avere altezze anche di molto maggiori, come in realtà già lo hanno alcuni dei padiglioni esistenti, sempre che il progetto non preveda un loro frazionamento verticale

<sup>30</sup> v. Odum & Odum (2006; 2008)

<sup>31</sup> <https://www.nbfc.it/>

<sup>32</sup> non si spendono qui ulteriori parole sul problematico concetto di "rigenerazione urbana"

<sup>33</sup> c'è chi riferisce che i laghi siano emersi durante dei lavori di sterro che avrebbero toccato la falda del sottostante fiume Almona (v. Giovannini, 2025), così come nei casi del lago Bullicante a Roma e del Marais Wiels a Bruxelles

<sup>34</sup> anche detta deimpermeabilizzazione o depavimentazione

<sup>35</sup> <https://www.facebook.com/reel/1402357494558243> (accesso più recente alla pagina: 11 dicembre 2025)

<sup>36</sup> *ibid.*

<sup>37</sup> termine effettivamente fumoso (viene da una in parte diversa proprietà meccanica dei materiali, di principale interesse industriale), spesso usato senza troppa cura della sua più ampia definizione e ridotto principalmente a risposte tramite soli mezzi economici e tecnici

<sup>38</sup> a sua volta minato da una precarizzazione economica e da una colonizzazione economicistica (quindi strutturalmente anti-ecologica e anti-sociale) dell'immaginario sociale – con le eccezioni, naturalmente, di approcci eterodossi quali l'economia ecologica (in lingua italiana, v. Distefano) o la bioeconomia *à la Georgescu-Roegen* (v. Bonaiuti e Menegat)

<sup>39</sup> v. primo paragrafo "Trasformazioni e futuro"

<sup>40</sup> uso consapevole di questa variante del nome

<sup>41</sup> <https://www.domosustienese.it/progetto/> (accesso alla pagina: 11 dicembre 2025)

<sup>42</sup> <https://romamobilita.it/it/progetti/grab-ciclovia-romana> (accesso alla pagina: 19 dicembre 2025)

<sup>43</sup> <https://caragarbatella.it/un-sepolto-vivo-l-almona-fiume-sacro-della-garbatella/> (accesso alla pagina: 18 dicembre 2025)

<sup>44</sup> con intensità che variano in base alle caratteristiche geologiche del terreno

<sup>45</sup> <https://ideasostenibile.com/perche-il-dibattito-sui-fiumi-veneti-ignora-la-vera-rivoluzione-in-corso-da-jeremy-rifkin-ai-contratti-di-fiume/#page-content> (accesso alla pagina: 23 dicembre 2025)

<sup>46</sup> <https://www.protezionecivile.gov.it/it/approfondimento/che-cos--il-rischio/>

<sup>47</sup> <https://www.rainews.it/tgr/lazio/articoli/2026/01/esonda-il-fiume-aniene-allagamenti-a-ponte-mammolo-e-colli-aniene-2b353de3-eabb-49cd-b7d1-1f-f1a9267150.html> (accesso alla pagina: 7 gennaio 2026)

<sup>48</sup> <https://www.rainews.it/tgr/lazio/articoli/2026/01/roma-dopo-il-maltempo-fiumi-sotto-controllo-madanni-e-allagamenti-in-tutta-la-citta-a9f2dcd0-b16e-4c70-922f-c859a8954018.html> (accesso alla pagina: 7 gennaio 2026)

<sup>49</sup> Comune di Roma, Piano Strategico e Operativo "Tevere", Allegato alla relazione "A1 Interventi" [http://www.urbanistica.comune.roma.it/images/pso-tevere/A1\\_Allegato-Relazione\\_Interventi.pdf](http://www.urbanistica.comune.roma.it/images/pso-tevere/A1_Allegato-Relazione_Interventi.pdf)

<sup>50</sup> <https://www.comune.roma.it/web/it/notizia/mun08-parco-tor-marancia-aperto-ingresso-piazza-lante.page> (accesso alla pagina: 7 gennaio 2026)

<sup>51</sup> [https://www.archiportale.com/news/2018/11/architettura/hunting-pollution-il-murales-man-gia-smog\\_66851\\_3.html](https://www.archiportale.com/news/2018/11/architettura/hunting-pollution-il-murales-man-gia-smog_66851_3.html)

<sup>52</sup> <https://www.comune.roma.it/web/it/scheda-servizi.page?contentId=INF1450687&stem=inquinamento>

<sup>53</sup> sono raramente resi disponibili gli studi a supporto di simili pretese, forse anche in ragione dei segreti industriali; non sembrano mai affrontate le emissioni necessarie alla produzione di simili sostanze (nozioni base di valutazione del ciclo di vita – ISO (2006) – lasciano sospettare che, come ad esempio i balconi "verdi" e altre soluzioni del greenwashing, il gioco potrebbe non valere la candela) né i tempi di saturazione – dopo quanto tempo, cioè, le vernici smettono di assorbire quello che prometterebbero di assorbire.

<sup>54</sup> <https://www.panorama.it/attualita/cronaca/roma-addio-al-bosco-sacro-di-augusto-abbattuti-alberi-sani-per-fare-cassa-e-scontro-su-gualtieri>;

<sup>55</sup> (v. ad esempio Mancuso, 2023)

<sup>56</sup> oltre 120 milioni di euro ([www.polito.it/ateneo/comunicazione-e-ufficio-stampa/comunicati-stampa/pnrr-il-politecnico-di-torino-partecipa-a-sei-partenariati](http://www.polito.it/ateneo/comunicazione-e-ufficio-stampa/comunicati-stampa/pnrr-il-politecnico-di-torino-partecipa-a-sei-partenariati))

<sup>57</sup> 230 milioni di euro (fonte già citata)

<sup>58</sup> al momento non pare chiaro in cosa consista il pubblico interesse deliberato e non sembrano disponibili i dettagli della convenzione

<sup>59</sup> è assolutamente repellente, ma abbiamo ancora con noi le generazioni che ci ricordano degli orti di guerra: un margine di sicurezza nell'uso del territorio, un cuscinetto può servire anche a non morire di fame; preparazione al multi-rischio

<sup>60</sup> la maggior parte dei contributi è stata scritta in lingua inglese, troppo spesso una sorta di lingua franca in ambito scientifico; per chi non ci avesse dimestichezza mi prendo la responsabilità oggettiva e me ne scuso, ma il consiglio è più quello di impararlo con qualche amicizia che non di ricorrere a una traduzione artificiale – un po' per il significato che necessariamente si perderebbe (lo ha fatto qualche settimana fa una mezza classe di studenti internazionali con un mio articolo in italiano e l'operazione ha portato una sintesi eccessiva e giusto qualche vago residuo dei messaggi più importanti), un po' perché... se domani non ci fosse più l'intelligenza artificiale?! [Che non diventi un'ossessione, ma, appunto, prepararsi a ogni eventualità è in qualche modo coerente con i temi trattati in questo numero speciale]

<sup>61</sup> occasione notoriamente sprecata durante la pandemia da covid-19

<sup>62</sup> "Man and the Biosphere" (<https://www.unesco.it/it/iniziativa-dellunesco/mab-3/>; accesso alla pagina: 8 dicembre 2025)

<sup>63</sup> traducibili come "quartieri a energia positiva" e definiti dall'Unione Europea, che li promuove, come aree urbane o gruppi di edifici interconnessi definiti come efficienti e flessibili dal punto di vista energetico e che producono (sì, è un linguaggio un po' economicista; in termini fisici vorrebbero dire convertono, trasformano, nota dell'autore.) emissioni di gas serra zero netti (per una critica al concetto di "zero netto" riferito lì al consumo di suolo, v. Cristiano, 2024b) e che ogni anno gestiscono attivamente un surplus di produzione di energia rinnovabile al livello locale o regionale; «richiedono l'integrazione di diversi sistemi e infrastrutture e l'interazione tra edifici, utenti e sistemi regionali di energia, mobilità e tecnologie informatiche» (Urban Europe, Positive Energy Districts, <https://jpi-urban-europe.eu/ped/>, accesso alla pagina: 15 dicembre 2025); ovviamente le città sono sistemi altamente dissipativi, dunque non produttori, ma consumatori di energia e di altre risorse, sia in loco, sia soprattutto lungo tutte

le filiere di tutto ciò che entra e di tutto ciò che esce dalle città e dai suoi quartieri; questi flussi in ingresso e in uscita vengono associati al concetto di metabolismo urbano e territoriale e non sono legati solo alla sostenibilità ma anche alla resilienza: più lunghe e complesse le filiere, più vulnerabilità in un secolo di crisi interconnesse

<sup>64</sup> traduzione propria; nella sezione "Lecture" è disponibile uno stralcio più ampio in lingua inglese

<sup>65</sup> e non solo

<sup>66</sup> v. ad esempio la definizione dei Positive Energy Districts offerta in nota poco fa

<sup>67</sup> Moccia, F. D. (2025). Tavola rotonda "Discutendo intorno ad Ecopoli", coordinatori: De Luca, G., & Mascarucci, R., XIV Giornata di Studio Internazionale dell'Istituto Nazionale di Urbanistica, Università degli Studi di Napoli Federico II, Napoli, 12 dicembre 2025.

<sup>68</sup> Romito, L. (2025). La natura si riprende i Mercati. Un ecosistema unico al servizio del quartiere. Prima Conferenza Urbanistica Civica dell'VIII Municipio di Roma, 13 dicembre 2025.

<sup>69</sup> evidentemente prima dell'espansione e del collasso dell'impero: tutto pulsa, sì, se non degenera oltre i limiti

<sup>70</sup> <https://www.turenscape.com/en/news/detail/412.html> (accesso alla pagina: 10 dicembre 2025)

<sup>71</sup> non si sono stati affrontati rischi più "convenzionali" come quello geologico, sismico, vulcanico, industriale, radiologico-nucleare, etc.

<sup>72</sup> dotazioni di servizi pubblici pro capite – almeno in teoria, poiché (a) i servizi sono calibrati sulle superfici abitabili, non sul numero di abitanti (in breve, quindi, chi ha casa più grande ha più servizi in zona); (b) certe nuove costruzioni, come visto, ne sono esonerate; (c) in altri casi, invece, è previsto che, anziché realizzare dei servizi a fronte di nuove costruzioni, i privati versino dei soldi nelle casse comunali (monetizzazione sostitutiva della cessione degli standard urbanistici)

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**Saggi**  
Essays

# Urban Climate Change Mitigation, Adaptation, and Disaster Risk Reduction – a Review on their joint use for Spatial Resilience

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adaptation  
literature review  
urban planning  
urban design  
resilience

## Introduction

An increasing number of catastrophic events was recorded in the first two decades of the 21<sup>st</sup> century compared to the previous twenty years (UNDRR, 2020) and the exposure of persons and assets increased more than vulnerability decreased (UNDRR, 2015), with impacts on the social, economic, environmental, cultural, and health sectors. The ongoing climate crisis suggests more disasters will happen, while other existing crises (ecological, energy, resources, socio-economic, geo-political, etc.) cannot be disregarded while trying to anticipate and handle

them (ANONYMISED), both as possible concauses and as crucial factors in tackling them over time. So, since risk is defined as the product of the probability of hazards to happen, exposure, and vulnerability (see e.g. Cardona *et al.*, 2012), disaster risk reduction (DRR) seems all but an automatic trend, and requires instead urgent action on those three factors.

Given the complexity of hazards, and the often extensive temporal and spatial scales re-

*An increasing number of catastrophic events was recorded in the first two decades of the 21st century compared to the previous twenty years. The ongoing climate crisis suggests more disasters will happen, while other existing crises (ecological, energy, resources, socio-economic, geo-political, etc.) cannot be disregarded while trying to anticipate and handle them, both as possible concauses and as crucial factors in tackling them over time. Among different models and paradigms to address an uncertain era, Disaster Risk Reduction (DRR) and Climate*

*Mitigation and Adaptation (CMA) represent two major categories aimed at inspiring urban and regional strategies, planning, and design options to pursue (climate-related) spatial resilience. This article presents a novel systematic literature review conducted through a Scopus-based query and subsequent qualitative content analysis, to understand how DRR and CMA are dealt with together in spatial planning, governance, and design, and to critically assess the depth, coherence, and disciplinary orientation of this integration. Findings highlight a fragmented and technocentric landscape, where DRR and CMA are frequently treated in parallel and rarely embedded in spatially grounded, participatory, or systemic frameworks. The review identifies significant gaps in disciplinary engagement – especially from planning, design, and political ecology – and proposes the need for a more transdisciplinary and situated understanding of spatial resilience. The literature review is ultimately aimed at providing new knowledge to strengthen DRR and CMA joint use for spatial resilience.*

quired to address them, direct intervention is not always viable; when it is possible, efforts are often concentrated on managing exposure and vulnerability. This is true especially in the case of so-called *natural* risks that are considered e.g. earthquakes or volcanic eruptions, where the probability of occurrence is largely independent of human influence. When it comes to anthropogenic risks, the hazard can be tackled; this is the case of those deriving from the climate crisis, in which two strategies of action are often considered: mitigation, on one side, (see IPCC, 2022a; Working Group III) which refers to making the impacts less severe through the prevention or reduction of greenhouse gas (GHG) release into the atmosphere, while adaptation (see IPCC, 2022b; Working Group II), on the other side, consists in anticipating the adverse impacts of climate change by taking appropriate measures to prevent or minimise their damages (European Environmental Agency, 2023). In other words, mitigation tackles upstream the drivers, it points at removing or at least reducing the causes of climate change, while adaptation acts downstream to get prepared to face its consequences. It is therefore important to address them altogether, for mitigation can make adaptation easier.

Different taxonomies have been proposed to systematise hazards; according to UNDRR (2020), they are either biological, hydrometeorological, technological, geohazard, chemical, environmental, extraterrestrial, or societal; based

on the European Commission (Casajus Valles *et al.*, 2020) they can be geophysical, hydrogeological, meteorological, climatological, and human-made; finally, IPCC (2021; Working Group I) classifies hazards as: heat and cold; wet and dry; wind; snow and ice; coastal; oceanic; other.

If hazards may *also* be natural, “disasters are *not* natural” (UNDRR, 2022): “what turns a hazard into a disaster is the consequence of human decisions: where and how we build, how we access and share resources, how we protect and restore healthy ecosystems” (*ibid.*). “High vulnerability and exposure are generally the outcome of skewed development processes, such as those associated with environmental mismanagement, demographic changes, rapid and unplanned urbanisation in hazardous areas, failed governance, and the scarcity of livelihood options for the poor” (IPCC, 2022b). In other words – and practically and operationally speaking – when passing from hazards to disasters, i.e. to the actual damages to persons and assets, the spatial dimension matters (Pisano *et al.*, 2020). Associated with situated multidisciplinary skills and knowledge, urban and regional planning and governance play therefore a crucial role in Disaster Risk Reduction and Climate [Change] Mitigation and Adaptation (CMA) efforts, in the light of their potential to minimise exposure and vulnerability (risk adaptation), and to prevent or reduce the hazards (risk mitigation).

According to the World Bank (2023), 4.5 billion people are currently living in urban areas. Projec-

tions show that urbanisation, matched with the overall growth of the global population, could add two billion people more to urban areas by 2050 (United Nations, 2019). This is why it is important to address DRR and CMA from an urban perspective. Of course, local and global levels are often intertwined, as “disasters unfold across national boundaries, involving a range of interrelated hazards and complex dynamics” (UNDRR, 2022) and requiring the building of resilience (*ibid.*). As a matter of fact, “lack of resilience and capacity to anticipate, cope with, and adapt to extremes and change are important causal factors of vulnerability” (Cardona *et al.*, 2012). The precondition for risk-informed decision making and long-term resilience lies in the establishment and maintenance of an inclusive governance system, “integrated with climate change adaptation” (UNDRR, 2022). Not surprisingly, among different models and paradigms to address an uncertain era, Disaster Risk Reduction (DRR) and Climate Mitigation and Adaptation (CMA) already represent two major scientific categories aimed at inspiring urban and regional strategies, planning, and design options to pursue (climate-related) spatial resilience. Spatial resilience is defined as “the ability of a territorial system to bounce back to desired functions after unexpected shocks and disturbances in order to improve its adaptive capacity, intending to evolve all its material and immaterial components toward a new territorial system’s organisation” (Brunetta & Caldarice,

2020). In principle, space and its related resilience also encompass non-populated production sites, such as industrial parks (see Lee *et al.*, 2023), but, in the light of the above-cited interest for the increasing urbanisation trends, a focus is here dedicated to cities and highly or lowly densely inhabited human settlements.

Although a significant overlap exists between the problems that disaster risk reduction and climate change adaptation seek to address (Mercier, 2010), the article distinguishes them according to the following definitions: DRR as the strategy to prevent, reduce, and manage existing, new, and residual risks, thus contributing to strengthen resilience and helping achieve sustainable development (UNDRR, 2017); CMA as the strategy to anticipate the adverse effects of climate change and to take appropriate action to prevent or minimise the damage they can cause, while making the impacts of climate change less severe by preventing or reducing the emission of greenhouse gases (GHG) into the atmosphere (EEA, 2023).

The ultimate goal of the present article is to support risk-informed decision-making for long-term resilience at the urban and metropolitan level, by finding out possible common approaches and detecting possible gaps, biases, and margins for further studies. With a focus on the two aspects of resilience that are currently present in the United Nations agenda and that can be addressed spatially, as per another globally recognised issue such as the increasing ur-

banisation, this will be done by building a comprehensive and up-to-date literature review on urban climate change adaptation and mitigation and on urban disaster risk reduction, jointly addressed from a spatial perspective. The specific research question consists in the understanding of whether and to what extent CMA and DRR are addressed through the scientific and professional lenses of spatial studies: such a review is meant to offer the most recent state of the art on those topics, whether and when addressed altogether in terms of urban and regional planning, governance, and design, while critically understanding whether research gaps and margins for improvement exist.

### Materials and method

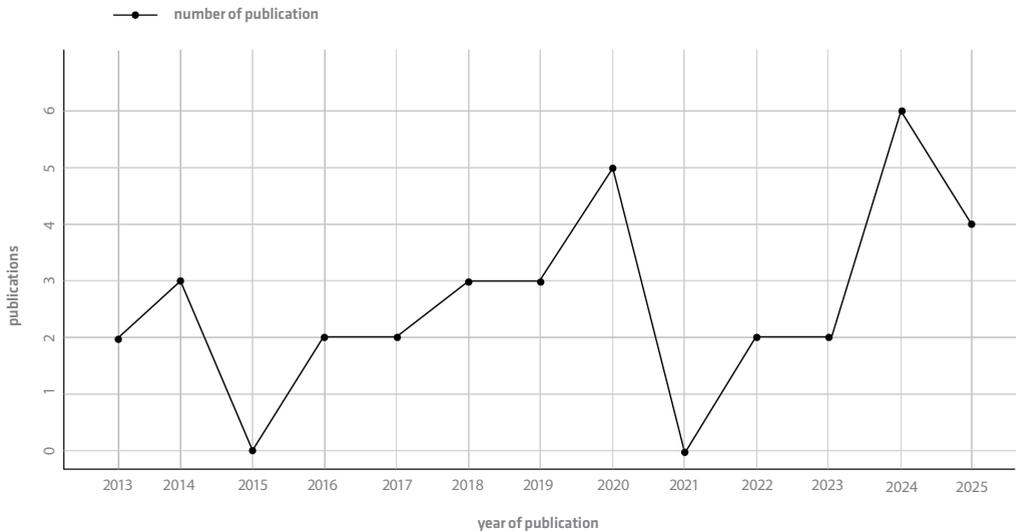
To support risk-related decision-making for long-term resilience, the article develops a comprehensive and up-to-date literature review. The review is operated by analysing the Scopus database on urban climate change adaptation and mitigation and urban disaster risk reduction, according to the following specifications. The systematic literature review is based upon the following inclusion criteria:

- date: up to May 30, 2025;
- language: English;
- peer review: not requested, since books, grey literature, letters, viewpoints, and editorials may be useful;
- type of publication: any, if present in Scopus;
- citation: none, since recent and/or niche pa-

# Publications resulting from the literature review: references, publication type, and number of citations as of May 30, 2025.

Tab. 1

Short reference	Publication type	Number of citations
Ajibade (2017)	Scientific journal article (Research paper)	110
Attolico (2014)	Scientific journal article (Conference proceedings)	0
Banwell et al. (2020)	Scientific journal article (Research paper)	17
Biancifiori et al. (2024)	Scientific journal article (Conference proceedings)	0
Bogaard et al. (2016)	Book chapter(Conference proceedings)	11
Cadiz (2018)	Scientific journal article (Conference proceedings)	10
Carlone & Mannocchi (2024)	Scientific journal article (Research paper)	1
Cervelli et al. (2020)	Scientific journal article (Research paper)	27
Devès et al. (2018)	Book chapter	4
Djalante & Lassa (2019)	Scientific journal article (Invited viewpoint)	35
Espada et al. (2017)	Scientific journal article (Research paper)	33
Galderisi (2014)	Scientific journal article (Research paper)	7
Hanna et al. (2025)	Scientific journal article (Research paper)	0
Indal & Arriola (2024)	Scientific journal article (Research paper)	0
Islam et al. (2025)	Scientific journal article (Research paper)	0
King & Curtner (2017)	Book chapter	0
King et al. (2016)	Scientific journal article (Research paper)	77
Klima & Jerolleman (2014)	Scientific journal article (Research paper)	13
Lam & Delina (2024)	Scientific journal article (Research paper)	0
Ling & Fujino (2013)	Book chapter	0
Myers et al. (2020)	Scientific journal article (Research paper)	2
Perney & D'Angelo (2023)	Scientific journal article (Research paper)	4
Rani et al. (2020)	Scientific journal article (Conference proceedings)	10
Schneider et al. (2022)	Scientific journal article (Research paper)	2
Sethi et al. (2025)	Scientific journal article (Report)	2
Sharkus et al. (2025)	Scientific journal article (Research paper)	0
Taramelli et al. (2019)	Scientific journal article (Review)	21
Tulloch et al. (2020)	Scientific journal article (Research paper)	32
Wamsler (2013)	Scientific journal article (Meeting report)	4
Widiati & Irianto (2019)	Scientific journal article (Conference proceedings)	0
Yoshikawa & Koshiyama (2024)	Scientific journal article (Conference proceedings)	2



## Publications distribution over time.

Fig. 1

pers are considered to still matter, and possibly make a difference instead.

Exclusion criteria are:

- duplicates, i.e. same author(s) and similar content or editorial describing a paper in a given Special Issue or book review or preface/afterword talking about their related book;
- unobtainable publications;

Search terms for the collection of results (titles, abstracts, and keywords, through Scopus);

- Climate AND mitigation AND adaptation AND “disaster risk reduction” AND urban OR spatial OR regional OR city OR cities OR town AND planning OR governance OR design.

## Results

### 3.1. General information

The Scopus search by titles, abstracts, and keywords produced 41 items; 7 articles have been discarded based on the established exclusion

criteria. The criteria by which they have not been included is the obtainability. One of the articles is not retrievable as finished/completed source but as a repository version (Wamsler, 2013), however for the sake of the relevancy to this research it has been included. **Table 1** shows the resulting scientific works, listed in alphabetical order and organised by publication type and number of citations as of May 30, 2025 (as per their respective publisher’s webpages or, as a second choice, in Scopus, and – if need be – in Google Scholar). 31 items (84%) have been published in scientific journals, of which 21 are research articles (68%), 7 conference proceedings (23%), 1 invited viewpoint (3%), 1 review (3%), and 1 meeting report (3%); 4 items are book chapters (11%), and 2 are a book (5%). The approach taken in the publications is a scientific one, on the other hand, some scientific contributions are authored (Attolico, 2014) or co-authored (e.g. Djalante & Lassa, 2019) by non-research experts.

# Geographical distribution of authors' affiliations.

Tab. 2

Continent	Country	#
<b>Africa</b>		3
	Uganda	1
	Tanzania	1
	Kenya	1
<b>Asia</b>		14
	Bangladesh	1
	Hong Kong	1
	India	1
	Indonesia	2
	Iraq	1
	Japan	3
	Malaysia	1
	Philippines	1
	Vietnam	1
<b>Europe</b>		13
	France	1
	Germany	1
	Italy	7
	The Netherlands	1
	Spain	1
	Sweden	1
	Switzerland	1
<b>North America</b>		9
	Canada	3
	United States of America	6
<b>Oceania</b>		5
	Australia	4
	New Zealand	1
<b>South America</b>		1
	Chile	1
<b>undefined</b>		2

## Top institutions among authors' affiliations.

Tab. 3

Institution	Country	#
University of Naples Federico II	Italy	3
James Cook University	Australia	2
Griffith University	Australia	2
Istituto Universitario di Studi Superiori di Pavia	Italy	2
Hospital of Potenza	Italy	1

### 3.2. Distribution over time

The items resulting from the literature review at hand are distributed in a timeline ranging from 2009 and 2025 (**Figure 1**), most of which (17, i.e. 65%) were published between 2016 and 2020, namely the year after and the same year as two milestones by the United Nations agency for the coordination of disaster risk reduction, respectively UNDRR (2015) and UNDRR (2020), also corresponding to the five years immediately following the Paris Agreement (UNFCCC, 2015), setting climate related goals and pledges.

### 3.3. Top authors, top affiliated institutions, and related geographical distribution

Geographically speaking (**Table 2**), most of the authors come from Europe (30%) and from Asia (28%), followed by North America (21%); Oceania (12%), African (7%) and South American (2%) affiliations are much fewer. Based on the Brandt line (ICIDI, 1980), the authors' affiliations are mostly located in the Global North (72%),

and close to a third of them are in the Global South (28%). Affiliations are counted based on each publication, so the (rare) authors who are present in two publications are counted twice.

The sample of resulting scientific works here is too little, and, inside it, the multiple publications by the same authors are too few to apply Price's law on scientific productivity in each field (Price, 1976).

The top authors in the resulting publications, with two works each, are:

- Yetta Gurtner (Centre for Disaster Studies, James Cook University, Townsville, Queensland, Australia);
- David King (Centre for Disaster Studies, Centre for Tropical Urban and Regional Planning, School of Earth and Environmental Sciences, James Cook University, Townsville, Queensland, Australia).

Some institutions are recurring in the analysed publications, as shown in **Table 3**. Top three institutions are all universities: University of Na-

# Authors' disciplinary distribution.

Tab. 4

Disciplinary cluster	ERC codes	# Authors
Earth science; hydraulics; hydrodynamics; water management; engineering; hazard mitigation; disaster studies	PE8	30
Mathematics	PE1	1
Ecology; soil pedology; agricultural and environmental sciences	PE10	12
Urban and regional planning; urban systems design; urban sustainability; environmental governance, policy and planning; geography	SH2	32
Political science, law, sustainability science	SH2	3
Sociology and Anthropology	SH3	4
Molecular Biology, Biochemistry, Structural Biology and Molecular Biophysics	LS1	4

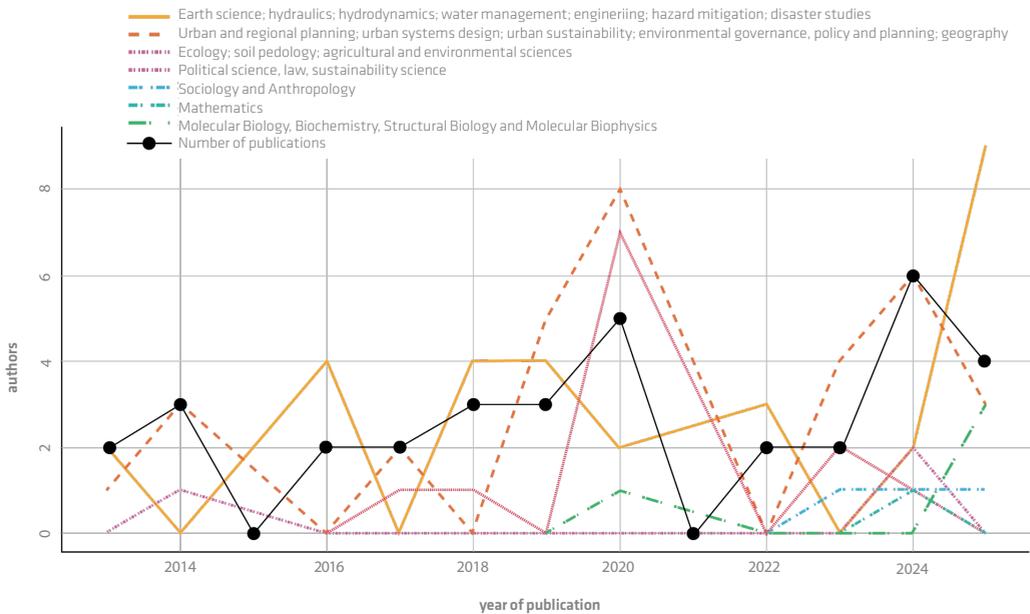
ples Federico II (with its Department of Agricultural Science and its Department of Civil, Architectural and Environmental Engineering), James Cook University (namely, its Centre for Tropical Urban and Regional Planning at the School of Earth and Environmental Sciences and its Centre for Disaster Studies) and Griffith University (namely, its Australian Rivers Institute and its School of Environment and Science).

**Affiliations concentrate in the Global North (72%) while many cases studied are in the Global South. This asymmetry matters: knowledge is produced about southern territories but largely by northern institutions, with predictable consequences for what counts as “evidence” and which interventions are preferred**

**(engineering-heavy, finance-legible). The recurrence of a few institutions also hints at epistemic clustering that can narrow methodological repertoires.**

### 3.4. Authors' disciplinary distribution

As seen at the end of the previous sub-section, even inside the same institution, authors may be affiliated with different departments, focusing on different aspects of climate change adaptation and mitigation and of disaster risk reduction. Authors' core disciplines have been found in the webpages of their institutions and/or in their personal webpages, and clustered based on multiple occurrences (i.e. in each cluster, pairs or triplets of disciplines may be associated with the same author), as shown in **Table 4**.



## Authors' disciplinary clusters per year of publication and number of publications.

Fig. 2

Half of the authors (43 i.e. 50%) are affiliated with disciplines falling under the Physical Sciences and Engineering (PE) macro-sector of the European Research Council (ERC, 2020), including earth science, hydraulics, hydrodynamics, water management, engineering, hazard mitigation, disaster studies (PE8), mathematics (PE1), ecology, agricultural sciences and environmental sciences (PE10). Authors working within the Social Sciences and Humanities (SH) macro-sector represent 39 individuals (45%), with concentrations in urban and regional planning, urban systems design, urban sustainability, environmental governance, policy and planning, and geography (SH2: 32 authors), as well as political science, law, sustainability science (SH2: 3 authors), and sociology and anthropolo-

gy (SH3: 4 authors). A smaller portion (4 i.e. 7%) operate within the Life Sciences (LS) macro-sector, specifically in fields such as molecular biology, biochemistry, and structural biology (LS1). The disciplinary distribution of authors shows a predominance of hard and technically applied sciences, suggesting that a technocentric approach may exist in addressing CMA and DRR. This tendency will be further verified in the following content analysis. However, there is a substantial representation of scholars from urban and regional planning, geography, environmental governance and related domains. This aspect might signal a significant spatial and policy-oriented engagement with the topic. The temporal distribution of publication in comparison with the disciplinary distribution, re-

# Journals, book series and publishers' publications impact factor

Tab. 5

Journal/Book Series/Publisher	(Parent) Publisher	Location	Impact factor*
Springer Water	Springer	Cham, Switzerland	N/A
International Journal of Disaster Risk Reduction	Elsevier	Amsterdam, The Netherlands	4.5
Procedia Economics and Finance	Elsevier	Amsterdam, The Netherlands	N/A**
E3S Web of Conferences	EDP Science	Les Ulis, France	0.8***
World Bank Publications	World Bank	Washington, DC, United States	N/A
Procedia Engineering	Elsevier	Amsterdam, The Netherlands	N/A**
Ecological Indicators	Elsevier	Amsterdam, The Netherlands	7.4
Earthscan	Taylor & Francis	London, United Kingdom	N/A
Springer Climate	Springer	Cham, Switzerland	N/A
Progress in Disaster Science	Elsevier	Amsterdam, The Netherlands	3.8
International Journal of Disaster Resilience in the Built Environment	Emerald	Bingley, United Kingdom	1.9
WIT Transactions on Ecology and the Environment	WIT Press	Ashurst Lodge, United Kingdom	0.2
Geophysical Monograph Series	Wiley	Hoboken, NJ, United States	N/A
Journal of Homeland Security and Emergency Management	DeGruyter	Berlin, Germany	1.0
Tsukuba International Office	N/A	Tsukuba, Japan	N/A
IOP Conference Series: Earth and Environmental Science	IOP Science	Bristol, United Kingdom	0.2***
CLEAN – Soil, Air, Water	Wiley	Hoboken, NJ, United States	1.4
Lecture Notes in Energy	Springer	Cham, Switzerland	N/A
Community, Environment and Disaster Risk Management	Emerald	Bingley, United Kingdom	N/A
Remote Sensing	MDPI	Basel, Switzerland	4.1
Biological Conservation	Elsevier	Amsterdam, The Netherlands	4.4
Climate and Development	Taylor & Francis	Abingdon, United Kingdom	3.5
Pakistan Journal of Life and Social Sciences	Elite Scientific Publications	Accra, Ghana	N/A

Town and Regional Planning	University of the Free State	Bloemfontein, South Africa	0.6
Journal of Water Resources Planning and Management	American Society of Civil Engineers (ASCE)	Reston, United States	3
International Journal of Disaster Resilience in the Built Environment	Emerald	Bingley, United Kingdom	1.1
Theoretical and Applied Climatology	Springer	Cham, Switzerland	2.7
Lecture Notes in Networks and Systems	Springer	Cham, Switzerland	0.6**
Climate Smart Development in Asia	Taylor and Francis	London, United Kingdom	N/A
Scientific Reports	Springer Nature	London, United Kingdom	3.9
Climatic Change	Springer	Cham, Switzerland	4.8
Irrigation and Drainage	Wiley	Hoboken, NJ, United States	1.7
Sustainability	MDPI	Basel, Switzerland	3.3
Land	MDPI	Basel, Switzerland	3.2
Climate	MDPI	Basel, Switzerland	3.2
Environmental Research Communications	IOP Science	Bristol, United Kingdom	2.5
Environmental Science and Policy	Elsevier	Amsterdam, The Netherlands	5.2

\*approximated to decimals

\*\*discontinued

\*\*\*impact score

veals again a dominance of technical and environmental, indicating a possible constant presence and central role of engineering and earth sciences in climate and risk research. Urban and regional planning disciplines have surprisingly maintained a steady presence, with surges in 2020 and 2014. It might appear that the hard sciences have been communicating almost directly with planning practices and urban studies, with an almost steady increase in spatial studies' interest in the topic. Ecological and Environmental sciences show a more sporadic pattern, peaking in 2020, likely reflecting a growing awareness in nature-based dimensions. Social Sciences and Life Sciences appear only recently and in small numbers, suggesting a delayed but emerging transdisciplinary engagement with CMA and DRR. Mathematics, as a singular oc-

currence, appears in a research article in collaboration with another author coming from Social Sciences; this presence is justified as the study process structured interviews which could require mathematical and statistical analysis.

The PE dominance (50%) with SH2 as second pole confirms a two-pillar architecture: modeling/engineering and policy/planning. Missing are political ecology, environmental humanities, and design practice as epistemic engines (not just recipients of models). This imbalance helps explain why DRR and CMA appear “in parallel” rather than operative within spatial projects.

### 3.5. Journals, book series, and publishers

The works resulting from the literature review at hand are mostly published (**Table 5**) by El-

sevier, with 7 items (21%), followed by Springer with 5 items (15%) and Multidisciplinary Digital Publishing Institute (MDPI) with 4 items (12%); Wiley has 3 items (9%) and Taylor and Francis has 2 items (6%). Based on the aforementioned Brandt line, most of the publishers are from the Global North (86%), the two exceptions from the Global South are Elite Scientific Publications, located in Ghana, and the University of the Free State in South Africa with one publication each (3%). Overall, 53% of the publications are available in open access; 55% when limiting to papers in scientific journals. When available, the impact factors of scientific journals range between 0.2 and 7.4.

The book series related to the selected book chapters are within Springer Climate series (Springer) (Deves *et al.*, 2018), the book *Climate Smart Development in Asia* printed by Routledge (Taylor & Francis) (Ling & Fujino, 2013) and the series of conference proceedings collection *Lecture Notes in Networks and Systems* (Springer). The book *Communicating Climate Change Information for Decision-Making*, part of the Springer Climate series, includes interdisciplinary research focusing on climate change sciences, fields of knowledge such as ecology, water management and communication sciences (Serrao-Neumann *et al.*, 2018). *Climate Smart Development in Asia* explores topics around economics, finance, business and sustainable and global development (Srinivasan *et al.*, 2012). The third and last book series *Lecture Notes in*

*Networks and Systems* can contain proceedings of conferences in the fields of decision making, applied sciences, engineering, computer sciences, economics, social and life sciences.

The fields of the journals cover the following disciplines: earth sciences and their implications, environmental sciences, engineering, urban studies, geography, and the social sciences (International Journal of Disaster Risk Reduction; Ajibade, 2017; Banwell *et al.*, 2020); economics and finance (Procedia Economics and Finance; Attolico, 2014); environment, energy, and earth sciences (E3S Web of Conferences; Bogaard *et al.*, 2016); engineering (Procedia Engineering; Cadiz, 2018); ecological modelling, ecology, evolution, behaviour and systematics (Lecture Notes in Networks and Systems; Biancifiori *et al.*, 2024); disaster risk reduction, response, emergency management and recovery (Progress in Disaster Science; Djalante & Lassa, 2019); disaster risk reduction, response and reconstruction to reduce the impact of natural and anthropogenic hazards (International Journal of Disaster Resilience in the Built Environment; Espada *et al.*, 2017; King *et al.*, 2016); sustainable development (WIT Transactions on Ecology and the Environment; Galderisi, 2014); homeland security and emergency management (Journal of Homeland Security and Emergency Management; Klima & Jerolleman, 2014); earth sciences and environmental sciences (IOP Conference Series: Earth and Environmental Science; Rani *et al.*, 2020; Widiati, 2019); environmental safety

# Keyword occurrences (higher than two).

Tab. 6.a

#	Keyword	Number of occurrences
1	Climate Change	19
2	Risk Assessment	13
3	Disaster Risk Reduction(s)	11
4	Disaster Management	10
5	Sustainable Development	7
6	Resilience	6
7	Disasters	6
8	Adaptation	6
9	Urban Planning	5
10	Decision Making	5
11	Climate Change Adaptation	5
12	Adaptive Management	5
13	Risk Perception	4
14	Risk Management	4
15	Mitigation	4
16	Urban Development	3
17	Strategic Approach	3
18	Land Use Planning	3
19	Green Infrastructure	3
20	Governance Approach	3
21	Extreme Event	3
22	Ecosystems	3
23	Disaster Mitigation	3

## Keyword occurrences (clustered by affinity).

Tab. 6.b

#	Keywords	# occurrences
1	Risk Analysis, Mapping, Management; (Natural) Disaster Risk Reduction (DRR) and Mitigation, Local Government and DRR, Emergency Management	32
2	Climate Change: Adaptation, Mitigation, Science and Policy, and/or Governance	31
3	City / Territorial / Urban / Resilience / Planning	11
4	Resilience, resilience planning, and resilient	8
5	Flooding or Coastal Risks, Flood risk and or management, Flood Mitigation, Flood Governance, Flood Damage Mitigation	6
6	Ecosystems, Ecosystem Services, Ecosystem-based Management, Vegetation and Energy Indices, or Regulating Services	4
7	Sustainability Science, Environmental Justice, or Environment and Sustainability	4
8	(Resilient) Cities, Future City, Built Environment	3
9	Infrastructure or Green Infrastructure	3

and sustainability: air pollution, waste management, the water cycle, and environmental conservation (Schneider *et al.*, 2022); science and application of remote sensing technology (Remote Sensing; Taramelli *et al.*, 2019); conservation science: biological, sociological, ethical, and economic dimensions (Biological Conservation; Tulloch *et al.*, 2020); interfaces between climate, development, policy, and practice to make analysis of climate and development issues (Climate and Development; Wamsler, 2013).

Of all editorial positions, only two book series explicitly address city and urban planning, urban studies, communities and human settlements, and urban development (Eltinay & Egbu,

2024; Ling & Fujino, 2013), and only one scientific journal is primarily concerned with such subjects and topics (Town and Regional Planning). Nevertheless, two journals cover urban studies together with engineering and with earth and environmental sciences (International Journal of Disaster Resilience in the Built Environment; Town and Regional planning). These cases represent a disciplinary exception, since engineering, earth sciences, environmental sciences, and development studies – together with life sciences – are rather the regular foci of the book series and journals that host the publications of the present literature review. Finally, it may be interesting to note that disaster risk reduction

and emergency management appear as the core topics of four journals in which five papers are published, i.e. well below one third of the total selected scientific articles.

### 3.6. Keywords

The study of keywords can reveal the internal connections of scientific knowledge with a given discipline (Liao & Furuya, 2023). Thus, a frequency analysis of keywords can offer a preliminary overview of the hotspot in a specific subject (Pan *et al.*, 2023).

Related to the literature review at hand, keywords – which were found in 16 out of 26 publications – are reported in **Table 6.a**, limited to occurrences higher than one, in **Table 6.b**, clustered by affinity.

Other occasionally occurring keywords include: habitat connectivity; governance, future city, forestry, flood risks; flood risk management; flood maps; finance; equitable disaster management; environmental justice; environmental impact assessment; energy indexes; energy crop; ecosystem services; ecosystem resilience; ecosystem; economic growth; development planning; decision making; decision support system; copernicus services; conservation management; community; co-design; climate model; cities; built environment; building; bioenergy; biodiversity; artificial intelligence; anthropogenic pressures; agriculture; abandoned land. Although “Climate Change” shows a higher frequency (19 occurrences), no other keyword emerges as overwhelmingly dominant; the re-

maining terms show relatively balanced frequencies (**Table 6.a**). Most of the keywords occurring more than once are either directly (#2–6, #8, #12) and quasi-immediately (#9–10) related to the search terms, or corresponding to currently dominant frameworks and narratives (#1, #7) which such search items fall within. When keywords are grouped by affinity (**Table 6.b**), CMA and DRR are addressed with comparable emphasis (31 and 32 occurrences respectively), which is unsurprising inasmuch as they represent the core paradigms of the literature review at hand; terms related to resilience are still important (#3), as outlined above; cities and more generally built environment on the one side and spatial planning on the other – i.e. the main foci of CMA and DRR in the present contribution – also rank high (#4 *ex aequo*). Next are some terms related to ecosystem services and to environmental and sustainability sciences (#6 *ex aequo*), whose connections to CMA and DRR have been outlined (Munang *et al.*, 2013). The crucial impacts of land use on disaster risk (Burby, 1998; Su *et al.*, 2021) and climate change (Pielke Sr, 2005; Dale *et al.*, 2011; Popp *et al.*, 2014) have been also clear for quite a long time, yet the occurrence of related keywords is poor (they only appear twice), and so is their overall presence in the selected publications’ contents and highlights, as shown in the next section.

### 3.7. Publications’ contents and highlights

Content-wise, the most used words have been

## Most used words in selected publications.

Tab. 7

#	Most used words	Occurrences
1	Climate	816
2	Change	558
3	Risk	508
4	Adaptation	377
5	Local	342
6	Disaster	342
7	Policy	331
8	Urban	329
9	Planning	327
10	Flood	323
11	Development	230
12	Management	223
13	Community	200
14	Land	199
15	Resilience	195
16	Heat	195
17	Implementation	190
18	National	163
19	Reduction	179
20	Coastal	175
21	Water	172
22	Mitigation	168
23	Economic	164
24	Rainfall	160
25	City	158
26	Green	157
27	Government	156
28	Energy	150
29	Research	140
30	Policies	139

searched for in the selected works, excluding determinative and indeterminative articles, adverbs, pronouns, conjunctions, and cited references. The resulting words are ranked in **Table 7** based on their occurrence.

Items #1–4, #6 and #8–9 are all part of the search items (title, abstracts, and keywords), so their frequent occurrence is no surprise. In **Table 7b** are listed only the terms included in the research query in order of ranking. “Reduction” only ranks #20 followed at #23 with “mitigation”, while interesting to note how “governance” and “disasters” (i.e. #49 and #68) are ranked really low in comparison to other terms like “resilience” or “economic” (i.e. #15 and #23). The word “Cities” – also ranked quite low at #64 – is found coupled with “smart” and “future” (Ajibade, 2017), or “resilient” and “communities” (Djalante & Lassa, 2019). Among the terms that are not included in the search items, we can find “resilience” (#15), which is actually quite a trendy word in the considered timeframe, and business-oriented words such as “development” (#11), “management” (#12), “implementation” (#17), and “economic” (#23). Some words can suggest the type of risks and climate change topics tackled in the selected literature: “flood” #10, “heat” #16, “coastal” #20, “water” #21. Even though climate is concerned (#1 word by occurrence), the adjective “environmental” does not even appear in the table as it only ranks #68, together with “environment”, “ecology”, “ecological”, and alike do not even appear in the first 100 words.

### 3.8. *Publications’ reading, summary, critique and relevance to query*

This section synthesises findings from 34 academic contributions that address the integration of Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) within urban and spatial planning. For each article, a brief summary is provided, followed by a critical reflection and an assessment of its relevance to the central research question. Rather than serving as a purely descriptive inventory, these readings are used to trace recurring patterns of discourse, disciplinary positioning, and methodological orientation across the reviewed literature. Together, they form the analytical groundwork for the subsequent cross-comparison (Section 3.9) and the interpretive discussion (Section 4), where broader tendencies and gaps are systematically articulated.

- **Ajibade (2017)** analyses critically the Eko Atlantic City project in Lagos, Nigeria, a development that has been framed mediatically and politically as a climate resilient response to coastal inundation risk of the area. Through a political ecology lens, the study intends to expose how mega-projects such as Eko Atlantic City, while claiming to enhance resilience, often reinforce capitalist accumulation, socio-spatial inequality and ecological degradation. It highlights how it can be problematic to detach the term ‘resilience’ from social and environmental justice, arguing that this can in fact create

'maladaptation'. While highly relevant to the discourse on CCA, CCM and urban resilience, the article does not engage with spatial planning or design practices. Its methodology is instead grounded in geography and critical social sciences, offering a structural critique rather than operational planning insights;

- **Attolico (2014)** examines how DRR is integrated into land use planning in the province of Potenza, Italy. It emphasises the importance of stakeholder engagement and institutional awareness in the face of increasing climate-related risks. The study offers a governance framework that supports territorial decision making for risk management, while highlighting the need for municipalities to be aligned with funding opportunities. While the article acknowledges the role of urbanisation in shaping exposure and adaptive capacity, its contribution remains on procedures and assessment tools rather than spatial or design strategies. It does offer generic guidelines for institutions, but overlooks that potential of local communities' knowledge as a proactive force in territorial planning. CCA and CCM are mentioned but not explored in depth;
- **Banwell et al. (2020)** examine the barriers to implementing climate resilience policies in the Araucanía Region of Chile, highlighting the gap between international agreements and local realities. Using a mixed-methods

approach, primarily based on questionnaire data, the study frames climate resilience as a convergence of DRR, CCA, and CCM, and argues for the essential role of community engagement in achieving sustainable development. The findings reveal a disconnect between policymakers and local populations: while officials assume that communities are disengaged or unaware, the data show that local actors possess significant awareness and culturally embedded knowledge to address climate risks. The article identifies socio-political, economic, and cultural factors as key obstacles to effective resilience implementation. Methodologically, it engages directly with participatory planning practices, making it relevant to urbanism both conceptually and in terms of applied tools, particularly regarding the inclusion of local knowledge in spatial governance. However, It does not engage with operational spatial planning or urban design practices;

- **Biancifiori et al. (2020)** present a case study on the use of participatory design and gamification to support Nature-Based Solutions (NBS) in urban regeneration, focusing on the redevelopment of Fioccardo Park in Turin. Through the *Start Park* board game, the study simulates a co-design process with students, aiming to raise awareness on climate change, promote social engagement, and inform adaptive planning. The main contribution lies in translating citizen partic-

ipation into a structured, replicable method that connects policy frameworks with local experimentation. While the approach fosters interaction and shared decision-making, its reliance on students as stand-ins for community members limits its external validity, and its application remains confined to the pre-design phase, without yet addressing spatial or operational dimensions. Nonetheless, the study offers relevant insights for integrating Climate Change Adaptation (CCA), Disaster Risk Reduction (DRR), and participatory planning into urban practice, emphasising the value of early engagement, transparent processes, and context-sensitive governance;

- **Bogaard et al. (2016)** present the early stages of a research project aimed at developing Coastal Early Warning Systems (CEWS) across 11 European sites. While primarily focused on prevention, mitigation, and preparedness, the article notably incorporates CCA as part of its objective, aligning with broader resilience frameworks. The project emphasises the creation of generic, engineer-driven decision-support tools, targeting hazard anticipation and risk communication in coastal areas. Although relevant to the discourse on climate resilience and risk reduction, the article remains outside the scope of spatial or urban planning, offering no direct engagement with design practices or planning processes. Its relevance to the

research query lies in its technical contribution to DRR and CCA, rather than in its integration into planning or participatory governance frameworks;

- **Cadiz (2018)** introduces the UP NOAH initiative (Nationwide Operational of Hazards for the Philippines), a geospatial research project focused on multi-hazard risk mapping in the Philippines to support DRR. The study applies GIS-based tools to identify high-risk areas, aiming to inform prevention strategies and early interventions. While the project is primarily oriented toward risk mitigation rather than long-term climate adaptation, it does position spatial mapping as a planning-relevant tool, connecting scientific data to territorial governance. Its contribution lies in operationalising hazard awareness through spatial analysis, but it does not engage with adaptive planning or design approaches. The study is relevant to the research query in terms of DRR and geospatial integration, though its framing remains more technical than participatory or design-oriented;
- **Carlone & Mannocchi (2024)** examine the institutional and societal barriers to the adoption of Nature-Based Solutions (NBS) for DRR within the socio-ecological system of Emilia-Romagna. Through a qualitative case study, the article highlights how, despite being recognised as effective DRR tools, NBS remain marginal in practice due

- to resistance from technical professionals, limited policy integration, and socio-economic constraints. The study positions NBS within the framework of spatial planning, identifying governance and cultural shifts as necessary conditions for their mainstreaming. Directly relevant to the research query, the article reinforces the potential of NBS in planning but underscores the structural inertia that hinders their full implementation;
- **Cervelli et al. (2020)** investigate the potential of marginal areas for hosting bioenergy crops, aligning with the European renewable energy agenda. Using land use change modelling and scenario-based ecosystem service (ES) assessment, the study explores spatial strategies for sustainable development. While the concept of resilience is mentioned, it is drawn primarily from policy references and not elaborated within the spatial or ecological dynamics of the study. The framing of ES as exact and quantifiable overlooks ongoing debates about their contextual and socio-ecological variability. Furthermore, concerns arise from the monocultural approach to crop selection, particularly the ecological appropriateness of using riparian species without restoring wetland conditions. Although the article does not directly address CCA or CCM, it engages with planning tools and spatial decision-making, offering indirect relevance to sustainability-oriented territorial governance;
  - **Chandra et al. (2023)** investigate how Pacific Small Island Developing States are addressing climate-induced Non-Economic Loss and Damage (NELD), with particular attention to cultural, ecological, and identity-related impacts. Through stakeholder interviews and policy analysis, the article reveals a persistent disconnect between emerging adaptation and relocation strategies and the formal recognition of intangible losses in governance frameworks. Although spatial dimensions are not central, the study's emphasis on cultural erasure, traditional knowledge, and biotic relations invites deeper reflection within biocentric urbanism. It challenges technocratic approaches to climate planning by foregrounding non-technical, life-anchored values, even if it stops short of engaging directly with design or spatial planning practices;
  - **Cottar & Wandel (2024)** analyze the post-2021 flood recovery in Merritt, British Columbia, focusing on municipal approaches to flood mitigation and the contested potential of managed retreat. Through interviews with local officials, the study underscores the dominance of short-term rebuilding over long-term adaptation, constrained by political hesitation, funding gaps, and housing pressures. While not centered on spatial planning, it offers valuable insight into how local governance structures and policy inertia can obstruct transformative responses to

climate risk. The article is particularly relevant for urban resilience planning, highlighting the need to bridge emergency recovery with proactive land-use and relocation strategies;

- **Devès et al. (2018)** critically examine the structure and knowledge production processes of the IPCC, highlighting the limitations of its top-down, expert-driven model in supporting the bottom-up implementation of the Paris Agreement. The chapter advocates for a more inclusive, multi-actor and interdisciplinary approach to CCA and DRR, arguing that broader stakeholder engagement could help bridge the persistent gap between science and policy. While the study is not directly situated within urban planning or spatial design, its call for transdisciplinary integration offers an implicit relevance to urbanism, particularly in its potential to incorporate diverse knowledge systems and contextual responses to risk;
  - **Djalante & Lassa (2019)** assess progress on Priority 2 of the Sendai Framework for DRR, focusing on governance as a key enabler of risk reduction. The authors stress that disaster impacts are deeply rooted in social vulnerability, particularly affecting marginalised populations, and call for adaptive governance models that respond to these structural inequalities. The study proposes a five-step pathway – from recognising community vulnerabilities to institutionalising
- adaptive governance – but its recommendations remain primarily within the political and institutional realm. While not directly engaging with spatial planning or design, the governance shifts outlined could support more equitable territorial strategies, making the article indirectly relevant to spatial resilience discourse;
- **Galderisi's (2014)** structure is around the integration of CCA and DRR in urban planning, the article offers a valuable theoretical framework for understanding adaptation phases across European contexts. The study critiques the limited intersectoral coordination and vagueness of vulnerability indicators, proposing a more systemic planning logic beyond isolated tools. While it lacks operational design applications, it remains an asset for resilience-oriented planning;
  - **Hanna et al. (2025)** introduce a novel evaluation tool for riverine flood policies in New Zealand, highlighting institutional inconsistencies and a slow but significant shift toward risk-informed planning. The work enriches DRR-CCA integration discourse with a governance-focused lens, emphasising policy coherence over design. It's particularly relevant for translating adaptive principles into actionable planning criteria;
  - **Indal & Arriola (2024)** explore how LGUs in Basilan Province implement CCM and DRR strategies through local policies and administrative action. While the study sheds light

on institutional barriers in resource-scarce contexts, it remains descriptive and detached from spatial or design perspectives. Nonetheless, it offers critical insights into governance challenges shaping local climate resilience efforts in the Global South;

- **Islam et al. (2025)** analyze long-term precipitation trends along coastal Bangladesh, revealing spatial and seasonal variability linked to monsoons, land use, and the Sundarbans. While methodologically robust, the study remains within climatological boundaries, offering limited engagement with planning or governance. Nonetheless, its findings provide essential data for anticipatory adaptation and water risk strategies in vulnerable deltaic contexts;
- **King & Gurtner (2017)** draw on post-disaster surveys in Australia to highlight how communication, preparedness, and community education can reduce flood risk. While rich in empirical insight, the chapter focuses more on governance and behavioral aspects than on spatial or design dimensions. Still, it offers relevant contributions to DRR through socially grounded approaches to risk and resilience;
- **King et al. (2016)** examine how land-use planning frameworks in post-disaster contexts support or hinder DRR and CCA goals across Australia, Thailand, and Indonesia. Emphasising institutional gaps and development-driven priorities, the article critiques current planning systems for neglecting long-term resilience. While lacking design-specific tools, it offers valuable insights into the governance conditions necessary for embedding risk sensitivity in spatial planning;
- **Klima & Jerolleman (2014)** trace the evolution of hazard mitigation from siloed practices to more integrated, cross-sectoral approaches linking DRR, adaptation, and resilience. Through U.S. based examples, the article advocates for governance reform and professional collaboration. While not spatially grounded, it offers conceptual clarity on institutional barriers and enablers for integrated climate risk planning;
- **Lam & Delina (2024)** review financing strategies for extreme heat adaptation in Southeast Asian cities, emphasising the divide between structural and non-structural measures. While regionally grounded and aligned with the Sendai Framework, the study remains largely descriptive and under-engages with urban design. Still, it offers valuable insights for integrating climate finance, heat governance, and socio-spatial equity in resilience planning;
- **Myers et al. (2020)** analyze recent trends in CCA, resilience, and DRR through urban and regional planning policies in Zanzibar, Tanzania. The study highlights the dominance of land use and zoning approaches, critiquing their limited capacity to respond to the

complexities of climate-related risks. It also points to a reliance on externally driven funding and policy frameworks – primarily from non-African actors – which perpetuate top-down models that marginalise local knowledge and participation. While the article engages with DRR, CCM and CCA, it does so without clearly differentiating between these concepts, and without addressing concrete design or implementation practices. Its focus remains on the planning discourse and the early stages of project development, offering critical insights into the structural and governance challenges of resilience-building in postcolonial contexts;

- **Perney & D'Angelo (2023)** examine the integration of DRR and CCA into urban governance through the EU-funded SEACAP 4 SDG project in Naples. Focusing on the implementation of a Living Lab and an updated SECAP, the study documents participatory tools and training sessions involving municipal, academic, and civil society actors. While the article emphasises collaborative methodology and EU alignment, it remains largely descriptive and offers limited critical reflection on power dynamics or spatial negotiation. Nonetheless, it provides a replicable model for advancing climate resilience in urban planning, especially in cities navigating capacity constraints and supranational frameworks;
- **Rani et al. (2020)** analyze the incorpora-

tion of CCA and DRR into Malaysian urban development plans across governance levels, using policy content analysis. They find stronger integration at the local scale – particularly in the Cameron Highlands – compared to the more sector-specific national frameworks. While the study offers a useful institutional mapping, it lacks engagement with governance dynamics or spatial design practices. Still, it contributes to understanding how national directives translate into localised climate resilience planning, especially in contexts balancing top-down policy coherence with place-based adaptation;

- **Schneider et al. (2022)** investigate how urban green infrastructure (UGI) and nature-based solutions can mitigate climate extremes in Holguín, Cuba. Through ecological engineering and spatial mapping, they identify pilot interventions targeting flood and heat risks, especially in vulnerable neighborhoods. While the study offers practical methods for applying NbS in data-poor settings, it remains technocratic, with limited attention to governance or spatial equity. Nonetheless, it contributes to DRR-CCA integration by showcasing how green urbanism can enhance resilience and ecological functionality in Latin American cities;
- **Sethi et al. (2025)** provide a longitudinal analysis of interannual climate variability in coastal Odisha, revealing increasing temperature fluctuations and their links to ex-

treme weather events. Drawing on 54 years of station-level data, the study highlights how shifts in seasonal variability exacerbate climate risks for agriculture, infrastructure, and disaster response. While technically rigorous, the article remains within the domain of climate science, offering limited engagement with planning or governance. Nonetheless, it presents valuable insights for regional DRR-CCA strategies and underscores the climatic volatility shaping socio-ecological vulnerability in coastal regions;

- **Sharkus et al. (2025)** analyze spatial and temporal trends in flood risk across Environmental Justice communities in Massachusetts, revealing that low-income, minority, and limited-English-proficient populations are increasingly concentrated in high-risk zones. Using the Environmental Justice Index and geospatial data from 2010–2020, the study exposes structural inequalities in flood exposure. While grounded in strong spatial analysis, it lacks participatory depth and remains focused on technical risk mapping. Nonetheless, it contributes to DRR and CCA by foregrounding equity in climate adaptation, making a strong case for justice-centered and place-based flood governance;
- **Taramelli et al. (2019)** assess the potential of Copernicus Global Land Service data to monitor green infrastructure, particularly natural water retention measures (NWRMs),

as nature-based solutions for DRR and CCA. By linking vegetation indices with ecological functions and policy goals, the study provides decision tools to inform spatial planning. Despite limitations in resolution and validation, it offers a practical framework for integrating remote sensing into design and environmental governance, supporting the spatialisation of water retention and biodiversity goals;

- **Tulloch et al. (2020)** evaluate global cumulative impacts on marine ecosystems by disaggregating stressors into climate, land, and marine-based categories, and assess the alignment of management tools such as Marine Protected Areas (MPAs), Integrated Coastal Management (ICM), and climate hazard reduction with dominant threats. Their conservation-effectiveness index reveals mismatches between impact sources and policy responses, especially in small island states with high climate vulnerability. By linking impact mapping with governance indicators, the study advances a multi-scalar, spatially grounded approach to DRR and CCA, reinforcing the need for trans-jurisdictional, ecosystem-based, and context-sensitive resilience planning;
- **Wamsler (2013)** discusses the outcomes of the Fourth Global Platform for DRR, arguing for integrated risk governance that bridges global frameworks and local realities. She highlights the importance of including civil

# Publications' macro-themes clustering

Tab. 8.a

Macro theme	#
Land Use Planning	2
Global South and Indigenous Perspectives	5
Techniques, modelling and mapping	5
Urban Governance	10
Urban Planning	7
Water Techniques	3

society, personal responsibility, and behavioral change, while challenging the binary between global mitigation and local adaptation. The paper calls for systems thinking and enforceable global targets in shaping the Hyogo Framework for Action (HFA2), aligning with trans-scalar accountability and the systemic nature of risk;

- **Widiati & Irianto (2019)** assess the Multi-Stakeholder Fora (MSF) in Papua Province, eastern Indonesia. It looks at MSF as a participatory platform for climate mitigation and adaptation, focusing on mangrove conservation and local governance. While MSF fosters coordination across sectors, its reliance on external funding and limited institutionalisation of community participation undermine long-term resilience. The case illustrates the promises and fragilities of localised, stakeholder-driven DRR and CCA governance, offering insights into the pro-

cedural and structural challenges facing bottom-up adaptation in resource-constrained contexts;

- **Yoshikawa & Koshiyama (2024)** evaluate the potential of Tambo Dams – small, low-cost water regulation devices in paddy fields – as a flood control measure in Japan. Framed within the concept of Eco-DRR, the study highlights a systemic shift in Japanese water governance from centralised river control to integrated basin-level flood management. The research shows that widespread implementation of Tambo Dams can simultaneously reduce flood risks and enhance food security, particularly for vulnerable communities. While the article does not explicitly address CCA, its integrated, ecosystem-based approach aligns with adaptive planning principles. Though rooted in technical water management, the study's recognition of multifunctional landscapes

## Risks tackled in the publications

Tab. 8.b

Type of risk	#
Flooding	13
Extreme Heat and Heatwaves	3
Earthquake and Tsunami	1
Biodiversity loss	1
Undefined	14

positions it as relevant to spatial resilience and nature-based planning.

All the analysed publications show a wide range of thematic orientations. In order to offer a systematic understanding of the contents of the contributions, in **Table 8a** seven macro-themes within each article have been categorised. The themes are: 'Land Use Planning', 'Global South and Indigenous Perspectives', 'Techniques, modelling and mapping', 'Urban Governance', 'Urban Planning' and 'Water Techniques'. 'Land Use Planning' refers to those works which interrogate the classic territorial instruments (e.g. zoning) and their inclusion in DRR. Attolico (2014) and King *et al.* (2016) argue how land use planning is constrained and rigid in comparison with the need for flexibility and understanding of uncertainty that climate related risks ask for. The contributions which take into account the 'Global South and Indigenous Perspectives' put in the foreground the (higher) climate vulnerability in postcolonial and resource-lacking contexts. These articles prioritise cultural, so-

cio-political and epistemic dimensions. In the case of Ajibade (2017), Myers *et al.* (2020), Islam *et al.* (2025), Indal & Arriola (2024) and Chandra *et al.* (2023), place-based knowledge and institutional fragilities are highlighted: Global South territories are often excluded or subordinated in the adaptation process and dialogue. As it was noticed throughout this review, technical and technocratic approaches seem to be at the forefront of DRR, CCA and CCM, it was crucial to notice which contributions are purely focused on these techno-oriented themes. 'Techniques, modelling and mapping' macro-theme integrates quantitative, technical or model-driven approaches and methods to hazard and risk prediction and assessment. Cadiz (2018) and Sethi *et al.* (2025) focus on GIS techniques for risk identification, Taramelli *et al.* (2019) use remote sensing for mapping ecological resilience and Schneider *et al.* (2022) use mapping for implementation of NbSs. Then there is the 'Urban Governance' and 'Urban Planning' themes that together count almost half of the total contri-

butions. The first cluster contains how institutions and policies shape CCA, Articles such as Wamsler (2013), Devès *et al.* (2018), and Djalante & Lassa (2019) critically assess the global picture of climate governance, drawing attention to the limitations of top-down, expert-driven frameworks in fostering locally grounded action. In contrast, studies like Cottar & Wandel (2024), Perney & D'Angelo (2023), and Hanna *et al.* (2025) delve into municipal-level responses. Yoshikawa & Koshiyama (2024) and Lam & Delina (2024) expand this theme by highlighting how hydrological regimes, flood control, and urban heat management are increasingly entangled with administrative and planning systems. The second cluster brings together the contributions that focus on spatial practice, participation and co-design techniques and procedural explorations. Biancifiore *et al.* (2020) explores the use of gamified co-design to support Nature-Based Solutions (NbS); Galderisi (2014) and Carlone & Mannocchi (2024) engage with scenario-based tools; Rani *et al.* (2020) and Banwell *et al.* (2020) further expand this perspective by examining how planning hierarchies, local capacities, and community knowledge systems influence the integration of CCA and DRR across governance levels. Finally the 'Water Techniques' include technical infrastructures and spatial tools addressing water-related risks. Articles like the one of Bogaard *et al.* (2016) on Coastal Early Warning Systems (CEWS), Tulloch *et al.* (2020) on marine stressor mapping, and Sharkus *et al.*

(2025) on spatial injustice in flood exposure exemplify this approach.

Among the reviewed contributions, water-related climate risks emerge as the most dominant concern, with 38% of the publications addressing flooding in its various forms (**Table 8b**). Within the total addressing floods, 25% are about coastal inundation and 17% about riverine or pluvial events. These threats are not only environmental but also deeply urban and political, intersecting with themes of speculative development (Ajibade, 2017), spatial injustice (Sharkus *et al.*, 2025), and institutional reform (Yoshikawa & Koshiyama, 2024). This prevalence confirms the centrality of water in shaping both vulnerabilities and adaptive strategies within climate-resilient urbanism. Nature-Based Solutions (NbS) feature in 16% of the contributions, signaling their rising role as mediators between design, governance, and ecosystemic processes. From ecological engineering in Latin American cities (Schneider *et al.*, 2022) to participatory co-design in Italy (Biancifiore *et al.*, 2020), and governance critiques (Carlone & Mannocchi, 2024), NbS emerge as both tool and paradigm in rethinking resilience. Additionally, 9% of the articles specifically engage with heat-related risks, especially in urban contexts with rising energy demand and unequal exposure (Lam & Delina, 2024; Schneider *et al.*, 2022). While less represented than flooding, heat adaptation appears increasingly relevant in discussions of urban equity and infrastructural planning.

### 3.9. Publications' cross reading: a fragmented landscape of spatial engagement and practice

The critical reading of the literature resulting from the set query, reveals a fragmented and non-homogenous incorporation of DRR, CCA and CCM within spatial practices. DRR, CCA and CCM are often involved in the arguments of the articles as “components” of *resilient strategies* but seldom translated into spatial operative frameworks or design processes. Many contributions look at resilience under a technological or institutional lens, detaching it from spatial design and planning or from socio-political-environmental ecologies that might emerge from resilient urban adaptation strategies. The analysis of the Eko Atlantic City in Nigeria, demonstrates how urban projects that have been called “resilient” might perpetuate instead “maladaptation”: favoring vulnerability and displacement of already at risk communities, legitimising private capital accumulation and economic growth, and creating socio-ecological hazards under the disguise of heavy-engineered coastal protection projects (Ajibade, 2017). This case underlines how there might be an assumption that resilience is only beneficial and neutral, while in reality spatial interventions can reinforce existing inequalities. Similarly, Banwell *et al.* (2020), with the case study of the Araucania Region of Chile, show the exclusion of local community engagement and knowledge from policy frameworks and implementations. This aspect produces gaps between state and com-

munity actors. Local communities, often overlooked and forgotten by resilience strategies, are in fact aware of climate related risks and are prepared in their adaptive day to day practices. Other contributions highlight more explicitly how planning perspectives are yet only descriptive and technocratic. Attolico (2014) describes DRR integration in the territorial planning of the Potenza province in Italy, yet, fails to interrogate the spatial consequences of the planning decisions. In the case of Naples studied by Perney and D’Angelo (2023), the effort is to align local governance tools to the EU governance frameworks, but overlook the spatial and socio-political reconfigurations necessary for long-term adaptation. Technical tools like GIS and Geoinformatics are also taken into account in the literature (e.g. Cadiz, 2018; Taramelli *et al.* (2019; Cervelli *et al.* (2020)). The use of these tools is often in service of risk identification, prediction and management rather than an integrated component of a participatory spatial design and planning practice. These tools are powerful in revealing exposure and infrastructural fragility, yet they frequently bypass the relational and cultural dimensions that define how space is inhabited, claimed, and governed. As seen in Cervelli *et al.* (2020), land use scenarios are generated to support ecosystem service optimisation, but the resulting “resilience” is tied more to energy productivity than to social or ecological needs. A relevant amount of the selected literature (16%) attempts to in-

tegrate Nature based Solutions into urban and spatial planning. For instance, Carlone & Manocchi (2024) focus their research on NBSs – defined by the European Commission in 2022 – as solutions that are locally adapted, systemic interventions that enhance resilience by integrating natural elements and processes into urban, rural, and coastal environments (UNEP, 2022). As it is noted in the article, NBSs are gaining traction in DRR strategies and regional planning, but reluctance in institutions and disciplinary conservatisms limit their application and transformative potential. Yoshikawa & Koshiyama (2024), for example, highlight how relatively low-tech Eco-DRR measures such as tambo dams can provide both flood mitigation and food security, particularly when supported by state-led decentralisation efforts, but their scalability and integration into planning systems remain uneven.

Meanwhile, Bogaard *et al.* (2016) propose generic early warning and decision support tools for coastal resilience, but these approaches, while scientifically grounded, often operate independently of spatial governance or urban design perspectives. Devès *et al.* (2018) critically reflect on the IPCC's (Intergovernmental Panel on Climate Change) disciplinary biases and call for more inclusive, multi-actor perspectives – emphasising the need to bridge the gap between scientific expertise and situated decision-making. This resonates with Djalante & Lassa's (2019) argument that complexity and govern-

ance failures – particularly the lack of integration across sectors and scales – undermine the effectiveness of the Sendai Framework and delay the structural shift toward adaptive governance.

Moreover, systemic ecological and political perspectives remain marginal across the sample of literature. The absence of references to urban political ecology (with the notable exception of Ajibade, 2017) and the underuse of frameworks such as territorial metabolism or socio-natural assemblages indicate a gap in the research and integration of these essential approaches to DRR and CCA. While keywords such as “resilience”, “adaptation”, and “urban planning” appear frequently, their presence in titles or abstracts is not consistently matched by critical engagement in content. As noted in the content analysis, key terms like “land use” and “governance” are underrepresented relative to their importance in shaping risk and response dynamics.

## Discussion

The results of this systematic literature review confirm a persistent gap in how Disaster Risk Reduction (DRR) and Climate Mitigation and Adaptation (CMA) are jointly conceptualised and operationalised within the spatial disciplines. Our results triangulate discipline-outlet-lexicon to evidence a structural technocentrism: this three-way convergence is a stronger claim than any single indicator alone.

Although “resilience” emerges as a recurring term across the reviewed literature, its articula-

tion is predominantly embedded in technological or institutional frameworks. These framings tend to overlook non-technocratic approaches to spatial governance – such as participatory planning, place-based design, and landscape or ecosystemic strategies – that are essential for integrating DRR and CCA in context-sensitive ways.

**As Nadin et al. (2021) argue, spatial planning should evolve beyond its traditional technocratic rationality towards adaptive and participatory modes capable of negotiating uncertainty and contextual diversity.**

The inclusion of DRR and CMA as core components of spatial thinking remains the exception rather than the rule. Even when both frameworks are addressed, they are typically treated as parallel technical objectives, rather than as interrelated, territorially situated practices that require coordinated, long-term engagement. This fragmentation is clearly reflected in the disciplinary distribution of the selected publications: a strong dominance of engineering, environmental modelling, and geosciences is observed, with urban planning, spatial design, environmental humanities, and political ecology significantly underrepresented.

These disciplinary imbalances are mirrored in the limited engagement with governance complexity. Many of the contributions fail to address how institutional fragmentation, lack of cross-sectoral coordination, and insufficient

attention to local agency constrain the transformative potential of spatial strategies. Planning remains largely instrumental: a vehicle for implementing externally defined goals, rather than a situated practice of negotiation, cultural meaning-making, and ecological attunement. The review highlights how such blind spots lead to maladaptive outcomes – spatial interventions that inadvertently deepen socio-ecological inequalities, reproduce vulnerability, or privilege private interest under the guise of resilience.

Technical tools such as GIS, remote sensing, or early warning systems, though widely adopted in planning and design practices, are predominantly deployed for risk mapping and hazard prediction. While they are indispensable for identifying exposure and fragility, they rarely contribute to participatory spatial storytelling or collective imaginaries of climate futures. As shown by Cadiz (2018), Cervelli *et al.* (2020), and Taramelli *et al.* (2019), the reliance on modelling and remote-sensing tools often confines resilience to a technical exercise of measurement and control. Devès *et al.* (2018) and Djalante and Lassa (2019) similarly note that expert-driven and data-centred frameworks, while valuable for policy coordination, tend to marginalise contextual and co-produced knowledge. As a result, design and planning often appear as passive recipients of scientific data, rather than as active, generative processes capable of framing alternative responses and fostering embedded resilience.

A fundamental shift is thus required: from resil-

ience as a technical or managerial goal to resilience as a socio-spatial and political process. This shift entails more than the integration of DRR and CMA into planning frameworks – it requires a radical rethinking of how resilience is conceived, governed, and enacted. It calls for crossing disciplinary boundaries, foregrounding ecological interdependencies, and valorising local knowledge systems. Crucially, it demands that we design *with* communities and ecosystems, not merely *for* them. As the climate emergency accelerates and planetary boundaries are increasingly breached, the urgency of such a reorientation becomes both evident and inescapable. In synthesis, and drawing upon the foregoing discussion, the following concluding considerations may be advanced:

- The reviewed corpus delineates a terrain wherein Disaster Risk Reduction (DRR) and Climate Change Mitigation (CCM) and Adaptation (CMA) gain progressive salience, yet persist largely inscribed within paradigms of technocratic and hierarchical governance;
- Planning emerges, in the majority of contributions, as a mere vehicle for external objectives, rather than as a forum of contention, deliberation, or co-creational agency;
- The domain of design is seldom articulated as an epistemic practice that might mediate between ecological thresholds and socio-cultural needs;
- This critical reading discloses the necessity for a more profound confluence of ecological

sensitivity, political contestation, and spatial praxis – not solely to render resilience operational, but to redefine it through the lenses of justice, vital conditions, and relational place-making.

While the review provides a structured and cross-disciplinary overview, several methodological boundaries must be acknowledged. First, the exclusive use of Scopus as the research engine inevitably restricts the corpus to indexed, peer-reviewed publications, excluding grey literature and certain practice-oriented planning and design journals not captured by the database (Gavel & Iselid, 2008). Nevertheless, Scopus remains the most comprehensive and transparent platform for cross-sectoral analyses of academic production. Second, the inclusion of English-language publications only reflects both a pragmatic and methodological necessity, as English constitutes the *lingua franca* of international research and ensures the comparability of keywords and metadata across disciplines. This choice, however, may contribute to the underrepresentation of locally grounded or Global South perspectives more frequently published in other languages. Third, the temporal frame (2013–2025) does not represent a restriction but rather the effective onset of the debate: systematic intersections between Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) within spatial and planning literature begin to appear on-

ly after the Sendai Framework (2015) and the Paris Agreement (2015). Earlier publications, therefore, do not constitute a meaningful reference set.

Taken together, these methodological boundaries do not undermine the validity of the analysis but delineate its epistemic perimeter, pointing to the need for future reviews to broaden linguistic and source diversity while deepening the comparative reading of practice-based and policy-oriented knowledge.

### Conclusion

In the light of the increasing number of catastrophic events and the ongoing climate crisis, a novel systematic literature review has been conducted to understand how Disaster Risk Reduction (DRR) and Climate Mitigation and Adaptation (CMA) approaches are dealt with in urban and regional spatial governance strategies, planning, and design. Inherent search terms for titles, abstracts, and keywords have been used in Scopus, resulting in the selection of 34 publications. This is a limited number and can be read as an important information *per se*, since more scientific interest may be expected for addressing spatially and altogether two relevant approaches dealt with by the United Nations in the presence of a globally increasing urbanisation; as a consequence, the first result can be seen as the existence of some margin for further scientific work on CMA and DRR, jointly addressed in terms of spatial planning, governance, and de-

sign. Also, particular attention has been paid to understand their common features for climate-related spatial resilience and to critically detect possible biases and/or margins for improvements. The main findings may be summarised as follows:

- Most publications (84%) have been published in scientific journals, and almost all of them authored by scholars;
- The time distribution ranges from 2013 to 2025, with a majority of contributions (65%) being published between 2016 and 2020, i.e. in the lustrum immediately following the Paris Agreement on climate emissions (UNFCCC, 2015) and the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR, 2015; 2020);
- Most of the authors are based in Europe (30%) and Asia (28%), followed by North America and Oceania with fewer affiliations in Africa and South America; a strong majority (72%) works in the Global North;
- Half of the authors (50%) are affiliated with disciplines in the Physical Sciences and Engineering (PE macro-sector: ERC, 2020), including earth sciences, engineering, hydrology and environmental sciences. Social Sciences and Humanities (SH) account for 45%, primarily in planning, geography, governance and policy. Only 5% belong to Life Sciences (LS), focused on molecular or structural biology;
- The editorial collocations are also oriented

- towards physical sciences and engineering, in addition to life sciences; only two book series explicitly address city planning, urban studies, communities and human settlements, and urban development, while no scientific journal is primarily concerned with such subjects and topics; one journal covers urban studies together with engineering and with earth and environmental sciences;
- The disciplinary distribution of authors and editorial contexts, with a predominance of hard and technically applied sciences, suggests that a technocentric approach may exist, partly supported by the content analysis, also highlighting some business orientation; surprisingly, no author has a hard science background on climate studies;
  - Except for Ajibade (2017), no specific research or professional interest has been found in urban political ecology, which has been recently confirmed as a crucial way to address the climate emergency (Kaika *et al.*, 2023); technology-centered and de-politicised discourses on climate change have been already highlighted by Swyngedouw (2010), an author who is considered to unpick “the dissonance between the need for urgent action on climate change on the one hand, and the failing attempts to deflect the trajectory of the climate future on the other” and, “in a situation where we are already living the apocalypse”, to call for “a new temporality and spatiality around a democratising re-politisation of the current socio-ecological state of affairs” (Haarstad *et al.*, 2023, p. 7);
  - Keywords and recurring contents are significantly affected by the search terms, yet a mismatch can be found between the occurrence of concepts from the urban and regional studies and the actual presence of authors from those disciplines; it seems pleas are made by technicians and hard and life scientists to spatially manage their knowledge, but a margin for improvement and further development is detected for a proper integration of DRR and CMA into spatial governance, planning, and design;
  - Albeit 29 of the 34 selected works were published from 2016 on, only 15% of those mention the Paris Agreement (UNFCCC, 2015), and none refer to the seminal works by the United Nations Office for Disaster Risk Reduction (UNDRR, 2015; 2020);
  - On top of cultural aspects and proper climate- and risk-oriented spatial planning, governance, and design, underrepresented topics include environmental studies and sustainability science, despite their demonstrated relevance in DRR and CMA; systemic and ecosystemic approaches seem therefore deserving higher attention, including foci on such a crucial trigger of disasters as land use.
- Among the possible future actions to possible make up for some of the lacks that have been

found in the present literature review, some paths are here envisioned to integrate DRR and CMA into best practices for urban and regional governance, planning, and design: in order to avoid fragmented research, missing key knowledge from key disciplines, one may consider some larger integration of ecology, environmental studies, and sustainability science, together with cultural, social, economic, political, and political ecological aspects. Some currently neglected aspects may be addressed too, e.g. this century promising to be very different from the previous one, in terms of expected disasters, changing climate, and overall resource availability to reduce disaster risk and climate effects also in the presence of changing and not always predictable events, available technologies, economies, priorities, etc. Factors and stressors emerging from that larger involvement and transdisciplinary dialogue may be therefore tested in a given context (e.g. at the city level, the country level, etc.), also through the local cultural realm (Pisano, 2023). The review also highlights that spatial design, planning, and governance are underrepresented, and – when present – often treated as passive recipients of technical knowledge, rather than as active, place-based practices capable of shaping climate and disaster responses. This technocratic orientation risks reproducing fragmented or de-contextualised responses to climate risks. Some indicators may be identified to follow this path, and existing guidelines for policies and/

or planning – anyway deserving further development, as emerged from the present review – may be reinforced and complemented by informed and tailored small-scale design solutions.

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# Staying With the Disruption to Break the ‘As Usual’

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## The troublesome chances of disruption

In urban design and planning, the concept of resilience is invoked in the face of assumed or actual instability, such as floods, earthquakes, heatwaves, and infrastructure collapse. These instabilities could make a given territorial configuration vulnerable to such events (Balducci, 2020), meaning that areas designed to remain unchanged are exposed to change instead, posing a risk of losing settings that are relied upon. Resilience comes into play to avert unexpected modifications to existing structures and the practices and behaviours they support, which may result from a disruptive event. This

is because resilience is understood as the capacity to overcome destabilising pressures by incorporating them. For this reason, resilience is a fetish that is widely studied and frequently referenced in planning policies and plans<sup>1</sup>. The ultimate goal is to organise resilient settings in order to avoid the inconveniences caused by contextual disturbances or disruptive events and the subsequent unexpected changes. However, a

*Disruption unveils the massive, often invisible, complexes of contemporary urban infrastructure that carry energy, communications, transport and water. In so doing, it reveals the social control of nature exerted through technology. Disruption also embodies the agency of the world and its constant transformation. But what part does disruption play in making the territory more resilient? To answer this question, it is illuminating to look at two urban lakes that emerged unexpectedly from disruption: the Marais Wiels*

*Lake in Brussels and the Bullicante Lake in Rome. In both cases, the removal of topsoil by bulldozers during land redevelopment projects reached the water table, causing it to flow up and fill the excavations. Both lakes have formed in areas that were previously floodplains. These two disruptions are home to diverse species, and the social learning that is essential for evolutionary resilience is routine here.*

fundamental ambiguity remains. Should resilience be viewed as a concept that facilitates the circumscribing and avoidance of change, or as a concept that enables openness to the unexpected, which disruption itself is often about?

Unless there is constant maintenance and repair, mismatches and breaks occur more or less constantly (de Roo, 2017). Whether one travels through the planet or listens to the often sensationalist media reports of the day's events, disruption is omnipresent<sup>2</sup>. It is experienced when disasters occur, but it is also a regular part of daily life. Disruption indeed can take the form of landslides, fires, flooding, and the related or not collapse of buildings and major infrastructure. But disruption can also take the form of mundane, everyday impasses such as pipeline explosions and other infrastructure

collapse, which result in the interruption of services. Disruption can be dramatic regardless of its physical size and magnitude, especially when it affects properties or involves bodies and results in the loss of homes and loved ones or when it makes life impossible. Whether dramatic or not, disruption often has a direct impact on one's life course anyway. Let's take the most mundane ones. Someone has to change their route to work because a section of the road has turned into a puddle due to a storm or a burst pipe. Someone has had to stop working in the office because of a black-out caused by a collapsed high-voltage power line in a storm. On their way to work, someone else has to turn back because a sinkhole has caused part of the road to collapse and blocked the area<sup>3</sup>. Disruption operates as a *diversion*; it literally makes us *turn in a different direction*. It marks a turning point, shaking things up and forcing a change in how one relates to things one usually overthinks or takes for granted. Disruption, from the Medieval Latin *disrumperere*, composed of *dis-*, "apart" and *rumpere*, "to break", means "a breaking asunder" (Online Etymology Dictionary, 2025). It is "the action of preventing something, especially a system, process, or event, from continuing as usual or as expected" (Cambridge Dictionary, 2025a). A disruption is a discontinuity. Stephen Graham (2011; anticipated by Graham and Thrift, 2007) recognised the forceful value of disruption for urban geography

and thus for urbanism and planning. Graham describes disruption as a heuristic device. Both figuratively and literally, disruption is a crack – *ruptus* is Latin for ‘crack’ – a crevice in the smooth urban surface, it is a window into urban circuits. The so-called *modern infrastructural ideal* made a planet extensively served by transport, communication and other networked grids, rendering the urban life and urbanisation viable. Yet this ideal fails, resulting in splintered and uneven geographies (Graham and Marvin, 2001). Within this rolling out and still fragmented surface of urbanisation, there are patterns of cracks. To break down is the infrastructure that, running beneath the surface, has reached its highest degree of fetishisation, namely that of invisibility (Swynedouw and Kaika, 2000)<sup>4</sup>. With disruption, the largely invisible and subterranean complex of pipes, cables and networks, through which transformed nature flows, becomes intelligible, albeit only partially and for the duration of the waiting time before any repairs are carried out. For instance, flooding on the street may be caused by a burst pipe resulting from ground settlement, or the electricity supply may be interrupted due to lightning damage to the network, which may be caused by a storm. Energy networks, huge water systems, global agricultural complexes, mobility networks, electronic communication systems, these are the “vast and unknowably complex systems of infrastructure and technology stretched across

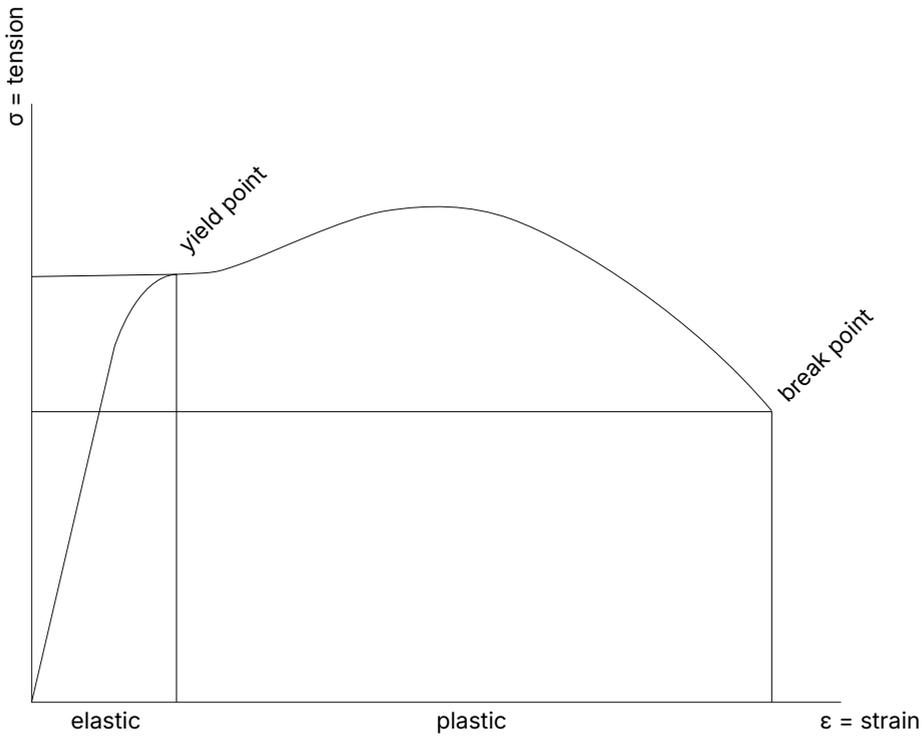
geographic space” largely taken for granted and that disruption unmasks (Graham, 2010, pp. 1). By pointing out the heuristic potential of disruption, the seminal work of Graham and colleagues was substantially focused on reinstating the attention on the infrastructural networks as key physical and technological assets of modern urbanization that with disruption – but also interruption – become visible in the urban scene. Therefore, these influential studies focused on disruptive events that have a direct or indirect effect on infrastructure and how it functions<sup>5</sup>.

However, another aspect of unravelling accompanies disruption that is equally relevant to urban studies and the pursuit of resilience. Disruption also signifies the agency of the world. The breaking up of the Earth’s surface, which if it were all the same could be used and taken advantage of, and of the networked systems, which if they were all the same and everywhere could be used and taken advantage of, is the world and its agency. Gaia, swept under the carpet, intrudes as a being in its own right (Haraway, 2019; Stengers, 2021), splitting the surface of the urban palimpsest. These infrastructure “immobilised in space” which “continually bring into being the mobilities and circulations of the city and the world” (Graham, 2010, pp. 66), interact with volcanic eruptions, earthquakes, floods and soil compaction, erosion and wind erosion, as well as variations in pressure and temperature. This agency is

largely understood as instability and a cause of uncertainty when it disrupts human plans. And it is precisely to cope with the instability and uncertainty that this entails that resilience in urbanism and urban planning comes into play.

But what has happened to make disruption so prevalent in our daily lives, despite the amplification from press reports and television scenes? On the one hand, there is an increase in stress on the infrastructural apparatus. This is due to rising demands caused by growing expectations of comfort, which is a result of urbanisation and population growth (Ritchie et al., 2025). As a response, extraction is happening in more complex and extensive geographical areas (Prior et al., 2012). While technological innovation undoubtedly increases reliability, the risk of collapse is also growing due to enterprises becoming more sophisticated and daring. On the other hand, is the fact that predictions relating to changing climate patterns are coming true. This has reached a point where the climate is clearly showing its temperament (see Stengers, 2021; Schultz, 2023). As McKibben (2010, quoted in Jackson, 2014, p. 221) argues, humankind now inhabit an *Earth 2.0*, where many of our long-held assumptions about society and nature no longer prove valid. The intensification of perturbations and the resulting disruption make it appear that the “natural systems in which we have long lived and relied [...] have been irreversibly altered” (Jackson, 2014, p. 221).

In a time of widespread instability, where urban disruptions appear to be increasing in both number and intensity (see for instance Field et al., 2012; Fu et al., 2024), urban and architectural planning is focusing, not only, as is obvious, on repair (Jackson, 2014; Hertweck et al., 2023) but also on resilience (e.g. Balducci, 2020). Since its revival in ecology in the 1970s, the concept of resilience has been variously interpreted and has experienced mixed fortunes. In this article, ambition is to review the relationship between disruption and resilience perspectives. It will be noted how some interpretations of resilience, despite being open to instability, actually neglect or diminish disruption. Specifically, the aim is to emphasise that the focus is often on what precedes disruption, such as prevention, or what follows it, such as again adaptation and then repair and innovation although disruption itself can provide fertile ground from which to engage with and learn for the future<sup>6</sup>. The purpose is also to provide evidence of the significant cognitive and generative implications of engaging with disruption for urban practice, which remain largely unexplored but could still be relevant in terms of innovation. It is argued here that understanding the transformative potential of disruption is vital for grasping the intricate web of organisation and subordination in the urbanised world. As mentioned above, *staying with disruption* is also pivotal because it is recognised as a key sign of the agency of the



world – a vital force that urban planners cannot afford to overlook, particularly in light of their increasing awareness of it (de Roo, 2017). To emphasise the transformative potential of disruption and inhabiting it, this contribution focuses on two urban areas marked by disruption: the Marais Wiels Lake in Brussels and the Bullicante Lake in Rome. Both areas are discussed because they emerged from disruptions that were not repaired. In both cases, the disruption has been retained and inhabited instead. The persistence of the outcome of disruption in Brussels and Rome provides elements for a critical re-examination of the concept of resilience in urban design and planning. They reveal how a possible route to take is to try to inhabit the disruption, if it is not

dramatic, rather than counting on what comes before or after it. These spaces of rubble are characterised by invention and reassortment – in system theory this is known as the back loop stage of the adaptive cycle (Holling and Gunderson, 2002). It is in these spaces that it is possible to reconnect with a plurality of agencies and practise unlearning and relearning. The empirical work discussed here is based on the author’s direct observations of the two cases, as well as encounters with some of the human protagonists involved in the two areas and the researchers who studied them. This first occurred in Brussels as part of two pieces of ethnographic research conducted for the project *Ilot d’Eau Le Retour*, with the scope of investigating the relationship with ground-

## Tension-strain diagram.

Source: author.

Fig.1

water and flooding of the inhabitants of Saint Antoine, the neighbourhood just south of Lake Marais Wiels (Aragone et al., 2020), and *Ethnographie du Bas de Forest*, research conducted for Metrolab.Brussels in the lower parts of the municipality of Forest, where the lake is located, to understand the use of public space by different social groups (Carlier et al., 2021). Additionally, the author supervised a master thesis examining the two lakes (Vichi and Coppola, 2025). This study was carried out between July 2024 and February 2025, and some of its findings have been incorporated here<sup>7</sup>.

One final remark. The term ‘urban disruption’ is sometimes used to emphasise the link between disruption and urban lifestyles (Amin and Thrift, 2002). Recognising that urban disruption occurs in cities as much as in other urban-rural areas helps highlight the complex interdependencies between different geographical areas (cities, hinterlands, and distant spaces) that disruption can reveal. It also highlights the widespread boredom that unexpected events cause in urban and rural areas alike.

### Disruption and resilience

In a well-known article from a decade ago, Simin Davoudi (2012) reread the main interpretations of resilience in relation to equilibrium and stability, in order to understand how the concept can be fertile for planning theory and practice. Here, the same three main interpretations discussed by Davoudi – engineering,

ecological and evolutionary – are considered in relation to disruption. The aim is to understand how uncertainty and changes due to dynamic forces that cause disruption are treated in the three interpretations of resilience.

The first group, taking up the seminal work of the ecologist Holling (1973), includes engineering resilience, i.e. “the ability of a system to return to an equilibrium or steady-state after a disturbance” (Davoudi et al., 2013, pp. 308). Accordingly, for a stressed system, there is only one equilibrium, which is the initial one. After a disruption, after something has been bent, stretched, or squeezed, it does not go on as usual or as expected (Cambridge Dictionary, 2025a). There is not *as before* to go back to, there is no usual shape, unless more or less extensive parts of the system are repaired or replaced to restore the initial equilibrium. As can be seen from the tension-strain diagram (Fig. 1), engineering resilience not only precedes the moment of disruption to some extent, but also averts it. The ultimate goal is to maintain the efficiency of the system, and accordingly, resilience could be associated with the elastic field rather than the plastic field, which anticipates disruption. In other words, in the diagram, resilience occurs before the system/object changes state due to deformation, before its structure and functioning shift. Engineering resilience shows no readiness for change and disruption is taken as something to be avoided, to resist from. For a

system, this means that it must not break and must bounce back to its initial equilibrium. As Holling and Gunderson (2022) note, attention is given to avoiding other operating states. This is possible with appropriate safeguards to ensure that variables remain well away from dangerous break points (Ibid.). Beyond the tension-strain diagram, practical questions arise regarding engineering resilience in urban design and planning. Firstly, what kind of design and planning work towards engineering resilience? According to Fünfgeld and McEvoy (2013), this form of resilience thinking is manifest in adaptation measures conceived to safeguard extant assets, people and places from the repercussions of climate vulnerability and, to a lesser extent, climate change. Therefore, the ideal state for design to aim for is one in which disturbances can be avoided or kept to a minimum (Ibid.). Secondly, disregarding the fields of the tension-strain diagram for a moment, what kind of disruption does not involve structural or functional change, enabling the system to revert to its initial equilibrium? Any disruption from which the socio-spatial configuration that existed prior to the disruption can be more or less easily restored through repair or replacement.

The second group relates to ecological resilience. According to Davoudi (2012, pp. 300), ecological resilience, “rejects the existence of a single, stable equilibrium, and instead acknowledges the existence of multiple equilibria, and

the possibility of systems to flip into alternative stability domains.” Perturbation is accepted, and disruption is taken as what brings the system into different states, what changes the system’s structure and functioning (Holling, 1996). As shown by Holling and Gunderson (2002), the system undergoes an adaptive cycle comprising four ecosystem functions: exploitation, conservation, release and reorganisation. Here, disruption corresponds to the release phase, during which the connections among elements cease. Holling and Gunderson (2002) refer to this as the *creative disruption* phase. During this period, loosely regulated domain of stability and the wide latitude and flexibility allow for the formation of unpredictable associations, some of which have the potential to initiate novel reorganisation and renewal (Ibid.). However, despite being open to dynamic forces and changes, Davoudi (2012) considers ecological resilience to still be potentially normative for design and planning. This involves searching for equilibrium, accepting change through the power of the plan, as well as integrating it with explanation, prediction and probability calculations.

In light of the still static and command-and-control nature of ecological resilience, Davoudi (2012) introduces the concept of evolutionary resilience. This third interpretation is based on the adaptive cycle proposed by Holling and Gunderson (2002), but here it is used to emphasise the chaotic, complex,

uncertain and unpredictable behaviour of ecosystems rather than their tendency to reach one or more equilibrium states. With evolutionary resilience, the ideas of bouncing back to an equilibrium and bouncing forth to new equilibria, which are specific to engineering and ecological resilience respectively, are overcome. To emphasise “the ubiquity of change, inherent uncertainties, and the potential for novelty and surprise” as opposed to equilibrium or equilibria, Davoudi (2012, pp. 304) turns to the concept of *panarchy* developed by Gunderson and Holling (2002), and which provides a long-term framework for the adaptive cycle. Accordingly, on the one side, exploitation, conservation, release and reorganisation phases “are not necessarily sequential or fixed”, and, on the other, “systems function not in a single cycle, but rather in a series of adaptive cycles that operate and interact” (Davoudi, 2012, pp. 304). In evolutionary resilience, therefore, the perturbation is acknowledged as structural and the disruption as recurrent. Resilience is thus understood “not as a fixed asset, but as a continually changing process”; “not as a state of being, but as a state of becoming.” Above all, “resilience is performed when systems are confronted with disturbance and stress” (Davoudi, 2012, pp. 304). Therefore, it is precisely these disturbances and adversities that provide the foundation for resilience, despite the disruption they cause. Evolutionary resilience clearly encourages urban designers and

planners to embrace uncertainty, exploration, and the potential for novelty and surprise, rather than fixity and rigidity.

In the three interpretations just discussed, the common factor seems to be that both disruption and resilience are strictly related to the perturbation that threatens or upsets one or more supposed or given conditions of equilibrium. Disruption and resilience stem from an unstable world. However, while disruption is a contingency, resilience qualifies and addresses the relationship with instability to some extent. As seen above, in evolutionary resilience transformability is truly inevitable, and disruption can even be creative. Acknowledging the ubiquity of change and viewing uncertainty – due to instability – as intrinsic rather than accidental should encourage planners to move beyond the *will to order* and embrace relational forms of understanding space and time (Davoudi, 2012).

Even in the context of evolutionary resilience, though, it could be argued that the emphasis remains on innovative aspects that follow disruption, glossing over the pivotal role of it in favour of earlier and later phases. In the four-dimensional framework for building resilience developed by Davoudi et al. (2013), are included persistence (being robust), adaptability (being flexible) and transformability (being innovative), but it is preparedness (learning capacity) that stands at the centre of the scheme (Davoudi et al., 2013). From this evolu-

tionary perspective, social learning is realised through exploring future scenarios in which disruption plays a central role (Ibid.). However, Davoudi et al. (2013, pp. 320) remind us that these same explorations may be perceived as destabilising, provoking public resistance in the absence of “continual social intelligence gathering” in climate adaptation planning. Nevertheless, it is unclear where social learning really takes place. It is also unclear whether it is possible to become acquainted with uncertainty by anticipating future arrangements or by experiencing it first-hand. Similarly, the position of disruption among persistence, adaptability, transformability and preparedness is as yet unknown.

Drawing on these interpretations of resilience, this contribution highlights the transformative potential of disruption and the opportunity to experience it first-hand. Disruption is an indispensable condition of the phenomenology of acting in the world. It could be embraced not merely as a resignation to the inevitability of the end, but as a way to fully experience the belonging to the agency of the world and its vibrant matter (Bennett, 2010). This is a challenging path, in some respects a gamble. However, the notion of dedicating time to disruption, as planners and collectives, despite seeming absurd, is connected to the idea that during this time, and amidst its fragments and dismemberments, it is possible to break free from the captivating and pervasive presence

of, and reliance on, the given technological apparatuses – and the modern infrastructural ideal. During this time, it becomes possible to perceive and experience the world and its inherent agency, acknowledging it as part of the design operation rather than reducing it to probability estimates and structural oversizing to welcome uncertainty dictated by experts. In disruption, the pulse of Gaia is palpable. It is thus argued that to try to inhabit the disruption is key for resilience and may be significant for the design project. This refers to brief, temporary and even playful encounters as well as widespread or large-scale ruptures. In these spaces of rubble, it is possible to try to reconnect with a variety of agencies and to practise unlearning and relearning, again and again.

### **Two urban lakes as inhabited urban disruptions**

In recent years, two disruptions, the Marais Wiels Lake and the Bullicante Lake, have attracted the interest of researchers due to the opportunity they offer to highlight issues relating to urban struggles (Cirillo and Wei, 2023), urban ecology (Battisti et al., 2017), urban hybrids (Do and Fassari, 2023) and land pressure (Wei, 2025) (Fig. 2). These two disruptions also highlight the importance of experiencing disruption and how it can contribute to resilience, particularly evolutionary resilience.

The story of the Marais Wiels Lake began in 2007. During the construction of the foundations for a future office complex on the site

of the former Wielemans-Ceuppens brewery in Forest, south of Brussels, which had been abandoned in the 1980s, excavators pierced the surface layer of clay and tapped into the resurgent aquifer. The puddle of rising water spread until it filled the entire excavation. Construction was halted, and the following year the project was abandoned, partly due to the 2008 financial crisis which reduced demand for commercial space. The site remained closed and, within a few years, the area had become overgrown with reeds and the fauna typical of the floodplain of the nearby Senne River. In 2015, a group of residents opposed to the private real estate initiative named the *puddle*, which was already home to many species, *Marais Wiels*<sup>8</sup>. United under the name *Fê.e.s du Marais* (Marsh Festivals), the collective of residents organised the cleaning of the site, offered guided tours and created some urban gardens. With the involvement of amateur naturalists, they also took care of cataloguing the species present. In 2020, the Brussels-Capital Region purchased the plot with plans to build housing (some of it social), urban green spaces, and a rainwater retention basin half the size of the current lake. Recently, some individuals fighting to defend *Marais Wiels* formed legal entities to leverage their ties to the site and thus avert real estate development (Wei, 2023).

The story of Bullicante Lake is similar. At the heart of the story is the disruption caused

by the bulldozers of a real estate company in 1992. At that time, north of the Prenestino Labicano district, just east of the centre of Rome and in the area of the former SNIA Viscosa textile factory, which was abandoned in the mid-1950s, excavation work was carried out for the construction of the underground car park of a future shopping centre. During this work, the bulldozers pierced the ground and intercepted the old Fosso della Marranella collector and the aquifer. Water gushed out of the subsoil here too, flooding the excavation site. The construction company used water pumps to discharge the rising water into the public sewer system, but the first heavy downpour flooded part of the surrounding district. Protests by residents and reports of irregularities in the permits, reported to the authorities by the residents themselves, brought the construction site to a halt. Since then, the site remained closed for a long time. In 2004, the area between the lake and the adjacent Via di Portonaccio was expropriated to extend the nearby Parco delle Energie, which opened in 1997. It was the presentation of another urbanisation project in 2014 that attracted the attention of residents and the Parco delle Energie Forum, established in 2008. Meanwhile, the lake had become overgrown and inhabited by various plant and animal species, necessitating protection. In 2015, a group of residents and local committees cut a hole in the fence to open up access to the lake and some of the surrounding area. They

named it *Lago Bullicante* after the nearby Via dell'Acqua Bullicante – *bullicante* referring to the water gushing from the ground, which was bubbling due to sulphurous gas emissions. In 2021, the Bullicante Lake area and the nearby Parco delle Energie were designated a Natural Monument by the Lazio Region. However, the private portion of the site (approximately 40%) has been granted a new building permit for the construction of a logistics hub (Do and Fassari, 2023).

Over time, these disruptions in Rome and Brussels have become home to a variety of species and human practices. According to ecologists (Battisti et al., 2017), it is a combination of time and action and inaction that makes passive ecological restoration possible. In the two urban lakes, guided tours and collective clean-up operations are organised, open workshops are held, beehives are installed and honey is produced, nature observation is practised, and surveys of animal and plant species are carried out. Cultural activities are also organised, such as open-air film screenings and book presentations (Cirillo and Wei, 2023).

The Marais Wiels Lake and Bullicante Lake are two inhabited disruptions that remain unrepaired. They are two urban wetlands resulting from failed land redevelopment projects. As well as being two brownfield sites of high ecological value due to abandonment, they are two 'failed' attempts to re-capitalise disused industrial sites. Above all, however, the two

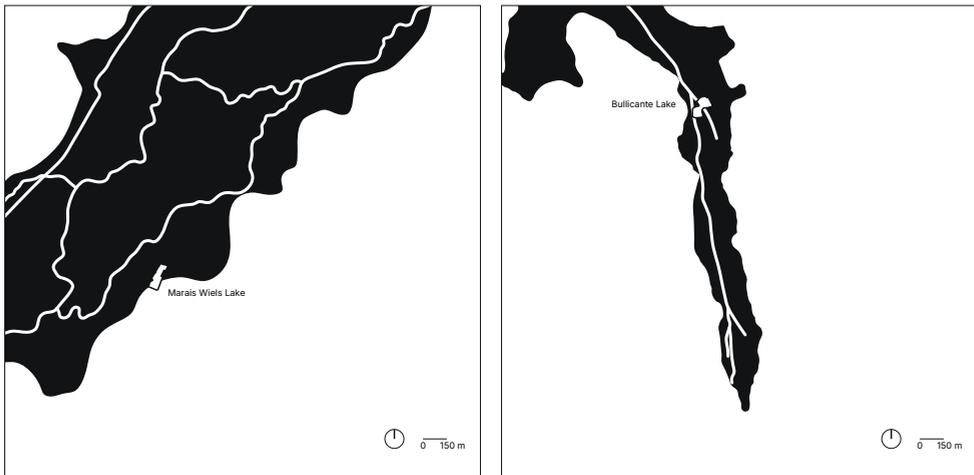
lakes are places where the water has regained ground by breaking through the cracks made by the bulldozers. The superimposition of historical maps of the pre-industrial development (Vichi and Coppola, 2025) shows that Marais Wiels Lake and Bullicante Lake are part of two watercourses (Fig. 3). In Brussels, the area of the lake is at the right margins of the floodplain of the Senne River, a marsh area where soil was often saturated with groundwater. In Rome, the plot was part of the riparian area of the Fosso della Marranella, therefore presumably prone to flooding. Before the rapid urban development of the last century, spring water fed the Fosso della Marranella, and this had been piped to the Aniene River since 1934. In both cases, the excavation work required to construct new building foundations and basements broke the soil layers that, decades earlier, had been created to contain aquifers and accommodate industrial warehouses. As mentioned above, this caused water to gush out and transform the excavations into urban lakes over time (Ibid.). The wet landscapes of the Marais Wiels Lake and the Bullicante Lake reconnect with underground water flows that urbanisation processes have tried to obliterate by installing drainage pipes and raising the ground level with fill soil. In both Brussels and Rome, disruption enables a reconnection with these more-than-human agencies. However, land speculation in the guise of repair, once again attempts to neglect them. Recently, in



**Left: Marias Wiels Lake located on the site of the former Wielemans-Ceuppens brewery in Forest.**  
**Right: Bullicante Lake on the site of the former SNIA Viscosa in the Prenestino Labicano district.**

Source: inspired by Iannizzotto and Delli Ponti (2025), based on OpenStreetMap and Google Maps.

Fig. 2



**Left: superimposition of the Marias Wiels Lake on the Ferraris map, (Ferraris, n.77, 1777). Right: superimposition of the Bullicante Lake on the map of Rome (Roma. Foglio 150 della Carta d'Italia, IV.S.O. 1876). Black: floodplain. White lines: hydrography. I**

Source: elaboration from Vichi and Coppola (2025)

Fig. 3

the face of repeated attempts by real estate developers and public institutions to fill in the lakes, reclaim the land and privatise it again, Marais Wiels Lake and Bullicante Lake have twinned, thanks to the efforts of researchers and activists who decided to intertwine their histories and support each other. This alliance of counter-narratives of European urban spaces amplifies the significance of these two urban disruptions. Through this twinning, Marais Wiels Lake and Bullicante Lake also embody green democracy, which Ghelfi and Papadopoulos (2022) describes as a combination of alternative forms of sociability and materiality, protest politics, and new institutional structures forming alliances.

In Brussels and Rome, urban nature emerges from a combination of seemingly contradictory elements, such as speculation, instability, passivity, indifference, activism and care. Today, Marais Wiels Lake and Bullicante Lake are socio-ecological pools involving human and more-than-human terrestrial communities (Wei, 2025, quoting Gutwirth and Tanas, 2021). However, despite being surrounded by vegetation, the sign of unfinished construction sites persists at these two lakes, which emerged from a cycle of earth fills, excavation and re-surgent groundwater. While the people who use and manage these spaces have envisaged certain areas being used more frequently than others, there is still an element of uncertainty surrounding their function and, overall, their

infrastructure remains rather weak. Moreover, in both cases, there is an ongoing conflict regarding the present and future of the area, which perpetuates the disruption and the inability to establish a status quo or finalise a given expectation. A suspension arises primarily from the convergence of attempts at 'repair' through land speculation, the ambiguous attitudes of administrations and the struggles of activists. However, it is also a disruptive condition that occurs due to internal conflicts within the groups that frequent the two lakes and have diametrically opposed visions of what the lakes should be. As Do and Fassari (2023) point out, in the Bullicante Lake, the *cradle of abandonment*, and this the idea of preserving auto-rewilding, clashes with the concept of transforming the lake into a park for use by humans and more-than-humans alike, following appropriate soil treatment. According to Wei (2025), in the Marais Wiels Lake, the issue is not so much about allocating space for specific subjects and uses. Rather, it is about excluding the logics of domination that underpin a social order (Ibid.). It is about delimiting an area of counter-power with respect to dominant intensive interventionism (Devictor, 2021). In other words, it is about deliberately occupying a portion of territory and time in different ways and connecting with its more-than-human inhabitants. It is about inhabiting a disruption and the ruins of the urbanisation, with all its uncertainty.

### **Inhabiting the disruption as a form of social learning**

In the urban lakes of Brussels and Rome, the cracks left by the excavation work of the bulldozers have been left open, and one can still see inside. The stratigraphies are still visible, as well as the underground infrastructure: the old stream collector in Rome, but also the fill dirt, the river floodplains and the groundwater in Brussels and Rome. The two breaks still bear the marks of the ongoing forces at play: the resurgence of fluctuating groundwater, the repeated attempts to extract or bury it through new real estate projects, and the resistance of residents and activists.

When viewed through the lens of resilience, it appears that Marais Wiels Lake and Bullicante Lake are enduring chronic disruption, experiencing only slow and weak levels of reorganisation. It is almost as if the urban disruption is still unfolding, with, as Holling and Gunderson (2002) would say, only space for pioneer species – both human and more-than-human – that are not yet dominant. The two areas remain permeated by uncertainty caused by disturbances that are both external and internal to the lakes. They are not just vacant lots or empty spaces, but rather places where disruption has not been repaired. Here, it is not just a matter of the disappearance of an economy or a use. Rather, there is a clash of forces, both human and more-than-human, with turbulent waters at the forefront. These troubled waters

have become a breeding ground for human conflict and confrontation regarding how to think about the present and the future.

#### *Disruption as lack of equilibrium*

According to Davoudi (2012), the responses planned by institutions in the event of disruption are geared towards restoring equilibrium. However, in Marais Wiels Lake and Bullicante Lake, the disturbances that led to the disruption are manifold and it is their convergence and perpetuation over time that caused and continue to cause the disruption. A series of blockages have allowed these places to become sites of accumulation of tensions, issues, living beings, struggles, but a new equilibrium or normativity in which to live has yet to be reached. As previously said, these disturbances range from the burial and urbanisation of a floodplain area and the extractive force of a new, more voracious round of urbanisation seeking depth, to the resurgent power of water. These forces are added to by human action, which creates passages, organises learning activities, consults documents and questions the authorities, as well as designs contrasting management scenarios and approaches. Human activity is characterised by support, collaboration, dialogue as much as conflict (Do and Fassari, 2023). Unlike engineering resilience, there is no bounce-back repair, and even the motion to bounce forward, as in ecological resilience, remains inefficient.

Paradoxically, this state of being stuck is the true transformative state, perhaps an expression of evolutionary resilience. After all, this is the quintessence of evolutionary resilience, alias “its rejection of equilibrium, emphasis on inherent uncertainty and discontinuities” (Davoudi, 2012, pp. 306).

#### *Disruption as not settling*

In systems thinking, energy becomes available through the processing of matter based on experience and information sharing (de Roo, 2017). Actors organise themselves to optimise information sharing and enhance their capacity to generate energy: “this is a settling society in action” (Ibid., pp. 12). In this regard, the cases of Marais Wiels Lake and Bullicante Lake suggest that living with disruption means living with uncertainty, which delays the prospect of growth and thus resists institutional organisation and the capacity to generate and extract energy. It means maintaining a high level of information sharing, yet without any certainty about the future. Here, exchanging information remains unproductive at least in terms of the ability to organise material through work in order to extract and produce energy from the context.

#### *Disruption to unlearn and relearn*

Inhabiting the disruption does not necessarily mean experiencing the disruptive moment when forces are unleashed. Rather, it could mean experiencing the outcomes: the legacy of ruins and fragments. Oxymoronically, it

means inhabiting a space that resists the process of settling. A space that remains difficult to navigate. A space that has a pronounced topography or it remains arid and unproductive. The ruins of disruption are what Matteo Meschiari (2018, pp. 15) calls “a mirror of the here and now”, resistant to rooting, recognition and recovery. They compose a space in which identity dynamics are emptied and the landscape is reset to a pre-cultural condition. The same is also true, to a certain extent, of the two lakes. However, Cirillo and Wei (2023) caution against the institutionalisation of forms of life and inhabitation in their discussion of the future of the two lakes. Wei (2025) recognises that the regional authority’s takeover of lake maintenance in Marais Wiels is imposing a series of rules of use and management, thereby eroding some of the coexistence practices that had developed. But despite attempts at institutionalisation, inhabiting here remains informal because there is no normativity to which one must respond. In the ruins of urban disruption, habits, patterns and traditions are broken. While the disruption limits living in terms of habitus, custom and practices (Agamben, 2019), it also prevents the establishment of new norms. Disruption enables active living instead, which Ivan Illich (1988, pp. 22) defines as the ability to leave one’s mark. At least until now, the signs of habitation are not indelible marks that inhibit overwriting and must be protected by creating a new covering surface. They are instead signs among signs, writings among the diverse writings of a multispecies

assemblage (see Do and Fassari, 2023). Disruption is a field in which new relationships and forms of collective imagination can be explored, but without the realisation of new truths, only relationships that are open to continuous mutation. Remaining in the disruption means staying in a co-agent condition. In this sense, the words of Isabelle Stengers (2021) resonate: according to her, there is nothing to invent, only a reality to rediscover and work with. The two lakes are spaces for social innovation, where new rituals and relationships can flourish (Cirillo and Wei, 2023).<sup>9</sup> Disruption is interpreted as a space for collective reflection and learning, a space for the “continuous social intelligence gathering” advocated by studies on evolutionary resilience for climate adaptation planning (Davoudi et al., 2013, pp. 320). An opportunity is offered to the project by inhabiting urban disruption, to get inside things, to accompany rather than guide and dominate rather than be an exact formulation before and after the disruptive event. While not without paradoxes, disruption, with its divergent forces, is a space of suspension, reconnection and rewriting that is free from the norm as well as rebound and return.

#### *Disruption to experience*

In these chronic slow burns, the preparedness that Davoudi et al. (2013) call for is put into practice. Learning capacity is realised through direct experience of disruption rather than through exploring future scenarios in which disruption plays a central role. As the

examples of Marais Wiels Lake and Bullicante Lake show, a disrupted space provides an environment in which to practise shifting from a *control over* to a *responding to* attitude (to paraphrase de Roo, 2017, pp. 12). There, a state of chaos persists, reminiscent of the idea that in evolutionary resilience there is “no proportional or linear relationship between the cause and the effects” (Davoudi, 2012, pp. 302). The delay in repair or replacement work means that, in the two lakes, it is possible to get close to, contemplate and experience what de Roo (2017, pp. 18) calls “the extreme forces that have pushed the system off track”. Both Marais Wiels Lake and Bullicante Lake exhibit characteristics that align more closely with the forces that disturbed these areas. There, the aquifer can fluctuate more freely as it is no longer buried. It is possible to reconnect with the local hydrography there, understand the presence of groundwater and recognise its powerful agency. According to the principles of systems thinking, the context could be said to dominate; in this case, the context is the floodplain in Brussels and the riparian zone in Rome. At Marais Wiels Lake and Bullicante Lake, the flesh is exposed. More-than-human forces are at work, perhaps more intelligibly than in other widespread abandoned, post-use areas of the urban landscape. They are groundwater and the riparian environment that continues to resist. It is there that Gaia breathes.

## Notes

<sup>1</sup> A recent and well-known application of resilience occurred in response to the disruptive consequences of the Coronavirus pandemic. The conventions and practices that were traditionally endorsed by numerous spatial configurations have been suspended. In response, the EU launched the Recovery Plan Next Generation EU, which aims to make Europe “greener, more digital and more resilient”. At the single EU state level, this resulted in policies where resilience is again the core concept on the base of which to implement a large number of spatial interventions.

<sup>2</sup> Smith Aldrich (2020, pp. 2) talks about “amplified disruption on just about every front – political, economic, technological, environmental, and societal”. She adds that “there has always been, and always will be, disruption. However, disruption in the modern world is amplified by a 24/7 news cycle and the content and engagement-hungry social media landscape” (Ibid.). The daily bombardment of press reports and television scenes amplifies the disruption, which ranges from lost and smashed infrastructure to mega-fires (Cottle, 2023).

<sup>3</sup> A major event may have negligible consequences and not be perceived as dramatic, while a minor local disruption could prove fatal. The former may correspond to a social event, the latter to a more personal event, or vice versa. Furthermore, disruptions can be local and have supra-local consequences, or planetary with cross-cutting or different consequences depending on the context. Major, trivial, dramatic, unimportant, societal, personal, planetary and local are just some of the possible types. This article does not focus on building a taxonomy of urban disruptions, but rather on opening up a working perspective on disruption that would still require, later on, the elaboration of a taxonomy and the evaluation of the working strategies.

<sup>4</sup> Kaika and Swyngedouw (2000) reminds that infrastructure systems are often physically and metaphorically veiled beneath the surface of urban life. Graham and Thrift (2007, pp. 10-11) also say that “the common reliance on teleological and deterministic notions, and master narratives [...] add to a sense of the infrastructural palimpsests sustaining cities as being homogeneous, utterly internally coherent and

singular machinic systems that are somehow installed en masse as if by magic (Stivers, 1999) – to function automatically, and purely, until they are replaced as a whole by some new technoscientific order.”

<sup>5</sup> This ranges from the “natural” events such as extreme weather, floods, earthquakes and tsunamis, up to more “social” events such as wars, terrorist attacks, sabotage, network theft and technical malfunctions.

<sup>6</sup> According to (de Roo 2017, pp. 10), there is not such a strong separation between post and pre-events and “purposeful actions and autonomous change cannot always be seen as independent from each other.”

<sup>7</sup> The master thesis was supervised by the author and co-supervision from Allan Wei and Riccardo Ruggeri.

<sup>8</sup> The word *marais* is French for marsh or wetland.

<sup>9</sup> This is the trajectory of artistic practice that the Stalker collective insists on at Bullicante Lake (Cirillo and Wei, 2023).

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# Promotion of Community Resilience through Citizen Science Approaches

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community resilience  
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resilient  
participatory methods  
citizen scientists.

## Introduction

In recent decades, the occurrence of natural and technological disasters, with devastating impacts on local communities, has become increasingly frequent around the world (CRED, 2022). In 2021, the Emergency Events Database (EM-DAT) recorded 432 natural hazard-related events worldwide, which affected more than 101.8 million people, causing 10,492 deaths and \$252.1 billion in economic losses. For this reason, 2021 is the fourth most damaging year recorded in EM-DAT over the last two decades (CRED, 2022). Given the current trends in population growth and urbanization, as well as

climate change, it is expected that more and more people worldwide to be exposed to various types of hazards, such as earthquakes, storms, and epidemics. As a result, there is the urgency to make disaster risk reduction and the promotion of resilience a core element in public policy, especially in the case of developing countries (Data Pop Alliance, 2015). According to Haja, Teo, Goonetilleke, and Ziyath (2021) resilience is the

*The promotion of community resilience is a complex and understudied phenomenon. This article aims to contribute to this literature gap by assessing the role of citizen science (CS) approaches in the development of community resilience, since CS is considered a promising approach for generating new knowledge through fostering the participation of citizens (non-professional scientists) in research activities. The results show that CS approaches are relevant for developing resilience abilities through i) the collection*

*of new data from new sources or remote places where data is scarce, allowing for a better characterization of potential hazards, and the identification of community needs, perceptions and behaviours; ii) enhancing community awareness and knowledge about hazard protection; iii) increase human and social capital through specific training initiatives; and iv) promote the cooperation between community (citizens), academia (professional scientists) and government (policymakers), which is relevant for the development of public policies shaped to local context, and aligned with community's needs and expectations.*

ability of social entities to effectively mitigate disaster impacts and to recover in a way that would minimize future social, economic, technological or environmental disasters.

The relevance of human agency in the promotion of community resilience is highlighted in several studies (Bristow & Healy, 2014). Nevertheless, this is easier said than done, since there is still a limited knowledge about how to effectively promote the active participation of communities in the development of local resilience, and how individual and community recovery can be effectively supported

(Talbot et al., 2020). In this case, citizen science (CS) has been highlighted as a form of research collaboration that involves citizens in research activities together with professional scientists, and, thus, promoting the development of skills and social networks, as well as the generation of data on local communities (Chari et al., 2019).

This chapter provides a critical review of the available literature on the role of CS approaches in community resilience, and, therefore, contributing to a better understanding of how CS can foster community resilience. The present chapter hopes to provide several contributions to both theory and practice. On the one hand, it attempts to explore the broader effects of CS initiatives on communities. Typically, the outcomes of CS include research findings and publications, which contribute to scientific advances; legislation and policy measures; and an increase in citizens' skills and knowledge (Gray et al., 2017). However, CS approaches can have broader impacts, such as contributing to the development of a community and making it better prepared to face future challenges. On the other hand, this work seeks to determine if community resilience can be improved through the participation of citizens in CS initiatives. In the literature, several studies have identified the various dimensions that form the resilience of a community, but until now, no study has discussed in detail which measures and initiatives can effective-

ly improve these dimensions. Therefore, the present study hopes to clarify how CS can contribute to each dimension and sub-dimension of a community's resilience and, thus, advance research in this area.

### **Community resilience: a context-based ability of territories**

Resilience is a concept with roots in the fields of environmental change (Bronfenbrenner, 1979; Holling, 1973) and psychology of personal development and mental health (Luthar, 2006). Nevertheless, in the last decade, the term social (or community) resilience has emerged in the field of business and management, mostly due to the general agreement that social systems and ecosystems should be considered together, as they are interdependent and co-evolutionary (Buikstra et al., 2010; Folke, 2006). This is evident, for instance, in the study of Rindrasih (2019), which assessed the impact of the 2004 Indian Ocean tsunami and concluded that it impacted not only the local environment, politics, and society, but also the performance of tourism as an economic sector in Aceh, Indonesia. In this case, the disaster triggered the rise of new forms of tourism that impacted local development. According to Saja et al., p. (2021, p. 1), "social resilience is defined as the ability of social entities to effectively mitigate disaster impacts and to recover better and to minimize future social disruptions and disaster risks". However,

over the last few years, the definition of social resilience has gone beyond the capacity of social entities to "bounce back" from social disruptions, focusing, more and more, on human agency (Bristow & Healy, 2014; Steiner et al., 2018). In this case, the main assumption is that a community comprising individuals who are personally resilient in the face of disasters or crises is likely to be a resilient community (Berkes & Ross, 2013). In the same vein, Buikstra et al. (2010) argued that community and individual resilience are interrelated, since the same factors generally contribute to both levels, even if to different extents. In fact, several researchers have highlighted that community resilience is not only achieved by improving the built environment or by developing or enhancing warning systems and increasing rules and regulations, but also when communities are able to develop a "learn to learn" mentality and the skills and capacity needed to promote innovative solutions in the face of new challenges (Azizi et al., 2022). Thus, a resilient community is "one that takes intentional action to enhance the personal and collective capacity of its citizens and institutions to respond to and influence the course of social and economic change" (Colussi, 2000, p. 5). As a result, a community becomes able to absorb a disturbance (e.g., a crisis or disaster) and maintain its development path or radically restructure system conditions in a way that sets it off from its historical development

Resilience abilities	Plan/Prepare	Absorb	Recover	Adapt
Timeline	Pre-disaster	During disaster	Post-disaster (short-term)	Post-disaster (long-term)
Aim	Prepare the system against identified threats	Absorb the consequences of a shock without breaking and maintaining a certain degree of function	Recover system's functionality at post-shock level	Improve system's capacity to absorb and recover from shocks based upon past experience
Activities	Identification of threats and development of warning systems and mitigating measure	Use of assets to mitigate system losses	Implementation of resources to bring the system back to full function	Promotion of built-in system "learning" through the enablement of the system to change and better cope with system shocks

## Resilience abilities. Adapted from National Research Council (2012).

Tab. 1

trajectory (Folke et al., 2010; Martin, 2012). Resilience emerges both from top-down strategies at the state level and from bottom-up approaches at the local community level, which allow communities to plan and prepare for, absorb, and recover from disasters, adapting to new and diverse conditions (National Research Council, 2012). Table 1 presents a social system's abilities to achieve resilience.

### Citizen Science: types and characteristics

Some researchers consider CS a specific field of research (Jordan et al., 2015) while others consider it a new form of science (Irwin, 1995) or a new means of research (Shirk & Bonney, 2019).

Either way, it has disrupted the way science is conducted, since it enables the generation of new knowledge by fostering the participation of citizens (non-professional scientists) in research activities (Hecker et al., 2018), often in collaboration with or under the direction of professional scientists. It has been widely used in research in the fields of ecology, environmental science, geography, and biodiversity conservation (Kullenberg & Kasperowski, 2016).

In recent years, the number of CS projects has grown rapidly, mainly due to advances in mobile computing, the emergence of devices equipped with sensors, and online sharing technologies (Buytaert et al., 2014) that facil-

itate the collection of large volumes of data by non-professional scientists, as well as a dynamic interaction between them and professional scientists for hypothesis formulation, research design, data analysis, and knowledge generation.

CS projects vary in terms of focus and structure, as well as the level of citizen engagement. The first level, named *crowdsourcing* or *volunteered geographic information* (VGI), considers the minimum involvement of citizens. Crowdsourced data include messages, photos, videos, and social media posts produced by citizens, as well as data from mobile sensors, such as GPS and credit cards, among others. In this case, citizens act as a “kind of sensor”, enabling a rapid generation of spatiotemporal data with minimum direct engagement. This approach is considered a rich source of continuous of updated information, which helps to improve the quality of analysis (de Albuquerque et al., 2015), and its usefulness in disaster management has already been demonstrated (Goodchild, 2007; Le Coz et al., 2016). However, the use of location-based social network data is not without challenges and there are some arguments over the validity of this source of information (Martí et al., 2019) and the quality of the raw data, which may be low.

The second level is called *distributed intelligence* and, in this case, citizens are required to carry out tasks using interpretation and reasoning, such as sightings (e.g., eBird), tran-

scription of data (e.g., Transkribus), and classification of phenomena (e.g., Galaxy Zoo). Citizen scientists are usually trained before the research work begins. Also, citizen scientists can contribute to the development of a comprehensive scale model of the social milieu, through social cartography or social mapping approaches, in a way that can be studied (Liebman & Paulston, 1994). Several researchers have followed this approach to identify the vulnerabilities of communities through a reflective and open dialogue with community members and, in this way, articulate scientific and popular knowledge (Arias et al., 2016; Khair et al., 2020).

At the third level, called *participatory science*, citizen scientists not only collect data but also participate in the design of the research project through the definition of the research question and the design of the data collection methodology. Moreover, citizens can be involved in the analysis of the data and the interpretation of the results, but this research stage requires the contribution of experts (Haklay, 2013).

The final level of citizen engagement - *extreme citizen science* - is reached when citizens are stakeholders and active participants in all decision-making processes of a scientific investigation (Irwin, 1995), contributing to data collection and data processing and following rigorous scientific principles. In this case, scientific research questions are of interest to both scientists and citizens, and, therefore,

Inclusion criteria	Scopus	Web of Science
Keywords	<ul style="list-style-type: none"> <li>Resilient/Resilience</li> <li>Citizen Science</li> <li>Crowd Science</li> </ul>	<ul style="list-style-type: none"> <li>Resilient/Resilience</li> <li>Citizen Science</li> <li>Crowd Science</li> </ul>
Subject Area	<ul style="list-style-type: none"> <li>Social Sciences</li> <li>Business, Management and Accounting</li> <li>Economics, Econometrics and Finance</li> </ul>	<ul style="list-style-type: none"> <li>Social Sciences Interdisciplinary</li> <li>Economics</li> <li>Management</li> </ul>
Document Type	<ul style="list-style-type: none"> <li>Article</li> <li>Review</li> </ul>	<ul style="list-style-type: none"> <li>Article</li> <li>Review Article</li> </ul>
Language	<ul style="list-style-type: none"> <li>English</li> <li>Portuguese</li> </ul>	<ul style="list-style-type: none"> <li>English</li> <li>Portuguese</li> </ul>
<b>Scopus Full Query Search</b>		
<p>TITLE-ABS-KEY ((resilien* AND ("citizen science" OR "crowd science"))) AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English") OR LIMIT-TO (LANGUAGE, "Portuguese"))</p>		

## Inclusion criteria used for article selection.

Source: Author's own elaboration

Tab. 2

the project outputs should be of benefit to both parties as well. Building on this perspective, *Community Science* has been increasingly recognized as an approach that overlaps with, but also extends beyond, *extreme citizen science* by emphasizing collective action, locally grounded knowledge, and sustained partnerships between researchers and communities. This perspective highlights the importance of co-designing research questions, methodologies, and outcomes with citizens, thus fostering resilience not only through data collection but also through empowerment and community capacity-building. Integrating insights from *Community Science* provides a stronger conceptual and methodological framing for

participatory approaches in risk governance (Pandya, 2012)

### Research Methodology

A systematic review of existing literature was performed since the proposed research topic is still understudied and existing literature is spread through several research areas. For data sourcing, we used two scientific databases, Scopus and Web of Science, as both are widely used by scholars and researchers. Moreover, both databases provide extensive and significant bibliographic data sets, comprehensive journal coverage, ease of keyword searching, accessibility within academia, and popularity across multiple disciplines (de Souza et al.,

2019). The electronic database search for this review was conducted in December 2022.

To identify relevant articles, keywords such as resilience, resilient, citizen science, crowd science were used. Thus, the search query (resilien\* AND (“citizen science” OR “crowd science”)) was applied to the ‘title, abstract and keywords’ field. The process of selecting articles for the research was based on several steps according to the PRISMA method (Moher et al., 2015). The first includes the definition of the inclusion criteria regarding subject area, document type and language (Table 2). No time limitation was considered so that all relevant articles could be identified.

The keyword search retrieved 377 articles from the selected electronic databases, and applying the selected inclusion criteria the number was reduced to 35 articles. A first screening step was performed to remove duplicates, and after excluding 2 identified duplicates, 33 studies were selected for assessment based on their abstracts and keywords. All irrelevant articles were excluded, leaving a total of 22 articles to be read in full, and unfortunately 1 article could not be retrieved. A total of 9 articles were excluded after reading the full text because they did not provide clear information on the impact of CS methodologies on resilience, leaving a final set of 12 eligible articles for analysis.

After applying the inclusion criteria and identifying the final set of eligible articles, it was

conducted a qualitative content analysis to assess how citizen science projects addressed different aspects of resilience. Each article was examined in detail and classified according to: (i) the level of citizen engagement (contributory, collaborative, or extreme citizen science), (ii) the resilience ability addressed (plan/prepare, absorb, recover, or adapt), and (iii) the observed or reported impacts on specific resilience dimensions and sub-dimensions. The classification followed a two-step process: first, an independent coding of the articles was performed based on their descriptions of citizen participation and outcomes; second, the codes were systematically compared and synthesized to ensure consistency. This approach allowed for a structured evaluation of the strengths, limitations, and effectiveness of citizen science initiatives in contributing to resilience.

## Results and discussion

The sample articles describe CS initiatives in different geographic locations, such as Nepal, Puerto Rico, Brazil, Italy, USA, Australia, among others, and focus on natural environmental hazards such as floods, extreme heat, or volcanic events (Table 3).

The level of citizens’ involvement varies from crowdsourcing to participatory science approaches. It was observed that *distributed intelligence*, where citizens perform simple interpretation activities and data gathering, and

*participatory Science*, where citizens participate in the problem definition, data collection, and data analysis (with support from experts), were the most used types of CS participation in the different case studies analysed. The absence of Extreme Citizen Science cases in the final sample should not be understood solely because of citizens' lack of skills to engage in complex data analysis and interpretation. Rather, it may also reflect limitations in how research processes are designed, as well as the willingness or capacity of researchers to foster inclusive practices that value and integrate community knowledge. This observation highlights the need for further exploration of frameworks such as Extreme Citizen Science, Community Science, and community-based participatory research, which emphasize more equitable forms of collaboration between citizens and researchers (Hoffman, 2016). In this sense, the predominance of contributory and distributed intelligence approaches in the literature suggests a tendency to use citizen science primarily for data collection and monitoring, while more collaborative or extreme forms remain underexplored. This imbalance reveals a potential limitation in the transformative capacity of citizen science, as less engaged approaches may contribute valuable data but often fail to fully empower communities or integrate their knowledge into decision-making processes.

In the case of resilient abilities, three of the ar-

ticles report effects of CS on the **ability to plan and prepare for hazards**, mainly those related to environment (e.g., droughts, flooding, invasive species). In this case, CS initiatives were used for collecting information and data, especially using *distributed Intelligence* approaches, which enabled a better understanding of local resources, capacities and vulnerabilities. This was relevant for the development of early warning systems and hazard prevention plans. For instance, in Nepal, floods and landslides are the most devastating natural hazards, and its severity has increased in recent years (Pandeya et al., 2021). Himalayan region is known for its remote and largely unexplored terrain, which has become a bottleneck for improving local flood capacity. In order to enhance local flood resilience, a CS project was implemented for developing accurate flood predictions, through a participatory science approach and the use of low-cost sensing technology (Pandeya et al., 2021). This has enabled researchers to gather data on local resources, capacities and vulnerabilities from remote areas and, thus, overcoming the data limitation in a data-scarce region, fostering the development of an effective community-based flood early-warning system. Additionally, this project was relevant to empower and educate local stakeholders to build flood resilience. When compared with contributory initiatives, such participatory projects show greater potential to strengthen resilience in the long term, since

they not only generate data but also foster community learning and local ownership of risk management strategies.

The **ability to absorb the consequences of a shock** was also highlighted in two articles. In the face of major hazard events, resilience depends first on the actions of people operating at the individual and neighbourhood level (Renschler et al., 2010). Therefore, CS is important to understanding people's behaviour and attitudes for assessing the social impact of hazards. Nevertheless, observational data during a disaster is often lacking. CS approaches can overcome this knowledge gap, since it can be used to collect data on people's perceptions, behaviours and attitudes during a disaster. For instance, Zhao et al. (2021) used CS approaches to better understand heat risk in the Phoenix area, where summer temperatures can exceed 49°C. In this case, volunteers were recruited to collect data on location/time, climate, human activities and heat exposure during their daily routine, through paper-based survey and portable sensing, as well as a smartphone app (ActivityLog). The research results allowed to understand user behaviours for daily log activities and how human activities interact with the urban thermal environment, informing further planning policy development. In addition, CS approaches were useful to identify what actions people took to mitigate hazards, as well as how these mitigation measures impacted local well-being.

Here, a clear distinction emerges: while contributory approaches are effective in quickly collecting behavioural data during crises, more engaged forms could provide deeper insights by involving communities in co-designing mitigation strategies, which is still rarely documented in the reviewed studies.

In turn, four articles focus on the **post-shock level**, namely how the system recovers its functionality after a major hazard or disaster. CS projects were relevant to understand community's coping capacity and mitigation strategies to overcome the main consequences of hazards by implementing distributed intelligence approaches. These was important for assessing community's preparedness and their ability to apply measures for protecting and reducing hazards impact. For instance, the area around the active Tungurahua volcano in the Ecuadorian Andes (Ecuador) is in persistent danger that could culminate in a major disruptive event. Stone et al. (2014) describe a network of volunteers, known as *vigías*, which started as a compromise following citizens' decisions to forcibly return to risk areas after a forced evacuation. This movement allowed the population to become involved in volcanic monitoring in the area around the volcano, through the collection of scientific data. As the authors note, this civic initiative has played an important role in community response to episodes of volcanic activity, providing a communication channel for community awareness

and preparedness, strengthening social capital, mutual relationships and trust among citizens, scientists, and local authorities. As a result, this initiative has brought solutions to the situation created by the reoccupation of risk areas, increasing the community's capacity to take protective measures, as demonstrated by self-evacuations, thus allowing risk reduction. This example illustrates that citizen science initiatives situated between contributory and collaborative models may already produce tangible recovery benefits; however, their scalability and sustainability remain underexplored in the literature, limiting broader generalizations.

Finally, three articles describe how CS could be used to **improve a system's capacity to adapt after a shock**. The capacity to adapt is related with building resilience to cope with future hazards and other stressful events through empowering citizens to design and implement preventive measures by their own. Therefore, participatory science approaches were relevant to develop human and social capital, as well as to design prevention strategies based on the knowledge and experience of past hazard events. J. S. Hoffman (2020) describes a small-scale community-based citizen science initiative to assess the urban heat island effect in the city of Richmond (USA), where community volunteers collected data to provide a description of the climatologically coolest, hottest, and early evening temperatures along pre-de-

termined driving routes that pass through the greatest variation in land use/land cover across the urban area. The data collected allowed the development of a heat vulnerability index map that can identify areas that may need to be prioritised for action due to excessive vulnerability. Thus, this CS project was relevant to improve citizens' literacy, as well as the development of specific emergency and recovering measures to build resilience to extreme heat by using the urban heat vulnerability index as a guide to design the urban space in one of Richmond's hottest and most vulnerable neighbourhoods. Compared to projects focusing only on short-term data collection, this adaptive dimension shows how citizen science can also act as a driver of structural change, encouraging long-term resilience planning. Nevertheless, such transformative projects remain scarce in the literature, highlighting an opportunity for future research. In most of the cases analysed, the use of data generated from remote sensing is a common practice. Big data (e.g. call detail records, satellite imagery or social media) has shown real and potential value as an important mean to monitor and detect hazards, mitigate their effects, and assist in relief efforts (Data Pop Alliance, 2015). Nevertheless, most of the big data applications for resilience development consist of small pilots (Data Pop Alliance, 2015), which cannot capture specific aspects of vulnerability. In the articles analysed, CS enables to overcome this limitation by combin-

Resilience Abilities	Objectives of CS projects	Output of CS projects	References
Plan/Prepare	Collect data, especially from data-scarce regions, regarding exposure and vulnerability of a community to hazards;	<ul style="list-style-type: none"> <li>• Development of early-warning systems and tools to support decision making processes;</li> <li>• Shape local-level strategies planning and implementation regarding risk prevention;</li> <li>• Raise awareness of local exposure to hazards;</li> <li>• Empower and educate local stakeholders to build resilience;</li> <li>• Strengthen social capital, mutual relationships and trust among citizens, scientists, and local authorities;</li> </ul>	Parajuli et al. (2020) Pandeya et al. (2021) Rossi et al. (2022)
Absorb	Collect data regarding people's behaviour, attitudes and perceptions during hazards events	<ul style="list-style-type: none"> <li>• Assessment of hazards social impact;</li> <li>• Development of specific emergency and recovery measures;</li> <li>• Development of tools to facilitate decision-making processes during a disaster;</li> <li>• Empower and educate local stakeholders to build resilience;</li> <li>• Strengthen social capital, mutual relationships and trust among citizens, scientists, and local authorities;</li> </ul>	Mahajan et al. (2021) Zhao et al. (2021)
Recover	Collect data about the lived experience of those directly impacted by disasters, as well as coping measures in place	<ul style="list-style-type: none"> <li>• Development of recovery plans aligned with local context;</li> <li>• Contribute to community preparedness to hazards and capacity to take protective measures;</li> <li>• Empower and educate local stakeholders to build resilience;</li> <li>• Strengthen social capital, mutual relationships and trust among citizens, scientists, and local authorities;</li> </ul>	Thomas et al. (2016) Alves et al. (2021) Stablein et al. (2022) Stone et al. (2014)
Adapt	Collect data on potential unforeseen hazards	<ul style="list-style-type: none"> <li>• Design of mitigation measures to deal with potential hazards;</li> <li>• Empower and educate local stakeholders to build resilience;</li> <li>• Empower and educate local stakeholders to build resilience;</li> <li>• Strengthen social capital, mutual relationships and trust among citizens, scientists, and local authorities;</li> </ul>	Zeng et al. (2020) Vadjunec et al. (2022)

## Impact of CS projects on community resilience abilities.

Source: Author's own elaboration  
Tab. 3

ing citizen scientists' observations with mobile phone technology, making knowledge creation multidirectional, easy to use and access, fostering the mitigation during a disruptive event, natural or otherwise. This comparison suggests that citizen science complements big data by adding contextual and community-based insights that large-scale datasets alone cannot capture, thereby reinforcing its unique contribution to resilience research.

Beyond their academic relevance, the findings of this review also raise important practical and political implications. Citizen science initiatives can support decision-makers by generating locally grounded evidence for resilience planning, while at the same time empowering communities to become active stakeholders in risk governance. By creating spaces for collaboration between citizens, scientists, and institutions, such initiatives have the potential to foster trust and social capital, thereby enhancing both the legitimacy and effectiveness of resilience strategies. Politically, the integration of citizen science into resilience frameworks highlights the need for policies

that actively value community knowledge, allocate resources for participatory practices, and address inequalities in access to scientific processes.

Table 3 summarises the main findings of the sample analysed.

### Conclusion

CS approaches show great potential to contribute to the development of community resilience's abilities. For this, CS approaches enable the collection of data from new sources or remote places where data is scarce, as well as historical data that is not recorded, allowing for a better characterization of potential hazards, and the identification of community needs, perceptions and behaviours. As a consequence, a more accurate understanding of local context and community's characteristics will be generated, enabling the development and implementation of more effective early warning systems, tools, and mitigation measures. In addition to data collection, the use of citizen science approaches also impacts community resilience by enhancing community awareness

and knowledge about hazard protection (Rossi et al., 2022), which then improve their capacity to take protective action, such as coping and adaptive measures. The increase in human and social capital is also fostered in CS through specific training initiatives, related with data gathering, data processing and validation, and, thus, increasing community's capacity to take measures towards hazards.

Moreover, CS approaches promote the cooperation between community (citizens), academia (professional scientists) and government (policymakers). This is relevant for the development of public policies shaped to local context and aligned with community's needs and expectations (Mahajan et al., 2021).

In sum, through the implementation of this citizen science initiative, community members were able to increase their understanding of their environment, establish community leaders, grow local networks and improve communication between the community and local authorities, making them better prepared for future challenges.

### Limitations

The present study was based on a qualitative and exploratory research method. Despite the well-known limitations related to the generalization of results in this type of approach, the possibility to explore very complex and understudied processes, such as the promotion of community resilience, clearly outweighs the

disadvantages. The set of qualitative studies examined provided valuable information on several facets of CS phenomenon, thus contributing to setting the bases for quantitative studies in this area.

Furthermore, the present study only included peer-reviewed articles published in English, which may have led to the exclusion of relevant articles from the analysis. Finally, there may have been some bias related to the content analysis due to the personal views of each researcher. However, an attempt was made to minimize this bias through the individual evaluation of the articles, followed by a consensus discussion where the researcher and a research assistant tried to reach an agreement regarding the classification performed.

### Further Research

As noted by Stablein et al. (2022), it is important to explore and understand what role citizens and scientists can play in supporting community resilience. Therefore, there is the need for more transdisciplinary and integrative research approaches to explore the different facets of community resilience, as well as to identify the main barriers and drivers in the implementation of CS approaches.

It is important to note that the findings of this review reflect the current state of the literature, which is still limited in terms of studies addressing more engaged forms of citizen science, such as community-driven or extreme

citizen science. While contributory approaches appear more frequently in the analysed sample, this should not be interpreted as a lack of relevance of more participatory models, but rather as an indication of a gap in the existing research. Future studies could therefore explore these more engaged forms in greater depth, as they hold significant potential for strengthening resilience and advancing participatory approaches in risk governance.

Finally, further research should promote quantitative analysis and cross-community comparisons to deepen the understanding of the resilience in the context of territories and communities.

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# Innovative approaches to address territorial multi-risk: rethinking spatial planning processes in the era of transition

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### keywords

spatial planning  
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adaptive governance

*In a context marked by environmental crises and interdependent vulnerabilities, this article introduces an innovative methodological approach to spatial planning based on the paradigm of multi-risk transition. The L methodology combines a vertical axis, ensuring strategic coherence across governance levels, with a horizontal axis focused on territorial multi-risk diagnosis. Unlike existing planning frameworks that*

### Introduction

The increasing complexity of territorial transformations—exacerbated by climate change, human pressure on ecosystems, and the intensification of socio-economic vulnerabilities—requires a radical revision of spatial planning approaches. In this context, the emergence of the ecological transition paradigm has marked a significant turning point, reshaping priorities, frameworks, and instruments of public action in the spatial domain. However, despite the proliferation of strategies, plans, and programs aimed at sustainability, a structural gap persists between the systemic vision

*often treat multi-risk assessment and governance coherence as separate analytical domains, the L methodology integrates them into a single operational structure. This dual-axis framework enables planners to simultaneously interpret systemic vulnerabilities and align adaptive strategies across scales, thus addressing a critical gap in the current literature on spatial and climate planning. The article primarily explores the latter through an experimental application in the UNESCO MAB Biosphere Reserve of the Po Delta (Veneto Region). By integrating vulnerability and exposure data, the multi-risk assessment is conceived as both a cognitive and operational device to inform place-based visions and strategies. The proposed methodology serves as a transformative tool to rethink spatial planning as an adaptive governance process, capable of bridging scales, actors, and knowledge in complex territorial contexts.*

promoted by higher-level strategic frameworks and the capacity of local planning tools to translate such objectives into territorially

contextualized operational practices. At the same time, the concept of resilience, although widely adopted in the discourse on climate planning, has often been reduced to a set of technical responses lacking a truly transformative vision, and limited to the management of specific risks. In response to these criticalities, a new paradigm is emerging—that of multi-risk transition—which encourages the interpretation of territorial vulnerabilities not as isolated or sectoral phenomena, but as outcomes of interdependent and systemic processes. This perspective requires a fundamental rethinking of the role of planning, which should no longer be understood solely as a normative or regulatory tool, but as a cognitive and strategic device capable of anticipating challenges, integrating knowledge, and guiding transformations (Pasqui, 2005). This contribution situates itself within this theoretical and operational framework, by proposing a methodological approach to address the complexity of the multi-risk transition through a multiscale perspective on spatial planning. The proposed methodology—referred to as the “L methodology”—is structured along two interrelated analytical and operational axes: a vertical axis aimed at fostering strategic coherence across governance levels and regulatory tools; and a horizontal axis focused on interpreting territorial specificities through multi-risk diagnosis and the definition of site-specific trajectories for action. While the methodology is conceived

as a coherent and integrated framework, this contribution intentionally focuses on one specific component: the development and use of multi-risk assessment as a diagnostic device within the horizontal axis. The vertical dimension—namely, the analysis of multi-level regulatory and strategic frameworks—was activated in the case study but will not be explored in detail here. Likewise, the full articulation of the visioning phase and the definition of objectives, strategies, and actions will be addressed in future applications. The chosen focus aims instead to highlight the transformative potential of the multi-risk approach, conceived not as a mere technical tool but as a cognitive and projective infrastructure capable of guiding planning choices in contexts of high complexity and uncertainty.

This research builds upon a consolidated body of international studies that have progressively reframed spatial planning as a key instrument for resilience-building (Fleischhauer, 2008; Pelling et al., 2024; Weichselgartner & Kelman, 2015). However, as noted by Panwar, Wilkinson and Pelling (2024), the translation of risk knowledge into planning practice remains limited, revealing persistent disconnections between scientific assessment and policy design. Within this debate, the approach proposed here aligns with recent attempts to address risk through integrated, multi-scalar and cross-sectoral frameworks (Ferreira et al., 2023), contributing to the ongoing redefinition

of planning as a transformative governance process, and introducing an original framework that connects diagnosis and strategy in multi-risk planning.

Building on this theoretical background, the research emphasizes the necessity of developing integrated frameworks capable of reconnecting environmental sustainability, social cohesion, and systemic resilience. From this perspective, risk—especially in its multilevel and multidimensional configuration—is no longer conceived as an object to be managed, but rather as an interpretative lens through which to guide territorial visions and strategies. The proposed methodology was tested in the UNESCO MAB Biosphere Reserve of the Po Delta (Veneto Region), selected as an emblematic context for the application of the multi-risk approach. This choice is rooted in the hybrid nature of the area, which combines ecological fragility, socio-economic pressures, and a stratified governance structure, making it particularly suitable for experimenting with the L methodology. The UNESCO MAB area also represents a virtuous example of a supra-local governance framework which, through its management plan, integrates conservation and development objectives, offering a fertile ground for developing a comprehensive territorial diagnosis. As previously stated, this article places specific emphasis on the development of an integrated multi-risk model, which combines the assessment of

intrinsic territorial vulnerability with the exposure of socio-economic and environmental components. This approach not only enables the identification of areas under highest pressure but also supports the construction of a synoptic map of cumulative stressors, functional to the definition of place-based visions and strategies. The multi-risk framework is thus conceived as a strategic and enabling device, capable of supporting informed decisions aligned with systemic priorities and local specificities.

The structure of the article reflects the conceptual and operational articulation of the proposed framework. The methodological section outlines the foundations of the L methodology, with particular focus on its dual-axis logic (vertical and horizontal) and on the construction of the multi-risk assessment as a diagnostic tool. The results section presents the application of the model within the UNESCO MAB Po Delta Reserve, highlighting territorial dynamics emerging from the intersection between vulnerability and exposure, and identifying priority areas for intervention. The discussion explores the main elements of innovation and the potential of the methodology, comparing the proposed approach with the limitations of conventional planning practices. The conclusions reflect on the theoretical and practical contribution of the research, its potential for transferability, and future avenues for development. The article ultimately reaf-

firms the strategic role of spatial planning in shaping resilient development trajectories in an era of transition and uncertainty.

Ultimately, this research aims to contribute to the scientific and operational debate on the reconfiguration of spatial planning processes by proposing multi-risk as both a cognitive and operational lever to reorient spatial strategies toward more coherent, integrated, and transformative pathways.

### **Framing the research: from ecological transition to multi-risk transition**

The ecological transition has become a central paradigm in contemporary environmental and territorial policy agendas. It reflects a growing awareness that responding to climate change, biodiversity loss, and systemic ecosystem degradation requires a profound reorganization of socio-territorial models (Carrosio, 2019; Magnaghi, 2014). Far from being a purely sectoral or technical matter, this transition entails a comprehensive restructuring of institutions, infrastructures, and spatial practices, in line with long-term principles of sustainability and resilience (Ronchi, 2021).

Strategic frameworks such as the *European Green Deal* (2019) play a fundamental role in this regard, promoting a systemic vision built on interconnected objectives: decarbonization, ecosystem protection, sustainable mobility, and the promotion of the circular economy. At the national level, this vision has been adopt-

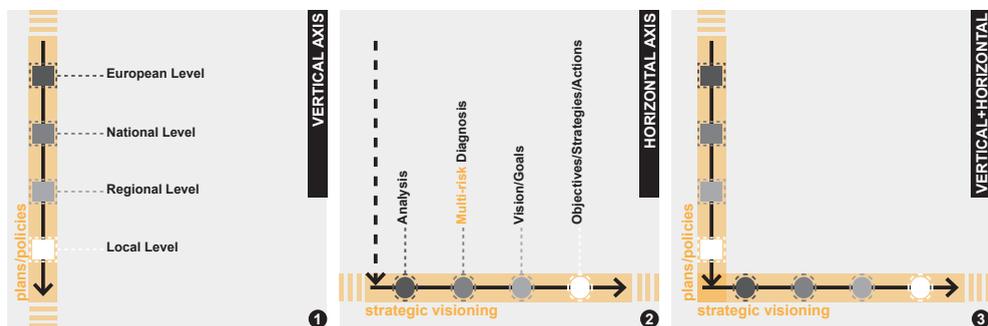
## Graphical representation and methodological construction of the “L” framework.

Source: authors' elaboration.

Fig.1

ed through the *National Plan for Ecological Transition (PTE)*, which outlines eight strategic pillars: climate neutrality, air quality improvement, reduction of land consumption and hydrogeological risk, sustainable water management, biodiversity restoration, protection of marine and coastal environments, sustainable agriculture and bioeconomy, and circular use of resources. These priorities aim to provide a coherent, cross-sectoral framework for guiding territorial transformation. However, policies and planning tools still operate along a silos approach, thereby limiting the transformative potential of the ecological transition. Planning instruments often struggle to address the complexity of territorial vulnerabilities, treating sustainability objectives as ancillary components rather than structural principles of spatial action (Orioli et al., 2023). The risk is that the transition may result in a fragmented set of sectoral interventions disconnected from broader governance and systemic adaptation processes (Giudice et al., 2022). Similar limitations emerge in the implementation of resilience-oriented strategies. While the concept of resilience has gained a central role in territorial planning—especially in relation to climate risks—it has often been translated into narrowly defined operational measures: adaptation plans, defensive infrastructures, and single-risk interventions (Davoudi et al., 2012; Vale et al., 2014). These approaches tend to separate hazards from their social and ter-

ritorial contexts, overlooking the interdependencies among systems and the cumulative nature of vulnerabilities (Friend, 2013; Pelling, 2010). International frameworks such as the Sendai Framework for Disaster Risk Reduction (2015–2030) have emphasized the need to move beyond hazard-specific approaches. Rather than treating risks as isolated events, planning should address how climatic, environmental, infrastructural, and socio-economic factors interact and reinforce each other (Ward et al., 2022; Zschau, 2017). Recent reflections on risk governance highlight the inadequacy of mono-risk readings, calling for approaches capable of addressing systemic threats and multidimensional fragilities (Gallina et al., 2020). Several international frameworks have been developed to operationalize multi-risk assessment and to move beyond single-hazard perspectives. Gallina et al. (2020) proposed a methodology for the integrated assessment of climate-related hazards in coastal areas, based on multi-criteria analysis and GIS. While the model provides a replicable structure for identifying combined risks, it remains largely descriptive and detached from planning practice. Stalhandske et al. (2024) developed a global modelling framework using the CLIMADA platform, capable of analysing compounding and sequential hazards at different temporal and spatial scales. However, its highly quantitative nature and global scope limit its applicability for territorial governance



and local-scale planning. At a conceptual level, Graveline and Germain (2022) contributed to advancing the theoretical understanding of resilience by identifying its multiple dimensions and emphasizing the shift from reactive to transformative approaches, though without providing operational tools to translate this vision into spatial practice.

However, despite these advances, the L methodology aims to bridge analytical and territorial dimensions by integrating multi-risk diagnosis with spatial and governance coherence. Unlike purely quantitative or conceptual frameworks, it embeds vulnerability and exposure within a spatially grounded, multi-scalar structure that connects scientific evidence, territorial knowledge, and policy frameworks. This integration between horizontal and vertical axes operationalizes multi-risk assessment as both a diagnostic and strategic device for spatial planning.

Considering these criticalities, this article advances the concept of multi-risk transition as a conceptual and operational advancement over traditional resilience paradigms. In this perspective, risks are no longer conceived as separate technical phenomena to be managed, but rather as complex, interconnected processes that require cohesive, flexible, and context-sensitive responses. This approach

encourages a rethinking of planning as an anticipatory tool capable of structuring coherent future trajectories by aligning local decision-making processes with supra-local strategies. The aim is no longer merely to mitigate the impact of isolated emergencies, but to read systemic dysfunctions, structural vulnerabilities, and the transformative potential of territories through the lens of risk—understood as a critical infrastructure of meaning for spatial design (Liao, 2012; Renn, 2017).

### Methodology: designing the “L” framework for integrated and multi-risk-informed spatial planning

The methodology proposed in this contribution is conceived as an integrated framework for addressing the complexity of the multi-risk transition within territorial planning processes. It is structured along two interconnected analytical axes—a vertical and a horizontal one—whose intersection forms an “L”, highlighting the link between top-down priorities and bottom-up dynamics (Fig. 1).

The vertical axis begins with an analysis of supranational and national regulatory and strategic frameworks, particularly the *European Green Deal* and Italy’s *National Plan for Ecological Transition (PTE)*, as well as key strategies for climate adaptation and resilience, such



as the *National Adaptation Plan to Climate Change (PNACC)* and the *National Strategy for Sustainable Development (SNSvS)*. This top-down trajectory enables the identification of institutional priorities, intervention domains, and critical issues that structure the transition across multiple administrative scales—from national to municipal levels.

Unlike the knowledge framework typically developed within the cognitive phase of a spatial plan, the vertical axis does not serve a descriptive function. Its role is strategic and comparative: by cross-reading supranational, national, regional, and local frameworks, it identifies consistencies, gaps, and overlaps among policy agendas. This process provides a synthetic reference grid that guides the subsequent territorial diagnosis developed along the horizontal axis. In this way, the vertical axis establishes the strategic coherence that orients the multi-risk assessment, ensuring that local analyses and actions remain aligned with broader transition priorities. While the horizontal axis focuses on the analytical reading of territorial vulnerabilities and potentials, the vertical one operates at a meta-level, translating institutional frameworks into strategic guidance for action. This distinction prevents any overlap with the cognitive phase of planning, ensuring complementarity between diagnostic and strategic dimensions.

The translation of general objectives into place-based priorities allows for the construc-

tion of an initial framework of alignment between environmental policies, planning tools, and programmatic agendas (Torresan et al., 2020). However, this axis does not merely identify formal objectives; it also reveals gaps, misalignments, and fragmentation across sectors and levels of governance, offering a first orientation for the design of localized strategies. Subsequently, the horizontal axis develops an in-depth reading of the territorial context through a multi-phase process: integrated analysis, territorial diagnosis, shared vision building, and the definition of objectives, strategies, and actions. Within this dimension, the methodology draws on the vision-goals-objectives-strategies-actions (VGOSA) model, which supports backcasting processes for defining desirable future scenarios and designing context-specific interventions (Bryson, 2011; Davoudi, 2017; Kahn, 1962; Simon, 1976).

A core component of the horizontal axis is the development of an advanced territorial diagnosis, based on a multi-risk approach that enables the integrated interpretation of both environmental and socio-economic dimensions of vulnerability. The methodology adopted for defining multi-risk is grounded in two complementary dimensions—intrinsic vulnerability and exposure—identified as crucial for supporting complex decision-making in territorial management (Stalhandske et al., 2024) (Fig. 2). The first addresses intrinsic vulnerability, assessing risks arising from climatic

## Graphical representation of the methodology adopted for multi-risk assessment.

Source: authors' elaboration.

Fig. 2

and physico-environmental factors affecting the territory, while the second focuses on exposure, evaluated through the presence and spatial distribution of socio-economic and natural assets potentially subject to impacts. This contribution examines the following exposed elements: built assets, agricultural areas, natural resources, population density, and socio-economic activities.

According to the “*Rapporto Clima in Veneto*” (2024) by the Regional Environmental Protection Agency of Veneto (ARPAV), the mean air temperature in the Veneto region has increased by approximately +0.6 °C per decade since 1993, with higher warming rates in summer and autumn (+0.76 °C and +0.68 °C/decade). The Po Delta and coastal plains are explicitly identified among the areas most exposed to extreme heat, tropical nights, and surface warming phenomena due to low wind ventilation and high evapotranspiration rates. At the same time, hydraulic risk represents a long-standing and increasing concern: the ARPAV analysis confirms that the southern plains and deltaic zones are the least rainy ( $\approx 650$  mm/year). These dynamics, together with projected increases in extreme winter precipitation (+15 – 35 %) and longer dry spells in summer (up to +20 days) under high-emission scenarios (RCP8.5), imply a marked rise in flood and waterlogging frequency. Finally, the salinization of soils emerges as a critical climate-induced process in the coastal and del-

taic systems, tightly coupled with the previous two: the combination of increased temperature, reduced summer rainfall, and more frequent extreme hydrological events contributes to the inland progression of the salt wedge and soil salinity, which ARPAV lists among the priority adaptation challenges for low-lying coastal areas of the Veneto Region. Considering these regional trends, while other climatic descriptors described from ARPAV (e.g., wind regime, humidity, snow cover, and extreme convective activity) are present but only partially relevant for these territorial contexts, these three variables were prioritized as the most representative for evaluating multi-risk exposure in transitional coastal systems such as the Po Delta.

The heatwave-related risk was calculated through statistical analysis conducted on a collection of Landsat-8 satellite images, used as an indicator of land surface temperature, within the Google Earth Engine environment. Hydraulic risk was derived from data provided by the *Flood Risk Management Plan* (PGR), reclassified on a progressive scale highlighting increased hazard levels in proximity to the secondary hydrographic network of the plain. Finally, soil predisposition to salinization was obtained through a progressive classification of data provided by ARPAV.

The second part of the equation refers to the exposure of territorial and socio-economic elements and was defined using four main

indicators: the density of points of interest (densPOI), the density of vulnerable population (densPOP), urban and agricultural areas potentially affected by salt wedge intrusion (SALTexp), and the reserve areas recognized under the UNESCO Man and Biosphere (MAB) Programme (2020). The density of points of interest was obtained from OpenStreetMap data and reflects the concentration of commercial, touristic, cultural, and recreational activities, serving as an indicator of socio-economic exposure. OSM POIs were aggregated by ISTAT 2021 census spatial geometry and normalized by area ( $\text{POI}\cdot\text{km}^{-2}$ ) for each single unit. We adopted three fixed thresholds – 0–5  $\text{POI}\cdot\text{km}^{-2}$  (low), 5–10  $\text{POI}\cdot\text{km}^{-2}$  (medium),  $\geq 10$   $\text{POI}\cdot\text{km}^{-2}$  (high) – defined through a multi-stage process: (i) exploratory analysis of the indicator distribution identifying two local discontinuities around  $\sim 5$  and  $\sim 10$   $\text{POI}\cdot\text{km}^{-2}$ ; (ii) domain calibration with respect to the local functional hierarchy (episodic absence of services in widespread reclamation areas, fractional nuclei with basic facilities, municipal centers with a broader portfolio of functions); (iii) criterion of interpretability and comparability over time/space, preferring stable thresholds to purely data-driven methods (quantiles/Jenks) that vary with the sample. Population density, derived from ISTAT data, is a key parameter for identifying the presence of potentially vulnerable populations (under 15 and over 65 years of age) in the event of ex-

treme climate events. Urban and agricultural areas located below sea level were identified as particularly exposed to salt wedge intrusion, as they are susceptible to salinization, with consequences for agricultural productivity and the economic value of cultivated land. Finally, UNESCO MAB areas represent contexts of high ecological and cultural value, where environmental risks may generate direct impacts on biodiversity, conservation practices, and overall touristic appeal. These areas are structured into three functional zones: “core zone”, “buffer zone”, and “transition zone”. The Core Zones represent strictly protected areas of high importance for biodiversity, subject to stringent restrictions to prevent significant disturbance.

The Buffer Zones serve as protective buffers and allow activities compatible with conservation, such as scientific research, sustainable tourism, and low-impact agriculture. The Transition Zones extend outward and are dedicated to the experimentation of sustainable development strategies, involving local communities, public authorities, and private stakeholders (UNESCO, 2022).

This diagnosis relies on methods and indicators capable of representing the co-occurrence of natural, climatic, and anthropogenic risks, as well as the cumulative pressures affecting communities, infrastructures, and ecosystems. In this way, multi-risk is not conceived as a mere sum of stress factors, but as an interpretative

Definition	Risk Equation component	Source	Range Value	Details
Land Surface Temperature over mean value threshold	Vulnerability	Landsat 8	0,25-1	% of anomaly over average LST in summer 2024
Flood Vulnerability Index	Vulnerability	PGRA	0,25-1	Flood vulnerability classes from RSP by PGRA ADBPo
Surface Salinity Class: soil predisposition to salinization	Vulnerability	ARPAV	0,25-1	Salinity class of the surface soil horizon (0-30/50 cm)
Point of Interest Density	Exposure	OpenStreetMap	1-3	OSM amenities + Rural Heritage per square km
Vulnerable Population Density	Exposure	ISTAT	1-3	ISTAT 2021, <15 + >65 years old per square km
Saline Exposed Surfaces Atlas	Exposure	Veneto Region Land Use & Land Cover	1-3	Natural, Urban and Agricultural Land
MAB	Exposure	UNESCO MAB	1-3	Transition, Buffer, Core

## Elements used for the calculation of the multi-risk equation and corresponding classification adopted by the authors.

Source: authors' elaboration.

Tab. 1

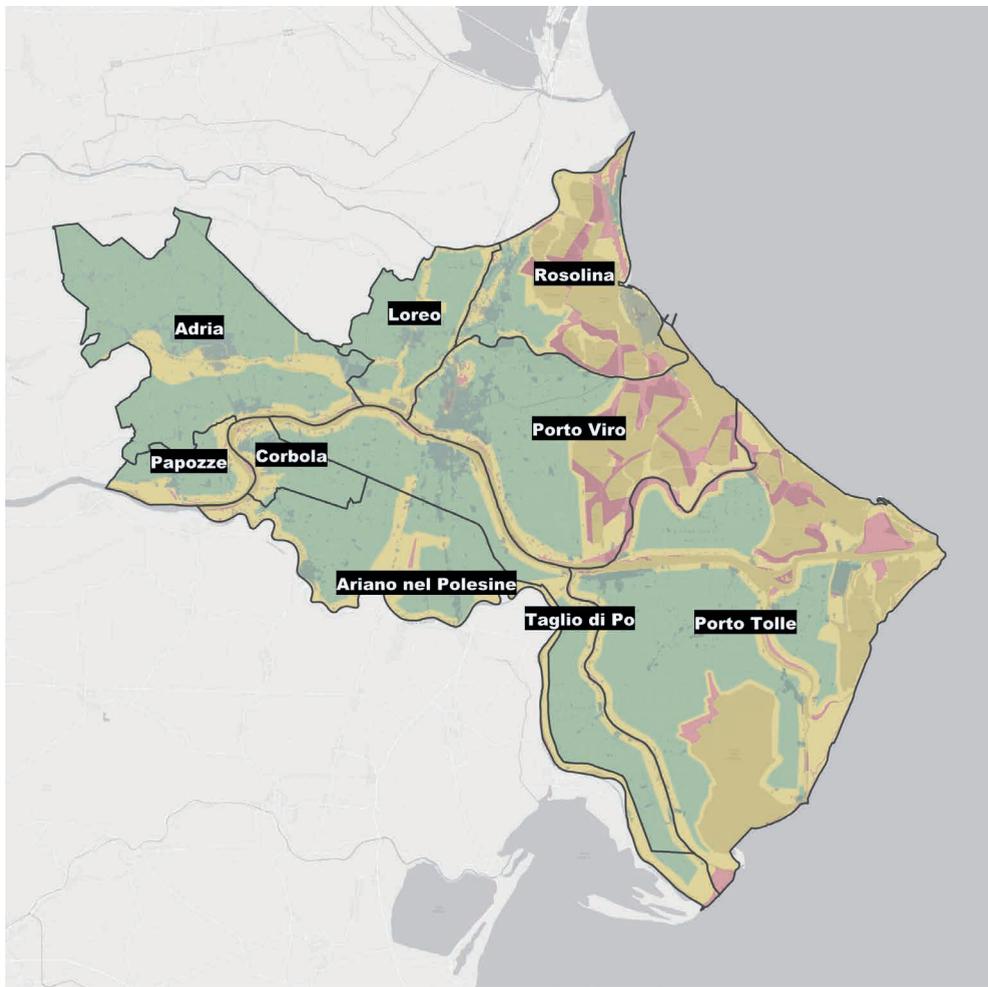
framework capable of guiding the selection of objectives and the definition of strategies.

The interaction between the two axes—rather than their simple overlap—represents the operational core of the methodology. While the vertical axis identifies the coherence and relevance of systemic needs and the strategic directions emerging from institutional frameworks, the horizontal axis allows these to be translated in relation to local characteristics,

vulnerabilities, and resources. Their intersection generates a framework capable of linking strategic priorities with local dynamics and enabling integrated planning processes.

### **Results: applying the “L” methodology in the Po Delta MAB Area – a multilevel and multi-risk-based reading**

The proposed methodology was applied to the UNESCO MAB Po Delta Reserve, selected as a pilot case to verify its operational validity



at a meso-local scale – an intermediate level between municipal planning and regional coordination (Fig. 3). The application focused primarily on the diagnostic phase (horizontal axis) and on the construction of the multi-risk map, while the visioning and strategic components will be developed in subsequent stages. Although this area geographically coincides with the boundaries of the Po Delta Regional Park, it was not interpreted strictly as a protected area, but rather as a biosphere reserve, in line with the UNESCO MAB designation and its associated strategic framework. This choice

was not merely cartographic but methodological: the UNESCO MAB Programme provides a governance model capable of combining environmental protection with the promotion of sustainable socio-economic development—a duality that aligns fully with the multi-risk perspective adopted by the methodology. The reference to the UNESCO MAB framework enabled the identification of a supra-local governance structure in which environmental, social, and economic dimensions are institutionally integrated.

Unlike the *Management Plan of the Po Delta*

## Administrative subdivision of the Veneto Po Delta overlaid with the zoning of the UNESCO MAB area. Transition areas (green) allow for sustainable human activities; buffer zones (yellow) serve as protective belts for the core zones; core areas (red) are designated for the long-term conservation of biodiversity and ecosystems.

Source: authors' elaboration.

Fig. 3

*Regional Park*, which is primarily focused on conservation and renaturalization, the UNESCO MAB strategic framework offers a broader interpretative lens for territorial transformation processes. This allowed for the selection of a study area that is not only ecologically significant but also characterized by internal inequalities, exposure to multiple risks, and substantial anthropogenic pressures—all elements that define its relevance for multi-risk planning.

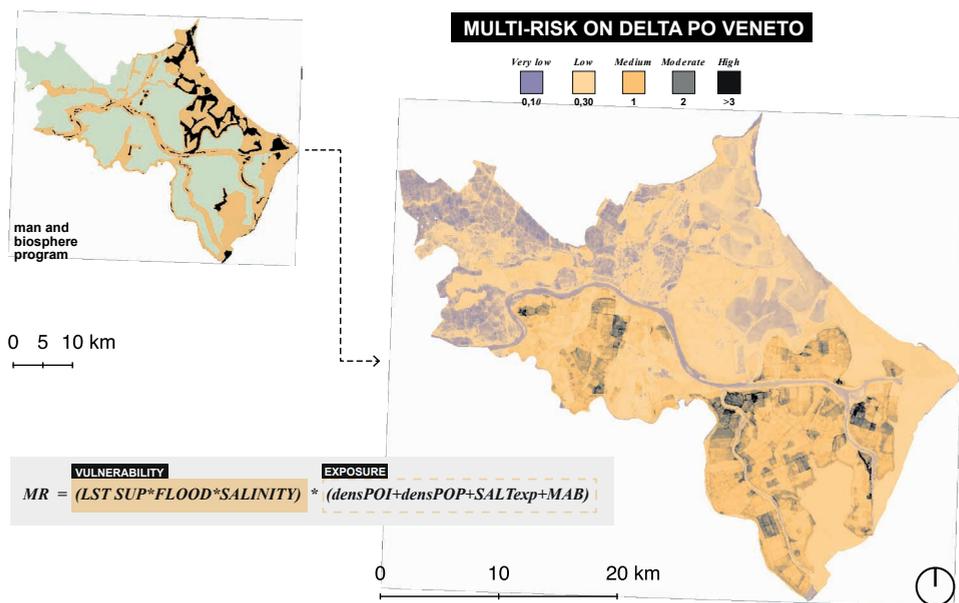
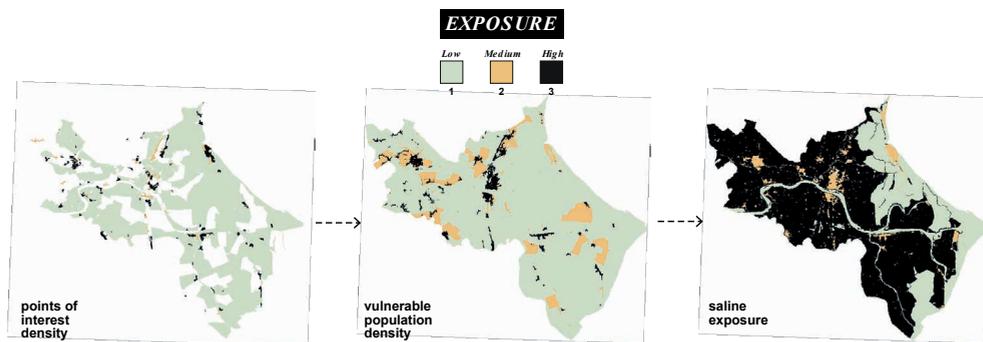
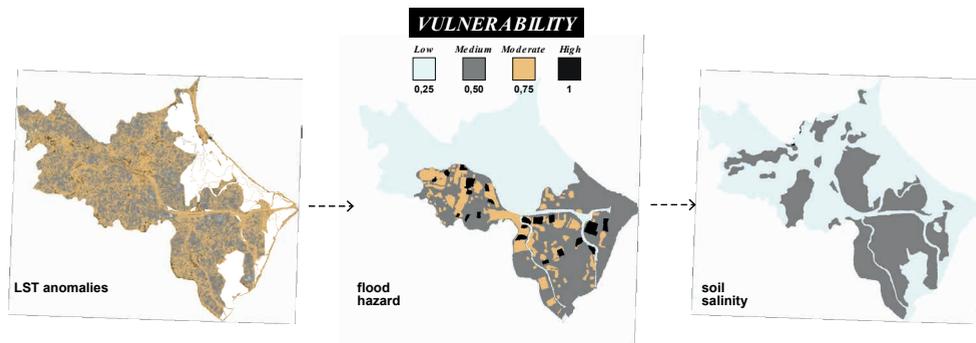
Within this territorial perimeter, the vertical component of the methodology was activated through a multilevel analysis of political and planning frameworks. At the European level, the analysis considered the *European Green Deal* and the *European Strategy for Climate Change Adaptation (SEACC)*. At the national level, the analysis examined the *National Plan for Ecological Transition (PTE)*, the *National Strategy for Climate Change Adaptation (SNACC)*, and the *National Adaptation Plan to Climate Change (PNACC)*, from which cross-cutting priorities emerged concerning decarbonization, biodiversity, circular economy, and hydrogeological risk prevention.

At the regional scale, the analysis included the *Veneto Regional Spatial Coordination Plan (PTCR)* and the *Regional Strategy for Climate Change Adaptation (SRACC)*. These instruments revealed the persistence of sectoral approaches and the need for integrated tools capable of mediating between environmental

urgencies and socio-economic development objectives. Finally, at the local level, the analysis focused on urban planning instruments (*Piani di Assetto del Territorio* and *Piani degli Interventi*) of the nine municipalities within the UNESCO MAB area: *Adria*, *Ariano nel Polesine*, *Corbola*, *Loreo*, *Papozze*, *Porto Tolle*, *Porto Viro*, *Rosolina*, and *Taglio di Po*.

The analysis revealed a limited capacity of individual municipalities to address interdependent risks, due to both institutional fragmentation and a disconnect between intervention scales and actual territorial dynamics. This finding reinforced the need to refer to the UNESCO MAB strategic plan as a supra-local framework capable of operationalizing the vertical component of the methodology.

The analysis thus enabled the reconstruction of a coherent trajectory of strategic priorities, tracing their evolution across different governance levels and identifying inconsistencies, redundancies, and gaps within the planning system. This output served as the foundation for activating the horizontal component, dedicated to the spatial and systemic articulation of risks and to the construction of a shared vision calibrated to the specificities of the UNESCO MAB reserve territory. The activation of the horizontal component of the methodology took place through an analytical-diagnostic reading of the territory, aimed at building a robust knowledge base from which to derive, in line with the strategic approach of the L meth-



**Multi-risk assessment for the Veneto Po Delta, combining spatial indicators of vulnerability and exposure to climate-related hazards. Vulnerability is assessed through the integration of land surface temperature (LST) anomalies, flood hazard zones, and soil salinity patterns. Exposure is determined by mapping the density of points of interest, the distribution of vulnerable populations, areas affected by saline intrusion, and the extent of the UNESCO MAB Programme. The resulting multi-risk map highlights areas where these factors converge, offering a composite view of zones most at risk from the combined impacts of climate stressors and human presence.**

Source: authors' elaboration.

Fig. 4

odology, the future transformative vision and actions. This reading was formalized in an operational model of territorial diagnosis based on the concept of multi-risk, understood not as a sum of isolated hazard factors, but as a multilevel and multidimensional integration of intrinsic territorial vulnerabilities and the socio-economic and environmental exposure to stressors. The weighted combination of these two sections resulted in a synoptic map of territorial multi-risk, useful not only for identifying areas of highest risk concentration, but also for understanding the overlaps and potential interactions among environmental, infrastructural, and settlement components. In this sense, the model functions as an essential diagnostic layer, capable of guiding the subsequent definition of a strategic vision and local actions in line with the priorities that emerged from the vertical framework.

Specifically, the integration between the vulnerability framework and the exposure framework generates a new informational layer. In the area of the UNESCO MAB Po Delta Reserve, the application of a weighted calculation strengthens the policy design framework within the L-methodology process, producing an output that identifies portions of territory organized according to a hierarchy of risk pri-

orities.

As shown in *Fig. 4*, the municipalities of Ca' Tiepolo, Donzella, Polesine Camerini, and Scardovari are among the most exposed. This is due to their agricultural vocation, the significant presence of vulnerable residents (under 15 and over 65 years old), the concentration of socio-economic activities, and specific morphological conditions which, according to the current *Flood Risk Management Plan (PGRA)*, make parts of these areas particularly prone to flooding from the secondary hydrographic network of the plain. The territory of the Municipality of Corbola and the agricultural mosaic stretching between Taglio di Po and Ariano nel Polesine also shows simultaneous exposure to multiple forms of vulnerability. On one hand, the area is subject to hydraulic risks, linked to the presence of a complex hydrographic network and reduced soil drainage capacity. On the other hand, it exhibits an increasing predisposition to surface salinization, a phenomenon aggravated by marine intrusion and changes in tidal and groundwater regimes. This stretch of land, characterized by multidimensional fragility, is located near the Buffer Zones of the UNESCO MAB Biosphere Reserve, posing additional challenges for the integrated management and protection of the area's

agricultural and environmental ecosystems. The island of Boccasette represents another strategic area, situated in a highly sensitive environmental context and surrounded by zones belonging to the UNESCO MAB Biosphere Reserve. Although its surface area is smaller than that of other zones mentioned above, Boccasette presents a combination of critical conditions that make it particularly vulnerable. It hosts small settlement clusters exposed to both hydraulic and climatic risks, as well as agricultural surfaces increasingly subject to thermal stress and saline intrusion. The coexistence of these conditions exposes the area to diffuse multi-risk, requiring targeted monitoring and adaptation interventions, particularly considering the area's ecological and landscape value.

The introduction of the multi-risk dimension within the methodology thus strengthens the coherence between analysis and design, bridging the traditional gap between technical knowledge and strategic decision-making. The diagnostic output does not merely provide a snapshot of risk conditions but rather initiates a transformative process in which the definition of territorial visions, objectives, and strategies can rely on an integrated, multidisciplinary, and territorially targeted knowledge base.

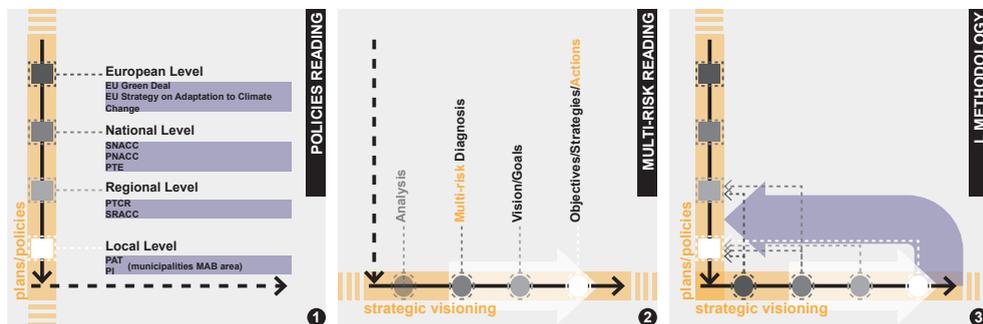
Beyond the specificities of the Po Delta, the results demonstrate the replicable potential of the “L” framework as a diagnostic and de-

cision-support tool for other areas exposed to multi-risk dynamics. However, its current application remains partially limited by the limited availability of localized socioeconomic data and the uneven institutional capacity of municipalities. Future developments could therefore aim to strengthen the integration of social vulnerability indicators and improve the model's operational scalability within regional and national planning systems.

### **Discussion: rethinking spatial planning through multi-risk – insights, limits and strategic potential of the “L” approach**

The application of the L methodology to the UNESCO Po Delta Biosphere Reserve highlights its potential to strengthen spatial planning in contexts marked by interdependent risks and fragmented governance. The framework translates risk analysis into an operational system, enabling the convergence of data, indicators, and governance priorities into coherent spatial decisions. Rather than producing descriptive maps, it operationalizes the transition from diagnosis to the formulation of targeted actions and investment priorities.

In the Po Delta case, the model combined diverse datasets to generate a composite multi-risk map identifying critical sub-areas. This output supported the prioritization of interventions, such as retrofitting drainage infrastructure, mitigating salinity intrusion, and



## Graphic representation and application of the L methodology.

Source: authors' elaboration.

Fig. 5

enhancing ecological corridors, thus connecting analytical evidence with planning practice. A key strength of the methodology lies in its flexible yet structured design. Its analytical backbone remains fixed, while thematic components are adaptable to local contexts: in this study, three primary risks—land surface temperature, flooding, and soil salinization—were analyzed as most relevant, though additional factors such as ecosystem health or drought severity could easily be integrated without compromising conceptual consistency. This modularity makes it applicable across diverse territorial systems, from coastal and deltaic landscapes to inland or mountainous regions, according to specific local stressors.

Although tested within a UNESCO MAB designated area, the methodology's logic extends beyond biosphere reserves. It can be applied to territories governed by other protection regimes, such as national parks, nature reserves, or Natura 2000 sites, by integrating their zoning schemes into the exposure component to represent ecological and cultural values. In areas without formal protection, the model can identify zones that warrant enhanced conser-

vation measures, transforming risk mapping into a design instrument for developing or revising protection frameworks. This projective capacity underscores its strategic rather than procedural nature, positioning it as an enabling tool for adaptive territorial governance (Fig. 5).

For the discipline of spatial planning, this dual analytical and projective capacity is particularly relevant. The methodology bridges data-driven assessment and territorial visioning, reframing planning as an anticipatory practice capable of addressing cumulative vulnerability and uncertainty.

The empirical results confirm that a supra-local governance structure, such as the UNESCO MAB Management Plan, serves as an enabling condition for the methodology's implementation. Nonetheless, the analysis of municipal plans revealed persistent barriers, including fragmented institutions, weak coordination, and limited analytical capacity. The L methodology can therefore function not only as a decision-support system but also as a capacity-building mechanism, strengthening local competences and promoting dialogue across

governance levels.

Despite its potential, the methodology faces practical and epistemic challenges. Its effectiveness depends on data reliability and cross-institutional coordination, both of which are frequently weak or uneven. Moreover, the weighting and normalization of indicators involve interpretative choices that can affect results. Future implementations should therefore adopt sensitivity analyses and participatory validation to improve transparency, robustness, and stakeholder trust.

Even acknowledging these limitations, the L methodology demonstrates strong potential for advancing the integration of multi-risk perspectives into spatial planning. Its clear procedural logic, adaptability, and spatially explicit outputs provide a solid foundation for informed, place-based strategies. Future research should test its transferability across contrasting territorial settings, urban, rural, and peri-urban, and refine indicators linked to ecosystem performance, social vulnerability, and resource management.

Ultimately, the L methodology offers a structured yet flexible pathway for planning under complexity and uncertainty. By operationalizing the concept of multi-risk transition, it shifts planning from reactive adaptation to proactive design, using risk as a catalyst for transformation and as a basis for more coherent, resilient, and adaptive forms of spatial governance.

## Conclusions

This contribution presented the development and testing of an integrated methodological framework designed to address territorial complexity in the current phase of transition. The proposed methodology—articulated along two analytical and conceptual axes, vertical and horizontal—aimed to connect institutional, programmatic, and strategic levels with local dynamics and emerging vulnerabilities, through a systemic reading of risks and ongoing transformations. Within this framework, the concept of multi-risk transition was adopted as both an interpretative and operational key to renew the epistemological and technical foundations of spatial planning.

The most innovative element of the work lies in the adoption of risk not as a sectoral variable to be mitigated, but as a cognitive and design infrastructure forming the basis of a new methodological approach for guiding spatial transformation. Constructing multi-risk as an interpretative matrix made it possible to overcome the hazard-specific and sectoral approach that still characterizes many planning tools, providing instead a composite and integrated reading of the environmental, social, and economic challenges affecting territories. This shift is significant not only from an analytical standpoint, but also for its capacity to offer a solid and coherent basis for medium- to long-term strategic planning. In the case study

of the Po Delta Reserve, the methodology demonstrated how it is possible to reconstruct interscalar coherence and align supra-local agendas with local specificities, even in the presence of strong misalignments across levels of governance and planning. Although tested within this framework, the methodology is conceived as adaptable to different territorial contexts – urban, inland, and mountain areas – where the interplay between environmental pressures and governance fragmentation generates similar multi-risk conditions.

The multilevel analysis confirmed the persistence of fragmentation, redundancy, and gaps that, in practice, hinder the implementation of genuinely integrated transformative strategies. In this sense, the UNESCO MAB context proved to be a useful reference to define an operational perimeter for testing the methodology, offering a regulatory and programmatic framework that integrates both environmental protection and sustainable socio-economic development goals. This approach demonstrated how spatial planning can benefit from supra-local frameworks oriented towards the integration and coherence of different dimensions of transformation. The diagnostic component of the methodology—based on the multi-risk grid—represented a key step, not only as a knowledge base but also as an enabling factor for new decision-making processes. The articulation between intrinsic vulnerability and socio-economic exposure allowed

for the identification of the most fragile areas and for reading the overlaps between different stress factors, thus contributing to the construction of an articulated and dynamic representation of the territory. This representation is a fundamental prerequisite for guiding the definition of localized strategic visions, capable of accounting for the specific features of the context and its evolutionary trajectories.

At the same time, it is important to recognize the limits of the proposed approach. The application of the methodology was limited to the diagnostic phase and did not extend to the full definition of visions, objectives, and actions. This limitation does not concern the method itself but reflects the scope of the present work, which aimed primarily to explore the articulation and transformative potential of the multi-risk concept within planning processes. Moreover, the integration between the vertical and horizontal axes – while conceptually defined – still requires further operational development to be effectively implemented within existing institutional and regulatory frameworks. Future experimentation should therefore focus on translating this integration into practice, involving stakeholders, local planning instruments, and decision-making arenas more directly. Despite these limitations, the work has laid a solid foundation for rethinking spatial planning processes in a historical phase marked by profound transformations, widespread uncertainty, and interconnected risks.

Spatial planning is therefore called not only to incorporate new knowledge and data but also to redefine its intervention paradigms, opening to flexible and adaptive tools capable of operating under conditions of systemic complexity. Within this context, the L methodology emerges as a tool capable of reconciling vision and operability, top-down and bottom-up approaches, strategies, plans, and actions. Its articulation allows for the reconstruction of strategic and project coherence across different levels of governance, offering a useful framework for the critical revision of existing tools and the introduction of innovative elements in territorial planning.

Ultimately, this contribution aims to foster debate on how planning can transform to respond to contemporary challenges. The multi-risk transition, understood here as both a reading and action paradigm, allows for the integration of elements often addressed separately, such as environmental sustainability, social cohesion, climate change adaptation, and quality of life in territories. This approach does not intend to propose definitive solutions but to open a working perspective that—through the joint analysis of vulnerability and policy—enables the construction of pathways toward resilient and conscious development. Strengthening the connection between technical knowledge and institutional design remains one of the central challenges for spatial planning. In this direction, the proposed

methodology offers a flexible and replicable framework for developing place-based multi-risk strategies, adaptable to diverse territorial contexts. By integrating analytical and governance dimensions, it contributes to the international debate on how planning can evolve as a transformative discipline capable of addressing the complexity of contemporary

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# Living with Water: toward an amphibious planning paradigm for multi-risk territories

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### keywords

multi-risk  
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perception mapping  
adaptive scenarios

*Historically, climate adaptation responses have focused on large-scale mitigation strategies, often overlooking local needs, knowledge, and perceptions. Traditional planning—rooted in land-based logics and constrained by rigid borders—struggles to address the complexity of risks that are deeply interwoven with water. In Italy, a multi-risk landscape where land and sea interact constantly, challenges such as unsustainable growth often take the form of overbuilt, impermeable coastal zones that disrupt natural water*

## 1. Introduction: why do water cities matter in the light of multi-risk conditions?

In an era marked by accelerating climate change and increasing environmental threats, water cities—as urban regions shaped by rivers, deltas, coasts, and other aquatic systems—are emerging as critical frontiers for spatial planning (Olivadese & Dindo, 2024; Hein, 2020; Granceri et al., 2024, Bradaschi, 2024; Pelling & Blackburn, 2013; Bongarts et al., 2021). These are not only fragile ecosystems but also complex socio-technical systems where overlapping risks—flooding, pollution, sea level rise, subsidence—converge with infrastructural

*cycles; social inequalities are evident in unequal access to safe, resilient public spaces along bodies of water; and intensifying environmental risks—from coastal erosion to flooding—are symptoms of failing to engage with water’s dynamic character. Drawing on research from the PNRR-funded MIRACLE project, this contribution calls for adaptive, amphibious strategies that bring local knowledge to the forefront. We propose urban laboratories as platforms for resilience, structured around three steps: (1) multi-risk analysis, (2) participatory and perceptual mapping, and (3) scenario building. By embracing water’s fluidity and relational nature, these labs foster inclusive, context-specific adaptation planning for more just and water-sensitive urban futures.*

vulnerability and socio-economic inequalities. In this sense, water cities are not only “front-lines” of climate change but also emblematic lenses through which to rethink our relationship with nature, as they bring together environmental, social and governance challenges (Hein, 2021; van Leeuwen et al., 2019). Their existence unfolds through the interplay between land and water—a liminal, fluctuating condition that challenges traditional binaries

and planning paradigms (Fig. 1). These hybrid geographies do not just require resistance to water but invite us to imagine new urban forms, strategies and governance models fundamentally shaped by its presence (Silva et al., 2023, De Martino et. al, 2023).

This contribution embraces water as both diagnostic lens and design agent, highlighting its capacity to make climate change visible and tangible: it rises in floods, disappears in droughts, infiltrates soils, erodes coastlines, and compromises infrastructures (Fig. 2). These manifestations are particularly acute in the Italian context, where recent events—from high tides in Venice to the Emilia-Romagna floods—underscore how urban vulnerability is deeply linked to historical patterns of land use and water governance.

The disconnection between planning practices and hydrological cycles, the impermeabilization of surfaces, and the marginalization of wetlands have exacerbated exposure to cascading risks. As noted by Fabian (2012) and Viganò (2009; 2012), the issue is not just water itself, but the territorial systems that seek to govern it through exclusion and rigidity. In this sense, water becomes a “revealing substance”—an analytical and projective lens through which the cascading nature of multi-risk conditions can be better understood (Fabian, 2012; Viganò, 2009, 2012; Viganò & Secchi, 2009; Gill et al., 2022, Komendantova et al., 2014, 2016).



**Venice Lagoon from above in the North of island Burano. Meanders in the saltmarshes of Palude Pagliaga in estuary of river Dese at confluence with Canale Silone (Sile).**

Source: Tony Hisgett from Birmingham, UK, CC BY 2.0  
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Fig. 1

This calls for a paradigm shift: from risk control to adaptive coexistence; from static zoning to relational design; from centralized governance to multi-actor negotiation. Urban resilience must be reframed not as resistance to change, but as the capacity to live with water in its multiple temporalities and forms. New spatial strategies—restoring wetlands and ecological corridors, integrating blue-green infrastructure, designing floodable public spaces—must be grounded in territorial specificities and community knowledge (Sohn et al., 2018).

This shift also demands a rethinking of scale and governance. From neighbourhood rain gardens to transboundary watershed management, effective responses must be coordinat-

ed across ecological, social, and institutional boundaries. Governance becomes a matter of justice: who gets to decide how water is used, stored, diverted, or protected? Whose voices are heard when planning for climate adaptation? As water governance intersects with access, equity, and rights, it reveals underlying power asymmetries and opens space for democratic experimentation and community-led action.

Ultimately, water territories are laboratories of experimentation. They expose the limits of land-centric planning and invite the development of new grammars, tools, and imaginaries. Planning with water is not only a necessity—it is an opportunity to reimagine how we



## May 2023, Emilia-Romagna Flood. The town of Conselice completely submerged by water.

Source: Cesare Barillà, CC BY-SA 4.0

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Fig. 2

design, inhabit, and govern our shared spaces in a changing climate.

This article aims to contribute to the rethinking of spatial planning in water territories by conceptualizing “amphibious risk” as both a diagnostic and design-oriented approach (Ran, & Nedovic-Budic, 2016). Through an interdisciplinary lens and grounded in the experience of the MIRACLE (*Multi-risk Integrated Resilience Approach for Coastal Landscapes and Environments*) project (<https://storymaps.arcgis.com/stories/f6f607ad8bf14521b3fd34b1a6d6b2d8>), this contribution proposes a new approach to multi-risk conditions that embraces the fluid nature of territories and challenges conventional planning paradigms (Krause, 2017, 2022, Linton, 2014).

The structure of the article reflects this ambition. The first section introduces the theoretical grounding of amphibious risk, drawing from environmental humanities, spatial theory, and climate literature. The second part presents the methodological framework and the co-design process developed within the MIRACLE urban laboratories. The third section analyses key outcomes from four case studies in Italy—Verona, Vicenza, Bagnoli and Castellammare di Stabia—highlighting how amphibious thinking can be translated into spatial strategies (Morita, 2016). The conclusion discusses the broader implications of this paradigm shift for spatial planning theory and practice under conditions of accelerating climate uncertainty.

# FLUID ENCOUNTERS by Marie Benninghoven, Ramona Buia, Jules Bresson, Lada Leidmane, Tim ter Heide.

Source: The project was developed at the design studio Urban Archipelago at TU Delft between April and June 2023.

The course was coordinated by Carola Hein and Maurice Hartevelde.

Teachers: Paolo De Martino, John Hanna, Muamer Tabakovic.

Fig.3

## 2. Toward a liquid perspective: the amphibious risk

### 2.1. Limits of Conventional Approaches to Water-Related Risk

Despite the growing attention to water-related risks, conventional approaches continue to treat them as technical issues to be solved through sectoral engineering solutions and rigid planning frameworks. These responses often remain reactive and fragmented, failing to reflect the lived dimensions of risk or the overlapping nature of contemporary hazards. In many cases, strategies such as large-scale flood barriers fail to engage with the everyday realities, experiences, and knowledge of the communities most affected. Moreover, planning processes confined by administrative boundaries are unable to navigate the systemic, interdependent character of water-related threats. Water, however, is a carrier of systemic interdependencies—intertwining physical processes with socio-political, ecological, and infrastructural dynamics. This complexity has sparked a growing critique of static models and siloed assessments, highlighting instead the need for dynamic, integrated frameworks capable of accounting for multiple hazards and evolving vulnerabilities (Gallina et al., 2016; Sperotto et al., 2016; Gill & Malamud, 2014).

### 2.2. Water as Structuring Force: From Amphibious Territories to Amphibious Risk

A broad literature now argues for a shift

toward more integrated and holistic perspectives—ones that view water not as an external threat but as a structural agent shaping identities, landscapes, and modes of inhabitation. Water is no longer a passive background to urban life; it shapes vulnerabilities, imaginaries, and possibilities. Water cities—and water territories more broadly—are increasingly recognized as complex environments where hydroclimatic processes and socio-political dynamics interlace. This has led to a reconceptualization of urban and territorial space as inherently **amphibious**, situated between land and water, stability and flux. Hydroclimatic threats such as tidal surges, saline intrusion, shoreline retreat, and cumulative flooding intertwine with urbanization patterns, infrastructural fragilities, and social inequality, revealing amphibious conditions as constitutive rather than exceptional. Recent scholarship emphasizes the metabolic, relational, and dynamic nature of these amphibious territories (Morita, 2016). Water acts both as connector and destabilizer, giving rise to **amphibious risk**: a situated condition of coexistence between multiple thresholds—social, ecological, infrastructural—shaped by the fluid entanglement of land and water. Amphibious risk is an ontological condition inherent to coastal and water-based environments, demanding adaptive and negotiated planning responses (Lawyer, 2023; McArdle, 2023; Bailey-Charteris,



2024; Baumeister, 2023; Belland et al., 2025). Framing water as a relational and political medium—not merely a biophysical hazard—requires engaging with wet ontologies and hydro-social imaginaries (Peters & Steinberg, 2019; Roca & Salazar, 2022; Steinberg & Peters, 2015; Franco-Torres et al., 2020). These frameworks reject the land-sea binary and foreground interdependence between bodies, ecologies, and territories. Hydrofeminist perspectives (Neimanis, 2017; Siegel, 2019; Helmreich, 2011) further decenter the human as a sovereign subject, emphasizing relationality, vulnerability, and coexistence—dimensions central to amphibious planning.

### 2.3. *Implications for Adaptation, Governance, and Spatial Imagination*

This reconceptualization of water and risk entails a parallel shift in how adaptation is understood (Neil, 2005; Nilubon & Laeni, 2024; Nilubon et al., 2016; Radhakrishnan et al., 2018; Olivadese & Dindo, 2024). Adaptation is reframed not as a technical fix but as a negotiated, anticipatory practice grounded in context-sensitive strategies

such as nature-based solutions, green infrastructures, and participatory mapping. Frameworks like Water Sensitive Cities and adaptive pathways advocate for planning as a fluid, co-designed process embedded in local knowledge and resilience capacities. The case of Venice, alongside other coastal contexts, demonstrates how participatory tools—such as bottom-up flood models and collective mapping—can translate adaptation into spatial and institutional practice (Sperotto et al., 2016; Bianchi, 2023). Underlying both risk and adaptation is the fundamental issue of **governance**. Water territories—marked by institutional fragmentation and overlapping competences—become arenas of negotiation over legitimacy, authority, and knowledge. The literature highlights the need for multi-level and multi-actor coordination, the integration of vulnerability assessments into planning tools, and the incorporation of risk management within broader social justice agendas. These challenges are especially acute in dense urban environments, where adaptive capacity is constrained by infrastructural ex-

# MIRACLE

## Multi-risk Integrated Resilience Approach For Coastal Landscapes And Environments

Francesco Musco, Denis Maragno, Paolo De Martino, Elena Ferraioli, Carlo Federico Dall'Orto, Gianfranco Pozzer, Daniele Pagliari (IUAV)

### What MIRACLE is about?

MIRACLE aims to enhance the resilience of urban and metropolitan areas to **multiple risks** through a participatory and **multiscale approach**. By involving citizens, stakeholders, and local administrations, the project integrates bottom-up **perceptions** with traditional knowledge frameworks. This is achieved through urban laboratories focusing on **vulnerability mapping** and the **co-design** of adaptation strategies from a **metabolic perspective**.

#### Transect approach

Verona | Venezia  
Delta del Po | Rimini  
Bagnoli | Napoli

#### multi-risk analysis

urban heat island,  
hydrogeological/hydraulic/water  
risk, flooding, coastal erosion,  
seismic/volcanic risk



### Urban Laboratories

#### UrbLab problem definition

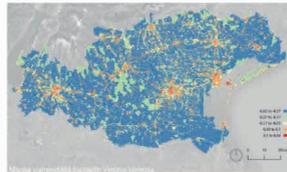
- task 2.1: integration of cognitive frameworks with mental maps
- task 2.2: development of a catalogue of problems/challenges
- task 3.1: review and formulation of key challenges
- task 3.2: identification of local pilot cases (most vulnerable areas)

#### UrbLab II: co-creation and co-design

- task 4.1: developing future scenarios
- task 4.2: developing a catalogue of future strategies

#### UrbLab III: validation and final recommendation

- task 5.1: analysis and validation of the strategy catalogue
- task 6.1: discussion and finalization of the catalogue with local administrations



### Objectives

- A. analysis of **challenges** and **opportunities** of the territories
- B. **assessment** and **mapping** of vulnerabilities
- C. integration of traditional **cognitive frameworks** with the **perceptions** of local stakeholders
- D. development of **co-designed processes** to guide adaptation strategies (**urban laboratories**)



This study was carried out within the RETURN Extended Partnership and received funding from the European Union Next-GenerationEU (National Recovery and Resilience Plan – NRRP, Mission 4, Component 2, Investment 1.3 – D.D. 1243 2/8/2022, PE0000005)

posure and institutional inertia (Poljansek et al., 2021). They call for new spatial imaginaries—osmotic, filtering, floating—that translate amphibious thinking into design practice, as illustrated in Figure 3. Planning in amphibious conditions thus means designing osmotic, percolating, porous spaces aligned with the rhythms and thresholds of water (Baumeister, 2023; Setiadi et al., 2023). Together, these interdisciplinary insights lay the groundwork for a new paradigm: **planning not in spite of water, but through it**. The amphibious city becomes a site of coexistence, negotiation, and invention—where instability becomes a condition for adaptive, inclusive, and ecologically grounded transformation.

### 3. Planning through Water: experimental approaches from the MIRACLE project

In order to shift from conceptual framing to situated experimentation, it is essential to explore how planning practices are beginning to engage with water-related risks as structural conditions of urban life. The MIRACLE project,

developed within the Italian *PNRR* framework, offers a concrete space for this engagement—where the interplay between environmental vulnerability, territorial transformation, and collective imagination is addressed through co-design and participatory planning and cartography.

Focusing on coastal and multi-risk landscapes in Italy, MIRACLE establishes urban laboratories as sites of experimentation where water is reconceptualized as a territorial agent—a medium through which risks, vulnerabilities, and opportunities become legible and actionable (Fig. 4). Within these labs, technical analysis and local knowledge converge through a three-step process that includes multi-risk analysis, perceptive mapping, and co-design scenarios. Each lab is structured around three phases: a diagnostic phase based on scientific data, a perceptive phase involving participatory mapping, and a design phase dedicated to future scenarios. This structure enables the combination of formal tools with collective narratives. This three-phase structure reflects a hybrid

## Poster presentation project **Miracle** during the Dissemination Workshop held in Bologna between the 27 and 29 of November 2024.

Fig. 4

and iterative methodology that combines spatial analysis, qualitative foresight techniques, and participatory design practices—in line with the intuitive logics tradition of scenario planning (Wilkinson & Edinow, 2008; Spaniol & Rowland, 2018).

Urban laboratories were facilitated through interactive workshops involving multiple stakeholders, including local administrations, experts, community representatives, and students. Each phase relied on dedicated tools: gis-based risk datasets and thematic maps in the diagnostic phase; paper or digital base maps for participatory annotations in the perceptive phase; and visual synthesis tools (collective drawings, strategic schemes, scenario narratives) in the co-design phase.

Data collection combined semi-structured mapping protocols and informal interviews. Participant inputs were then analyzed through inductive coding, enabling a triangulation of visual, verbal, and spatial datasets—a strategy that ensured consistency across cases while respecting local specificity (Bradfield et al., 2005). Preliminary findings show that most regional threats have a hydrological component, reinforcing the idea that water is not just one risk among others, but rather a condition that underpins and connects multiple forms of exposure. At the core of this methodology lies a radical rethinking of water—no longer confined to the hydraulic infrastructure or emergency planning domain but understood as a concep-

tual and operational lens for spatial and metabolic regeneration. Water flows, accumulates, erodes, reveals, and connects; it draws lines of separation and invites crossings. This amphibious lens unlocks a new grammar of urban design, one that accounts for material and social permeability, thresholds of vulnerability, and the fluid boundaries between crisis and care.

The diagnostic phase begins with the triangulation of existing data from regional risk maps, hydrological indicators, and environmental reports. Each urban laboratory begins by constructing a shared framework that integrates these data with spatial analysis tools and local risk assessments. The outputs of this phase include composite maps that identify vulnerable areas based on multi-risk conditions (heat, flooding, subsidence, etc.), and are used to trigger reflection in the subsequent workshop sessions.

However, this is only the starting point: a second, equally crucial phase invites participants—citizens, professionals, educational institutions, decision-makers—to map their own perceptions of risk, translating lived experiences into collective spatial narratives. Far from being banal, perception reflects how communities interpret and interact with their environments—what they value, fear, protect, or contest. Participatory mapping exercises were conducted using paper-based or digital maps, where participants marked spaces of memory, fear, and opportunity, thus enabling the

**Top: multi-risk map showing areas exposed to heat and hydrogeological risks.**

**Bottom left: perception map developed with local stakeholders, highlighting lived experiences of vulnerability and spatial disconnection.**

**Bottom right: strategy map outlining proposals for green corridors, risk mitigation, and urban regeneration.**

Fig. 5

production of “perception maps” that complemented the scientific baseline. Mapping these perceptions allows us to visualize the social and cultural layers of water territories, uncovering insights that traditional scientific or technical approaches often overlook.

These mappings do not seek precision, but resonance. They reveal emotions, memories, disruptions, and informal practices that remain invisible in conventional readings. They activate what Kevin Lynch once called “the image of the city”, built not from abstract geometry but from affective and symbolic structures.

The final phase of urban laboratories opens a space for co-design future imaginaries, where knowledge and perception are recombined into adaptive strategies. These future scenarios do not offer blueprints, but hypotheses—territorial narratives that explore how to live with overlapping risks through spatial, ecological, and institutional transformations.

Strategic maps were then produced collectively to translate shared priorities into design hypotheses: green corridors, floodable spaces, blue-green infrastructure, governance arrangements. These maps were drawn on large printed bases and digitized after the workshops to allow comparison across cases.

The analysis of outputs from the labs combined qualitative coding of participant feedback, visual analysis of mapped content, and comparison with scientific data. This triangulation method ensured that each case pro-

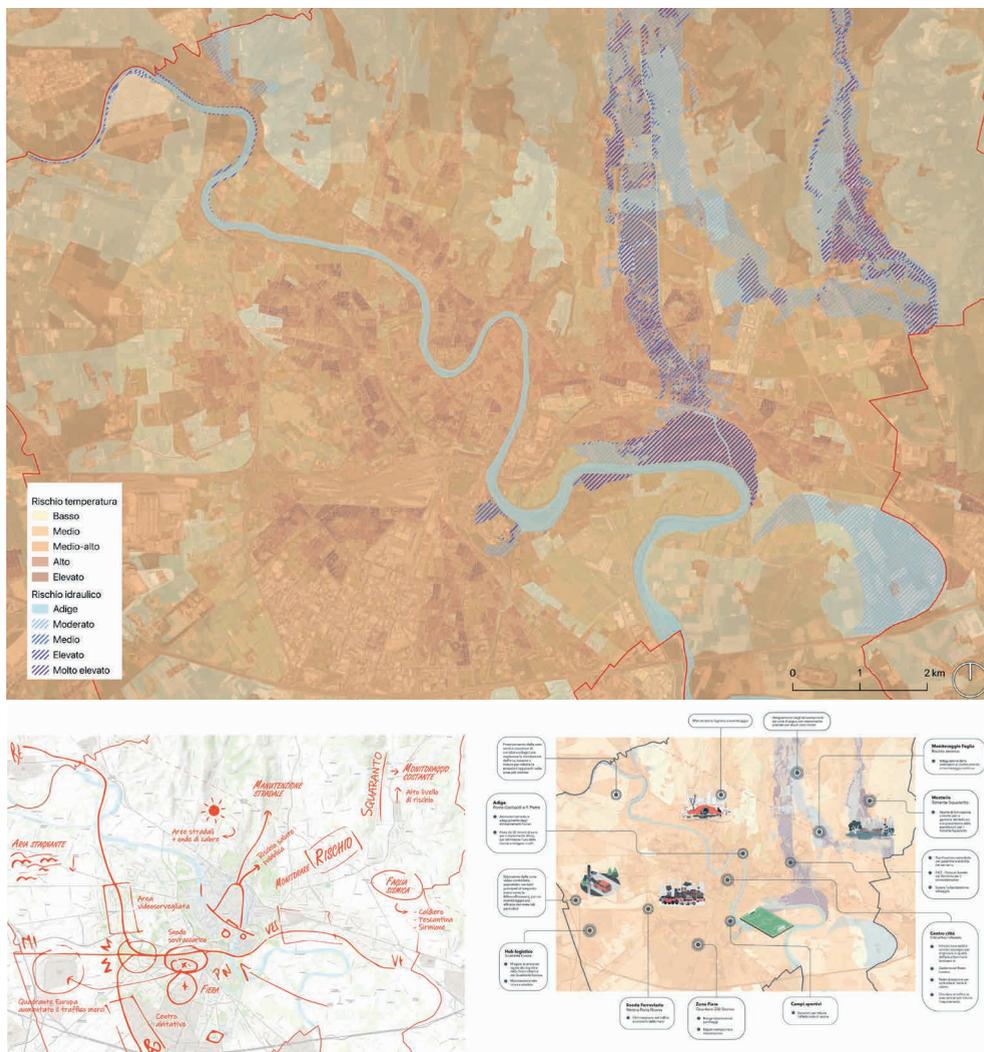
duced insights that were both locally rooted and comparably structured.

Water, in this framework, becomes not just the object of intervention but the opportunity through which to reconnect fragmented territories, overcome planning enclaves, and cultivate new spatial changes. The MIRACLE project thus positions itself at the crossroads of environmental urgency and planning innovation, advocating for a culture of anticipation grounded in community knowledge and hydrological awareness.

In the following section, four urban laboratories—Verona, Vicenza, Bagnoli, and Castellammare di Stabia—illustrate how this approach unfolds in diverse territorial contexts, each marked by distinct challenges and opportunities. Each urban laboratory offers a distinct lens through which to examine the entanglement of hydro-climatic risks, urban practices, and institutional arrangements. These cases reveal how planning can be reoriented toward more anticipatory, inclusive, and water-sensitive approaches.

### *3.1. Verona: mapping overlaps, designing with vulnerability*

In Verona, the mapping of perceptual and strategic vulnerabilities offered a multi-layered reading of how water and heat-related risks intersect with broader territorial fragilities. The co-design process revealed the Adige River corridor, particularly the areas of Montorio and



the northeastern belt, as highly exposed to hydrogeological threats, including landslides and flooding, calling for organized evacuation plans and long-term mitigation strategies. Through workshops and stakeholder dialogues, a network of vulnerabilities emerged, touching not only environmental but also infrastructural and social dimensions of the city (Fig. 5). Participants emphasized that Verona’s urban fabric is increasingly pressured by urban heat islands, mobility congestion, and the strategic

vulnerability of critical infrastructures, such as the southern highway and the congested freight nodes at Scalo Libero and Quadrante Europa. These hubs, while economically strategic, generate pollution, increase land consumption, and amplify existing exposure to climate-related risks. As a result, a cross-scalar analysis was undertaken to identify intervention areas ranging from specific neighbourhoods to broader ecological systems, stressing the need for green infrastructures and ecological corridors that can

**Top: multi-risk map illustrating heat and water-related vulnerabilities, especially in peri-urban areas. Bottom left: perception map reflecting concerns over impermeability, infrastructure, and social exposure to climate risks. Bottom right: strategic map proposing integrated nature-based solutions and mobility enhancements for a more resilient cityscape.**

Fig. 6

both mitigate environmental pressures and enhance territorial permeability.

From a spatial perspective, the western part of the city revealed chronic air stagnation and pollution accumulation, demanding targeted actions to restore urban ventilation and reduce emissions. At the same time, stakeholders identified the fragmented and insufficiently integrated green areas as a missed opportunity for resilience-building. Enhancing their connectivity would enable them to function as natural pollution buffers and biodiversity habitats, while also contributing to the city's hydraulic safety. Along the riverbanks, areas such as Caldero, Pescantina, and the Isolotto of San Pancrazio emerged as particularly fragile, underscoring the urgency of integrated planning approaches that address both fluvial risks and the city-river relationship.

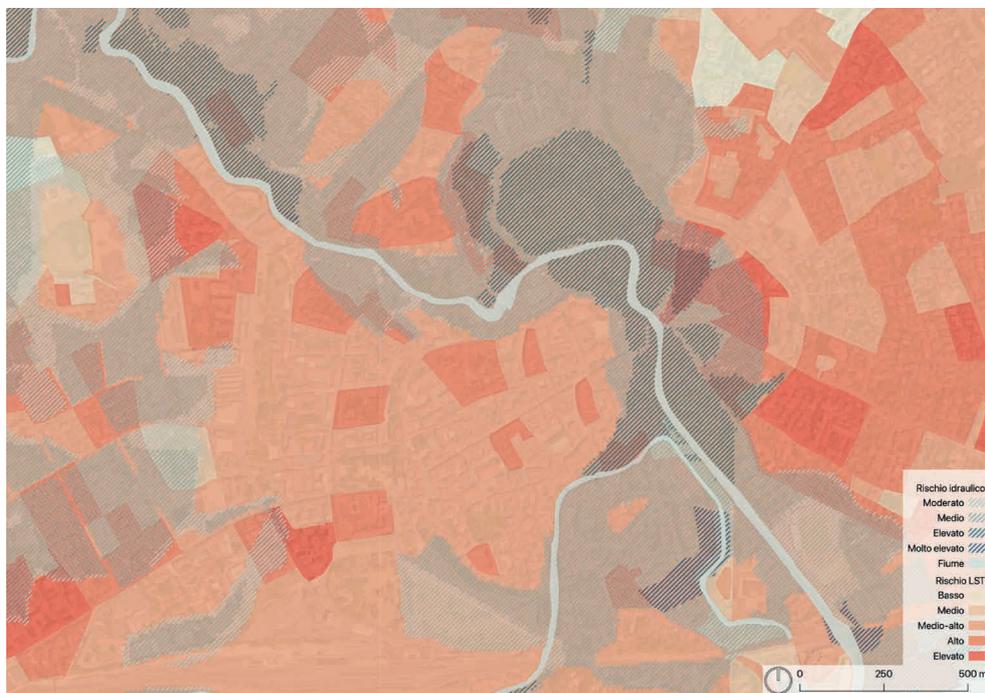
Strategic planning in Verona is beginning to reflect this shift in perspective. A 32 million euros of public investment in water remediation and management has been allocated to improve water retention capacity, optimize irrigation systems, and contain the impact of urban expansion on fragile soils. This shows a growing awareness of the need to reconfigure the water-land relationship, not only to prevent risk but also to reshape territorial strategies. In this sense, water emerges as a structuring element of the urban landscape—an active vector through which vulnerabilities are revealed, and adaptive planning can unfold.

At the same time, the city's rapid residential growth has raised concerns about soil stability, with landscape alterations such as terracing and hill cutting accelerating runoff and erosion. These issues require careful governance to maintain a balance between development and ecological integrity. Equally pressing are mobility and logistics challenges, which demand a systemic redesign of freight flows, stronger rail infrastructure, and more sustainable modes of transport, particularly in areas burdened by the transit of hazardous materials.

Overall, the Verona urban laboratory illustrates how participatory mapping and multi-risk analysis can illuminate the spatial translation of vulnerability, transforming diffuse concerns into territorial knowledge. The process not only mapped risks but also generated visions of transformation—anchored in water as a relational medium—that integrate risk mitigation, ecological restoration, and territorial innovation as core principles for a new planning culture.

### *3.2. Vicenza: toward an ecological and inclusive regeneration*

In *Vicenza*, the urban laboratory highlighted the cumulative nature of environmental, infrastructural, and social vulnerabilities, revealing a complex urban landscape marked by territorial fragmentation and declining ecological performance. A key issue that emerged was the city's impermeability, intensified by the



predominance of car-centric infrastructures, huge industrial and military zones, large parking lots devoid of vegetation, and a network of disconnected public spaces. These conditions not only worsen urban heat island effects, especially in the industrial zones, but also reduce water infiltration, increasing the risk of surface flooding during heavy rainfall events. Vicenza's natural basin morphology, which limits air circulation, exacerbates pollution accumulation and heat stress, particularly during

summer months. Ongoing construction sites for the high-speed rail line (TAV) add another layer of environmental stress, which will contribute to noise, dust, and vibrations, while also posing soil and water contamination risks. The city thus faces a dual exposure to long-term systemic risks and short-term construction impacts, both of which were intensely debated during the laboratory sessions (Fig. 6). A critical concern voiced by participants was the growing disconnection between urban

development and socio-environmental needs. The expansion of commercial hubs in the outskirts has drained vitality from the historic centre, while large areas of vacant buildings and underused spaces remain inaccessible due to regulatory barriers and institutional inertia. This dynamic contributes to an overall sense of urban dispersal, weakening the potential for collective spaces and social cohesion.

Social tensions are further deepened by gentrification processes that exclude vulnerable populations, alongside the progressive reduction in public transport services—a phenomenon that encourages private car use and undermines sustainable mobility. Although a cycling network is present, it is largely peripheral and used recreationally rather than for everyday commuting. Waterways, once central to the city's spatial logic, remain an untapped potential for sustainable mobility and ecological reconnection.

To counter these trends, the urban laboratory identified a set of integrated spatial and policy responses. First, urban greening emerged as a key priority: the introduction of green roofs, vertical vegetation, and tree-lined corridors was seen as essential to reconnect ecological functions, support biodiversity, and provide climate mitigation benefits. The use of permeable surfaces and innovative CO<sub>2</sub>-absorbing materials was proposed as a technical response to surface runoff and heat accumulation. These environmental solutions were linked to a

broader urban quality agenda, centred on the reappropriation of spaces for collective and inclusive uses also through temporary uses.

A second set of proposals focused on adaptive reuse and housing pressure. The reactivation of vacant buildings was strongly advocated, not only as an answer to housing demand, but also as a tool to counter speculative development and reduce the city's ecological footprint. This was supported by calls for renovation incentives tied to environmental performance, and fiscal policies to protect small businesses and prevent the displacement of lower-income residents. Avoiding the commodification of the city's real estate was recognized as a core condition for social resilience.

On the mobility front, participants proposed a reorganization of parking systems, prioritizing peripheral park-and-ride structures and disincentivizing car access to the central area. Plans included low-speed zones, pedestrian-first strategies, and the reintegration of waterways as soft mobility corridors, reconnecting fragmented parts of the city and offering climate-adaptive routes. The historic centre, in particular, was framed as a testing ground for mobility innovations capable of combining safety, accessibility, and environmental awareness. Finally, the discussion pointed to the need for new modes of governance and citizen engagement. Participants emphasized the urgency of breaking institutional silos, promoting collaborative platforms between public author-

ities, civic actors, and private stakeholders. Digital tools, public forums, and participatory mapping were proposed as concrete devices to democratize planning processes and foster transparency. In this context, the protection of Vicenza's UNESCO heritage was reframed not as a constraint, but as a driver of innovative and inclusive environmental planning.

Through its participatory approach, the Vicenza laboratory revealed the layered nature of urban fragility and the need for systemic and place-based responses. The city's future depends on the ability to synchronize ecological regeneration, social equity, and infrastructural transformation, building a shared vision capable of steering Vicenza toward a more liveable and inclusive environment.

### *3.3. Bagnoli: the politics of risk and regeneration*

In Bagnoli, the overlapping of environmental fragility, industrial legacy, and institutional stagnation reveals the full complexity of planning in amphibious territories. Here, bradyseism—a slow and intermittent uplift and subsidence of the ground—is indeed part of the public discourse, yet it is rarely considered in relation to the broader system of interconnected risks. Its implications for seismic safety, infrastructure resilience, and water management are significant, but often treated in isolation rather than as part of a cumulative and interdependent landscape of vulnerability. This natural condition intertwines with a

long-standing legacy of contamination, inherited from the ILVA steelworks and other decommissioned industrial sites, which have left behind critical pollutants such as asbestos and heavy metals, requiring ongoing and complex remediation processes.

The participatory mapping and expert interviews revealed not only environmental but also institutional and communicative risks. As emphasized by Daniela Mello (Invitalia), the transformation of Bagnoli is not hindered solely by technical complexity, but by a persistent deficit in public communication and shared vision. Mello pointed to the polarization of public discourse, fuelled by media narratives and political conflict, which has undermined trust and generated a deep sense of distance between communities and institutions. While environmental monitoring systems—such as the installation of real-time air and water quality stations—have improved transparency, many residents still perceive the planning process as opaque or imposed from above. This creates a “democratic risk,” in which technical decisions lose legitimacy and trigger opposition, even when well-grounded.

Urban ecologist Antonio Di Gennaro further emphasized the lack of coordination between planning tools, describing the coexistence of multiple, often contradictory plans as a key factor behind delays and dysfunctions. This has resulted in paradoxical situations—such as the dismantling of a previously built park



to comply with updated remediation protocols—reflecting the rigidity of normative approaches and the absence of integrated, adaptive frameworks. Di Gennaro argued for a science-based pragmatism, capable of balancing precautionary principles with timely action, thereby reducing delays and public costs while increasing confidence in the redevelopment process. Within this landscape, design responses developed through the MIRACLE laboratory fo-

cused on three integrated trajectories (Fig. 7). First, ecological connectivity and remediation emerged as a priority. The creation of a new urban forest was envisioned as a keystone intervention to restore ecological continuity, improve air quality, and provide a multifunctional green infrastructure supporting biodiversity, climate adaptation, and human wellbeing. This forest acts as a “green lung” between the sea and the hills, symbolizing a break from industrial toxicity and a step toward regeneration.

**Top: multi-risk map displaying areas exposed to heat, hydrogeological, volcanic, and seismic hazards, as well as land and water pollution.**  
**Bottom left: perception map generated through stakeholder engagement, capturing local concerns, spatial imaginaries, and risk awareness.**  
**Bottom right: strategic map outlining key design proposals for ecological remediation, public space regeneration, and infrastructural reconnection.**

Fig. 7

Second, coastal and cultural redevelopment was seen as essential for reactivating the waterfront and reconnecting Bagnoli to the wider urban and social fabric of Naples. This involves opening up physical and symbolic access to the coast, currently hindered by barriers, contamination, and institutional ambiguity. The reuse of industrial archaeology as cultural infrastructure—galleries, open-air museums, performance venues—was proposed not only as a heritage valorisation strategy but also as a participatory process, engaging residents in shaping the meanings and uses of new public spaces.

Third, infrastructure and public health were addressed through the revitalization of mobility networks—including tramway and maritime transport—paired with real-time environmental monitoring of pollutants and asbestos residues. This integration of mobility, health, and transparency represents a concrete step toward restoring institutional credibility, reducing risk perception gaps, and enabling informed, inclusive decision-making.

In Bagnoli, planning is not only about building infrastructure or remediating soil—it is about reconstructing trust, navigating between memory and possibility, and reimagining public space as a site of ecological and democratic transformation. The case exemplifies how am-

phibious risk must be understood not just in physical terms, but as a social and institutional condition, requiring flexible, communicative, and visionary planning tools.

#### *3.4. Castellammare di Stabia: reclaiming the waterscape*

In *Castellammare di Stabia*, the MIRACLE urban laboratory unfolded within one of the most hydraulically and environmentally compromised territories in Italy. The Sarno River, long burdened by illegal discharges, industrial effluents, and infrastructural decay, emerged as both a symbol and a material expression of the city's fragility. Decades of uncoordinated urban growth, inadequate sewage systems, and pollution from tanning and industries have left deep marks on the territory, compounded by sediment accumulation, vegetation overgrowth, and persistent flooding risks. Despite past remediation attempts, the incomplete functionality of treatment plants and ongoing water losses underscore a persistent paradox: abundant water resources coexist with infrastructural neglect and environmental injustice. The Laboratory revealed how this layered landscape of risk is not limited to ecology, but intersects with longstanding social vulnerabilities, informal urbanization, and frag-

**Top: composite map of multi-risk conditions (heat, hydrogeological, volcanic, and seismic hazards) highlighting the most vulnerable areas.**

**Bottom left: perception map co-created with local stakeholders, indicating perceived risks, criticalities, and spatial narratives.**

**Bottom right: strategic vision map identifying key design directions for reconnection, regeneration, and ecological transformation.**

Fig. 8

mented planning tools. The presence of natural springs, landslides, and unstable soils—combined with illegal construction and weak enforcement—has produced a condition of chronic precariousness. In some cases, buildings damaged by seismic events could not be rebuilt in situ, forcing relocations to peripheral zones with exceptions to soil protection laws. In this context, the Sarno basin emerges not only as a site of contamination and hazard, but as a potential infrastructure of reconnection—linking ecological restoration to a broader urban regeneration strategy.

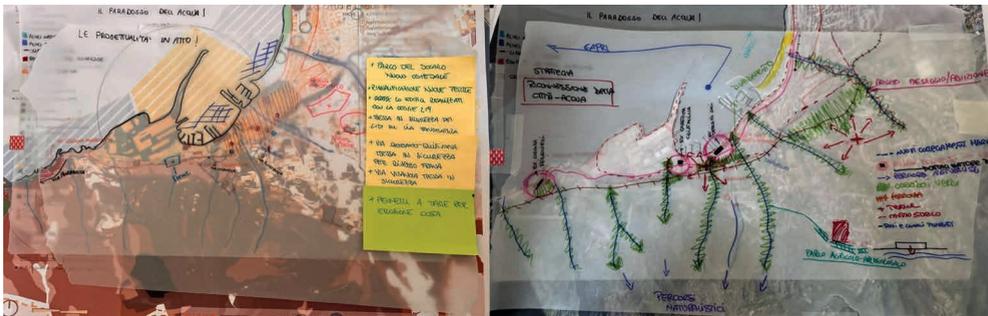
Four design trajectories emerged from the participatory process, each grounded in the desire to reorient the city's relationship with water. The first centres on the northern zone of Castellammare, where the creation of a continuous green buffer—a so-called “mirror band”—would parallel existing infrastructure and serve as a connective tissue between the inner city and the coast. This linear space, framed by ecological “green branches” and water-sensitive “blue branches,” proposes the transformation of disused industrial areas into new multifunctional districts with cultural, educational, and sports facilities, while also addressing hydraulic vulnerabilities in a phased and integrated manner.

The second trajectory addresses the urban border between Castellammare and Torre An-

nunziata—an area marked by isolation, infrastructural voids, and spatial fragmentation. Here, the proposal focuses on activating transversal links that reconnect peripheral neighbourhoods to the port and waterfront, softening the exclusivity of luxury marinas through inclusive public functions. A new riverside park at the Sarno's mouth is envisioned as a gathering place and flood mitigation device, reconfiguring the riverbank as both ecological asset and civic commons.

The third trajectory reframes the “paradox of water” as a narrative driver for urban transformation. While Castellammare is rich in water sources—thermal springs, coastal waters, buried canals—this abundance is often hidden or disconnected from everyday urban life. The design vision seeks to reclaim these latent ecologies, unearthing canals, repurposing abandoned buildings, and restoring the coastal threshold as an interface of memory, care, and sustainability. In this perspective, *landscape becomes an infrastructure of repair*, capable of absorbing risk, strengthening social bonds, and reactivating Castellammare's identity as a water city.

The fourth trajectory highlights a socio-cultural dimension, focusing on the reactivation of thermal baths not merely as physical infrastructure, but as spaces of collective memory, identity, and everyday engagement with wa-



ter. Thermal baths are often part of neglected or underused water infrastructures. Their rehabilitation offers an opportunity to reimagine existing assets not only for leisure but also for emergency response, water reuse, or even climate adaptation functions (e.g., passive heating, water storage). Term baths act also as soft-critical infrastructure, which supports the emotional, symbolic, and social fabric that communities rely on in times of uncertainty or stress.

Through these situated imaginaries, the MIRACLE project positions Castellammare di Stabia as a critical testbed for planning through water—where ecological challenges, infrastructural gaps, and collective aspirations converge. Far from offering prescriptive solutions, the process opened up new questions on how to inhabit and govern complexity, embracing water not as a hazard to be controlled but as a generative element in shaping liveable, connected, and resilient urban futures (Fig. 8).

Case Study	Main Risks Identified	Social & Urban Vulnerabilities	Main Participatory Methods Used	Strategic Design Directions	Key Outcomes / Spatial Vision	Role of Water in the Transformation
Verona	Flooding, heatwaves, air pollution, landslides	Critical infrastructure exposure, logistics congestion, urban sprawl, soil instability	Risk perception mapping, stakeholder workshops, cross-scalar dialogues	Green corridors, floodable areas, urban ventilation, ecological restoration	Water as territorial infrastructure for resilience and permeability	Medium to reconnect fragmented ecologies and manage multiple risks
Vicenza	Urban heat, surface flooding, pollution, soil and water contamination (TAV construction)	Car-dependence, urban sprawl, vacant buildings, social exclusion, institutional inertia	Participatory mapping, public forums, co-design charrettes	Urban greening, adaptive reuse, soft mobility, temporary uses	Inclusive and ecological regeneration of fragmented urban fabric	Tool for ecological and social reconnection, especially through waterways
Bagnoli	Bradyseism, contamination (asbestos, heavy metals), institutional and communicative risks	Distrust in institutions, fragmented governance, loss of public legitimacy	Expert interviews, participatory mapping, thematic workshops	Urban forest, cultural reuse, mobility infrastructure, environmental monitoring	Democratic and ecological transformation via integrated planning	Axis for remediation, trust-building, and reactivation of collective space
Castellammare di Stabia	Water pollution (Sarno River), flooding, unstable soils, illegal construction	Informal settlements, infrastructural neglect, socio-spatial fragmentation	Co-design sessions, visual mapping, spatial scenario development	Green-blue infrastructure, riverside park, thermal baths reactivation, unearthing canals	Reclaiming water as connective and symbolic infrastructure	Narrative and material infrastructure of memory, care, and regeneration

### 3.5. Comparative synthesis: convergences and differences across urban labs

The MIRACLE urban laboratories unfolded in diverse socio-ecological contexts, yet revealed striking commonalities in the way water-related risks intersect with spatial fragilities, infrastructural gaps, and socio-political dynamics. Despite local specificities, all cases pointed to the urgency of reframing water not as a threat to be controlled, but as a relational medium to reconfigure urban logics, mobilize collective agency, and generate situated design strategies.

The table below provides a comparative overview of the four case studies, highlighting the main risks, vulnerabilities, participatory tools,

design directions, and spatial imaginaries that emerged throughout the process.

## 4. Conclusion: towards fluid geographies

This article has argued that planning in water territories requires a conceptual and operational shift—one that recognizes amphibious risk not merely as the sum of hydrological threats, but as a condition of territorial life marked by fluidity, interdependence, and instability. Drawing from environmental humanities, climate theory, and spatial planning literature, the notion of amphibious risk was proposed as both a diagnostic category—to read the complexity of water-related vulnerabilities—and a design-oriented paradigm, capable of gener-

ating new spatial and governance imaginaries. The MIRACLE project embodied this shift through a threefold methodology based on multi-risk mapping, co-design charrettes, and situated experimentation in four urban laboratories. Verona, Vicenza, Bagnoli, and Castellammare di Stabia offered highly diverse socio-ecological contexts, yet all revealed the limits of compartmentalized planning and risk governance. Across these territories, amphibious conditions—material, institutional, and symbolic—emerged not only as sources of fragility, but as opportunities to reframe planning logics, reconnecting ecological processes with spatial justice, public space, and collective agency.

In Verona, the convergence of riverine hazard, heat vulnerability, and logistic congestion called for integrated green corridors and the repositioning of water as territorial infrastructure. Vicenza emphasized the legacy of car-centric development and vacant buildings, suggesting a shift toward permeable, inclusive, and participatory urban regeneration. Bagnoli revealed the entanglement of environmental remediation and democratic legitimacy in a context shaped by bradyseism and industrial decline, pointing to the need for risk governance that is science-based yet socially anchored. Castellammare di Stabia exposed the paradox of water abundance and infrastructural neglect, where polluted riverbanks and buried canals became sites for ecological

and civic reactivation. In each case, water was reframed not as a threat to be contained, but as a medium for transformation, linking space, memory, and care.

Beyond site-specific outcomes, MIRACLE proposes a broader culture of anticipation, one that contests the reactive, technocratic approaches often found in spatial planning. By embracing local knowledge, collective imagination, and hydrological awareness, the project fosters an epistemology of resilience rooted in transformation rather than recovery, in coexistence rather than control. Water is thus repositioned as a relational actor, capable of reorienting not only planning practices, but the very geographies of governance.

What emerges is the need for a new planning paradigm attuned to fluid geographies: territories where land and water no longer operate as binary opposites, but as interwoven domains co-constituted by metabolic, social, and political flows. Embracing amphibious risk does not mean resigning to precarity but learning to govern through it—designing for uncertainty, negotiating across disciplines and communities, and cultivating spatial futures grounded in ecological justice. MIRACLE's contribution lies precisely in showing that such a shift is not only necessary, but possible—when planning becomes an imaginative, situated, and collective act.

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# Framing a metabolic risk.

## Sviluppare un framework metodologico per l'analisi e il monitoraggio del potenziale di resilienza dei wastescape in contesti urbani critici multirischio

Developing a methodological framework for analysing and monitoring the resilience potential of wastescapes in critical multi-risk urban contexts

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#### 1. Introduzione

##### 1.1. Inquadramento del contestodi ricerca e obiettivi del paper

La crescente complessità dei sistemi urbani contemporanei e la loro esposizione a una mol-

teplicità di rischi - naturali e antropici - hanno stimolato un ampio dibattito internazionale sul tema della resilienza urbana (Meerow et al., 2016; Chelleri, 2015; Ahern, 2011). Le città contemporanee si configurano come sistemi

*Urban multi-risk systems are characterised by systemic vulnerability and poor resilience to crises. Starting from an analysis of the relationship between the concepts of resilience and metabolic risk, this study proposes a methodological framework for analysing, evaluating and*

*mapping the resilience potential of wastescapes in multi-risk urban contexts, characterised by unexpressed resource capital (matter, nature, space). The framework has the dual value of being an assessment tool and a support in guiding the definition of regenerative strategies for wastescapes in the perspective of the circular economy model applied to urban metabolism, in order to improve the resilience of cities and communities starting from the potential of places.*

socio-ecologici interdipendenti, in cui fattori ambientali, economici e sociali si combinano generando vulnerabilità diffuse ma anche potenzialità di adattamento e rigenerazione (Davoudi, 2012). In questo quadro, la resilienza, intesa come “la capacità non solo di resistere alle sfide e di farvi fronte, ma anche di attraversare le transizioni in modo sostenibile, equo e democratico” (EU Consiglio dell'Unione Europea, 2025), è divenuta un riferimento centrale non solo per la gestione del rischio, ma anche per orientare strategie di pianificazione e trasformazione urbana più sostenibili e adattive (Faivre et al. 2018). E' possibile interpretare dunque la resilienza come lente per orientare il cambiamento nella transizione.

Negli studi più recenti, l'attenzione si è progressivamente spostata verso la definizione

di strumenti valutativi e metodologie di analisi multidimensionale, in grado di misurare e rappresentare la resilienza in chiave spaziale, ecologica e socio-economica (Lindfors, 2021; Fotheringham & Rogerson, 2009; Behnisch & Meinel, 2018). L'uso di approcci GIS e modelli multicriterio (MCDA) consente oggi di osservare e comparare i processi di trasformazione territoriale e di costruire quadri conoscitivi integrati utili alla pianificazione resiliente. In questa prospettiva, la resilienza urbana è interpretata come una proprietà emergente del metabolismo urbano (Kennedy et al., 2011; Girardet, 2010), espressione della capacità dei sistemi urbani di attivare meccanismi auto-rigenerativi, circolari e sostenibili intercettando i propri flussi di materia, energia e risorse.

La letteratura scientifica sul tema della resilienza nasce all'interno di una letteratura sul Disaster Risk Management/Reduction (DRM-DRR), trasformandosi gradualmente in una categoria analitica per misurare la capacità di risposta ai disastri naturali (Benadusi, 2013), adottando gradualmente una prospettiva sistemica in grado di considerare contemporaneamente anche gli effetti del cambiamento climatico, le caratteristiche degli ecosistemi e i modi di funzionamento delle società insediate (Faivre et al., 2018). Nella letteratura recente, il concetto di Metabolismo Urbano Circolare (CUM) risulta ancora fertile per ulteriori sperimentazioni sia sul piano teorico, sia attraverso applicazioni pratiche tecnicamente pertinenti,

anche se non sempre in coerenza con l'innovazione degli strumenti di pianificazione (Gejer et al., 2021).

Di conseguenza, entrambi questi concetti - resilienza e metabolismo urbano circolare - fanno parte del più ampio dibattito contemporaneo sui modelli sostenibili di sviluppo contemporanei, caratterizzati da una "diversa crescita" (Russo, 2014) non più meramente energivora e basata su logiche estrattive ma che si concentra invece sulla rigenerazione e valorizzazione del patrimonio esistente, nonchè sull'esigenza di lavorare entro una prospettiva di riequilibrio dei modelli socio-economici esistenti (Kolkwitz et al., 2022). Tradizionalmente lineari, i modelli di crescita attuali scontano, da un lato l'assenza di una gestione in equilibrio dei flussi metabolici, dall'altro la complessità di indagini che guardino complessivamente all'interazione tra i sistemi naturali e tutti i beni umani materiali e immateriali che vi interferiscono. In quest'ottica, l'articolo mira a definire un quadro interpretativo e metodologico per l'analisi del potenziale di resilienza dei territori urbani multirischio, in cui le dinamiche di consumo e rigenerazione delle risorse si intrecciano con condizioni di multirischio, con particolare riferimento ai wastescape come spazi in cui tali relazioni emergono in forma critica ma anche generativa. Il termine *wastescape* compare per la prima volta nel dibattito europeo grazie alla ricerca REPAiR<sup>1</sup>, per descrivere paesaggi di scarto e zone di transizione tra

cicli di produzione e abbandono nei territori periurbani; in questo contesto, il termine *wastescape* mette in tensione la dimensione dei territori residuali dello scarto nel periurbano, con la gestione dei flussi di rifiuti da considerare come risorse innovative. Successivamente, Armiero (2021) definisce il *Wasteocene*, come strumento interpretativo per gli spazi residuali come espressione materiale delle crisi socio-ecologiche contemporanee., collegando scarti, giustizia spaziale e i processi di costruzione del mondo contemporaneo (Armiero, 2021). I *wastescape*, intesi come territori - industriali dismessi, infrastrutture in abbandono, spazi aperti contaminati o sottoutilizzati - rappresentano una componente strutturale caratterizzante delle città contemporanee, dove le fragilità materiali e sociali, rappresentate dalla condizione multi-rischio, si intrecciano con potenzialità di rigenerazione. In questo contesto, si inserisce la riflessione sulla potenzialità rigenerativa dei *wastescape*, reinterpretabili come spazi di resilienza latente, così come descritti nel partenariato esteso PNRR RETURN (*Multi-risk science for resilient communities under a changing climate*), che lavora per rafforzare le competenze di ricerca e la gestione dei territori multirischio (rischi ambientali, naturali e antropici). La ricerca RETURN, e in particolare il Task 5.4.4.<sup>2</sup>, esplora le relazioni tra ambienti multi-rischio e metabolismo urbano circolare, con una particolare attenzione alla rigenerazione territoriale sostenibile e nature-based,

con approcci di co-creation elaborati nel Task 5.5.2 - City-scale exercise for risk scenarios evaluation. , con approcci di co-creation elaborati nel Task 5.5.2 - City-scale exercise for risk scenarios evaluation.

La reinterpretazione dei wastescape richiede l'adozione di un approccio integrato e multidimensionale, attuato attraverso il coinvolgimento attivo degli stakeholder locali, in ambienti collaborativi dove implementare azioni progettuali in co-creazione sul modello Urban Living Labs (Amenta et al., 2019; Steen & Bueren, 2017; Steen & van Bueren, 2017).

Il presente contributo propone una ulteriore elaborazione e rilettura critica del framework metodologico elaborato nei Task 5.4.4.e Task 5.5.2 del progetto RETURN approfondendo la dimensione del potenziale di resilienza insito nei wastescape, utile per l'interpretazione delle caratteristiche spaziali di un caso di studio e per orientare la selezione delle aree prioritarie su cui indirizzare l'azione di co-progettazione (si veda il concetto di *enabling context*, già indagato in REPAiR 2018). Attraverso la definizione di indicatori per l'individuazione e valutazione del potenziale di resilienza si intende dimostrare che è possibile informare tutte le fasi di un processo situato di co-creazione, come definito in RETURN e come meglio dettagliato nella sezione metodologica di questo paper.

Questo studio intende approfondire la seguente domanda di ricerca:

*“Come valutare e mappare il potenziale di resi-*

*lienza dei wastescape in contesti urbani critici multirischio?”.*

L'obiettivo principale del paper è - attraverso l'identificazione di un framework teorico-metodologico integrato finalizzato a identificare i diversi gradi di potenziale di resilienza dei wastescape - orientare strategie progettuali per la mitigazione delle condizioni di rischio, migliorando così la resilienza delle città a partire dalle potenzialità intrinseche dei luoghi, combinando dati quantitativi e qualitativi, approcci spaziali e partecipativi (co-creation), valutazioni ex-ante, in-itinere ed ex-post. Lo studio si avvale di un set di esempi, tratti da una selezione di articoli individuati attraverso un'analisi sistematica della letteratura. Il contributo si avvale, inoltre, della lente interpretativa del metabolismo urbano (Wolman, 1965; Kennedy et al. 2011), del metabolismo urbano circolare e della città rigenerativa (Girardet, 2010) e dell'economia circolare (Geissdoerfer et al. 2017), integrando ulteriori approfondimenti di letteratura.

In questa prospettiva, gli indicatori identificati nel framework non rappresentano solo strumenti di valutazione, ma agiscono come dispositivi progettuali in grado di orientare le decisioni per la selezione del caso di studio e delle aree da attenzionare, e per supportare la definizione di strategie di rigenerazione per un progetto urbanistico circolare e sostenibile dei territori in transizione (Russo 2023). Attraverso la loro natura multidimensionale – quantitativa, qualitativa – essi consentono di

tradurre fenomeni complessi in informazioni operative, rendendo misurabili aspetti altrimenti difficili da integrare nei processi di pianificazione (De Toro, 2013; Forte, 2019), anche quando finalizzati alla collaborazione tra sapere esperto e sapere contestuale. Il sistema di indicatori, se costruito in modo integrato e partecipato, può diventare, infatti, una piattaforma di apprendimento collettivo, capace di sostenere processi decisionali complessi, orientando la selezione di aree prioritarie su cui di promuovere visioni condivise di rigenerazione (Fusco Girard & De Toro, 2010; Russo, 2018; Russo 2014).

Il paper è articolato in quattro sezioni principali. Nella prima parte (1. Introduzione) vengono chiariti i presupposti concettuali che collegano i temi della resilienza, del metabolismo urbano e del rischio metabolico, approfondendo il ruolo dei *wastescapes* come spazi di transizione e potenziale rigenerativo nei contesti urbani multirischio. La seconda parte (2. Metodologia) descrive l'impianto metodologico sviluppato nell'ambito della ricerca PNRR RETURN, illustrando il framework proposto per l'analisi e la mappatura del potenziale di resilienza dei *wastescapes* attraverso l'integrazione di approcci GIS-MCDA e processi di co-creazione. Il set di indicatori proposto per la valutazione del potenziale di resilienza dei *wastescapes* è elaborato a partire dalla revisione della letteratura sui metodi di valutazione esistenti e applicati in contesti urbani multirischio (GIS -

MCDA) (par. 2.2.1). A partire dallo stato dell'arte, viene sviluppato un framework di indicatori misurabili e criteri quali-quantitativi utili a individuare e mappare il potenziale di resilienza dei *wastescapes* a livello multidimensionale (par. 2.2.2). Nella terza parte (3. Risultati) sono presentati gli esiti principali dello studio, articolati nella revisione sistematica della letteratura e nella definizione di un set di criteri e indicatori multidimensionali utili alla costruzione del framework metodologico. Infine, la quarta parte (4. Discussione e conclusioni) offre una riflessione critica sui risultati raggiunti, mettendo in evidenza le potenzialità operative del framework per la pianificazione circolare e resiliente dei territori multirischio e delineando possibili direzioni di ricerca futura.

### 1.2. Fondamenti teorici

In questa sezione si intende chiarire i fondamenti teorici sui quali questo contributo è stato costruito; in particolare, questa parte intende esplorare le relazioni tra il rischio metabolico sviluppato nella ricerca RETURN e lo spazio cui è riferito, attraverso il concetto di *wastescape*, sviluppato invece nella precedente ricerca REPAIR.

Il Rischio Metabolico Urbano - concetto usato fino a questo momento principalmente in campo medico (Piccirillo et al. 2024) - è ancora in fase di definizione nella ricerca in corso PNRR Return (*Multi-risk science for resilient communities under a changing climate*). Il Ri-

schio Metabolico Urbano attiene all'analisi dei modi in cui fenomeni e processi contemporanei (quali la deindustrializzazione, l'urbanizzazione incontrollata, la periferizzazione, etc.) interagiscono con sistemi territoriali complessi producendo impatti ambientali, sociali ed economici e diminuendo la resilienza delle aree interessate. Il concetto, dunque, rappresenta un'estensione di quello di metabolismo urbano e punta a descrivere il rischio che determinati territori, possano rimanere esclusi dalle dinamiche di rigenerazione circolare. La ricerca, in particolare, associa questo concetto alla lettura di fenomeni di stagnazione e attesa di trasformazione, dopo l'interruzione o l'esaurirsi dei cicli di vita (RETURN, 2025).

Il Rischio Metabolico Urbano può essere, quindi, interpretato come una categoria dell'approccio multi-rischio che applica una dimensione *temporale* allo studio di fenomeni di alterazione socio-spaziale del territorio contemporaneo, *in primis* quelli ritenuti alla base della formazione dei *wastescape*. Questi sono stati definiti come territori residuali o marginalizzati, spesso derivanti da processi di deindustrializzazione o abbandono, intesi come spazi urbani in stato di abbandono o degrado, ma con un capitale inespresso di risorse (materia, natura, spazio), utile per identificare strategie e processi alternativi di recupero e valorizzazione. Il progetto Horizon 2020 REPAiR, in riferimento ai processi di metabolismo urbano, li definisce come territori (edifici, infrastrutture

e spazi aperti) che si trovano in una fase *temporale* di transizione tra cicli di vita esauriti e nuovi cicli non ancora iniziati, caratterizzati da sottoutilizzo, abbandono (REPAiR, 2018).

La riflessione sul *tempo* in cui si è dispiegato un fenomeno patologico per il territorio, prelude inoltre alla necessità di progettare in maniera resiliente anche il tempo della trasformazione, come tempo di un rimedio che prefiguri un beneficio nel breve-medio termine (e.g. usi temporanei, accessibilità e messa in sicurezza delle aree, etc.) e che non rimandi tutto alla soluzione trasformativa nella sua composizione finale (Attademo, 2022).

La dimensione tempo è in stretta relazione di interdipendenza con la dimensione ecologica quando ci si trova a dover affrontare e/o facilitare il processo di transizione sostenibile verso la circolarità (Amenta, 2025).

Tale approccio, che tiene conto del tempo come materiale per la rigenerazione, prevede la reinterpretazione di tutte le dimensioni, e quindi dei relativi fattori, che hanno contribuito alla condizione di un paesaggio come *wastescape*, includendo, dunque, oltre agli aspetti ambientali, sociali, culturali ed economici, quelli strettamente legati allo spazio fisico. Il *wastescape*, infatti, è inteso contemporaneamente come "questione" – legata ad abbandono, dismissione, ritrazione funzionale e economica – e come "risorsa", in cui processi adattivi e resilienti possono identificare le azioni tecniche necessarie a riconoscere il valore dello scarto, di pa-

esaggio e materia (Russo & Attademo, 2022). Il progetto di rigenerazione sostenibile e resiliente dei wastescape considera, infatti, sia aspetti “hard” (quantitativi, quali flussi, materia e luoghi) che “soft” (qualitativi, quali attori e governance), alludendo ad una resilienza potenziale e intrinseca, basata non solo su dati oggettivamente rilevabili ma anche su condizioni sociali e culturali legate a quanto è rappresentato dal capitale sociale e umano delle comunità.

In questo senso lavorare all'interno di processi di co-creazione (modello Urban Living Lab) può aiutare a superare anche i casi di *path dependence* con il perpetuarsi nel tempo degli stessi fenomeni lineari che hanno provocato l'esaurirsi di un ciclo, in cui proprio gli attori coinvolti nella rigenerazione dei wastescape possono spesso ritrovarsi bloccati (Amenta, van Timmeren, 2018).

Nei su menzionati task della ricerca RETURN, il Rischio Metabolico Urbano è stato, quindi, definito a partire dal territorio multirischio di Bagnoli, a ovest di Napoli, che rappresenta uno dei più importanti siti post-industriali e paesaggi inquinati della Campania, che si apre verso il mare e si configura come un contesto emblematico per sperimentare, alla scala urbana e territoriale, con il concetto di potenziale inespresso di resilienza. Tale potenziale, inteso come capitale latente di risorse immateriali (valori, memoria) e materiali (spazio, natura), può orientare strategie e processi alternativi

di recupero e valorizzazione circolari e resilienti (Vendemmia et al- 2024; Piccirillo et al. 2024). Tra gli obiettivi del progetto RETURN vi è la definizione di linee guida per la rigenerazione sostenibile e circolare dei contesti multirischio, con particolare attenzione a progetti e processi urbani orientati all'ecologia. Gran parte del territorio di Bagnoli, dove sorgeva l'ex stabilimento ILVA, versa ancora oggi in una condizione di negata accessibilità e abbandono, principalmente a causa dell'inquinamento del suolo e dei processi di bonifica ancora in corso. RETURN sperimenta a Bagnoli un approccio collaborativo in ambienti di co-creazione per sperimentare una gestione innovativa dei rischi immaginando un processo di rigenerazione ecologicamente orientato (Amenta 2025).

## 2. Metodologia

### 2.1. Rapporto con la metodologia di indagine della ricerca RETURN

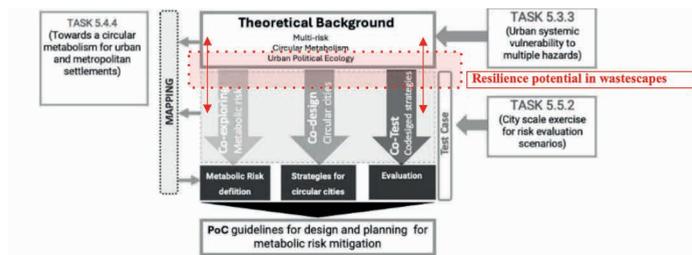
A partire dai fondamenti teorici che legano i concetti di rischio metabolico e wastescape (Parte 1.2), questo contributo propone un framework metodologico per l'individuazione di indicatori per la definizione del potenziale di resilienza intrinseco nei wastescape, per orientare la selezione di aree prioritarie – enabling contexts (REPAiR 2018) – sulle quali è possibile intervenire con il progetto urbanistico di rigenerazione sostenibile e circolare.

La ricerca RETURN ha sperimentato nel Task 5.5.2 un metodo di co-progettazione situato

## Rielaborazione degli autori dello schema contenuto nel Deliverable DV 5.4.5

Evaluation Framework for monitoring circularity, sustainability and resilience of urban metabolism.

Fig. 1



che intreccia desk research e attività di co-creazione, organizzate in tre fasi: co-exploring, co-design e co-test (Vendemmia et al., 2024) (Figura 1).

Il potenziale di resilienza dei *wastescape* è indagato a livello multidimensionale, con particolare applicazione sulle specificità che caratterizzano i paesaggi dello scarto. L'avanzamento che il contributo propone, è indicato in rosso nella Fig.1, ed integra lo schema metodologico proposto dai Task 5.5.2 e 5.4.4 di RETURN. Obiettivo di questo approfondimento è mettere in luce le potenzialità intrinseche di questi paesaggi in termini di resilienza, all'interno di tutte le fasi del processo di analisi e progetto al fine di produrre una conoscenza situata utile per orientare un progetto sostenibile e adattivo.

Tale framework, quindi, rappresenta non solo uno strumento di analisi e valutazione che informa la prima fase di co-exploring, ma può supportare inoltre la seconda fase di co-design per definizione condivisa di strategie rigenerative dei territori di scarto, aiutando nella sele-

zione delle aree prioritarie per il progetto a partire dalle condizioni di resilienza intrinseche.

La prima fase di co-exploring prevede, tra i primi step, la delimitazione spaziale dell'area di studio e la ricognizione preliminare degli attori territoriali, umani e non-umani, coinvolti nel sistema locale per la definizione collaborativa di un atlante di mappe, che si configura come l'analisi spaziale, e che sia in grado di restituire la complessità del territorio indagando soffermandosi sulle condizioni multirischio e su quelle metaboliche; in questa fase sono previste diverse interazioni con gli attori locali attraverso attività di workshop e focus group sviluppate in situ (RETURN 2025b).

La seconda fase di co-design in RETURN prevede le sperimentazioni di co-progettazione vere e proprie da sviluppare in attività collaborative supportate da strumenti come serious-game e co-mapping sviluppati ad hoc per la ricerca RETURN, finalizzate a migliorare la consapevolezza delle condizioni multi-rischio del territorio di Bagnoli (RETURN 2025b).

La terza fase, di co-test e governance adattiva,

include momenti di confronto con stakeholder locali, amministrazioni e comunità, con l'obiettivo di favorire conoscenza condivisa sui possibili impatti multidimensionali (sociali, culturali, ambientali ed economici) delle strategie di rigenerazione identificate.

Il framework qui proposto rappresenta uno strumento a supporto di tutte le fasi della metodologia di Urban Living Lab del progetto RETURN. ... Pertanto, le due fasi che la costituiscono sono indicate come Fase Trasversale 1 e Fase Trasversale 2 (per brevità saranno indicate di seguito rispettivamente come T1 e T2).

Il processo di co-test è inteso come un meccanismo di apprendimento collettivo e progressivo, in cui i risultati intermedi dell'analisi spaziale (co-exploring) e del progetto (co-design) vengono verificati e discussi con i soggetti coinvolti, orientando la successiva definizione di linee guida operative. Tale impostazione favorisce una governance multi-attore e multilivello, capace di adattarsi a differenti contesti territoriali e di promuovere processi di rigenerazione circolare.

## 2.2 Definizione di indicatori per l'analisi del potenziale di resilienza dei wastescapes

### *Fase 1: Review di letteratura sugli indicatori esistenti*

Nell'ambito di questo studio è stata condotta una revisione sistematica della letteratura sui metodi e gli strumenti di valutazione utilizzati

per l'analisi del potenziale di resilienza dei *wastescape*, per identificare gli aspetti chiave e lo stato dell'arte in questo campo.

Questa revisione sistematica della letteratura ha adottato il metodo PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) di Moher et al. (2009), con un processo in quattro fasi: identificazione degli studi, screening, ammissibilità e inclusione (Figura 1). La Figura 2 mostra le fasi del processo di ricerca sistematica per la revisione della letteratura sui metodi e gli strumenti di valutazione utilizzati per l'analisi del potenziale di resilienza dei *wastescape* nella prospettiva del modello di economia circolare applicato al metabolismo urbano. In ogni fase è indicato il numero di fonti scientifiche selezionate.

Nella fase di identificazione, sono state scelte come fonti di ricerca tre banche dati principali, tra cui Web of Science, Scopus e ScienceDirect. La ricerca degli articoli è stata effettuata per titolo, abstract e parole chiave scelte dall'autore, utilizzando gli operatori booleani "OR" e "AND". Le parole chiave utilizzate per la ricerca degli articoli sono state organizzate nelle seguenti stringhe (Tabella 1): 122 pubblicazioni sono state sottoposte ad una fase di screening adottando alcuni filtri:

- sono stati selezionati solo gli articoli in lingua inglese;
- sono stati esclusi gli articoli in stampa;
- sono stati esclusi gli articoli con accesso a pagamento.

## Fasi della revisione sistematica: il flusso PRISMA

Fig. 2

### Identification

122 records identified through 3 database searching  
(Science Direct, Google Scholar, Web of Science)

### Screening

79 records screened  
(Exclusion criteria: article in press, restricted access)

### Eligibility

52 full-text articles assessed for eligibility  
(articles excluded for lacked connections to the research goal)

### Inclusion

45 studies included in qualitative synthesis

Non sono stati applicati filtri alla ricerca di articoli in base alla data di pubblicazione. Nella fase di ammissibilità, 79 pubblicazioni sono state esaminate in base a titoli, abstract e parole chiave. Per evitare di omettere informazioni importanti, eventualmente non emerse dall'analisi dei soli titoli, abstract e parole chiave, è stata condotta un'altra analisi sul contenuto degli articoli ritenuti inizialmente non idonei.

79 articoli sono stati valutati per l'ammissibilità e quindi inclusi nella sintesi qualitativa.

Nella fase di inclusione, è stata poi condotta un'analisi del contenuto di queste pubblicazioni per individuare argomenti e prospettive rilevanti su metodi e strumenti di valutazione utilizzati per l'analisi del potenziale di resilienza dei *wastescape* nella prospettiva del modello di econo-

mia circolare applicato al metabolismo urbano. La revisione sistematica della letteratura, pur basandosi sul metodo PRISMA, è stata successivamente ampliata includendo contributi provenienti da differenti contesti geografici e culturali, con l'obiettivo di esplorare come il concetto di resilienza urbana venga declinato in relazione ai processi di rigenerazione e trasformazione territoriale.

Nelle esperienze europee, la resilienza è spesso letta come un processo di adattamento strutturale e morfologico, strettamente connesso alla pianificazione spaziale (Davoudi, 2012; Ahern, 2011). In contesti extraeuropei, come l'Asia e l'America Latina, prevale invece un'interpretazione socio-culturale che enfatizza la capacità adattiva delle comunità locali e la co-produzione di strategie di rigenerazione

## Stringhe utilizzate nelle tre banche dati per la ricerca finalizzata alla literature review

Tab. 1

N. stringa	Stringhe
1	("Resilience" AND "circular urban metabolism" AND "waste") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
2	("Resilience" AND "circular urban metabolism" AND "contamination") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
3	("Resilience" AND "circular urban metabolism" AND "abandonment ") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
4	("Resilience" AND "circular urban metabolism" AND "neglection") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
5	("Resilience" AND "circular urban metabolism" AND "decommission") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
6	("Resilience" AND "risk" AND "waste") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
7	("Resilience" AND "risk" AND "contamination") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
8	("Resilience" AND "risk" AND "abandonment ") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
9	("Resilience" AND "risk" AND "neglection") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")
10	("Resilience" AND "risk" AND "decommission") AND ("multidimensional evaluation" OR "multidimensional assessment" OR "multidimensional indicators") AND ("territory" OR "landscape")

(Meerow & Newell, 2019; Surya et al., 2020).

L'integrazione di tali prospettive consente di leggere i wastescape non solo come spazi di abbandono, ma come laboratori di resilienza in cui le pratiche locali, la dimensione culturale e la governance partecipata giocano un ruolo determinante. Questo approccio comparativo rafforza la validità del framework proposto, ponendo l'accento sull'interdipendenza tra dimensione spaziale e socio-culturale nella valutazione della resilienza.

*Fase 2: Framework metodologico per l'analisi del potenziale di resilienza nei wastescape*

La Fase 2 ha l'obiettivo di definire un metodo di mappatura multicriteriale, a partire dagli indicatori emersi dalla fase uno. Sono stati esclusi taluni indicatori ritenuti esclusivamente rispondenti all'analisi di criticità intrinseche dei sistemi territoriali analizzati, non opportuni per la valorizzazione delle potenzialità latenti nei *wastescape*.

In particolare, si è scelto di perseguire un approccio che incrocia alla valutazione multicriterio tradizionale un'operazione di spazializzazione del dato, attraverso mappature in grado di supportare decisioni complesse, ponendo in evidenza le relazioni sistemiche e le ricadute territoriali degli indicatori. Ogni criterio qualitativo è così traducibile in un indicatore misurabile, la cui spazializzazione consente la definizione delle geografie che tali criteri mettono in campo. In questo modo, a valle della

selezione delle aree prioritarie su cui concentrare l'attenzione ed il progetto, è possibile individuare il peso sulla decisione finale.

Il metodo di mappatura utilizzato è l'Analisi Spaziale un metodo di analisi applicata al territorio finalizzato all'utilizzo di dati geografici per descrivere e comprendere le relazioni tra entità semplici e complesse (Fotheringham, Rogerson, 2009; Behnisch, Meinel, 2018). Il metodo si basa sull'elaborazione e il trattamento di dati in ambiente GIS, su cui applicare componenti quali-quantitative (criteri e indicatori) per ottenere rappresentazioni grafiche descrittive di molteplici caratteristiche spaziali (Haining, 2003; Haining et al., 2010). Il presente contributo fa riferimento alle tre principali Geografie con cui un territorio può essere esplorato (RE-PAiR 2017), collegandole inoltre alla mappatura di agenti fisici, umani e non-umani:

- Geografia Generale, identificando le componenti del sistema regolativo (e.g. limiti amministrativi, censuari, etc.);
- Geografia Fisica e Non-Umana, tradizionalmente relativa a componenti abiotiche, ad aria, terra, natura e acqua, interpolata con componenti non-umane, quali organismi viventi (piante, animali, funghi, microrganismi), anche per il valore di questi ultimi nella prospettiva metabolica;
- Geografia Umana, relativa a cultura, economia, società, ed in quest'ultima le relazioni con sistemi di governance, insediamenti, infrastrutture, etc.

Le geografie di analisi spaziale sono state poste in relazione con i criteri identificati nel framework. La tradizionale geografia fisica è stata qui definita “Fisica e Non-umana”, in relazione ad uno sguardo post-antropocentrico (Braidotti, 2014), qui particolarmente rilevante in quanto molto spesso il potenziale di resilienza si basa soprattutto su sistemi di naturalità sopravvissuti alla compromissione ecosistemica e al decadimento sociale ed economico.

Sulla base degli indicatori della Fase 1, si restituisce un set di criteri tematici di interpretazione del potenziale di resilienza nei *wastescapes*, suddivisi nelle tre suddette geografie. La mappatura di base dei *wastescapes* si intende eseguita secondo le metodologie già definite in precedenti ricerche (REPAiR, 2018; Amenta & Attademo, 2023). Gli step della valutazione multicriterio sono, quindi:

1. Definizione dei criteri di valutazione rappresentativi delle caratteristiche necessarie a definire il potenziale di resilienza dei *wastescapes* analizzati, e suddivisione nelle geografie dell'Analisi Spaziale.
2. Raccolta dei dati necessari per valutare ogni *wastescapes* in base ai criteri definiti.
3. Pesatura dei criteri, indicando la loro importanza relativa nella decisione.
4. Valutazione dei *wastescapes* finalizzata ad ottenere una gerarchizzazione e una classificazione dei *wastescapes* in base al livello del loro potenziale di resilienza e considerando i diversi pesi attribuiti ai criteri nella

fase precedente per individuare gli *enabling context*.

Nel presente articolo vengono illustrate le prime due fasi del processo metodologico – relative alla definizione del quadro teorico e all'impostazione del framework analitico – mentre le successive fasi di sperimentazione e test sono già state avviate nell'ambito del progetto RETURN (Deliverable 5.5.2) e sono tuttora in corso di sviluppo.

In continuità con le attività di *co-exploring* e *co-design* realizzate nei casi studio del progetto, la ricerca qui presentata intende costituire una base di riferimento per future sperimentazioni sul campo, orientate alla costruzione di mappe percettive del rischio e alla validazione partecipata del potenziale di resilienza dei *wastescapes*.

A completamento dell'approccio metodologico, è prevista una fase di analisi *in situ*, finalizzata alla verifica empirica dei dati e alla validazione dei risultati ottenuti dall'analisi spaziale. Tale fase comprenderà attività di ricognizione diretta e mappatura partecipata, attraverso rilievi fotografici, osservazioni sul campo e interviste esplorative con gli attori locali.

All'interno del percorso RETURN, la *co-evaluation* è concepita come parte integrante del processo di co-creazione e non come fase conclusiva o separata. Essa si colloca trasversalmente alle tre fasi operative del modello RETURN – *co-exploring*, *co-design* e *co-test* – e mira a garantire un apprendimento continuo

attraverso la verifica condivisa dei risultati intermedi e finali. In questo senso, la *co-evaluation* è intesa come un meccanismo adattivo di apprendimento collettivo, che consente di ricalibrare indicatori, strategie e priorità in funzione delle evidenze emerse dal confronto tra sapere esperto e sapere contestuale.

L'obiettivo è duplice: da un lato, integrare le informazioni provenienti dai database GIS con evidenze qualitative sullo stato dei luoghi; dall'altro, individuare risorse latenti e pratiche spontanee di adattamento e riuso, già emerse nelle esperienze condotte nell'ambito di RETURN, e sviluppare ulteriori strumenti a supporto di processi di co-creazione e valutazione percettiva del rischio. L'analisi *in situ* rappresenta dunque una componente essenziale e dinamica del framework, capace di restituire una lettura situata e multiscalare dei *wastescapes*.

### 3. Risultati

#### 3.1. Risultati della Fase T1: temi e sfide da una revisione della letteratura sugli studi per *wastescape* circolari e resilienti

Il concetto di resilienza applicato ai *wastescapes* rappresenta oggi una sfida metodologica e operativa. La letteratura scientifica recente si è concentrata principalmente sulla definizione di strumenti valutativi finalizzati ad un'analisi delle trasformazioni da un punto di vista spaziale e ambientale. Dai casi studio raccolti nella literature review (vedi allegato A), emer-

gono approcci eterogenei per quanto riguarda la scala di applicazione (dal distretto urbano al quartiere), sia per il tipo di contesto urbano analizzato (*ex-aree* industriali, siti contaminati, aree portuali dismesse), sia infine per la tipologia di indicatori impiegati (ambientali, sociali, infrastrutturali, ecologici, ecc.).

La metodologia di analisi si articola in tre fasi complementari, che riflettono un processo di valutazione dinamico e multilivello.

- I. Nella fase *ex-ante*, precedente all'applicazione delle strategie di progetto, i metodi basati su GIS-MCDA sono impiegati per simulare e valutare scenari di trasformazione territoriale, individuando i fattori socio-spaziali che possono contribuire a invertire le condizioni di vulnerabilità dei paesaggi esposti a rischio metabolico.
- II. La fase *in-itinere*, corrispondente al periodo di implementazione e monitoraggio delle strategie, consente una valutazione continua dell'efficacia delle azioni circolari attraverso il confronto tra previsioni e risultati intermedi. In questa fase, il framework consente di leggere anche gli effetti temporanei delle strategie – come gli usi adattivi e le pratiche di riattivazione di risorse latenti – che possono innescare processi di rigenerazione paesaggistica e sociale.
- III. Nella fase *ex-post*, successiva all'attuazione delle strategie, vengono analizzati i risultati complessivi e gli impatti generati nel medio periodo. I metodi GIS-MCDA consentono di

valutare il grado di successo delle strategie implementate, confrontando gli indicatori osservati con gli obiettivi iniziali e il livello di circolarità raggiunto nelle diverse dimensioni – sociale, economica e ambientale.

In tutte le fasi, il set di indicatori mantiene coerenza metodologica pur adattandosi alla disponibilità dei dati e al contesto di applicazione. L'integrazione dei dati provenienti da diverse fonti mediante strumenti GIS permette approcci flessibili e comparativi, capaci di restituire una valutazione sistemica e scalabile del potenziale di resilienza dei *wastescares*.

Gli indicatori utilizzati nel framework derivano da una sistematizzazione della letteratura internazionale sulla valutazione della resilienza urbana e territoriale. Essi sono classificati in tre categorie in base alla loro natura e funzione nel processo valutativo – quantitativi, qualitativi e *performance-based* – e messi in relazione con le tre geografie dell'analisi spaziale (*generale, fisica e non-umana, umana*), in coerenza con il modello RETURN, per garantire maggiore trasparenza metodologica e replicabilità del framework. Tale articolazione consente di integrare approcci misurabili e interpretativi, combinando dati oggettivi e conoscenze situate per la valutazione multicriteriale (GIS-MCDA):

- Indicatori quantitativi, che misurano variabili oggettive e comparabili (es. consumo di suolo, densità abitativa, accessibilità, copertura del suolo);
- Indicatori qualitativi, basati su percezioni,

valutazioni sociali o culturali, e informazioni raccolte attraverso strumenti partecipativi (es. coesione comunitaria, sicurezza percepita, grado di partecipazione);

- Indicatori di performance, che descrivono la capacità del sistema territoriale di reagire o adattarsi ai cambiamenti (es. diversificazione funzionale, efficienza energetica, governance adattiva).

L'interrelazione tra criteri quantitativi, qualitativi e di performance permette di restituire una valutazione integrata e adattiva, in grado di misurare non solo lo stato dei *wastescares* ma anche la loro capacità trasformativa nel tempo.

La letteratura recente converge sull'idea che la resilienza urbana richieda strumenti integrati in grado di leggere insieme dimensioni ecologiche, spaziali e socio-economiche, con un ruolo crescente di metodi GIS-MCDA e di set indicatori multidimensionali. In un'ottica circolare, le revisioni sistematiche e i contributi di indirizzo mettono in luce la necessità di passare da quadri concettuali generali a dispositivi operativi capaci di orientare decisioni e progetti: le rassegne di Rocha, Pak & Piccardo (2024) e Marzani & Tondelli (2024) evidenziano, rispettivamente, come la partecipazione e i trend delle *circular cities* si traducano in criteri e indicatori spaziali (reti ecologiche, morfologia urbana, accessibilità), suggerendo la scala distrettuale come livello privilegiato per l'implementazione operativa. Sul fronte ambientale-ecologico, diversi autori

propongono di integrare infrastrutture verdi/blu, servizi ecosistemici e connettività ecologica dentro processi valutativi trasparenti: studi su infrastrutture verdi e giustizia ambientale (ad es. Hoover et al., 2021) mostrano come l'uso di indicatori ambientali supporti scelte localizzative eque; lavori più recenti su biodiversità e blue-green infrastructure (Perrelet et al. 2024) e su mappature ecosistemiche (Shmelev et al., 2023) consolidano approcci che combinano metriche ecologiche, monitoraggio e visualizzazione spaziale. A scala metodologica, contributi come Lindfors (2021) e Razzaghi Asl (2022) rafforzano l'integrazione tra MCDA e sostenibilità, mentre applicazioni su contesti costieri (Liao et al. 2023) e agricoli/territoriali documentano la trasferibilità del quadro.

Sul versante socio-spaziale, la resilienza è letta come qualità emergente dalle interazioni tra spazi, comunità e pratiche d'uso. In contesti post-industriali, ricerche su Detroit evidenziano l'uso di indicatori ambientali per valorizzare i vuoti urbani in chiave multifunzionale (Hoover et al. 2021). Studi comparati in contesti extra-europei – ad es. Surya et al. (2020) – integrano analisi GIS con dati socio-economici per leggere trasformazioni e capacità adattiva delle comunità. La scala intermedia è ricorrente: lavori alla scala di distretto (ad es. Nocca, De Toro & Voysekhovska, 2021; Capolongo et al., 2018/2020) mostrano maggiore operatività nella definizione di priorità e nel governo della transizione. In parallelo, contri-

buti su resilienza infrastrutturale e morfologia (González-Sánchez et al. 2023) sottolineano ridondanza funzionale, interconnessione dei servizi e modularità, mentre casi di co-progettazione e linee guida operative (ad es. Escandón-Panchana et al., 2024) illustrano criteri per trasformazioni partecipate di aree degradate. La letteratura conferma inoltre l'avanzamento di strumenti e modelli che integrano dati ambientali, indicatori sociali e componenti decisionali: lavori che combinano big data/remote sensing e valutazione spaziale (Yu & Fang, 2023; Pan et al., 2021) supportano mappature dinamiche della resilienza; approcci MCDA/PROMETHEE e AHP sono sperimentati in ambito smart city (Mutambik, 2024; Seidu et al., 2025) e in applicazioni di eco-turismo e pianificazione (Marzuki et al. 2023). Per i *brownfield*, l'uso di metodi MACBETH per decisioni di riuso (Mateus et al., 2017) mostra come la valutazione multi-criteriale possa tradursi in scelte progettuali condivise. In ambito europeo, si consolidano indicatori legati a reti ecologiche, permeabilità del suolo, accesso agli spazi pubblici (ad es. Rocha, Pak & Piccardo, 2024), con supporto di metriche ecosistemiche (Perrelet et al., 2024).

Una linea di lavori insiste sulla dimensione sociale della resilienza: la co-creazione e il coinvolgimento degli stakeholder (Souza et al., 2021; Barreiro-Pérez et al., 2023) sono considerati fattori determinanti; Surya et al. (2023) includono tra gli indicatori coesione co-

munitaria, percezione di sicurezza e accesso ai servizi. Esperienze italiane come Ingrassia et al. (2023) combinano indici di vulnerabilità sociale con metriche fisico-spaziali in GIS partecipativi, evidenziando indicatori ricorrenti (partecipazione, qualità percepita degli spazi, accessibilità). In sintesi, gli articoli analizzati convergono su: approcci sistemici, valorizzazione delle pratiche adattive, adozione di strumenti valutativi replicabili e centralità del progetto urbano come catalizzatore del cambiamento. Da qui discende il nostro impianto: un quadro metodologico integrato che combina dati quantitativi e qualitativi, approcci spaziali e partecipativi, e fasi di valutazione ex-ante, in-itinere ed ex-post, con un ricorso trasversale a indicatori compositi (consumo di suolo, biodiversità urbana, connettività ecologica, densità abitativa, prossimità ai servizi, qualità dell'aria, diversificazione funzionale) e con particolare attenzione alla scala distrettuale per l'operatività delle scelte.

Nel complesso, gli articoli analizzati convergono su alcune traiettorie comuni:

- l'urgenza di approcci sistemici,
- la valorizzazione delle pratiche adattive,
- l'adozione di strumenti valutativi trasparenti e replicabili,
- e la centralità del progetto urbano come catalizzatore di cambiamento.

Questi esempi, tratti da una selezione di articoli dedotti da una literature review, dimostrano che il potenziale di resilienza dei *wa-*

*stescapes* può essere analizzato attraverso un quadro metodologico integrato che combina dati quantitativi e qualitativi, approcci spaziali e partecipativi, valutazioni ex-ante, in-itinere ed ex-post. Il ricorso a strumenti GIS-MCDA è trasversale nella letteratura esaminata, così come l'enfasi su indicatori compositi in grado di cogliere le molteplici dimensioni della resilienza (ecologica, sociale, economica).

Gli indicatori più frequentemente utilizzati comprendono:

- il consumo di suolo,
- la biodiversità urbana,
- la connettività ecologica,
- la densità abitativa,
- la prossimità ai servizi,
- la qualità dell'aria,
- la resilienza economica misurata in termini di diversificazione funzionale.

### **3.2 Risultati della Fase T2: definizione di un framework metodologico per l'Analisi Spaziale del "potenziale di resilienza" a livello multidimensionale**

Nel corso di questo lavoro che integra il lavoro di ricerca portato avanti nella ricerca PNRR RE-TURN, è stato sviluppato un framework teorico-metodologico (vedi Allegato B), costituito da criteri e indicatori, elaborati a partire dalla revisione di letteratura della Fase 1 e rappresentativi delle caratteristiche necessarie a definire il potenziale di resilienza dei *wastescapes* analizzati.

I criteri, inizialmente interpretati come fattori semplicemente descrittivi delle caratteristiche di spazi aperti, insediamenti e infrastrutture, in coerenza con le tassonomie dei *wastescapes*, sono stati successivamente adattati e rielaborati alla luce degli indicatori emersi come risultato della literature review (Allegato A), al fine di identificare caratteristiche del potenziale di resilienza più coerenti con gli obiettivi della valutazione multicriterio. L'obiettivo è stato quello di trasformare tali indicatori in criteri di selezione per i *wastescapes* che mostrano un maggiore potenziale di resilienza intrinseca (*enabling contexts*), conservando un focus sulla mappatura spaziale e sulla selezione di aree prioritarie su cui intervenire. Per questo motivo, si è cercato di mediare tra le due prospettive spaziale e valutativa, adottando un quadro di analisi spaziale ispirato alla letteratura delle geografie indicate (REPAiR 2018), e integrando indicatori rappresentativi del potenziale di resilienza, e dunque di opportunità di trasformazione e rigenerazione dei *wastescapes*. Inoltre, si è scelto di escludere gli indicatori riferiti a caratteri esclusivamente critici dando priorità a potenzialità e opportunità latenti nei *wastescapes*.

I criteri proposti nel framework hanno un duplice valore: essi non fungono solo come parametri valutativi rispetto ai quali analizzare il potenziale di resilienza dei *wastescapes*, ma possono essere interpretati anche come supporto nell'orientare le strategie di trasfor-

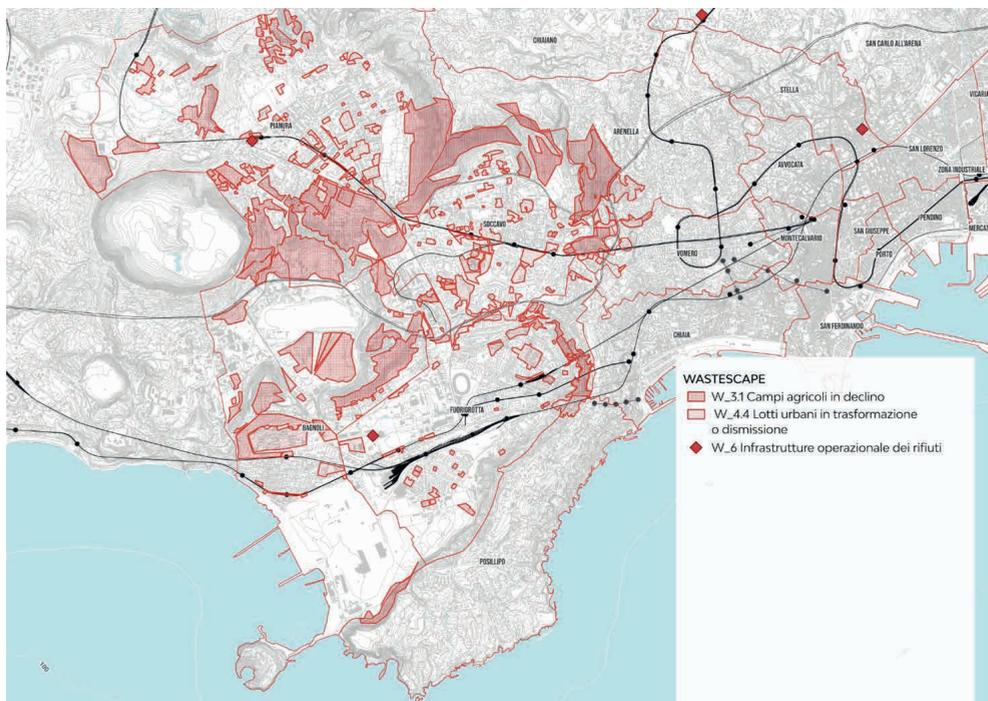
mazione e rigenerazione dei *wastescapes*, alimentando e fertilizzando la discussione in attività di co-creazione e in processi decisionali multiattore, in cui è necessario mediare tra dati e mappe del sapere esperto e di quello contestuale.

Ogni criterio è associato a una specifica dimensione di sostenibilità (ambientale, economica, sociale, culturale), a una tipologia (quantitativo, qualitativo, performance-based) e alla fonte o tecnologia utilizzata per la sua misurazione.

La classificazione consente di integrare approcci misurabili e interpretativi, combinando dati oggettivi e conoscenze situate per la valutazione multicriteriale (GIS-MCDA). Essa risponde all'esigenza di garantire trasparenza, coerenza metodologica e tracciabilità scientifica, in linea con i principi di *co-evaluation* e governance adattiva promossi dal progetto RETURN.

La costruzione di questo framework teorico-metodologico consente di affiancare alla tradizionale mappa generale dei *wastescape* – basata sulle categorie inizialmente definite nel progetto REPAiR e successivamente integrate (REPAiR, 2018) – una lettura che ne evidenzia quelli potenzialmente più resilienti, sulla base di criteri ponderati e multidimensionali, utilizzabili per analisi di dettaglio e applicazioni su casi specifici.

La metodologia proposta rappresenta un avanzamento nelle pratiche di mappatura e valu-



## Categorie esemplificative di definizione di database wastescape sull'area occidentale del Comune di Napoli.

Fonte: Laboratorio Governare il Metabolismo Urbano, A.A. 2023/24 (docente: A. Attademo).

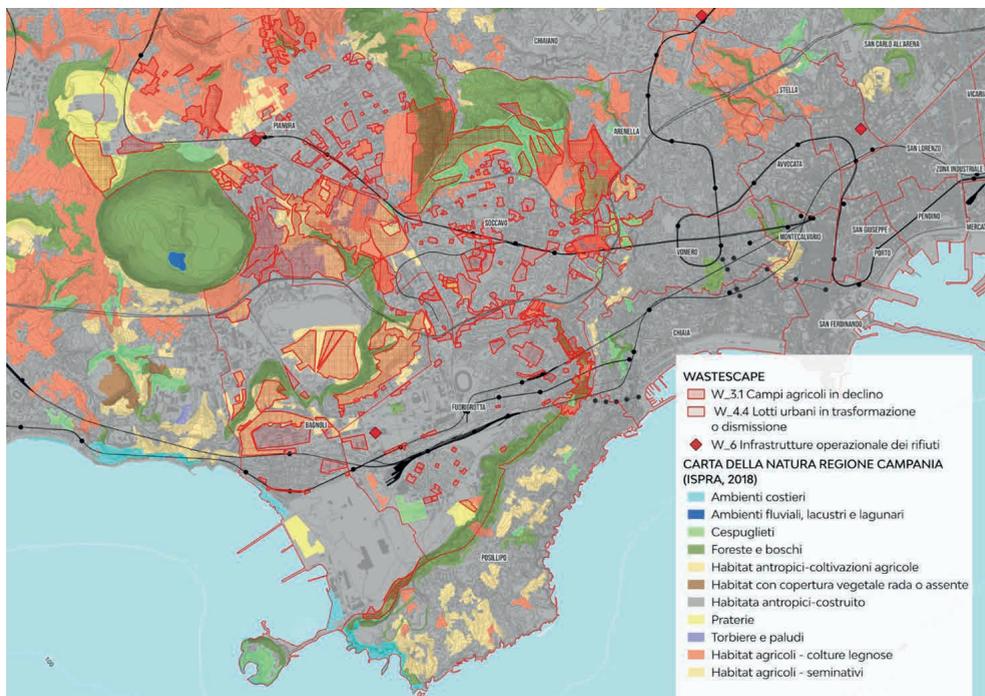
Elaborazione dati: F. S. Sammarco.

Fig. 3

tazione del potenziale di resilienza, offrendo strumenti operativi per la costruzione di scenari e per la pianificazione territoriale in contesti multirischio. Il processo di spazializzazione consente di riportare lo spazio vissuto al centro dell'analisi, interpretandolo non solo attraverso i suoi caratteri morfologici e infrastrutturali, ma anche in relazione ai legami sociali, metabolici e produttivi che lo configurano.

In questo quadro, la dimensione dell'analisi sul campo assume un ruolo determinante. Essa si fonda su attività già sperimentate nell'ambito del progetto RETURN, nei tasks 5.5.2 e 5.4.4, e

in particolare nel Living Lab di Bagnoli-Coroglio (Deliverable 5.5.2), dove sono state condotte azioni di co-exploring, co-design e co-testing. Queste hanno incluso walkthrough esplorativi, focus group con studenti e cittadini, laboratori di mappatura percettiva del rischio e camminate partecipate (es. Jane's Walk "Bagnolinsi-de ILVA"), finalizzate a raccogliere conoscenze situate, percezioni e narrazioni locali dei luoghi. Tale sperimentazione costituisce la base empirica per una successiva integrazione della metodologia proposta: i risultati delle analisi spaziali potranno essere validati e arricchiti



## L'identificazione spaziale della presenza di habitat naturali nei wastescape dell'area occidentale di Napoli.

Si riporta a titolo esemplificativo l'identificazione spaziale della presenza di habitat naturali nei wastescape dell'area occidentale di Napoli, attraverso un indicatore riferito alla copertura dei suoli.

Sovrapposizione Carta Natura Regione Campania (ISPRA, 2018) sul database wastescape dell'area occidentale del Comune di Napoli. Il dato evidenzia nelle categorie scelte, la presenza di habitat naturali, che possono essere utilizzati nella definizione della Geografia (Fisica) Non-Umana. Il raffronto con l'area dell'ex-Italsider a Bagnoli evidenzia però come sia necessario integrare questa tipologia di dato aggregato con un lavoro di mappatura sul campo, per evidenziare la presenza di praterie, cespuglieti, etc. e habitat di fatto di rinaturalizzazione qui non registrati.

Fonte: Elaborazione dati: F. S. Sammarco.

Fig. 4

attraverso rilievi diretti, osservazioni in situ e interviste esplorative, al fine di identificare risorse latenti, pratiche spontanee di riuso e forme di adattamento locale non rilevabili dai soli dati secondari.

In questa prospettiva, l'analisi sul campo non rappresenta una fase accessoria, ma un livello strutturale del framework, capace di connettere la rappresentazione cartografica dei *wastescapes* con la loro dimensione esperienziale e percettiva, rendendo il processo di valutazione più aderente alla complessità dei paesaggi del rischio.

In una prima fase, la metodologia proposta consente di mappare i *wastescape* individuando aree ad alto potenziale di resilienza sulla base di indicatori quali copertura del suolo, accessibilità, biodiversità residua e presenza di risorse ecologiche latenti.

Nelle immagini di questo contributo, si riporta a titolo esemplificativo l'identificazione spaziale della presenza di habitat naturali nei *wastescape* dell'area occidentale di Napoli, attraverso un indicatore riferito alla copertura dei suoli (Figura 3-4).

#### 4. Discussione e prospettive di ricerca

Approcci settoriali possono portare a uno sviluppo iniquo tra le sfere socio-economiche ed ecologico-ambientali. Con il concetto di resilienza urbana trasformativa (Ajibade, 2022) si riconosce anche alla sfera sociale un ruolo fondamentale per una transizione verso un territorio sostenibile e resiliente.

Nella dimensione spaziale delle città contemporanee, l'interazione tra processi socio-ecologici, dinamiche ambientali e risorse naturali può generare effetti positivi sulla riduzione della vulnerabilità fisica e sociale (Chelleri, 2015). A tal fine, il coinvolgimento di tutti gli stakeholder nei processi di pianificazione seguendo un modello tipo Urban Living Lab dimostra una certa rilevanza per la transizione dei *wastescapes* verso uno sviluppo circolare e sostenibile e verso diversi tipi di crescita (Russo 2014). Il coinvolgimento degli stakeholder locali nei processi decisionali permette di aumentare la consapevolezza delle condizioni multi-rischio per una migliore gestione del territorio, per lo 'una diversa crescita' (Russo 2014) e per un uso cosciente delle risorse, al fine di accelerare l'implementazione della circolarità nella città contemporanea (REPAIR 2017; Gejer et al., 2021). In linea con le ricerche più recenti, i *wastescapes* non sono più letti come spazi residuali, bensì come dispositivi territoriali dall'alto potenziale di resilienza in grado di attivare cicli rigenerativi attraverso approcci interdisciplinari e multi-attore, supportati da strumenti anali-

tici avanzati e pratiche progettuali circolari.

I *wastescape*, da territori marginali spesso trascurati, divengono spazi fondamentali per la rigenerazione urbana, in un'ottica di resilienza e sostenibilità. I *wastescape* sono qui considerati come risorse latenti capaci di riattivare cicli metabolici urbani in una prospettiva circolare. In tale direzione, il framework metodologico sviluppato rappresenta uno strumento innovativo e multidimensionale per valutare il potenziale di resilienza nei contesti urbani multirischio.

Il framework sviluppato assume il duplice ruolo di strumento analitico e guida operativa, capace di integrare criteri spaziali, ambientali e sociali per la selezione di aree ad alto potenziale di resilienza e per la definizione di strategie di rigenerazione circolare nei contesti urbani multirischio.

La letteratura analizzata conferma l'urgenza di approcci integrati e adattivi, capaci di tenere insieme dimensioni ambientali, sociali, economiche e spaziali. La scala distrettuale, già adottata nel progetto RETURN, emerge come livello privilegiato per l'attuazione di strategie efficaci. Questa scala consente infatti una lettura più granulare del territorio, facilitando l'individuazione di hotspot d'intervento e la definizione di priorità operative. Inoltre, permette di riconoscere la presenza di capitale inespreso - materiale, naturale o sociale - che, se opportunamente valorizzato, può costituire il motore della trasformazione.

La metodologia GIS-MCDA si dimostra partico-

larmente efficace in quanto consente una valutazione combinata di dati quantitativi e qualitativi, facilitando il monitoraggio continuo e la comparazione tra scenari. La possibilità di articolare il processo valutativo in tre fasi – ex-ante, in-itinere ed ex-post – rafforza l'adattabilità del framework e ne estende l'applicabilità nel tempo. Questa struttura consente non solo di pianificare interventi mirati, ma anche di misurarne l'impatto e adattare le strategie in corso d'opera, garantendo un feedback costante alle politiche urbane.

L'approccio prevede momenti di valutazione partecipata condotti con il coinvolgimento diretto di amministrazioni locali, stakeholder territoriali, enti di ricerca e comunità, in linea con la logica dell'Urban Living Lab, già sperimentata nei task 5.4.4 e 5.5.2 del progetto.

Dal punto di vista operativo, la co-evaluation è supportata da strumenti di analisi spaziale e multicriteriale (GIS-MCDA), che permettono di visualizzare in modo trasparente gli esiti delle strategie di rigenerazione e di condividerli all'interno di tavoli di confronto multi-attore.

Tale struttura favorisce l'attivazione di meccanismi di governance adattiva, fondati sulla cooperazione inter-istituzionale e sulla negoziazione continua tra i diversi livelli di decisione (accademico, tecnico, politico, comunitario). In questa prospettiva, RETURN ha iniziato a costruire un quadro di governance sperimentale orientato alla co-progettazione e alla co-valutazione delle azioni, in grado di sostenere l'im-

plementazione del framework metodologico in contesti territoriali reali, come dimostrano le prime applicazioni nel caso di studio di Bagnoli.

Questo approccio multilivello consente di integrare la valutazione quantitativa (indicatori spaziali, ambientali e sociali) con quella qualitativa (percezioni, pratiche d'uso, forme di collaborazione), restituendo un processo circolare di conoscenza e decisione che alimenta nel tempo la capacità resiliente dei territori.

Il caso studio dell'area ex-Italsider di Bagnoli rappresenta un banco di prova emblematico. Qui, le criticità legate alla deindustrializzazione, alla contaminazione e all'abbandono sono al tempo stesso ostacoli e opportunità. L'applicazione del framework in questo contesto potrà contribuire a ri-orientare le strategie di rigenerazione, mettendo al centro non solo il recupero fisico dell'area, ma anche la valorizzazione del capitale umano e delle risorse ecologiche latenti. Questo studio assume la condizione di deindustrializzazione (perdita di funzioni e presenza di paesaggi inquinati e abbandonati) come punto di partenza per investigare tre dimensioni in cui rileggere il potenziale di resilienza del luogo analizzato:

- a livello sociale, le aspettative della comunità e il fenomeno di *dispossession* associato a un abbandono prolungato;
- a livello economico, l'effetto sul mercato immobiliare e le aspettative degli sviluppatori (anche in rapporto con gli strumenti normativi e di pianificazione);

- a livello ambientale, la presenza di risorse ecologiche latenti.

L'approccio finale del progetto potrebbe legare le geografie umane e non umane all'interno di una geografia unica più-che-umana (Franklin, 2017), intesa come prospettiva di messa in relazione e non escludente.

Infine, la proposta di adottare una "geografia più-che-umana" nel caso di studio di Bagnoli (RETURN 2025a) e in generale nei *wastescapes* dal grande potenziale di resilienza, che tenga insieme elementi naturali e culturali in una visione relazionale e inclusiva, rappresenta un'apertura verso futuri sviluppi teorici. Essa suggerisce la possibilità di superare la visione antropocentrica nella pianificazione urbana, riconoscendo l'interdipendenza tra ambiente, società e infrastrutture. In questo quadro, i *wastescapes* possono davvero diventare laboratori di innovazione spaziale, sociale e ambientale, orientati verso città più resilienti, giuste e sostenibili.

### Attribuzioni

Tutte le parti di questo articolo sono state scritte e approvate da tutti gli autori - Libera Amenta, Anna Attademo, Martina Bosone, Pasquale De Toro, Michelangelo Russo. Tutti gli autori hanno letto e accettato la versione corrente del manoscritto. La Sezione 1.1 è stata scritta da tutti gli autori; la sezione 1.2 da Libera Amenta, Anna Attademo, Michelangelo Russo; la Sezione 2 e le Discussioni sono state scritte da tutti gli autori; la sezione 2.1 da Martina Bosone e Pasquale De Toro, la sezione 2.2 da Anna Attademo; la sezione 3.1 da Martina Bosone e Pasquale De Toro, la sezione 3.2 da Libera Amenta e Anna Attademo.

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## Note

<sup>1</sup> Il concetto di wastescape è stato introdotto per la prima volta nella ricerca Horizon 2020 REPAiR (Amenta, Attademo, 2026; REPAiR 2018; Amenta, van Timmeren 2018, 2022) per individuare i paesaggi spazi aperti, edifici e infrastrutture sottoposti a processi di degrado e/o abbandono e attraversati dai flussi metabolici di rifiuti intesi come risorse. La definizione è stata elaborata a partire dalla definizione di drosscape (Berger, 2006) riadattata al contesto europeo con un approfondimento in sei casi di studio in Olanda, Italia, Belgio, Germania, Polonia e Ungheria.

<sup>2</sup> Il paper è relativo alla ricerca condotta all'interno del partenariato esteso RETURN, (Multi-risk science for resilient communities under a changing climate), con particolare riferimento allo spoke TS1 "Urban and metropolitan settlements", Task 5.5.2 - City-scale exercise for risk scenarios evaluation e Task 5.4.4. Towards a circular metabolism for urban and metropolitan settlements.

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## Allegato A

Metodi di valutazione e indicatori del potenziale di resilienza nei paesaggi di scarto dedotti dalla letteratura

Critero	Tipologia	Descrizione sintetica	Principali riferimenti bibliografici
<b>GEOGRAFIA GENERALE</b>			
Accessibilità multimodale	Quantitativo	Densità e continuità delle reti di mobilità; distanza da nodi di trasporto sostenibile.	Lindfors 2021; Fotheringham & Rogerson 2009; Capolongo et al. 2020
Uso e copertura del suolo	Quantitativo	Percentuale di superficie impermeabilizzata e rapporto spazi aperti/spazi edificati.	Hoover et al. 2021; Rocha, Pak & Piccardo 2024; Marzani & Tondelli 2024
Vincoli paesaggistici e ambientali	Qualitativo	Presenza di aree tutelate, corridoi paesaggistici o aree di valore ecologico.	Davoudi 2012; Girardet 2010; REPAIR 2018
Capacità di trasformazione normativa	Performance-based	Grado di flessibilità degli strumenti urbanistici e delle politiche locali.	De Toro 2013; Russo 2018; RETURN 2025
<b>GEOGRAFIA FISICA NON-UMANA</b>			
Biodiversità e naturalità residua	Quantitativo	Indice di presenza e varietà di habitat naturali o semi-naturali nei wastescape.	Perrelet et al. 2024; Grootjans et al. 2012; Hoover et al. 2021
Connettività ecologica	Quantitativo	Continuità delle reti ecologiche e integrazione con infrastrutture verdi/blu.	Faivre et al. 2018; Liao et al. 2023; REPAIR 2018
Contaminazione ambientale	Quantitativo	Presenza e gravità di siti inquinati o aree SIN/SIR.	RETURN 2025; Piccirillo et al. 2024
Rinaturalizzazione spontanea	Qualitativo	Evidenza di processi ecologici auto-organizzati in aree dismesse.	Attademo 2022; Amenta & van Timmeren 2018
Capacità ecosistemica rigenerativa	Performance-based	Potenziale del sistema ecologico di ridurre vulnerabilità e ristabilire funzioni.	Ahern 2011; Chelleri 2015; Gejer & Gomes 2021
<b>GEOGRAFIA UMANA</b>			
Densità insediativa e mix funzionale	Quantitativo	Rapporto tra edificato, abitanti e diversificazione d'uso.	Nocca, De Toro & Voysekhovska 2021; Lindfors 2021
Capitale sociale e partecipazione	Qualitativo	Livello di coinvolgimento comunitario nei processi di rigenerazione.	Souza et al. 2021; Steen & van Bueren 2017; RETURN 2025

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Valore d'uso percepito dei wastescape	Qualitativo	Percezione del valore sociale, ambientale e simbolico dei luoghi.	Ingrassia et al. 2023; Surya et al. 2020
Governance multilivello	Performance-based	Coordinamento e collaborazione tra enti, ricercatori e cittadini.	Fusco Girard & De Toro 2010; Russo 2023; RETURN 2025
Resilienza economica locale	Performance-based	Capacità di attrarre funzioni e attività economiche diversificate.	González-Sánchez et al. 2023; Marzuki et al. 2023

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## Allegato B

Framework teorico-metodologico per l'individuazione delle aree di intervento per processi di trasformazione e recupero dei wastescape

Critério	Tipologia	Dimensione di sostenibilità	Indicatore / Misura	Fonte o tecnologia
<b>GEOGRAFIA GENERALE</b>				
Sostenibilità tecnico-finanziaria del settore pubblico	Quantitativo	Economica	Mq di spazi di proprietà pubblica	Catsto, strumenti urbanistici
Adattamento e gestione di ambienti multi-rischio	Performance-based	Sociale / Economica	N. di progetti o aree destinate alla gestione resiliente	Strumenti urbanistici, piani di protezione civile
<b>GEOGRAFIA FISICA NON-UMANA</b>				
Qualità del sistema naturale e paesaggistico	Quantitativo	Ambientale	Mq di aree permeabili, agricole o silvicole	CORINE Land Cover, ISPRA, Piani di gestione rischio alluvioni
Connettività ecologica e infrastrutture verdi/blu	Performance-based	Ambientale	Percentuale di aree verdi e corpi idrici; prossimità a corridoi ecologici	Rete Natura 2000, Carta della Natura 2018
Qualità della vita per le specie	Quantitativo / Qualitativo	Ambientale	Indice NDVI, diversità vegetale, presenza di specie autoctone	Dati satellitari, ARPA regionali
<b>GEOGRAFIA UMANA</b>				
Città compatta	Quantitativo	Ambientale	Rapporto superficie edificata/ superficie territoriale	Dati censuari, DM 1444/68
Accessibilità dello spazio pubblico	Quantitativo	Sociale	Distanza media (m) da nodi di trasporto e servizi	Piani della mobilità, GIS
Cooperazione multi-attore	Qualitativo	Sociale / Culturale	N. di partnership attivate, dispositivi normativi abilitanti	Osservazione diretta, survey RETURN
Coesione e inclusione sociale	Qualitativo	Sociale / Culturale	N. di enti del Terzo Settore, usi temporanei, campagne di sensibilizzazione	Osservazione diretta, indagini RETURN

Sostenibilità delle risorse umane	Performance-based	Sociale / Economica	N. di progetti di formazione, livello di partecipazione degli stakeholder	Osservazione diretta, documenti RETURN
Efficienza delle risorse	Quantitativo / Performance-based	Economica / Ambientale	Quantità di energia e acqua autoprodotte, progetti di riuso funzionale	Strumenti urbanistici, rilievi RETURN
Progetti non-estrattivi e metabolismo circolare	Performance-based	Economica / Ambientale	N. di progetti di riuso, prossimità a impianti di materia prima seconda o flussi organici	GIS, osservazione diretta

# The temporal dimension in climate adaptation and mitigation strategies and solutions aimed to increase urban integrated resilience

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### keywords

climate resilience  
disaster risk management  
temporal dimension  
climate-resilient design

*Climate change poses critical challenges to urban and metropolitan settlements' resilience, increasing their vulnerability and exposure to extreme events. The article proposes a conceptual and operational framework that integrates the assessment of climate-resilient strategies and solutions into the four phases of disaster risk management (DRM) cycle: preparedness, absorption, response/recovery, long-term adaptation. Emphasizing the temporal dimension of resilience,*

### Thematic framework

Climate change is one of the most urgent and complex challenges facing contemporary societies, with significant impacts at the global, regional, and local levels. Impacts such as rising average temperatures, changes in precipitation patterns, sea level rise, intensification of extreme events are not isolated events but act as “amplifiers” and multipliers of risk impacting on natural and anthropic habitats (IPCC, 2022b). In this scenario, urban and metropolitan areas assume strategic significance, as they are both particularly vulnerable to climate impacts and, at the same time, respon-

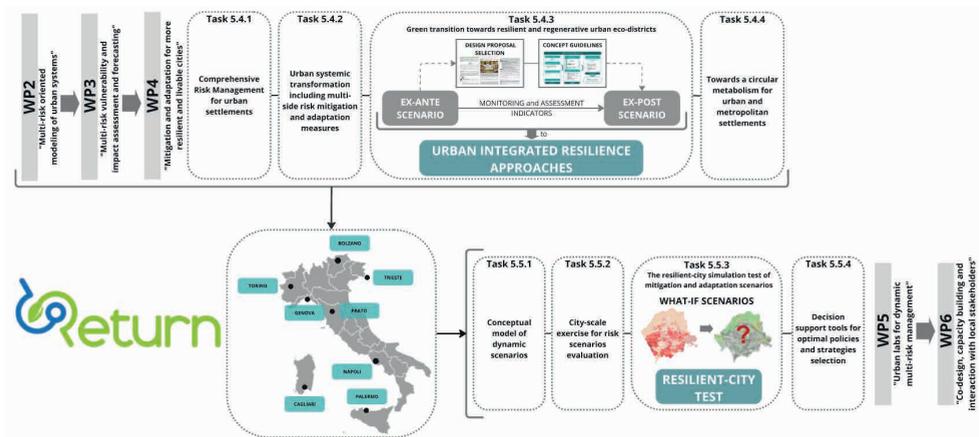
sible for a significant part of human pressures that contribute to climate change. Settlements are in fact characterised by high population density, intense anthropisation processes, complex socio-technical systems, factors that amplify exposure to risks (UN-Habitat, 2022).

The growing complexity of climate risks, which are often interconnected, highlights the ineffectiveness of sectoral, linear design and

*the study highlights the need for dynamic, multi-scalar and systemic design approaches that enhance urban capacity to anticipate, withstand and recover from climate-related impacts, also considering the long-term perspective. The framework aims to support decision-making processes for the development of climate adaptation and mitigation measures within the DRM phases, providing a basis for resilient and sustainable design of urban settlements.*

management approaches, requiring systemic and integrated models capable of managing the complexity of urban settlements and the interactions between environmental, social, technological, and economic dimensions. Within the scientific debate, the concept of urban climate resilience is a central concept for the definition and the implementation of risk reduction design measures. According to the IPCC's AR6 report, resilience represents "the capacity of interconnected social, economic, and ecological systems to cope with a hazardous event, trend, or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure" (IPCC, 2022a, p. 2929). However, in urban areas, scientific literature shows that climate resilience is treated in a fragmented approach and still presents several critical issues linked to the

lack of systems for its implementation and assessment, due to the diffusion of sectoral and one-dimensional operational approaches that are unable to adequately consider the systemic and interconnected nature of urban challenges (Sharifi et al., 2020; Heinzlef, et al., 2022). Furthermore, there is a lack of attention to the temporal dimension of design processes in relation to critical event phases. In most applications, resilience is considered primarily in spatial and physical terms, while the time and temporality of actions are rarely assessed or discussed (Chelleri et al., 2015; de Herve, 2024). According to the scientific literature, the temporal dimension play a central role, as it allows measures concerning the different phases of the risk management cycle to be implemented and ensures their effectiveness not only in the short term but also in the medium/long term, in a context characterised by uncertainty and increasing complexity (Barroca & Serre 2013; Fisher et al., 2019; Alexander, 2021). Limited attention in literature to these aspects highlights research perspectives, since resilience objectives should not be limited to the ability to respond to impacts but should extend to the construction of urban, environmental, and social systems capable of addressing the entire disaster management cycle, integrating preventive measures, adaptive capacities, and regenerative processes in long-term scenarios. Design innovation therefore lies in the ability to integrate the temporal dimension into the



definition of resilient design measures. Adaptation, mitigation, and risk reduction actions must be evaluated not only in terms of their immediate effectiveness but also in terms of their sustainability and robustness through time. This implies the need to use conceptual models and operational frameworks to associate design solutions with the phases of the risk management cycle.

The research, developed as part of the Extended Partnership RETURN project and in particular as part of the activities of the Spoke TS1 - Urban and Metropolitan Settlements, is set within the international debate on the convergence between Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) approaches, proposing a conceptual and operational framework based on the centrality of the temporal dimension in climate risk adaptation, mitigation, and reduction strategies and solutions integrating the temporal dimensions of Disaster Risk Management (DRM) in an urban integrated resilience perspective. The concept of urban integrated resilience is, in fact, can be declined as the ability of the settlement, or parts of it, to cope with and adapt to potential stresses, disruptions and

crises, ensure the core functionalities effectiveness, preserve and promote the wellbeing of communities, and foster the integration of resource management, security, risk assessment and active participation of local communities into urban planning and design. The activities are developed within the context of Task 5.4.3 “Green transition toward resilient and regenerative urban eco-districts” (Fig. 1), and concern the proposal of a conceptual and operative framework to integrate the temporal dimension articulated in the four phases of the disaster management cycle - preparation, absorption, response/recovery, and adaptation - into the climate-resilient design strategies and solutions.

### The evolution of the concept of Disaster Risk Management

The growing impacts of climate change, the increase in the frequency and intensity of extreme weather events have gradually highlighted the need to reconsider risk management models, traditionally focused on emergency and reactive phases, towards more integrated and proactive approaches aimed not only at immediate response but also at

## Research framework. The Extended Partnership RETURN and the activities of the Spoke TS1 – Urban and Metropolitan Settlements.

Source: Elaboration by the authors.

Fig. 1

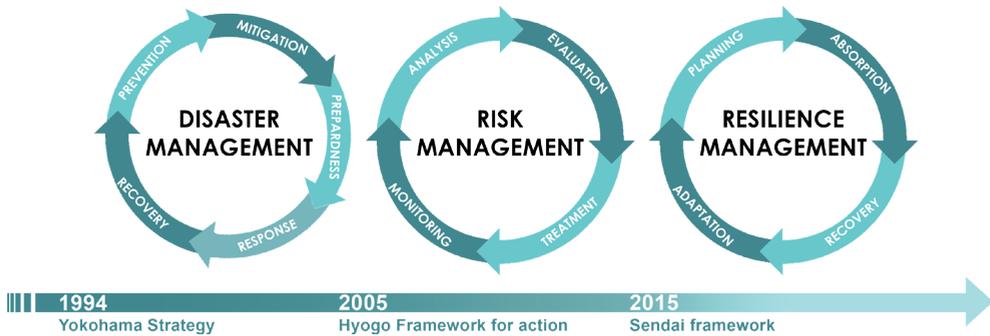
prevention, adaptation, mitigation of exposed systems (Goklany, 2007; Tucci, 2021b), promoting a systemic vision of urban resilience. In this context, resilient strategies and solutions acquire a central role, as they combine urban requalification with environmental risk reduction and sustainable resource management, defining a systemic approach that integrates physical, technological, social, and environmental components.

Climate resilience thus becomes a key element of urban design through the combination of Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) approaches. DRR is defined in the scientific literature as the set of policies, strategies, and practices aimed at reducing vulnerabilities and risks related to disasters, preventing the development of new risks, and reducing existing ones, with the aim of increasing the resilience of settlements and communities (Twigg, 2015; IPCC, 2022c; UNDRR, 2022). CCA is intended as a process of adapting natural, social, economic systems to climate change and its impacts, with the aim of reducing vulnerability and increasing the adaptive capacity of urban systems (IPCC, 2022b). In recent decades there has been a gradual convergence between DRR and CCA approaches, recognising the need to set up climate and environmental risk management processes based on systemic, integrated, and resilient approaches (Mitchell & van Aalst, 2008; Dias et al., 2018; Zuccaro & Leone, 2018;

Wen et al., 2023).

Within this scenario, Disaster Risk Management (DRM) has emerged as a dynamic risk management system that includes prevention (DRR), adaptation (CCA), response and recovery from impacts in a circular perspective aimed at building resilience. Resilience, in this context, is understood as the ability of impacted systems to anticipate, absorb, adapt, and transform in response to critical events, maintaining essential functions and developing the ability to learn from perturbations (Linkov et al., 2014; Barroca, 2018). DRM therefore involves the implementation of policies and strategies aimed at preventing new risks, reducing existing hazards and managing residual risks, thereby contributing to strengthening resilience and reducing impacts in a long-term perspective, configuring as a continuous and synergistic process (Toseroni, 2017; UNDRR, 2022).

The relevant scientific and technical literature, both at European and national level, highlights how resilience must be integrated into urban risk management strategies, acting on multiple levels – physical, environmental, social, and institutional – and focusing not only on the prevention of human losses but also on the sustainability of interventions from a socio-cultural, environmental, and economic perspective (D'Alençon et al., 2021). In this context, urban and environmental-technological design becomes the main tool for imple-



## Evolution and comparison between Disaster Management, Risk Management, and Resilience Management and the policy frameworks.

Source: Authors elaboration starting from: Wen, J., et al (2023).  
Fig. 2

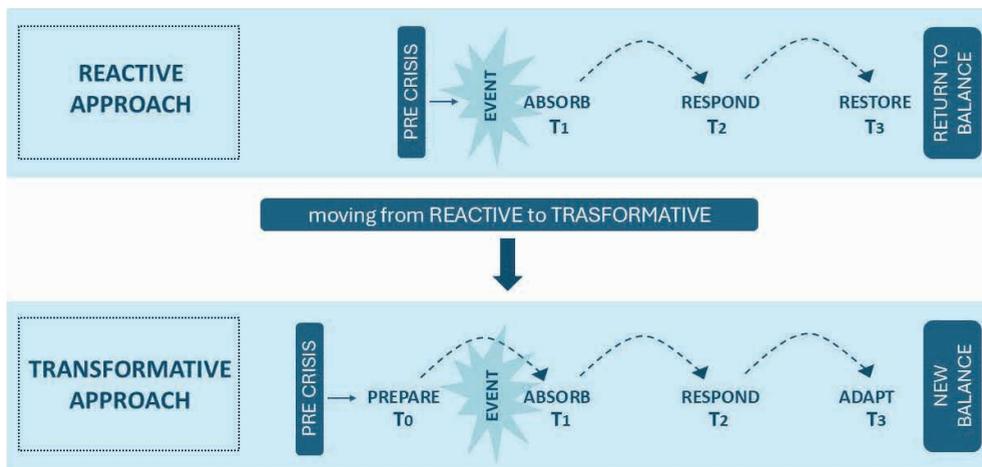
menting DRM-oriented strategies, facilitating the synthesis of the various dimensions of risk into operational and integrated design solutions.

DRM becomes part of a paradigm shift that has affected emergency management in recent decades, undergoing a significant evolution both in concept and in practice, in parallel with the evolution in how the scientific and political communities have addressed risks and disasters management. This process can be attributed to three key moments, linked to the first three World Conferences on Disaster Reduction, which resulted in three strategic action documents: the 1994 Yokohama Strategy, the 2005 Hyogo Framework for Action, and the 2015 Sendai Framework (Stanganelli, 2008; Mal et al., 2018; Rajabi et al., 2022; Graveline, 2022; Wen et al., 2023) (Fig. 2):

1. Disaster Management (DM) - 1990s - an international debate emerged that focused

mainly on DM, understood as the management of emergencies and post-event phases, where the approach was reactive and attention was concentrated on preparedness and immediate response to disasters. This period coincided with the first World Congress on Disaster Reduction, held in Yokohama in 1994, which represented the first moment of global awareness of the need to initiate disaster management processes worldwide, establishing the foundations for a more coordinated disaster management system while maintaining an event-centered approach;

2. Risk Management (RM) - 2000s - the focus shifted to risk management: with the Hyogo Framework for Action 2005-2016, 168 countries gathered in Hyogo for the second world conference on disaster reduction, drawing up an action document that stated the importance of moving beyond an emer-



### Shift from reactive to transformative approach.

Source: Elaboration by the authors.  
Fig. 3

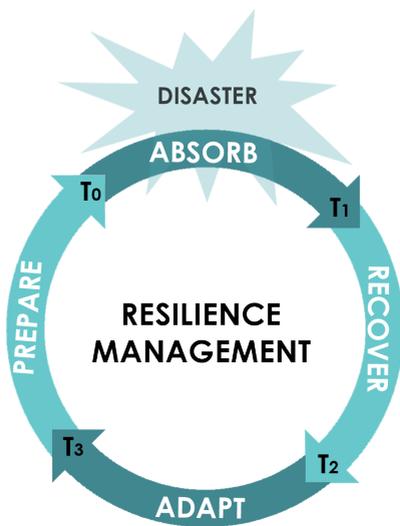
gency-based approach and recognizing the importance of prevention and reduction of existing risks, which became the most important phases compared to the response phase;

3. Resilience Management (RM) – since 2010 – has consolidated a further new paradigm shift: the integration of the concept of resilience into DRM. In 2011, the third World Conference on Disaster Reduction was held to formalise a new global framework for the development of resilient communities and countries, resulting in the Sendai Framework for Disaster Risk Reduction (2015–2030), a globally recognised strategic document. In this perspective, risk management is no longer limited to reducing vulnerabilities and preventing disasters but includes the ability of systems to adapt, transform, and learn over time.

This conceptual transition reflects a paradigm

shift from a reactive to a transformative, proactive and integrated approach (Fig.3), in which urban risk management considers the entire cycle of critical events and emphasizes preparedness and resilience. In this perspective, the convergence between DRR and CCA within DRM allows the implementation of design measures that reduce vulnerability, increase adaptive capacity, and promote an ecological and sustainable transition of urban and metropolitan settlements (McCormick et al., 2013).

The integration of the temporal dimension within DRM therefore enables a more accurate assessment of the effectiveness of design measures for climate mitigation and adaptation throughout the entire risk management cycle, promoting the construction of resilient urban settlements capable of responding effectively to climate impacts and maintaining essential functions and services in the short,



T <sub>0</sub>	Prepare	prevention and preparedness strategies and solutions
T <sub>1</sub>	Absorb	ability of a system to withstand damage while maintaining its performance unchanged
T <sub>2</sub>	Recover	emergency and rapid response actions aimed at minimizing damage and restoring essential services
T <sub>3</sub>	Adapt	system's ability to recover lost functions by re-establishing a state of equilibrium

medium, and long term perspectives.

### Climate adaptation and mitigation measures towards a resilient perspective

The growing complexity of climate risks in urban and metropolitan settlements requires the definition and adoption of strategies and solutions to ensure resilience, sustainability, and adaptability in the medium to long term. In climate change scenarios, climate proof strategies represent an integrated approach aimed not only at reducing the direct environmental impacts of climate phenomena, but also at mitigating the indirect consequences on urban ecosystems and local communities, based on a principle of multi-level and multi-scale integration that aims at actions that not only reduce the immediate impacts of disasters, but also determine the conditions for a sustainable and regenerative evolution of urban settlements.

The impacts on exposed elements and the vulnerabilities of systems are characterised as site-specific and hazard-specific factors. Therefore, design solutions and their effective-

ness assessment must be aimed at defining methodologies, procedures, and operational tools designed to guide interventions, taking into account the complexity of urban settlements and the environmental and socio-economic consequences of interventions (Losaso, 2017; Tucci, 2021a), through *downscaling* and *upscaling* approaches (Musco et al., 2016). Urban resilience, understood as the ability to absorb, adapt and transform facing multiple disruptions, must therefore be interpreted in relation to a climate-resilient perspective that requires efficient strategies and design solutions that even consider future scenarios by uncertainty and complexity, combining actions aimed at climate adaptation, mitigation and risk reduction (D'Ambrosio et al., 2023b). Climate-resilient strategies and solutions are more effective if integrated into a dynamic decision-making framework that combines the temporal dimension of DRM. In this perspective, the temporal variable assumes a crucial role: if risk is defined by the dynamic interaction between hazard, exposure, vulnerability, adaptation and mitigation strategies must

## The resilient disaster management cycle.

Source: Elaboration starting from: Linkov et al. (2014) e Wen, J., et al (2023).

Fig. 4

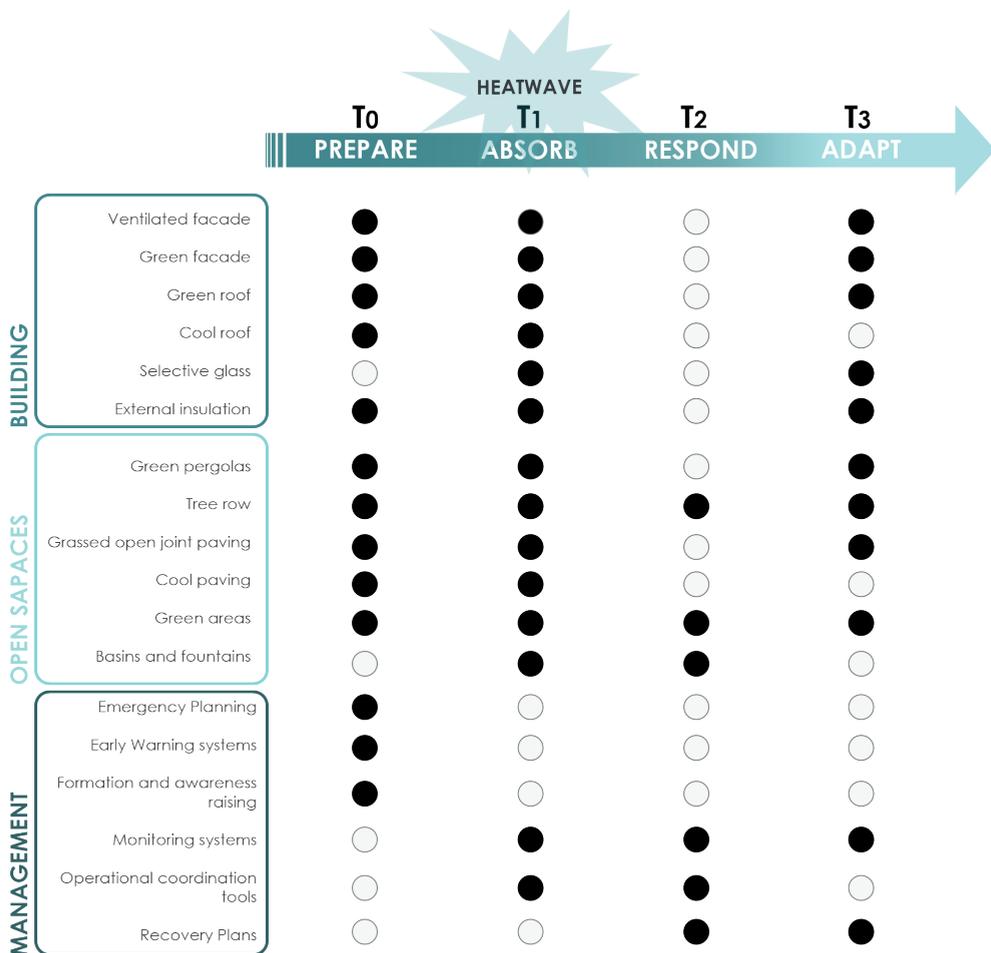
necessarily consider the temporal dimension, understood not only as the urgency of action but also as the articulation of risk management phases and cycles (Cardona, 2013), going “behind the barriers” spatial and temporal of the events (Barroca & Serre, 2013).

The implementation of resilient climate proof actions requires effective strategies and actions across the different temporal and spatial scales of critical events (Serre et al., 2012; Sawalha, 2020). In this perspective, the temporal dimension becomes an essential driver in urban and building-scale projects, to make the recovery phase more efficient and sustainable, in order to understand the most efficient and effective measures in the prevention and mitigation phases of impactful phenomena from a resilient perspective with reference to natural environmental, natural, or anthropogenic hazards (Linkov et al., 2019). This allows us to distinguish between rapid response design actions, medium-term interventions and long-term transformation strategies, avoiding the risk of maladaptation (Magnan et al., 2016) and ensuring the ability of urban communities to maintain their adaptive capacity over time.

The integration of resilience into conceptual and operational approaches to disaster management must therefore be characterised by systemic and integrated approaches in order to enable urban settlements to anticipate, resist and recover from critical events. In order to understand and analyse the effectiveness of

climate proof design measures from a climate resilience perspective, it is therefore necessary to adopt a model that takes into account the temporal dimension of risk and the capacity of urban systems to respond, adapt, and transform according to the temporal evolution of critical events. In the scientific literature several studies, such as Barroca & Serre (2013), Linkov et al. (2014), and Wen et al. (2023), highlight the need for a change in the design paradigm, moving from linear and reactive approaches to dynamic and cyclical approaches that allow the integration of prevention, response, adaptation to potential impacts within a perspective of integrated urban resilience. In this scenario, a conceptual and operational framework is proposed to integrate the temporal dimension into the climate-resilient design of strategies and solutions. The framework is structured in four phases (Fig. 4):

- time  $T_0$  (before the impact event occurs): corresponds to the prepare phase and includes all prevention and preparation strategies and solutions, identifying the role of the adopted measures also in a long-term perspective;
- time  $T_1$  (during the impact event): corresponds to the absorb phase, which identifies a system's ability to withstand damage while maintaining its performance unchanged or partially operational, without limiting the entire capacity of the system;
- time  $T_2$  (immediately after the impact



event): corresponds to the recover/respond phase in which the system's recovery and response capabilities are identified, with emergency and rapid response actions aimed at minimising damage and restoring essential services;

- time T<sub>3</sub> (following the impact event): corresponds to the medium- to long-term adaptation phase and represents the system's ability to recover lost functions by re-establishing a state of equilibrium, transforming itself in order to maintain its ability to adapt in the long-term perspective.

Linking climate proof strategies and solutions

to the risk management cycle means that they cannot be reduced to a single phase but must constitute an integrated and cyclical approach in which each action is closely linked to the previous and subsequent ones, with a view to a multi-temporal and multi-scale approach that allows the design of effective climate-resilient interventions in the short, medium, and long-term scenarios.

### Climate-resilient strategies and solutions to heatwaves

Climate-resilient strategies and solutions are effective when integrated into a dynamic de-

## Examples of strategies, solutions and their effectiveness in relation to the four phases of risk management.

Source: Elaboration by the authors.

Fig. 5

cision-making framework that combines the temporal dimension of DRM with design and technological solutions, allowing for continuous assessment of the impact of interventions through verification using metrics, parameters, and indicators, review of operational priorities and adaptation of urban policies in response to climate change. Adopting this approach is key to building resilient urban settlements that can ensure quality of life, sustainability and safety.

Among the critical events that are becoming increasingly significant on a national and European scale, heatwaves are one of the most impactful phenomena, with particularly significant effects especially in densely urbanised contexts characterised by high population density and intensive anthropisation, that are vulnerable to extreme temperature changes (Spano et al., 2020; Naheed & Eslamian, 2022). In recent decades, international studies have highlighted a significant increase in the frequency, duration, and intensity of such events, with direct consequences for public health, energy consumption and urban functionality. Managing these phenomena requires the implementation of specific climate-resilient strategies and solutions that are capable, on one hand, of combining prevention, mitigation, and adaptation, in line with the principles of DRM and urban resilience; and, on the other hand, of operating on multiple levels through a multi-scalar perspective (Tersigni & Leone,

2018) that considers functional, technical, environmental, and social critical factors, also taking into account local communities (Boeri, 2020).

In this scenario, the technological and environmental design of public spaces plays a crucial role in increasing urban resilience, capable of relating to the various phases of managing impactful events, such as prediction/prevention, adaptation to impacts, reduction of vulnerabilities, and planning measures for long-term risk mitigation (Coaffee, 2008; Losasso, 2018; D'Ambrosio et al., 2023a).

In reference to the conceptual and operational framework proposed for the analysis of climate-resilient design strategies and solutions from a resilience perspective, an example is developed, analysing the main strategies and solutions aimed at countering the impacts of heatwaves in relation to the four temporal phases of hazard occurrence (Fig. 5).

At Time  $T_0$ , before the critical event occurs, all preventive and mitigation measures are focused on improving the physical characteristics of buildings, urban spaces and the preparedness of communities. For example, interventions on the building envelope are based on the use of innovative techniques and materials with high thermal capacity, solar shading, reflective paints, which contribute to increasing comfort conditions by acting on transmittance and phase shift indicators. These measures are also effective in the medium to long term,

limiting the need for cooling and the associated energy consumption, reducing emissions of climate-changing agents, thus mitigating the causes of rising temperatures. Phase  $T_0$  also includes the development of monitoring and early warning systems for extreme events, enabling proactive risk management, all population training and education activities.

Time  $T_1$  refers to all actions capable of absorbing climate impacts during a heatwave event, corresponding to the immediate response during the event; all emergency measures aimed at protecting vulnerable groups and immediately reducing the impact are included. This refers to temporary, reversible, rapidly implementable operational strategies that are flexible and adaptive, including the distribution of essential resources and the activation of mobile urban cooling systems, accompanied by communication and alert actions capable of quickly reaching individuals most at risk. The measures already planned will also contribute to this phase, such as green infrastructure and nature-based solutions, including extensive tree planting, green walls and roofs, and shading systems. These solutions, integrated with existing urban infrastructure, play in fact a crucial role in improving urban microclimate, also mitigating thermal stress on inhabitants. In Time  $T_2$ , i.e., the period immediately after the heat peak, in addition to the structural measures already planned in phases  $T_1$  and  $T_2$ , the efficiency of urban management becomes

crucial in terms of the coordination capacity between local authorities, health services, public infrastructure, communities, highlighting the role that social and organisational factors cover in urban resilience.

Finally, at Time  $T_3$ , after the event, the adaptation phase aims to consolidate the resilience of the urban system through the integration of permanent and structural solutions. An example is the implementation of climate shelters, physical and social urban infrastructures essential for supporting adaptation to extreme weather conditions by offering safe and temperate spaces, both indoors and outdoors ensuring the prospect of adaptation even in the long-term perspective (Amorim-Maia et al., 2023).

The implementation of strategies and solutions within an integrated framework guarantees the effectiveness of projects aimed at reducing the impact of heatwaves in urban areas. Once the interventions have been identified, their effectiveness in relation to the temporal phases must then be verified through the use of specific performance indices and indicators such as the LST (Land Surface Temperature) reduction, the UTCI (Universal Thermal Climate Index), or the NDVI (Normalized Difference Vegetation Index) to monitor the quantity and health of green vegetation. These tools enable dynamic and continuous monitoring, which is essential for proactive adaptation in order to design effective interventions in a cli-

mate-resilient perspective, combining safety, well-being, and environmental sustainability, integrating physical, ecological, and social dimensions and enhancing the temporal dimension in the risk management cycle.

### **Conclusions and research perspectives**

Urban settlements resilience requires the introduction of conceptual and operational approaches aimed at implementing systemic, integrated design strategies and solutions that combine adaptation, mitigation, and risk reduction. The proposed conceptual framework emphasises the temporal dimension of risk management, highlighting how it is a critical variable for assessing the effectiveness in climate-resilient design and highlighting the need for measures that are effective not only in the immediate term but also in the medium and long term perspective.

The innovation in defining these strategies and solutions lies in their ability to act proactively, anticipating and mitigating risks, enabling urban systems to respond resiliently during potential climate events, maintaining their adaptive capacity in the long-term perspective. Considering the risk management four-stage cyclical process – preparation, absorption, recovery/response, adaptation – the assessment of design strategies and solutions in relation to the temporal dimension is a critical issue for understanding the evolution of the system's response capacity and adapt-

ability over time, allowing the management of the complexity of design alternatives, through proactive approaches.

The framework proposal highlights how urban resilience cannot be conceived exclusively as a static characteristic of settlements and must be treated as a dynamic and cyclical process that integrates knowledge, design tools, governance capabilities. Consequently, resilient design strategies and solutions must be evaluated in relation to their effectiveness in reducing the exposure and vulnerability of exposed elements, considering future risk scenarios and possible climate developments. This approach enables not only an effective response to extreme events but also increases the adaptive capacity of urban systems, promoting the transition to more sustainable and resilient cities. Furthermore, the temporal perspective makes it possible to overcome the dichotomy between prevention and response, integrating short-term interventions with long-term strategies and transforming urban resilience from a theoretical concept into an operational criterion for urban design.

The framework represents a conceptual and practical basis for future applications. The possible developments of this approach lie in the construction of a design decision support catalogue that identifies the contribution of strategies and technical solutions to increasing resilience regarding the four temporal dimensions of risk management and the related

indicators/indices for verifying effectiveness, with the aim of testing to validate the proposed approach.

### Acknowledgements and Attributions

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In terms of the unity of the contribution to the concept, methodological approach and research activities, the paragraphs 'Thematic framework', 'Climate adaptation and mitigation measures towards a resilient perspective' and 'Conclusions and research perspectives' are attributable to Maria Fabrizia Clemente, while the paragraphs 'The evolution of the concept of Disaster Risk Management (DRM)' and 'Climate-resilient strategies and solutions to heatwaves' are attributed to Sabrina Puzone.

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# Teaching methods for sustainable urban and territorial design: the case study of the Prato Ready Laboratories

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*Designing is a complex, personal, creative, and open-ended process of exploring and deciding, often seen as implicit (Schön, 1985). In teaching urbanism, we frequently need to make this process explicit and transferable. To do so, this paper uses a conceptual framework based on Elise van Dooren's model (2013, 2020), which identifies five key elements: (1) experimenting/ exploring and deciding, (2) guiding theme or qualities, (3) domains, (4) frame of reference, and (5) laboratory or (visual) language. This paper evaluates*

## 1. Critical design approach in urban planning

The ontology of the project historically stems from our dissatisfaction with the current state of reality regarding our basic needs and prospects. In other words, design exists because the world around us does not satisfy us (Gero, 1990, 27), and this leads us to create artefacts to supply our needs or expectations. This makes design an activity – decisional, exploratory, learning-focused and goal-oriented – based on the hope that the world is perfectible (Bloch, 1959) and therefore in need of being transformed through design.

Since the 1960s, research on design theory and process has made significant progress in our understanding of design thinking. During the modern movement, design thinking was mainly understood in technical-rationalist terms: it was seen as the search for the optimal solution to a problem, based on a complete set of data and parameters (Rowe, 1987, 49). The process was conceived as a linear sequence, beginning with problem analysis and followed by synthesis, eval-

*the application of this framework in the Prato Ready Laboratories, a multidisciplinary program at the University of Florence (2024/25), involving nearly 150 students from four design labs in Architecture and Planning master courses. The program focuses on sustainable urban and territorial design, addressing climate change, disaster response, and energy resource challenges. Through comparative analysis, it aims to make explicit the teaching methodologies for resilient urban design in multi-hazard environments.*

uation, and the selection of the best design solution (Asimov, 1962, 42–46).

This positivist view of the design process, however, immediately clashed with the highly subjective nature of some of the steps that characterise the process itself, such as the definition of the problem and its objectives or the constraints that characterise its development, which are often linked to the specific context, the client's perception or the designer's sensitivity (Gero, 1990); steps that make the process difficult to model and abstract in a general theory.

Moreover, contemporary design, and in particular urban planning, is increasingly called upon to deal with problems characterised by

high levels of complexity, uncertainty, multiple actors involved and the absence of unambiguous solutions. In the literature, these conditions refer to the so-called “wicked problems”, a concept introduced by Rittel and Webber (1973) in “Dilemmas in a General Theory of Planning” to describe problems that are difficult or impossible to solve because the requirements underlying their solution are contradictory, incomplete and constantly changing. Migration, energy transition or climate change are often included in this category of problems.

According to Rittel and Webber (1973), urban planning constantly faces wicked problems, as planning involves diverse interests, clashes with structural uncertainties and generates effects that are often not immediately visible. Traditional problem-solving methods, based on deterministic scientific models, have proven insufficient in these contexts.

For these reasons, the evolution of studies and research related to the design process and the methodologies connected to it have often had to be commensurate with the intimate dialectical nature of the project, in the constant search for a mediation between a technical-scientific intelligentsia and a plethora of assumptions that are, by their very nature, arbitrary (Maldonado, 1970, 57). All design-related sciences are strongly characterised by this irremediable dialectical nature in which even the most refined techniques of system analysis or problem solving cannot make them-

selves perfectly neutral to arbitrary choices and contingency.

Precisely based on the imperfect nature of the design process, the second half of the 20th century saw numerous studies on different models and cognitive processes, with an attempt to interpret the linearity of technical-rationalist models in various ways.

Concerning the different approaches developed towards the design problem, in his famous *Design Methods* (1992 [1970]), Jones identified three main models, classifying the process leading to design as a black box, a glass box and a self-organising system, according to the different ways in which the relationship between analysis, synthesis, evaluation and decision is articulated.

In the first model, design is understood as a subconscious activity in which creativity is fuelled by intuition and sudden moments of rupture. This makes a rational explanation of 'what happens inside' the black box (Jones, 1992, 46), the designer's mind, impossible.

The second approach, in line with what has been described concerning the technical-rational model (Asimov, 1962, 42-46), is based on the positivist premise of design as a rational solution to problems, inevitably supported by the flow of information from the outside world, in which the process proceeds according to a rational and linear sequence.

The third way described by Jones (1992 [1970]), that of Self-organising Systems (SOS), envisages a flexible cognitive structure in which the design process is seen as a self-reflective activity that responds to the actions of the

designers themselves. Consequently, the designer can control the design process by monitoring his or her actions through the constant evaluation of intermediate and partial solutions.

This third way thus appears as a mediation between a hermetic approach to design as a work of art and a transparent and rational one. Similarly to what occurs within Von Foerster's (2003) famous non-trivial machines, self-organising systems are understood as open and dynamic systems, capable of modifying their internal structure and/or function in response to external circumstances.

This model seems to be reflected in the "swampy plain" that, according to Schön (1993, 68), constrains the positivistic epistemology of practice. In his famous "The Reflective Practitioner: How professionals think in action", the American philosopher clarifies that in situations where goals are defined and clear, the decision to act presents itself as an instrumental problem that can be solved through technique. But when the ends are confused and contradictory – a condition that is quite common in urban planning and even more so when dealing with wicked problems – there is still no clear goal to solve. A conflict concerning ends cannot be resolved using techniques derived from applied research; rather, it is through the non-technical process of structuring the problem situation that we can organise and clarify both the ends to be achieved and the possible means to achieve them.

In this reflexive conversation, the practitioner's effort to solve the restructured problem

Approach / Model	Main Authors / References	Key Features	Interpretive axes			
			Rationality/ Linearity	Creativity/ Intuition	Adaptivity/ Reflexivity	Complexity/ Wickedness
<b>Technical-rational (Positivist)</b>	Asimov (1962); Rowe (1987)	Linear sequence of analysis–synthesis–evaluation–choice; assumes complete data and optimal solutions.	High	Low	Low	Low
<b>Black Box</b>	Jones (1970/1992)	Design as subconscious, intuitive activity; creativity emerges from intuition and sudden insights.	Low	High	Low	Low
<b>Glass Box</b>	Jones (1970/1992); Asimov (1962)	Transparent, rational process; linear and information-driven.	High	Low	Low-Medium	Low
<b>Self-Organising Systems (SOS)</b>	Jones (1970/1992); Von Foerster (2003)	Flexible, adaptive, self-reflective design process; iterative evaluation of partial solutions.	Medium	Medium	High	Medium
<b>Wicked Problems / Argumentative Planning</b>	Rittel & Webber (1973)	Design as negotiation of contradictory, incomplete and shifting requirements.	Low-Medium	Low-Medium	High	High
<b>Reflective Practice</b>	Schön (1983, 1985, 1993)	Spiral of appreciation–action–reappreciation; learning-by-doing and reflection-in-action.	Low-Medium	Medium	High	High
<b>Designerly Ways of Knowing</b>	Cross (2007)	Distinct cognitive mode of design; iterative and abductive reasoning.	Low-Medium	High	Medium	Medium

The table compares theoretical approaches to design by summarising their defining features and situating them along four interpretive axes. “Rationality/Linearity” indicates the degree to which design is conceived as a logical, sequential process. “Creativity/Intuition” highlights the role of tacit knowledge, intuition, and imagination. “Adaptivity/Reflexivity” refers to the capacity of the process to self-adjust through iterative feedback and reflection. “Complexity/Wickedness” captures the extent to which an approach acknowledges uncertainty, multiple actors, and the open-ended nature of design problems.

Tab. 1

produces discoveries that require further reflection during action. The process spirals through stages of appreciation, action, and new appreciation. The unique and uncertain situation comes to be understood through the attempt to transform it and is transformed through the attempt to understand it.

This reflexive process – in which the project assumes the characteristics of a complex, personal, creative, and open-ended process of exploring and deciding (Schön, 1985) – in professional practice is often kept implicit and under-recorded (Schön, 1985), reduced to an instrumental action in the definition of the design deliverables. Even the argumentative approach (Rittel, Weber, 1973) – in which urban planning decisions are publicly discussed and negotiated between the actors involved, recognising the complexity and plurality of perspectives – does not completely overcome this step as the discussion/participation phase is often unconnected to the one in which choices take on an operational character by landing on a design solution or a rule. Only in some co-design experiences is this iterative and reflexive process manifested and made observable, although these experiences remain limited and difficult to convey through the scientific literature.

In teaching urban planning and design, it is essential to make this process as explicit and therefore transferable as possible. It is during the didactic and interdisciplinary workshops,

now widespread in all schools of architecture globally, that this process of “designerly way of knowing” (Cross, 2007) is absorbed by the students in a learning-by-doing process.

In his studies on the practice of architecture, Schön (1985; 1987) emphasised the paradoxical character of design education. He stated that the student is expected to “immerse himself in the studio, trying from the beginning to do what he does not yet know how to do, in order to obtain the kind of experience that will help him learn what it means to design” (Schön 1985, 57).

More recent contributions extend these trajectories. Paola Viganò’s work, particularly “*I territori dell’urbanistica: Il progetto come produttore di conoscenza*” (2010), foregrounds the epistemic role of design, conceiving the project not merely as the production of artifacts but as a generator of situated knowledge about territories, societies, and their transformations. Andri Gerber’s “Handbook of Methods for Architecture and Urban Design” (2018) provides a comprehensive repertoire of methodological tools – ranging from mapping to scenario-building – emphasising methodological pluralism as a necessary response to the complexity of design problems. Simon Kretz’s “The Cosmos of Design” (2020) deepens our understanding of design cognition, articulating how iterative experimentation, speculation, and reflection constitute the core processes of creative practice. Marcel Smets’s “Foundations

of Urban Design” (2022) reframes the conceptual apparatus of urban design through a dialectical vocabulary that juxtaposes pairs of notions, enabling designers to reflect on urban form and intervention critically. Finally, Carlo Pisano and Giambattista Zaccariotto’s “Urbanistic Projects. The Next Generational Paths: A European Perspective” (2024) highlights the contemporary evolution of urbanistic projects in Europe, interpreting them through the lenses of issues, tools, and alliances, and framing them as situated practices that mediate between theoretical innovation and operational governance.

To make the design process in urban planning explicit, and thus replicable and transferable, this paper uses a conceptual framework based on Elise van Dooren’s (2013, 2020) model, which identifies five key elements: (1) experimenting/exploring and deciding, (2) theme or guiding quality, (3) domains, (4) framework, and (5) laboratory or (visual) language. This paper evaluates the application of this framework in the *Prato Ready Laboratories*, a multidisciplinary programme of the University of Florence (2024/25), involving almost 150 students from four design laboratories of Master’s degree courses in Architecture and Planning that address one of the most evident wicked problems of the contemporary world, climate change and its repercussions in the urban environment.

The next section will describe the conceptual framework based on Elise van Dooren’s (2013;

2020) model; the third section will evaluate the application of this framework in the *Prato Ready Laboratories*; the fourth section will compare the results obtained in the four Laboratories using van Dooren’s framework; and the final section will elaborate on some conclusions and possible implementations.

## 2. Methods

Designing is a complex, personal, creative, and open-ended process of exploring and deciding (Schön, 1985). Design is an exploratory practice, referring to this term as a process of being open, playful, and curious, of generating alternatives and options, both intuitively and rationally (van Dooren, 2020). It is especially during interdisciplinary workshops that this “designerly way of thinking” (Cross, 2007) is absorbed by students in a learning-by-doing process. To improve the quality of architectural design education, Elise van Dooren elaborates a vocabulary to make the design process, at least to a certain extent, explicit. Her model (2013; 2020) identifies five key elements: (1) experimenting/exploring and deciding, (2) guiding theme or qualities, (3) domains, (4) frame of reference, and (5) laboratory or (visual) language.

While several models could have been adopted, the choice of Elise van Dooren’s framework (2013; 2020) is consistent with the pedagogical approach traditionally cultivated in design studios, conceived as laboratories of inquiry rath-

er than as spaces for the production of a single correct solution. The framework provides a clear and transferable structure for making the implicit processes of design more explicit, particularly the dialectical tension between exploration and decision, the articulation of guiding themes, and the role of visual language in shaping knowledge. The innovation introduced here lies in integrating this model with the school's long-standing emphasis on situated design research, collective discussion, and interdisciplinary collaboration. In this sense, the *Prato Ready Laboratories* not only apply an existing method to a case study but extend its scope, showing how van Dooren's categories can be mobilised within a pedagogical culture that treats the design process itself as an object of research and as a producer of knowledge.

### 2.1. Design process

According to van Dooren (2020), the design process is inherently dialectical, characterised by a continuous oscillation between divergence and convergence. It alternates between opening to new ideas – through observation, association, and proposing alternatives – and narrowing down by applying criteria, testing, and assessing outcomes. This dynamic movement is central to design thinking and forms the backbone of her framework.

Other scholars have elaborated on this dynamic. Schön (1985) described experimentation as

a form of reflective dialogue or “conversation with the situation,” in which the designer's iterative moves constantly reframe both problems and intentions. Similarly, Cross (2001) and Dorst (2015) conceptualised design as a co-evolution of problem and solution spaces, underlining the interdependence between exploration and evaluation.

### 2.2. Guiding themes

In van Dooren's framework, defining a guiding theme or “guiding quality” is a key step in structuring the design process (2013; 2020). The theme acts as both anchor and compass, providing coherence to design development and supporting decision-making in complex contexts. It frames what matters, filters competing options, and lends identity to the project.

This resonates with Schön's (1985) idea of “naming and framing” as a central act of design, where designers construct the lens through which they engage with a situation. By articulating guiding themes, especially in educational settings, students learn to structure their work conceptually while maintaining openness to emerging insights.

### 2.3. Domains

Van Dooren (2013; 2020) synthesised Schön's (1985, 1987) original twelve domains of architectural design into five overarching categories: (1) form and space, (2) material, (3) func-

tion, (4) physical context, and (5) social, cultural, historical and philosophical context. These domains provide the conceptual scaffolding through which designers explore and test their guiding themes.

This categorical thinking enables the articulation of diverse aspects of the built environment. By shifting between domains, designers move across disciplinary boundaries and integrate multiple perspectives, making the process both structured and flexible.

#### 2.4. References

Van Dooren (2020) also emphasises the role of references as part of the designer's toolkit, underscoring how precedents and exemplars inform new design work. References are not neutral but shape the way designers interpret situations, make choices, and develop solutions.

This idea aligns with Cross (2007), who highlights that design knowledge is embedded in the artificial world and transmitted through exemplars, images, and diagrams. Schön (1985) similarly stresses that designers build a repertoire over time, enabling them to interpret new contexts by varying familiar patterns.

#### 2.5. Visual language

For van Dooren (2013; 2020), visual language is not a mere representational tool but a constitutive element of design cognition. Sketches, diagrams, and models function as a laboratory

of thought, where ideas are externalised, tested, and transformed.

According to Lawson (2004), sketches externalise elements of the design situation, allowing the designer to stand back and examine them from a new perspective. They reduce complexity, simplify relationships, and clarify decisions. As the designer sketches and models, they become aware of the implications of each move, shaping and reshaping the problem and the potential responses.

In this iterative process, what Schön (1985) calls "moves" are expressed through changing configurations, sketches, and words. The traces left by these moves – in lines, forms, or virtual representations – carry meaning and influence further development. Thus, drawing and modelling become active forms of reasoning within a "web of moves."

### 3. Materials

Building on the reference model proposed by van Dooren (2013; 2020) to clarify the often-implicit nature of design processes, this section offers a comparative analysis of the pedagogical approaches and outcomes of four design laboratories conducted at the School of Architecture, University of Florence, during the fall semester of 2024/25.

The *Prato Ready Laboratories* were developed as an integrated, multidisciplinary teaching initiative aimed at rethinking the northern periphery of the city of Prato as a coherent syn-

## Articulation of the 4 laboratories

Tab. 2

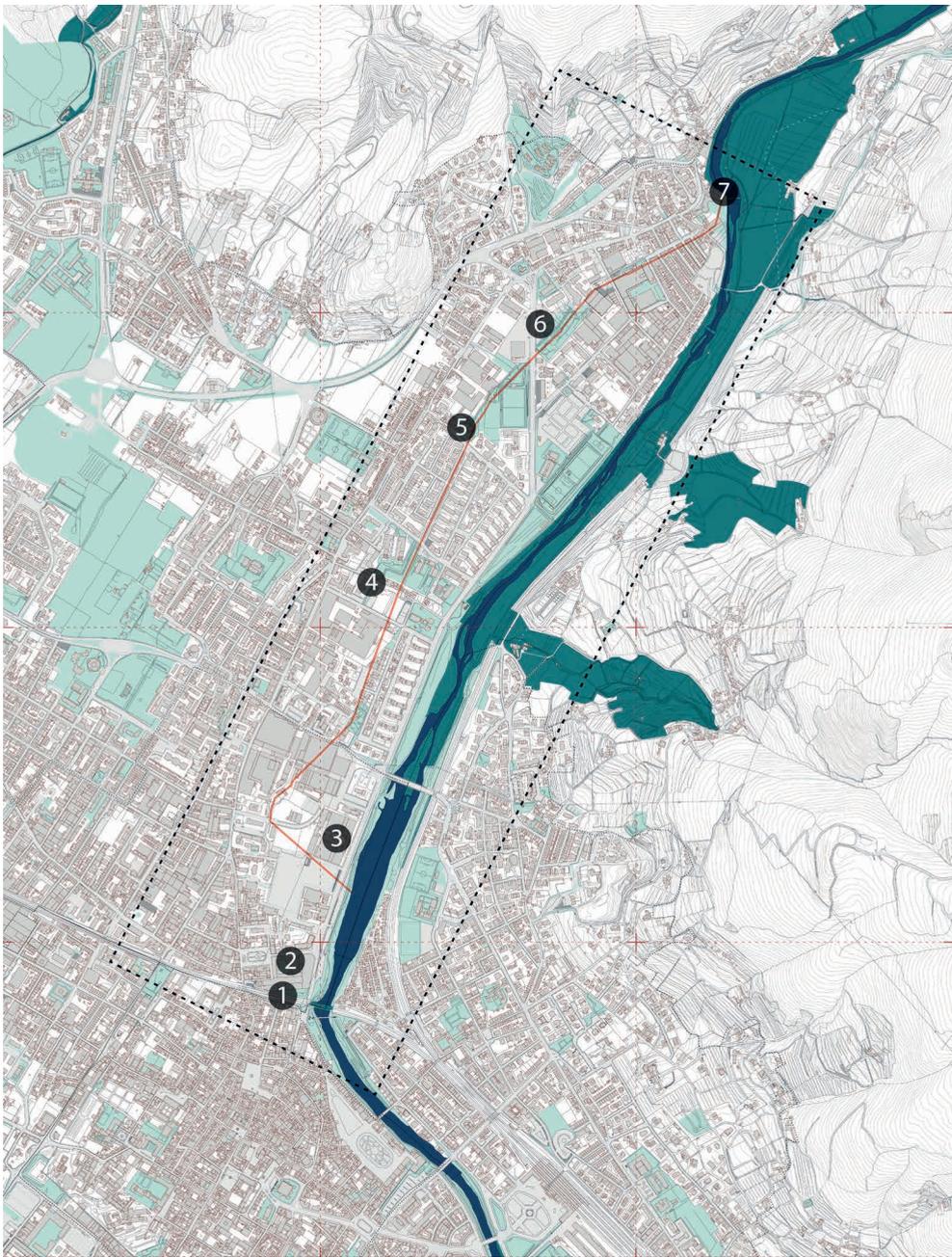
	Lab. A	Lab. B	Lab. C	Lab. D
Full Title	Architecture and Town Lab.	Architecture and Town Lab.	Lab. of urban metabolism and resilience	Lab. of urban metabolism and resilience
Master course	Architecture	Architecture	Planning and Design for Urban and Territorial Sustainability	Planning and Design for Urban and Territorial Sustainability
Language	Italian	English	Italian	English
Total Credits	18 ECTS	18 ECTS	12 ECTS	12 ECTS

thesis of functions, spaces, infrastructures, and natural systems, across the scales of architecture, urbanism, and territorial planning. The primary objective was to engage students in sustainable urban and territorial regeneration, with a focus on climate change adaptation, disaster risk reduction, and energy transition, in line with the goals of the RETURN Extended Partnership, in which some members of the teaching staff were involved (see the Acknowledgements section for further details). To this end, the program aligned the activities of four laboratories: the *Architecture and Town Lab* (Italian - Lab A; English - Lab B) within the Master's in Architecture, and the *Resilience and Urban Metabolisms Lab* (Italian - Lab C; English - Lab D) within the Master's in Planning and Design for Urban and Territorial

Sustainability. Altogether, the initiative involved nearly 150 students.

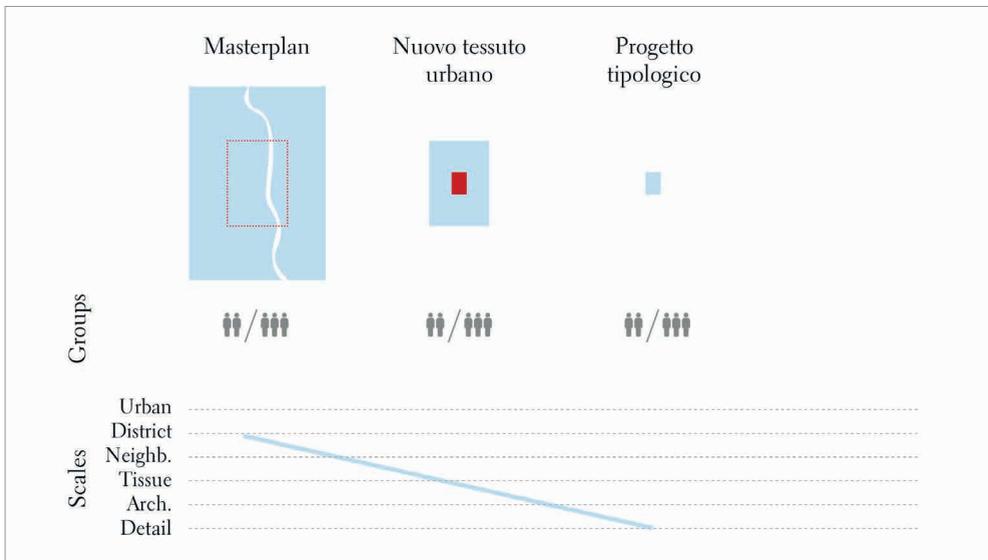
At the School of Architecture in Florence, design studios are often structured as pedagogical devices through which research projects are advanced and tested. What distinguishes this initiative is its systemic articulation: four interconnected laboratories that engage both students and faculty members from two master's degree programs, collectively involving twelve courses. This configuration not only fosters cross-fertilisation between disciplinary domains but also enhances the integration of teaching and research, positioning the studios as experimental arenas for knowledge production.

The design context is the area north of the city of Prato that extends from the historic centre



**Design context of the northern area of Prato. 1) Porta al Serraglio train station; 2) PIN - University of Florence Prato Campus; 3) Calamai Wool Factory; 4) Niccolini Villa; 5) Coiano Fulling mill; 6) Abatoni park; 7) Cavalciotto Weir; Red line) Gorone canal**

Fig. 1



## Design process of the Lab. A

Fig. 2

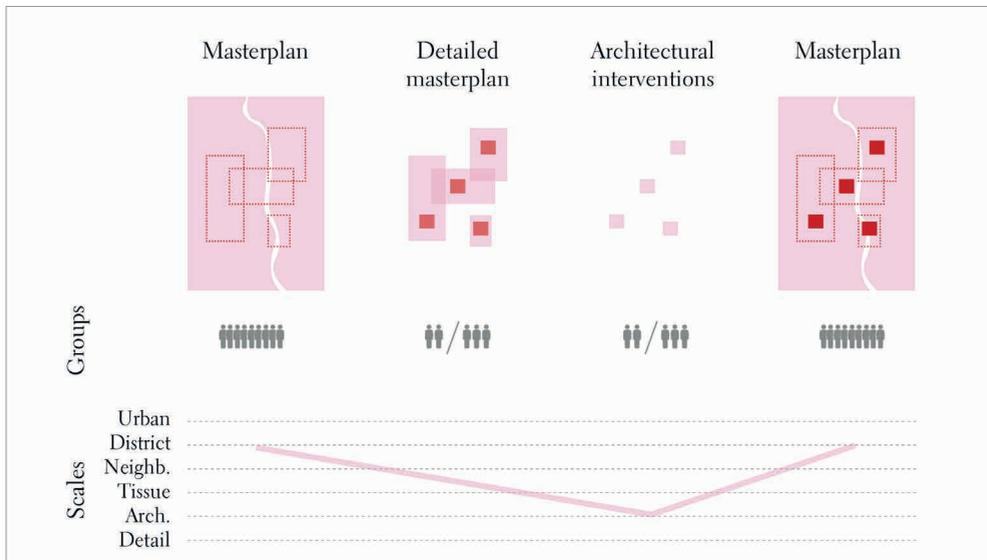
along the Bisenzio river to Cavalciotto. Located in the heart of Tuscany, just a few kilometres from Florence, Prato is the second-largest city in the region and one of Italy's most dynamic urban centres. Historically known as a textile and manufacturing hub, Prato has long been recognised for its industrious spirit, multicultural population, and deep-rooted traditions in craftsmanship and entrepreneurship. Over the centuries, the city has evolved from a medieval trading post into a modern industrial capital. Prato's textile district, among the most important in Europe, has played a crucial role in the city's development, both economically and socially. Today, this legacy continues to shape the city's identity, blending traditional know-how with cutting-edge technologies and a growing commitment to sustainability and circular economy principles.

Prato's peri-urban area stretches along the

Bisenzio River, which was historically shaped by water infrastructure that supported its textile industry. Today, urban infilling has buried much of this infrastructure. However, the region's industrial, agricultural, and residential mix highlights its potential for urban regeneration strategies that revitalise Prato's industrial heritage and address modern living needs. The design context is part of a broad regeneration programme that includes the reopening of the Gore system – the complex system of canals that runs across the city – and in particular, the Gorone, the main canal of Prato that runs from Cavalciotto to Piazza del Mercato Nuovo, near the University of Florence Prato Campus.

### 3.1 Design process

This section examines the evolution of decision-making processes across the *Prato Ready Laboratories*, focusing on course goals,



## Design process of the Lab. B

Fig. 3

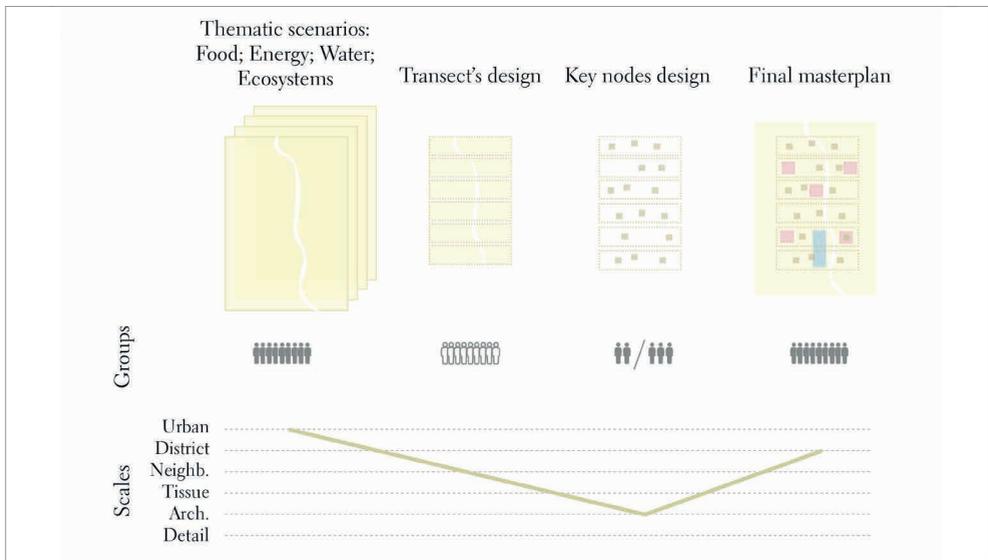
student composition, and the design process across multiple scales.

In *Lab A* (Architecture and Town Lab, Italian curriculum), twenty-eight primarily Italian students adopted a multi-scalar design approach. Working in groups of two to three, each team addressed the project at three key scales: a 1:5,000 masterplan, establishing urban and territorial relationships; a 1:500 detailed plan, articulating a new urban fabric through the integration of architectural, landscape, and urban elements; and a 1:100/200 architectural scale, focused on housing typologies and spatial detail.

In *Lab B* (Architecture and Town Lab, English curriculum), forty-five international students engaged in a circular design process structured in iterative phases. Initially divided into four macro-groups of 10–15 students, the class developed a shared masterplan. In the second

phase, these macro-groups split into smaller units (1–3 students) to design individual interventions derived from the collective rules and strategy (Pisano, De Luca, Dastgerdi, 2020). In the final phase, the groups reconvened to reintegrate the detailed proposals into a revised and cohesive masterplan.

*Labs C and D* (Urban Metabolism and Resilience Labs, Italian and English curricula) worked as a single integrated unit, involving approximately fifty students from the Master's in Planning and Design for Urban and Territorial Sustainability. The design process began with a scenario-based thematic analysis, focused on key systems – water, food, energy, and ecosystems. In a second phase, students were reorganised into smaller groups (2–3 members) to develop site-specific interventions within strategic nodes along defined transects, applying an integrated and multi-scalar design approach.



## Design process of the Lab. C

Fig. 3

### 3.2. Guiding Themes

Before the start of the semester, each laboratory defined a distinct set of guiding themes or design qualities, formally communicated to students through the course syllabi.

In *Lab A* (Architecture and Town Lab, Italian curriculum), the guiding focus was urban, architectural, and landscape regeneration within peri-urban contexts, spaces of transition and hybridisation between urban and rural conditions. Students were driven to reflect on themes such as historic memory, typological and functional heterogeneity, and configurational discontinuities, all viewed as opportunities for spatial and formal reintegration of fragmented urban areas.

*Lab B* (Architecture and Town Lab, English curriculum) approached the project through urban macro-functions designed to address local needs while promoting typological innovation.

Design explorations included vertical parking as a response to impermeable surfaces, a covered market to reinterpret the weekly open-air market, vertical agriculture for environmental and social resilience, and inhabited bridges to reconnect fragmented urban fabric across infrastructural and riverine barriers.

In *Labs C and D* (Urban Metabolism and Resilience Labs), the design agenda was explicitly shaped by the climate crisis and the decline of material and energy resources. The concept of resilience served as a guiding principle to counteract soil consumption and soil sealing, intending to restore ecological functions such as rainwater infiltration, evapotranspiration, and temperature regulation.

### 3.3. Domains

This section examines how the *Prato Ready Laboratories* align with the disciplinary do-

## Articulation of the different disciplines and credits in the 4 laboratories

Tab. 3

	Lab. A	Lab. B	Lab. C	Lab. D
<b>Architectural Design</b>	6 ECTS	6 ECTS	3 ECTS	3 ECTS
<b>Landscape Design</b>	6 ECTS	6 ECTS	-	-
<b>Technology Design</b>	-	-	3 ECTS	3 ECTS
<b>Urban Design</b>	6 ECTS	6 ECTS	6 ECTS	6 ECTS

mains outlined in van Dooren's framework (2013, 2020), reflecting the varied pedagogical structures across the four studios.

In *Labs A and B* (Architecture and Town Labs), the laboratories were evenly divided across three core domains – Architectural Design, Urban Design, and Landscape Design – each accounting for 6 ECTS credits (48 hours of instruction), thus promoting a balanced, integrated approach across spatial scales and design disciplines.

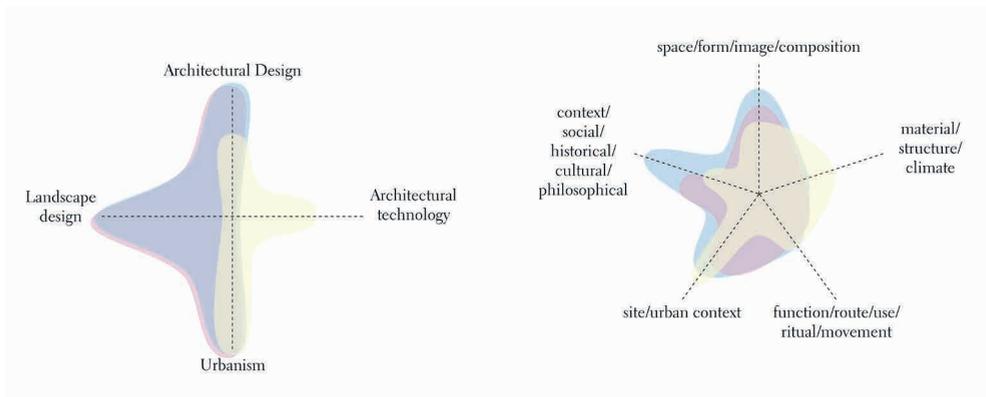
In contrast, *Labs C and D* (Urban Metabolism and Resilience Labs) were structured around Urban Design (6 ECTS), Technological Design (3 ECTS), and Architectural Design (3 ECTS), emphasising technical and environmental dimensions of urban transformation, in line with their sustainability-oriented pedagogical focus.

Despite sharing common disciplinary domains, the *Prato Ready Laboratories* showed distinct

pedagogical emphases shaped by their design processes and guiding themes. *Lab A* placed particular emphasis on the specificity of the urban context, interpreted through social, historical, and cultural lenses, a focus reinforced by the requirement for each group to independently address all design scales.

*Lab B*, by contrast, concentrated on functional programming and the activation of open spaces, exploring how new typologies could catalyse contextual transformation.

In *Labs C and D*, the inclusion of Technological Design introduced a strong focus on climatic and technical performance, aligning with the labs' resilience-oriented agenda. The greater weight of Urban Design credits and the planning background of the students further oriented the design work toward large-scale territorial analysis, encompassing extended portions of the Prato urban region.



**Disciplines (on the left) and domains (on the right) connected to the Laboratories: in blue the Lab A; in pink the Lab B; in yellow the Labs C and D.**

Fig. 5

### 3.4. References

This aspect is closely tied to the individual pedagogical orientations of each lecturer, which often diverge significantly, even within shared disciplinary domains. The four laboratories reflect a broad diversity of teaching approaches, shaped by each instructor's research focus and professional background. The following comparative overview presents the main academic profiles by discipline and laboratory, based on information drawn from the University of Florence's institutional website.

#### 3.4.1. Architectural Design

*Lab A*, led by Professor Francesca Mugnai, adopts a symbolically and historically grounded approach to architectural design. Her pedagogy draws on extensive work with spatial typologies – such as places of worship, social housing, and commemorative sites – through symbolic language and archetypal forms. Mugnai's research includes archival and critical studies on twentieth-century Italian architec-

ture, with a focus on Edoardo Detti and Carlo Scarpa. She also explores sustainable housing, combining energy-efficient strategies with morphological analysis of traditional Tuscan typologies.

*Lab B*, led by Professor Michelangelo Pivetta, centres on architectural theory and contemporary design, emphasising the intersection of conceptual frameworks, compositional practice, and advanced visual representation. His research engages with international and multidisciplinary projects, particularly in historically and infrastructurally significant contexts across Italy, the European Union, and the United Nations. Pivetta's method foregrounds applied design research shaped by socio-political dynamics and collaborative processes.

*Labs C and D*, coordinated by Professor Luca Barontini, integrate academic research with professional practice. As a founding partner of *Eutropia Architettura*, Barontini has received recognition in architectural competitions, notably winning the international competition for

the Justice Park in Bologna. His research examines the work of leading figures in contemporary Italian architecture, including Francesco Tomassi and Adolfo Natalini, with a focus on the interplay between urban form and public space.

#### 3.4.2. Landscape Design

In *Lab A*, Professor Tessa Matteini is specialised in the design and active conservation of historic gardens and archaeological landscapes. Her research integrates interpretative design with conservation practices to creatively preserve and revitalise heritage contexts. Matteini also contributes to international research networks and policy initiatives, promoting the cultural and scientific recognition of landscape heritage.

*Lab B*, under the direction of Professor Ludovica Marinaro, focuses on urban landscape design and regeneration. Her work investigates the evolving relationship between city, port, and sea, emphasising participatory planning and the restoration of public and monumental spaces. As founder of SMALLStudio Architecture and Landscape, she leads interdisciplinary projects that integrate landscape design with infrastructural systems, including energy and water networks.

#### 3.4.3. Technology Design

The Technology Design component is shared by *Labs C and D*, with an integrated teaching method. In *Lab C*, Professor Giulio Hasanaj

focuses on sustainable architectural technologies and climate adaptation, contributing to the development of tools and strategies for environmentally responsive design. His research includes participation in national and international initiatives on urban resilience and environmental performance. He also engages in applied research on collective housing and university residences, with particular attention to the Italian regulatory framework (e.g., Law 338/2000).

In *Lab D*, Professor Antonella Trombadore brings expertise in innovative technologies for environmental sustainability. Her work emphasises the integration of green infrastructure, NZEB standards, and digital tools such as Digital Twin models. She also investigates energy-efficient renovation processes, especially within university campuses, employing Living Labs as platforms for participatory design and environmental innovation.

#### 3.4.4. Urban Design

Professor Carlo Pisano is responsible for the Urban Design courses across *Labs A, B, C, and D*. His research focuses on regional design and multiscale strategic planning, with particular attention to the regeneration of transitional and peripheral urban areas. As coordinator of the Regional Design Laboratory, he promotes an action-research approach that combines visionary planning with context-specific, operational design practices. His work advocates

## Examples of graphic materials produced by the students in the Lab A: A) Giuseppe Catalanotto, Federico Dondi, Jose Daniel Belaunde, Architectural reading; B) Irene Mereu, Marta Linguanti, Urban reading; C) Carolina Kuhl, Elena Moroni, Landscape reading

Fig. 6A-6B-6C

for integrated models of urban transformation that bridge long-term strategies and short-term, adaptive interventions.

In *Labs C* and *D*, Urban Design is co-taught with Professor Silvio Cristiano, whose research addresses sustainable and resilient urban and regional planning. He investigates spatial strategies and governance mechanisms that support low-carbon and socially equitable development. His work employs environmental accounting and socio-ecological metabolism frameworks to analyse urban resource flows and environmental impacts, with a focus on systemic sustainability transitions.

### 3.5. Visual language

The structure and articulation of visual materials played a central role in shaping both the design process and outcomes across the four design laboratories. While all labs adopted integrated and interdisciplinary approaches, each defined a distinct set of deliverables aligned with its conceptual priorities, organisational model, and methodological framework.

In *Lab A*, production was highly structured and uniform. All students had to submit a standardised set of outputs, including a 9-page A3 project dossier, seven A0 boards, and two physical models. These materials ranged from territorial and urban analyses to detailed architectural drawings of a residential block at 1:200 scale, emphasising clarity, disciplinary integration, and multiscale coherence.

*Lab B* adopted a more flexible structure, accommodating varied group configurations such as “supergroups” and “microgroups.” Each group produced 3-4 A1 boards focused on urban and landscape analysis, while smaller teams developed 2 A1 boards with architectural proposals. Physical models at different scales complemented the graphic materials, supporting diverse representational approaches and fostering a tangible understanding of spatial interventions.

*Labs C* and *D* implemented the most articulated and hierarchical system of deliverables, organised across macro-groups, groups, and micro-groups. In the initial phase, macro-groups produced three thematic A0 boards and a synthetic masterplan (A0), addressing specific topics, such as water, food, energy, and ecosystems, through the transversal lenses of soil, built environment, and infrastructure. Design groups then developed an A0 study area project at 1:500 scale, while micro-groups contributed three A1 boards focusing on a strategic architectural node, climate-responsive strategies and Nature-based Solutions, and detailed construction drawings at 1:20. The process concluded with a standardised 3D-printed model (38.5 × 38.5 cm, 1:100 scale), highlighting the lab's focus on precision, innovation, and environmental awareness.

The diversity of deliverables across laboratories reflects the plurality of didactic strategies within a shared academic framework, offer-





Examples of graphic materials produced by the students in the Lab A: D) Irene Mereu, Marta Linguanti, Birdview of the design solution; E) Sara Ceccotti, Chiara Baggiani, Masterplan of the design solution; F) Sara Ceccotti, Chiara Baggiani, Renders.

Fig. 6D-6E-6F



ing students multiple modes of engagement with complex urban and architectural issues through drawing, modelling, and interdisciplinary synthesis.

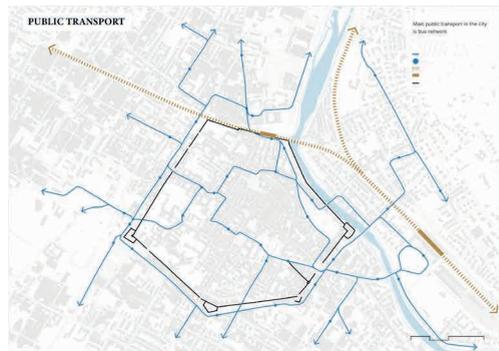
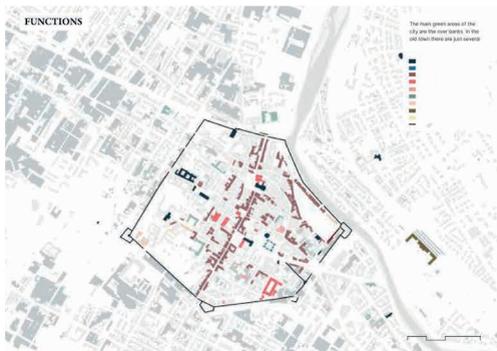
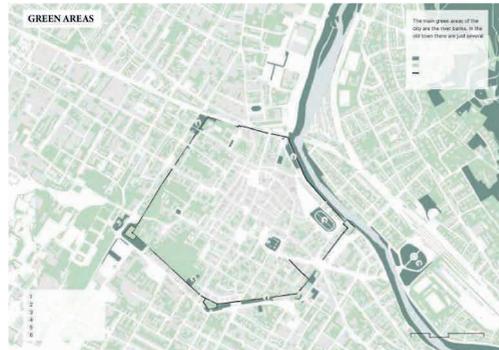
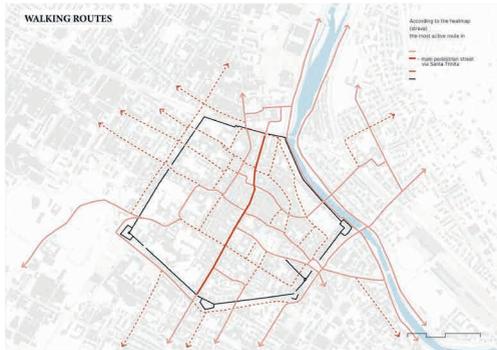
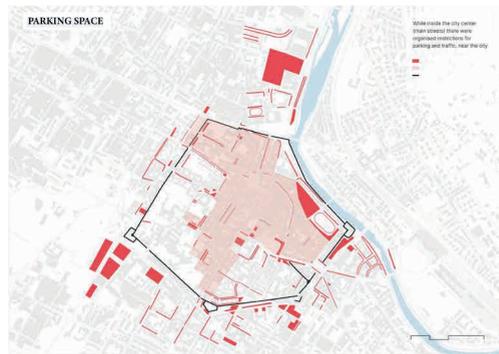
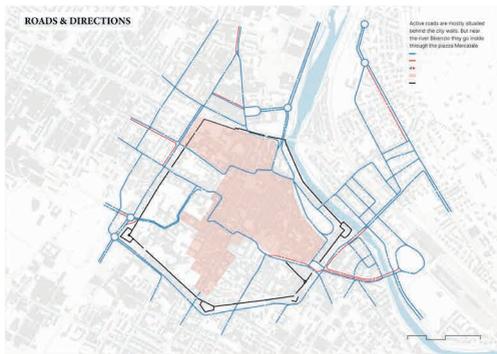
#### 4. Discussion

Although grounded in a shared design context – the peri-urban area north of Prato – and a common goal of urban regeneration, the four *Prato Ready Laboratories* adopted distinct pedagogical strategies in addressing themes of territorial risk, resilience, and sustainability. These differences were clear not only in the design processes but also in the disciplinary orientations, representational formats, and theoretical frameworks specific to each lab.

##### 4.1. Lab A

In *Lab A*, risk was primarily understood as a

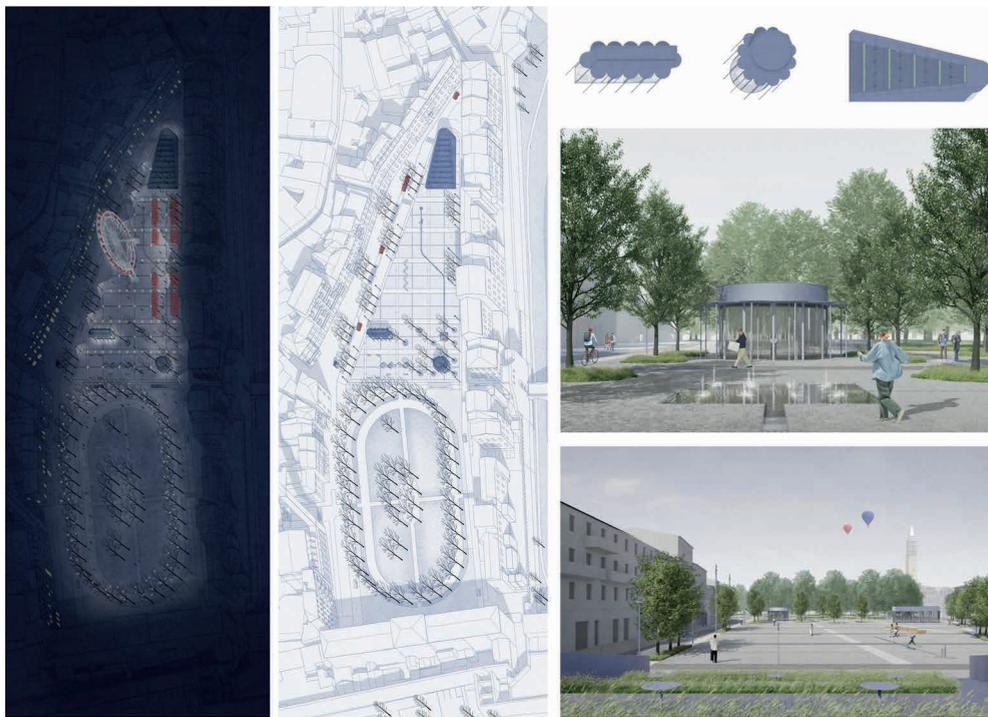
consequence of spatial and historical discontinuities caused by uncoordinated urban development and the neglect of infrastructural and landscape systems. Students adopted a transcalar approach that combined architecture, urban design, and landscape architecture. Through analytical and projective drawings, the proposals aimed to reconnect fragmented urban fabrics, reactivate the hydraulic heritage of the Gore system, and reinterpret residual spaces as new ecological and social linkages. The visual outcomes from *Lab A* prove a strong engagement with territorial stratification, where design interventions mediate between the built environment and natural systems. The reimagining of the Gorone canal exemplifies an ecological strategy for risk mitigation, addressing issues such as flooding, impermeability, and urban disconnection. At the archi-



**Examples of graphic materials produced by the students in the Lab B: A) Elizaveta Dvorshchenko, Boris Gusev, Urban reading of Prato historical centre; B) Orestis Hasikos, Sensitive reading of the urban landscape; C) Anastasia Lukash, Anna Yakubova, Eduard Asimolov, Foteini Ioannidi, Iliia Shapoval, Inna Korolevskaia, Juan Francisco Morejon, Letitia-Maria Boeru, Orestis Hasikos, Pinar Yalin, Vanda Antunovic, General masterplan of the super-group number 1; D) Francisco Morejon, Letitia Boeru, Orestis Hasikos, Detailed masterplan of the design proposal**

Fig. 7A-7B-7C-7D





## Examples of graphic materials produced by the students in the Lab B: E) Elizaveta Dvorshchenko, Boris Gusev, Detailed design solution.

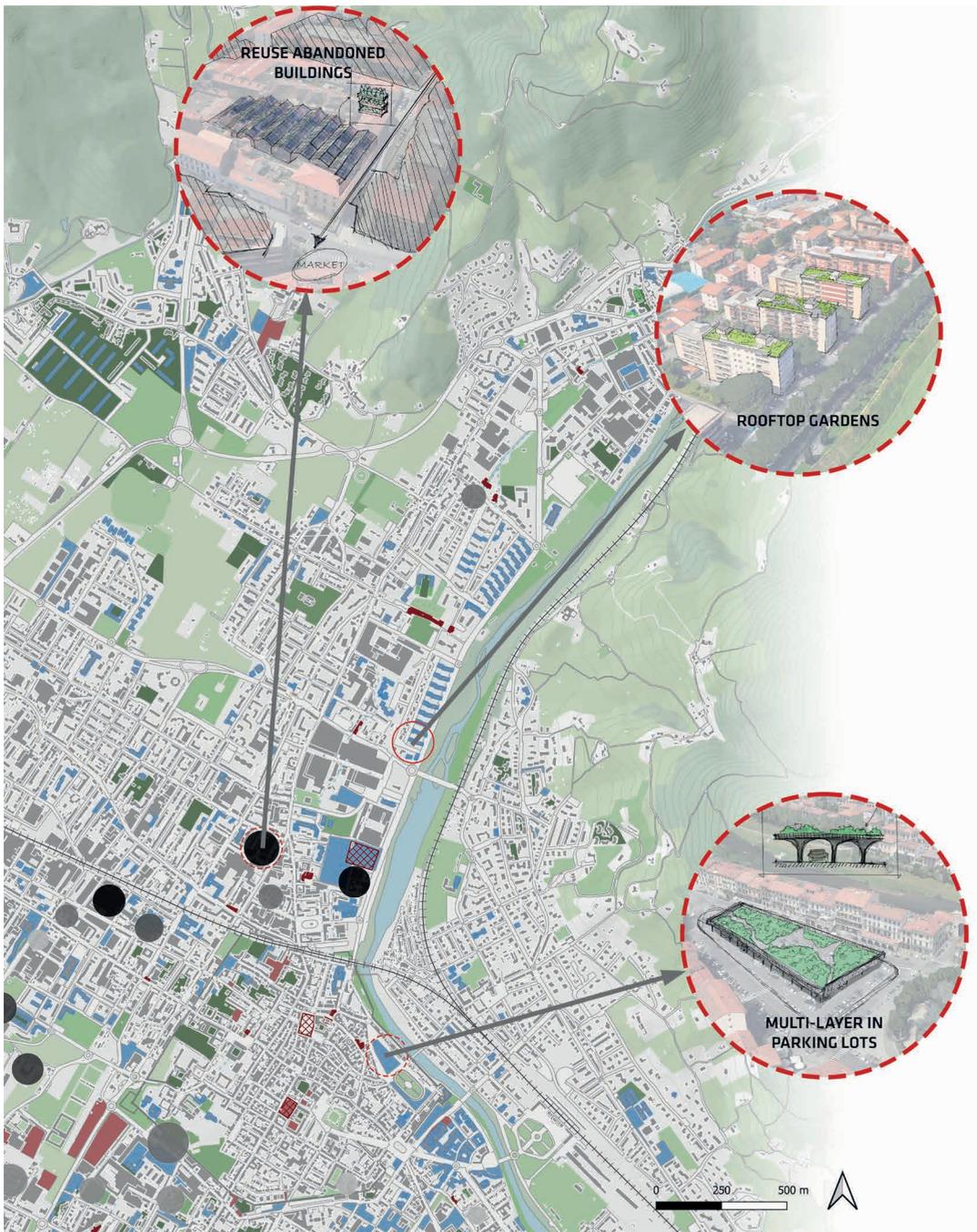
Fig. 7E

tectural scale, new housing typologies incorporate public and semi-public spaces to foster socio-spatial resilience, framing sustainability as both environmental responsiveness and inclusive urban design.

### 4.2. Lab B

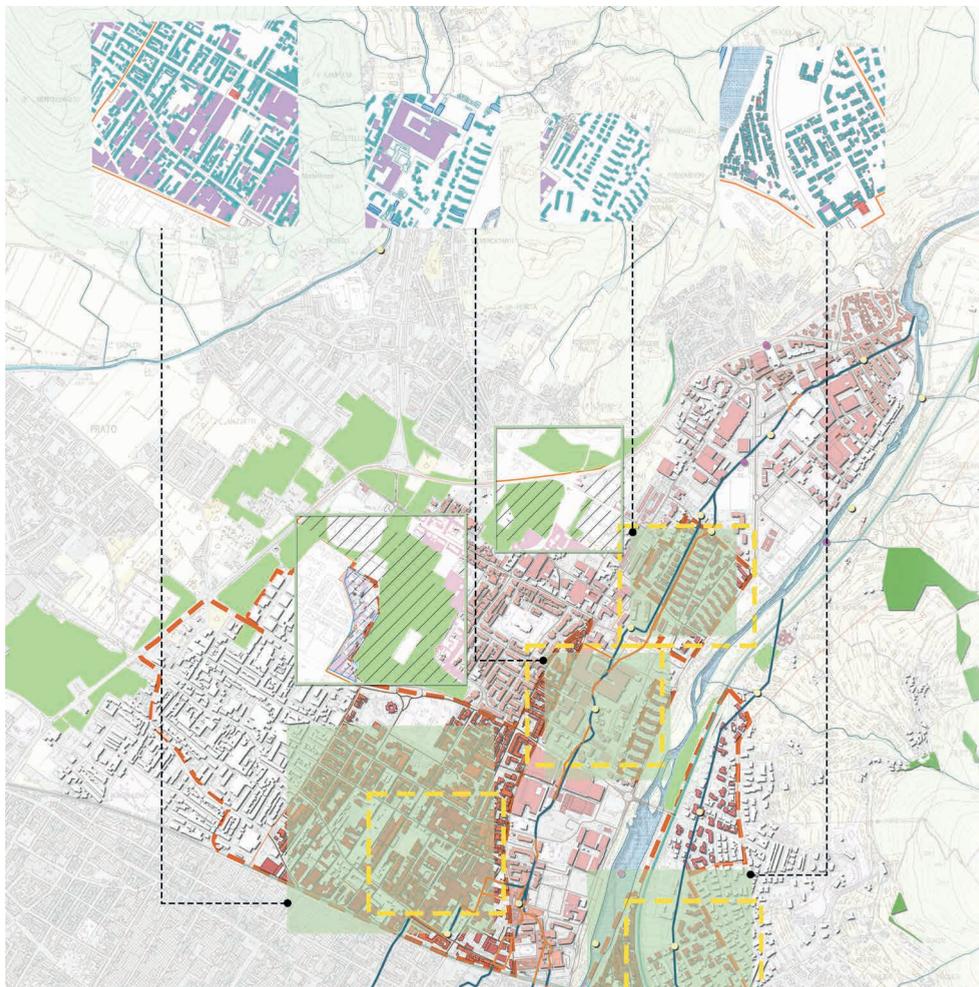
*Lab B* approached risk through a programmatic and experiential perspective, interpreting it as the cumulative result of functional obsolescence, degraded public spaces, and disconnection across urban systems. The lab employed a circular design process that enabled students to alternate between collective and individual phases, fostering a dynamic, feedback-oriented approach to territorial transformation.

A key methodology was the creation of a “Sensitive Map,” translating spatial analysis into multisensory readings – soundscapes, olfactory zones, and tactile surfaces – that revealed less visible forms of environmental and perceptual risk. In response, students developed adaptive typologies such as vertical farms, covered markets, and inhabited bridges, reconfiguring circulation patterns, and programmatic functions. The “Degli Abatoni Urban Farm & Community Hub” (Fig. 7D) exemplifies this strategy, combining minimal physical intervention with high social and ecological impact. Through selective demolitions, re-naturalisation of paved areas, and vertical reuse of existing structures, the project proposes resilient transformation



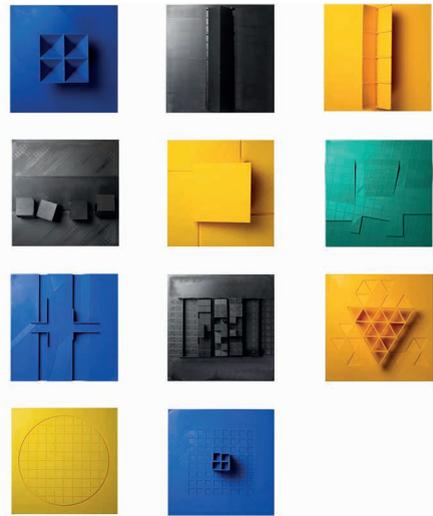
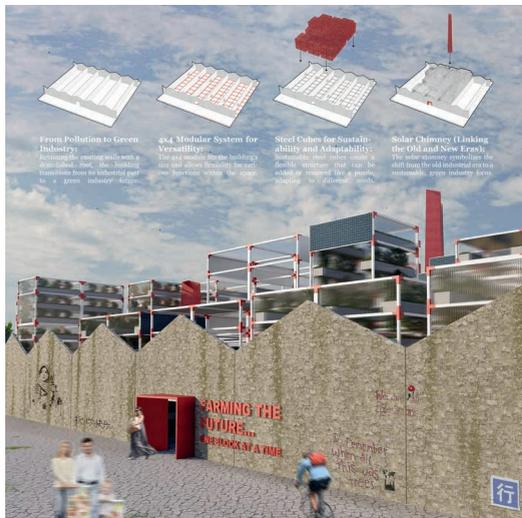
Samples of graphic materials produced by the students in the laboratory C: A) Macrogroup 1, Potential food production in the study area.

Fig. 8A



**B) Macrogroup 2, Analysis of the consumption and potential production of energy in the study area; C) Duaa Osama Mohamed Abdelrahim, Noelia Patricia Ibarra Cáceres, Hanadi Ibrahim Ali Tashani, Render of the potential reuse of an abandoned factory for urban farming; D) Overview of the detailed design of urban pavilions to stock rainwater and produce energy through PV panels.**

Fig. 8B-8C-8D



grounded in subtraction, reuse, and landscape productivity. In *Lab B*, sustainability is framed as a tactical recalibration of the urban system, addressing risk through programmatic adaptability and ecological restoration.

#### 4.3. Labs C and D

In *Labs C* and *D*, the theme of risk was central to the design process and explicitly framed through the lens of the climate crisis, resource scarcity, and territorial metabolism. The methodological structure – organised into macro-groups, groups, and micro-groups – guided students from territorial scenarios (water, food, energy, ecosystems) to site-specific architectural and technological solutions at critical urban nodes.

Projects integrated Nature-based Solutions (NbS), passive climate strategies, and digital tools to enhance design performance and decision-making transparency. Environmental risks related to soil sealing, urban heat islands, and water mismanagement were addressed

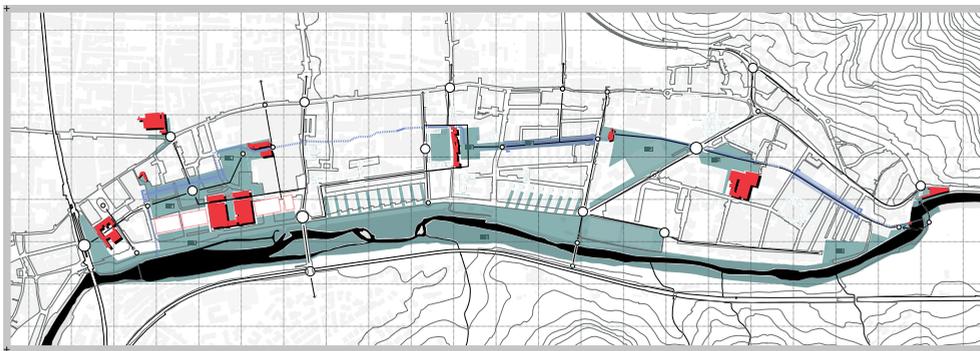
through spatially integrated, quantifiable interventions such as green roofs, permeable surfaces, and urban agroforestry systems.

The 3D-printed architectural models produced in the final phase of the lab reflect the emphasis on material systems and design logic. Resilience in *Labs C* and *D* is conceived as a systemic recalibration, combining spatial and formal innovation with performance-based metrics, policy sensitivity, and technical viability.

#### 4.4. Final synthesis

A key moment in the final phase of the semester was a cross-laboratory workshop, coordinated within *Labs C* and *D*, which brought together students and lecturers from all four studios in a collective synthesis exercise. This initiative marked the pedagogical and conceptual result of the semester, aiming to translate diverse speculative proposals into a shared strategic vision for the transformation of the project area.

Through collaborative dialogue and critical



**Fig. 9 Final synthetic map that integrates the most coherent, feasible, and impactful design actions emerging across the laboratories. In red, architectural landmarks; in blue the reopening of key segments of the Gorone canal; circles, urban nodes. In green are represented the vast regenerated areas: 1) Park along the Bisenzio river, 2) From Gualchiera to Abatoni park, 3) villa Niccolini and via Goldoni park, 4) New market.**

Fig. 9

evaluation, the workshop generated a synthetic cartography that integrated the most coherent, feasible, and impactful design actions developed across the labs. Far from a formal summary, the map functioned as a planning tool for territorial resilience, oriented toward climate adaptation and risk mitigation. It reflects a collective effort to identify structural interventions capable of addressing environmental vulnerabilities while enhancing ecological and social performance.

Central to the synthesis is a redefined mobility framework, which reorganises traffic flows to reduce private car access in sensitive areas, lower emissions, and improve air quality. In parallel, the reopening of key segments of the Gorone canal is envisioned as both a cultural and ecological strategy, restoring Prato's hydrological identity, reducing flood risk, and improving water retention. The de-sealing of

extensive paved surfaces, particularly former parking areas, supports increased permeability, evapotranspiration, and urban microclimate regulation.

The integration of new parks and ecological corridors, strategically positioned to link existing green spaces, contributes to a broader landscape infrastructure designed to support biodiversity, manage stormwater, and mitigate extreme weather events. These spaces are conceived not merely as amenities but as active environmental systems embedded in the urban metabolism and capable of adapting to long-term climate pressures.

The students' proposals functioned as instruments of situated knowledge, revealing local opportunities, vulnerabilities, and capacities. As such, the final cartography works not only as a design product but as a resilience-oriented territorial framework, where architecture,

open space, infrastructure, and ecological systems converge into an adaptive, systemic vision. The emergence of new mobility nodes, the activation of public spaces, and the valorisation of architectural landmarks reinforce the identity of the area while enhancing its capacity to absorb and respond to future risks. In this sense, the *Prato Ready Laboratories* culminate in a collective exercise in spatial intelligence, advancing a design culture attuned to the challenges of climate transition and urban sustainability.

The *Prato Ready Laboratories* culminated in a public event held in Prato on 14 February 2025, attended by leading representatives of the city's political and administrative institutions, as well as by a large group of academics from the Department of Architecture at the University of Florence. Within this framework, students presented their work in an exhibition that became a platform for dialogue with local stakeholders. The occasion not only enabled the discussion of aims and perspectives for the future of the area but also provided a tangible form of feedback to citizens and institutions, thereby reinforcing the laboratories' role as a situated exercise embedded in the dynamics of urban governance.

### Conclusion

The *Prato Ready Laboratories* illustrate the potential of a structured yet open-ended pedagogical framework to make the urban design

process – often implicit and intuitive – explicit, reflective, and transferable. Grounded in van Dooren's conceptual model, this paper enabled the articulation of five key dimensions of design learning across four laboratories, each with distinct disciplinary orientations.

First, the labs effectively supported students in navigating the tension between exploration and decision-making. Whether through iterative cycles (*Lab B*), transcalar synthesis (*Lab A*), or scenario-based strategies (*Labs C* and *D*), students were encouraged to test hypotheses, assess consequences, and transform abstract intentions into spatial proposals, interpreting design as a communicable process of informed choices.

Second, the identification of guiding themes or design values in each lab – ranging from historical continuity and typological innovation to systemic resilience and environmental equity – provided meaningful conceptual instruments that fostered coherence and depth across scales and outputs.

Third, the differentiation of disciplinary domains (Architecture, Urban Design, Landscape, and Technological Design) enabled a layered approach to complex urban challenges. The comparison among labs highlighted how variations in disciplinary emphasis shape distinct interpretations of risk, resilience, and sustainability, underscoring the role of curricular design in cultivating design thinking.

Fourth, the plurality of reference frameworks,

shaped by the diverse research backgrounds of the teaching staff, expanded students' conceptual toolkits. From symbolic and historical analysis to socio-ecological systems thinking and technological innovation, the labs exposed students to a range of interpretive lenses, promoting critical awareness and intellectual autonomy.

Fifth, visual language emerged as both a cognitive and communicative tool. The varied representational formats – multi-scalar deliverables, sensory mappings, and scenario-based visualisations – reflected and reinforced each lab's epistemological orientation. By making risk and resilience visible, students learned not only to design but also to build arguments, narratives, and communicative clarity around complex urban issues.

Sixth, the integration of these heterogeneous pedagogical models was not without challenges. Differences in disciplinary traditions, teaching methods, and epistemological assumptions sometimes created tensions in achieving a coherent narrative across the laboratories. Coordinating between analytical, symbolic, and systemic approaches required negotiation and continuous adjustment, and the ambition to converge toward shared frameworks occasionally clashed with the specificity of each disciplinary stance. Yet, these frictions proved pedagogically valuable: they exposed students to the realities of interdisciplinary collaboration, highlighting both its difficulties

and its innovation potential. Acknowledging and working through these challenges was itself an exercise in reflective practice, making explicit the conditions under which design education can foster not only technical competence but also resilience, adaptability, and critical awareness.

Ultimately, the *Prato Ready Laboratories* affirm that teaching urban and territorial design in contexts of climate uncertainty and multi-hazard risk requires more than technical training. It calls for a pedagogical approach that cultivates systemic thinking, spatial imagination, and ethical responsiveness. Operationalising van Dooren's framework, the program clarified the structure of the design process while proving the role of education in preparing future designers to act with clarity, adaptability, and care in increasingly fragile and dynamic urban environments.

### **Acknowledgements**

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**Ricerche**  
Research

# Participation and Spatial Analysis to make Cities Resilient to Climate Change. The Historic Center of Genoa

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### keywords

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historic centers  
participation

## 1. Introduction

Climate change is unequivocal and represents one of the most urgent and critical challenges of the 21st century. It results unambiguously from human activities, mainly due to anthropogenic greenhouse gases emissions, leading to a global surface temperature of 1.1C above 1850-1900 during the period 2011-2020. Many

of the observed changes are unprecedented, with widespread negative impacts and associated loss and damage to both human and natural systems [IPCC, 2023], including urban areas. Cities have, over time, become a privileged

*Climate change represents one of the most urgent challenges of the 21st century; Historic Centers are highly vulnerable to its effects, and, in a scenario of worsening climate regimes, it is crucial to explore innovative methods and tools to promote adaptation to climate change specific to these multi-*

*risk contexts. However, research in this field is still underdeveloped, especially when it comes to the active involvement of territorial stakeholders in identifying and managing multiple climate-related risks-prone areas. This research paper proposes a methodology for participatory planning processes developed within the EU-funded HERIT ADAPT project aims at analyzing the criticalities affecting Historic Centers and co-planning interventions for the multi-risk adaptation of them to climate change. The application of the methodology to the case study of the Historic Centre of Genoa is presented and first results are reported. The goal is to test and generalize the approach to make it as objective and replicable as possible, by identifying processes and technological tools, as well as categories of data that can be easily found in official databases (e.g. ISTAT data, SIT, Municipal Urban Plans, SECAPs, Emergency Plans, etc.) related to historical urban contexts.*

platform for discussion and experimentation on climate change: they cause it -cities account for more than half of the world's population, consume 75 per cent of all energy consumption [UN-HABITAT, 2020] and emit over 70 per cent

of greenhouse gases [Mukim et al. 2023]- and bear its impacts. The increased incidence of extreme weather events is the most evident effect of changing urban climate regimes: pluvial and river floods, droughts, heatwaves, storms, both tropical and extratropical cyclones, atmospheric rivers and compound events. Although cities are affected by the same adverse conditions as their surroundings, the coexistence of context-specific factors ends up exacerbating the negative consequences of various climate events and causing even more severe impacts. Along with increasing population density, higher concentration of productive activities, limited soil permeability, etc., the presence of urban cultural heritage also contributes to the particularly unfavorable scenario that cities are confronted with. Urban cultural heritage is to be understood as a common that contributes to the identity and continuity of urban communities. It includes intangible elements, such as traditions, social practices and collective memories, as well as the (tangible) physical features of cities including Historic districts and Centers [Sadowski et al. 2018]. The latter represents a non-renewable resource that embodies the link between the community and space: despite their intrinsic value, today Historic Centers are highly vulnerable to current and future climate-related phenomena, negatively impacting the degree of resilience of the whole city. Such vulnerability is mainly due to their urban, architectural and socio-economic characteristics:

- First, Historic Centers are generally typified by a dense layout: while certain density configurations can enhance factors positively associated with health and life quality (e.g. walkability, accessibility to services, and opportunities for social interaction) [Pont et al. 2023], these same morphologies often suffer from impervious surfaces, acute poor airflow, high thermal mass, etc. and do not allow much room for maneuver where it is necessary to intervene through comprehensive adaptation strategies, such as the re-integration of nature [Tzortzi et al. 2022]. Furthermore, excessive or poorly managed density can generate environmental stressors that can lead to climate-related mortality and morbidity [Cleland et al. 2023].
- Second, materials (generally, but not exclusively: metal, stone, glass, wood and ceramics) and structures in Historic Centers are particularly vulnerable to increased flood frequency and magnitude, as well as wind-related hazards, which initiate mechanisms of corrosion, biological growth, salt crystallization and erosion of materials and related direct impacts (e.g. decay, erosion, collapse of building, etc.); in addition, an increasingly warm and dry climate also leads, on the one hand, to the degradation of materials and, on the other, to soil desiccation and the subsidence of building foundations [Sesana et al. 2021].
- Third, Historic Centers have spatial exter-

nalities (e.g. the attractiveness of visitors and tourists, as well as residents, investors, entrepreneurs in the creative industry, etc.); however, this centripetal force concentrates a large number of local economic activities -which often work to preserve local folk traditions- in urban areas where the tension between the conservation of the past and adapting for future needs is palpable [Kourtiti et al. 2014].

Against this backdrop, it is more crucial than ever to act proactively and explore innovative methods and tools for promoting multi-risk adaptation of Historic Centers to climate change, considering the context-specific characteristics of the territory in which intervention occurs. Speaking of which, Sabbioni and colleagues [Sabbioni et al. 2010] propose recommendations for planning adaptation interventions to the impacts of climate change and accompany these with management guidelines (e.g. monitoring, maintenance, preparation). More recently, Blavier et al [Blavier et al. 2023] review practical solutions for adaptation to climate change, offering a categorization of such measures into traditional (e.g. façade drips, storm rolls, etc.), adaptive technological (e.g. actively ventilated crawl spaces, seasonal insulation, spaceframe system foundation, etc.), and emerging technological (e.g. solar refrigeration technologies, active cooling systems in crawl spaces, etc.). Rosso and co-workers [Rosso et al. 2023] cluster the (Ital-

ian) historic built environment and describe for each proposed category specific combinations of interventions for multi-risk reduction. With a broader perspective, Nicolini [Nicolini, 2024] proposes urban planning strategies to tackle the climate crisis concerning the following urban sectors: energy (e.g. redeveloping public lighting, electrifying the municipal fleet, etc.), buildings (e.g. installing green roofs and walls, designing multi-purpose facilities, etc.), infrastructure and landscape (e.g. waterproofing road surfaces, maintaining and repairing infrastructure, shading public spaces, etc.), transport (e.g. providing different lanes for pedestrians and bicycles, etc.), resources (e.g. storing, filtering and recirculating rainwater, preventing waste, cultivating in urban areas, etc.). Some international organizations also provides inputs regarding soft and cross-cutting actions: ICOMOS [Wilson, 2019] identifies additional variables needed to accompany the implementation of technical adaptation measures: knowledge, understanding and the provision of sectoral leadership are some of the most crucial elements; UNESCO [UNESCO, 2023] clarifies how governance, finance and technological innovation are among the conditions facilitating climate action.

### *1.1. Research Gaps and Rationale for the Research*

Research on multi-risk adaptation of Historic Centers to climate change remains underde-

veloped, with several gaps requiring further investigation. First, a clear understanding of climate change impacts, the design of appropriate metrics and monitoring tools, and the development of methodologies that effectively balance conservation and adaptation are among the most frequently identified unexploited potentials in the literature [Orr et al. 2021]. Furthermore, some authors highlight that interdisciplinary, multidisciplinary, and transdisciplinary studies are still underrepresented, limiting the co-production of integrated and nuanced knowledge of climate change phenomena [Nguyen et al. 2023]. Most contributions to date have focused on technical approaches; the question of how to collectively engage territorial stakeholders in identifying disaster-prone areas and in managing and maintaining urban spaces affected by climate-related multi-risk scenarios remains largely unresolved [Akturk et al. 2024]. Enhanced collaboration, however, represents a significant opportunity to more effectively implement climate change adaptation strategies promoted by the international scientific community [Sesana et al. 2018], the EU [EU, 2022], and UNESCO [UNESCO, 2021]. This research paper contributes to this emerging field by proposing a transdisciplinary and participatory methodology for planning processes aimed at analyzing the criticalities affecting Historic Centers, with the goal of co-planning interventions for multi-risk climate adaptation. Fur-

thermore, the methodology is applied within the EU-funded HERIT ADAPT project (Interreg Euro-MED) to the case study of the Historic Centers of Genoa -specifically the buffer zone defined by the UNESCO Site Management Plan “Strade Nuove and the Sistema dei Palazzi dei Rolli”- and presents first results. The rest of the research paper is structured as follows: Section 2 delves into the topic of participation in the adaptation of historic centers to climate change. Section 3 contextualizes and briefly describes the methodology used in this research. Section 4 applies the methodology to the case study. Section 5 draws the main conclusions of the research and highlights opportunities for further improvement.

## **2. Participation In Adaptation Of Historic Centers To Climate Change**

Participation is an umbrella term that encompasses a range of forms of interaction amongst stakeholders in decision-making processes, from informing and listening through dialogue, debate and analysis, to the implementation of jointly agreed solutions [Hugel et al. 2020]. Despite its still blurry conceptual boundaries, participation is comprehensively considered as a key tool in the multi-risk adaptation of Historic Centers [UNESCO, 2017]. The latter is to be understood as the approach for both moderating or avoiding damage caused by current or projected climate, and for exploiting positive opportunities, by considering mul-

ti-ple climate-related hazards in a territory and their potential interactions that contribute to a social or environmental risk. Such hazards may coincide with, trigger, catalyze or hinder the occurrence of other events, etc. [Stalhandske et al. 2024]. It results from the integration between disaster risk reduction and climate change adaptation, which have been lines of research for a long time addressed by very separate scientific communities. Unlike the traditional paradigm in managing climate-related risk in Historic Centers, which is dedicated to top-down and technocratic conservation models, rooted in architectural preservation and hazard-specific mitigation, participatory planning of multi-risk adaptation to climate change is still underexplored. The origin of this approach might be traced down to Agenda21 [UNCED, 1992], which calls for a close collaboration amongst governmental and local authorities, local communities, NGOs and private business for intervening in multi-risk context. And this is further confirmed and deepened in later frameworks. But, still, between the 1990s and 2000s the theoretical and practical integration of stakeholder engagement and multi-risk approach specifically into cultural heritage climate-related planning persists slowly. Perhaps, the real turning point comes only in the 2010s when the Sendai Framework for Disaster Risk Reduction [UNDRR, 2015] provides a forward-looking and action-oriented agenda: it takes up the legacy of precedent

agreements, advocates for inclusive multi-risk approaches and highlights the role of cultural heritage in promoting urban resilience to the effects of climate change. It is noteworthy that UNESCO [UNESCO, 2023]: recognizes the urgency of climate change impacts already in the early 2000s; values the role of stakeholder engagement in heritage management practices in the early 2010s; but only recently multi-risk approaches to climate change adaptation and governance are incorporating, revealing a space for experimentation and innovation.

However, scientific literature investigating participatory planning processes and stakeholder engagement in the multi-risk adaptation of Historic Centers to climate change is underrepresented. Despite this, literature plays an essential role in the paradigm shift towards participatory planning of multi-risk adaptation to climate change: it contributes to highlighting how traditional top-down practices often fail to properly deal with the challenges posed by climate change, while participatory approaches prove to enable context-specific solutions and increase the legitimacy of adaptation strategies [Holtof, 2018]. Indeed, the inclusion of different categories of actors in the decision-making process fosters the knowledge co-production through the systematization of local knowledge and technical and scientific background; from such synergy, the possibility of developing scientifically sound

and socially acceptable adaptation strategies is maximized [Fatoric et al. 2019]. According to some authors [Li et al. 2020a], literature dealing with cultural heritage (including Historic Centers) climate-related planning generally introduce local communities as “associated users”, supporting functions and meaning of the sites the participatory process focuses on: local identity, sense of belonging, traditions, ownership, custodianship; conversely, Administrations, experts, economic actors and NGOs are generally presented as “facilitators” who support, guide and assist local communities in the decision-making process. To the authors’ knowledge, however, no study has yet applied the Quadruple Helix Model [Cai et al. 2022] to the topic as a way of systematizing the stakeholders to engage.

Among action research techniques, questionnaires or semi-structured interviews are the most common, whereby stakeholders are directly involved, particularly in identifying the objective of the participatory process and supervising the study [Pisa et al. 2024]. Beyond consultative involvement, participatory methodologies adopted in risk management contexts are used -albeit to a lesser extent- in more collaborative and co-decision-making forms, such as local labs, scenario workshops, gamified activities often supported by digital tools. Participatory Geographic Information Systems [PGIS/PPGIS] stand out as effective tools, as they enable the mapping of both

scientific data (for instance, data extracted from planning tools) and local knowledge, lived experience, and perceived risk among stakeholders. In doing so, they provide a continuously updated, participatory planning and decision-support system. Barbi et al. [Barbi et al. 2020] offer a valuable example in this regard: the authors engaged residents in co-designing climate-resilient cultural routes that connected heritage value with environmental awareness, linking heritage preservation with climate adaptation goals. The ResCult project developed a 3D-GIS compliant with INSPIRE standards by combining data on hazards, vulnerability, heritage and stakeholder/user interfaces to facilitate continuous monitoring and preventive planning [Colucci et al. 2022]. Moreno et al. (2024) studied how the use of remote sensing and GIS data can predict subsidence and damage to historic fortifications due to heavy rainfall, also incorporating elements of perceived vulnerability and historical material conditions. Other scholars [Del Espino Hidalgo et al. 2023] experimented with collaborative maps in vulnerable rural areas, where citizens actively participate in building heritage knowledge and identifying environmental and infrastructural criticalities. Clearly, several challenges remain in implementing participatory planning processes for multi-risk climate change adaptation in Historic Centers. How to effectively integrate the quantitative data typically used in disaster risk

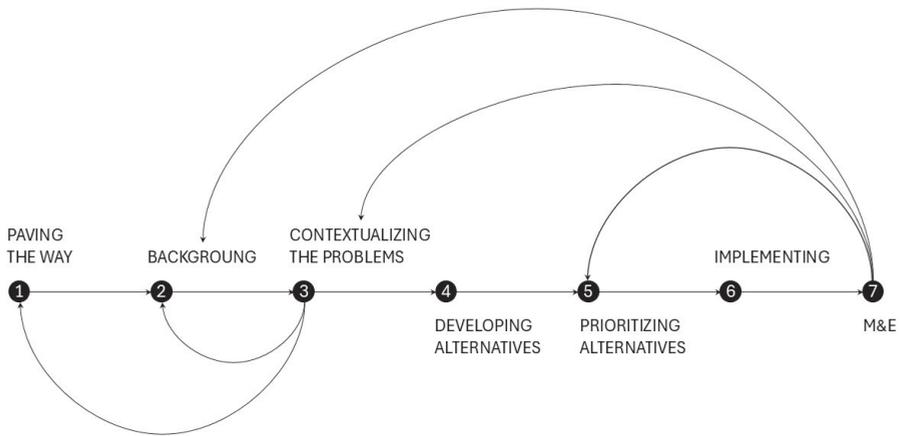
## Methodological framework.

Fig.1

reduction and climate adaptation with local knowledge remains an open question. Moreover, there is still limited understanding of how to systematically manage the coexistence of diverse social groups characterized by varying levels of digital literacy, language barriers, and unequal access to information sources. Finally, cultural and institutional inertia continue to undermine efforts toward awareness-raising and co-creation, preventing such initiatives from fully empowering the stakeholders involved [Egusquiza et al. 2023].

### 3. Methodology

The research paper presents a methodology for participatory planning processes [FAO, 2003] for the analysis of spatial criticalities affecting Historic Centers, to co-plan interventions to adapt to climate change in multi-risk context (Fig.1). To address the gaps highlighted in Section 1.1, this process innovatively enhances the typical steps of heritage management [UNESCO, 2013] with the useful phases of planning urban regeneration projects [Natividade-Jesus et al. 2019], the stages of designing climate change adaptation strategies [ClimateADAPT, 2016] and the cycle of participatory action research [Cornish et al. 2023; Feekery 2024]. It is defined as a flexible yet potentially dynamic set of best practices, capable of responding to developments -often unforeseen- within the specific context of intervention.



### 3.1. Phase I-Paving the way

Phase I covers all those anticipatory governance actions in support of the participatory planning processes for multi-risk adaptation. It is initially necessary to set up a working group that includes the actors of the Quintuple Helix Model of Innovation -Administration, Business, Academy, Third Sector, Citizenry- thereby enabling the synergistic integration of scientific expertise, public governance, economic actors, and civil society. This approach ensures that resilience strategies address not only technical and infrastructural aspects but also social, cultural, and ecological dimensions, generating contextualized solutions that are accepted, sustainable, and resilient over the long term [Iaione et al. 2022]. High-quality participation is further indicated by engaging already well-established and active networks, provided they are complemented by other skills and actor categories to avoid participation fatigue and the repeated involvement of the “usual suspects”. The formation of the working group relies on mapping local actors to determine precisely who should be involved, in what capacity, and for what purpose. Engaging local actors implies the need for care-

ful awareness of the ethical implications of such engagement. Participation should be voluntary and conducted with full respect for the privacy, rights, and autonomy of all participants. Particular attention should be paid to avoiding the reinforcement of existing power imbalances, the marginalization of less visible groups, or the imposition of external agendas. Maintaining ethical vigilance safeguards both the integrity of the participatory process and the trust of the involved actors [OECD, 2022]. The working group is tasked with co-developing a clear work programme, as well as coordinating and monitoring its implementation. Drafting the programme requires several preliminary actions: ensuring that all members are fully informed about the framework guiding the process, i.e. the multi-risk adaptation of Historic Centers to climate change and the added value of participation; homogenizing the degree of perceived environmental risk among group members; aligning members’ perceptions of environmental risk; securing political support; reaching consensus on the vision, specific objectives, and targets to be achieved, both in terms of strategic directives and the macro-categories of climate-related risks to

address; conducting an ex-ante assessment of the necessary (financial, human and technical) resources; defining a timetable, thematic sub-groups, and a clear division of responsibilities. These tasks can be effectively carried out through dedicated workshops conducted in a hybrid format, combining in-person and remote participation. Hybrid settings often encounter technological barriers and imbalances in participation between online and on-site attendees. To overcome these challenges, it is essential to ensure the use of equitable and inclusive interaction tools, such as web-based platforms like Mentimeter (successfully employed within the SUSTAINadapt project) and Wooclap (effectively applied within the EU City Lab project). These platforms provide virtual environments that can be accessed without the need for login credentials, using either an alphanumeric code or a QR code, and allow participants to engage anonymously. This feature encourages immediate involvement through some of the most established participatory techniques (such as polls, brainstorming, and cognitive mapping) which can be easily managed and used by both in-person and remote participants. Furthermore, these tools offer instant and continuously updated visual representations of participants' inputs, creating a dynamic foundation for in-depth intra-group discussion. Interspersing the use of digital platforms with structured opportunities for oral discussion is essential to avoid

superficial responses that overlook the complexity of the phenomena under examination and to promote deeper qualitative interaction. The latter are among the most significant limitations, in addition to potential difficulties arising from limited familiarity with the tools, which may result in initial time loss and participant frustration.

### *3.2. Phase II-Background*

Phase II intends to collect all data necessary for the definition of strategic actions for multi-risk adaptation. In alignment with the work programme, the working group identifies and agrees upon the data generation methods that best correspond to the specific objectives of the process. Subsequently, the group undertakes the collective collection and documentation of data relevant to the case study. The first step is to consult existing planning tools and urban policies from which to extract raw data relating to socio-economic (ISTAT and Municipal Urban Plan), environmental (River Basin Plan, SECAP, Landscape Plan and other sector plans and strategies) and territorial governance dimensions; climate trends (considering hazards), the impacts of climate change and the propensity of the case study to suffer damage (calculating vulnerability), the environmental and local actors conditions (assessing vulnerability and exposure); and the adaptation measures already in place or planned (preventing maladaptation) can be

consulted in the SECAP, in the Civil Protection Plan or in further plans approved ad hoc. This can be done collaboratively among the members of the working group in a brainstorming session [ISPRA, 2013], but care must be taken to prevent loss of focus or dominance by some participants, which could marginalize others' contributions. It is also essential to activate a cycle of on-site visits and participatory walks [Evans et al. 2011] to engage additional local actors - not formally part of the working group- met on the territory in an unpremeditated way [consult the ClimateGO project]. These latter are conducted by a thematic subgroup and involve the collection of qualitative and quantitative indicators selected ad hoc for the multiple risks identified in Phase I. However, systematically recording and organizing field observations can be challenging, particularly when multiple participants contribute simultaneously. The on-site visits represent the opportunity to collect photographic material to support the documentation of spatial conditions and highlight the specific characteristics of the context. Participatory walks enable the collection of contextual information that helps to fill the gaps often found in data obtainable from official public databases. They add interpretive depth to previously conducted analyses by incorporating the local knowledge and lived experiences of community members. Nevertheless, it should be acknowledged that the individuals encountered along the route

represent a non-representative subset of local stakeholders. Their perceptions are also likely to be context-dependent, for instance influenced by weather or immediate environmental conditions.

### *3.3. Phase III-Contextualizing the problems*

Phase III involves interpreting the data to identify criticalities and opportunities, which are to be addressed and leveraged, respectively, in the subsequent phase of developing alternative solutions. In participatory planning processes, it is essential to triangulate the collected data -that is, to integrate and harmonize qualitative and quantitative methods and/or data sources- to enhance the understanding of phenomena and validate interpretations [Hanson-DeFusco, 2023]. To complement technical studies on planning tools, online questionnaires are among the most widely used techniques in participatory planning processes. To administer them, it is necessary to rely on platforms for designing anonymous online questionnaires such as LimeSurvey and GoogleForm [tested in the RAINMAN and STRENCH projects, respectively]: allow questionnaires to be customized using a wide range of question types, enabling efficient data collection and analysis. Moreover, being open-source software, they offer a high degree of flexibility and adaptability to specific research needs. Although questionnaires may at times flatten the depth and

nuance of the responses obtained, their use nonetheless represents one of the most efficient and scalable tools available for gathering structured information. Conducting a series of semi-structured interviews with experts in specific sectors represents a time-efficient approach to obtaining relevant information too. Despite the difficulties inherent in comparing and standardizing the collected information, such interviews substantially improve comprehension of the territory and the dynamics that shape it. Phases II and III are closely interconnected and are presented here in chronological order solely for conceptual clarity. In practice, however, participatory planning processes are highly iterative, and these phases often overlap and become indistinguishable, as stakeholder engagement frequently involves working with already processed data. To capture a snapshot of the case study, the working group members may conduct a PPGIS session in which they collaboratively create a shared map highlighting localized or areal criticalities related to the multiple macro-categories of risk defined during Phase I. Technological barriers for non-expert participants constitute a significant limitation, which can be mitigated by providing facilitator support and ensuring that the map includes reference landmarks for spatial orientation, as well as pre-processed information derived from existing planning tools and urban policies. Google-

MyMaps represents an effective tool for this purpose (as already employed within URCA! and ADAPT projects). It is user-friendly even for participants whose digital literacy is limited to everyday tasks; it allows downloading data gathered via participation in formats directly importable into Geographic Information Systems [GIS], tools extremely useful at this stage of the process (and subsequently) to robustly manage datasets subjected to recurring changes, visualize through multi-level representations of a large number of spatial data for urban planning purposes and develop models to thoroughly characterize the case study. An important consideration, which also guides the subsequent selection of multi-risk adaptation alternatives in Phase IV, is the degree of elasticity inherent in the planning process. This involves identifying, a priori, the barriers imposed by key legal, regulatory, and political frameworks that influence climate change adaptation in multi-risk contexts. A practical approach to achieve this is through a participatory SWOT analysis, which can generate a structured database of strengths and weaknesses (arising from within the case study) and threats and opportunities (emerging from external factors) to guide planning strategies [Tavares et al. 2021]. It is crucial to ensure that the use of SWOT does not devolve into a superficial or overly cursory listing of factors but rather facilitates in-depth reflection and critical discussion.

### 3.4. Phase IV-Developing alternatives

Phase IV entails the compilation of a catalogue of relevant adaptation options, building on the insights generated in Phases II and III. To this end, the working group collaboratively collects good practices, which may be sourced from scientific and grey literature, emerge from innovative combinations of traditional actions, or consist of original and novel interventions (consult the ADRISEISMIC project). Each participant enters in a shared spreadsheet the good practices of his knowledge, categorized by: typology (plans and strategies, processes, technologies, other); objectives and expected results; applicability and adaptability to the case study. It is then possible to set up a shared spreadsheet in which each participant -within a workshop or autonomously- can enter good practices, categorized by type (plans and strategies, processes, technologies, others); objectives and expected results; applicability and adaptability to the case study. In this context, GoogleSheets (a platform not previously employed in participatory planning workshops) can be effectively utilized, as it demonstrates many of the advantages of GoogleMyMaps (see subsection 3.3). A key factor for the success of these methods, particularly when collaborating with stakeholders during regular office hours, is to make access links to the shared map and spreadsheet available for a flexible period. This approach allows data to be integrated at a later stage, including contribu-

tions from absentees or collaborators who join subsequently. This flexibility, while beneficial, may lead to unintentional alterations or data loss, and therefore requires careful oversight and clearly established guidelines.

### 3.5. Phase V-Prioritizing alternatives

Phase V encompasses all assessments carried out to propose a hierarchy of multi-risk adaptation alternatives, indicating their recommended sequence of implementation. From a multi-risk perspective, it is essential to examine the interrelationships among the pool of good practices, the macro-categories of climate-related risks identified in Phase I, and other projects already approved by public authorities. The objective is to ensure that the implementation of any specific action does not undermine the effectiveness of other policies or projects, contribute to maladaptation, or exacerbate the vulnerability of Historic Centers to additional risks. These aspects can be explored in a brainstorming session facilitated through Miro platform (used as part of the Climatactions project) which provides participants with a versatile and collaborative digital workspace. Its whiteboard enables real-time interaction, fosters visual thinking, and improves coordination among geographically distributed teams. The use of pre-structured templates, clearly defined roles and timelines, and a final synthesis phase with all participants helps mitigate risks of data dispersion

**a) national level: Italy;**  
**b) regional level: Liguria;**  
**c) municipal level: Genoa;**  
**d) the case study perimeter**  
**(buffer zone).**

Fig.1

or loss. At this stage of the process, the participants can implement a territorialization of the proposed alternatives on a shared map; in this PPGIS activity, the marked points may represent specific interventions, and the polygons may be broader infrastructural or social policies, programmes or interventions. Comparing solutions through environmental, social and economic benefit-cost analysis is ultimately the responsibility of Public Administration and other actors contributing to financing multi-risk adaptation action. In this case, you can consult the experience developed within the BASE project.

### 3.6. Phase VI-Implementing

Phase VI corresponds to the operational phase, which involves drafting, reviewing, and approving a clear Action Plan to be integrated into urban policies and planning tools.

### 3.7. Phase VII-Monitoring and Evaluation

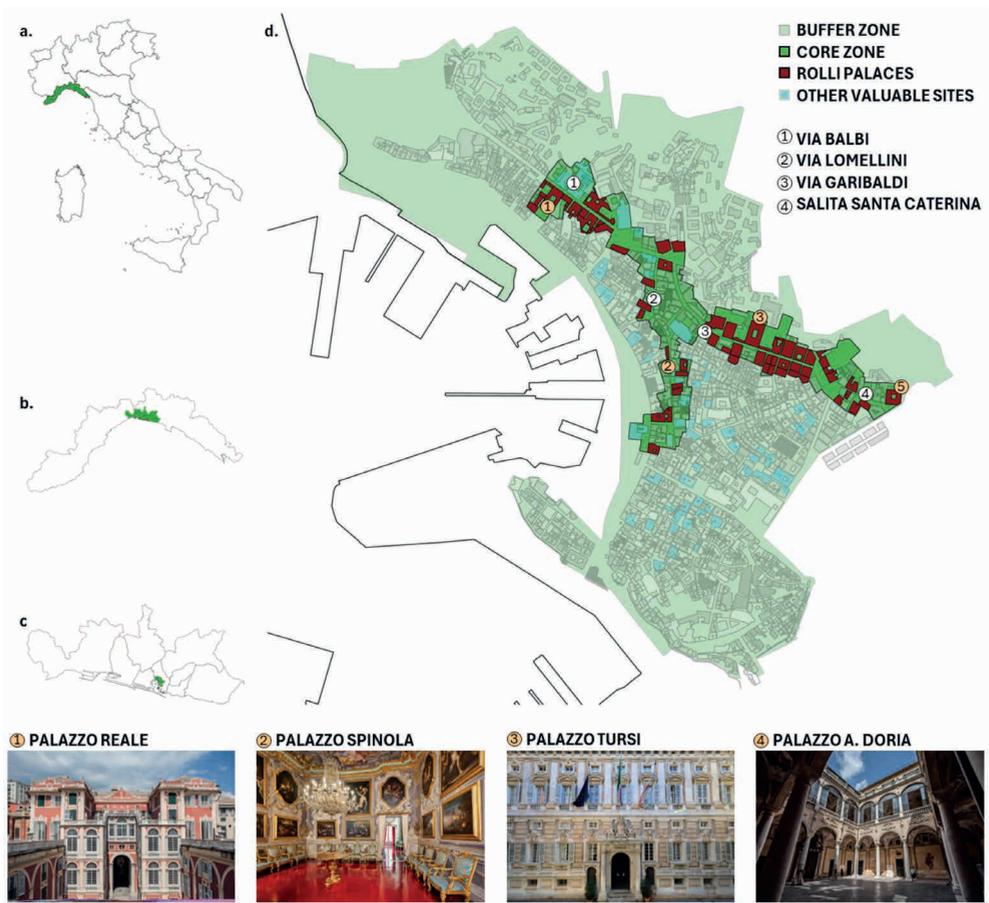
Phase VII involves the development of a monitoring and evaluation approach, the use of maintenance mechanisms, process improvement and continuous learning. The monitoring and evaluation of co-planned multi-risk adaptation actions can be carried out through the participatory application of a system of qualitative and quantitative indicators, which encompass process indicators (tracking the implementation of adaptation measures), outcome indicators (assessing the direct ef-

fects of these measures), and impact indicators (evaluating long-term changes in urban resilience), thereby combining local knowledge with scientific assessments to ensure relevance and effectiveness [Feldmeyer et al. 2019]. Establishing a shared data collection platform, digital or physical, for working group members and partially for public access, is desirable to promote transparency and ensure the traceability of information. This phase also encompasses the transparent dissemination of project results through both institutional and informal channels of the working group members. It includes identifying public meetings and press conferences during which intermediate results of the process can be communicated.

## 4. Application

### 4.1. Case Study: Strade Nuove and the Sistema dei Palazzi dei Rolli

The selected case study is the Historic Center of Genoa and, more specifically, the buffer zone defined by the Management Plan of the UNESCO Site “Strade Nuove and the Sistema dei Palazzi dei Rolli”. Genoa is a medium-sized city (24,013 ha) located in northern Italy and 2022 data state that it hosts a population of almost 566,410 thousand (density of 94 inhabitants/ha in urban areas) (Fig.2a-b) [ISTAT, 2023]. According to the Kopper-Geiger climate classification, the city belongs to the Mediter-



ranean CSA zone, characterized by a temperate climate with hot and dry summers (total annual rainfall and maximum daily temperature are: 1340 mm; 19 °C on average). In 2024 Genoa is the second major Italian city most affected by the climate change effects while Liguria is the first region for number of extreme events recorded per km<sup>2</sup>, i.e. 1/319 km<sup>2</sup> [Legambiente, 2024]. Due to its morphology, Genoa is mainly subjected to: floods, where soil sealing is high and urban development interferes with the characteristics of watercourses; heat-waves, where most of the elderly population is concentrated; windstorms, in correspondence with built environments undergoing maintenance, with decorations, overhangs,

etc.; storm surges, especially in correspondence with urbanized coastlines; wildfires near peri-urban forests, Mediterranean scrub and cultivated fields [SECAP, 2020]. As far as the urban environment is concerned, the Historic Center of Genoa represents a hotspot and an interesting urban lab for experimenting with multi-risk approaches: the city has an old age index -i.e. the ratio between the population aged 65 or over and the 0-14 age group- equal to 249, 84 units higher than the national average and the population over65 is concentrated mainly in densely populated areas, including the Historic Center; the city hosts 40% of the foreign population of the entire region who live predominantly in the Historic Center and

## Participatory planning process for multi-risk adaptation.

Tab. 1

in a few other border neighborhoods; tourism is one of the municipal driving economic sectors and the Historic Center is a gathering area for various tourist flows; among the various elements on exposure, the Historic Center also has tangible cultural heritage to be adequately conserved in light of the increasingly pressing effects of climate change.

The Historic Center of Genoa is one of the largest medieval centers in Europe (about 198 ha) and is made up of the districts Prè-Mollo-Maddalena (about 113 ha) and the historic port area (85 ha), for a total of about 23,000 inhabitants (Fig.2c). It is characterized by a predominant medieval settlement structure (12th-13th century), still recognizable in the pace of the building parcels and in the architectural features of the buildings, which leads to a high density with an overall volume of approximately 10,000,000 m<sup>3</sup>. Yet, the Historic Center shows a certain degree of urban heterogeneity, given the local custom of building on already existing structures, the numerous architectural modifications carried out during periods of economic prosperity and growth of the city, the interventions on the road network, the reconstructions following the bombings by the French fleet in 1684; the repression carried out by the Savoy of the independence movements of 1849; the attacks by the allies in the Second World War. A more recent notable transformation -dating back to the last three decades- takes place since the redevelop-

ment of the waterfront in 1992 (International Exhibition) with the consequent repurpose of buildings originally intended for port warehouses and the enhancement of both the piers and the surrounding public spaces. This revitalization is mainly dictated by the contraction of employment in the port sector and the crisis of maritime passenger transport, with consequent depopulation of the urban area (in favor of public housing in the hilly neighborhoods) and an increase in social, building, architectural and urban degradation. The urban planning strategy is to guide the city in the dismantling-delocalization of industrial activities and promote a new tourist vocation. In doing so, the Historic Center is suffering from the gentrification of some areas and the consequent social exclusion of the weakest and most marginal groups; therefore, in addition to a certain climatic vulnerability and urban complexity, the Historic Center also shows a certain degree of social complexity, both in terms of residential and fruition [PUC, 2015].

In line with the revitalization of the Historic Center (1990s-the early 2000s), the reorganization of cultural circuits and the valorization of the tangible cultural heritage also take place. including the inscription of the Site "Strade Nuove and the Sistema dei Palazzi dei Rolli" on the World Heritage List in 2006. The Site represents the first example in Europe of an urban development project parceled out by a public authority in a unitary framework and

Method	Setting	Goals	Techniques	Tools	Actors
I Workshop	In presence	Co-designing the adaptation process	Presentations	Power Point	Quintuple Heix Model
			Polls	Wooclap	
			Brainstorming	Wooclap	
II Workshop	Remotely	Background and contextualizing	Presentations	Power Point	Quintuple Heix Model
			Community mapping	Google MyMaps	
			Good practices	Google Sheet	
I Interview	Remotely	Contextualizing	Semi-structured interview	Microsoft Teams	Local Administration Academia
II Interview	Remotely	Contextualizing	Semi-structured interview	Microsoft Teams	Academia
On-site visits	In presence	Contextualizing	Indicator-based site inspection	Photographic support	Academia
Survey	Remotely	Contextualizing	Participatory SWOT	LimeSurvey	Quintuple Heix Model
III Workshop	Remotely	Planning and prioritizing alternatives	Presentations	Power Point	Quintuple Heix Model
			Brainstorming	Miro	
			PPGIS	Google MyMaps	

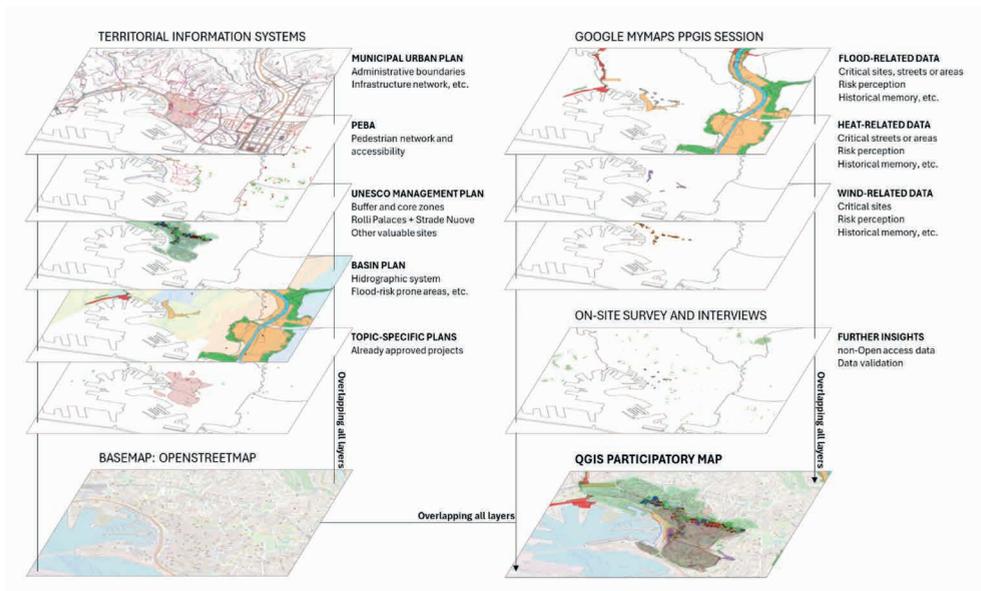
associated with a particular network of private residences intended to host state visits: these residences (accommodation of the most powerful aristocratic families of the then Republic of Genoa), according to a decree of 1576, are in fact classified by the value of the land and the quality of the building and divided into three categories; each of them corresponds to a different degree of dignity of the visitors, including ambassadors, dignitaries, sovereign princes, popes and emperors. The Site includes 42 Renaissance and Baroque palaces -Rolli- along the streets with the highest concentration of noble residences, namely Via Garibaldi, Via Balbi, Via Lomellini and Salita Santa Caterina (Fig.2d). The buildings, generally three or four floors high, are characterized by spectacular staircases, courtyards and loggias overlooking gardens, built on different levels in a relatively small space. The buildings offer an extraordinary variety of different solutions and achieve universal value by adapting to the peculiar characteristics of the Historic Center of Genoa and to the needs of a specific social and economic organization.

In this context, the EU-funded project HERIT ADAPT aims at strengthening the resilience of tourist destinations in the Euro-Mediterranean area, increasing the capacity to adapt and mitigate the risks of urban natural and cultural heritage related to tourist overflow and climate change.

#### 4.2. The Participatory Planning Process for Multi-Risk Adaptation

The research was carried out by activating a participatory process and applying specific engagement techniques for participatory spatial analysis to make cities -and Historic Centers- resilient to climate change (Tab.1).

A 1st Workshop was organized to pave the way (Phase I). The established working group included the following categories of stakeholders: local, regional and national administrators; the local Chamber of Commerce; trade associations; private businesses; the University; foundations and cultural associations operating in the territory; representatives of the citizens. The composition of the group aligned with the Quintuple Helix model of Innovation



and drew on the Management Committee of the UNESCO Site of Genoa, a formalized body previously tested and subsequently expanded within this participatory planning process for multi-risk adaptation of the Historic Center, encompassing the following profiles: technical experts in sustainable tourism management and/or climate change adaptation; and professionals in urban planning and facilitation of participatory planning processes. The University of Genoa took on the role of facilitator of the process; Administrations, public bodies and private companies that of supporters and financiers; Third Sector bodies and citizenry that of gatekeepers and end users. An instant poll conducted via Wooclap to assess participants' perceptions of the case study's resilience to climate change revealed a lack of consensus: 50% of working group members considered the territory already resilient. The direct poll was introduced briefly and subsequently served as a starting point for more in-depth reflections, thereby overcoming the potential limitation of oversimplifying com-

plex issues. From these reflections, the need to organize capacity-building activities and to engage specialized expertise in climate change adaptation emerged. Subsequently, the group identified the most widespread hazards in the territory, categorizing them into three macro-groups: hydraulic, wind-related, and heat-island risks. This task was addressed during a brainstorming session, in which the risks of topic dispersion or dominance by certain participants were mitigated through several measures: setting a maximum time for individual interventions and encouraging contributions grounded in information available from existing planning tools. Notably, the outcomes of this session were consistent with the municipal Action Plan for urban resilience. Finally, the group planned several information dissemination actions, including the preparation of targeted press releases for distribution through the official websites of participating stakeholders and participation in relevant international events.

A 2nd Workshop was held (Phase II and III),

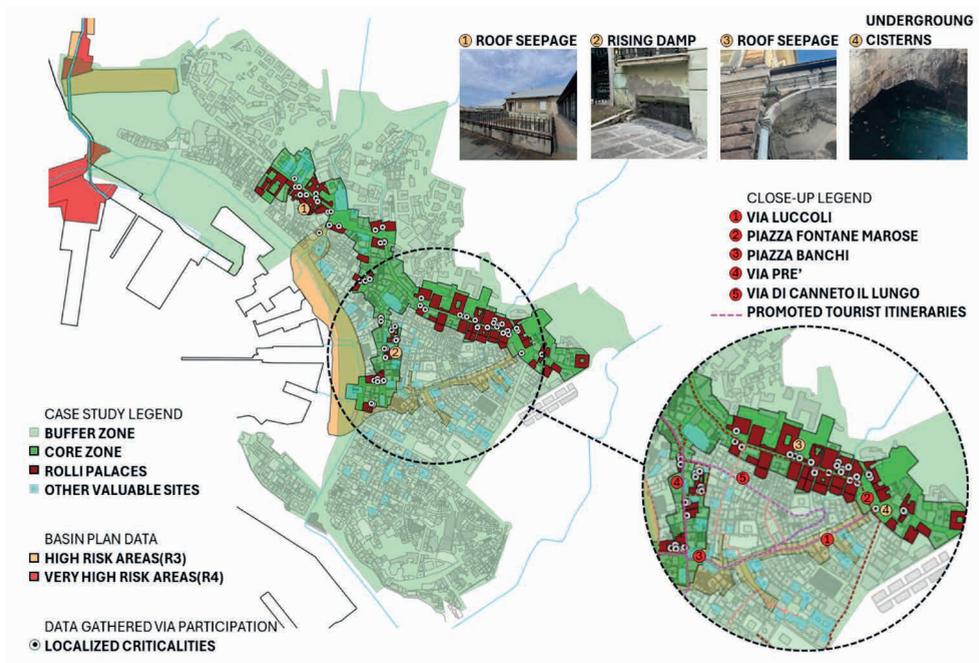
**The co-mapping procedure. As outlined in the text, this figure conceptually depicts the overlap within the GIS environment of data obtained from technical sources as well as non-technical sources.**

Fig. 3

and a capacity building activity was provided regarding the adaptation of Historic Centers to multiple risks through brief presentations by ad hoc experts. Based on the new knowledge acquired, the members of the working group co-produced a participatory map of the localized and areal criticalities related to hydraulic, wind-related and heat-island risks. As described in Section 3.3, the PPGIS activity was implemented using the GoogleMyMaps platform. No technological barriers or usability issues were reported by non-expert participants. In some cases, participants experienced cognitive fatigue and a temporary loss of attention. To address this, the link to the shared map was kept available for a pre-agreed period, allowing all workshop participants to contribute data at a later stage.

Subsequently, the georeferenced information collected during the workshop was downloaded from GoogleMyMaps and as shown in Figure 3, integrated with other datasets in QGIS. As shown in Figure 3, OpenStreetMap was set as the base map in QGIS. The datasets derived from existing planning tools -as reported directly by the working group during a brainstorming session (1st Workshop)- were then added. These included, for example, the Municipal Urban Plan, the Plan for the Elimination of Architectural Barriers (PEBA), the UNESCO Management Plan, the Basin Plan, and several sectoral plans. Up to this stage, the mapping process reflected the current state of affairs,

based on the knowledge already held by the Public Administration. Subsequently, the layers produced during from the PPGIS activity with GoogleMyMaps were incorporated. Participants identified critical sites, roads, and areas, but more importantly, they spatialized their perceptions of risk and historical memory. This information was then integrated with findings from on-site visits, participatory walks and interviews. During the on-site visits, photographic material was collected to validate data obtained from other sources. In the participatory walks, non-preselected local stakeholders accompanied the technical team through the study area, jointly reflecting on past events and on bottom-up self-protection strategies. Interviews were conducted remotely in a semi-structured format. Two experts on the Historic Center of Genoa were involved: one senior official from the public administration and one researcher from the local university. These profiles were selected based on internal discussions within the working group and according to their specific expertise (convenience sampling). The interviewer prepared only two guiding questions: Which places are the most critical in terms of hydraulic, wind-related and heat-island risks, and why? and What are the reasons for these criticalities, and how has action already been taken or is planned to be taken? After initial transcription, the data were georeferenced and incorporated directly into the GIS environment.



## Georeferenced participatory map of criticalities concerning hydraulic risk.

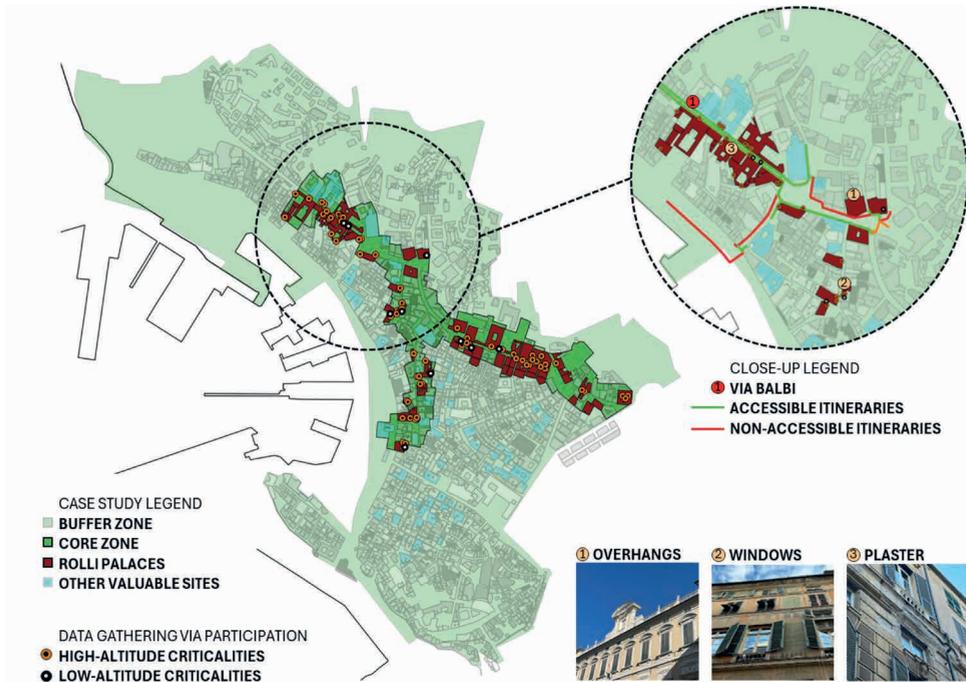
Fig. 4

In terms of hydraulic risk, the areas identified as critical were Via Luccoli, Piazza Fontane Marose, Piazza Banchi, Via Prè, and Via di Canneto il Lungo, primarily due to rainwater flow, aligning with the risk areas highlighted in the Basin Plan. A notable concern is that these areas intersect pedestrian tourist routes promoted by the Municipality of Genoa, increasing exposure during peak tourist seasons. Localized criticalities were especially evident near the Palazzi dei Rolli and historic villas, which feature exposed lower floors, deteriorating roofs, blocked drains, and impermeable surrounding pavements. Figure 4 illustrates the georeferenced participatory map of hydraulic risk criticalities.

Regarding wind-related risk, mapped critical elements included overhanging features above

roofs and balconies, severely degraded window and door frames, and detached or raised slabs in relief decorations, plasters, or stone coverings. Via Balbi was identified as one of the most critical areas, experiencing high pedestrian traffic from residents and tourists due to its role as a key intermodal transport corridor near the central station and multiple bus, metro, and vertical lift stops. It is also one of the few streets currently recognized by PEBA as accessible to people with psychomotor limitations. Figure 5 shows the georeferenced participatory map of these criticalities.

For the macro-categories of risk “heat-islands”, areas such as Piazza della Commenda, Piazza Caricamento, Via Turati, Piazza Sarzano, and Via Dante were mapped as particularly prone to elevated summer temperatures. Via Turati



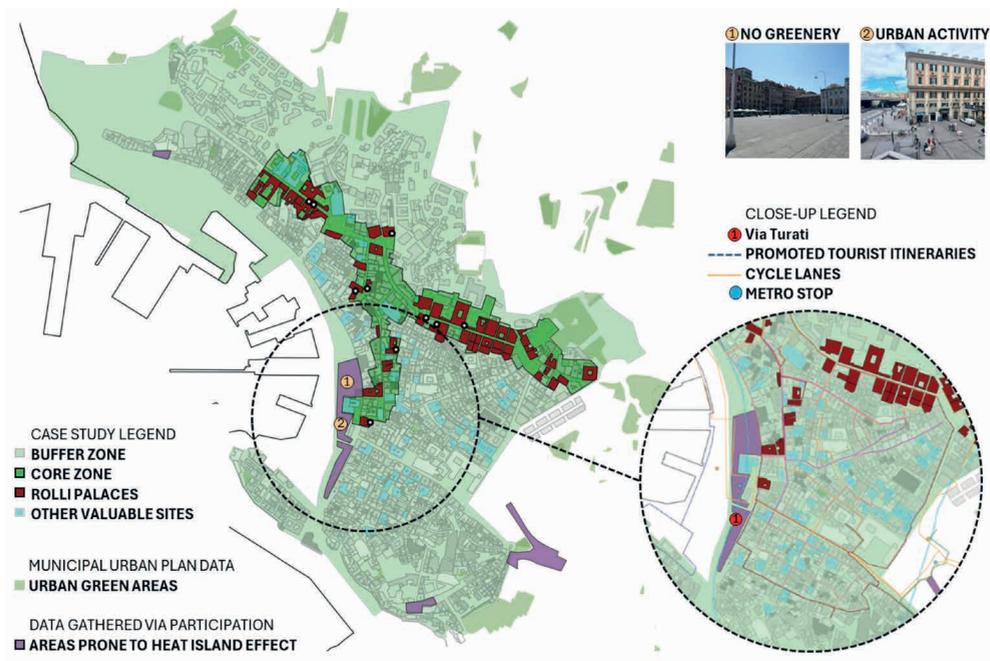
## Georeferenced participatory map of criticalities concerning wind-related risk.

Fig. 5

warranted special attention due to heavy vehicle traffic, impermeable surfaces, and the absence of shading (neither natural nor artificial), despite its importance for residential, commercial, and tourist activities, as well as its cultural heritage and role in the city's soft mobility network. Figure 6 shows the georeferenced participatory map of criticalities concerning heat-island risk.

Best practices (Phase IV) were determined based on territorial analysis, resulting in participatory maps (Figs. 4, 5, 6) and further elaborated during brainstorming sessions in the 2nd Workshop with GoogleSheets and the 3rd Workshop with Miro. The use of these platforms involved a significant initial learning curve. Reliability of the data was maintained through effective facilitation and by keeping

platform access links active for a pre-determined period, enabling participants to contribute as needed. The most frequently suggested categories of alternatives of solution were: 1\_Awareness and training of stakeholders, beginning with commercial operators and non-technical staff, focused on the main criticalities (such as impermeable roads, exposed ground floors, and commercial activities) and on adaptation and self-protection measures; 2\_Scheduled maintenance of interventions, including the use of innovative technological tools such as periodic photographic monitoring and reality-based 3D modelling, with shorter intervals between maintenance cycles; 3\_Climate-proofing of road surfaces in compliance with historical and monumental heritage, aiming to reduce surface runoff and heat-islands



## Georeferenced participatory map of criticalities concerning heat-island risk.

Fig. 6

while improving accessibility. At the strategic level, priorities included seeking external (national or international) funding, ensuring coherence with existing planning tools, and creating synergies with ongoing projects.

Prioritization of solution alternatives (Phase V) was carried out primarily according to the following criteria: focusing on the areas of the case study most affected by criticalities identified in Phase IV; considering projects and policies already approved or under implementation; evaluating environmental, social, and economic cost-benefits; and taking into account the constraints imposed by planning tools and urban policies. As a first solution, the working group agreed to focus on the Museo d'Arte Orientale E. Chiossone—one of the most important collections of Oriental

art in Europe—located in Villetta Di Negro, on the western side of the UNESCO buffer zone in Genoa. The group decided to enhance the visibility of the museum and Villetta through the installation of vertical and horizontal signage along the most congested and adjacent historic streets, and by integrating recommended accessible routes on official public websites, thereby providing populations exposed to heat-island risk with usable alternatives to the most critical areas (see Fig.6). The working group further decided to improve the museum's climatic adaptation, addressing the absence of an air-conditioning system that adversely affected artefact conservation and visitor experience. Measures included installing climate control systems in showcases containing the most vulnerable artefacts and

engaging start-ups to create digital scans and digital twins for 3D modelling.

### 5. Conclusions And Future Prospects

This research paper presents a methodology grounded in technological tools and processes, utilizing data readily available from official sources. In the coming months, multi-risk climate adaptation measures will be implemented in the Historic Center of Genoa and their effectiveness systematically assessed. The research will additionally examine the participatory planning process as a driver of innovation and collaborative resilience in Historic Urban Centers.

Overall, the main limitations of the participatory process included cognitive fatigue and attentional lapses, especially during remote sessions. Although activities were clearly introduced, rules were explained, digital and verbal interactions were alternated, and techniques were diversified, engagement was not always maintained. Workshops conducted during working hours may have exacerbated this issue, as participants were subject to workplace distractions. Additionally, map development relied on currently available data and did not integrate novel scenario analyses. Future research could explore cross-referencing the generated maps (Figs. 4–6) with data from initiatives such as the SEAGUL platform, addressing social inclusiveness and economic development, and the ReMED platform, focused

on climate adaptation measures in Genoa.

### Author Contributions

Introduction: F. Pirlone, I. S. and F. B.; Section 2: F. Paoli and F. B.; Section 3: F. Pirlone, I. S., F. B., F. Paoli; Section 4: F. Pirlone, I. S., B. P., F. B., F. Paoli; Section 5: F. Pirlone, I. S., B. P., F. B., F. Paoli.

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# Climate Risk Analysis Related to Urban Heat Islands in Metropolitan Areas for Urban Health: The Case Study of the Florence Plain

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## keywords

urban heat island  
spatial risk assessment  
heat-related health risk  
adaptation strategies

*Urban heat islands (UHI) have become a widespread phenomenon in metropolitan areas worldwide, manifesting as an increase in the average ground surface temperature in urban environments compared to suburban areas. Climate change and intensified urbanization exacerbate this process, making it a key challenge of our time. In this context, urban planning plays a crucial role in developing UHI mitigation plans and adaptation strategies aimed at enhancing urban livability and climate resilience. This research*

## 1. Introduction

In recent years, the climate emergency has impacted various environments across the globe, manifesting through extreme temperatures and severe natural hazards, and leading to an

increase in hot days and tropical nights. The World Health Organization highlights that heatwaves are among the deadliest natural hazards, with older adults, infants, and socially disadvantaged groups being most at risk. Elevated temperatures contribute to an increase in human mortality, a phenomenon that is further exacerbated during heatwaves, resulting in a spike in deaths (Tomlinson et al., 2011). Densely

*carries out a model for assessing and tackling climate risk associated with UHI in the Piana Fiorentina area, focusing on areas where thermal stress and population sensitivity are especially high, making heat-reduction interventions a priority. The study also proposes targeted responses and simulates the effectiveness of various design solutions for mitigating UHI effects and implementing adaptation strategies, highlighting the potential to adapt this method to other metropolitan areas.*

populated areas are particularly affected, as they tend to heat up more than surrounding regions (fig. 1), creating what are known as 'Urban Heat Islands'.

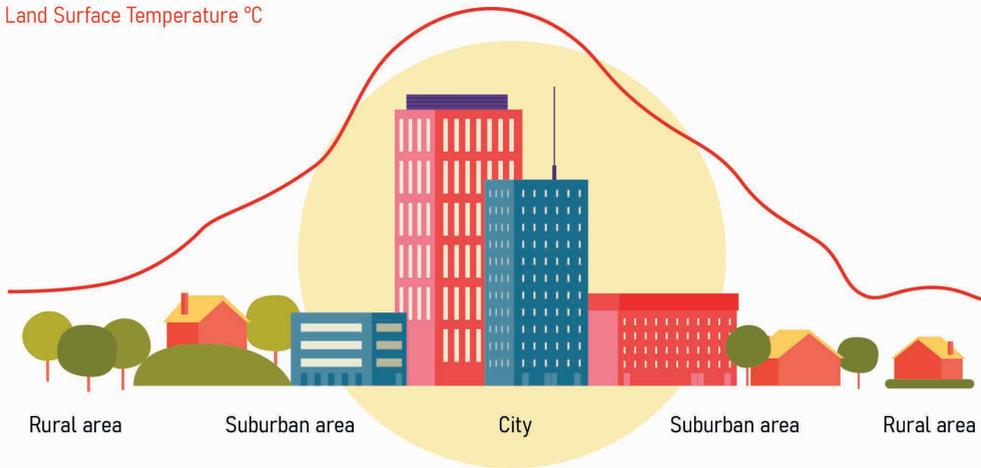
This creates significant discomfort for people who live in cities, which currently account for more than half of the global population, with projections indicating that by 2050, approximately 88% of people will reside in metropolitan areas (Guerri et al., 2021). As population grows, so does the amount of urbanized land, leading to more impervious surfaces such as roads and buildings. The degree of impervious surface coverage, along with the amount of vegetation present, are among the most influential indicators in moderating surface temperature levels in urban environments (Mancuso, 2023).

That's why more and more cities around the world are looking for ways to tackle urban overheating in order to preserve a high quality of life and actively safeguard the health of their inhabitants. This is where technical planning for heat adaptation becomes essential. It identifies the most critical sectors for temperature reduction and develops concrete strategies to address the issue in urban contexts, based on two primary objectives: preventing overheating of the entire urban area and specifically alleviating conditions in vulnerable urban zones. By learning from strategies already implemented in other cities, it is possible to identify the most compatible solutions for the city under consideration.

This study aims to develop a model for analyzing the urban heat island phenomenon in the area known as the Piana Fiorentina, a region that includes 20 municipalities across the provinces of Prato, Pistoia and the Metropolitan City of Florence. The approach combines satellite-based remote sensing data on urban heat with social segmentation data, using a spatial risk assessment methodology to pinpoint areas where heat-related risks may be especially high.

Taking inspiration from Zurich's 'Heat Mitigation Plan' and building on earlier research carried out in this region, the study conducts a climate risk analysis for the Piana area and puts forward adaptation strategies aimed at guiding territorial interventions.

Land Surface Temperature °C



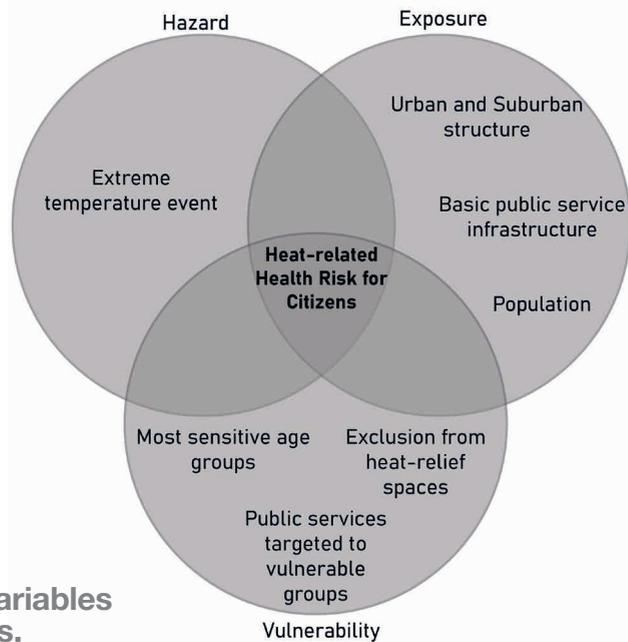
## Conceptual diagram of Urban Heat Island Effect.

Fig. 1

### 2. Materials and Methods

Risk is determined by the interaction of three key factors: Hazard, Exposure, and Vulnerability, as defined in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2014). In the context of heatwaves, the hazard refers to the rise in temperatures. Exposure relates to the presence of people or assets in areas affected by such extreme events, typically measured using census data that show how population is distributed across impacted zones. Vulnerability, on the other hand, reflects the limited ability of individuals or communities to cope with or adapt to extreme heat. This can be influenced by personal factors, such as age or health conditions, as well as urban characteristics, like the availability of adequate infrastructure. By combining these three components, it's possible to create a comprehensive risk map, integrating a hazard index with indicators of exposure and vulnerability. Tools like the Land Surface Tem-

perature (LST) index (Morabito et al., 2015), which captures ground-level thermal variations and serves as a key indicator for assessing the intensity of urban heat, are crucial for informing urban planning interventions aimed at reducing the environmental and public health impacts of extreme heat. Certain demographic groups, including the elderly, young children, individuals with chronic illnesses, or those experiencing social isolation, are particularly sensitive to extreme heat. The physical structure of the city also plays a crucial role: a lack of green spaces and high building density can worsen thermal discomfort and reduce a city's ability to adapt (Buscail et al., 2012). Vulnerability is not a static condition: it can be reduced through targeted and inclusive adaptation strategies. Increasing a system's adaptive capacity directly enhances its resilience to extreme weather events, by reducing both immediate risks and long-term exposure. Climate change adaptation, therefore, involves



## Synthesis chart of risk variables and associated elements.

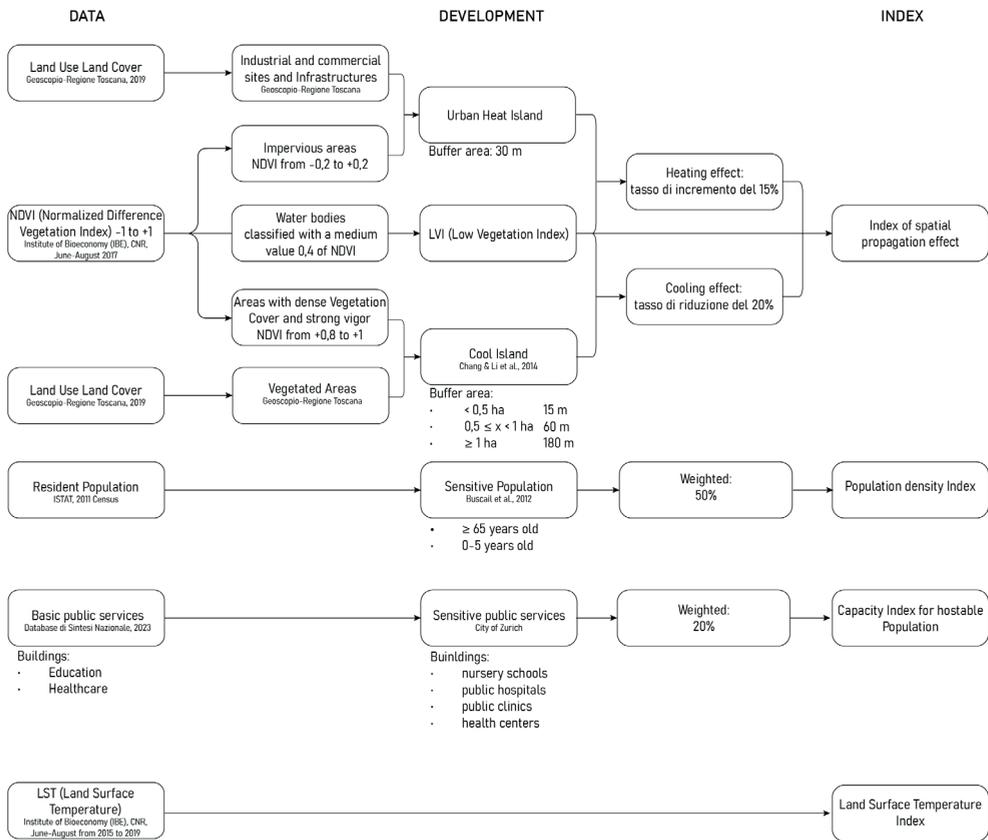
Fig. 2

the implementation of measures that address existing vulnerabilities to minimize future impacts. In urban contexts, this often means rethinking and redesigning public and private spaces to improve their capacity to withstand and moderate the effects of global warming (D'Ambrosio, 2016; Losasso, 2021).

Analyzing climate risk associated with urban heat islands requires a structured investigation of the underlying dynamics driving the phenomenon, along with a detailed assessment of its impacts on the population. This study focuses on identifying the most vulnerable urban areas, those characterized by critical levels of heat stress, where high concentrations of at-risk populations coexist with a lack of green spaces capable of providing thermal relief. The percentage of vegetation cover in the area is derived using the Normalized Difference Vegetation Index (NDVI) and hierarchically classified based on its definition (Morabito et al., 2015).

The vulnerability component adds further depth to the analysis, with particular attention to the most fragile population groups, such as the elderly and young children, who require priority protection measures against high temperatures. Facilities frequented by these groups – including hospitals, schools, and childcare centers – are also considered, as they represent critical points of exposure (fig. 2).

By combining these layers of information, the analysis pinpoints the urban areas within the Piana Fiorentina where climate risk is highest, highlighting priority zones for implementing heat reduction strategies and protecting the population from thermal stress. Among the proposed solutions, the expansion of green infrastructure stands out as an essential strategy, offering tangible and lasting benefits by creating cooler and more livable microclimates within the urban fabric (Morabito et al., 2021). To support the planning of heat adaptation measures, the urban area was analyzed based



## Flowchart of the risk assessment model adopted.

Fig. 3



## Geographic Framework and definition of the study area based on administrative boundaries and the 200-meter elevation threshold.

Fig. 4

on Land Use and Land Cover (LULC) categories. These categories provide a fundamental reference for assessing thermal load and vulnerability, while also serving as a basis for developing city-wide analyses and proposals. They help identify potential pilot areas for testing various operational approaches and developing targeted intervention plans. In this study, raw data for each of the three key variables – hazard, exposure, and vulnerability – were processed and scaled using linear normalization, making the analyses more locally accessible and interpretable (fig. 3). This approach produced synthetic indicators of hazard, vulnerability, and overall risk, all expressed on a standardized scale from zero to one. Such normalization facilitates planning efforts and supports decision-making processes (Buscail et al., 2012). The results of this analysis can also be applied to other areas with similar urban characteristics and environmental conditions, enabling more targeted and effective planning across comparable contexts.

The analysis is structured into three domains (fig. 4), based on Land Use and Land Cover:

- a. Social domain
- b. Spatial domain
- c. Structures domain

Each of these includes relevant exposure factors, from which vulnerability components are derived. This reasoning led to the development of a risk assessment formula in which the indicators of Exposure and Vulnerability

are broken down into the three domains: social, spatial and structural. Among these, the social dimension serves as the essential foundation for evaluating the others, since the aim of this research is to identify areas where the population suffers particularly from high temperatures.

This relationship is represented in the following formula:

$$R = H \times E_a \times V_a \times [(E_b \times V_b) + (E_c \times V_c)]$$

R: Risk

H: Hazard

E: Exposure

V: Vulnerability

a: Social domain

b: Spatial domain

c: Structures domain

### 2.1. Study area

This research considers the territory of the Piana Fiorentina as the study area for the phenomenon of urban heat islands. The area includes 20 municipalities (tab. 1), located within the provinces of Prato, Pistoia, and the Metropolitan City of Florence, from which only the portions of territory located below 200 meters above sea level are selected. This choice was made to reduce elevation variance, as the subject matter requires the analysis to be limited to a geographically and morphologically homogeneous area and focused solely on the most densely populated

Province	Municipality
Pistoia	Pistoia
	Agliana
	Montale
	Serravalle Pistoiese
	Quarrata
Prato	Montemurlo
	Vaiano
	Prato
	Poggio a Caiano
	Carmignano
Metropolitan City of Florence	Signa
	Campi Bisenzio
	Calenzano
	Sesto Fiorentino
	Fiesole
	Firenze
	Lastra a Signa
	Impruneta
	Bagno a Ripoli
	Scandicci

## Municipalities located within the provinces of Prato, Pistoia, and the Metropolitan City of Florence.

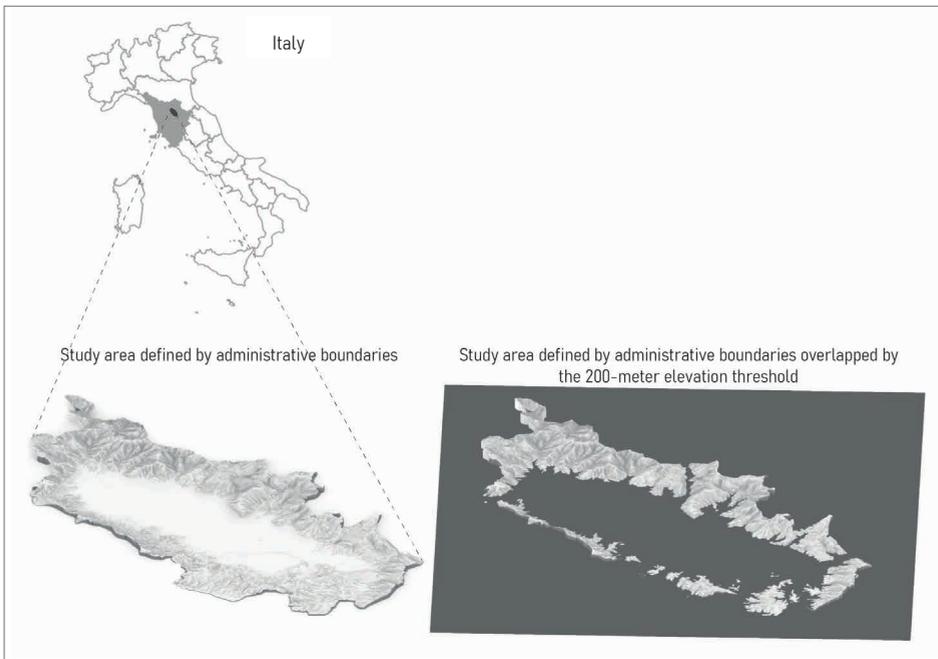
Tab. 1

portion. The boundary of the study area was defined by combining administrative limits and the 200-meter contour line (fig. 5), resulting in a total surface of approximately 675 km<sup>2</sup>. As an additional spatial reference, the reconstruction of the Roman centuriation system was adopted, based on Schmiedt's model (1989), providing a regular extended grid that subdivides the study area and supports both analysis and design. The Roman centuriation offers a coherent, historically grounded spatial framework. In fact, it was a central element of Roman territorial expansion, enabling struc-

tured land planning and resource distribution. Its traces remain visible today, integrated into the current landscape and road network.

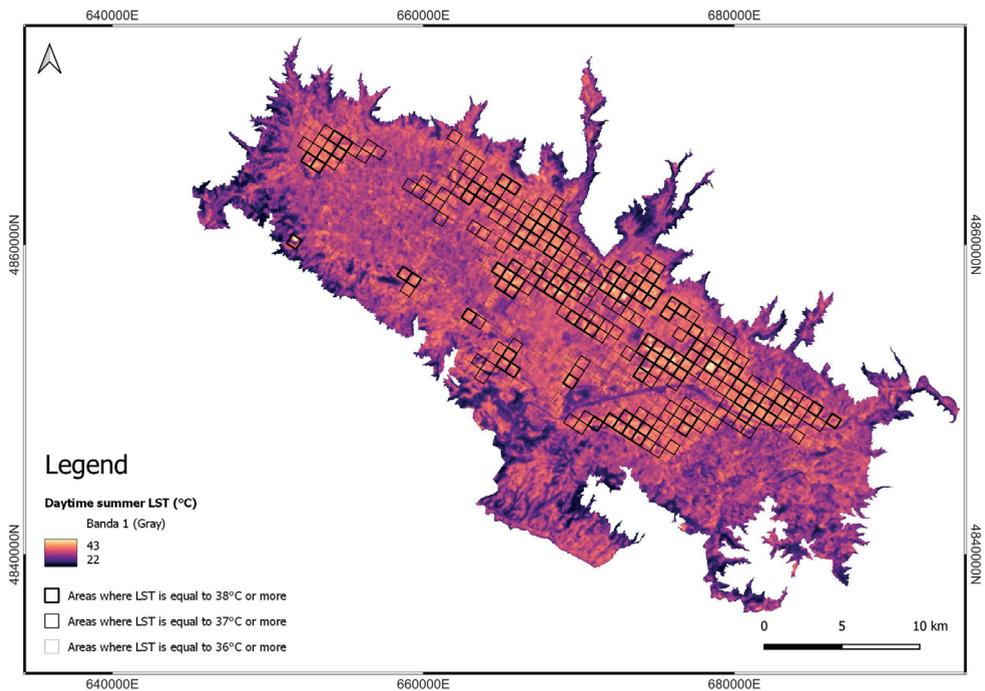
### 2.2. Hazard Index

The hazard is represented through thermal stress mapping (fig. 6) with LST data derived from Guerri et al. (2021). Research has shown that 37°C is the threshold temperature for human heat tolerance (Harlan et al., 2014); beyond this point, mortality rates increase. Centuriation sectors were used to highlight temperature ranges around this threshold –



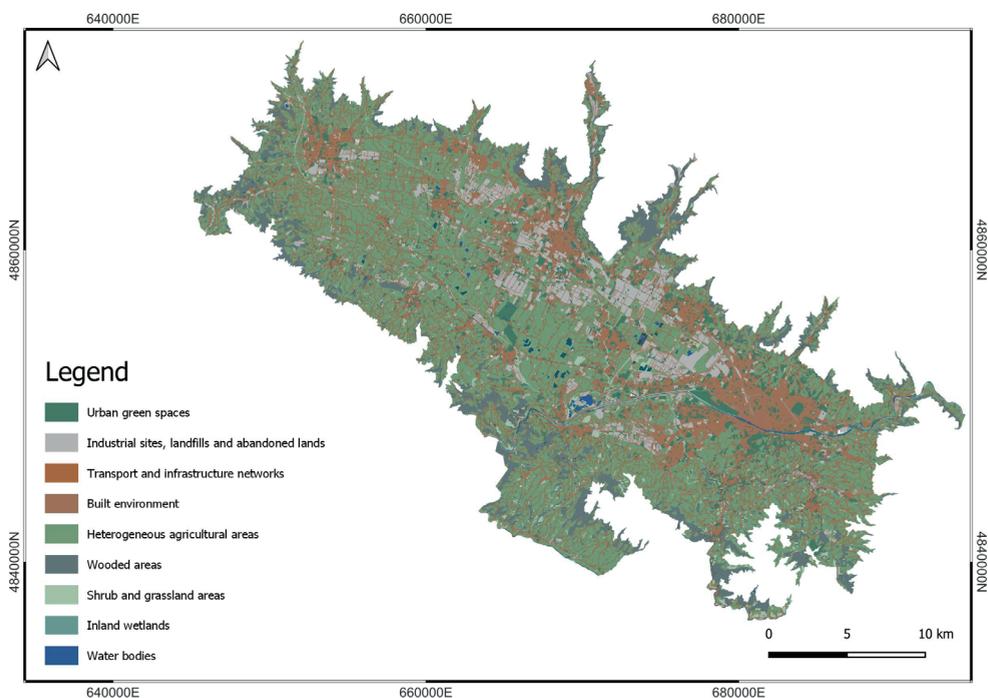
## Conceptual axonometric diagram for representing the three domains of analysis.

Fig. 5



## Thermal stress map – LST.

Fig. 6



## Exposure map.

Fig. 7

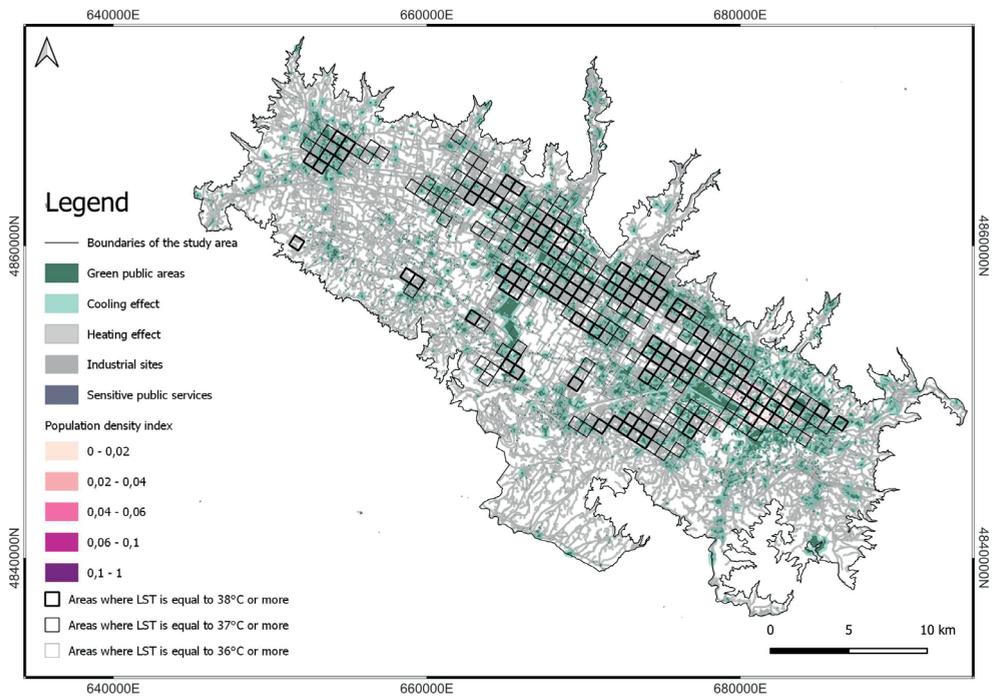
36°C, 37°C, and above 38°C – each representing a level of severity to be considered in adaptation plans. Land Surface Temperature data for this study was derived from Landsat 8 satellite imagery, analyzing three summer months (June to August) each year from 2015 to 2019. The 37°C threshold helped identify hotspots correlated with highly urbanized zones, although other factors also contribute. For the spatial analysis, the coordinate reference system used was WGS 84 / UTM zone 32N. This projection was selected due to its suitability for the study area, which falls within the central European region. The use of UTM zone 32N ensures accurate distance and area calculations, which are essential for reliable geospatial assessments and for the precise localization of interventions within the urban fabric.

### 2.3. Exposure Index

Exposure includes all territory elements potentially affected by excessive heat events, such as built surfaces, natural land, and resident populations (fig. 7). A special focus was given to land type, distinguishing between impervious (paved) and pervious (natural) soil. Impervious surfaces, lacking evapotranspiration capacity, contribute significantly to local heat increases.

### 2.4. Vulnerability Index

Vulnerability to heatwaves results from a combination of risk factors, with socio-demographic variables playing a decisive role. Age extremes, such as children under the age of five and seniors over sixty-five, are particularly sensitive, due to their reduced physiological re-



## Vulnerability map.

Fig. 8

silience to extreme heat (Morabito et al., 2015). Elderly individuals face increased difficulty coping with thermal extremes, often exacerbated by limited mobility or pre-existing medical conditions. Numerous studies highlight this population segment as among the most affected during heatwave events. Similarly, very young children are also vulnerable. Research from countries such as Australia, the United States, and the UK confirms the high risk for this age group, which is often overlooked in adaptation strategies (Tomlinson et al., 2011). This study includes population segments particularly sensitive to extreme heat: children up to 5 years old and individuals aged 65 and over. The value of this population group is weighted by 50% more than the general population to emphasize its significance in the vulnera-

bility index. In the present study, the youngest age group is novelly considered on equal terms with the elderly population, who are typically prioritized in assessments of vulnerability to urban heat island impacts (Morabito et al., 2015; Tomlinson et al., 2011). Population groups with disabilities, respiratory or cardiovascular diseases, or precarious socio-economic conditions are not included due to the lack of publicly available spatialized data. In the spatial domain, all open surface elements in the Piana are considered exposed. Vulnerable areas are those not within urban park cooling zones or located within or adjacent to industrial sites, where heat-accumulating effects are expected. In the infrastructure domain, public service facilities such as schools and health-care centers are considered exposed. Among

**Intervention methodology for the study area based on the cited criteria. Site 1: a predominantly residential area within the municipality of Prato, extending from Mezzana to the Macrolotto industrial site. Site 2: a predominantly industrial area, also located within the municipality of Prato. Site 3: a predominantly industrial area within the municipality of Florence, corresponding to the area of Calenzano.**

Fig. 9

these, facilities primarily serving vulnerable populations, such as kindergartens, hospitals, local health units, and clinics, are categorized as vulnerable.

In summary, the following levels are considered vulnerable (fig. 8):

4. Population density: weighted toward sensitive demographics (ages 0-5 and 65+ years), as they are most affected by thermal stress.
5. Sensitive facilities: kindergartens, clinics, and hospitals are prioritized as areas requiring heat-mitigation strategies.
6. Heat-influenced zones: vegetation has a proven cooling effect in urban settings, based on plant vitality and park size. Air temperature in areas surrounding urban parks is affected by the movement of cool or warm air masses above the vegetation and water vapor release from plant transpiration. These processes create a cooling effect that extends beyond park boundaries, acting as a counterbalance to the urban heat island (Chang & Li, 2014). For this reason, differentiated buffer zones were applied based on park size. Only urban parks with the highest NDVI were considered - with NDVI data derived from Guerri et al. (2021) - representing optimal vegetation health and cooling capacity. In contrast, industrial areas, lacking vegetation, exacerbate urban heating. While there is no definitive study on the extent of their

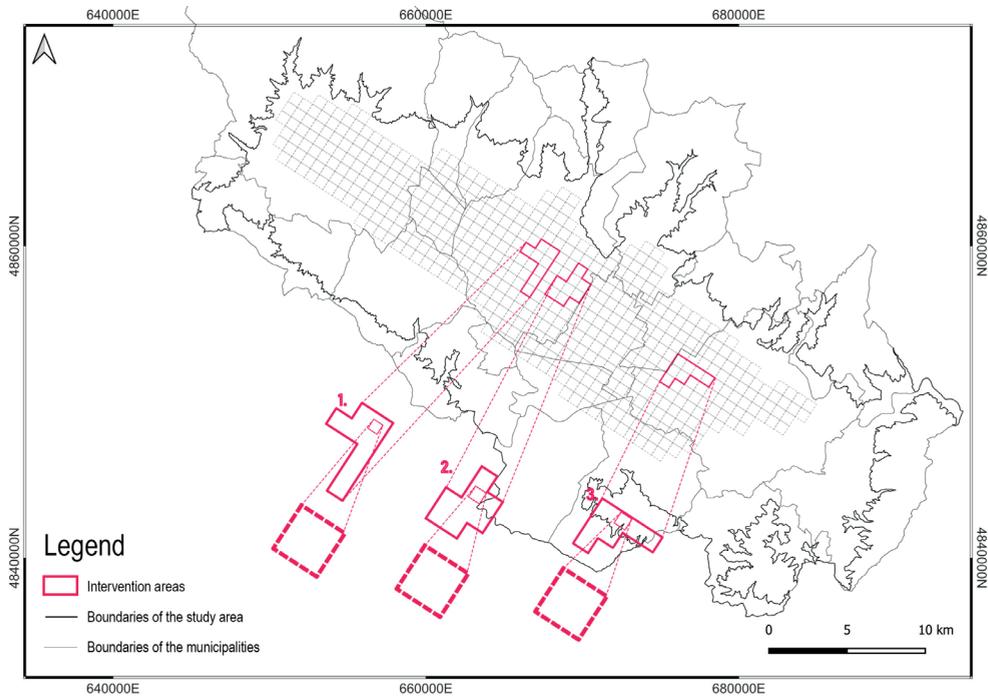
heat influence, a fixed minimum buffer was applied around industrial sites to model a worst-case scenario. These areas are thus characterized by a lack of cooling relief and proximity within 30 meters to heat-generating sources.

### *2.5. Intervention Methodology*

The identification of the areas with the greatest need for intervention is not solely derived from the results of the risk assessment; it is also informed by a strategic reasoning process that considers the potential for urban transformation. Areas with a high degree of immutability are excluded, while those with a greater adaptive capacity are prioritized. This approach allows for a more realistic assessment of the feasibility of implementing proposed interventions in the actual urban context.

As such, areas that, despite exhibiting a high level of risk, are located within or in close proximity to historic city centers are excluded. These zones are often associated with heritage conservation constraints and possess limited adaptive potential. Conversely, peri-urban areas, typically subject to fewer planning restrictions, represent more plausible contexts for the implementation of climate adaptation strategies.

Similarly, urban areas located near significant sources of air cooling, such as large urban parks, are evaluated based on their spatial relationship to these features and are thus



potentially considered mitigated by the beneficial effects of their surroundings.

As a result, the areas identified for transformation interventions tend to be those situated towards the inner part of the Piana Fiorentina, distant from forests and large green parks. These are zones characterized by a high percentage of sealed surfaces and located outside the historical city centers.

An additional parameter considered in the selection process is the identification of which component of the risk analysis had the greatest influence on the results. This allows for a more precise selection of the most appropriate strategies to be applied, depending on whether the greatest vulnerability is found in relation to the resident population, the open spaces, or the public service infrastructures.

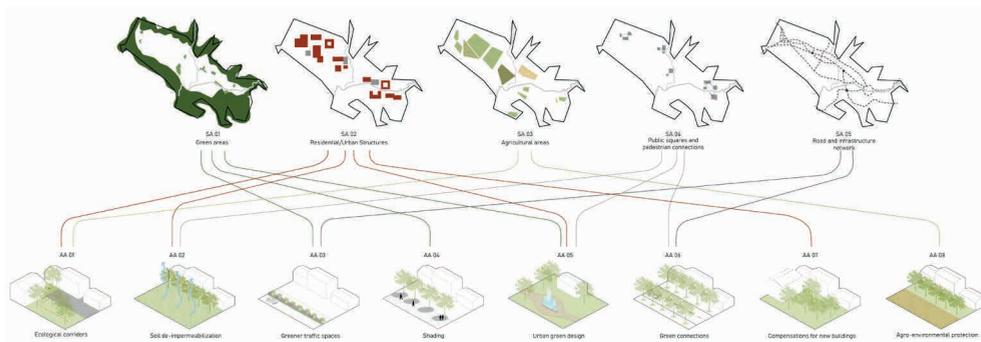
Three areas were ultimately selected (fig. 9): the first is where risk is primarily driven by the density of population, weighted by the pro-

portion of sensitive individuals; the second is characterized by a high percentage of impermeable surface; the third features a combination of different urban fabrics, residential and industrial, as well as the presence of certain sensitive public service facilities. This typological differentiation enables a more tailored intervention strategy.

Selected areas:

- A predominantly residential area within the municipality of Prato, extending from Mezzana to the Macrolotto industrial site.
- A predominantly industrial area, also located within the municipality of Prato.
- A predominantly industrial area within the municipality of Florence, corresponding to the area of Calenzano.

The proposed methodology draws upon the Zurich Heat Mitigation Plan (2023) and Prato's urban Forestry Action Plan (2019), and is based on the implementation of specific ap-



## Schematic representation of adaptation strategies associated with primary Land Use/Land Cover classes.

Fig. 10

proaches within five Action Spheres (fig. 10), each representing a distinct planning layer of the urbanized territory. These spheres guide strategic implementation and help clarify the urban structures involved in each intervention. Serving as the foundational framework for territorial planning, they address urban challenges related to thermal stress mitigation, by focusing on key urban priorities, such as green spaces, connectivity between open and green areas, streets and squares, as well as sources of heat emissions. Moreover, they provide a reference for interpreting and guiding potential future urban development. Each sphere may be linked to one or more actionable approaches, which can be applied at the local scale.

Spheres of Action (SA):

- SA 01 – Green Areas
  - SA 02 – Residential/Urban Structures
  - SA 03 – Agricultural Areas
  - SA 04 – Public Squares and Pedestrian Connections
  - SA 05 – Road and Infrastructure Network
- Action Approaches (AA) define the applicable intervention type for each vulnerable area:
- AA 01 – Ecological corridors
  - Integration of green and interstitial agricultural zones via biodiversity-oriented ecological corridors.
  - AA 02 – Soil de-impermeabilization
  - The de-impermeabilization of soil surfaces contributes to a significant reduction of the urban heat island effect. Vegetated areas can lead to decreases in temperature of 1 to 4°C in their immediate surroundings.

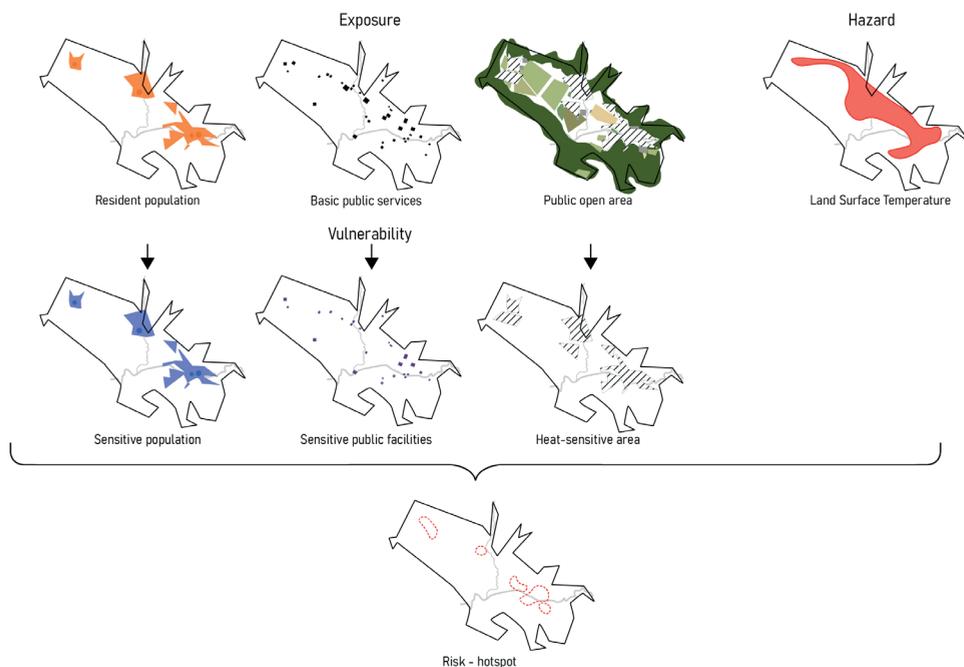
- AA 03 – Greener traffic spaces
- De-sealing and greening surfaces mitigate heat by enhancing evaporation and transpiration, with temperature reductions reaching up to 6°C (Zurich Heat Mitigation Plan, 2023), particularly when asphalt is replaced by grass. These interventions also promote improved air quality, biodiversity and the overall quality of public spaces.
- AA 04 – Shading
- Shading in urban public spaces, such as rest areas, pedestrian pathways, and streets, contributes to improved quality of life and reduces thermal load. Trees and artificial structures are key instruments for achieving these objectives. Beyond providing shade, trees offer further climate-related benefits through evapotranspiration and air purification.
- AA 05 – Urban green design
- Effective planning of urban green spaces is essential to balance competing land-use demands while enhancing climate resilience. As climate change intensifies, prioritizing diverse, multifunctional green infrastructure becomes vital for sustainable and livable cities.
- AA 06 – Green connections
- Linear afforestation zones established along major roadways and within densely built-up urban areas function as key strategies for environmental mitigation and air pollution reduction. These green corridors also help

improve urban livability through the integration of public spaces and vegetated areas, thereby enhancing the overall quality of the urban environment.

- AA 07 – Compensation for new buildings
- New urban developments incorporate land compensation mechanism by offsetting sealed surfaces with the creation of green spaces, aiming to maintain ecological balance and mitigate the environmental impact of increased soil impermeability.
- AA 08 – Agro-environmental protection
- The establishment of an agro-environmental buffer zone at the urban-rural interface serves to protect the boundaries of agricultural land from expanding urban areas. Afforestation along agricultural edges, through rows of trees and hedgerows, can contribute mitigating the urban heat island effect while maintaining, or even improving, crop productivity.

### 3. Results

The final analysis, combining the layers of social, structural, and spatial vulnerability, yielded a total vulnerability map showing populations at risk due to urban heat islands in the Piana Fiorentina. The risk map was created by mathematically multiplying the vulnerability, exposure, and hazard layers. This produced hotspot areas where urgent mitigation interventions are necessary. Figure 11 illustrates the spatial risk



## Conceptual flowchart according to the three components of risk.

Fig. 11

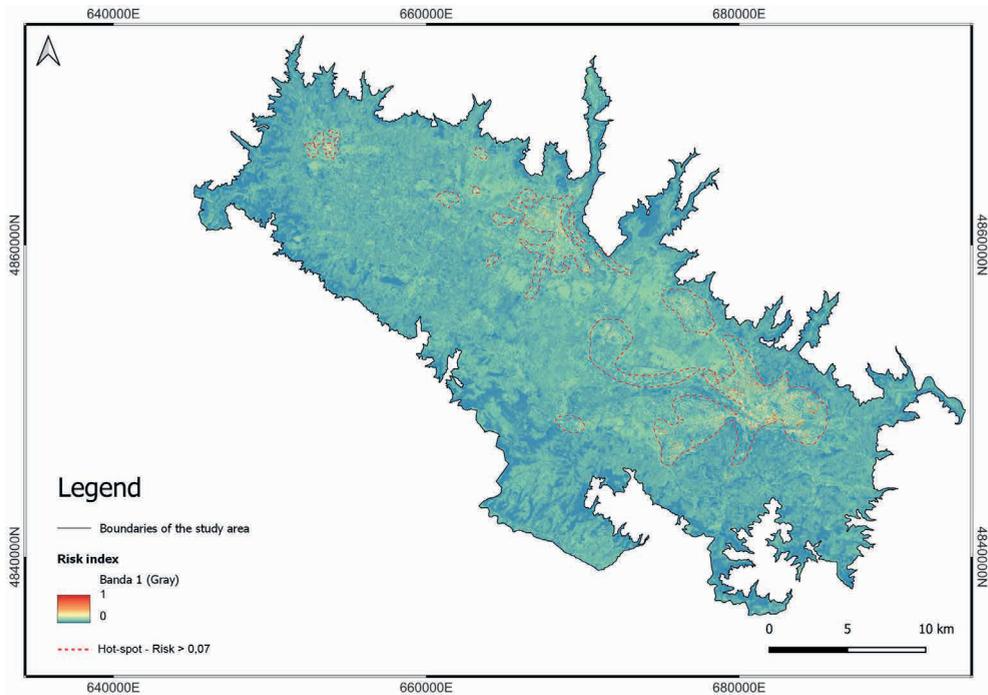
model as a conceptual flowchart showing how exposure, hazard, and vulnerability converge to produce risk and define hotspot zones. Risk is highest in urban centers such as Florence, Prato, and Pistoia, especially in city cores and densely built neighborhoods like Rifredi and Novoli, as well as smaller urban centers like Sesto, Scandicci, and Campi Bisenzio. Some areas exhibit moderate risk, driven primarily by land type: for instance, industrial zones with low population density, where risk remains significant due to the proportion of impervious surfaces and industrial land use (fig. 12).

The proposed interventions outlined in the previous section are applied within the identified areas, with the aim of mitigating the analyzed levels of risk.

The first project intervention (fig. 13) targets

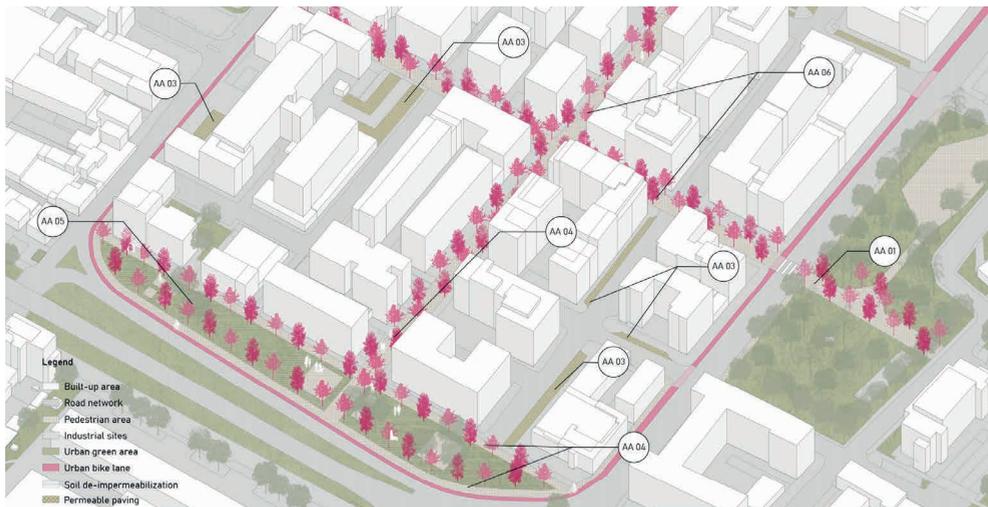
a predominantly residential urban area characterized by high weighted population density. The selection of the intervention site was informed by a risk analysis, prioritizing areas with elevated demographic concentration in order to maximize the impact of mitigation strategies.

The intervention focuses on restructuring internal mobility by restricting vehicular access exclusively to residents. This approach supports the gradual transformation of the area into a pedestrian-oriented environment. Two perpendicular pedestrian axes are introduced as key connective elements linking existing green infrastructures: one axis extends from the Karl Marx Park, a central green node, while the other originates from a green space situated at the edge of the site along Viale Leonar-



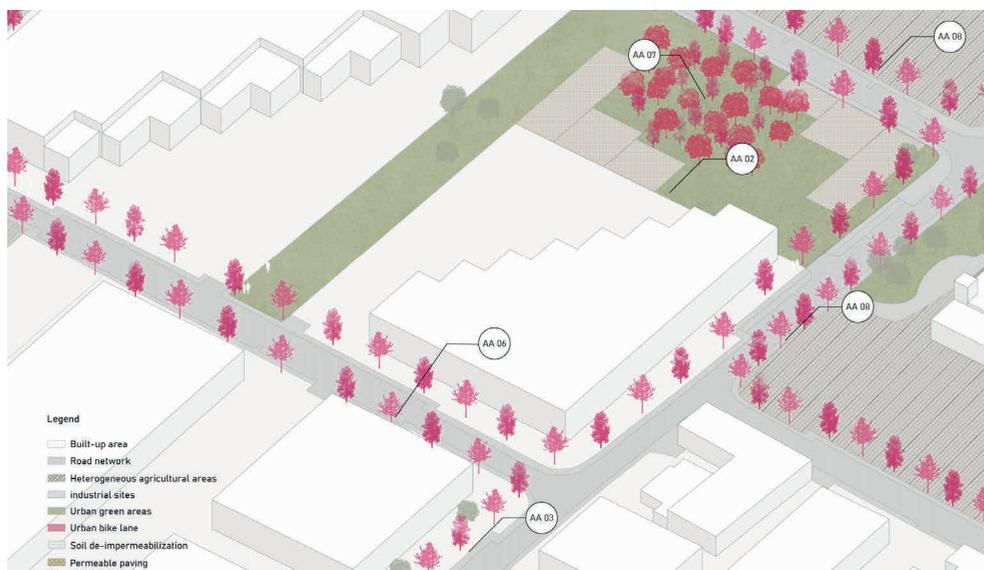
**Map of heat-related health risk in the study area.**

Fig. 12



**Axonometric view of the project area and implementation of Action Approaches for adaptation.**

Fig. 13



## Axonometric view of the project area and implementation of Action Approaches for adaptation.

Fig. 14

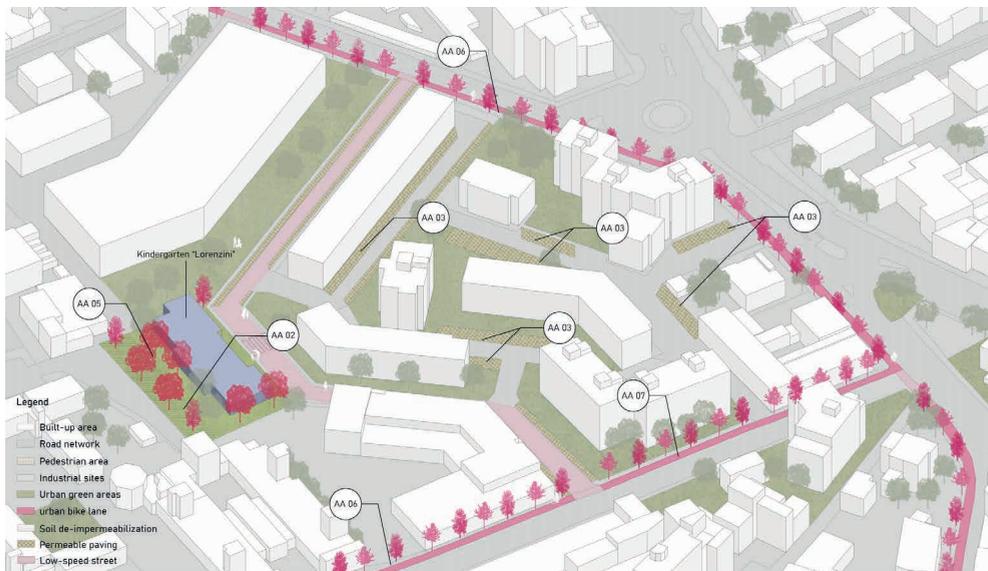
do da Vinci, which is also subject to ecological restoration and demineralization. Open space design emphasizes ecological enhancement through new tree plantings, particularly along the main pedestrian routes, with the goal of improving environmental and microclimatic quality. Perimeter mobility is reconfigured to accommodate a new bicycle lane, promoting sustainable transportation and ensuring effective integration with the surrounding urban fabric.

The second intervention (fig. 14) addresses an area characterized by a high degree of soil impermeability and a predominantly industrial land use, with minimal residential presence and scarce public green spaces. In response to these conditions, the project adopts a set of strategies aimed at ecological restoration and environmental mitigation, including the establishment of ecological corridors, compensation measures for new developments,

agro-environmental protection, soil de-impermeabilization, green connectivity, and the integration of vegetation within transportation infrastructure.

The proposed design focuses on the creation of multifunctional tree-lined boulevards. These green corridors serve multiple roles: providing shade, integrating vegetation into traffic routes, and acting as buffers between urbanized and agricultural areas. Particular emphasis is placed on the demineralization of non-essential paved surfaces to restore soil permeability and support natural drainage processes.

The third design intervention (fig. 15) is located within the Municipality of Florence, in an area characterized by predominantly residential land use, interspersed with some industrial sites and a limited supply of public green spaces. The adopted strategies include the creation of new green areas, soil de-impermeabiliza-



## Axonometric view of the project area and implementation of Action Approaches for adaptation.

Fig. 15

tion, compensation measures for new buildings, the implementation of tree-lined boulevards, and the integration of vegetation into traffic-related infrastructure. The site includes a kindergarten, identified during the analysis phase as a sensitive urban function. The project proposes to enhance the safety and quality of the school's immediate surroundings by converting into a pedestrian zone the street segment directly in front of the facility, thereby limiting vehicular traffic and promoting pedestrian and bicycle mobility. Vehicular circulation is redirected along peripheral streets, where a dedicated bike lane is also introduced. Additional measures involve the demineralization of parking surfaces to increase soil permeability and mitigate urban heat island effects. New tree plantings are planned along pedestrian paths to provide shading, improve public space usability, and enhance the microclimatic resilience of the area.

## 4. Discussion

This study contributes to the growing body of research on urban heat islands and heat-related health risks by advancing an integrated and context-specific approach. While much of the existing literature tends to focus either on the physical dimension of UHI dynamics or on epidemiological correlations between heat and health outcomes, the present work combines remote sensing indicators of surface temperature with socio-demographic measures of exposure and vulnerability. This integration makes it possible to generate a spatialized representation of heat risk that captures not only where extreme thermal conditions occur, but also who is most affected by them. This orientation is consistent with the findings of the IPCC Sixth Assessment Report, which highlights that urbanization processes interact with climate hazards to amplify vulnerability and exposure, particularly for low-income

groups, children and the elderly (IPCC, 2022). The proposed formula is derived from the risk equation commonly found in literature, but has been here adapted to better align with the specific objectives of this research. The modification emphasizes the estimation of population health risk as a function of both environmental and contextual determinants. In this framework, factors such as the availability of supportive facilities and the cooling or heating effect produced by the surrounding urban environment contribute to shaping the overall level of exposure and vulnerability. Drawing on the review of several comparable methodologies, this study introduces a revised version of the equation that preserves its conceptual framework while incorporating these local dynamics essential to a territorial understanding of heat-related risk. This formulation provides a conceptual basis for further testing and validation in future applications.

A distinctive aspect of this work is the strategic assessment of urban transformability. Rather than focusing solely on risk identification, the study evaluates the feasibility of interventions according to the adaptive potential of different areas, prioritizing peri-urban zones while excluding highly immutable contexts such as historic centers. The application of the proposed strategies to the selected areas provides a robust validation of the model, establishing a foundation for a realistic visualization of potential urban heat mitigation scenarios. In this way, the research advances a perspective that not only diagnoses urban cli-

mate risks but also outlines operational strategies, thereby bridging analytical results with planning practice. Such an approach aligns with recommendations from the WHO, which stress that the adverse health impacts of heat are largely preventable when supported by urban planning, preparedness of health and social systems, and timely public communication (WHO, 2020). By linking environmental and social data with local planning constraints, the research moves beyond descriptive mapping to provide a framework that is both diagnostic and operational. This dual orientation distinguishes it from previous approaches and offers a practical reference for aligning climate adaptation strategies with the socio-spatial realities of contemporary urban systems. In line with recent calls from both IPCC and WHO, which emphasize the need for timely, context-sensitive, and multi-level responses to extreme heat (IPCC, 2022; WHO, 2022), the proposed methodology demonstrates how research can support actionable, locally grounded adaptation strategies that enhance both environmental resilience and social well-being.

## 5. Conclusions

Given the complexity of the urban heat island phenomenon, the numerous ongoing studies, and the intricate urban ecosystems affected by it, a comprehensive consideration of all contributing variables to the risk analysis remains a considerable challenge. The following is a list of the limitations of this research, detailing all those elements that were excluded, due to

gaps in the literature, lack of accessible data, or the impossibility of data collection, leaving room for potential future integration:

- Pre-existing health conditions can increase susceptibility to heat-related illnesses and mortality.
- Air conditioning is a strong protective factor against heat-related deaths but is not recorded in census databases.
- Public transport services.
- Public nursing homes and residential care facilities for the elderly.
- The effects of water bodies (lakes and rivers) on temperature and urban heat island intensity.
- Elements of urban settlement structure, which further contribute to temperature increases.
- The impact of heat islands on the conservation status of buildings and infrastructure.
- The impact of heat islands on protected natural ecosystems in the territory.

As noted in the limitations above, water bodies, although not considered in the present work, could be integrated into the analytical framework as cooling elements, similar to urban parks, whose actual contribution would warrant further investigation.

The research could be further refined by differentiating the subject of the analysis affected by urban heat island according to gender, economic status, level of education, marital status, and health-related information such as past or existing physical conditions. From an urban perspective, further variables may in-

clude the state of building conservation, considered in terms of their performance under high-temperature stress, as well as building density.

The analysis conducted in this research highlights that urban heat islands represent a growing threat to public health and well-being, especially in the context of climate change, where extreme temperatures are expected to become more frequent and intense. Through the assessment of climate risk in the Piana Fiorentina, it was possible to identify the most vulnerable areas and propose targeted adaptation strategies capable of mitigating the impacts of urban overheating and improving the quality of life in cities. The resulting maps are derived from numerical datasets, which, due to space constraints, are not fully reported within this article. Once the post-implementation scenario of the proposed strategies is calculated, it will be possible to quantitatively evaluate their effectiveness, thereby offering a concrete method to assess and optimize urban planning measures aimed at reducing heat-related vulnerabilities.

The challenges posed by urban overheating require timely responses and strategies that are both effective and sustainable over time, strategies that combine environmental resilience with social well-being. This study has provided a useful framework to guide planning and design decisions in the Piana Fiorentina, emphasizing the importance of placing climate and livability at the core of future urban transformation processes.

### Author Contributions

Conceptualization: C.P., S.C., E.G., B.D.D.; Methodology: C.P., S.C., E.G., B.D.D.; Formal analysis: B.D.D.; Investigation: S.C., E.G., B.D.D.; Resources: E.G.; Data curation: B.D.D.; Writing - Original Draft: B.D.D.; Writing - Review & Editing: C.P., S.C., E.G., B.D.D.; Visualization: B.D.D.; Fund acquisition: S.C., C.P.; Supervision: S.C., C.P.

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### Data Availability Statement

The datasets generated and analyzed during the current study are available in the Zenodo repository, <https://doi.org/10.5281/zenodo.17414886>

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# Infrastrutture verdi urbane e offerta di servizi ecosistemici: uno studio sulla Functional Urban Area della Città di Cagliari

Urban Green Infrastructures and ecosystem service supply: a study on the Functional Urban Area in the City of Cagliari

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urban green infrastructure  
ecosystem services  
urban ecological corridors  
functional urban area

### L'importanza delle reti ecologiche nella pianificazione dello spazio urbano

Diversi autori e documenti hanno contribuito a costruire e affinare il concetto di servizi ecosistemici (SE). La definizione più nota è stata fornita dal Millennium Ecosystem Assessment (2005), che li descrive come benefici forniti dagli ecosistemi agli esseri umani. Attualmente, il concetto ha subito significative evoluzioni: per esempio, La Notte et al. (2017), spostan-

*Urban green infrastructure (UGI) is an interconnected system of natural and semi-natural spaces, such as green areas, open spaces, and water features, which are strategically planned to provide ecosystem services and address community needs. UGIs should be inclusive and enhance human well-being, supporting biodiversity and facilitating access to natural*

*resources. This study introduces a methodological framework for identifying UGIs, based on a taxonomic analysis of key ecosystem services (ES) essential to urban quality, including outdoor recreation, flood risk management, carbon capture and storage, habitat quality, and climate regulation. Furthermore, UGIs are modelled as complex networks composed of core areas, and urban ecological corridors. This approach is applied to the Functional Urban Area (FUA) of Cagliari in Italy. The findings indicate that areas with high levels of climate regulation, carbon storage and habitat quality are particularly well-suited for inclusion in UGI. While recreational potential is comparatively lower, it remains locally significant. On the other hand, flood mitigation zones demonstrate reduced connectivity due to urban impermeable surfaces.*

do il focus sull'ecologia, definiscono i SE come flussi generati dagli ecosistemi che includono interazioni ecologiche e informazioni utili agli esseri umani, distinguendo tra funzioni, servizi e beni. Il concetto di SE è strettamente connesso a quello di infrastruttura verde (IV). L'IV, secondo la definizione della Commissione Europea, è una rete strategicamente pianificata di aree naturali e seminaturali progetta-

ta per fornire un'ampia gamma di servizi ecosistemici (SE) (EC, 2013). Include elementi sia terrestri che acquatici, e favorisce efficacemente la promozione della connettività ecologica, la conservazione della biodiversità e la riduzione della frammentazione degli ecosistemi, in particolare nell'ambito della Rete Natura 2000 e degli obiettivi definiti dall'articolo 10 della Direttiva Habitat (Liquete et al., 2015). La categoria concettuale di infrastruttura verde urbana (IVU) si pone come un importante punto di riferimento nella pianificazione territoriale. Le IVU consistono in reti interconnesse di spazi verdi e blu, come parchi, foreste urbane, tetti verdi e corsi d'acqua, che mirano a potenziare l'erogazione di SE in contesti densamente urbanizzati. Dal punto di vista urbanistico, l'IVU si riconosce quale sistema multifunzionale per la conservazione ed il miglioramento delle condizioni dello sviluppo sostenibile in relazione ai profili ecologico, sociale e spaziale (Sandström, 2002). L'integrazione delle IVU nella pianificazione urbana contribuisce al raggiungimento di obiettivi fondamentali quali incrementare la resilienza climatica, mitigare il calore urbano, migliorare la qualità dell'aria e dell'acqua, tutelare la salute pubblica e garantire una fruizione equa delle risorse naturali (Eggermont et al., 2015). Queste infrastrutture fungono da sistemi adattivi in grado di affrontare le sfide urbane attraverso soluzioni basate sulla natura, come la de-impermeabilizzazione dei suoli e il ripristino della

vegetazione, che reintegrano le funzioni ecologiche nei paesaggi urbanizzati (Tzoulas et al., 2007). La pianificazione, lo sviluppo e la gestione delle IVU richiedono un approccio di governance multidimensionale, ed è essenziale che esse siano integrate nei quadri normativi degli strumenti di pianificazione territoriale e urbana. Una governance efficace dipende anche dalla partecipazione attiva delle comunità locali, delle istituzioni pubbliche, dei privati cittadini e delle organizzazioni della società civile, affinché i processi partecipativi accrescano la legittimità e la sostenibilità degli interventi, sia nel breve, che nel medio e lungo periodo, allineando le strategie territoriali con i bisogni e le aspettative delle società locali (Zoppi, 2012; Walmsley, 2006). In questo senso, le IVU rappresentano un cambio di paradigma nella pianificazione urbana, in cui i sistemi ecologici siano considerati componenti fondamentali per il funzionamento e la qualità della vita nelle città. La loro implementazione come elemento centrale nella pianificazione territoriale riflette una visione olistica che integra sviluppo sostenibile, equità sociale e resilienza ecologica. Studi recenti evidenziano l'importanza di un approccio proattivo, inclusivo e sensibile al contesto, che rafforzi il ruolo delle IVU come infrastrutture per l'erogazione dei SE. Tuttavia, la letteratura scientifica, in particolare i contributi di Sandström (2002), Tzoulas et al. (2007) e Breuste (2021),

## La Functional Urban Area (FUA) di Cagliari.

Fonte: Limiti amministrativi comunali - Geoportale della Regione Sardegna:

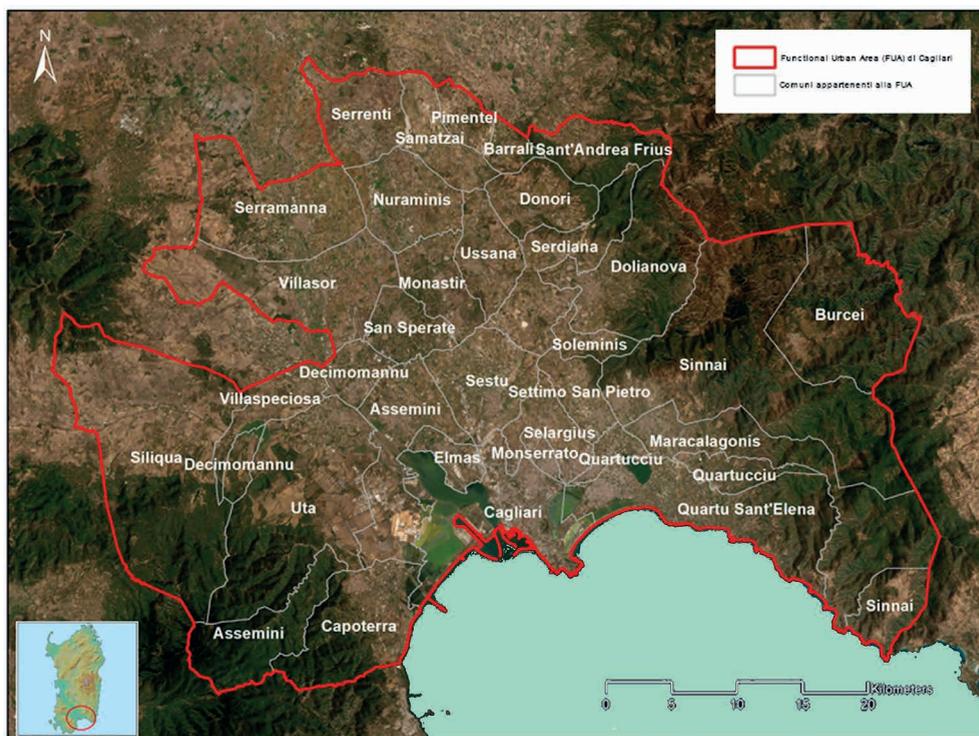
Fig.1

segnala l'assenza di una definizione teorica e operativa universalmente condivisa delle IVU, distinta dal concetto più ampio di IV. Per colmare questa lacuna, questo studio propone un quadro metodologico per identificare e classificare le IVU in termini di attuazione delle IV nei contesti urbani.

L'approccio si articola in tre fasi analitiche:

1. l'identificazione spaziale delle IVU tramite un'analisi tassonomica di SE fondamentali per la qualità urbana: attività ricreative all'aperto, gestione del rischio alluvionale, cattura e stoccaggio del carbonio, qualità degli habitat e mitigazione delle ondate di calore;
2. la modellazione delle IVU quali reti complesse costituite da nodi, identificati come le aree protette presenti nella Functional Urban Area (FUA), e da corridoi ecologici urbani (CEU), definiti in base a criteri di integrità ecologica e di naturalità;
3. l'analisi della correlazione funzionale tra CEU e fornitura di SE attraverso una sovrapposizione dei CEU con la tassonomia spaziale delle IVU.

La metodologia è applicata alla FUA di Cagliari, localizzata nella Regione Sardegna, e costituisce un modello replicabile in altri contesti urbani, nazionali ed internazionali. La sezione conclusiva riflette sul ruolo delle IVU nel quadro complessivo delle IV, e proponendo alcune direzioni per il futuro della ricerca.



### Analisi delle relazioni spaziali tra funzionalità ecosistemica e connettività ecologica nella FUA di Cagliari

In questa sezione si propone una descrizione del territorio della FUA di Cagliari, utilizzato come caso di studio sperimentale. Successivamente, si descrive la metodologia adottata per la costruzione della tassonomia spaziale dell'IVU. In terzo luogo, si definiscono i CEU. L'ultima parte della sezione presenta un modello di regressione lineare multipla finalizzato all'identificazione delle relazioni tra i SE costituenti la tassonomia spaziale dell'IVU ed i CEU.

L'area di riferimento per l'applicazione della metodologia è, dunque, la FUA di Cagliari, che si estende per circa 1.950 km<sup>2</sup>, comprende 32 comuni e conta una popolazione complessiva di oltre 476.000 abitanti (dati 2022). Emergo-

no marcate differenze nella dotazione di aree verdi tra il centro urbano di Cagliari e le altre zone della FUA. Il 42,06% del territorio è occupato da aree verdi, di cui solo lo 0,47% è destinato a verde urbano mentre il 3,87% è costituito da zone umide (fig. 1).

L'assetto spaziale delle IVU è identificato sulla base della distribuzione spaziale dei seguenti SE: le opportunità ricreative basate sulla natura; la capacità di regolazione del deflusso superficiale, soprattutto in caso di importanti eventi meteorici; la regolazione del clima mediante la cattura e stoccaggio del carbonio; la qualità degli habitat, intesa come riferimento per il potenziale di fornitura di cibo e rifugio per la fauna e la flora selvatiche; la temperatura al suolo, considerato come indicatore per la mitigazione del calore urbano, in relazione alle zone vegetate e alberate.

Variabili	Dati di Input	Fonti dati
RECR_OUT	Mappa della copertura dei suoli	Copernicus Europe's Eyes on Earth. Land Monitoring Service. Urban Atlas, 2018.
	Popolazione residente per sezione censuaria	Censimento Nazionale (Anno 2022).
FLD_CNTR	Mappa della copertura dei suoli Mappa della permeabilità dei suoli Valori relativi al parametro "Curve number" nell'Area di riferimento	Geoportale della Regione Sardegna.
	Dati sulle precipitazioni	Annali idrologici regionali.
CA_CP_ST	Mappa della copertura dei suoli	Copernicus Europe's Eyes on Earth. Land Monitoring Service. Urban Atlas, 2018.
	Dati sui serbatoi di carbonio (biomassa epigea, biomassa ipogea, necromassa, suolo)	Progetto pilota regionale dell'AGRIS. Inventario nazionale delle foreste italiane (2005).
HAB_QUAL	Mappa della copertura dei suoli	Copernicus Europe's Eyes on Earth. Land Monitoring Service. Urban Atlas, 2018.
	Aree protette presenti nella FUA	Geoportale della Regione Sardegna.
	Minacce agli habitat.	Formulari standard Rete Natura 2000. Geoportale della Regione Sardegna.
	Peso delle minacce e distanza di decadimento. Vulnerabilità degli habitat alle minacce.	Questionari somministrati ad esperti locali.
L_S_TEMP	Immagini Landsat collection 2, level 2	Earth Explorer - United States Geological Survey (USGS).

La tab. 1 riporta i dati di input e le fonti utilizzate per l'individuazione della distribuzione spaziale dei SE presi in considerazione.

I servizi ricreativi basati sulla natura (RECR\_OUT) sono valutati mediante due indicatori: la disponibilità di aree potenzialmente idonee per le attività ricreative all'aperto e la popolazione residente in prossimità di tali aree, considerata come potenziale beneficiaria del servizio. Le aree sono individuate tramite il dataset Urban Atlas 2018, pubblicato dall'European Land Monitoring Service (2018)<sup>1</sup>. Grazie all'elevata risoluzione spaziale del dataset, è stato possibile selezionare le coperture dei suoli rilevanti ai fini dello studio: aree verdi urbane, strutture sportive e ricreative, aree naturali vegetate, acque interne e acque marine. I dati sono stati elaborati su una griglia vettoriale di 100x100 metri calcolando, per ciascuna cella, la quota percentuale di aree che offrono opportunità ricreative. La popolazione residente

è stata individuata utilizzando i dati del Censimento ISTAT 2021<sup>2</sup>, assumendo una distribuzione uniforme all'interno delle unità censuarie e considerando un raggio di 500 metri da ciascuna cella. La variabile RECR\_OUT è stata, infine, calcolata come il prodotto tra la percentuale di aree idonee per le attività ricreative presenti in ciascuna cella e la popolazione residente entro 500 metri. La scelta della distanza entro la quale le aree verdi sono individuabili come idonee per lo svolgimento di attività ricreative da parte della popolazione residente è stata effettuata tenendo in considerazione le esperienze, riportate in letteratura, di diverse città nelle quali è previsto un limite massimo di distanza tra ogni residenza e la più prossima area verde. Tale limite è concepito come la distanza entro la quale si ritiene che anche bambini e anziani possano raggiungere la più vicina area verde con una passeggiata di durata inferiore a dieci minuti. A seconda del-

## Dati di input e fonti utilizzate per la valutazione della distribuzione spaziale per ciascun SE preso in considerazione.

Tab. 1

la città, anche sulla base di fattori di contesto quali clima e orografia, tale distanza è assunta tra 300 e 1000 metri (cfr., ad esempio, De Sousa Silva et al., 2018; Kabisch et al., 2016; van Herzele e Wiedemann, 2003); tra le città che hanno scelto 500 metri come soglia si segnala Berlino (Kabisch e Haase, 2014). Per quanto riguarda la risoluzione spaziale del dataset utilizzato, va posto in evidenza come informazioni più dettagliate di quelle offerte da Urban Atlas sarebbero necessarie qualora, in termini di sviluppi futuri della ricerca, si sviluppasse studi analoghi a questi al livello del singolo comune. Sarebbe, inoltre, importante, poter discriminare le aree verdi in termini di regime di proprietà e di utilizzo, in modo da garantire che le aree individuate quali potenzialmente idonee siano effettivamente accessibili e fruibili dalla popolazione residente.

La variabile FLD\_CNTR descrive la capacità degli ecosistemi di mitigare il rischio idraulico, tramite l'intercettazione del deflusso superficiale. Per stimarla, è stato impiegato il modello "Urban flood risk mitigation" della suite InVEST<sup>3</sup>, che utilizza come input la mappa della copertura del suolo, il gruppo idrologico del suolo (SHG), l'intensità delle precipitazioni e il *curve number* (CN), che rappresenta il potenziale di deflusso. La mappa SHG deriva dalla riclassificazione della carta regionale di permeabilità (in scala 1:25.000)<sup>4</sup>, mentre la copertura del suolo è tratta dalla Carta Tecnica Regionale (CTR) (in scala 1:10.000)<sup>5</sup>. I dati pluviometrici

provengono dall'Annuario Idrologico Regionale, disponibile sul sito dell'Agenzia Regionale per l'Ambiente<sup>6</sup>. La variabile FLD\_CNTR è calcolata per ciascuna cella della griglia 100x100 m, aggregando i volumi di ritenzione idrica a livello di bacino idrografico.

Per mappare la variabile CA\_CP\_ST, relativa alla capacità di cattura e stoccaggio del carbonio, è stato utilizzato il modulo "Carbon storage and sequestration" (InVEST). Tale modello considera quattro principali componenti (pool): la biomassa epigea, la biomassa ipogea, la materia organica morta e il suolo organico. I dati di input includono una mappa d'uso del suolo e una tabella con i valori della densità di carbonio per ciascun tipo di copertura in riferimento ai diversi pool. Le fonti comprendono la letteratura scientifica, gli inventari forestali, le banche dati, i rilievi ed i calcoli allometrici. A causa della mancanza di dati attendibili per la biomassa ipogea, sono considerati solo i tre pool relativi alla biomassa epigea, alla materia organica morta e al suolo. I valori di riferimento derivano dal progetto-pilota regionale dell'Agenzia della Regione Sardegna per la ricerca scientifica, la sperimentazione e l'innovazione tecnologica nei settori agricolo, agroindustriale e forestale (AGRIS), e dall'Inventario nazionale delle foreste italiane (2005). Il calcolo della variabile è stato effettuato mediante software di calcolo delle statistiche zonali in relazione a ciascuna cella.

Per stimare la variabile HAB\_QUAL, che dà

Fasi	Dati di input	Fonti dati	Risultati	Strumenti/Modelli
Step 1: elaborazione mappa del grado di naturalità	Land cover map	Copernicus -Land Monitoring Service.	Mappa del grado di naturalità	Guido Toolbox
Step 2: elaborazione mappa di integrità ecologica.	Land cover map	Copernicus - Land Monitoring Service.	Mappa di integrità ecologica	Matrice di Burkhard.
Step 3: elaborazione mappa di resistenza al movimento	Mappa del grado di naturalità	Step 1	Mappa di resistenza al movimento	Analisi in ambiente GIS
	Mappa di integrità ecologica	Step 2		
Step 4: elaborazione mappa relativa alla distanza pesata in riferimento al costo (CWD)	Mappa di resistenza al movimento	Step 3	Mappa relativa alla distanza pesata in riferimento al costo (CWD) Mappa vettoriale della distribuzione spaziale dei CEU	Applicativo GIS "Linkage Pathways Tool" del Linkage Mapper Toolbox.
	Mappa delle core areas	Geoportale della Regione Sardegna] Agenzia europea dell'Ambiente		

conto della qualità degli habitat, è utilizzato il modulo "Habitat Quality" della suite InVEST. Gli input comprendono la mappa d'uso del suolo (Corine Land Cover 2018) e i dati sulle pressioni ambientali che influenzano la qualità degli habitat. Le minacce sono state identificate consultando i formulari standard dei siti della Rete Natura 2000, con riferimento a dieci categorie di impatto (urbanizzazione, agricoltura, incendi, etc.). L'assegnazione dei valori di intensità delle minacce e sensibilità di ogni habitat a ogni minaccia è stata effettuata da un gruppo di esperti locali.

Infine, la distribuzione spaziale della temperatura superficiale terrestre (LST) è ottenuta utilizzando una serie di mappe raster disponibili sulla piattaforma Earth Explorer dello United States Geological Survey (USGS). Le immagini sono state selezionate in base a criteri specifici (l'estensione territoriale, la copertura nuvolosa inferiore al 10%, l'intervallo temporale, scelto tra maggio e ottobre 2023). Tra le 13 mappe acquisite della collezione Landsat Collection 2 - Livello 2, è selezionata quella con i valori medi di LST più elevati.

Con riferimento alla definizione spaziale dei CEU, vi sono numerose metodologie impiegate nella letteratura scientifica per individuarli. Peng et al. (2017) classificano questi approcci in quattro categorie: la valutazione empirica, l'analisi di idoneità/sensibilità, l'analisi reticolare e l'analisi del costo cumulativo minimo per il movimento delle specie. Accanto ai metodi qualitativi, basati su giudizi di esperti, si individuano approcci quantitativi, tra i quali l'analisi multicriteri proposta da Ferretti e Pomarico (2013). L'analisi reticolare, fondata sulla teoria dei grafi, interpreta il paesaggio come una rete di nodi e connessioni. Li et al. (2022) combinano questo approccio con modelli di simulazione d'uso del suolo per valutare la connettività ecologica urbana.

L'analisi Least-Cost Path (LCP), invece, misura la resistenza al movimento della fauna selvatica in riferimento alle caratteristiche del paesaggio. Con riferimento a quest'ultimo approccio, questo studio adotta un approccio basato sull'utilizzo del tool Linkage Mapper, che combina la teoria dei grafi con i modelli LCP secondo la metodologia sviluppata da Cannas et al.

## Dati di input e fonti utilizzate per ciascuna fase di costruzione della mappa dei CEU.

Tab. 2

(2017) e da Isola et al. (2022), con un focus specifico sui corridoi ecologici urbani. La metodologia si articola in quattro fasi che consistono nelle elaborazioni delle mappe seguenti: grado di naturalità, integrità ecologica, resistenza al movimento, distanza pesata in riferimento al costo (Cost-Weighted Distance, CWD). Il grado di naturalità è calcolato attraverso la Landscape Mosaic Methodology del Joint Research Centre (JRC) (Maes et al., 2019; EC, 2023). L'integrità ecologica è misurata sulla base della capacità del suolo di fornire servizi ecosistemici, attraverso sette indicatori, tra cui livello di biodiversità e capacità di ritenzione e immagazzinamento dei nutrienti. La mappa di resistenza è ottenuta invertendo e normalizzando gli indici relativi al grado di naturalità e all'integrità ecologica. Utilizzando lo strumento Landscape Pathways si individua, infine, la distribuzione spaziale dei CEU che connettono le aree protette (parchi regionali, siti Natura 2000 e zone Ramsar) all'interno della FUA di Cagliari. L'output è costituito da una mappa vettoriale dei CEU e da una mappa raster dei valori della CWD. La tab. 2 riporta i dati di input e le fonti utilizzate per ciascuna fase di costruzione della mappa dei CEU.

Le relazioni tra l'offerta di SE e l'identificazione dei CEU vengono identificate tramite un modello di regressione lineare multipla. I CEU sono identificati applicando l'algoritmo LCP alla distribuzione spaziale della CWD. Le porzioni di territorio corrispondenti ai CEU sono definite

come quelle con valori di CWD inclusi nel ventesimo percentile della sua distribuzione statistica, individuando così le connessioni ottimali tra le patch con il minor costo di movimento. Il modello di regressione è definito nel modo seguente:

$$\begin{aligned} \text{CO\_W\_DIS} = & \beta_0 + \beta_1 \text{RECR\_OUT} + \\ & \beta_2 \text{FLD\_CNTR} + \beta_3 \text{CA\_CP\_ST} + \\ & \beta_4 \text{HAB\_QUAL} + \beta_5 \text{L\_S\_TEMP} + \\ & \beta_6 \text{ALT\_ELEV} \end{aligned}$$

Le variabili incluse nel modello, i cui valori sono riferiti a celle di 100×100 metri, sono così definite:

- CO\_W\_DIS: distanza ponderata in base al costo (CWD);
- RECR\_OUT: percentuale di area disponibile per attività ricreative all'aperto, moltiplicata per la popolazione residente entro un raggio di 500 metri;
- FLD\_CNTR: volume di deflusso idrico superficiale trattenuto;
- CA\_CP\_ST: quantità di carbonio organico sequestrato e immagazzinato;
- HAB\_QUAL: valore relativo alla qualità degli habitat;
- L\_S\_TEMP: valore della temperatura superficiale terrestre (LST);
- ALT\_ELEV: altitudine media, utilizzata come variabile di controllo.

Il modello di regressione lineare multipla (1) rappresenta un iperpiano in uno spazio n-dimensionale tangente a una superficie di for-

ma sconosciuta. In questo contesto, questo modello costituisce un'approssimazione locale di una funzione sconosciuta, cioè l'equazione di un iperpiano tangente a questa superficie in uno spazio a otto dimensioni (Wolman e Couper, 2003; Byron, 1983). ALT\_ELEV funge da variabile di controllo relativa all'impatto dell'altitudine sulla CWD. Se il coefficiente  $\beta_6$  stimato è significativo, questo indica che l'altitudine ha un effetto positivo o negativo sulla CWD, a seconda del segno del coefficiente, con l'entità dell'impatto determinata dal valore del coefficiente stesso. Infine, per verificare la significatività dei coefficienti  $\beta$  del modello (1), sono condotti specifici test basati sul *p-value*.

### **Corridoi ecologici e servizi ecosistemici: gli esiti delle analisi spaziali**

Con riferimento alle opportunità di fruizione ricreativa in natura, rappresentate dalla variabile RECR\_OUT, circa due terzi delle celle della griglia analizzata presentano valori nulli. Tali celle includono sia aree prive di copertura vegetale idonea alle attività ricreative (come le pianure agricole o le zone urbane ad alta densità), che aree vegetate e prive di popolazione residente, come i boschi situati ai margini orientali e occidentali della FUA. I valori più elevati si concentrano nelle aree urbane verdi centrali e nelle zone periurbane, mentre alcuni raggruppamenti, con valori medio-bassi, si trovano nella porzione orientale della FUA, dove sono presenti insediamenti a bassa densità immersi in un con-

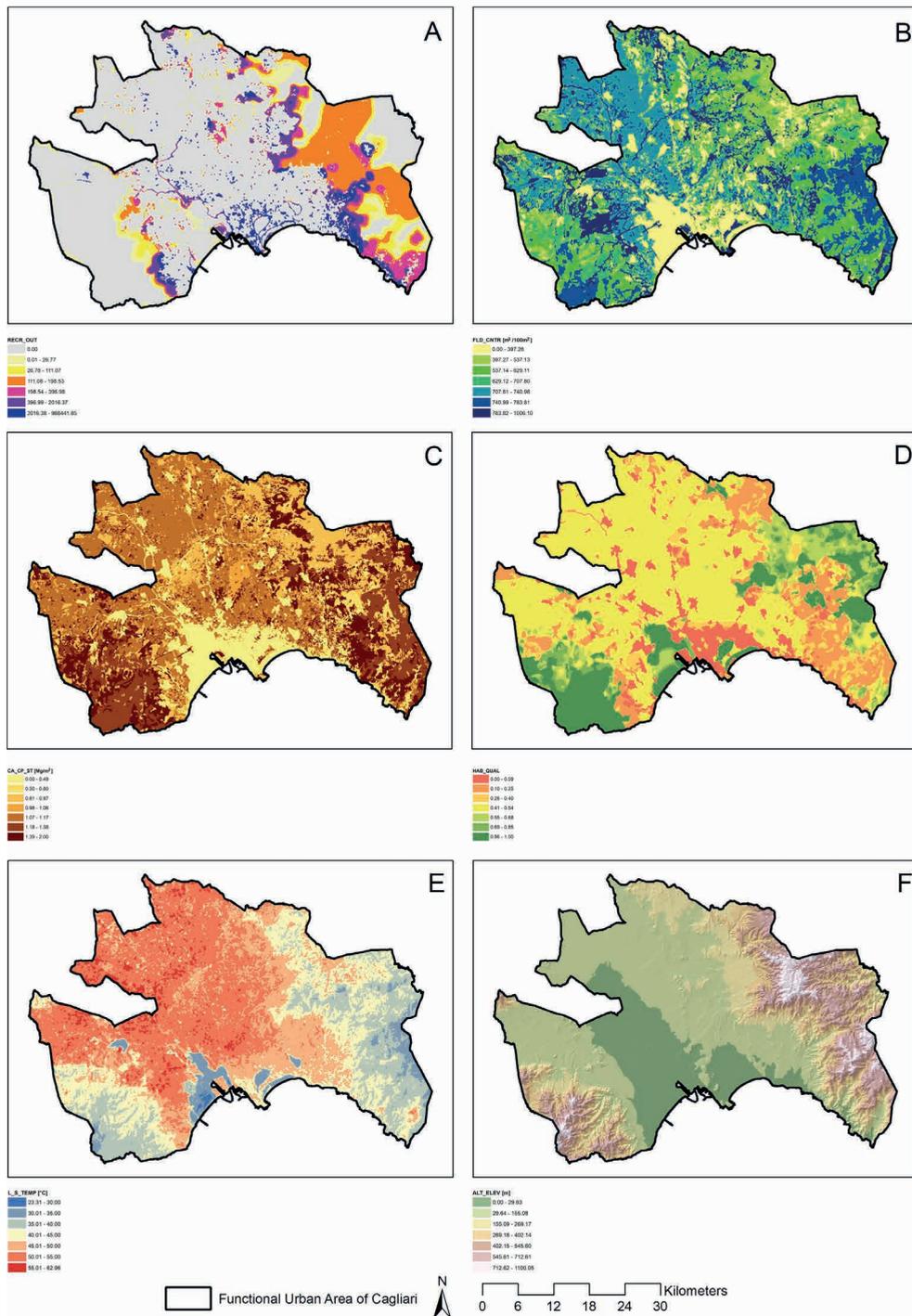
testo prevalentemente naturale (fig. 2.A).

La seconda variabile, FLD\_CNTR, riferita alla capacità di ritenzione del deflusso idrico, registra valori nulli o trascurabili nelle aree urbanizzate, mentre raggiunge valori elevati nei suoli agricoli e naturali permeabili, soprattutto nelle zone pianeggianti a bassa quota. Valori significativi si riscontrano, anche, in due promontori costieri rocciosi, dove la presenza di fenomeni carsici e fratture geologiche favorisce l'infiltrazione dell'acqua (fig. 2.B).

La variabile CA\_CP\_ST, relativa alla cattura e allo stoccaggio del carbonio, evidenzia valori minimi nella zona centro-meridionale della FUA, corrispondente all'area urbana di Cagliari ed alle aree umide in essa localizzate o ad essa adiacenti. Inoltre, si osservano due assi lineari con valori bassi lungo le principali arterie stradali. I valori massimi si registrano nelle aree boscate a est e nelle aree protette a ovest, mentre le pianure agricole e le colline con vegetazione rada mostrano valori intermedi (fig. 2.C).

Per quanto riguarda la qualità dell'habitat (HAB\_QUAL), circa il 6,8% delle celle presenta valori nulli; queste celle sono localizzate prevalentemente in corrispondenza delle aree fortemente artificializzate. I valori più elevati si riscontrano nelle aree boscate, distanti dai principali insediamenti, e nelle aree umide interne. Le zone agricole fanno rilevare valori intermedi, con una qualità ecologica contenuta, ma non trascurabile (fig. 2.D).

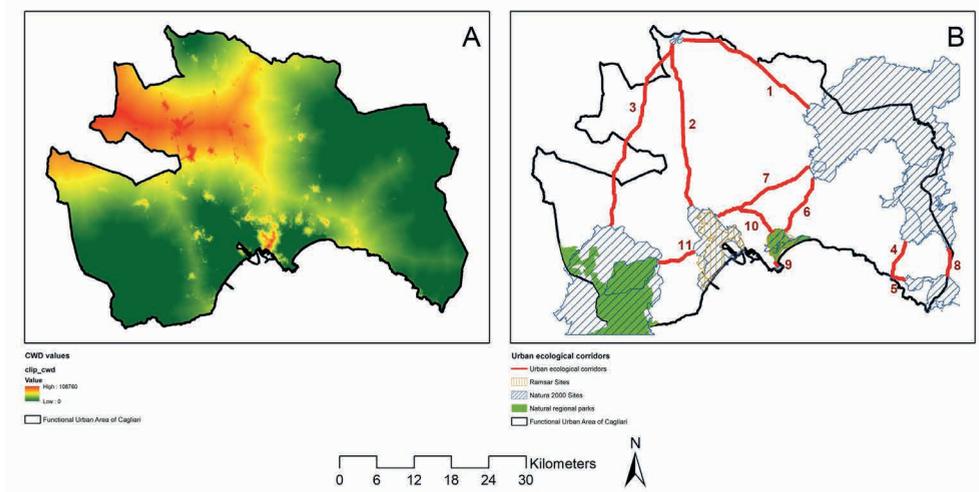
La variabile L\_S\_TEMP, indicativa della capaci-



**Distribuzione spaziale dei cinque servizi ecosistemici selezionati (A-E) e della variabile di controllo relativa all'altitudine media nella FUA di Cagliari (F)**

Fonte: elaborazione degli autori

Fig. 2



## Mapa della distribuzione spaziale dei valori di CWD (A) e distribuzione spaziale dei corridoi ecologici urbani nella FUA di Cagliari (B).

Fonte: elaborazione degli autori

Fig. 3

tà della vegetazione di regolare la temperatura al suolo, evidenzia valori termici più elevati nelle aree urbanizzate e nelle pianure agricole del Campidano. Le temperature più basse si osservano nelle aree umide, nei bacini idrici e sulle cime collinari e montane situate ai margini orientale e occidentale della FUA (fig. 2.E). La variabile di controllo ALT\_ELEV descrive la morfologia del territorio, evidenziando la pianura del Campidano che attraversa diagonalmente la FUA, separando le due catene montuose situate ad est e ad ovest: questa termina nella fascia costiera della FUA, dove sono localizzate due aree umide adiacenti al nucleo urbano di Cagliari (fig. 2.F).

L'approccio metodologico adottato per l'identificazione dei CEU è articolato in quattro fasi operative, ciascuna delle quali ha prodotto un risultato in termini di distribuzione spa-

ziale dei corridoi. In particolare, l'applicazione del modello genera due risultati fondamentali: una mappa raster dei valori della CWD (fig. 3.A) e una mappa vettoriale lineare dei CEU che connettono le aree naturali protette della FUA di Cagliari (fig. 3.B). Sono stati identificati 11 CEU, con valori di CWD compresi tra 0 e 108,76 km. Valori prossimi allo zero si osservano in prossimità delle aree protette, mentre i valori più elevati si riscontrano nel quadrante nord-occidentale della FUA, caratterizzato da un uso agricolo intensivo e da una rilevante urbanizzazione.

Per la valutazione della qualità della connessione ecologica, sono impiegati due indicatori:

- CWD/ED, che misura la qualità della connessione tra due aree centrali adiacenti; valori più bassi indicano connessioni più efficienti;
- CWD/LCP, che rappresenta la resistenza media al movimento delle specie lungo il corri-

Variabili esplicative	Coefficienti	t-statistic	p-value	Valori medi delle variabili	Elasticità ai valori medi della CWD e delle variabili esplicative in riferimento ad un incremento del 10% del valore di ciascuna variabile $[(\Delta y/y)/(\Delta x/x), \%$ ]
RECR_OUT	-0,019	-11,183	0,000	2.059,537	-0,199%
FLD_CNTR	1,574	7,189	0,000	614,434	4,797%
CA_CP_ST	-2.569,171	-19,302	0,000	1,044	-13,308%
HAB_QUAL	-4.254,389	-28,333	0,000	0,466	-9,835%
L_S_TEMP	1.728,278	237,612	0,000	46,143	395,542%
ALT_ELEV	-17,013	-78,048	0,000	205,219	-17,317%

Variabile dipendente: CWD: Media: 20.161,61 km; Deviazione standard: 21.180,06 km; Coefficiente di correlazione corretto: 0.436.

## I risultati dell'analisi di regressione lineare multipla.

Tab. 3

doio; anche in questo caso, valori più bassi indicano minore resistenza e, quindi, maggiore funzionalità ecologica.

I risultati mostrano come i corridoi n. 8 e n. 4 risultino maggiormente caratterizzati dalla migliore qualità di connessione. Al contrario, i corridoi n. 9 e n. 10 presentano valori elevati per entrambi gli indicatori, segnalando una maggiore frammentazione ecologica (fig. 3.B). La fig. 3 mostra, inoltre, i nodi relativi alle aree protette e i CEU tra queste. Sebbene l'identificazione dei corridoi non consideri direttamente le infrastrutture esistenti, è stata condotta una sovrapposizione con le reti idriche, stradali e pedonali. In diversi casi si rileva una coincidenza spaziale tra i corridoi e i tratti del reticolo idrografico e delle infrastrutture pedonali. La metodologia adottata consente di valutare l'efficienza ecologica delle connessioni territoriali e costituisce la base per la definizione

di politiche del territorio orientate alla pianificazione urbana sostenibile, che favoriscano la salvaguardia della connettività ambientale in contesti fortemente antropizzati.

I risultati della regressione lineare multipla (1) sono riportati nella tab. 3, che mostra gli effetti marginali, in termini di segno e valore, delle variabili esplicative relative all'offerta dei SE in riferimento alla CWD, ed ai relativi *p-value*, che rappresentano il riferimento per l'affidabilità statistica delle stime. I risultati relativi ai *p-value* mostrano come le stime dei coefficienti del modello (1) siano, generalmente, affidabili. Pertanto, questi coefficienti sono da considerarsi come indicatori affidabili delle relazioni tra la CWD e l'offerta di SE che le variabili associate rappresentano.

Va evidenziato come la probabilità che una patch sia inclusa in un CEU aumenta al decrescere del valore della CWD. Di conseguenza,

un coefficiente negativo indica un effetto positivo del SE, in termini di maggiore idoneità della patch a essere inclusa nella rete dei CEU. Per evidenziare, in maniera efficace, gli impatti delle variabili esplicative su questa idoneità, sono calcolate le elasticità della CWD rispetto a ciascun SE, considerando un incremento del 10% nell'offerta media di ciascuno di essi, ai valori medi della CWD e dell'offerta dei SE.

Dai risultati emerge che un aumento del 10% del valore medio della variabile L\_S\_TEMP comporta un incremento della CWD pari a quattro volte il valore iniziale, evidenziando come i SE di mitigazione delle temperature (olferti, ad esempio, dalla vegetazione urbana) siano determinanti per migliorare l'idoneità ecologica delle patch.

Anche i servizi relativi alla cattura e stoccaggio del carbonio (CA\_CP\_ST) e alla qualità degli habitat (HAB\_QUAL) mostrano effetti significativi: un aumento del 10% della loro offerta si traduce, rispettivamente, in una riduzione della CWD del 13% e del 10%, il che ne sottolinea il contributo fondamentale al miglioramento della connettività ecologica.

Per quanto riguarda i servizi ricreativi all'aperto (RECR\_OUT), l'analisi evidenzia che un incremento medio del 10% dell'area fruibile per attività ricreative, riferito a una popolazione residente media di 2.057 abitanti entro un raggio di 500 metri, è associato a una riduzione della CWD pari a 11.151 metri, corrispondente a

una diminuzione del 52,69% rispetto al valore medio. Questo risultato sottolinea l'elevata rilevanza della funzione ricreativa nel rafforzare la rete dei CEU.

Il servizio legato al controllo del rischio alluvioni (FLD\_CNTR) presenta un coefficiente positivo, con un'elasticità prossima al 5%. Ciò indica che una maggiore capacità di ritenzione idrica si associa ad un aumento della CWD. Tale relazione potrebbe essere dovuta alla localizzazione di aree ad alta capacità di assorbimento in contesti non facilmente connettabili ecologicamente. Infine, la variabile di controllo relativa all'altitudine (ALT\_ELEV) mostra una correlazione negativa con i valori della CWD: le aree situate a quote più elevate risultano più favorevoli alla connessione ecologica, presumibilmente per la minore presenza di infrastrutture artificiali e per la maggiore presenza di copertura vegetale.

Nel complesso, il modello conferma che la pianificazione dei SE incide in maniera differenziata, ma significativa, sull'efficacia della rete dei CEU nella FUA di Cagliari.

### **Infrastrutture verdi urbane e sostenibilità ambientale: questioni aperte**

I risultati ottenuti in questo studio arricchiscono la letteratura esistente, evidenziando l'importante contributo che le aree verdi forniscono ai contesti urbani e periurbani, in termini di benefici derivanti dai SE. Per quanto riguarda i servizi ricreativi, in linea con quanto osservato

da Larondelle e Haase (2013), non si rileva né una distribuzione lineare urbano-rurale, né una configurazione a U, nella quale la fruizione ricreativa diminuisce dal centro verso la periferia per poi aumentare nelle aree più naturali (Liu et al., 2022). Nella FUA di Cagliari, i nuclei edificati rappresentano un elemento critico, poiché le aree ad alta offerta ricreativa si alternano ad aree in cui la popolazione residente non ha accesso a spazi verdi. Tale condizione genera disuguaglianze nella distribuzione dello spazio pubblico, con implicazioni rilevanti in termini di giustizia ambientale ed equità nell'accesso alle risorse naturali (Suárez et al., 2020; Benati et al., 2024).

Nelle aree periurbane e rurali della FUA, uno degli elementi chiave è la presenza di potenziali fruitori in prossimità delle aree che erogano SE. L'indicatore utilizzato, che misura l'offerta di spazi per attività ricreative all'aperto, tiene conto sia della domanda che dell'offerta, valutando, quindi, il flusso potenziale del SE. Ne deriva come il valore dell'indicatore cresce con l'aumentare della densità di popolazione. Tuttavia, l'espansione delle aree urbanizzate tende a ridurre l'offerta ricreativa. Paradossalmente, in alcune aree rurali l'indicatore migliora grazie a una maggiore fruibilità favorita dalla crescente urbanizzazione in tali aree, che incrementa l'accessibilità agli spazi ricreativi: si tratta di un risultato ottenuto, presumibilmente, in risposta a una domanda crescente di contatto con la natura e le attività all'aperto

(Concepción, 2021). In questo contesto, strumenti di pianificazione integrata potrebbero svolgere un ruolo strategico nel mitigare gli effetti dell'espansione urbana, superando un approccio settoriale che separa rigidamente sviluppo urbano e rurale (Kirby et al., 2023). Queste politiche dovrebbero incentivare la gestione sostenibile degli spazi periurbani e agricoli, promuovendo infrastrutture e servizi per la mobilità dolce e le attività all'aria aperta (Cozzi et al., 2022).

Per quanto concerne i SE di regolazione, i modelli spaziali relativi alla cattura e allo stoccaggio del carbonio ed alla qualità degli habitat mostrano, come previsto, un chiaro gradiente positivo che va dalle coperture artificiali a quelle agricole, fino a quelle naturali (Larondelle et al., 2016). Tuttavia, l'indicatore relativo alla temperatura mostra anomalie in alcune aree rurali pianeggianti, dove i valori termici risultano simili o superiori a quelli dei centri edificati. Questo fenomeno, tipico del clima arido mediterraneo (Marando et al., 2022), è probabilmente attribuibile alla raccolta estiva delle colture erbacee, che lascia il suolo nudo e ne aumenta l'impermeabilità.

La capacità di ritenzione idrica, invece, risulta fortemente influenzata dalla tipologia di copertura del suolo, dalle proprietà fisiche dei terreni e dai fattori morfologici, come la pendenza e la struttura geologica (Nedkov e Burkhard, 2012). Nella FUA di Cagliari, i suoli agricoli permeabili mostrano capacità di ritenzione

comparabili a quelle dei boschi collinari. Sebbene le foreste offrano prestazioni idrologiche superiori, la riforestazione non sempre costituisce una soluzione praticabile nella gestione del rischio idraulico (Sebastiani e Fares, 2023; Buechel et al., 2024). Inoltre, l'analisi conferma la scarsa capacità dei centri urbanizzati di trattenerle le acque meteoriche, sottolineando la necessità di interventi infrastrutturali per aumentare la permeabilità del suolo e ridurre la sigillatura superficiale del terreno.

La distribuzione spaziale dei cinque SE analizzati evidenzia l'assenza, nella FUA, di aree in grado di fornire simultaneamente tutti i servizi considerati. Ciò sottolinea l'urgenza di dotarsi di strumenti di pianificazione territoriale e urbana finalizzati a garantire la multifunzionalità delle IVU, per una gestione efficace, resiliente e integrata del territorio (McDonald et al., 2023; Kourdounouli e Jönsson, 2020).

L'approccio metodologico adottato per l'identificazione dei CEU ha prodotto due risultati importanti: una mappa della configurazione spaziale dei CEU e una mappa dei valori di CWD. A differenza di quanto avviene per i corridoi ecologici a scala regionale o nazionale, i CEU rivestono un ruolo essenziale nella connettività tra porzioni frammentate degli ecosistemi, facilitando i flussi biologici all'interno del tessuto urbano (LaPoint et al., 2015). Inoltre, è opportuno sottolinearne il valore, culturale e sociale, oltre al contributo fondamentale sulla componente estetico-paesaggistica (Cohen, 2007).

L'analisi delle funzioni culturali dei CEU è ancora poco trattata in letteratura, sebbene studi recenti, come quello di Xu et al. (2019), ne evidenzino la doppia valenza, ecologica e sociale, proponendo strumenti e approcci integrati per la loro identificazione. Tra i metodi utilizzati per individuare i CEU, Peng et al. (2017) hanno confrontato vari approcci, tra cui l'analisi di idoneità/sensibilità, l'analisi di rete ed il modello LCP, adottato anche in questo studio. Il modello LCP si distingue per la capacità di individuare i percorsi a minore resistenza tra aree ad alto valore naturale, anche attraverso l'integrazione delle componenti funzionali del paesaggio. Tuttavia, presenta alcuni limiti, tra cui l'incapacità di definire la larghezza dei corridoi (Zhang et al., 2023).

I dati empirici mostrano che i valori più bassi di CWD si riscontrano nelle aree protette, caratterizzate da elevata integrità ecologica. Questo è coerente con quanto riportato da Isola et al. (2022), secondo cui le componenti forestali, quali boschi e sugherete, contribuiscono positivamente all'efficienza ecologica dei corridoi. Analogamente, Zhang et al. (2023) confermano che la CWD è un riferimento efficace della lunghezza e qualità funzionale dei corridoi: valori elevati indicano percorsi più lunghi e frammentati da barriere fisiche, tipiche delle aree urbanizzate. L'applicazione del modello LCP consente, quindi, di valutare, in termini adeguati, almeno con riferimento alla FUA di Cagliari, la connettività del sistema dei CEU

in relazione al grado di naturalità. La presenza diffusa di spazi verdi attrezzati e coperture vegetali di qualità rafforza, in questo caso, la funzione ecologica e multifunzionale dei CEU (Krosby, 2015).

Numerosi studi sottolineano come la protezione e il ripristino delle aree ad alta naturalità contribuiscano alla mitigazione delle emissioni climalteranti ed alla conservazione della biodiversità (Hilty et al., 2020). Pertanto, risulta fondamentale integrare le IVU nei processi di pianificazione territoriale, considerando le infrastrutture strategiche nella gestione degli ecosistemi. Dal punto di vista urbanistico, la distribuzione spaziale delle IVU, combinata con le analisi fondate sul LCP, può guidare la localizzazione delle aree per gli standard urbanistici, costituendo un riferimento utile per le future trasformazioni del territorio. In definitiva, la connettività ecologica non deve essere intesa solo come valore da proteggere, ma, piuttosto, e soprattutto, quale vera e propria condizione infrastrutturale su cui fondare transizioni spaziali integrate e sostenibili.

La significativa correlazione tra la temperatura superficiale (L\_S\_TEMP) e la CWD è in linea con gli studi di Gao et al. (2022) su Wuhan, secondo cui un incremento del 10% dell'indice *Spatial Connectivity between patches of the heat Source and Sink* (SCSS) comporta una riduzione di circa 1°C. La regressione stimata in questo studio mostra come ad una diminuzione di 1°C della L\_S\_TEMP corrisponda un aumento del 9%

della CWD, a conferma dell'effetto negativo della frammentazione sulla connettività ecologica ed in linea con l'articolo appena citato.

Anche He et al. (2024), nelle analisi condotte sulla città di Shanghai, confermano questa dinamica, sottolineando come l'abbassamento delle temperature sia legato all'estensione ed alla forma delle infrastrutture verdi e blu, la cui continuità spaziale migliora la fornitura dei SE. Risultati simili sono emersi in altre città cinesi come Xuzhou e Wuhan, a conferma dell'universalità del fenomeno (Zhang et al., 2023; Zhao et al., 2023).

Il servizio di cattura e stoccaggio del carbonio, strettamente legato alla continuità delle aree verdi, si conferma fondamentale per l'efficacia dei CEU. Valente et al. (2022), nello studio sulla città di Lecce, dimostrano che la qualità della vegetazione nelle aree urbane attrezzate favorisce l'assorbimento di CO<sub>2</sub>. Studi relativi al sud-ovest della Cina (Lv et al., 2023; Zhang et al., 2015) mostrano l'efficacia della vegetazione nelle zone carsiche in relazione alla regolazione delle ondate di calore. Floris e Zoppi (2020), inoltre, evidenziano la correlazione negativa tra consumo di suolo e capacità di cattura e sequestro di carbonio, ed il ruolo rilevante che le aree protette giocano nella sua conservazione.

Per la qualità degli habitat (HAB\_QUAL), Lai et al. (2018) individuano due fattori principali: la riduzione delle pressioni ambientali e il relativo aumento della qualità dei suoli. He et al. (2017)

propongono politiche per contenere la dispersione insediativa anche in ambito rurale. Inoltre, Sallustio et al. (2017) propongono criteri normativi per la selezione delle aree protette e la gestione della qualità dell'habitat e del degrado del suolo, con riferimento all'attuale quadro normativo italiano in materia di protezione dell'ambiente: la loro ricerca indica come la qualità degli habitat diminuisca con l'aumentare della vicinanza alle aree densamente popolate, e diminuisca anche in prossimità di coltivazioni intensive.

Infine, in riferimento agli spazi ricreativi all'aperto (RECR\_OUT), i risultati sono coerenti con Song e Liu (2024), che legano la fruizione degli spazi verdi all'accessibilità pedonale, mentre Richards et al. (2024) sottolineano come la connettività ecologica aumenti l'attrattività degli spazi verdi, soprattutto se contigui a zone fluviali o umide.

Per quanto riguarda il controllo del deflusso idrico (FLD\_CNTR), il coefficiente positivo suggerisce che una maggiore presenza di aree vegetate non sempre coincide con suoli ad alta capacità di filtrazione. La relazione tra copertura del suolo, gruppi omogenei di suolo (SHG) e infiltrazione è fortemente dipendente dal contesto locale, come indicano gli studi condotti in relazione a contesti spaziali localizzati in Nevada, Arizona e Spagna (Jordán et al., 2008; Stewart et al., 2012): questi confermano l'elevata variabilità delle dinamiche di deflusso.

## **Infrastrutture verdi e spazio urbano: sviluppi futuri della ricerca**

Come evidenziato nella prima sezione, l'obiettivo generale di questo studio è contribuire a colmare la mancanza di una definizione, sia concettuale sia applicativa, universalmente condivisa delle IVU, distinta dal concetto più generale di IV. Per affrontare questa carenza, il lavoro presenta un approccio metodologico per l'identificazione e la classificazione delle IVU, considerando l'attuazione delle IV nello spazio urbano.

Per raggiungere questo obiettivo, è adottata una metodologia articolata in tre fasi principali. La prima riguarda l'identificazione della tassonomia spaziale dell'offerta di servizi ecosistemici (SE), concepita come un indicatore composito della qualità della vita urbana e interpretata come un sistema complesso di benefici forniti dalla natura. La seconda fase si concentra sulla struttura spaziale delle IVU, rappresentata idealmente come una rete composta da nodi, ovvero aree ad alto valore naturalistico, e da collegamenti lineari ad alta connettività e capacità di fornitura di SE, cioè i CEU. La terza fase analizza la correlazione tra i CEU e i SE, con l'obiettivo di valutare l'impatto sulla connettività ecologica urbana dell'offerta di SE.

I risultati ottenuti per la FUA di Cagliari evidenziano l'importanza quantitativa degli spazi verdi urbani, pubblici e privati, che risultano fondamentali per la definizione e l'attuazione

di politiche urbanistiche volte ad uno sviluppo sostenibile del territorio, in termini ambientali, sociali e culturali. Tali spazi, siano essi alberati o boscati, e connessi tra loro dai CEU, dovrebbero costituire un elemento strutturale delle strategie urbane, promuovendo un'espansione significativa e diffusa delle aree verdi e valorizzando i corridoi ecologici come infrastrutture strategiche di connessione. Un elemento distintivo della metodologia proposta è la sua replicabilità in altri contesti urbani, in particolare in altre FUA, tramite un quadro valutativo basato sull'offerta di SE. Sebbene non esaustivo, questo quadro costituisce una matrice efficace nell'orientare le azioni volte ad una pianificazione territoriale realmente sostenibile. Tra i limiti della metodologia si segnala la selezione ristretta a sole cinque tipologie di SE, che definisce, in modo deterministico, la struttura spaziale della IVU della FUA di Cagliari. L'inclusione di ulteriori SE, come quelli legati all'agricoltura o al patrimonio culturale, potrebbe migliorare la rappresentatività della qualità della vita urbana. Inoltre, la qualità dei dati impiegati si basa spesso su stime piuttosto che su rilevazioni dirette, riducendo l'accuratezza di alcune valutazioni, come nel caso della cattura e dello stoccaggio del carbonio, per i quali mancano dati specifici sulle emissioni di CO<sub>2</sub>.

I risultati suggeriscono l'opportunità di superare l'approccio tradizionale, ancora prevalente nelle amministrazioni locali, che tende a subordinare la pianificazione dei SE alla defini-

zione dell'assetto delle aree destinate all'edificazione. Sarebbe auspicabile passare dalla logica della massimizzazione della rendita fondiaria a quella della valorizzazione dell'efficacia delle IVU, orientata alla massimizzazione dell'offerta di SE. In quest'ottica, è fondamentale disporre di osservazioni dirette più accurate, per migliorare l'affidabilità delle valutazioni e tradurre i risultati in soluzioni operative, anche attraverso il coinvolgimento proattivo delle comunità locali, che di tali benefici massimamente fruiscono.

Per gli sviluppi futuri della ricerca, si pone in evidenza quanto segue.

In primo luogo, sarebbe importante una discesa di scala, approfondendo l'identificazione delle IVU al livello del singolo comune, anche allo scopo di definire appropriate linee-guida, rivolte soprattutto a tecnici ed amministratori pubblici, finalizzate a promuovere l'efficacia e l'efficienza delle IVU nei contesti locali.

Inoltre, va sottolineato come le IVU ed i relativi CEU, identificati tramite l'approccio metodologico proposto in questo studio, vadano integrati nei tessuti urbani consolidati esistenti, quindi tenendo conto, a titolo di esempio, di parchi, piazze, aree per le attività ricreative all'aperto, infrastrutture lineari della mobilità, pedonali, ciclabili e carrabili, tetti e facciate verdi, e, anche, secondo il principio delle aree dismesse e delle aree libere localizzate nelle zone industriali e commerciali (Davies et al., 2015). Questi profili potranno efficacemente

essere approfonditi attraverso lo sviluppo futuro della ricerca.

Un affinamento della metodologia per l'identificazione delle IVU e dei relativi CEU comporta l'attuazione di confronti con altri approcci esistenti, e molti sono disponibili nella letteratura scientifica e tecnica (Salata e Yiannakou, 2016; Dover, 2015), e la revisione critica del set di SE adottato, al fine di ampliarlo e migliorarne le modalità di valutazione dell'offerta.

### **Riconoscimenti e attribuzioni:**

Il contributo è frutto della ricerca comune degli autori. Le sezioni "Infrastrutture verdi urbane e pianificazione spaziale", "Servizi ecosistemici, corridoi ecologici urbani e relazioni spaziali" (per quanto riguarda la parte relativa alla regressione lineare multipla), "Risultati" (per quanto riguarda la parte relativa alla regressione lineare multipla) sono state redatte da Corrado Zoppi; le sezioni "Servizi ecosistemici, corridoi ecologici urbani e relazioni spaziali" (per quanto riguarda la parte relativa alla tassonomia spaziale dei servizi ecosistemici), "Risultati" (per quanto riguarda la parte relativa alla tassonomia spaziale dei servizi ecosistemici), sono state redatte da Sabrina Lai; le sezioni "Servizi ecosistemici, corridoi ecologici urbani e relazioni spaziali" (per quanto riguarda la parte relativa ai corridoi ecologici), "Risultati" (per quanto riguarda la parte relativa ai corridoi ecologici), sono state redatte congiuntamente da Federica Isola e Federica Leone; la

sezione "Conclusioni" è stata redatta da Federica Leone; la sezione "Infrastrutture verdi urbane, servizi ecosistemici e corridoi: questioni aperte" è stata redatta congiuntamente dalle autrici e dall'autore.

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## Note

<sup>1</sup>Copernicus Europe's Eyes on Earth. Land Monitoring Service. Urban Atlas. Disponibile al sito: <https://doi.org/10.2909/fb4dffaf1-6ceb-4cc0-8372-1ed354c285e6> (06/2025).

<sup>2</sup>ISTAT. Dati per sezione di censimento. Disponibile al sito: <https://www.istat.it/it/archivio/285267> (06/2025).

<sup>3</sup>Natural Capital Project Stanford University. What is InVEST? Disponibile al sito: <https://naturalcapitalproject.stanford.edu/software/invest> (06/2025).

<sup>4</sup>Sardegna Geoportale. Carta della permeabilità dei substrati della Sardegna. Disponibile al sito: <https://www.sardegnaegeoportale.it/index.php?xsl=2420&s=40&v=9&c=94083&es=6603&na=1&n=100&esp=1&tb=14401> (06/2025).

<sup>5</sup>Sardegna Geoportale. Carta dell'uso del suolo. Disponibile al sito <https://www.sardegnaegeoportale.it/index.php?xsl=2420&s=40&v=9&c=14480&es=6603&na=1&n=100&esp=1&tb=14401> (06/2025).

<sup>6</sup>Idrologia e Idrometria [Hydrology and Hydrometry]. Disponibile al sito: <https://www.sardegnaambiente.it/index.php?xsl=611&s=21&v=9&c=93749&na=1&n=10> (06/2025).

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# Mapping Urban Proximity for Resilience: Testing a Methodological Framework for Local Resilience Units in Turin

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## Introduction

In the process that progressively integrated the concepts of sustainability and resilience into urban and territorial planning—where resilience can be understood as a subsystem or an operational dimension of sustainability (Folke et al., 2006, 2021; Brunetta, 2016)—the need emerged to combine conceptual paradigms with tools and methodologies capable of translating them into territorial innovation. In this context, resilience can be explicitly defined as the capacity of socio-ecological systems not only to absorb shocks and disturbances, but also to adapt and transform by reorganizing on new, more robust and flexible

bases (Holling, 1987; Gunderson & Holling, 2002; Davoudi, 2012; Brunetta et al., 2019; Folke, 2016).

At a global level, the push towards these paradigms has been determined by a growing awareness of the impact of human activities on the environment. First through the evidence of the damage caused by local pollutants, then through scientific observations on anthropogenic

*Growing awareness of the climate change effects made sustainability and resilience essential in the debate on territorial planning, yet their practical deployment is still constrained by siloed programmes and sector-based strategies. The Post Un-Lock project addresses this gap by introducing the Local Resilience Unit (LRU), an operational framework that translates urban-resilience theory into place-specific action. Each LRU blends territorial analysis with*

*community co-design to reinforce a city's and neighbourhood capacity to absorb shocks while preserving wellbeing and quality of life. This article describes an open-source GIS workflow - implemented in QGIS and OpenRouteService - for the identification of potential LRUs. After compiling a neighbourhood-scale inventory of everyday points of interest, isochrone-based service areas are generated for each facility under the paradigm of a walkable, proximity-oriented city. Overlaying these service areas delineates zones of high pedestrian accessibility, which are considered the most suitable locations for resilience-oriented interventions. The methodology is demonstrated in Turin, Italy. The results of the study provide a foundation for future deployment of LRUs both within Turin and in other urban contexts, and can be extended wherever identifying areas for essential services is required.*

climate change, a long process of renewal has developed. In this process, research played a crucial role – although with results that have not always been linear – in accompanying the evolution of rules, governance models and urban and territorial design tools and, finally, in

providing large amounts of robust and reliable data at ever finer scales<sup>1</sup>.

In the last decade we observe how the regulations and policies – from the mainstreaming of the Paris Agreements and the Sustainable Development Goals (SDGs) at a global level, the most recent European Green Deal, and the set of national and regional strategies and plans for adaptation to climate change – progressively attributed to spatial policies a central role in sustainable and resilient development. In some cases, this role is explicitly recognized, in others, it is evident through its absence or underestimation. If on the one hand, in Europe and Italy, there is now a shared awareness that climate change is one of the greatest threats to communities and of the impact that climate change has on cities and territories – with documented effects on ecosystems and landscapes (Voghera, 2024), production activities and human health (Ellena, 2023) – on the other hand, it remains difficult to consolidate, at a regulatory and operational level, a truly resilient approach, capable of acting in an integrated manner, on a multilevel and multidisciplinary scale. In fact, regulatory fragmentations and conceptual silos persist that hinder a systemic vision, translating into strategies, plans and programs that are often still highly sectoral.

This tension became particularly tangible during the COVID-19 pandemic. Although not the focus of this paper, the pandemic served as a

real-world stress test, exacerbating pre-existing urban issues and highlighting the structural limitation of urban organization, limitations of sectoral policy frameworks and on the other hand the importance of neighbourhood-scale accessibility in sustaining, or not, daily life under systemic disruption (Phua et al., 2024). Emergency measures and tactical urbanism interventions – such as temporary pedestrianization, rapid cycling infrastructure, and the redistribution of public space – highlighted how proximity-based configurations can support adaptive capacity when mobility and social interaction are constrained (Shah et al., 2023). While these measures were temporary and implemented under exceptional circumstances, they contributed to shaping the reflection – developed during the years of this research – on proximity as an operational dimension that can complement broader resilience strategies in urban contexts.

In this scenario, the research program Post-Un-Lock was developed between 2020 and 2023, with a dual objective: on the one hand, to build a conceptual definition of the *Local Resilience Unit*, proposed in the continuation of the article at the urban scale; on the other, to investigate more broadly the potential of resilience planning, considering the pandemic experience. Within this framework, proximity was examined not as a synonym of resilience, but as one operational condition able to support adaptive capacity in everyday urban life, particularly

when mobility and social interaction are constrained. In this sense, the focus of this contribution is limited to the urban scale, where pedestrian accessibility can function as a *practical entry point* to identify contexts potentially favorable to resilience-oriented actions. The possible extension of the LRU framework to wider territorial scales would be necessary for future research, beyond the scope of this work. The first results of the project, published in the volume *Post-UnLock - From territorial vulnerabilities to local resilience*, laid the foundations for the case study presented in this contribution and for the subsequent development of research on territorial vulnerability, conducted within the Responsible Risk Resilience Centre (R3C) of the Politecnico di Torino (Brunetta, Lombardi & Voghera, 2023). This article presents the concept of Local Resilience Unit applied to an urban context, illustrates the methodology developed and tested in the Turin case study, discusses the results and proposes, in conclusion, some lessons learned and suggestions for future developments.

### **The concept of Local Resilience Unit**

Covid-19 in 2020 highlighted how many of the measures adopted to manage the health emergency coincided, at least in part, with urban planning strategies oriented to resilience. This overlap revealed a convergence between short-term crisis management objectives and long-term ones aimed at making cities more

prepared to face future challenges, including those related to climate change (Martínez & Short, 2021). This convergence was particularly evident in pandemic-management policies concerning public space, transport, connectivity, and the economy<sup>2</sup>.

The strategies adopted by many Italian and European cities included the enhancement of open public spaces and ecosystem services, the decentralization – often temporary – of functions, and the promotion of sustainable mobility and remote working. Although mainly motivated by the need to reduce crowding and contagion risks, these measures reflected fundamental principles of sustainability and resilience, such as limiting forced mobility and overcoming urban mono-functionality. In this way, neighbourhoods re-emerged as central spaces of daily life, where diversified and accessible services can enhance quality of life, social cohesion, and the perception of safety, while reducing congestion and environmental impacts.

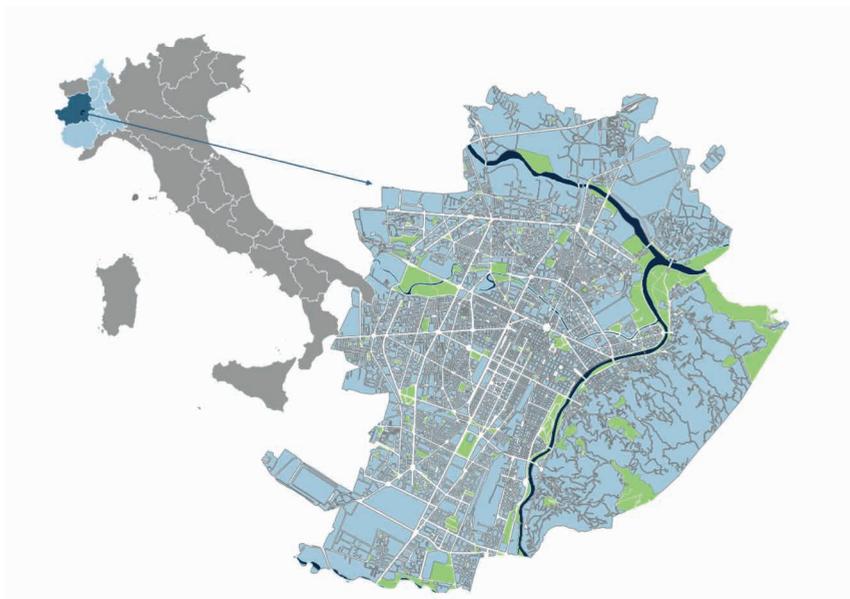
Urban planning has addressed these issues since the origins of the industrial city, from central place theory to the garden city model, both concerned with density, traffic, and the distribution of services. While some problems have been mitigated through planning regulation, new challenges persist—ranging from the quality of services to the adaptive needs posed by climate change. Within this long-standing trajectory, more recent proximity-oriented ap-

proaches such as the “15-minute city” (Moreno et al., 2021) and Barcelona’s “Supermanzana” (Rueda, 2007) can be interpreted as updated expressions of an enduring planning tradition that emphasizes neighbourhoods as functional and relational units.

The proposal of Local Resilience Units is situated within this broader framework. Rather than prescribing a new ideal model, LRUs are conceived as a flexible and scalable paradigm with a variable spatial dimension that allows application at different territorial scales. In this paper, the concept is employed as a methodological lens at the urban level, with the specific aim of developing a procedure to identify suitable areas for potential activation, while their actual implementation would necessarily require in-situ design and governance processes involving institutions, local actors, and communities (Brunetta et al., 2023).

### **Testing the methodology: Turin, Italy**

The implementation of a Local Resilience Unit requires a careful preliminary analysis of the city to identify areas with favourable conditions for hosting interventions. In this sense, the identification of Local Resilience Units needs a study of urban proximity and accessibility conditions. The development of a methodology to identify such areas was the subject of a doctoral thesis, aimed at distinguishing, within the city of Turin, the areas already prepared to accommodate transformative actions



for urban resilience, based on three fundamental assumptions (Scalas, 2024):

- a) the city as a unit of analysis.
- b) an explicit focus on the dimension of daily life.
- c) proximity as pedestrian accessibility to essential services.

The aim was to map the areas potentially suitable for Local Resilience Units, providing a practical tool to support planning. An early test in Novara validated the core of the calculation procedure (Scalas, 2023). The choice of Turin, a large city in north-western Italy (Figure 1), as a case study was motivated by a combination of strategic elements. First, the city has a broad and well-structured information base, useful for detailed analyses. Second, it boasts a rich history of experiences in sustainability and urban transformation. In addition, the authors' knowledge of the context from both scientific and planning perspectives proved decisive. Turin experienced rapid demograph-

ic growth and social diversification during the post-war industrial *boom*, followed by a phase of deep urban reconfiguration from the late 1990s, coinciding with processes of industrial relocation. This was followed by a significant season of strategic planning, during which the city demonstrated a notable ability to redefine its vocation in a post-industrial direction. These elements make Turin a particularly suitable terrain for experimenting with the methodology of mapping areas for the potential application of Local Resilience Units.

At the operational level, the first step was the analysis and selection of the most appropriate methodologies for the intended mapping. Among the available approaches, a distinction can be made between those based on pre-defined administrative geometries—such as districts, neighbourhoods, or census sections—and empirical ones, which rely on criteria more directly linked to the actual use of urban space. Within the latter, it is possible to distinguish

## Location of Turin

Fig.1

user-based methods, grounded in the observation of real user behaviour (e.g. GPS tracking of a representative sample of residents), and place-based methods, which are based on the spatial analysis of the characteristics of places, such as the areas of influence generated around points of interest. In this study, a place-based approach was adopted, based on the calculation and overlap of isochrones—polygons representing areas reachable on foot from a starting point within a given time interval. Isochrones, commonly used in service planning, trade, and mobility, provide a dynamic measure of actual proximity to services, overcoming the rigidity of administrative subdivisions and allowing a more refined and accurate reading of urban reality. All analyses were carried out using Geographic Information Systems (GIS) and other tools detailed in the following paragraphs.

The methodology consisted of the following steps:

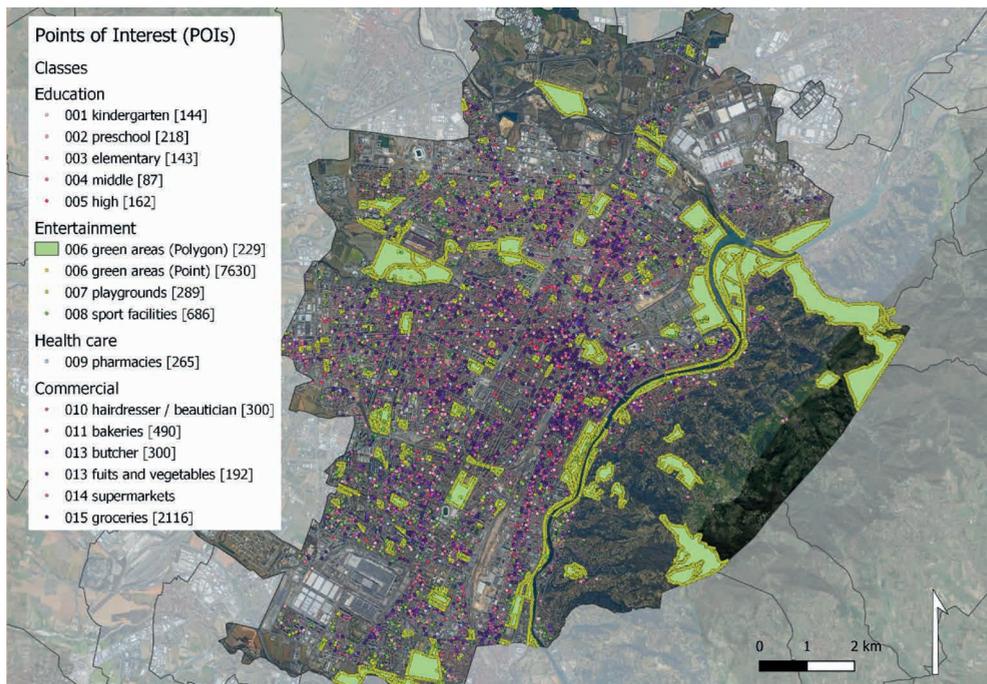
- a. Selection of points of interest, places representative of daily activities and able to comprehensively describe the offer of services available to citizens at the neighbourhood or district scale.
- b. Definition of the time intervals and travel parameters associated with the typical user.
- c) Calculation of the isochrones.
- c. Overlap of the isochrones.

For the selection of points of interest, four main categories were identified, corresponding

to dimensions considered essential in neighbourhood daily life: education, public spaces for leisure, health, and commercial services. Each category was further divided, as reported in Table 1, and mapped (Figure 2). In total, 6,828 points were considered. High-level services for which longer travel times are acceptable (e.g. universities, hospitals), or services related to mobility (bus stops, stations, parking lots), were excluded. Similarly, the health category did not include primary care physicians, due to difficulties in obtaining reliable data. However, the high spatial correlation between doctors' offices and pharmacies made it possible to approximate daily health needs through a single category. To model large surfaces, such as parks, their edges were converted into sets of points. The absence of a "work" category was due to the difficulty of tracking home-work trips at the neighbourhood scale without field data, and to the nature of such trips, which typically involve mobility well beyond the neighbourhood scale.

The second step involved defining the travel time to be used as the isochrone parameter. Threshold values were selected through a combination of literature review and direct experimentation on the case study. Three time intervals were adopted: five, ten, and fifteen minutes. This triple threshold allowed the evaluation of the model's robustness and supported reflection on which parameter best describes conditions of urban proximity in Turin.

Class	Point of Interest (POI)	Number	Source
<b>Education</b>	Kindergarten	144	Geoportale del Comune di Torino
	Preschool	218	
	Elementary schools	143	
	Middle schools	87	
	High schools	162	
<b>Entertainment / Leisure</b>	Green areas	229	
	Playgrounds	289	
	Sport facilities	686	
<b>Health</b>	Pharmacies	265	
<b>Commercial</b>	Hairdresser, beautician	300	
	Bakery	490	
	Butchery	300	
	Fruit & vegetables	195	
	Groceries	2116	
	Supermarkets	417	



## Points of Interest adopted in the mapping procedure.

Tab. 1

## The identified Points of Interest in the City of Turin.

Fig. 2

The model was based on an “average pedestrian” profile, with a walking speed of 5 km/h (Pellicelli et al., 2022).

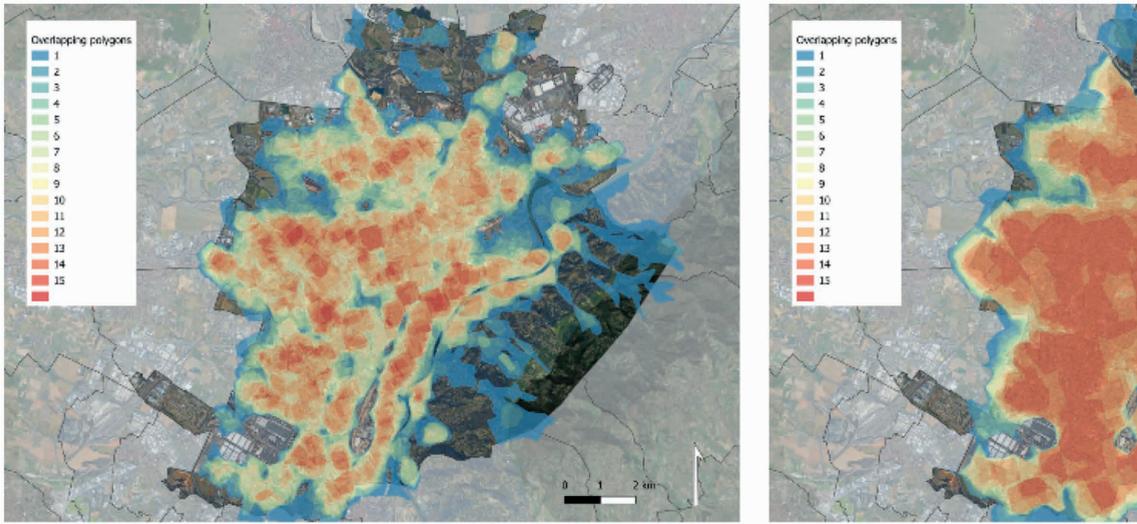
Isochrone calculations were performed using *Openrouteservice*, an open-source software developed by the *Heidelberg Institute for Geoinformation Technology*. It is based on graph theory, which determines routes through a road network where each segment is described by attributes such as length, travel time, and other topological characteristics. *Openrouteservice* uses the road graph derived from *OpenStreetMap* data. Although the service is available online in free mode for small-scale applications, in this study it was deployed on a local server using Docker. This allowed the software to be executed from the command line within an isolated environment (container), ensuring performance and process control. The results—20,484 total isochrones, corresponding to 6,828 points calculated for each of the three-time intervals—were saved in GeoJSON format, fully compatible with QGIS, for subsequent spatial analysis.

Isochrone overlap was conducted with QGIS. The aim was to identify areas suitable for experimenting with Local Resilience Units, through the construction of a geometry representing actual pedestrian proximity. The underlying principle is simple: each service generates its own accessibility basin (or service area) relative to a given travel time. By overlapping accessibility basins of different services, it is possible to identify the areas

from which all services can be reached within the predefined time threshold. These areas potentially represent the urban contexts most suitable for hosting integrated proximity interventions, and thus constitute the operational bases for experimenting with Local Resilience Units. The process was divided into two phases. The first phase involved aggregating isochrones by type of service (e.g. all isochrones of nurseries, pharmacies, etc.), to avoid duplicate counts within the same category. The second phase involved counting overlaps between different service types, i.e. identifying areas where the accessibility basins of different services overlapped within the same time interval. These operations were performed using bash scripts and the Graphical Modeler, with the aim of optimizing performance, automating workflows, and minimizing manual operations—thereby reducing the risk of errors and ensuring a high level of replicability by design.

### Results

Three maps of Turin were created, one for each time parameter used. The maps show the overlapping polygons obtained from the calculation procedure, classified according to the number of overlaps (Fig. 3). A polygon with a score of 1 indicates that only one service can be reached within the given time parameter, whereas a score of 15 indicates that all services considered in the analysis can be reached from that polygon within the same threshold.



**The results of the mapping procedure for 5 (left), 10 (center) and 15 minutes (right).**

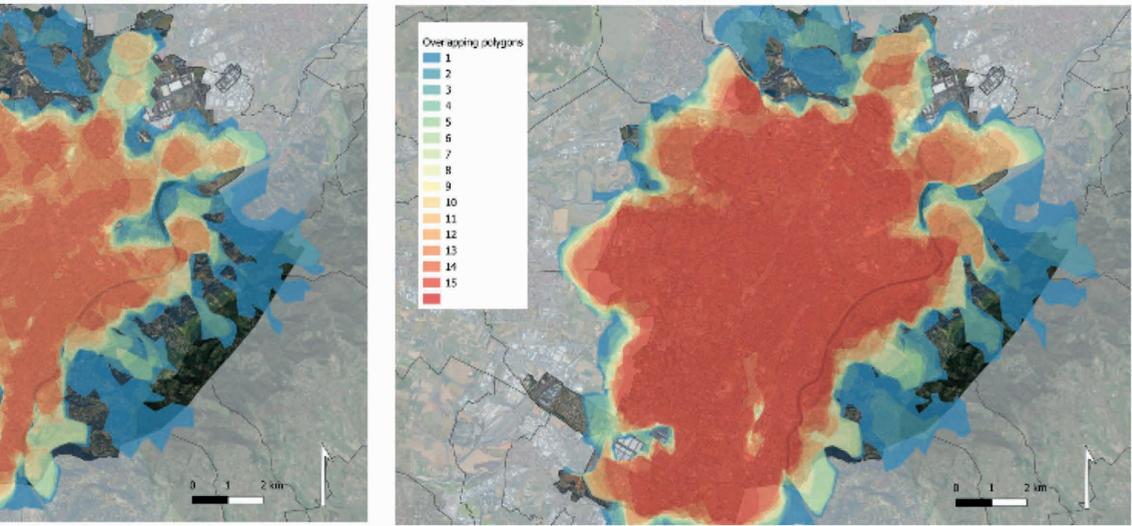
Fig. 3

For the 15-minute parameter, the results confirm—consistently with previous research—that most residential areas of Turin show a high degree of service overlap (Staricco, 2022). In practice, starting from almost any residential area of the city, it is possible to reach nearly all of the services included in the analysis within 15 minutes. Only some peripheral areas are less well served. A notable exception is the eastern hill area, characterized by low building density and a settlement pattern markedly different from the rest of the city. For the 10-minute parameter, the results also indicate good accessibility, although no areas of total overlap (score 15) were identified. While the lowest-scoring areas remain the hill districts, clusters of high scores emerge along two parallel north-south axes and in smaller clusters in the northern part of the city. Among the least-served residential areas, the north-western and northern peripheries are most evident. For the 5-minute

parameter, the results show greater differentiation, with a reduced presence of high-scoring areas. The analysis also reveals the emergence of service clusters and accessibility axes: one running north-south along the Po River, and another in an east-west direction towards the Susa Valley and France.

### Discussion

The methodology allowed a study of Turin based on pedestrian accessibility to services that characterize daily life, in order to identify areas potentially suitable for the experimentation of Local Resilience Units. These areas do not represent Local Resilience Units per se, but contexts whose accessibility conditions may justify and incentivize local actions that promote, for example, sustainable mobility, the strengthening of public services, and the co-management of common goods. Proximity is considered as a practical entry point to explore resilience potentials at the urban scale,



**The neighbourhoods of San Paolo, Santa Rita and San Salvario overlapped with the 5-minutes polygons**

Fig. 4

while broader systemic dimensions of resilience remain beyond this paper's scope. Moreover, this type of quantitative analysis does not assess the quality of services, but simply identifies the best-served portions of the city, under the assumption that in these contexts a Local Resilience Unit could express its full potential once activated. Conversely, low-scoring areas reveal gaps in service provision and accessibility, highlighting the need for policies aimed at reducing these disparities.

Overall, the analysis shows that Turin is already a positive example of service distribution, which makes it difficult to use the methodology alone as a criterion for selecting experimental areas. The high results obtained with the 15-minute parameter confirm previous findings on Turin's accessibility, but do not help to distinguish suitable areas. The five-minute threshold also proves too restrictive, while the ten-minute parameter provides more useful insights, even though the overall homogeneity of the results required refining the procedure. In particular, polygons with the highest scores (14) were isolated from the ten-minute map, allowing the identification of areas with greater potential. Figure 4 illustrates three neighbourhoods—San Paolo, Santa Rita, and San Salvario—as examples of contexts that could serve as laboratories for the possible activation of Local Resilience Units, pending further design and governance processes.

The methodology thus proved useful but not sufficient on its own for the final selection

of experimental areas, partly because Turin's structural characteristics already support walkability and service accessibility. Future applications could test the approach in other Italian and European cities to verify whether Turin's high scores are specific to its urban fabric or reflect broader planning traditions. At the policy level, the method may also provide a basis for participatory processes, enabling municipalities to share analyses of accessibility basins in a transparent manner, thereby fostering citizen awareness, reducing potential conflicts, and encouraging local support for interventions such as the redesigning of public spaces or the expansion of community facilities.

### Results and Conclusion

The methodology developed and tested in Turin has produced results that are valuable in themselves, showing how pedestrian accessibility analysis can highlight areas of the city with greater or lesser service proximity. The study confirmed Turin's strong predisposition to walkability and service distribution, but also showed the limits of proximity thresholds: the 15-minute parameter proved too homogeneous, the 5-minute threshold too restrictive, while the 10-minute interval offered more differentiated insights. By isolating the highest-scoring polygons, the method identified neighbourhoods—such as San Paolo, Santa Rita, and San Salvario—as potential laboratories for resilience-oriented experimentation. At a technical level, the procedure demon-

strated high levels of automation and replicability, as well as scalability, having already been applied in other contexts (e.g. Local Plan for Adaptation to Climate Change of Sassari<sup>3</sup>) with targeted objectives such as the definition of climate shelters.

Building on these results, the study must be situated within a broader process of developing Local Resilience Units. Three levels can be distinguished:

1. Theoretical-conceptual level – the formulation of LRUs as a flexible and scalable paradigm of resilience, applicable at different territorial scales.
2. Methodological level – the contribution of this paper, which operationalizes the concept at the urban scale through a mapping procedure to identify areas potentially suitable for the activation of LRUs.
3. Operational-implementation level – the subsequent step, which would require in-situ co-design processes with institutions, local stakeholders, and communities to activate LRUs as planning devices.

Accordingly, this paper does not claim to implement Local Resilience Units directly, but to advance the methodological phase of the process, providing a reproducible and adaptable tool to support urban planning.

Beyond the specific reference to LRUs, the methodology also demonstrates a high degree of versatility. By varying the sets of points of interest, the temporal thresholds, or the user profiles, it can be used to identify target areas

for specific social groups, to evaluate accessibility in thematic domains such as health or green infrastructure, and to compare different urban contexts. This flexibility suggests that the method can serve as a generalizable tool for resilience-oriented and proximity-based planning. Finally, the Turin case study confirms the importance of developing multi-scalar strategies for resilience planning in the Anthropocene. At the regional level, this implies strategic visions and shared agreements between institutions and stakeholders (Brunetta, 2015); at the local level, it calls for regulatory frameworks and innovative design actions for a green and equitable transition, rooted in co-design and co-management (Giudice, Novarina, Voghera, 2023). Within this framework, the Local Resilience Unit should not be seen as a new prescriptive paradigm, but as a heuristic and operational frame that can link theoretical principles, methodological tools, and concrete experiments, supporting cities in evolving through transformative resilience.

### **Acknowledgements**

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## Notes

<sup>1</sup> The Dataclime platform can be taken as a reference of the current state of the art in regional scale climate modelling. Developed by the REMHI Division of the Institute for Climate Resilience of the Euro-Mediterranean Center on Climate Change CMCC), it is accessible at the link <https://www.dataclime.com/en/>. It allows the consultation and download of over 200 climate indicators representing some of the most impactful climate hazards (heat, precipitation, wind, rain) throughout Italy.

<sup>2</sup> Mobility, however, represented a sector of partial divergence: the reduction in public transport use was often offset by an increase in private vehicles. When this shift involved low-impact modes such as cycling, convergence with resilience principles was evident; when it relied on cars, it instead conflicted with them, weakening public transport systems.

<sup>3</sup> Through the PASS project, the Municipality of Sassari has updated the Local Plan for Adaptation to Climate Change. The application of the methodology based on the overlap of isochrones can be viewed in the section on heat waves, on the capacity for adaptation in the municipal territory.

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# Mapping Urban Resilience Responses: Testing a Spatial Indicator Approach in Turin

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### keywords

urban resilience  
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qualitative-quantitative  
method  
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evaluation  
resilience indicators

*The complex and dynamic nature of urban resilience makes it both essential and challenging to define an appropriate qualitative-quantitative approach for its measurement that combines context-sensitive indicators with spatial analysis. The method proposed in this paper balances standardised frameworks with local specificity through the application of selected resilience indicators in the city of Turin (Italy). By spatially mapping territorial response elements related to natural vulnerabilities*

### Introduction

In an increasingly urbanised world (UN, 2019), cities face growing exposure to a wide range of natural and human-induced hazards, including extreme weather events, infrastructure failures, resource depletion, and socio-political uncertainty. In response to these escalating challenges, the concept of resilience has become central in both academic research and professional practice. It is now a focal point of interdisciplinary discourse across urban planning, engineering, architecture, psychology, and sociology. Although there is no single, universally accepted definition of resilience, primarily due to the varied theoretical foundations and methodological approaches of each field (Brand & Jax, 2007),

*and socio-institutional dynamics, it emphasises cross-sectoral integration for effective resilience strategies for spatial planning. It further stresses the importance of developing actionable indicators capable of informing planning tools and supporting adaptive, inclusive territorial governance. These insights are useful for the ongoing revision of Turin's land use plan and other supra-local planning tools, aiming to address socio-economic and environmental challenges more cohesively.*

there is broad consensus that enhancing resilience involves integrating both physical and non-physical assets. Traditionally, particularly within engineering disciplines, resilience has been conceptualised as the capacity to resist and recover from disturbances, often with the goal of returning to a prior state. However, this static and linear interpretation fails to capture the dynamic and evolving nature of urban social-ecological systems. To address this limitation, the concept of socio-ecological resilience (Holling, 1973; Folke, 2006) emphasises resilience as the capacity to adapt and transform in response to perturbations, recognising that disturbances can alter system behaviours, potentially leading to new and different states. When applied to urban environments, resil-

ience must be understood in relation to the spatial, social, and institutional complexity that characterise cities. Urban areas are not only densely populated and highly connected, but they also represent dynamic systems marked by constant transformation. As such, resilience requires a tailored, context-specific approach that goes beyond conventional risk reduction or infrastructure-based strategies. According to Meerow et al. (2016), urban resilience is “the ability of an urban system- and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales- to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.” This definition introduces key aspects, including flexibility, adaptability, and transformative capacity, underscoring the need for responses that operate across multiple scales and systems. Building on this perspective, the necessity for a multidimensional and dynamic understanding of urban resilience arises, one that evolves alongside the changing character of urban areas and better reflects the complexity of contemporary urban systems (Kapucu et al., 2024). A more forward-looking approach recognises resilience as a transformative process (Folke, 2016) that can reposition cities to become more sustainable, inclusive, and innovative, aligning directly with the goals set out in Sustainable Development Goal 11 of

the United Nations 2030 Agenda. Consistent with this view, transformative resilience is increasingly understood as a powerful conceptual tool with the potential to reframe planning practices and interventions (Giovannini et al., 2020), shifting the focus from recovery and resistance toward proactive adaptation and long-term transformation.

In this perspective, building on this evolution from traditional to more dynamic conceptualisations of resilience, our research seeks to advance the understanding of urban resilience within the fields of urban and regional studies and planning (Davoudi et al., 2012). By critically engaging with theoretical debates and practical applications, we explore how resilience can be operationalised in planning processes and spatial strategies that address and prevent contemporary vulnerabilities and systemic risks. In particular, as the concept of urban resilience gains attention in academic and policy spheres, concerns arise about effectively evaluating and operationalising such a complex and evolving notion. The multidimensional character of resilience, encompassing physical, social, institutional, and ecological components, complicates the definition of clear, measurable indicators. Moreover, the shift from static frameworks to more dynamic, transformative perspectives calls for new approaches to evaluation that can capture long-term learning, innovation, and systemic change processes. A resilience approach, therefore, challenges

traditional modes of governance grounded in predictability, controllability, and efficiency, replacing them with approaches better suited to complexity, non-linearity, and redundancy (Elmqvist, 2014). Within this context, evaluation needs to be carefully identified, not just as a technical exercise, but as a strategic act (Chmutina et al., 2023) that should shape how resilience must be understood, prioritised, and enacted in planning and governance.

Our research, developed within the framework of the RETURN project (Multi-Risk sciEnce for resilientT commUnities undeR a changiNG climate), funded by the European Union Next-GenerationEU programme, aims to address this gap by exploring how resilience can be operatively supported through evaluation practices that are both conceptually robust and practically applicable, particularly within the context of urban planning. This endeavour requires a holistic and integrated approach that acknowledges the complexity of urban systems and their interdependent relationships and dimensions (Sharifi & Yamagata, 2016) rather than addressing each risk in isolation. Such a perspective enables a comprehensive spatial understanding that captures the multifaceted nature and dynamic processes of urban environments. Indeed, while numerous evaluation models and indicators have attempted to measure resilience, many of these tend to focus primarily on evaluating vulnerability and exposure to risks and hazards.

From this perspective, it becomes clear that resilience is not merely the inverse of vulnerability, but should instead be understood as a “set of principles to be used for the reframing and transition of an existing system” (Chelleri et al., 2015). This distinction is particularly relevant given the persistent lack of conceptual clarity and definitional consensus around urban resilience, which continues to pose challenges for developing standardised and transferable evaluation frameworks. Ultimately, the objective of our research is to identify effective planning and design strategies that can operationalise urban resilience, supported by theoretically grounded and context-sensitive evaluation methodologies.

Within this framework, we identify five interrelated dimensions through which to conceptualise resilience in urban environments: the built environment, the environmental, the social, the economic, and the institutional dimensions (Brunetta et al., 2025). These dimensions constitute the main analytical domains for evaluating the capacity of urban systems to withstand, adapt to, and recover from stresses (Ostadtaghizadeh et al., 2015). Each dimension represents a distinct but interconnected facet of urban resilience, offering a structured lens through which to design integrated responses. This multidimensional reframing highlights the need for innovative planning tools that not only address systemic interdependencies and uncertainties but also

ensure the long-term provision of urban ecosystem services (Ahern, 2013; Elmqvist, 2014; Bush & Doyon, 2019). Nevertheless, despite growing academic and policy interest in resilience, the interplay between these dimensions has received limited scholarly attention.

In this regard, our research aims to address existing gaps by identifying and analysing potential interconnections and mutual influences across various dimensions of resilience and territorial risks. The primary objective is to develop a methodology capable of both monitoring progress and effectively representing urban resilience within a specific territory, thereby moving beyond vague or generic definitions. This approach is intended to support urban planning decisions and guide transformations and interventions within a more proactive, evidence-based development strategy. To this end, the study proposes a method for spatially mapping context-specific indicators, based on the identification of territorial elements that can respond to contextual risks. The goal is to promote a more integrated and systemic approach to resilience evaluation within urban planning.

Building on this framework, the paper is structured as follows: the methodology section details the approach adopted to test a tailored set of resilience indicators through GIS-based techniques within a selected case study (Turin, Italy) in relation to specific territorial risks; the results and discussion section illustrates the

main findings derived from urban resilience mapping and explores their implications for planning and evaluation; finally, the conclusion highlights key insights and reflects on the limitations encountered and potential future developments of the proposed approach.

### **Methodological approach**

The methodology presented in this article is grounded in an extensive literature review, which informed the identification of relevant indicators for evaluating the capacity of cities and territories to respond to ongoing transformations and emerging challenges. From an initial corpus of 141 scientific papers<sup>1</sup>, a final selection of 39 studies was conducted through systematic screening and qualitative-quantitative analysis (Cazzola et al., 2026). To ensure a comprehensive evaluation of urban resilience, this study adopts a multidimensional framework encompassing the five previously discussed dimensions of resilience: the built environment, environmental, social, economic, and institutional (Desouza & Flanery, 2013; Sharifi & Yamagata, 2016; Spaans & Waterhout, 2017; Tyler et al., 2016). The built environment dimension focuses on the physical infrastructures of cities (including buildings, transportation networks, and utilities), emphasising their capacity to withstand and recover from acute shocks such as natural hazards and infrastructure failures. The environmental dimension addresses a city's ability to

mitigate and adapt to environmental risks, incorporating sustainable land use, preservation of natural ecosystems, and management of pollution to enhance resilience against climate change and other stressors. The economic dimension considers the financial stability and adaptive capacity of urban economies through diversification, job creation, and resilient business practices to withstand economic downturns. The social dimension highlights the importance of community cohesion, social equity, and inclusivity in fostering collective capacity to cope with and recover from social and economic challenges. Finally, the institutional dimension relates to governance structures, policy frameworks, and institutional capacity for coordinated crisis response and long-term resilience planning.

These selected sources provided the foundation for constructing a structured catalogue of indicators, which were categorised according to these five resilience dimensions and their associated capacities. A significant limitation observed in existing literature is the frequent reliance on generic indicators that lack precise definitions, methodological transparency, and spatial specificity. In response, our research proposes a comprehensive framework for evaluating urban resilience by developing a set of clearly defined, measurable, and spatially explicit indicators. This process resulted in the refinement and selection of 76 indicators, which form the basis of an operational tool de-

signed to evaluate resilience across multiple urban dimensions and risks.

Given the diversity and complexity of urban settings, the adaptability of the indicator catalogue represents a fundamental requirement. Each city presents unique characteristics in terms of risk exposure, socio-economic and territorial conditions, institutional and governance structures, as well as data availability and collection capacity. Therefore, it is essential to incorporate context- and site-specific indicators that enable each city to develop a tailored framework for measuring resilience. The objective is to monitor resilience progress within the same city over time, rather than to construct cross-city rankings (Figueiredo et al., 2018). In this regard, the application of the catalogue to a specific case study is crucial, as it allows for the testing of both standardised indicators—applicable to a wide range of contexts—and customised indicators that depend on the distinctive features of a given urban environment.

To test our comprehensive framework, we identified the city of Turin (Italy) as a significant case study, given its recognised role in international urban resilience discourse<sup>2</sup>. Within this urban context, a segment of the Po River corridor—specifically at its confluence with the Stura di Lanzo stream—was selected as the territorial focus for testing the indicators. This area presents a particularly relevant case at many planning levels, as it is currently subject

to the drafting and implementation of multiple tools, such as the Piedmont Po Park Plan (Giudice et al., 2024), and, at the metropolitan scale, the Metropolitan General Plan of Turin (*Piano Territoriale Generale Metropolitan – PTGM*), which is currently under development. These plans play a critical role in shaping resilience strategies by framing hazards and risks as key territorial components and by proposing integrated technical and regulatory responses. The Po River offers an invaluable opportunity to explore the interdependencies between urban infrastructures, natural systems, and social dynamics. In the final stage, the analysis is downscaled to the mesoscale, focusing on three neighbourhoods along the Po River, to evaluate the spatial performance of the selected indicators in a more granular territorial context (Sharifi, 2019).

From the aforementioned refined catalogue, we selected a set of resilience indicators that best reflect the specific characteristics and needs of the case study. This selection was based on the following key criteria (applied in addition to those already used to develop the whole catalogue): the availability of open spatial data at the local (sub-municipal) scale, and the relevance of each indicator in addressing the territorial risks and hazards identified within the urban context—namely hydrogeological risk, urban heat island (UHI), air pollution, and social vulnerability (further detailed in the following section). The selection process

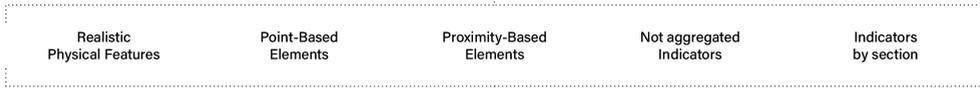
## Catalogue of Spatial Indicators for Resilience Evaluation

*Selection of relevant indicators*

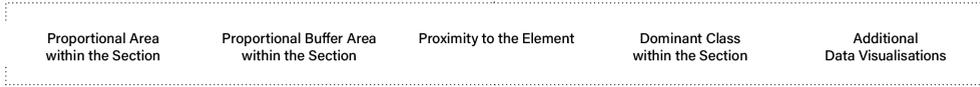


### Spatial Inventory of Risk Response Elements

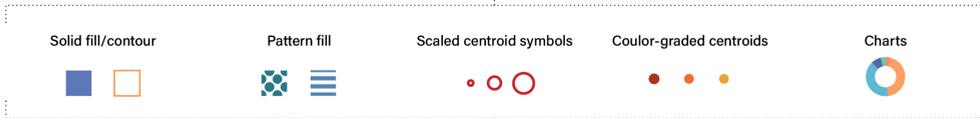
*Collection and mapping of territorial elements related to risk response*



*Conversion of territorial elements into indicators*



*Choice of the visualisation techniques to support comparative reading across sections*



*Selection and combination of relevant layers*

### Indicators of Risk Response by Section

also aimed to ensure a clear and effective spatial representation to support urban planning decisions, as discussed later in the paper.

Starting with this tailored set of resilience indicators for application to the case of Turin, we proceeded to collect a series of territorial elements identified by the research group as relevant in their capacity to address specific risks. In the initial phase, these elements were represented as spatialised vector data (linear, point based or areal, according to their original data source) and organised into simple, overlapping thematic layers. These were then re-processed by converting them into indicators. The conversion of vector data into indicator form required the definition of a minimum spatial unit of reference. In this case, census sections (*Sezioni di censimento*) were adopted,<sup>3</sup> as they represent the basic statistical

units defined by ISTAT (the Italian National Institute of Statistics) for all municipalities. Although designed for administrative and demographic purposes, these units are well-suited for spatial comparison across different areas according to official and standardised methods of territorial subdivisions. Different calculation methods were applied depending on the type of element: proportional area of the section, proportional buffer area, proximity measures (nearest-neighbour distance from the section centroid), or dominant class within the section. Additional data visualisations were used where required.

Once converted, the indicators were mapped through specific visualisation techniques (solid or patterned fill, scaled centroid symbols, colour-graded centroids, charts), enabling comparative reading across census sec-

## Methodological flow of map processing

Source: authors' elaboration

Fig. 1

tions. Finally, the different layers were jointly visualised in resilience maps, thematically structured by risk or vulnerability type<sup>4</sup>. The methodological workflow for this process is illustrated in Fig. 1.

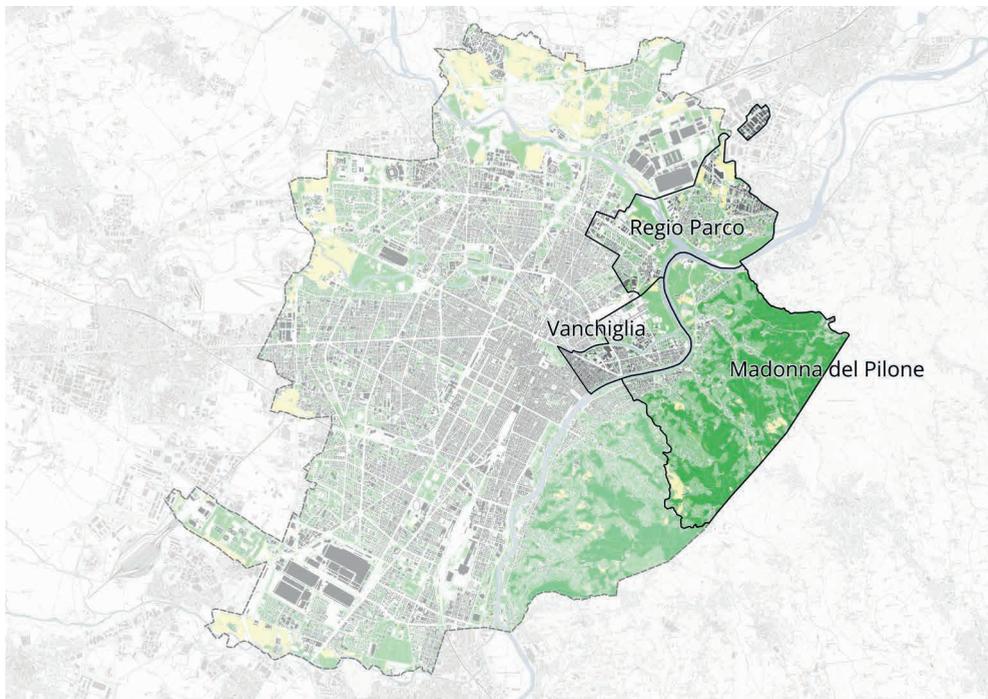
The resulting map-reading technique relied on visual overlays of multiple indicator layers based on the same spatial unit. Notably, the approach did not involve normalising or aggregating indicators into composite indices. Instead, a qualitative-quantitative method was adopted to preserve the spatial specificity of the data—an approach considered more appropriate for informing urban planning activities. The choice to avoid constructing synthetic indices reflects concerns over the limitations of purely quantitative standardisations and the need to retain a strong spatially grounded perspective to enhance territorial understanding. This representation strategy is intended to support decision-making through maps that are scientifically grounded yet accessible, making them communicable to various stakeholders. It aims to facilitate participation in urban transformations and to avoid misleading or abstract numerical simplifications, favouring more action-oriented maps.

Although the maps and indicators are initially organised by single risk types, the ultimate objective is to enable integrated, non-sectoral, multi-risk evaluations through the reasoned identification of multidimensional resilient areas or critical sites.

### Testing the indicator-based approach in the city of Turin

The city of Turin is in the western part of the Po Valley, in northwestern Italy. According to the most recent demographic data, the city's population is experiencing a modest increase, with 862.999 inhabitants recorded as of December 31, 2024, compared to 860.973 in 2023. The proximity to the Alps to the west and the hilly terrain to the east encloses the city within "a complex mosaic of microclimates, with dry summers and mild wet winters" (Ellena et al., 2023). This geographical configuration also contributes to high levels of air pollution, positioning Turin among the most polluted cities in Italy and Europe (EEA, 2024). The slow transition toward sustainable mobility, coupled with a high rate of private car ownership, further aggravates this condition.

A dense built environment (which accounts for approximately 65% of the municipal territory) characterises the city of Turin (Munafò, 2024). Such a high level of imperviousness limits natural drainage and increases the city's exposure to hydrogeological hazards, particularly flooding during high-intensity rainfall events, as experienced in recent years. The extensive built-up area also exacerbates the UHI effect, thereby compounding the impacts of heat waves. Additionally, the dense urbanisation is shaped by a significant hydrographic system and hilly terrain, composed of four rivers: the Po, the Sangone, the Dora Riparia, and the



Stura di Lanzo, which together form a complex network of green corridors and protected areas (Giaimo & Vitulano, 2022).

Despite a slight increase in population, Turin continues to face structural socio-economic challenges, including an ageing population and declining birth rates. These demographic changes are further exacerbated by the long-term impacts of deindustrialisation, which have contributed to spatial and social disparities across the city. Once mainly shaped by rapid industrial growth, the city has undergone significant economic restructuring, with the decline of traditional manufacturing and automotive sectors (Armano et al., 2016) generating additional complex socio-economic vulnerabilities. Moreover, the reinvention of its post-industrial identity has allowed it to promote greenery as a core urban asset further. This has contributed to making Turin one of

the greenest cities in Italy, with over 55 square meters of (public and private) green space per resident (Città di Torino, 2020a), thanks to the preservation of historic parks, the ecological recovery of river corridors, and the conversion of former industrial sites into public green areas.

In line with international and European objectives aimed at mitigating climate change and its associated impacts, the city of Turin joined the Mayors Adapt initiative in 2015 and signed up to the new Covenant of Mayors for Climate and Energy in early 2019. More recently, Turin applied to draft its Climate City Contract in 2022. These commitments are also increasingly evident in urban planning tools, as Turin is progressively adapting its instruments to address emerging societal challenges. Currently, the city of Turin is engaged in revising its municipal land use plan (*Piano Regolatore*

## Territorial overview of the study area

Source: elaboration based on data from Città di Torino, 2024

Fig. 2

*Generale* - PRG) through an intensive process of dialogue with inhabitants and interested stakeholders. This process is expected to incorporate emerging environmental, social and economic challenges while ensuring coordination with higher-level general and sectoral plans, such as the Territorial Regional Plan (*Piano Territoriale Regionale* - PTR), the Regional Landscape Plan (*Piano Paesaggistico Regionale* - PPR), the Hydrogeological Risk Management Plan (*Piano di Assetto Idrogeologico* - PAI), metropolitan-scale plans such as the ongoing PTGM, and nature park plans such as the ongoing Piedmont Po Park Plan. Alongside these supra-local plans, Turin is supported by a range of sector-specific local planning tools, including the Urban Climate Resilience Plan (*Piano di resilienza climatica*), the Strategic Green Infrastructure Plan (*Piano strategico dell'infrastruttura verde*), and the Civil Protection Plan (*Piano di protezione civile*). In addition to their strategic and regulatory roles, these tools serve as valuable repositories of spatial data, providing robust platforms for both qualitative and quantitative analyses. This analytical potential is crucial for informing evidence-based planning and resilience strategies. Nevertheless, while these tools offer targeted objectives, they often operate in parallel rather than in synergy, which hinders their integration and the formulation of coherent, cross-cutting responses to complex urban challenges—particularly those related to urban resilience.

In this context, our research focuses on three neighbourhoods (Vanchiglia, Regio Parco, and Madonna del Pilone), located in the north-eastern sector of the city along the Po River (Fig. 2). These areas represent a complex socio-ecological system where urban, natural, and social elements intersect, making them particularly relevant for testing the proposed resilience indicators. Moreover, some major urban transformation projects are scheduled for implementation in the coming years. Notably, the planned Metro Line 2 is expected to reach some of these areas, enhancing connectivity and accessibility in zones that have historically been underserved by public transport. Some brownfield sites are planned for regeneration, including the Manifattura Tabacchi (4,5 hectares of underused land), which is intended to be redeveloped to accommodate cultural hubs and university facilities. Furthermore, the introduction of a sports centre within Meisino Park (part of the protected area of the Piedmont Po Park) will contribute to reshaping the image of this part of the city. These transformations will be complemented by several smaller-scale interventions financed through the National Recovery and Resilience Plan (NRRP).

### Results and discussion

As mentioned in the methodology section, the selection of indicators derives from the need to construct a comprehensive and con-

Risk	Indicator	Resilience Dimension(s)	Data Source
Hydrogeological Risk	Dominant Class of Imperviousness	Built Environment Environmental	LCP – Land Cover Piemonte, Regione Piemonte, 2018
	Proximity to Temporary Emergency Shelters	Built Environment Social Institutional	Civil Protection Plan, Città di Torino, 2020
	Population Density	Built Environment Social	Census Sections, Città di Torino, 2024
	Percentage of Area Occupied by Brownfield Sites	Environmental	Municipal Technical Map, Città di Torino, 2024; Municipal Land Use Plan, Città di Torino, update 2024; Torino Atlas (Urban Lab), 2017
Urban Heat Island	Dominant Class of Normalized Difference Vegetation Index (NDVI)	Environmental	LCP – Land Cover Piemonte, Regione Piemonte, 2018
	Proximity to Public Water Fountains	Built Environment Institutional	I Love Toret, 2022
	Percentage of Green-Shaded Pathways	Built Environment Environmental	Municipal Technical Map. Città di Torino, 2024; Public Urban Trees (Alberate), Città di Torino), 2025
	Population Density	Built Environment Social	Census Sections, Città di Torino, 2024
	Percentage of Area Occupied by Public Services	Built Environment Institutional	Municipal Land Use Plan, Città di Torino, update 2024
Air pollution	Dominant Class of Carbon Storage and Sequestration	Environmental	Carbon Sequestration and Storage, Città Metropolitana di Torino, 2024
	Average Daily Traffic	Environmental	Regional Traffic Monitoring Graph, Regione Piemonte, 2025
	Number of Public Urban Trees	Built Environment Environmental	Public Urban Trees (Alberate), Città di Torino, 2025
	Proximity to Cycling Infrastructure	Built Environment	Territorial Coordination Plan, 2011
	Percentage of Area Occupied by Public Educational Facilities	Built Environment Social	AperTO, Città di Torino, 2011
Social vulnerability Population < 14	Aging Index	Social	Census Sections, Città di Torino, 2024
	Proximity to Urban Green Spaces	Environmental Institutional	Municipal Technical Map, Città di Torino, 2024
	Proximity to Public Educational Facilities	Built Environment Social	AperTO, Città di Torino, 2011
	Proximity to Public Sport Facilities	Built Environment Social	AperTO, Città di Torino, 2011
	Local associations*	Social	Municipal Register of Associations, Città di Torino, 2025
Social vulnerability Population > 65	Aging Index	Social	Census sections, Città di Torino, 2024
	Proximity to Urban Green Spaces	Environmental Institutional	Municipal Technical Map, Città di Torino), 2024
	Real Estate Values	Economic	Real Estate Market Zone, Osservatorio del Mercato Immobiliare, Agenzia delle Entrate, 2024
	Proximity to Hospitals	Social Institutional	AperTO, Città di Torino, 2011
	Proximity to General practitioners	Social Institutional	General Practitioners, Azienda Sanitaria Locale Città di Torino, 2025
	Income*	Economic	Socio-economic Indicator of the City of Turin, Città di Torino, 2023

\*The indicator refers to the neighbourhood scale

## Overview of the selected indicators tested in the case of Turin, grouped by hazard type and urban resilience dimension, with additional details on data sources.

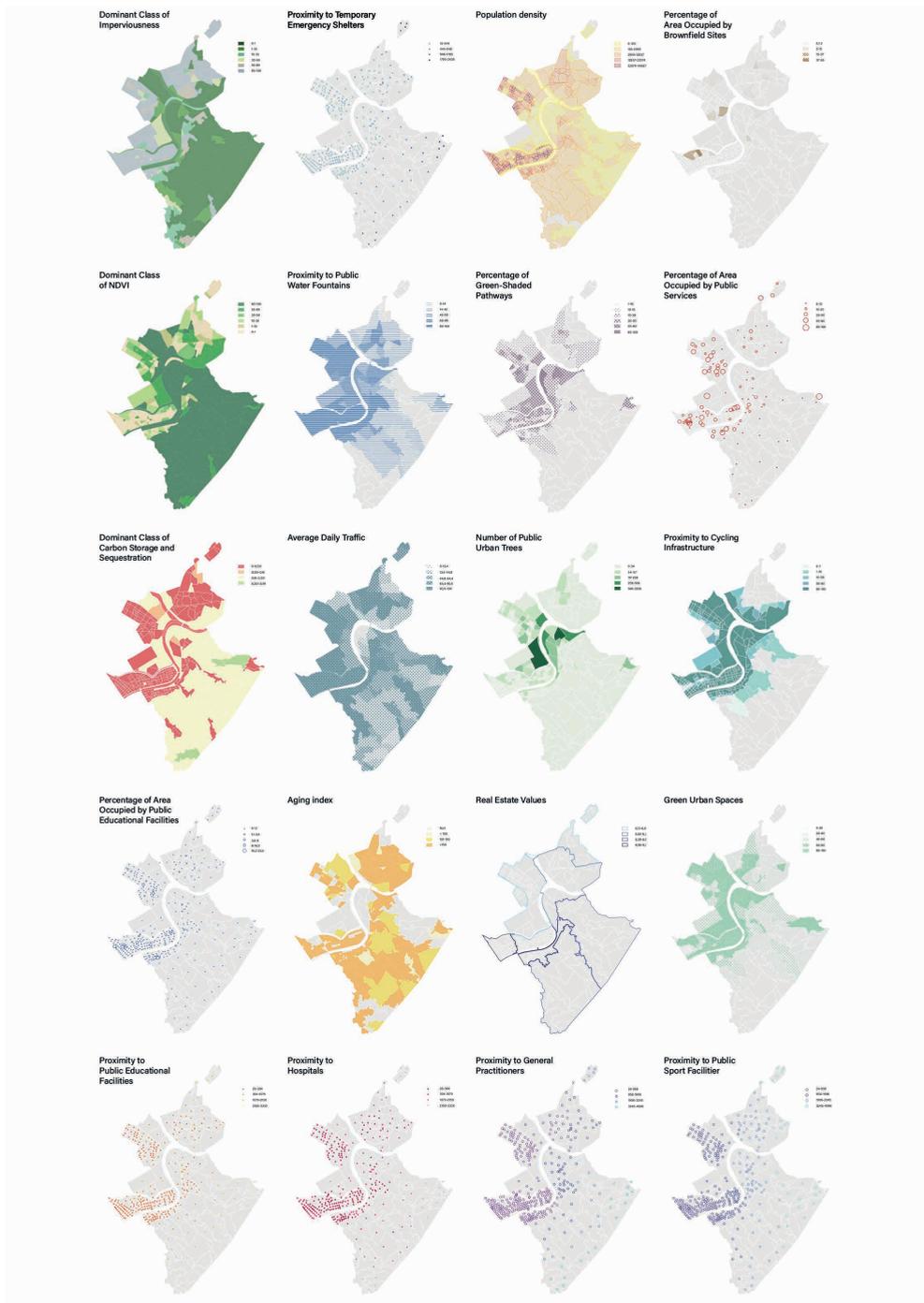
Tab. 1

text-sensitive framework for evaluating urban resilience across multiple dimensions and risk categories. The set of indicators used in the case study reflects an approach that combines both broadly applicable indicators—suitable for different urban contexts—and place-based indicators tailored to the city of Turin. Accordingly, a core set of common and transferable indicators, such as population density, proximity to urban green spaces/hospitals/public educational facilities, and the percentage of area occupied by public services, are complemented by more localized indicators that may not be essential in every context for evaluating resilience. These include the ageing index, the presence of local associations, proximity to public water fountains, percentage of green-shaded pathways, and the percentage of area occupied by brownfield sites, among others.

The following table and maps illustrate how the integration of these two typologies of indicators is implemented. It is not considered necessary to set a rigid rule based on pre-defined minimum thresholds or a fixed baseline of standardized indicators. Instead, the method emphasizes the importance of adapting the indicator catalogue by balancing generalizability with local specificity, according to different nuances of vulnerabilities and adaptive capacities, to ensure effective and operational transferability of the approach to other territories. Each indicator was carefully

chosen from the catalogue inventory not only for its relevance to the specific hazards identified in Turin (hydrogeological, UHI, air pollution, and social vulnerability), but also for its capacity to capture the interplay between the five dimensions of urban resilience. This multidimensional approach enables a more integrated analysis of urban resilience, considering both physical conditions and social, economic and institutional dynamics. An important additional selection criterion was the availability of open spatial data at the local scale, which particularly influenced the selection and technical refinement (calculation and visualization-visualisation methods) of the context-based indicators. All these features are reflected in Table 1.

The maps presented in Fig. 3 display the individual resilience indicators spatially distributed across the survey area. These indicators were produced using different calculation methods, tailored to specific needs: dominant class, defined as the most frequent value class within each spatial unit; proximity, calculated either as the percentage of area within a buffer zone (typically 300 meters) around the risk response element, or by applying the nearest-neighbour GIS tool based on the centroid of the census section; and percentage, representing the share of area meeting a specific condition relative to the total census section area. Classification of values in the map legends generally follows either the natural

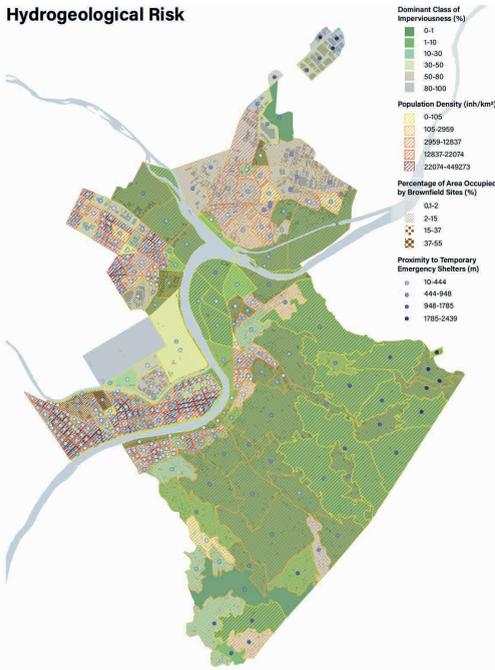


Map mosaic of individual selected resilience indicators spatialised across the three surveyed neighbourhoods in Turin

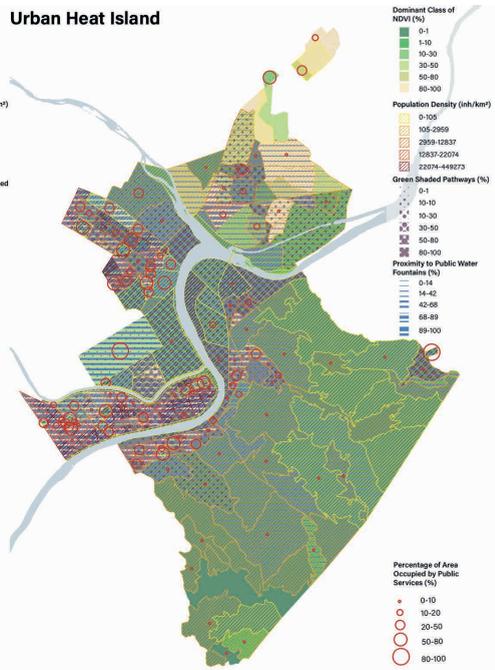
Source: authors' elaboration

Fig. 3

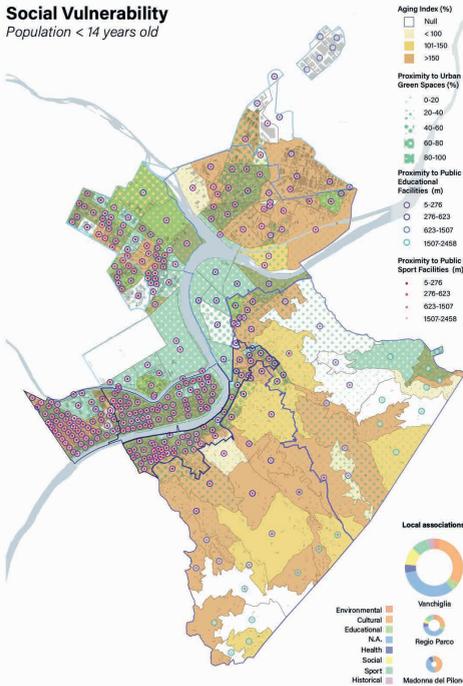
**Hydrogeological Risk**



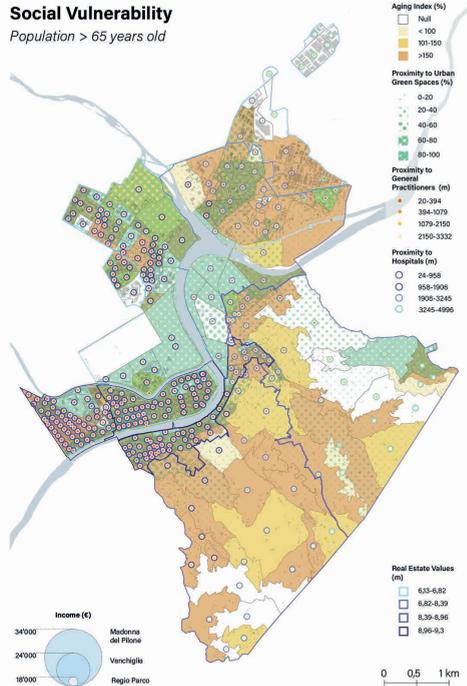
**Urban Heat Island**



**Social Vulnerability**  
*Population < 14 years old*



**Social Vulnerability**  
*Population > 65 years old*



**Thematic response maps displaying the spatial overlay of the selected resilience indicator**

Source: authors' elaboration

Fig. 4

breaks (Jenks) method or equal intervals, depending on data distribution.

The selected resilience indicators were subsequently grouped into specific thematic response maps (Figure 4), enabling a multidimensional analysis of the study area.

Regarding the first map concerning hydrogeological risk, the multidimensional nature of urban resilience is illustrated through the combined use of indicators, such as the dominant class of imperviousness, which represents physical criticalities related to soil sealing and water runoff, and population density, which highlights the concentration of people potentially exposed to hydrogeological hazards. This relationship is particularly evident in the Vanchiglia neighbourhood, within the area bounded by the Po and Dora Riparia rivers. Here, the high share of brownfield sites in some census sections represents an opportunity for future planning interventions aimed at restoring permeable surfaces (potentially through desealing) in these highly artificial and densely populated areas. Conversely, the hilly territory, with the lowest rates of imperviousness, still requires careful considerations of responses related to hydrogeological instability and landslides, suggesting the need for further analysis focused on consolidation interventions within these areas. Instead, the indicator on proximity to temporary emergency shelters introduces the institutional dimension, as these facilities are defined by the Civil

Protection Plan and represent essential infrastructure for emergency response and population safety provided by the public administration. The spatial distribution of these shelters shows a rational alignment with areas of higher population density, indicating a relatively equitable distribution in emergency planning. This reflects a proactive planning predisposition; however, it may also raise concerns about the city's adaptive capacity, especially in these peripheral areas where preparedness may be less robust.

In the case of the UHI phenomenon, the inclusion of NDVI as an environmental indicator offers a valuable measure of vegetation cover, which plays a central role in mitigating surface temperatures and enhancing microclimate regulation. Likewise, indicators such as proximity to public water fountains, percentage of green-shaded pathways, and public service availability underscore the presence and spatial distribution of climate-adaptive solutions. These elements not only represent physical mitigation responses but also align with objectives outlined in Turin's Urban Climate Resilience Plan, which focuses on relocating public fountains to more vulnerable areas, constructing shaded bike lanes, and ensuring cool and comfortable schools and public service areas (Città di Torino, 2020b). The inclusion of population density in this map also adds the importance of the social dimension, revealing the degree of exposure of in-

habitants to high temperatures. According to studies by Ellena et al. (2023), there is a high risk of UHI effects in the census sections near the Manifattura Tabacchi in the Regio Parco neighbourhood. These areas are characterised by dense population, where public services also reach significant percentages. The presence of such public spaces, together with the planned regeneration intervention of the former industrial site, represents an occasion to better qualify these areas with vegetation and shaded routes, thereby contributing to lowering temperatures, mitigating heat waves, and improving overall urban well-being. This spatial mapping thus helps identify areas where additional interventions are needed, providing the possibility to shift from simple diagnostic evaluation to proactive planning.

Social vulnerability in the study area is described through a set of demographic, socio-economic, and proximity-based indicators. To avoid overly generic evaluations, the analysis has a twofold objective, distinguishing between vulnerabilities affecting different age groups. For younger populations (under 14 years), proximity to urban green areas, public educational and sports facilities, as well as the presence of local associations, reflect not only access to essential services but also opportunities for social inclusion, physical and recreational activities, and overall quality of life. Conversely, the vulnerability of elderly populations (over 65 years) is mapped through

a complementary yet distinct set of indicators, including proximity to general practitioners and hospitals, as well as real estate values, which serve as proxies for both economic and health-related accessibility. While active access to green spaces is a shared indicator between the two maps, it assumes increased relevance for elderly residents in terms of mobility support, thermal comfort during heat waves, and broader physical and mental health. The census sections of Barca and Bertolla, located on the periphery of the Regio Parco neighbourhood and the municipality, are characterised by high values of aging index and poorer proximity to hospital facilities.

### Conclusions

The emerging and evolving discourse on urban resilience can benefit from integrating planning tools with evaluation methods that incorporate both qualitative and quantitative approaches. Through the development and testing of both standardised and context-sensitive indicators, this approach highlights the importance of integrating resilience thinking into both the strategic and operational dimensions of urban planning. The inherent context-dependency of resilience indicators can serve as either baselines or measures of progress (Chmutina et al., 2023). Moreover, while such indicators enable the exploration of long-term trends and system characteristics, they must be sufficiently specific and context-sensitive

to inform local decision-making and planning effectively. This is particularly challenging given the dynamic nature of urban systems where resilience indicators typically measure proxy characteristics rather than performance during actual shocks. Additionally, such indicators tend to be overly broad, reducing their operational value at the local scale.

Our research addresses this challenge by proposing an integrated qualitative-quantitative approach that can be exported to different urban environments, thanks to the flexibility and adaptability of the resilience indicators catalogue. This enables a more nuanced evaluation that captures not only the measurable aspects (such as the availability of green space) but also the social and institutional factors that influence urban responses to stressors and shocks (such as the collaboration pacts). However, further steps are required to operationalise these indicators into actionable guidance that can be effectively integrated into planning instruments and decision-making processes. Indeed, while standardised frameworks offer structure and comparability, they often lack the flexibility needed to respond to local specificities. Conversely, overly localised indicators risk becoming disconnected from broader policy and planning agendas. Reconciling these tensions – between generalisation and specificity, diagnosis and action – remains one of the most pressing tasks in resilience planning. A key contribution of our research

lies in addressing this tension by grounding the indicators within spatial planning processes at various scales, from regional to local levels. This once again highlights the importance of scale in resilience planning. As Elmqvist (2014) suggests, transformations at smaller scales are often necessary to sustain resilience at the urban or regional level. In our case, the downscaling of indicators within the Po River corridor in Turin demonstrates how localised evaluations can reveal spatial disparities and support targeted interventions, while still contributing to broader urban resilience goals.

One of the most pressing challenges we need to address is ensuring that these resilience indicators are not merely diagnostic tools but are also meaningful and actionable for policy and practice. Addressing this issue requires future efforts to go beyond the technical refinement of indicator sets and focus on strengthening institutional capacity to interpret, integrate, and act upon them in a coherent, inclusive, and adaptive manner over time. In the case of Turin, this challenge is compounded by the fragmentation of existing planning tools. While the city has developed a range of sectoral and thematic plans (the Urban Climate Resilience Plan, the Strategic Green Infrastructure Plan, and the Civil Protection Plan), these instruments often operate in isolation. The lack of coordination between them hinders the development of integrated strategies that can address the multifaceted nature of urban re-

silience. Embedding a unified indicator framework across these tools can offer a promising pathway to promote consistency, facilitate cross-sectoral dialogue, and enhance the city's capacity to respond adaptively to future challenges.

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### Attributions

The article is the result of a joint reflection by the four authors. However, the “Introduction” section is attributed to BG; the “Methodological approach” section to IC; the “Testing the indicator-based approach in the city of Turin” section to VV; the “Results and discussion” section to IC, MR, and VV; and the “Conclusions” section to BG.

## Notes

<sup>1</sup> The selection process was initially based on systematic queries of the Scopus database. It was subsequently expanded to include grey literature, institutional reports, and databases, thereby ensuring a more comprehensive coverage of resilience evaluation practices.

<sup>2</sup> In recent years, the city of Turin has actively participated in several European Union-funded projects (such as the H2020 projects CONEXUS and proGReg, as well as CLIMABOROUGH within the ‘100 Climate Neutral and Smart Cities’ Mission), focusing on climate change, green infrastructure, and the development of adaptive strategies to address ongoing urban challenges.

<sup>3</sup> Data source: 2024, Città di Torino.

<sup>4</sup> All analyses were primarily carried out using GIS software (QGIS version 3.40.6)

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# Planning 'Terra dei fuochi': Soluzioni Rigenerative per Territori Malleabili

Planning Terra dei fuochi: Regenerative  
Solutions for Malleable Territories

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latent risks  
project malleability  
spatial regeneration  
denied areas  
urban design studio

## 1. Introduzione: crisi sistemiche e nuovi paradigmi territoriali

Nel cuore delle transizioni che definiscono il nostro tempo – ambientali, climatiche, sociali ed economiche – si fa strada la consapevolezza che il territorio non possa più essere considerato un'entità stabile da governare secondo logiche predittive e funzionaliste (IPCC, 2022). I modelli di pianificazione tradizionale, figli di una razionalità lineare e gerarchica, si infrangono contro l'urto di crisi molteplici, intrecciate, spesso inintelligibili nella loro complessità sistemica. Le città, e ancor più le loro perife-

rie dilatate, appaiono come palinsesti vulnerabili, soggetti a processi di erosione ecologica, frammentazione sociale e instabilità economica. Nel groviglio di queste dinamiche emergono i rischi latenti (Guida, 2020), quei fenomeni che non esplodono in modo eclatante ma che lavorano nel silenzio, agendo per accumulo, per stratificazione, per sottrazione. Essi non si lasciano prevedere, né misurare agevolmente:

*The worsening of climatic, environmental and socio-economic crises highlights the urgent need to develop innovative approaches for territorial governance, promoting public policies and urban planning strategies capable of responding to the direct and indirect threats associated with these phenomena. Territories are exposed not only to declared risks but also to latent risks, characterized by dynamic evolution and not always evident. Managing such challenges requires a kind of planning which embraces a paradigm of radical*

*transformation and adaptation. The concept of 'territorial malleability' proves particularly fertile in this context. This contribution aims to explore the implications of such theories, in particular in the territory between Marcianise and Caivano. This fragment of territory has been the subject of design experiments carried out within the Urban Planning Laboratory at the Department of Architecture and Industrial Design at the University of Campania L. Vanvitelli.*

sono rischi che si addensano nei margini, si annidano nei vuoti, si insinuano nei tempi morti del progetto. È lì che occorre guardare. I territori periurbani, in particolare, si configurano come paesaggi dell'incompiuto, dell'ambiguo, del sospeso. Non più pienamente urbani, non ancora rurali, essi sfuggono alle tassonomie della pianificazione convenzionale e si presentano come territori-ponte, intensamente attraversati da flussi ma privi di coerenza strutturale. Ma è proprio in questa ambiguità che si addensa una qualità relazionale più profonda, una densità situata di condizioni materiali e simboliche che definiscono l'ambiente vissuto – il *milieu* – non come semplice supporto fisico, ma come tessuto di relazioni costitutive tra abitanti e spazio (Bourque, 2009). Il peri-

urbano si rivela così soglia sensibile, zona fertile per la costruzione di ecologie politiche del territorio (Swyngedouw, 2005), e teatro di una progettualità che si radica nella negoziazione, nel conflitto, nella differenza. In questa luce, ogni approccio riduzionista si rivela fallimentare, e lascia spazio a pratiche che sappiano leggere le forme di vita che abitano il margine non come deviazioni da ordinare, ma come presenze da ascoltare e articolare. Occorre invece una nuova postura, che accolga la complessità e si muova secondo logiche situate, adattive, capaci di attraversare le temporalità lunghe dei processi ambientali e quelle frammentate delle trasformazioni sociali. Il progetto di territorio non è più (o non è mai stato) esercizio tecnico, ma pratica culturale e politica. Da qui la necessità di riattivare altri strumenti – come quello della malleabilità – capaci di restituire senso, direzione e profondità al nostro agire sullo spazio. Questa esigenza non si manifesta solo come urgenza operativa, ma come necessità epistemologica. Essa coinvolge il modo stesso in cui produciamo conoscenza del territorio: non più descrizione oggettiva e neutrale, ma interpretazione situata, attenta ai contesti, ai linguaggi, alle temporalità multiple che attraversano i luoghi. È qui che l'urbanistica si riapre alla dimensione del progetto come forma conoscitiva e pratica cognitiva (Viganò, 2013), capace di generare mondi possibili più che soluzioni.

## Paesaggio Marcianise-Caivano

Fig.1

### 2. Verso una progettualità trasformativa: la malleabilità come concetto guida

Tra gli strumenti potenzialmente più fecondi per interpretare e governare la complessità contemporanea, quella di malleabilità si impone per la sua capacità di sfuggire a ogni forma di determinismo. Né resilienza né resistenza, la malleabilità è qualità porosa, disposizione al mutamento, forma che si modella e si lascia modellare. Non si tratta semplicemente di adattarsi, ma di saper trasformare le pressioni in opportunità, i vincoli in struttura, le discontinuità in progetto. Nel pensiero di Ascher (1995), la città contemporanea è *metapolis*: un organismo reticolare, pluritemporale, sfuggente, che richiede strumenti nuovi per essere letto e trasformato. In questa città fluida, la gestione del tempo diventa cruciale. La malleabilità non è allora solo proprietà spaziale, ma anche capacità di articolare ritmi diversi, di comporre durate eterogenee, di sovrapporre cicli produttivi, ecologici, sociali. È un pensiero del progetto che si nutre di instabilità, che assume la transitorietà come condizione originaria. Gwiazdzinski (2009, 2013) amplia questa visione introducendo la dimensione del tempo urbano come spazio progettuale. Le città non dormono più, i territori si distendono lungo le 24 ore, e con essi mutano usi, percezioni, conflitti. Pianificare in maniera flessibile, allora, è anche capacità di costruire scenari mobili, in cui il progetto si fa regia discreta di molteplici tempi dell'abitare. L'urbanistica smette di ope-

rare su un piano di stabilità e si addentra in una dimensione cronotopica, in cui spazio e tempo si co-producono. Essa non è solo proprietà tecnica, ma qualità che emerge dalle relazioni tra viventi, ambienti, dispositivi. Come i paesaggi agricoli plasmati dall'opera umana e dai cicli naturali, o come i tessuti urbani segnati da memorie, stratificazioni, abbandoni, la pianificazione futura deve manifestarsi in modo tale che il progetto sia capace di ascoltare le forme del vissuto e di tradurle in gesto trasformativo. L'idea stessa di progetto dovrebbe svincolarsi dalla ricerca di una forma compiuta e definitiva, per divenire strumento aperto, dispositivo relazionale, campo di possibilità (Viganò, 2013) (Corner, 1999) Lussault (2007). Si fa invece strumento processuale, attitudine analitica, apertura verso l'imprevisto. In questa visione, la malleabilità diviene condizione critica per una progettualità che vuole agire dentro la realtà senza irrigidirla in modelli astratti. Un'urbanistica del possibile, più che del probabile. Lungi dal rappresentare un'astrazione, la malleabilità diventa criterio operativo per orientare scelte progettuali in contesti instabili. Essa consente di articolare dispositivi capaci di mutare funzione nel tempo, di accogliere margini d'uso imprevisi, di ospitare dinamiche di coesistenza tra soggetti e pratiche differenti. Non esiste, in questo orizzonte, una forma ideale: esistono configurazioni mobili, costellazioni parziali, figure aperte. Il progetto non propone solo soluzioni, ma può generare condizioni



nuove che, a loro volta, reclamano interpretazioni inedite.

### **3. Il periurbano come campo sperimentale: il caso Marcianise–Caivano**

L'area compresa tra Marcianise e Caivano, nei territori di confine tra la provincia di Caserta e l'area metropolitana di Napoli, offre un campo d'indagine paradigmatico per comprendere la complessità della condizione periurbana nel contesto meridiano (fig. 1). Più che un'area dai confini definiti, si tratta di un sistema relazionale, una costellazione di trame eterogenee che si intrecciano senza risolversi in un disegno unitario.

La giustapposizione di funzioni – industriali, agricole, infrastrutturali, residenziali – convive con il sovrapporsi di condizioni ambientali compromesse, frammentazioni sociali, vuoti urbani e paesaggi dell'abbandono. In questo scenario,

l'idea di progetto non può che confrontarsi con l'instabilità come condizione primaria. Il territorio si presenta come un insieme incoerente di piani insediativi, reticoli infrastrutturali sovradimensionati, comparti industriali disarticolati e vasti tratti agricoli che conservano ancora forme di alta intensità produttiva. A questo si aggiunge una trama di edilizia popolare realizzata secondo logiche autoreferenziali e mai pienamente integrata con le dinamiche urbane. La presenza della storica infrastruttura dei Regi Lagni, un tempo concepita per il drenaggio delle acque, agisce oggi come elemento latente, una sorta di dorsale dimenticata che tuttavia mantiene un potenziale connettivo ancora inesplorato. La lettura del territorio condotta nel Laboratorio di Urbanistica dell'Università della Campania ha messo in luce come tali configurazioni, pur nella loro apparente disarticolazione, custodiscano possibilità

## Masterplan integrato di sistemazione idraulica del bacino idrografico e la valorizzazione paesaggistico-ambientale.

Fonte: relazione tecnico-illustrativa, LAND 2023.

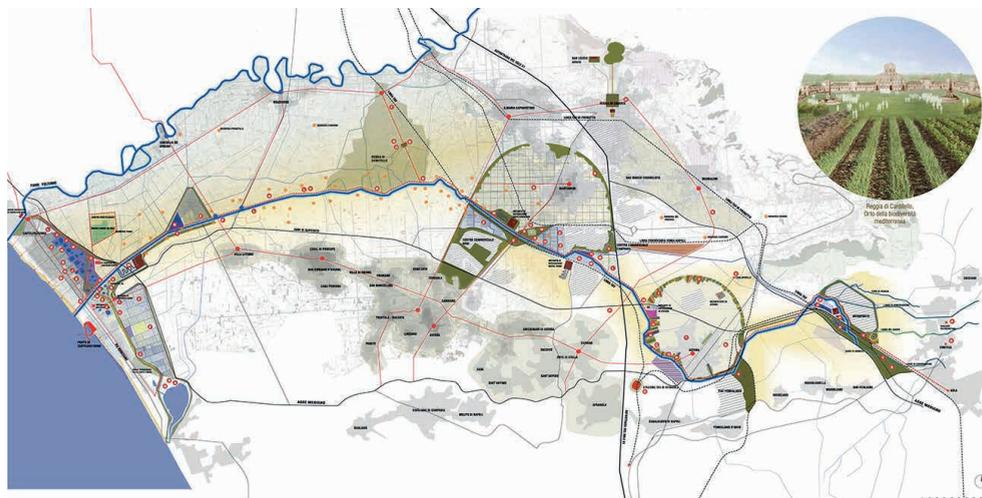
Fig. 2

progettuali capaci di produrre nuove geografie. Queste possibilità risiedono non nella continuità ma nella discontinuità, non nella formalizzazione ma nella tensione tra gli elementi. È nella logica dell'interstizio – caro alle riflessioni di Stan Allen (1999) – che si iscrive la potenzialità trasformativa di questo paesaggio. Non si tratta dunque di correggere l'anomalia del territorio, ma di assumerla come dispositivo progettuale. Le aree marginali e abbandonate, i bordi idraulici trascurati, i campi residuali lungo le arterie stradali: tutto ciò che sfugge alla logica funzionale può diventare soglia, connettore, infrastruttura minima. Questa visione assume l'incompiuto non come difetto ma come apertura. La malleabilità si manifesta qui come capacità del territorio di riorganizzarsi a partire dalle sue lacune, dalle sue ferite, dai suoi vuoti. In questo senso, Marcianise-Caivano non è solo uno spazio fisico, ma un atlante di tensioni, una composizione provvisoria di stratificazioni culturali, economiche e ambientali. La sua fragilità non è debolezza ma disponibilità alla trasformazione. Il paesaggio si configura come campo di forze, e il progetto come pratica di negoziazione tra queste forze: un atto che mette in relazione ciò che è disgiunto, senza forzare un ordine totalizzante. È da tale postura che possono emergere dispositivi di progetto capaci di dialogare con il contesto. Non interventi monumentali e razional-comprensivi, ma azioni lente, graduali, micro-infrastrutture che innervano il territorio e lo predispongono al

cambiamento. Il progetto lavora allora su geometrie aperte, sulle soglie tra funzione e disuso, sulle temporalità diseguali che coesistono nel paesaggio. Ogni segno deve fare i conti con ciò che già esiste, ma anche con ciò che potrebbe esistere. La proposta è dunque quella di un'urbanistica dell'intervallo, in cui la malleabilità diventa la chiave per costruire una nuova grammatica dell'abitare. Una grammatica che non impone, ma suggerisce; che non stabilisce, ma accompagna. Il territorio tra Marcianise e Caivano, nella sua condizione liminale, si offre come luogo generativo per tale sperimentazione: un archivio aperto, in cui le forme del possibile attendono solo di essere lette, interpretate, attivate.

### 4. Il Masterplan dei Regi Lagni: un'infrastruttura di riconnessione ecologica e simbolica

È utile leggere il contesto attraverso le coordinate del Piano Territoriale di Coordinamento Provinciale (PTCP) di Caserta, approvato con delibera n. 26/2012 (De Lucia, 2012). Lo strumento individua una tipologia specifica di paesaggi, definiti aree negate, dove si concentrano forme di abbandono funzionale e architettonico, sia nel tessuto urbano sia in quello rurale, segnate da una potenzialità ambientale mai valorizzata. Queste aree, caratterizzate talvolta da degrado e assenza di funzioni chiare, rappresentano attualmente dei 'non-luoghi' dai quali può certamente germinare una trasformazione attiva. Questo riconoscimento forma-



le della fragilità territoriale da parte del PTCB acquista valore strategico se letta in prospettiva progettuale: non come mera segnalazione di criticità, ma come mappatura di possibilità, come indizi di un tessuto da riattivare e governare in modo creativo. Qui si innesta il Masterplan dei Regi Lagni, che interpreta questi spazi – talvolta definiti “negati” – come infrastrutture ecologiche e simboliche, in grado di organizzare una risposta integrata alle fragilità ambientali, ai rischi idrogeologici, alle disgregazioni sociali. Il Masterplan sviluppato dallo studio LAND, sotto la direzione di Andreas Kipar per il Consorzio Generale di Bonifica del Bacino Inferiore del Volturno, rappresenta un caso esemplare di progettazione integrata su scala vasta (fig. 2). L'intervento si colloca in una regione storicamente segnata da un'elevata pressione antropica, un'evoluzione urbanistica disordinata, la presenza di economie informali e un progressivo degrado della rete idraulica e del paesaggio agrario. Il progetto assume l'intero reticolo idrografico come struttura fondativa del territorio, non solo per le sue valenze tecniche – drenaggio, contenimento idrogeologico – ma soprattutto per la sua capacità di

generare una nuova infrastruttura ambientale e sociale. Il Masterplan non lavora per comparti ma si struttura come palinsesto territoriale (Corboz, 1983): una matrice che rende possibile la coesistenza di più temporalità e che lavora per sovrapposizioni, innesti, discontinuità attivate. In questo senso, il paesaggio si configura come un medium operativo (Corner, 1999), capace di articolare complessità e trasformazioni. La strategia progettuale si articola su più livelli. Al primo, quello ambientale, si inserisce il tema della rinaturalizzazione dei canali, attraverso tecniche di fitodepurazione, reintroduzione della vegetazione ripariale, sistemazioni morfologiche leggere che permettano di restituire al corso d'acqua una funzione ecologica. In secondo luogo, il progetto introduce la forestazione lineare lungo un asse continuo di oltre 60 chilometri, creando un corridoio verde multifunzionale che agisce sia come dispositivo di connessione ecologica, sia come spazio pubblico lineare. Il paesaggio idraulico viene così ripensato come spina dorsale ambientale, capace di rigenerare intorno a sé forme di abitabilità diffusa. Parallelamente, la progettazione si confronta con il tema delle aree pro-

## Individuazione e riconfigurazione dei diversi ambiti territoriali: in questo lavoro sono stati individuati e riconfigurati quello naturale, agricolo, industriale e urbano. Nuove ecologie per una terra di mezzo.

Fonte: Laboratorio di Urbanistica, Università degli Studi della Campania Luigi Vanvitelli.

Allievi: Martina Iavarone, Md Mehzabin Islam.

Fig. 3

duttive, spesso marginali, degradate o sottoutilizzate, trasformandole in nodi strategici per un'economia rigenerativa. Non si tratta di cancellare la vocazione industriale del territorio, ma di accompagnarla in una nuova fase, in cui le imprese diventino parte di un sistema ecologico territoriale. L'industria non più come enclave autoreferenziale, ma come paesaggio operativo (Waldheim, 2006), capace di interagire con l'ambiente e con la società. Un ulteriore livello di intervento riguarda le centralità urbane e le connessioni con i quartieri residenziali, in particolare quelli a edilizia pubblica, spesso privi di relazione con il contesto. Qui il Masterplan propone una ricucitura spaziale e simbolica, attraverso la costruzione di una nuova rete di spazi pubblici, percorsi ciclo-pedonali, dispositivi ecologici integrati alla scala minuta. Il paesaggio diventa interfaccia tra sistemi, linguaggio comune tra luoghi diversi. In tutto ciò, il progetto non si propone come immagine compiuta, ma come matrice generativa. Le strategie sono formulate come condizioni abilitanti, orientamenti aperti che possono essere declinati e adattati in base alle specificità locali. Il disegno non impone forme ma suggerisce traiettorie. In questo approccio, la malleabilità si manifesta non solo come qualità del territorio ma come metodo del progetto: capacità di aprire possibilità, predisporre relazioni, accompagnare mutazioni. Il Masterplan dei Regi Lagni dimostra come sia possibile agire nella complessità senza cercare di sem-

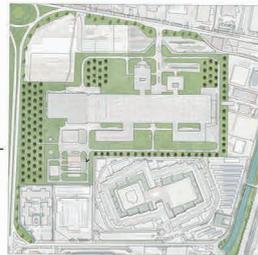
plificarla, ma piuttosto elaborando dispositivi in grado di attivare nuove logiche territoriali. Esso propone una visione che integra ecologia, produzione, abitare, mobilità, memoria, in un sistema articolato che riconosce i limiti ma li assume come leve per la trasformazione. Un progetto che non disegna il futuro, ma lo rende praticabile.

### 5. Il laboratorio di Urbanistica come dispositivo metodologico di sperimentazione e apprendimento trasformativo

Nel quadro teorico e metodologico delineato, l'esperienza del Laboratorio di Urbanistica del quarto anno del corso di studi in Architettura del Dipartimento di Architettura e Disegno Industriale dell'Università degli Studi della Campania "Luigi Vanvitelli" si configura come un dispositivo fertile per mettere alla prova, sperimentare e articolare strategie metodologiche capaci di interrogare il periurbano nella sua complessità. Qui, il progetto non si limita a un esercizio accademico ma si confronta direttamente con il territorio, facendo del laboratorio un ambiente transdisciplinare in cui convergono conoscenze, pratiche e visioni. Oggetto del corso è stato il periurbano compreso tra Marcianise e Caivano descritto nei paragrafi precedenti; oltre che per la sua straordinaria potenzialità in termini di analisi, ricerca e progetti trasformativi, questo territorio è stato scelto per la sussistenza di progetti di ricerca<sup>1</sup> in corso che indagano quei luoghi e collaborazioni



**ha: 5,54**  
63 Alberi di prima grandezza  
20 Alberi di seconda grandezza  
70 Arbusti  
550 Fiori di prima impollinazione  
210 Fiori di seconda impollinazione



**ha: 21,76**  
70 Alberi di prima grandezza  
15 Alberi di seconda grandezza

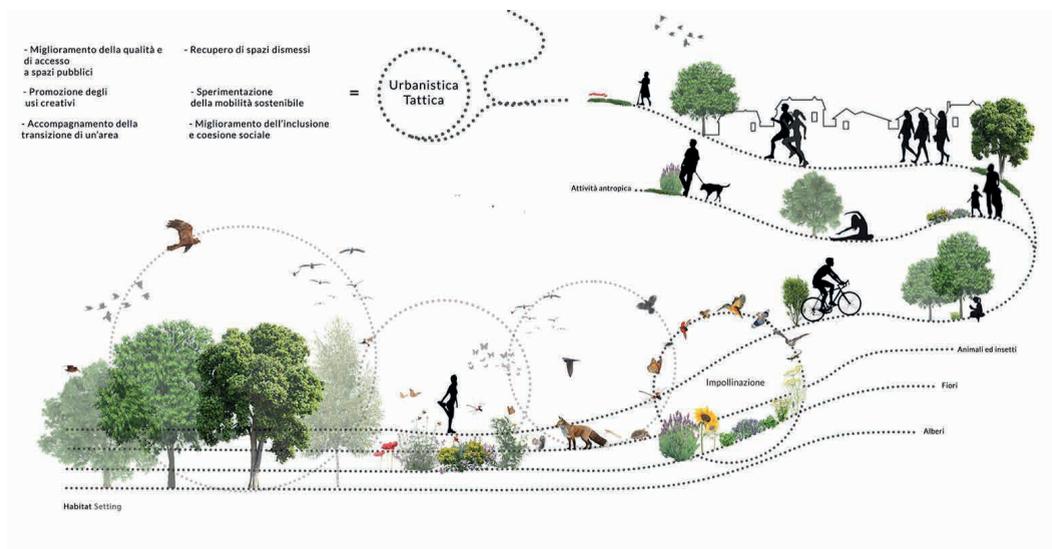


**ha: 6,7**  
30 Alberi di prima grandezza  
40 Alberi di seconda grandezza  
90 Alberi di terza grandezza  
1.020 Arbusti  
1.650 Fiori di prima impollinazione  
630 Fiori di seconda impollinazione



**ha: 2,5**  
40 Alberi di prima grandezza  
60 Alberi di seconda grandezza  
20 Alberi di terza grandezza  
600 Arbusti  
1.100 Fiori di prima impollinazione  
420 Fiori di seconda impollinazione





scientifiche tra il Dipartimento di Architettura e il Consorzio per l'Area di Sviluppo Industriale di Caserta. Le sperimentazioni progettuali degli studenti hanno assunto il Masterplan dei Regi Lagni come sfondo attivo e generativo. Le azioni immaginate non sono state traduzioni dirette delle strategie del piano, ma esplorazioni delle sue possibilità latenti. In particolare, si è lavorato su dispositivi adattivi capaci di connettere realtà territoriali eterogenee, rigenerare margini inerti, aprire nuove forme di interazione tra spazio costruito e dinamiche ambientali. Il laboratorio, dalla durata di quattro mesi, ha operato come una sorta di lente aumentata, in grado di rivelare micro-ecologie progettuali presenti nelle pieghe del territorio. I circa ottanta studenti del corso sono stati divisi in gruppi da due-tre-quattro persone; ogni gruppo ha scelto autonomamente di analizzare e progettare una porzione dell'area oggetto del corso, i gruppi più numerosi (4 persone) hanno analizzato aree più vaste e complesse. Tutti gli studenti sono stati incoraggiati ad interpretare il territorio come una vasta superficie malleabile in cui le aree industriali dismesse o sottoutilizzate potessero essere considerati

tessuti porosi da trasformare, tra produzione e paesaggio. Dai lavori degli studenti sono emerse diverse soluzioni interpretative e progettuali per i diversi ambiti del territorio preso in esame, di seguito riassunte: la costruzione di percorsi verdi lungo l'infrastruttura blu dei regi lagni; la penetrazione funzionale nelle piastre industriale dell'ASI; l'ideazione di diversi sistemi urbani tematizzati come la città industriale, la città agricola e la città residenziale; la parziale ricostruzione di corridoi ecologici, già previsti dal Piano Paesaggistico Regionale (PPR) ma mai realizzati; la messa a sistema di diverse tipologie di suolo permeabile, agricolo, naturale, e privato delle zone industriali, dedicando attenzione alla biodiversità reale e quella potenziale che potrebbe svilupparsi ulteriormente nel territorio grazie proprio alla messa a sistema delle infrastrutture verdi esistenti. Alcuni gruppi hanno deciso di riconfigurare gli ambiti agricoli intensivi come spazi capaci di ospitare biodiversità, filtrare inquinanti, accogliere nuove pratiche di abitabilità diffusa (fig. 3). I bordi infrastrutturali si sono prestati a essere pensati come corridoi ecologici e sociali, dispositivi ibridi tra accessibilità,

## Azioni progettuali di riconfigurazione degli ambiti agricoli intensivi come spazi capaci di ospitare biodiversità. Nuove ecologie per una terra di mezzo.

Fonte: Laboratorio di Urbanistica, Università degli Studi della Campania Luigi Vanvitelli.

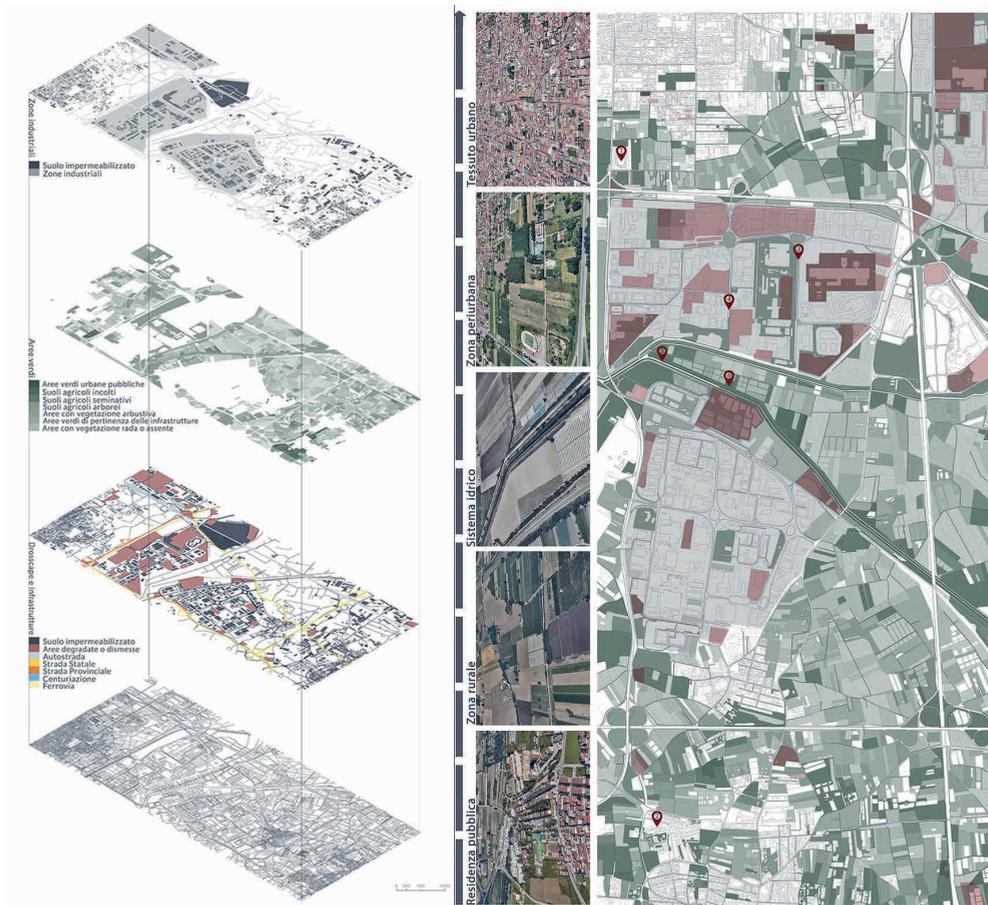
Allievi: Allievi: Martina Iavarone, Md Mehzabin Islam.

Fig. 4

ecologia e cultura (fig. 4). In questo contesto, il concetto di malleabilità non è stato concepito in modo astratto ma come criterio operativo, come griglia interpretativa utile a leggere i caratteri latenti del territorio non come vincoli rigidi ma come potenzialità utili a definire nuove strategie capaci di accompagnarne le trasformazioni. Ogni progetto ha cercato di lavorare sulle relazioni e i sistemi più che sulle morfologie, sui vuoti più che sui pieni, sulle soglie più che sui centri. Questa postura ha permesso di far emergere scenari in cui il progetto non risolve, ma apre. Gli studenti sono stati accompagnati in un percorso che ha permesso loro di abbandonare certezze pregresse e affrontare la complessità del territorio attraverso un atteggiamento esplorativo, critico, profondamente situato. L'atto progettuale si è configurato come occasione per imparare a leggere, interpretare e costruire futuro in territori segnati dalla vulnerabilità ma anche ricchi di potenziale latente. Questo tipo di didattica operativa si avvicina ad una forma di 'progetto aperto', in cui l'architettura e l'urbanistica diventano strumenti per abitare consapevolmente il tempo lungo del cambiamento. Il laboratorio si è così costituito come ambiente di apprendimento trasformativo, non solo per gli studenti, ma anche per i docenti e i ricercatori coinvolti, che si sono trovati a dover ripensare continuamente categorie, metodi, linguaggi. Ciò che questa esperienza restituisce è la possibilità di considerare il progetto urba-

nistico non come esercizio di formalizzazione, ma come pratica di relazione: con il territorio, con la sua storia, con i suoi abitanti, con le sue contraddizioni. La malleabilità, in questa visione, diventa non solo un attributo del territorio ma una qualità del pensiero progettuale stesso, che si fa più adattivo, attento, aperto alla complessità del reale. Questa forma laboratoriale ha permesso inoltre di testare nuove modalità di collaborazione tra saperi diversi: urbanistica, ecologia, sociologia, progettazione del paesaggio e politiche territoriali si sono intrecciate nel costruire letture plurali del contesto. In questa cornice il laboratorio non si configura più come semplice palestra didattica, ma come ambito di produzione di conoscenza applicata e riflessiva, capace di restituire al progetto il suo carattere fondamentale critico. L'approccio ha comportato anche un necessario spostamento epistemologico: non si è trattato di applicare metodi predeterminati, ma di costruire strumenti adatti a leggere un contesto specifico e instabile. Ne sono derivati atlanti di luoghi, mappe delle fragilità, cataloghi delle potenzialità dormienti. I risultati laboratoriali degli studenti sono il frutto di un processo di montaggio aperto; i masterplan di progetto hanno accolto tematiche e peculiarità del territorio diverse, raccolto visioni e prospettive dei singoli componenti dei gruppi talvolta disallineate ma allo stesso tempo utili alla configurazione di una pianificazione poco rigida e, al contrario, sempre più malleabile. È in questa





## Azioni di ricucitura dei margini territoriali. Ipotesi di compenetrazione tra il sistema industriale e quello agricolo.

Fonte: Laboratorio di Urbanistica, Università degli Studi della Campania Luigi Vanvitelli.

Allievi: Allievi: Giorgia Coviello, Annarita Di Domenico, Diodato Massaro.

Fig. 5

## Sperimentazioni di rigenerazione di infrastrutture e attrezzature.

Fonte: Laboratorio di Urbanistica, Università degli Studi della Campania Luigi Vanvitelli.

Allievi: Allievi: Giorgia Coviello, Annarita Di Domenico, Diodato Massaro.

Fig. 6

tensione che si è configurata una pratica progettuale generativa, orientata non tanto alla produzione di oggetti quanto alla cura delle relazioni: tra persone, tra spazi, tra tempi.

## **6. Conclusioni: progettare nella complessità, coltivare malleabilità**

Riflettere sulle trasformazioni del periurbano in epoca di crisi ecologica e sociale significa, in ultima analisi, interrogare la possibilità stessa del progetto come forma di conoscenza e azione situata. I territori fragili non si lasciano governare secondo logiche di previsione lineare né possono essere riportati a modelli funzionali stabili. Essi richiedono forme di ascolto radicale, di apertura epistemica, di cura. In questo quadro, la nozione di malleabilità si propone come una chiave più efficace per orientare una progettualità non riduzionista, capace di accogliere la complessità senza temerla. La malleabilità non designa una semplice qualità elastica del territorio, ma una disposizione a mutare mantenendo la memoria delle proprie stratificazioni. Essa è al tempo stesso attributo dei luoghi e delle pratiche che li attraversano, principio di organizzazione e postura progettuale. Agire per la malleabilità significa saper leggere il potenziale nascosto negli scarti, nei vuoti, nei conflitti; significa progettare configurazioni che non temono l'incompiuto ma lo assumono come condizione generativa. Il caso del corridoio Marcianise-Caivano mostra chiaramente come i paesaggi periurbani, spesso letti come luoghi incompiuti o marginali, custodiscano invece potenzialità latenti che emergono proprio dalla loro condizione di

instabilità. Qui, la discontinuità – rappresentata da vuoti urbani, bordi idraulici, insediamenti industriali sottoutilizzati – diviene risorsa progettuale, aprendo la strada a una nuova grammatica dell'abitare fondata su azioni minime, diffuse e cumulative. Le esperienze discusse – dal Masterplan dei Regi Lagni alle sperimentazioni del laboratorio di urbanistica – mostrano come sia possibile articolare un pensiero progettuale capace di produrre connessioni nuove, ricomporre discontinuità, generare ecologie relazionali. Il paesaggio non è più sfondo, ma dispositivo attivo; il territorio, non contenitore ma agente; il progetto, non risposta, ma interrogazione permanente. In questo senso, si può parlare di una transizione da una pianificazione normativa a una progettualità dialogica, in cui la forma non precede il processo ma ne è costantemente ridefinita. La malleabilità, in questo quadro, si configura come criterio metodologico ed epistemologico: implica la capacità di accettare l'incertezza, riconoscere le differenze, costruire scenari capaci di adattarsi a mutazioni d'uso, conflitti e processi di negoziazione. Il progetto, così, non ricerca più forme definitive, ma predispone condizioni che consentano al territorio di adattarsi, rigenerarsi e mantenere nel tempo la propria capacità di produrre qualità ambientale e sociale.

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## Note

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# Making the intangible visible: a methodological framework for recognizing Non-Economic Loss and Damage in multi-risk urban regeneration.

## Reflections from the Bagnoli- Coroglio SIN Area.

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#### Introduction

This work explores the multifaceted dimensions of loss and damage in critical urban contexts exposed to multiple risks, such as environmental and climatic, and undergoing processes of transition and urban regenera-

tion. The transition towards resilient and healthy urban environments for all represents one of the main goals of sustainable development policies. This goal becomes particularly challenging in multi-risk contexts where complex phenomena including contamination, social

*This paper explores the multifaceted dimensions of loss and damage within urban contexts exposed to multiple risk factors, such as environmental pressures, while undergoing processes of site regeneration. A critical analysis grounded in the framework of Urban Political Ecology highlights that prolonged urban regeneration is often stalled due to unresolved*

*conflicts over territorial risks and resources, leading to a profound disruption of the urban socio-environmental metabolism. This disruption results in significant, yet frequently ignored, immaterial "losses". To address this gap, this paper presents a systematic literature review of existing methods for estimating intangible non-economic loss and damage (NELD) The result is the proposal of a comprehensive methodological evaluation framework for NELD in urban studies. The Site of National Interest of Bagnoli-Coroglio will offer some preliminary considerations. Results demonstrate the need to critically reconsider the institutionalized concept of loss and damage, moving beyond economic metrics and extending the NELD framework beyond climate change. NELD, in fact, could be regarded as an opportunity to measure socio-environmental injustice and to enhance community resilience during urban transformation processes.*

vulnerability, and institutional fragility overlap with anthropogenic and climate pressures.

Such complexity, if left unaddressed and not codified within a critical planning framework, poses a threat to public health and well-be-

ing. It is crucial, on the contrary, to overlook interdependencies between transformative processes, metabolic dynamics, and risk factors, considering mainly the latter to oppose consolidating sectoral approaches to risk. The challenge, therefore, lies in placing the social effects of multi-risk at the core of territorial planning to reduce loss and damage, especially for the most vulnerable population groups.

This position asks a critical review of the concept of Loss and Damage itself. In recent years, it has undergone a process of institutionalization, particularly in relation to climate risks, to the extent that since 2015, its compensation has been recognized as the third pillar of the Paris Climate Agreement, alongside mitigation and adaptation efforts. However, beyond the accreditation of economic metrics for measuring loss and damage, research has recently broadened to include Non-Economic Loss and Damage (NELD). While damages may be quantified, it is still challenging to establish evaluation criteria for measuring those intangible dimensions of loss which are tied to social perception, and remain fundamentally incommensurable (Centemeri, 2015). What we believe is that understanding loss in these specific domains not only improves assessment accuracy but can also serve as a critical input in the design process, enabling more informed and resilient planning strategies.

This work explores how losses and damages – particularly non-economic ones linked to the social and territorial dimension – influence urban transformation and regeneration processes in multi-risk contexts. The long-lasting remediation of Bagnoli-Coroglio Site of National Interest (hereafter SIN for *Sito di Interesse Nazionale*) serves as a paradigmatic example to propose a more inclusive approach to assessment and planning. Furthermore, unlike a research field predominantly focused on the Global South (Appadoo, 2021), the site is in the Global North.

The contribution builds on the critical framework of Urban Political Ecology (UPE), which conceptualized territorial metabolism as a socio-environmental process that can either enable or constrain different groups and communities (Heynen et al., 2006). From this perspective, implementing strategies for mitigation, adaptation and loss reduction requires a deeper understanding of the full life cycle of territories. This broadens the scope of urban planning and design beyond merely achieving optimal spatial configurations, demanding engagement with dynamics, potentials, and conflicts inherent in the transformation process. Prolonged and ineffective urban transformation processes can, in fact, erode the involvement and trust of communities living in crisis-affected territories—those who most directly endure the resulting economic, social,

and spatial deprivations. Moreover, transformation processes are never socially or ecologically neutral. They produce forms of losses and damages that often exacerbate the existing disparities between those responsible for causing harm and those who suffer its consequences, across different scales. Nevertheless, loss can also be seen as an opportunity to react injustice by activating urban and territorial transformation (Roberts, Pelling, 2019) and reducing vulnerability and risk while fostering community resilience.

The paper is organized as follows: after a review of the existing literature on loss and damage, focusing on intangible aspects, the paper analyses the relation between loss and planning and more in detail the role of loss in long-lasting environmental risk; it then considers different methods for assessing tangible and intangible impacts up to the proposal of a methodological framework to analyse NELDS; Section 3 introduces the case of Bagnoli-Coroglio as a possible case for testing the methodological framework. The final section discusses the findings and outlines the future research directions.

The study is part of the RETURN project (Multi-Risk Science for Resilient Communities under a Changing Climate), TS1 “Urban and Metropolitan Settlements”, Task 5.4.4 “Towards a Circular Metabolism for Urban and Metropolitan Settlements”.

## **1. Loss and damage: acknowledging an emerging concept in planning multi risk contexts**

### *1.1. Framing loss and damage: intangible losses and territorial justice*

Literature on risk evaluation and reduction defines Loss and Damage as the impacts of a risk that have not been, or cannot be, avoided through mitigation or adaptation efforts. Loss and damage can result from both sudden and slow-onset events (Jensen, Jabczyńska, 2022; Appadoo, 2021).

The concept emerged for the first time during the UN Framework Convention on Climate Change in 1991 but was institutionalized, in 2013 during COP19 with the establishment of the Warsaw International Mechanism (WIM) for Loss and Damage (Jensen, Jabczyńska, 2022). Nevertheless, it is worth noticing that neither the Paris Agreement nor the WIM have clarified the financing aspects of Loss and Damage principle which, to date, are still not defined. This is due to both the unwillingness of developed countries to acknowledge monetary value on the concept, and to the lack of consensus on the framing and definition of the concept, together with a more general uncertainty about who takes on economic accountability (Appadoo, 2021).

Damage involves reparable harm, loss indicates irreversible damage, a situation of no return. Furthermore, it is possible to identify

a distinction between economic and non-economic loss. Economic losses refer to the loss of resources, goods and services commonly traded in markets, non-economic losses are understood as those that can impact individuals, society and/or the environment. To date, research focused on the impact of loss on physical cultural heritage, such as buildings or monuments, whereas there is still a gap on the investigation of the impacts of loss and damage on intangible cultural heritage (Markantonis et al., 2012; McNamara et al., 2021). Those are affecting people's physical and mental health, cultural heritage, identities, indigenous knowledge, traditions, or local biodiversity and are deeply tied to the values and cultures of the communities concerned (Centemeri, 2015). Implications of losses may also involve significant places for local communities, affecting people the same way as psychological wellbeing. In this sense places become a culturally significant category for loss estimation (Magee et al. 2016) and should be considered in urban planning and broader environmental risk management, particularly when the degradation or loss of shared collective spatial and territorial resources is at stake. More in general, not considering intangible loss in the evaluation of risk may potentially affect strategic decision-making for risk management as well as the design of strategies for mitigation and adaptation, worsening

its impacts. The geographical distribution of these differentiated impacts may intensify conflicts and territorial inequalities or generate new ones (Beck, 1992).

This is why intangible loss and damage estimation need to be considered in risk studies to deal with territorial justice while also emphasizing the spatial relationship between people, damaging events, and both measurable and non-measurable impacts. Several methods have been tested for evaluating loss and damage of natural disaster on human life (Kharb et al., 2022) although those are mainly replacement and treatment costs that minimize the experience of loss (Magee et al. 2016), focused on economic dimension and the insurance market. Long-term territorial and community-related issues, that are strongly linked to non-economic and not-measurable dimensions of loss, are less explored. Omitting the existence of intangible loss in risk assessment constitutes a deliberate political act, as it denies communities the agency to define what constitutes a loss in their specific context. Therefore, we argue that acknowledging the significance of community-experienced loss within risk evaluation frameworks—even if methods for its quantification continue to be refined—represents a critical step toward a more inclusive and context-sensitive approach to risk assessment and regeneration of multi-risk environments.

### *1.2. Loss and Damage: urban planning and metabolic perspectives*

According to the FCCC's report (2013) non-economic losses manifest in societies when non-economic public or cultural goods are damaged, or when social networks are disrupted. These impacts can be observed across three distinct spheres: private individuals, society, and the environment. The primary forms of such losses include harm to cultural heritage, local knowledge, and further expressions of social capital. Crucially, from the perspective of urban and spatial planning, this loss also extends to the degradation or loss of shared collective spatial and territorial resources. Although these losses are ultimately experienced by individuals, their nature remains inherently social, as these commons goods are shared across the entire community, profoundly impacting the collective well-being.

While the NELDs concept is extensively explored in the domain of climate change (McNamara, Jackson, 2019), its profound implications extend critically to urban planning and broader environmental risk management (Ambrosetti, Petrillo, 2016). This expansion is increasingly essential for understanding the multifaceted deprivations experienced by communities beyond purely climate-induced impacts, especially in complex, multi-risk urban contexts. In these areas, overlapping phenomena of contamination, social vulnerability, institutional fragility, and anthropogenic and climatic pressures demand

an approach that transcends sectoral simplifications integrating the territorial component with the social component of risk throughout the entire risk management cycle.

Urban metabolism can thus represent a key for interpreting such dynamics. While White's pioneering work from the 1940s already recognized how the severity of damaging events was deeply connected to human choices and actions, urban metabolism had offered a more profound perspective. It does not merely link impacts and actions, instead, it investigates the dynamics through which the urban environment actively reproduces specific socio-environmental conditions. Therefore, urban metabolism allows for the integration of spatial perspectives – focused on the life cycles of cities and flows (Kennedy et al., 2011; Pekdemir et al., 2025) – with social ones, which view the city as a product of socio-natural flows (Wachsmuth, 2012). Such a combined perspective is fundamental for developing an integrated understanding of risk.

Despite the definitional complexity surrounding NELDs, indeed, common patterns emerge. These patterns emphasize crucial forms of non-economic deprivation that significantly shape people's perception of the urban experience (Serdeczny et al., 2016). Among these, deprivation of territory represents a distinct and fundamental form of loss and damage. Beyond its economic value, in fact, the urban landscape holds significant non-economic im-

portance as a source of identity and belonging for local communities (Manzo, 2003). Territorial loss can be physical (e.g., land inundation) or functional, where the ability to inhabit or utilize a specific area is severely reduced, for instance, due to contamination or lack of access. This directly relates to the deprivation of public or common space and can profoundly undermine a community's sense of place among inhabitants and their connection to the environment. Among the forms of territory loss, human mobility and displacement directly impact the security and agency of individuals and communities, threatening their ability to control their location and livelihood, and disrupting social networks and identity (Sedrez, 2014). Moreover, the non-economic losses of cultural heritage (both tangible and intangible) and indigenous/local knowledge alongside social capital are deeply intertwined with territory. Their degradation threatens to hinder a community's sense of belonging and local aspiration to participate in shaping urban futures and also undermines trust in public actors and urban policies. Indeed, unlike other types of loss and damage, NELDs are fundamentally context-dependent (Serdeczny, 2018) as they emerge from deep human-environment interactions that have simultaneously moulded the physical common space and associated value systems of communities.

For a long time, architecture and urban studies have been cultivated specific terms to grasp

and preserve these intricate social and spatial dynamics. This reflection is historically rooted in concepts like the *genius loci* (Vecco, 2020): drawing from ancient Roman belief, places, in the same way as living beings, were thought to be animated by a protective spirit. Indeed, even an urban neighbourhood or a residential settlement – the *locus* – could not be merely reduced to its quantitative dimensions. Rather, it possesses a distinct character, a *genius*, representing a unique and evolving balance of natural, anthropogenic, environmental, and social elements. Moving beyond this historical concept, the notion of “intrinsic value” (Turner, 1992, 1993; Fusco Girard e Nijkamp, 1997) further captures this special relationship between the land and its inhabitants, manifesting over time as organizational, autopoietic, and adaptive capacity that ensures its long-time preservation (Bosone, 2019). As emphasized by Norberg-Schulz (1979), this profound relationship with the environment and the identification with the place enable an indispensable feeling of safety—a condition constantly undermined in multi-risk contexts. This feeling of safety, in turn, forms the foundation of belonging for humans to truly thrive in a place.

While these concepts effectively capture the holistic identity of a place, they often overlook the relational and power-laden dynamics that characterize socio-ecological flows and urban conflicts, which is where the critical lens of Urban Political Ecology and Urban Metabolism

offers a necessary theoretical step forward. Within this framework, inefficiencies in urban metabolism compromise urban and territorial sustainability and resilience (Mazzarella, Amenta, 2022). This outcome, in turn, exacerbates anthropogenic pressures, resource scarcity, risk conditions, and the marginalization of disadvantaged communities (Swilling et al., 2013). In Italy SIN Exemplify this condition. These urban areas had been historically sacrificed (Lerner, 2010) to intense industrial exploitation. Consequently, they are now confronting severe, legally recognized impacts on their unhealthy ecosystems and human populations (Art. 252, comma 2, D.Lgs. 152/2006). These impacts profoundly affect urban dynamics, leading to consequences including population displacement, loss of real estate value, and even intangible impacts such as stigma (Gemmiti et al., 2023).

In these multi-risk urban areas, completing remediation and regeneration processes is often complex, frequently necessitating extraordinary state intervention, as implied by their designation. Difficulties in addressing and completing lengthy interventions, due to both resource scarcity and governance and technical issues, amplify over time and concentrate spatially the damage linked to the SIN's risk condition (Mahlkow, Donner, 2017). Consequently, a pure technical remediation may not be sufficient to fully “compensate” inhabitants for the deep losses and damages incurred.

Instead, to effectively address these intertwined challenges that encompass the long and complex implementation process, slow loss and damage awareness and people-centred responses to risk are crucial to foster urban resilience (FCCC, 2017). Urban planning can leverage its instruments to significantly advance research and tools. However, current practices often struggle to find inclusive, context-adaptable tools for identifying and treating non-economic losses (McNamara, Jackson, 2019). This recognized gap in methodological tools underscores the central aim of this paper: to propose a systematic framework capable of translating NELDs theory into operational domains for assessment and urban planning.

### *1.3 Dealing with communities as a strategy to address loss in contaminated sites*

As previously discussed, in multi-risk planning processes, losses and damages cannot be always monetarily compensated nonetheless they can be addressed – or even repaired – through engagement with local communities. When considering the impact of risk on local communities, an extremely sectoral and technical approach can disregard the complex interdependencies among risks, transformative processes, metabolic dynamics, and lifestyles, intensifying stratified geographies of chronic risk-territories and increasing conflict, creating additional, unforeseen social risks. Additionally, the governance approach may be fur-

ther challenged with the onset of new events that could trigger such conflicts, in already complex and fragile territories. According to Nixon, this chronic condition may be considered as the result of “slow violence” (Nixon, 2011), that is a long-term, often invisible process characterized by “a violence of delayed destruction that is dispersed across time and space” (Nixon, 2011, 2), resulting in significant loss for local communities.

The concept of “slow violence” was developed through analytical studies on losses and damages due to environmental and socio-ecological degradation in the frame of the so called “environmentalism of the poor” (Martinez-Alier, 2002; Barca, Leonardi, 2018). These processes particularly affect disadvantaged workers – mainly located in the Global South – who are denied occupational health and daily living conditions guarantees. Nixon defines slow violence as the result of gradual, invisible deterioration processes that progressively unfold, accumulating over time, more precisely with “calamitous repercussions playing out across a range of temporal scales” (Nixon, 2011, 2).

Therefore, in risk assessment alongside conventional approaches focused on risk prevention and mitigation, there must be equally rigorous attention to individual and collective loss dimensions. Such attention is critical for identifying forms of reparation that may be activated, on a case-by-case, through the engagement with the affected communities. Ad-

addressing the effects of loss is also a mean for restoring the circularity of urban metabolism in areas where community resilience is undermined by long-term accumulation of shocks and traumas that aren't readily measurable, including trauma associated with denied rights to housing, health, employment, and future hope.

From an operational perspective, dealing with experiences of loss can facilitate those peculiar patterns of transformation that must necessarily go hand in hand with remediation processes, even considering immaterial flows as the social side of urban metabolism. To this regard, engaging with local communities through participative policies works as a strategy to strengthen environmental justice by sharing narratives of loss that encompass the analysis of traumatic events and the local aspirations for the future. In this way local stakeholders can be involved in defining their own compensation strategy, also including non-monetary measures such as ecosystem restoration, and the enhancement of human rights.

## **2. Beyond a definition: how to evaluate loss and damage for planning urban metabolism**

Despite its relevance, the inclusion of intangible loss and damage into urban planning processes is still a developing field. To address this gap, this section provides a review of the main existing tools and methods for the eval-

uation of intangible loss and damage. The objective is to explore how these methodologies can be applied to estimate territorial and community-specific losses, transforming a theoretical topic into a concrete approach for regeneration.

Several studies, such as CONHAZ (Costs of Natural Hazards) introduced the necessity of integrating intangible costs into decision-making processes even without being expressed in monetary terms. They are related to those impacts that are not easily monetised (e.g. on health, the environment, cultural heritage). Quantification of these intangible costs is rooted in welfare and environmental economics and the theory of Total Economic Value. This approach distinguishes between use values, such as the benefits derived from the direct or indirect use of a good (e.g. living in a safe house or enjoying a natural landscape), and non-use values, which include the value of a good's existence, the willingness to preserve it for future generations, or for others, even in the absence of immediate personal utility. This distinction allows for the incorporation of affective, moral or symbolic dimensions that often emerge in contexts of loss associated with disasters, as demonstrated by numerous empirical studies focusing on residential, coastal, rural and urban contexts.

Scientific research has progressively broadened its focus from tangible impacts – easily quantifiable in economic terms – to intangible

impacts. Interest in these impacts has grown, especially with the realisation that, many of the losses associated with natural disasters escape traditional metrics but are central to decision-making and to the evaluation of the effectiveness of adaptation and mitigation measures.

From a methodological point of view, numerous studies use established economic techniques for monetising intangible impacts, which can be divided into two main categories: methods based on stated preferences and methods based on revealed preferences. In both cases, the quality of the results depends on the design of the questionnaire, the representativeness of the sample and the clarity of the scenarios presented.

Methods based on revealed preferences, such as the hedonic approach (hedonic pricing), analyse variations in market prices – for example, real estate prices – as a function of the presence of environmental risks or proximity to vulnerable elements. Although these techniques are based on real data rather than hypothetical simulations, they have limitations in capturing the value of intangible components alone, as observed prices reflect the interaction between multiple and often confounding variables.

Several applied studies offer concrete examples of how these techniques have been adapted to specific contexts. Chiba et al. (2018) applied the Analytic Hierarchy Process (AHP) to

analyse NELD caused by climate-related disasters in Bangladesh and Japan through a community-based participatory approach (Chiba, Prabhakar, 2017) and to identify risk reduction strategies able to address NELD.

The XtremRisk project has developed an approach to estimate social (victims, injuries, cultural assets) and environmental (ecosystems) losses associated with floods in Germany, combining hydraulic models and spatial analysis on high-resolution grids, from a probabilistic perspective (Burzel et al., 2015). Other integrated approaches, such as the one proposed for Calabria Region (South of Italy) through the Support Analysis Framework (SAF), have attempted to translate qualitative descriptions of impacts (direct, indirect, intangible) into numerical indices, with the aim of supporting local authorities' decisions, even in the absence of a direct monetary assessment (Petrucci, Gullà, 2009). The application has highlighted how intangible impacts, such as psychological distress due to displacement or transport disruption, significantly affect risk perception and the demand for preventive measures.

In urban areas, methodologies such as GIS-based Fuzzy Comprehensive Evaluation (FCE) have proven particularly effective in assessing flood risk by integrating socio-economic variables (e.g. loss of production efficiency, psychological impact) with hydrodynamic models and geospatial data (Li et al., 2023). The use of fuzzy logic allows the uncertainty and sub-

Domains	Factors	Indicators
Physical and mental health	D I I D D D	Death and injury Level of fatigue or physical stress in carrying out daily activities Level of satisfaction for life Level of worry over future hazard events Mental health disorder Chronic diseases
Material living standards	D D D D I I I I	Loss of family economic stability Loss of housing protection Disruption to living, including isolation and evacuation Loss of income-generating activities Disruption to utility services Increased demand on existing services Loss of access to networks, services and assets including recreation areas Forced displacement
Functioning ecosystems	D D I D I	Damage to ecological sites Disruption of habitats and landscape Perceived non-use values of lost heritage and environmental sites Reduced land values Loss of biodiversity and ecosystem
Social capital	I I I I I	Loss of perceived social cohesion between individuals, family and community members after a catastrophic event Level of willingness of people to be volunteers Level of willingness of people to collaborate in informal safety nets Loss of sense of belonging to a place Diminished community activity as effort goes to individual recovery
Cultural heritage and identity	I I D D I I I	Loss of local narratives and memories Loss of the cultural community practices Loss of the historic buildings Loss of places in which festivals, norms and creative arts take place Loss of the local, indigenous and community knowledge Loss of the local handicraft skills Loss of community awareness about local cultural identity
Knowledge and education	D I I	Loss of educational places School discontinuity Perceived loss of social cohesion and identity
Governance and participation	D I I I I I D	Level of respect for human dignity Opportunity to lead legal and just lives Level of community participation in decision-making Level of collaboration between local government and community Loss of community capacity to activate self-managed recovery initiatives; Loss of perception to be valued, respected and treated-equally Level of perceived efficiency of recovery regulations
A desirable future	I I	Level of trust in the future Perception of still being able to realise own dreams

## NELDs evaluation framework. The developed framework proposes operative domains, impacts, and indicators for the identification and analysis of the intangible dimensions of NELD in multi-risk urban contexts.

Source: Authors' own elaboration.

Tab. 1

jectivity inherent in non-material impacts to be represented, improving risk representation and communication with decision-makers. Studies of flood-prone areas in Sardinia Region (Italy) show the effectiveness of combining models for estimating material damage (e.g., JRC depth-damage functions) with human safety simulations based on the Life Safety Model (LSM), which is useful for assessing the impact of evacuation times and accessibility on expected mortality. Such simulations not only identify infrastructure criticalities, but also estimate intangible implications related to distress, fear or prolonged discomfort.

Finally, in culturally sensitive contexts, such as Pacific Islands communities, ethnographic studies and artistic analyses have documented how the loss of territory, identity and spiritual continuity, is experienced as an existential loss that cannot be assimilated into conventional economic metrics (McNamara et al., 2021). Clissold et al. (2023) highlight the importance of including emerging categories of loss – identity, belonging and agency – in damage assessment, and propose an integration of qualitative approaches, local narratives and climate planning tools.

Taken together, these contributions highlight how the assessment of intangible impacts requires the integration of economic tools, spatial models, psychological approaches and cultural perspectives. The main challenge for research and institutions remains to harmonise

quantitative and qualitative methodologies, translating the invisible dimensions of loss into operational elements capable of guiding disaster resilience and adaptation strategies in a fair and sustainable manner.

Furthermore, it is possible to distinguish between direct and indirect, tangible and intangible dimensions. Direct intangible impacts include loss of life and injury, disruption of life, loss of leisure and recreational time and concern about future events, also including the loss of memorable objects (WMO 2013; Molinari et al. 2014), limited evacuation options, limited access to transport, delays in getting to and from work, road closures and children missing school (Bhuyian et al., 2021).

Indirect intangible impacts include those related to health, loss of community, loss of trust in authorities and service providers (Bhuyian et al., 2021; EMA 2002; Meyer and Messner 2005; Jonkman et al. 2008; Merz et al. 2010; Meyer et al. 2013; Kousky 2014; Lee et al. 2014). People may lose trust in authorities and service providers because they are often affected by catastrophic events (Romali et al. 2015). In indirect intangible impacts, it is assumed that disruption of public utilities, health problems and loss of community reduce the income opportunities of those affected. This is because, due to health problems, people may refrain from going to work (Chiba and Prabhakar, 2017).

Based on these studies, an evaluation framework (Table 1) for including non-economic as-

pects into the assessment of NELDs is proposed. In particular, the domains are identified following the research of Menk et al. (2022) and Fankhauser et al. (2014), Gough (2017), Verma (2017), and Tschakert et al. (2019). Intangible impacts are here distinguished in Direct (D) and (Indirect), in line with the existing state of the art. Indicators were identified and elaborated by the authors starting from the studies collected in the literature review, focusing on Bhuiyan et al. (2022), Menk et al. (2022) and Prabhakar et al. (2024).

### **3. Loss as a transformative opportunity for the Site of National interest Bagnoli-Coroglio**

The Bagnoli-Coroglio area, located in the tenth Municipality of Naples (Southern Italy), is one of the largest Italian SIN. Those are heavily contaminated areas, designated for remediation due to risks to human health and the environment, and are regulated by the Legislative Decree 152/2006. Currently, there are 42 SINs in Italy, covering approximately 149,000 hectares of land and over 77,000 hectares of marine areas (ISPRA, 2023). The Bagnoli-Coroglio SIN was established by ministerial decree on 08/08/2014 and includes 249 hectares of land and 1,453 hectares of water.

The area had hosted the ILVA steel plant since the early twentieth century. Production was shut down during the 1990s, and the site has since remained inaccessible. Bagnoli-Coroglio represents a paradigmatic

context for illustrating the functioning of loss when environmental risk acts upon local regeneration and affects inhabitants and the working community.

This is a multi-risk context, where soil and water pollution overlap with climate risks associated with a coastal plain entirely exposed to extreme weather events. There is also the volcanic risk linked to the bradyseism of the Phlegrean area, which in the last twenty years has been manifesting frequent and intense surface tremors and earthquakes. In addition, the Bagnoli-Coroglio SIN, together with the Eastern Napoli SIN report the highest average index of social and material vulnerability in Italy. Even though indicators from further Southern Italy SINs are slightly lower, economic deprivation and social fragility remain particularly concentrated in the two Neapolitan sites (Gemmiti et al., 2022), amplifying social risks. This is why several wicked problems emerge (Rittel, Webber, 1973), related to the try of planning resilience in contexts inhabited by communities exposed to multiple risks.

After the factory closure, between the late 1990s and the early 2000s, a promise was made by local politicians concerning the return to the original beauty of the site, with the prospect of reclaiming access to the sea and promoting tourism-based development. The failure of these promises still generates feelings of frustration and injustice among the local population, worsened by the fact that this vision had

been even endorsed in the 1996 urban plan of western Naples (Comune di Napoli, 1996).

The illusory promise of reconfiguring the everyday landscape has been nurturing a wearisome wait, progressively eroding the community's psycho-physical equilibrium. Although losses and damages to health resulting from industrial activity are monitored at the national level (see, for instance, the SENTIERI epidemiological project<sup>1</sup>), little attention has been paid to risks associated with prolonged times of remediation and regeneration. Remediation processes provided by law occur over extremely extended periods, due to both the length of administrative procedures<sup>2</sup> and the uncertain durations of remediation.

These prolonged timelines are incompatible with local populations' needs and aspirations and increase social distress. If environmental risks related with toxicity affects human and non-human health, risks tied to waiting and the betrayal of expectations has been producing, in Bagnoli, significant social vulnerability and symbolic losses. Consequences of losses are a perceived subalternity toward Neapolitan citizens, and a wish to struggle and vindicate the legacy of the former working-class, still alive in neighbourhood associations such as Circolo Ilva, Lido Pola, and Villa Medusa.

The sectoral and technocratic approach adopted in restoring the former ILVA plant neglects historical, socio-cultural, and economic risks, ignoring the community's loss of identity and

the erosion of trust in institutions at various governance levels. Moreover, excluding the local community from decision-making threatens the effectiveness of a just transformation strategy.

In the Bagnoli long-lasting remediation process, the lack of recognition by the overall city and the public administration for feelings of loss prevents the achievement of circular urban metabolism. It is therefore necessary to overcome governance models resistant to dialogue with local communities, questioning how to strengthen community resilience where structural fragilities emerge.

An effective strategy would consist in multi-voiced narratives aimed at discovering feelings of loss and damage by "natives", and critically spatialise a century-long process of industrial consumption. The idea would be to facilitate the sharing of territorial diagnoses in which the new interpretation of past memories becomes the breeding ground to regenerate the present neighbourhood, while closing the recovery stage. Such reconstruction would offer a starting point for actively triggering the "power of place" (Hayden, 1997) and involve the people's vision through participation. Narratives should complement spatial disciplines – such as collective mapping – and social science methodologies using the temporal dimension as a key to co-design change.

Looking at cities as the result of a historical-geographical process of the "urbaniza-

tion of nature” (Swyngedouw, Kaika, 2011), it becomes crucial to collectively represent the steel plant settlement on the Coroglio beach, aiming at analysing the original landscape consumption step by step. The initial cautious development of ILVA in the early 1900s was followed by increasingly rapid growth, culminating in the 1960s–1980s, when the artificial infill invaded the sea, effectively erasing any right to health and good living conditions (Andriello et al., 1991; Andriello, Palestino, 1992).

Under the lens of environmental justice (Schlossberg, 2007), two intertwined processes can be observed: on the one hand, the natural plain erosion due to increasing industrial expansion; on the other, the effects of wild urbanization on local communities. What emerges is a two-fold violence on people and places: the structural violence of the forced coexistence with toxicity (Galtung, 1969) – which turned Bagnoli into a subaltern enclave within the city – and the slow violence (Nixon, 2011) responsible for the chronic stagnation (Davies, 2020) together with the collapsing of productive economies, the never-ending remediation timelines, and administrative inefficiencies.

With such a dense natural past, uncertain present, and still unwritten future, risk planning and management must also assume public conflicts and collective distrust as something to inevitably treat. While the site original beauty, the working-class pride, and the collective well-being are getting lost, distress is growing among the young generations. The latter have

experienced neither the industrial era nor the original landscape beauty, consequently living a suspended space-time dimension where Bagnoli-Coroglio seems to be forgotten. The opportunity to communicate the legacy of their grandfathers by selecting collective memories of loss and damage and actively taking part in the still ongoing remediation process could be crucial for the local youth, to reactivate the circularity of urban metabolism.

#### 4. Discussion and conclusion

This paper aims to understand and recognize the dimensions of intangible loss and damage in multi-risk contexts by extending the application of the concept of NELD from the traditional climate change domain. The research highlights how loss is a relevant issue not only in the Global South (Appadoo, 2021) but also in developed countries, as evidenced by the Bagnoli-Coroglio case.

In such contexts, the effects of community loss are evident in the deprivation of public spaces (Magee et al. 2016; Manzo, 2003) and the erosion of public memory due to the removal of collective identity. These are manifestations of territorial deprivation and represent the inability to share future-oriented narratives for the area. Such dynamics weaken human agency and diminish community participation in decision-making processes both as consequence of both structural (Galtung, 1969) and slow violence (Nixon, 2011).

Omitting the dimension of loss from risk management is a political act, as it denies affected communities the agency to build their own narratives and to define what constitutes loss in their specific context. Acknowledging community-experienced loss within risk evaluation frameworks proves essential for promoting a more inclusive and context-sensitive approach to regeneration.

Although combining quantitative/qualitative methodologies remains a challenge, a territorial planning approach that takes loss seriously can become, if supported by committed policymakers, a strategic driver for inclusive regeneration, moving beyond a mere tactical tool for conflict management. In fact, recognizing loss as an integral element of regeneration may enable more inclusive strategies, calling for a shift beyond traditional models of economic compensation toward holistic, community-centered responses such as participatory urban planning. Those approaches support both environmental and spatial justice and facilitates the development of concrete and fairer policies and programs.

In order to consider nontangible losses as part of the planning process, the main contribution of this article lies in the definition and proposal of the NELDs Methodological Evaluation Framework. The framework was elaborated thanks to a thorough literature review. Its proposed evaluative approach is specifically articulated for making visible intangible dimensions of loss and damage, providing

useful tools for understanding and elaborating more equitable and inclusive regenerative strategies.

The next research step will consist in the experimental application of the framework to the Bagnoli-Coroglio case study. This process will involve further fieldwork investigation, including surveys and interviews, and a participatory approach, engaging with local actors and fostering intergenerational dialogues. The final aim will be to build collective narratives which prove to be essential for rediscovering the community's sense of place. The framework will allow to translate collective experiences into operational planning tools, activating crucial processes for reconstructing the *power of place*.

### Author Contribution

The contribution is the result of a joint reflection among the authors, although the introduction is attributed to all authors, paragraphs 1.1 and 4 are attributed to B. V., paragraph 1.2 to F.V., paragraph 1.3 and 3 to M.F.P., paragraph 2 to M. B.

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## Notes

<sup>1</sup> For more details, please refer to the sixth SENTIERI report – National Epidemiological Study of Territories and Settlements Exposed to Environmental Pollution Risks: Zona, A., Fazzo, L., Pasetto, R., Benedetti, M., Bruno, C., De Santis, M., Iavarone, I. (2023).

<sup>2</sup> For further information on this topic, please refer to the technical report Mettiamoci in Riga: Analysis of the timelines required for the authorization of remediation projects within Sites of National Interest (S.I.N.), their causes and consequences for stakeholders (2023), available at: <https://bonifichesiticontaminati.mite.gov.it/presentazione-dei-due-documenti-tecnici-curati-dalla-linea-l3-del-progetto-mettiamoci-in-riga/>

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# The project in landscapes at risk.

## Back to architectural design

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#### Introduction

In 2009, the United Nations published the first official definition of the term 'resilience' in the UNISDR glossary on Risk Disaster Reduction in which it states

[resilience is] The ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. [...] Resilience means the ability to 'resile from' or 'spring back from' a shock (UNISDR, 2009, p. 24)

Fifteen years later, 'resilience', 'mitigation', 'adaptation' and 'prevention' still seem to represent the key words of the contemporary designer, who is called upon to contend with an era of profound changes, not only cultural, economic, social but, above all, environmental, ecological, and climatic. Confrontation with a natu-

*This contribution traces the research conducted within the extended partnership PE3-Return (multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate) and is aimed at explaining the role that architectural design can and must assume in response to the contemporary condition, characterized by the profound changes imposed by climate change. Through the analysis of*

*four case studies, chosen with the aim of comparing interventions at different scales – the temporary device, the architectural artefact, the urban landscape and the low-density landscape – the study explores the possibility of overcoming the 'sectoral' and 'deterministic' approach that tends to break down the project into isolated disciplinary and operational domains. 'Resilience' is thus adopted in its humanistic, physical and sociological meaning, becoming a potential research tool for a 'new balance' to be achieved through methodological and design approaches capable of engaging with complexity, synthesizing diverse forms of knowledge, and fostering a conscious relationship with the built environment.*

ral system that is constantly changing in radical and pathological ways has often led to a preference for solutions selected from the abacus of technical alternatives, to react to sectoral stimuli, and to confuse tools and objectives, often producing partial responses.

In this context, the notion of resilience often invoked in the design field to urge 'adaptive' and 'reversible solutions or, rather, reactions', seems to penalize the 'creative and spatial' dimension of design activity. A deepening of

the term and its meanings in the physical, humanistic and sociological spheres, focused on the 'search for a new balance', instead legitimizes new methodological approaches to design, capable of addressing complex situations through synthesizing actions<sup>1</sup> based on reasons rooted in established methods and approaches to which the same prefix 're-' of the term resilience also refers.

Indeed, in the topical and token prefix re- lurks the idea of re-thinking in order to find a new idea; of re-doing in order to do better; of re-recovering and re-cycling, in order to save and build; of re-trying in order not to give up; of re-birthing, re-living, re-dying in order not to kill a system that is already collapsing and yet does not yet completely fall (Marini, 2016, p. 533).

In this perspective, the contribution explores, from the architectural design side, the methodological issues that have emerged in the research experience conducted within the extended PE3-Return (*Multi-Risk sciEnce for resilient commUnities undeR a chaNging climate*<sup>2</sup>) partnership and, in particular, in the context of the Spoke TS1 - Urban and metropolitan settlements activities that aims to develop models capable of assessing and predicting the impacts, present and future, of climate-related events on the built environment, urban settlements and cultural heritage, taking into account their multiple conditions of vulnerability to multiple hazards, as well as models to estimate urban resilience and the

potential benefits of adaptation and mitigation of impacts<sup>3</sup>.

With respect to these general objectives, drawing on the disciplinary background of architectural, urban and landscape design, and through a multi-scalar inquiry, both inductive and deductive, general methodological issues were investigated through the study of responses to multi-hazard conditions developed in the context of some case studies considered exemplary as expressions of a critical synthesis of solutions that respond, through solutions for different scales, to mutual intertwining between the modes of project development and specific local conditions related to hazards.

Overcoming a 'sectoral' and 'deterministic' conception that breaks down the project problem into distinct scalar and disciplinary domains, according to working schemes that operate 'in succession' or 'cascade', which correspond to partial solutions to be 'assembled' together without a careful analysis of the repercussions (positive or negative) that each action brings into play contributes to making explicit the key role that the approach developed through interscalar design can and must play in response to multiple contemporary 'crises'.

### **Architectural and Urban Planning towards new forms of balance**

Contrary to passive notions of resilience as mere reaction, emerging interpretations based

on new potential balance, drawn from the humanities and physics and based on prospects of new equilibria, restore agency to architectural and urban design, positioning it as a cultural and operational tool for governing territory through critical, synthetic responses.

As landscape architect Nunes notes, this design attitude begins with perceiving transformation potential within nature, an 'invested' observation that anticipates and enables change (Nunes, 2022). This combination of scientific analysis and creative intuition underpins resilient design strategies embedded in systemic, regenerative processes that address cultural and social needs.

This position asserts the cultural value of the built heritage as the outcome of a 'collective manifestation' and as the 'locus of collective memory' (Rossi, 1966), whose preservation cannot be subordinated solely to the protection of human and environmental systems.

In this approach, the critical reading of specific contexts becomes an indispensable prerequisite for any design action. Rooted in the disciplinary tradition of urban analysis, it unfolds across an interscalar dimension aligned with the growing relevance of the 'landscape area' concept. This conceptual framework seems to revive the cultural heritage of Italian urban studies from the 1960s (Gregotti, Renna, Bisogni), proving effective in making sense of type-morphological relations within the built environment and their perception by communities.

Understanding the nature of heritage exposed to risks entails identifying the identity structure of that heritage, knowing its constitutive and evolutionary rules, and, through them, assessing its vulnerabilities. Such knowledge is essential to evaluate the adequacy of adaptation and mitigation measures, aiming at the desired 'contextuality' and systemic coherence of interventions.

The methodological issues that emerged during research within the PE3-Return align with these approaches. While the initial goal was to define design solutions for multi-risk prevention, adaptation, and mitigation at various scales, the methodology employed seeks to reaffirm the interpretive and performative prerogatives inherent to architectural, urban, and landscape design.

The proposed methodological hypothesis assumed that systemic solutions could be identified through the analysis of specific responses developed by exemplary case studies, selected for the clarity of their design strategies. In this regard, the research conducted within PE3-Return expands on a method developed in the research *Horizon 2020 Clarity*<sup>4</sup>, which – through analysis and cataloguing of successfully implemented projects – seeks to identify and disseminate the 'added value' of each project as it reverberates through specific contexts, beyond its direct response to the expected risks.

Compared to the Clarity research, which fo-

cused on meteorological risks (such as heatwaves and flooding), the distinctive feature of the PE3-Return methodology lies in its focus on multi-risk scenarios across an interscalar dimension anchored to geographical contexts.

The cataloguing activity was developed within an interdisciplinary group<sup>5</sup> through the creation of a matrix that cross-references 'sustainable interscalar design actions' with multi-risk indicators. These design actions represent a finite set of multiscale interventions aimed at achieving sustainability goals in response to specific risks. They were derived by comparing tables of virtuous technical alternatives with critical analyses of recent projects, 'deconstructing' their design frameworks.

The set of multi-risk indicators is based on the inclusive classification proposed by the European Commission in *Science for Disaster Risk Management 2020 – Acting today – Protecting tomorrow*, (Casajus Valles, A. et al., 2020) covering geophysical, hydrogeological, meteorological, climatic, and anthropogenic risks. The framework was expanded to include risks related to the intangible cultures of place – those that generate social and economic environments by establishing regimes of inclusion/exclusion and that are embedded in settlement principles and type-morphological relations. This new macro-category, termed 'cultural impoverishment risk', was further articulated to include the physical aspects tied to

local typological traditions and the capacity to respond to community needs.

The selected case studies – WHATAMI, STARTT, Rome, 2011; Capela do Monte, Álvaro Siza, Algarve, Portugal, 2016; Bastide Niel, MVRDV, Bordeaux, 2010; Paseo de Platja Llargu de Salou, b2b Arquitectes, Cap de Salou, Spain, 2003-2022, allowed for a stress test of the matrix across four thematic fields to assess its adequacy and explore its scope of application.

These thematic fields – each embedded in the broader interscalar design framework – represent different project contexts: temporary installations, architectural artifacts, urban landscapes, and low-density landscapes. They were chosen to define a catalogue of comparable solutions based on contextual, dimensional, and programmatic differences.

The work employed both inductive and deductive investigation methods: the case studies were critically analysed and tested using selected indicators, enabling the derivation of general principles regarding intervention methods for risk response (in terms of prevention, adaptation, and mitigation) and for assessing systemic capacity.

The experimental evaluation of case studies using the matrix – combining sustainable interscalar design actions and multi-risk indicators – demonstrates that it is both possible and necessary to pursue objectives related to ‘natural environment defence and reclama-

tion’ alongside those concerning ‘cultural environment conservation and enhancement’.

Indeed, many key actions simultaneously address multiple objectives, sometimes even across different objective families. A detailed analysis of the sustainable interscalar design actions implemented in each case study, regardless of intervention scale, reveals how project ‘scales’ interact to achieve a ‘new equilibrium’.

This research highlights the positive impact of projects that transcend ‘sectoral’ and ‘deterministic’ design frameworks. In projects like WHATAMI, Capela do Monte, Bastide Niel, and Paseo de Platja Llargu de Salou, it is possible to recognize an architectural conception of space that hierarchically organizes all objectives – whether related to risk mitigation, prevention, and adaptation, or to functional requirements.

It is evident that these design ideas arise from the study and creative reinterpretation of context – sometimes through assimilation, as in the Capela do Monte and Paseo de Platja Llargu de Salou; other times through dissonance, as in WHATAMI and Bastide Niel. These ideas introduce an ‘infiltrated program’ (Zengheli, 1985), deeply rooted in the interpretation of geographical contexts and the recognition of foundational myths. They demonstrate the ability to reframe technical issues as broader cultural propositions.

Following the trajectory of these projects, it becomes possible, on the one hand, to reaf-

firm the driving role of architectural design and to understand how we might 'build new paradises' (Nunes, 2022). On the other hand, it becomes untenable to support processes that deconstruct design problems into separate scalar and disciplinary domains, working through 'sequential' or 'cascading' diagrams that generate partial solutions to be 'assembled' without a thorough analysis of the (positive or negative) repercussions that each action may entail.

The matrix employed, based on the intersection between interscalar design actions and multi-risk indicators, however, presents certain limitations that deserve to be made explicit. The first and most evident issue concerns the availability and consistency of data across different contexts, particularly in relation to the "lifecycle of projects", which may limit predictive capabilities in areas lacking established practices.

The second issue relates to the objectivity of assessing the added value of projects in terms of cultural environment conservation and evaluation. In fact, the assessment of whether objectives have been met often relies on critical interpretations that are not automatically comparable.

These considerations open the way to potential methodological developments. Among these is the introduction of a temporal dimension into the matrix, which would allow the modelling of the evolution of risks and design

responses over time, enabling an assessment of resilience in future scenarios. Cross-validation of the matrix in different contexts would help to identify recurring elements and replicable solutions. The integration of participatory processes could enrich the range of indicators with social perceptions of risks and resilience strategies. Similarly, integration with probabilistic scenarios would make it possible to simulate the effectiveness of design actions under extreme events, identifying optimal combinations of interventions based on matrix data and new case studies. In any case, the explicit articulation of the evaluator's scientific approach may enable a more critical and informed interpretation of the results.

Such developments would enhance the effectiveness of the matrix as a decision-support tool in multi-risk contexts, while maintaining the interpretative and design-oriented perspective that forms the core of the present research.

### **Exploring resilience in Architecture, Urban and Landscape design: four case studies**

Nowadays, responding to multi-risk conditions through contemporary design means translating the concept of resilience in terms of variable relationships to the context, which is often deeply rooted in the risk condition. Therefore, all the projects described below adopt a methodological approach that combines the continuous contextual change – driven by natural,



but also cultural and human-made risks – with a temporal change in the composition of architectural and urban space as a tangible form of dynamic rebalancing. Each case study offers a critical exemplification of a widespread design attitude, in which architecture, in different forms and at various scales, functions as a continuous reinterpretation of places, capable of recognizing, even in the most fragile and inhospitable contexts, the opportunity for innovative use of both natural and anthropic spaces. The aim is not to provide univocal or replicable models, but to validate the proposed experimental method through examples that,

despite their specificity, demonstrate architecture's ability to engage simultaneously with risk and with the resilient potential of places. This deliberately limited yet diverse selection – both in scale and type of intervention – makes it possible to see how the notion of resilience translates into radically different design solutions, while maintaining a shared interscalar and contextual approach that mediates between risk and spatial quality. In the field of temporary devices, WHATA-MI (fig.1) a provisional public space project designed by STARTT and realised by MAXXI in collaboration with MoMA in 2011.

## Rome, Italy. WHATAMI, STARTT, 2011. Digital collage

Source: visual elaboration: Marilena Bosone, 2025

Fig. 1

## Charneca, Algarve, Portugal. Capela do Monte, Alvaro Siza, 2016. Digital collage

Source: visual elaboration: Marilena Bosone, 2025

Fig. 2

Engaging with the idea of a possible future for urban transformation, STARTT's intervention offers a sensitive design solution that responds to the meteorological risks associated with heat waves and extreme temperatures, the environmental risks posed by the use of non-renewable resources and the risk of cultural impoverishment due to the lack of a relationship with the existing city.

Set in a historical moment characterized by an economic, environmental and cultural crisis, WHATAMI presents itself as an experimental form of mediation between the existing city and the emerging risk conditions, proposing a model of temporary and reversible spatiality.

The intervention is shaped as a responsive urban device, capable of activating variable relationships with a context profoundly marked by the mono-materiality of the MAXXI concrete square, by a lack of greenery and by a limited integration with the surrounding urban space. The design links environmental, climatic and cultural changes to a compositional transformation of the square, introducing a dynamic artificial topography – hill, mobile islands and water features – able to evolve over time and respond to climate and usage stresses.

The project applies a reversible material and construction logic, favouring dry-assembly techniques, natural materials and prefabricated modules, extending transformability to the technical dimension of the intervention. The architectural space appears as an archipelago

of hills, topped by 18 approximately 3-metre-high fibreglass flowers that illuminate the park at night and provide shade during the day. They also establish a dialogue with the city by reaching, together with the base, a dimension comparable to the surrounding buildings.

The spatial system is transformed through interaction with the visitors, whose presence and activity continuously redefine its boundaries and potential uses. The intervention thus becomes a dynamic relational space, where temporality, reversibility and participation are embraced as primary design tools. Each part of the project is, in fact, conceived to be dismantled, relocated, and reintegrated into other urban contexts, following a circular logic that integrates the production, consumption and reuse of space.

Finally, the planned decommissioning of the installation – with the reuse of the materials for the creation of urban gardens in the Garbatella neighbourhood – represents the coherent extension of a design methodology based on the capacity of the architectural project to act as a transformative interface between context and risk. WHATAMI does not merely offer an aesthetic or functional response to the issue of multi-risk but develops an operational model of spatial resilience in which the project becomes an instrument for negotiating environmental, cultural and social demands through an inherently adaptable architectural composition.



In the field of architectural design, the 'Capela do Monte' is a small, non-denominational Christian chapel designed by Álvaro Siza, in 2016, in the Algarve region (fig.2). The intervention is the centrepiece of a wider rehabilitation programme for the abandoned rural village of Monte da Charneca, which focuses on the restoration of existing architectural and agricultural heritage and the promotion of ecologically responsible rural tourism.

Siza's project skilfully deals with the risk of cultural impoverishment posed by the construction of a new building in the Algarve landscape – as well as the potential environmental and human-made risks associated with altering the ecosystem – by opting for a 'pure architectural object', that blends harmoniously into the context and is energy self-sufficient.

The design methodology is based on the direct association among environmental, landscape, and cultural components, and a spatial composition that integrates architecture into the very cycle of nature. This is achieved through a

material and functional protrusion of the landscape, an architectural gesture capable of fostering the conditions for a harmonious coexistence between humans and the environment. Siza's intervention is distinguished by its exceptional sensitivity to context: the chapel not only blends quietly into the hilly agricultural landscape but also avoids any significant alteration to the ground or existing vegetation. No trees were felled, and no road was built to reach the building, which is only accessible through a pedestrian path that preserves the aura of isolation and contemplative seclusion. The decision to construct the building at the top of the hill, far from any infrastructure, reflects both an aesthetic intention and an ecological logic: the elevated position allows optimal use of natural ventilation and sunlight, ensuring a pleasant indoor climate without the aid of mechanical systems<sup>6</sup>.

Its compact and carefully calibrated structure – measuring only 65 square meters – is built using local and natural materials: ther-

## Bordeaux, Nouvelle-Aquitaine, France. Bastide Niel, MVRDV, 2010. Digital collage

Source: visual elaboration: Marilena Bosone, 2025

Fig. 3

mal perforated bricks, limestone plaster, and a lightweight concrete roof covered with a layer of topsoil. This combination of construction choices guarantees excellent passive thermal performance, keeping the interior cool in summer and mild in winter.

The light colouring of the surfaces, inspired by the earthy tones of the surrounding landscape, further contributes to solar reflectance and heat control, thereby reducing the need for artificial climate regulation. The architectural form of the chapel is expressed by a volumetric purity that evokes the vernacular architecture of the Mediterranean. The simple and abstract façade, with its U-shaped opening to the west, leads into a sober and intimate sacred space in which spirituality arises from a direct dialogue with light, matter and the landscape. Inside, the prayer space is minimal, finished with white tiles, handcrafted oak furniture and a stylised cross, which stands out as a simple T on the back wall.

More than a religious building in the strict sense, the Capela do Monte represents a place of contemplation open to all sensibilities, a spatial device that invites reflection, meditation and connection with nature. This value is reinforced by the presence of a small churchyard that extends towards the landscape acting almost as a continuation of the interior silence toward the horizon. The intervention thus presents itself as a coherent and profound response to the cultural and envi-

ronmental degradation often associated with the abandonment of rural areas: it not only preserves the memory of the place but also demonstrates how architecture can act with lightness and respect, embracing the principles of resilience and sustainability not as technical add-ons, but as the very foundation of the project.

In their design for the new residential district of Bastide Niel in Bordeaux (fig.3), MVRDV engages with the 'urban landscape scale' as a heterogeneous and complex context marked by the coexistence of multiple risk conditions. The intervention area, located in the Bastide Brazza sector on the left bank (*Rive Gauche*) of the Garonne River, is an alluvial plain subject to frequent flooding events throughout the year. The site's unstable and shifting nature compels the designers to rethink the relationship with the river, establishing a symbiotic and synergistic connection with the natural system. The high hydraulic risk in the form of river and sea flooding is accompanied by a meteorological risk in the form of heat waves, a low seismic risk (Somival, 2013), an environmental risk due to the original industrial use of the site<sup>7</sup> and a man-made risk in the form of potential loss of riverside biodiversity<sup>8</sup>.

The unavoidable relationship with the context also outlines a risk of cultural impoverishment, connected to the potential loss of the existing building heritage or the inability to establish a conscious dialogue with the consoli-



dated urban fabric. The area, in fact, faces the historic center of Port de La Lune – a UNESCO World Heritage Site since 2007 – and preserves the traces and infrastructure of the disused railway yard of Bastide Amont, as well as the buildings of the nineteenth-century ‘Caserne Niel’. The challenge that the designers are called to face is therefore not only technical but rather concerns the construction of a new equilibrium between artifice and nature while also engaging with the memory of the site and enhancing its historical identity. The risk management solutions adopted are declined following this precise intention: the placement of new buildings is determined

through an analysis of historical flooding patterns; the buildings themselves are designed to be both earthquake-resistant and flood-resilient (with elevated ground floors and floodable crawl spaces). The relationship with the existing built heritage is reinforced through the preservation of the buildings of the ‘Caserne Niel’ and the decision to use the layout of the former railway infrastructure as a framework for the configuration of new volumes and open spaces.

The morphology of the nearby historic fabric is recalled by the decision to design the neighbourhood according to the principle of the ‘intimate city’, with streets between 6 and 10

## Cap de Salou, Spain. Paseo de Platja Llarga, b2b Arquitectos, 2003-2022. Digital collage

Source: visual elaboration: Marilena Bosone, 2025

Fig. 4

metres wide and a network of easily accessible, widely distributed services. diversification of building forms, which are shaped to optimize natural lighting and ventilation on a case-by-case basis – recalling a process of gradual transformation over time. The entire district is also conceived as a large urban cooling island, designed to address urban microclimate and solar exposure. It aims to reconcile urban densification with residents' well-being through the abundant presence of vegetation, the use of surfaces and finishes with low solar reflectance, and the integration of water features.

The enhancement of memory and place identity, combined with risk mitigation, are themes that also guide the 'low-density landscape' project for the Paseo de Platja Llarga in Salou – a coastal town south of Barcelona and a key tourist destination on the Costa Daurada. The project by B2B Arquitectos (fig.4) works on the redevelopment of the stretch of coast that connects the Port Aventura theme park to the coast and deals with the anthropic, hydrogeological, climatic and cultural impoverishment risks resulting from the progressive destruction of the original dune landscape due to the construction of a campsite (Bellmunt, 2011). The designers' choice is to maintain a balance between transformation and conservation, fully preserving the landscape and morphological characteristics of the area historically considered to be an identity for the city of Salou (Bellmunt J., Andreu X., 2007).

In this perspective, the constituent elements of the landscape – such as the beach, the pine forest, the vegetation of dwarf palms and agave, the dry-stone walls, and the red rocks – as well as perceptual and sensory aspects (such as sea views or the scent of shrubs), are recognized as integral components of the design and considered as pre-existences to be preserved and enhanced.

The dune system's profile is thus restored through the relocation of soil from the shoreline and consolidated by planting native species typical of the Catalan coast – well adapted to sandy, windy terrain and high temperatures (such as *Teucrium*, sea lilies, and *Tamarix*). The original pine forest, compromised by exposure to the saline coastal environment, is regenerated by replacing diseased *Pinus pinea* specimens and introducing new species, such as *Tamarix gallica* and *Acacia dealbata*, capable of protecting the vegetative system from sea breezes. In the *Platja Llarga* project, vegetation (*Lavandula stoechas*, *Rosmarinus officinalis*, *Thymus vulgaris*, and *Agave americana*) assumes a precise compositional role: it is used as a transitional element between the levels, marking or filling the gap created by the sloping paths and thus minimising the impact of human activity (Bellmunt J., Andreu X., 2007). The connection between the urbanity of Salou and the coastline is emphasised by the presence of a pedestrian walkway atop the sand dunes, which, along its course, offers meeting

spaces and impressive views of the sea, as well as easy access to emergency stations. Along this path, a linear bench made of white precast concrete – an actual landmark of the new landscape – conceals the lighting and water drainage system while bordering a vibrant pavement composed of oxide cement and beaten earth. The alternation of materials and colours helps control solar reflectance, ensuring thermal comfort and mitigating the effects of heatwaves.

In addition to the careful preservation of the area's natural morphology, the use of dry-stone walls made from local stone – used to drain rainwater, contain soil, or ensure user safety – permits the recovery of local building traditions, reinforcing the image of the place and the sense of belonging to the context. The promenade culminates on the eastern end in a small triangular public park designed to provide shade and refreshment for visitors, as well as playgrounds and public rooms – affirming the project's capacity to establish a resilient landscape in harmonious balance with both the urban and natural context of Salou.

These projects test the effectiveness of the proposed method in heterogeneous contexts. WHATAMI experiments with a provisional and playful language, transforming an urban square defined by material uniformity into an archipelago of interactive spaces interspersed with green areas, capable of responding to climatic stresses and restoring social life

to a place previously only sporadically used. In contrast, the Capela do Monte asserts a poetics of subtraction, pursuing an almost mimetic integration with the rural landscape and showing how even a targeted intervention can serve to enhance both the ecosystem and local history. Bastide Niel addresses the urban scale in a multi-risk context – hydraulic, seismic, and microclimatic – proposing a densification model capable of combining industrial heritage, biodiversity, and environmental comfort. Finally, the Paseo de Platja Llarga operates within a low-density coastal landscape, where the challenge lies in rebuilding an ecological balance threatened by human-induced erosion, through new forms of connection between nature and settlements, restoring continuity to the dunes and regenerating coastal vegetation.

All the interventions adopt resilience as a guiding principle: temporariness, flexibility, the use of local or recyclable materials, and attention to the life cycle of natural elements become tools to address the multidimensional risks of their respective contexts. The design strategies do not merely mitigate risks from a technical perspective but foster an active relationship with the place, recognising historical memory and cultural identity as fundamental components of sustainability.

Alongside these positive results, certain challenges emerge, reinforcing the experimental nature and validity of the method. WHATAMI,

due to its temporary nature, risks exhausting its transformative capacity if not accompanied by structural urban policies. Capela do Monte, while exemplary for its delicacy and self-sufficiency, raises questions about the replicability of the model in less protected contexts or those lacking a strong landscape identity. Bastide Niel, despite offering innovative hydraulic and microclimatic management solutions, requires constant monitoring of the relationship between building density and environmental quality, particularly in anticipation of extreme climate events. The Paseo de Platja Llarga highlights the difficulty of maintaining the fragile balance between tourist use and ecological conservation over time, demanding continuous management efforts and coherent maintenance policies.

Overall, the investigated interscalar method, deeply rooted in context and its adaptive capacity, proves to be an effective operational tool for addressing the complexity of contemporary design in landscapes at risk, provided that the concept of resilience is interpreted as an open-ended process, capable of integrating technical responses with environmental, social, and cultural dimensions.

## Conclusions

Addressing the problems posed by climate change, its current consequences and those that will intensify in the near future – in other words, the associated risks – is undoubtedly

one of the greatest challenges of our time. In line with the characteristics of the age in which we live in, it is, in many ways, a global challenge. It affects us all, albeit in different ways and with different possibilities for action: as inhabitants of the planet, as citizens of different – geographically, economically and socially – parts of the world, as scholars and technicians working specifically in the areas in which they have to imagine the possible changes.

It is also a global challenge because climate change affects many different scales: the architecture of the city – in its already interscalar connotations – but also the ‘planetary’ scale. The two scales, moreover, are both relevant because they deal with the ethical dimension of our collective living of the Earth, if it is true that

grammar tells us that the Latin *habitare* is a frequentative (or intensive) verb of *habere* (to have). It means, first of all, to have continuously or repeatedly. ‘To inhabit’ therefore refers to having with continuity. The inhabitant, then, ‘has’ the place where he lives. Not in the sense of ‘possession’ or ‘property ownership’, but through access, familiarity, and lived experience. The inhabitant ‘owns’ the home he resides in; the citizen ‘has’ the city they inhabit. Every inhabitant of our planet [...] ‘owns’ the world (Ghisu, 2005)

and everyone has the responsibility to pass it on to future in a condition no worse than that in which it was received. For several decades now, the *observation* of our Planet from Space has represented one of the most significant fields of research within astronomy. It is interesting to notice that the etymology of the

verb *osservare* (to observe) – derived from the Latin *servare*, meaning ‘to take care’ or ‘to preserve’ – suggests a form of looking grounded in *care*: astronauts look at the Earth’s surface and record its transformations on a large scale, both in terms of anthropic traces – such as the widespread urbanisation that not only consumes land but also ‘conquers’ the sea, as seen, for example, in the major eastern megacities – and in terms of the natural elements. Many of the phenomena associated with the latter – oceans, rivers, lakes, mountains, glaciers – are directly connected to climate change, and in many cases are its very manifestations. Conversely, when we return to the ‘human scale’ and observe our territories, cities, and landscapes from the ground level, we can even more clearly perceive how climate change is impacting both the overall well-being and quality of life in our environments. On the one hand, it affects the liveability of places; on the other, it contributes to the increasing frequency and intensity of so-called ‘exceptional’ – and catastrophic – events, which cause real destructions.

Astronauts help us to understand; it is our responsibility to work toward enhancing resilience – understood in a humanistic sense, as defined in the introduction – to create cities, territories, landscapes, buildings, and places in which we can live better.

Starting from this general framework, participation in the activities of the extended part-

nership PE3-Return (*multi-Risk sciEnce for resilient commUnities undeR a changiNg climate*) has represented not only a valuable opportunity to produce significant research outcomes – aligned with the specific objectives embedded in its title – but also, from the perspective of the present author, an important disciplinary field of experimentation within architectural and urban design.

With the shared and unavoidable ‘holistic’ goal of identifying strategies for the mitigation and the adaptation to contemporary risks – particularly those related to *climate change* – the disciplinary contribution has enabled a broadening of perspective. This has made it possible to expand, within evaluative processes applied analytically to realized interventions (case studies) and to future design proposals (guidelines), the set of *risk indicators* and *design actions*, integrating both material, formal, immaterial, meaning-related values of architectural, urban, territorial, and landscape structures. These values, in any case, should be understood as a form of heritage capable of influencing human well-being and therefore worthy of protection.

The three pillars of the New European Bauhaus – *sustainability*, *inclusion*, and *aesthetics* – remain essential to construct places that are not only safe, but also beautiful to inhabit.

Challenges related to the multi-risk conditions of the contexts we inhabit require not only analytical tools but also design approaches ca-

pable of generating integrated, multi-level responses. The experience of the selected case studies – WHATAMI, Capela do Monte, Bastide Niel, and Paseo de Platja Llarga – highlights the added value of interventions that go beyond solutions drawn from traditional technical repertoires. These projects, in fact, do not merely replicate pre-existing alternatives but critically reinterpret the environmental, cultural, and social context, developing systemic responses that combine risk prevention, adaptation, and mitigation with the improvement of the built environment and natural heritage.

The main operational outcomes of this advanced research emerge from the ability to integrate different design scales, simultaneously considering temporal and spatial dimensions, natural and cultural risks, the reversibility and transformability of interventions, and the relationship between design actions and context. The experimentation with a complex matrix demonstrates that design culture enables the creation of resilient solutions that not only address risks but also generate added value for communities and landscapes, producing adaptable and long-lasting spaces. Specifically, the inter-scalar approach fosters a systemic vision in which each design action is part of a larger process, with cumulative and synergistic effects, and allows the combination of scientific analysis and creative intuition to develop contextual and innovative strategies.

In summary, participation in the activities of

the PE3-Return partnership confirms that resilience can become an operational tool in architectural and urban design: no longer an abstract concept, but a concrete criterion for implementing interventions that harmonize sustainability, safety, aesthetic quality, and the cultural significance of places.

### Attributions

The article is the result of a joint research work carried out by the five authors. However, the *Introduction* paragraph is to be attributed to Bruna Di Palma; *Architectural and Urban Planning towards New Forms of Balance* to Paola Galante; *Exploring Resilience in Architecture, Urban and Landscape Design: Four Case Studies* to Marilena Bosone who described the examples of WHATAMI and Capela do Monte, and to Francesca Talevi, who focused on the design interventions of Bastide Niel and Paseo de Platja Llarga in Salou. The *Conclusions* were written by Federica Visconti.

## Notes

<sup>1</sup> For a more detailed discussion see Miano P., Di Palma B. 2024 (eds. by), *Paesaggi a rischio. Fragilità vulnerabilità e progetto*, LetteraVentidue, Siracusa.

<sup>2</sup> Extended Partnership PE3, RETURN Project “multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate” (MUR Project Code: PE00000005), Spoke TS1 - Urban and metropolitan settlements activities) – Principal Investigators Mario Losasso, Andrea Prota.

<sup>3</sup> Within the WP4’s work on Urban systemic transformation including multi-side risk mitigation and adaptation measures, task 5.4.2 the group has worked on the designing of measures and solutions to increase the resilience of building systems (both existing and new) towards intensive and extensive risks, and to reduce the impact of building risk on the urban environment.

<sup>4</sup> CLARITY “Integrated Climate Adaptation Service Tools for Improving Resilience Measure Efficiency”; Rif. 730355 – PI Denis Havlik, Austrian Institute of Technology. WP2 - Science Support, Task 3.4 Adaptation Strategies and Decision Support: Climate adaptation measures as tools of architectural and urban design in the context of fragile landscapes. Selection, analysis, and cataloguing of international projects to be integrated into the platform. CLARITY-CSIS (L. Pagano, P. Galante, M.L. Di Costanzo per Unità di ricerca Centro Studi LUPT-PLINIVS (Coord. G. Zuccaro).

<sup>5</sup> Proff. D. Francese (Coord.), B. Di Palma, P. Galante, M. Stanganelli, F. Visconti, M. Bosone, A. Picariello, E.M. Oliva, F. Talevi.

<sup>6</sup> As the chapel is completely self-sufficient in terms of energy, it has no electricity, heating or running water.

<sup>7</sup> The site formerly hosted a factory for the production of copper-based compounds; an environmental audit conducted in 1992 revealed leaks that had infiltrated the upper layers of the soil of the area. (Cfr. Somival, 2013, p. 150).

<sup>8</sup> The banks of the Garonne River are designated as a Site of Community Importance (SCI) and are in the Natura 2000 network (FR7200700-La Garonne en Nouvelle-Aquitaine).

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# Negotiating between the urban landscape and the domestic space: adaptive climates in Ostiense (Rome)

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## Introduction

The concept of resilience, originally associated with the resistance of materials, has gradually assumed a central role in urban and territorial debates. The literature distinguishes among engi-

neering, ecological, and evolutionary resilience (Holling, 1973; Davoudi, 2012).

Engineering resilience is based on the idea that a system, following a disturbance, has the capacity to return to its previous state of equilibrium. When the concept intersects with the field of ecology, resilience comes to indicate the ability of a system to absorb a certain degree of shock without altering its fundamental structure.

While both of these perspectives rely on the notion of equilibrium, either to be maintained or restored, evolutionary resilience questions the very existence of such a state, acknowledging the dynamic and transformative nature of socio-ecological systems (Scheffer, 2009).

*Technological rationalization of recent decades has definitively dissociated the management of comfort from its context. The “passivation” and “efficiency” of spaces of everyday life have led to a technological setup capable of altering temperature, lighting, and ventilation to achieve a standard, rather than a perceptive level of comfort. This “techno-” functionalism, however, is neither neutral nor democratic. By looking at the consumption patterns in the Mediterranean area, energy consumption increases significantly during the summer due to heat waves and the Urban Heat Island (UHI) effect, caused by impermeable surfaces, limited vegetation, and poor urban ventilation. The widespread use of cooling and ventilation systems leads to high energy demand, with environmental and economic consequences. However, access*

to these systems is not guaranteed for everyone, especially for those living in energy poverty, renters, or people in precarious housing conditions. Urban policies often prioritize technological models such as Positive Energy Districts and Near Zero Energy Buildings, which are frequently unsuitable for the existing building stock and more accessible in countries with greater investment capacity, thus reinforcing disparities between Northern and Southern Europe. Working with the actual capacity for renewable energy production, energy flexibility, and energy efficiency within given urban contexts is the perspective that interests PED4ALL, an European research project deeply connected to the specific context of Ostiense, a neighborhood adjacent to the city centre of Rome. Based on the recognition that current energy adaptation strategies have little room to take root in a district such as Ostiense, this contribution proposes a number of strategies for energy transition which are elaborated from the specificities of the site: analyses span from the domestic energy behaviors associated to a low-performing building stock, the quantity and quality presence of vegetation and wet areas, the geographies of paving and building materials, wind strengths and directions. The result of the design

exploration offers a possible way to adapt to the changing climatic conditions and to enhance the opportunities to reduce energy use. Like the analyses, the configurations that attempt to spatialise the possibilities of energy-climate resilience work at very different scales, from the domestic space to the street, to the vacant lot, up to the level of the river park crossing the area. They are certainly not ready-made answers, but rather keys to understanding and discussing the adaptability of existing parts of the city.

Davoudi (2012) explains that evolutionary resilience promotes the understanding of urban systems as complex and interconnected socio-spatial systems, while Geddes (2003 cited in Mancuso) draws strength from the evolutionary conception of the city through the co-operation of its inhabitants.

However, the transition from theory to practice has rendered the concept increasingly ambiguous. The drive toward “resilience” has, in many cases, resulted in an acceleration of efforts to identify rapid, efficient, and economically sustainable solutions aligned with logics of performance and accountability. Yet this pursuit of efficiency has often privileged technical and administrative criteria, overlooking the actual needs of citizens and local communities (Carrosio, 2020).

In the name of resilience, adaptation strategies have frequently taken the form of top-down interventions. This has, in some instances, produced a widening gap between proposed solutions and social or territorial demands, generating unequal and sometimes counterproductive outcomes. Conceived in this way, resilience risks becoming a technical rhetoric, functional to the justification of predetermined decisions rather than an opportunity to radically rethink the relationship between planning, governance, and spatial justice (Magnani, Carrosio, Osti, 2020).

Within this framework lies the work that began as a master's thesis and then expanded within the European research project PED-4ALL, promoted by JPI Urban Europe. The research investigates the application of Positive Energy Districts (PEDs) in three European contexts: Ostiense in Rome, the Abattoir in the Cureghem district of Brussels and Kizilay Boulevard in Kartal, Istanbul.

PEDs were conceived as an integrated approach capable of combining renewable energy production, flexibility and efficiency. However, their implementation in historic and consolidated urban areas often encounters building constraints, governance shortcomings and an excessive focus on technical parameters (Ranzato, Vanin, Cristiano, 2022).

Specifically, the Ostiense district, located in Municipio VIII (the eighth district of Rome) in the southern area of Rome, between the Au-

relian Walls and the Tiber River, belongs to the compact<sup>1</sup> part of the city. The morphology is predominantly characterized by a residential fabric built between the 1930s and the 1960s. It then unfolds into large, disused industrial and commercial areas. From an industrial hub to a territory in search of a new identity, Ostiense has always embodied a transformative character. The urban environment of Ostiense appears as an extremely specific and at times hostile context, marked by high temperatures, a lack of vegetation, air pollution and high population density. It constitutes a veritable ecological niche where only species (both human and non-human) adapted to such particular conditions can thrive.

Climate change, with its rapid and radical transformations challenges the resilience of these urban structures, highlighting the need to rethink these European urban models.

The aim of this article is to conduct an analysis grounded in the real conditions of the case study, questioning the standardized techno-functional approaches of the energy transition, and exposing their social and spatial limitations, while opening up possibilities for more equitable and adaptable forms of energy-climatic resilience.

The paper is structured into six main sections. The following section, *Theoretical Framework and Methodology*, explaining how the master's thesis *Ostiense Bioclimatica* was developed and how it expanded alongside the Eu-

ropean research project PED4ALL. *Urban Heat Island and Urban System: The Correlation between the Energy Production System and the Urban Heat Island in Rome*, highlights the severity and persistence of the urban heat island phenomenon and its negative impacts on the national electricity system. *The Behaviour of Vegetation within the Urban System*, drawing on experiments conducted in the United States, Japan, and Rome, provides a qualitative overview of the effects of vegetation as the main passive cooling device. *Analysis and Design Speculation*, together with its subsections, presents a primarily climatic analysis of the Ostiense context, describing a range of devices for the implementation of passive and active solutions in the neighborhood. *Domestic Practices and the Paesaggio Elettrodomestico*, delves into the domestic sphere, linking the strongly spatial and climatic structure of Ostiense Bioclimatica with more social issues. Finally, *Conclusions*, outlines the main findings of the study, discussing both its limitations and prospects for future development.

### **Theoretical framework and methodology**

The research originates from the master's thesis titled *Ostiense Bioclimatica*, dedicated to the Roman territory and in particular the Ostiense district, with the aim of intertwining analysis and design interpretation through maps and urban drawings. The initial study highlighted the correlation between the fa-

tigue of the urban energy system, exacerbated by the urban heat island phenomenon, and the behavior of vegetation, which served as a basis for outlining a climatic overview of the city of Rome. To gain a deeper understanding of the context and to develop a targeted proposal for Ostiense, the investigation then focused on several factors: building performance, mobility, vegetation distribution, permeable and reflective surfaces and areas most exposed to solar radiation. Building on these observations, the research engages with the model of Positive Energy Districts (PEDs), understood as urban subsystems capable of integrating expert and local knowledge through a co-production methodology, that combine energy strategies, policies, regulatory frameworks, as well as social and spatial dimensions (Maestosi, Salvia, Pietrapertosa, Romagnoli, Pirro, 2024). Despite growing interest the implementation of PEDs faces numerous challenges. Adapting to the existing building stock and the integration of new technologies present a complex processes; in addition, the lack of established technical strategies and adequate governance models poses further obstacles. There is a risk that PEDs may be reduced to a mere techno-scientific apparatus based solely on energy parameters and unable to address the critical issues and specificities of consolidated urban contexts such as the Ostiense district. To overcome these limitations, this work adopts a theoretical framework that inter-

prets the territory not merely as a collection of buildings, but as a complex urban and environmental system. Through reports from Legambiente – Associazione Italiana per l'Ambiente e l'Ecologia<sup>2</sup>, Terna – Rete Elettrica Nazionale S.p.A.<sup>3</sup>, Areti S.p.A.<sup>4</sup>, and other studies, it was possible to reconstruct a comprehensive overview of Rome's energy infrastructure and its energy transition highlighting its limitations and implementation challenges. It immediately emerged that many of the energy network's criticalities are exacerbated by climate change, particularly heat waves, which severely test the system's reliability. In this context, the studies by Asdrubali et al. are particularly relevant, as they analyse in detail the difficulties caused by heat waves.

In the name of resilience to these issues, various mitigation and adaptation measures have been developed in Rome, including the creation of reflective surfaces, soil permeabilization, protection of hydrogeological systems, and safeguarding of the ecological network (Rome Climate Plan, 2024). However, intervention is not straightforward: Rome's building stock is vast, heterogeneous and often subject to conservation restrictions, while territorial disparities and limited access to funding constrain the possibility of widespread and equitable action. In this perspective, reference is also made to the studies of Sproken-Smith (1998), Oke et al. (2017) and Scudo and Ochoa de la Torre (2003), which highlight the contribution of urban mor-

phology and vegetation to climate regulation and have allowed these aspects to be qualitatively represented across the city of Rome.

It is necessary to ask whether urbanized humanity is still capable of evolving and adapting to a rapidly changing environment, especially when the very structure of cities and the infrastructures that support them are under pressure. Is there a way in which the urban structure of our cities does not merely represent a limitation but through design and planning can actually promote and influence behavioural and social responses?

For this reason, *Ostiense Bioclimatica* seeks to propose a design alternative for public space that allows for a new vision of the territory and integrates climatic strategies, social practices and the quality of urban space. Particular attention is given to the role of passive climatic devices and the legacy of bioclimatic architecture, present in vernacular traditions that reveal traditional bioclimatic strategies transferable to contemporary architecture. Among the most renowned are the seminal works of Hassan Fathy (1986) and Paul Olivier (1997), as well as the studies of Victor and Aladar Olgyay (1963) and Baruch Givoni (1976). Contemporary reflections are also considered, such as the meteorological architecture of Philippe Rahm (2023) and the work of Kedziorek et al. (2023), which focus on creating variable comfort conditions in inhabited spaces through both low-tech and non-low-tech devices.

The design reflection drew inspiration from several international examples that have explored the creative use of urban spaces, the flexibility of street furniture and the integration of passive climatic devices. Among these are the Metropolitan Forest in Madrid (Lolalanda), which combines vegetation and public spaces; the project of Philippe Rham in Taiwan “Jade Eco Park”, which experiment with meteorological architecture as a form of climatic modulation; Scalo Farini in Milan (OMA), an example of converting railway spaces into multifunctional parking lots and open spaces into temporary gardens or interactive social spaces. Additional references include the projects of TVK - Trévelo & Viger-Kohler Architectes Urbanistes in Paris, such as Place de la République, Jardin Sportif Suzanne Lengles and the Michelet complex, which demonstrate how canopies, pathways and flexible spaces can foster social interaction and climate comfort. At the international level attention is also given to the Els Encants market canopy in Barcelona, the water square along the Garonne River in Bordeaux and the removable canopies at Centenary Square in Sydney illustrating how temporary or modular architecture can create multifunctional public spaces adaptable to climatic conditions and social activities.

Afterwards, by approaching the European research project PED4ALL, the investigation opened up to the socio-spatial dimension exploring everyday practices of energy consump-

tion and comfort. Through small workshops with the inhabitants of Ostiense, called Paesaggio Elettrodomestico, it was possible to observe how the indoor conditions of buildings are closely connected to the external climatic ones. It emerges that the organization of domestic space and everyday practices can affect the thermal regulation of indoor environments, reducing dependence on electric or gas devices, in line with the studies of Shove (2007), Boni (2014), and Oskar and Hansen (1996–2020).

#### **Urban heat island and urban system: the correlation between the energy production system and the urban heat island in Rome**

The significant temperature difference between city and countryside was a phenomenon already observed in the 19th century by the London pharmacist Luke Howard, who was a pioneer in identifying what is now known as the Urban Heat Island (UHI) effect. This effect consists of the formation of warmer microclimates within urbanized areas compared to the surrounding rural zones. The intensity of this phenomenon is currently measured by the Urban Heat Island Intensity (UHII) indicator, which expresses the difference between average, maximum or minimum temperatures recorded by urban microclimate stations and those recorded in reference rural areas.

The causes are multiple: the morphology of the territory which hinders natural ventila-

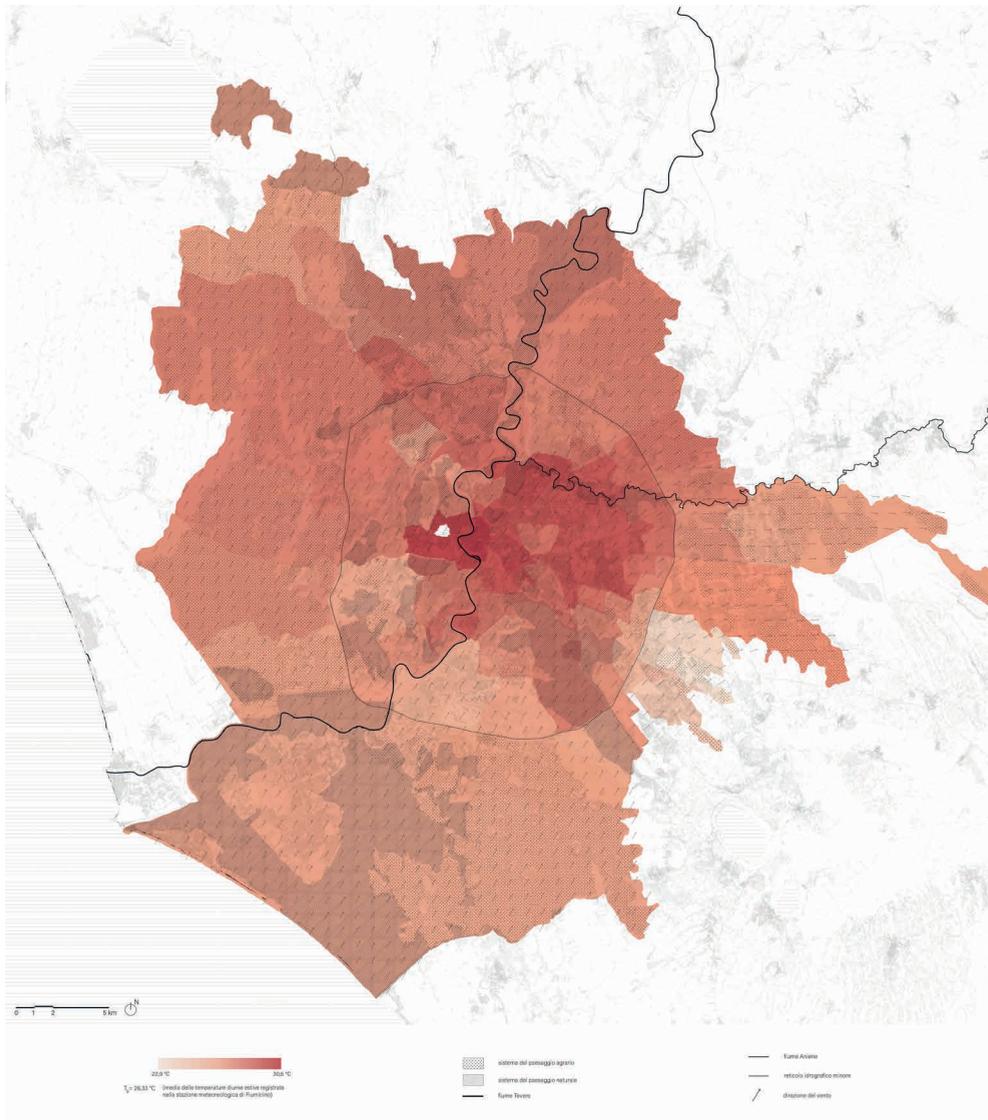
## Urban heat island and urban system: the correlation between the energy production system and the urban heat island in Rome.

Source: Asdrubali et al., 2022, reworked by Giordana Panella and Giancarlo Scarascia Mugnozza

Fig 1

tion; high levels of air pollution; soil impermeabilization and the limited presence of vegetation (Fawzi Arrar et al., 2024). In Rome, the urban heat island effect manifests particularly strongly, and forecast data indicate a constant worsening of the phenomenon. It is estimated that the number of extreme heat events will increase from an average of 2 to 28 days per year, with an overall temperature rise of  $+3.65^{\circ}\text{C}$  compared to 1960 (Legambiente, 2020). Quantifying the urban heat island phenomenon has become fundamentally important, both for design and forecasting purposes. Francesco Asdrubali, Full Professor of Technical and Environmental Physics, and Marta Roncone, PhD student in Technical Physics at the Department of Industrial, Electronic, and Mechanical Engineering of the University of Roma Tre, calculated the UHI in Rome's neighbourhoods using data from 35 urban microclimatic stations and the rural station at Fiumicino airport. The resulting map spatializes and makes legible the temperature differences within the city compared to the rural reference station, calculated by urban zones (Fig. 1). It is evident that the most pronounced phenomenon occurs in the central neighbourhoods and the eastern quadrant. The impacts of the intensification of the heat island effect are numerous and profound. Beyond the health risks, especially for the most vulnerable populations during heat waves, the phenomenon has direct implications on energy infrastructures.

The national electricity system, mainly based on centralized production, reveals a series of structural vulnerabilities. The Resilience Plan by the company Areti highlighted a significant correlation between rising ambient temperatures and increased electrical power demand. Analysing data from 2012 to 2022, critical stress thresholds on the grid were identified: high temperatures lead to higher energy demand precisely when the grid is more vulnerable, as heat impedes thermal dissipation along power lines, causing increased cable temperatures and raising the risk of infrastructure failure. In addition to structural problems, there are inequalities in energy consumption. Again, Asdrubali and Roncone (2023), together with De Lieto Vollaro and in collaboration with the collective #mapparoma (Keti Lelo, Salvatore Monni, and Federico Tomassi), presented maps of domestic consumption based on data provided by Areti for urban zones in 2021. They show that the lowest consumption is in the compact city, due to its dense fabric and medium-small housing, but also linked to social groups with limited economic resources. However, the largest percentage increase in domestic consumption during the summer months, when air conditioning peaks occur, is also observed in the compact city. In light of this morphological, climatic, infrastructural and social complexity, an integrated design approach becomes increasingly urgent, one capable of connecting the urban landscape, techno-



logical innovation and microclimatic resilience. Philippe Rahm (2023) proposes defining this approach as the “Anthropocene Style”: a way of designing that acknowledges the interdependence between the built environment and climatic phenomena, between daily comfort and urban energy metabolism. In a city like Rome, strongly marked by its historical layering but also subject to new climatic vulner-

abilities, planning sensitive to territorial specificities appears not only desirable but necessary to face the challenges of the present. Improving housing comfort, reducing energy consumption and limiting CO<sub>2</sub> emissions can no longer be pursued as separate objectives but must be achieved through a unified and situated vision capable of reading and transforming the city starting from its climate.

## The behaviour of vegetation within the urban system.

Source: author's elaboration

Fig 2

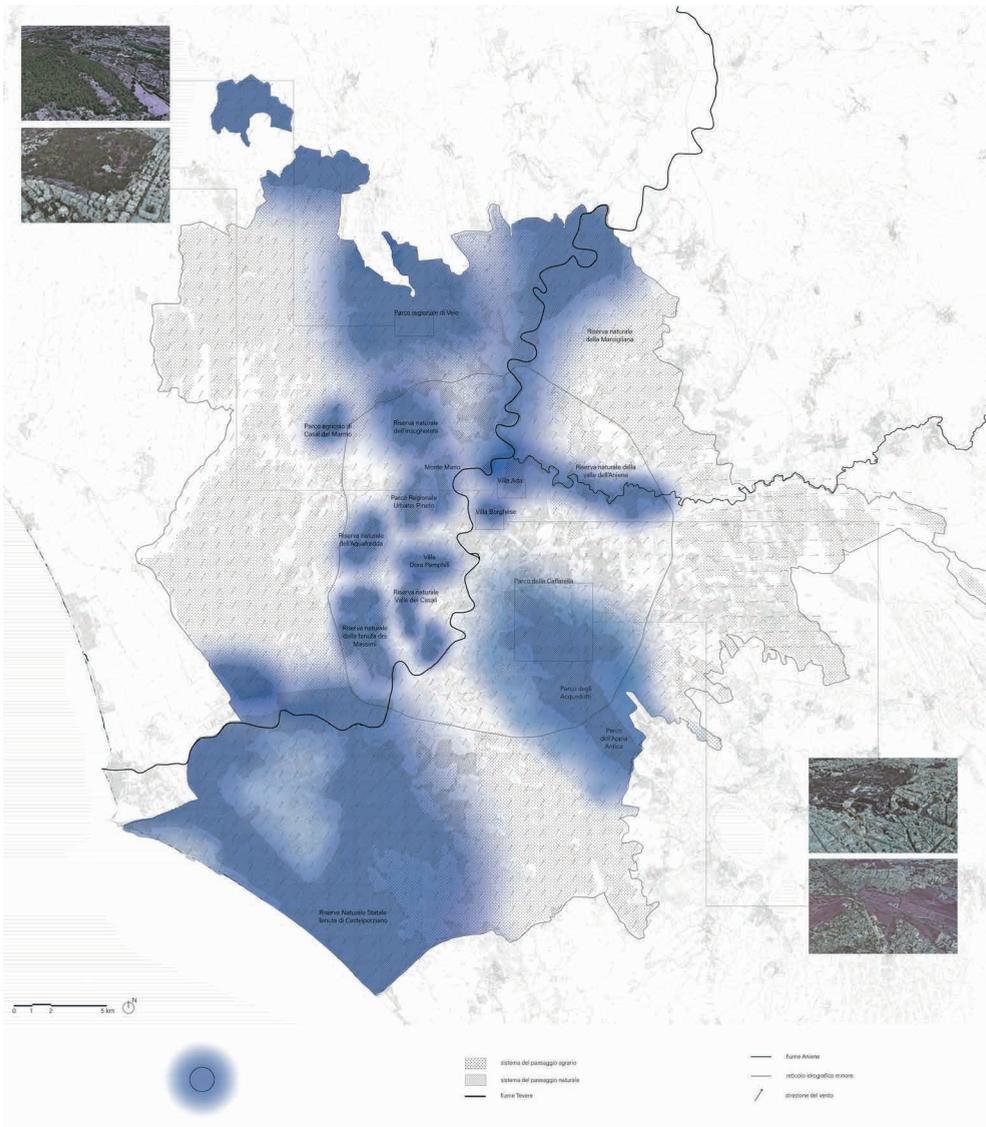
### The behaviour of vegetation within the urban system

The literature highlights the crucial role of urban vegetation as a tool for climate mitigation. It has been estimated that a 10% increase in green surface area would lead to a 2°C reduction in air temperature, with an energy saving for summer cooling of 8-11%. In particular, thanks to the shading provided by trees, depending on their position, species and canopy size, energy consumption for the air conditioning of residential and commercial buildings can be reduced by 15-50% (Akbari et al., 2001), as they generate a natural low-tech cooling effect. Unlike other types of surfaces, grassy areas remove heat from the environment through the process of evapotranspiration (Scudo, Ochoa De la Torre, 2003). Experiments by Sproken-Smith (1994), Brundl et al. (1986), Oke (1989), Jouregui (1975 and 1990), and Seito et al. (1990 and 1991) confirm that shading and evapotranspiration are the two main factors in lowering temperatures. In particular, Sproken-Smith states that the effect called the "cooling effect," i.e., the positive thermal influence of parks, is often noticeable within a distance approximately equal to the width of the park itself. Moreover, Marando et al. (2019) specifically studied this effect of vegetation in the Metropolitan City of Rome. By analysing different elements of Green Infrastructure during the summer period, they found that the Periurban Forest (Te-

nuta Presidenziale di Castelporziano) extends this effect up to about 170 meters beyond its boundary; for the Urban Forest (Villa Ada Savoia) it extends beyond the urban forest area up to a maximum of 100 meters; for the street trees of *Quercus ilex* L. along Viale Mazzini, the mitigation of local surface temperature, about 1.3°C, extends up to 30 meters from the row of holm oaks.

Although the mapping is qualitative (Fig. 2), it roughly proposes an offset of the average park width. However, as Sproken-Smith's research emphasizes, the surrounding urban context is essential for the irradiation of the climatic effect. Therefore, care was taken to limit the spread of the vegetation effect where the context is heavily built. In essence, this provides an indication of the effect that urban parks produce at the local scale, i.e. at the level of an urban district. When compared with the urban heat island map, it is evident how vegetation density and its effect are influenced positively or negatively depending on the urban context.

Villa Doria Pamphili, Villa Ada and Villa Borghese being surrounded by a continuous and dense residential fabric, struggle to produce a climatic resonance effect on a larger scale, similarly to what occurs in the eastern portion of the city. In contrast, the pine forest of Castel Porziano, the parks of the Appia Antica and the Veio Regional Park, characterized by extensive vegetated surfaces and a less compact

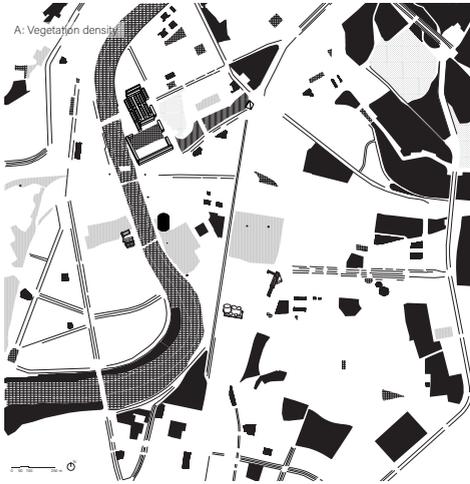


urban fabric, show a greater capacity to mitigate the urban heat island.

Rome is one of the largest urban systems, where different types of urban fabrics, a remarkable variety of landscape and environmental systems, a rich agricultural heritage characterized by a mix of intensive, rural and high-natural-value areas are intertwined.

Focusing on the parks highlights the lack of a coherent ecological network: the park system appears fragmented and the lack functional connections with both the consolidated urban fabric and with the surrounding agricultural landscape. This discontinuity undermines the systemic potential of vegetated spaces and reduces their overall impact on the city's climate resilience.

A: Vegetation density



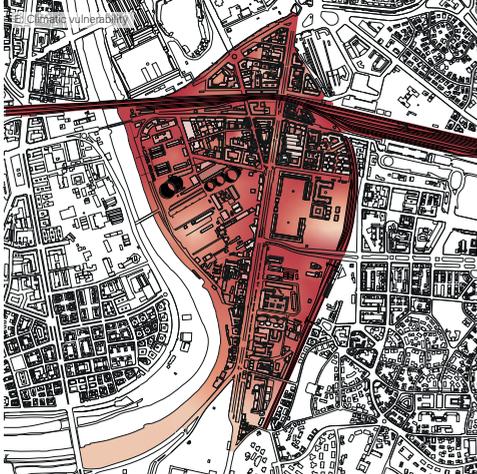
B: Climatic effects of vegetation



C: Albedo



D: Solar radiation



## Climatic and Morphological Analysis of the Ostiense District.

Source: maps designed by Giordana Panella and Giancarlo Scarascia Mugnozza

Fig 3

### Analysis and Design Speculation

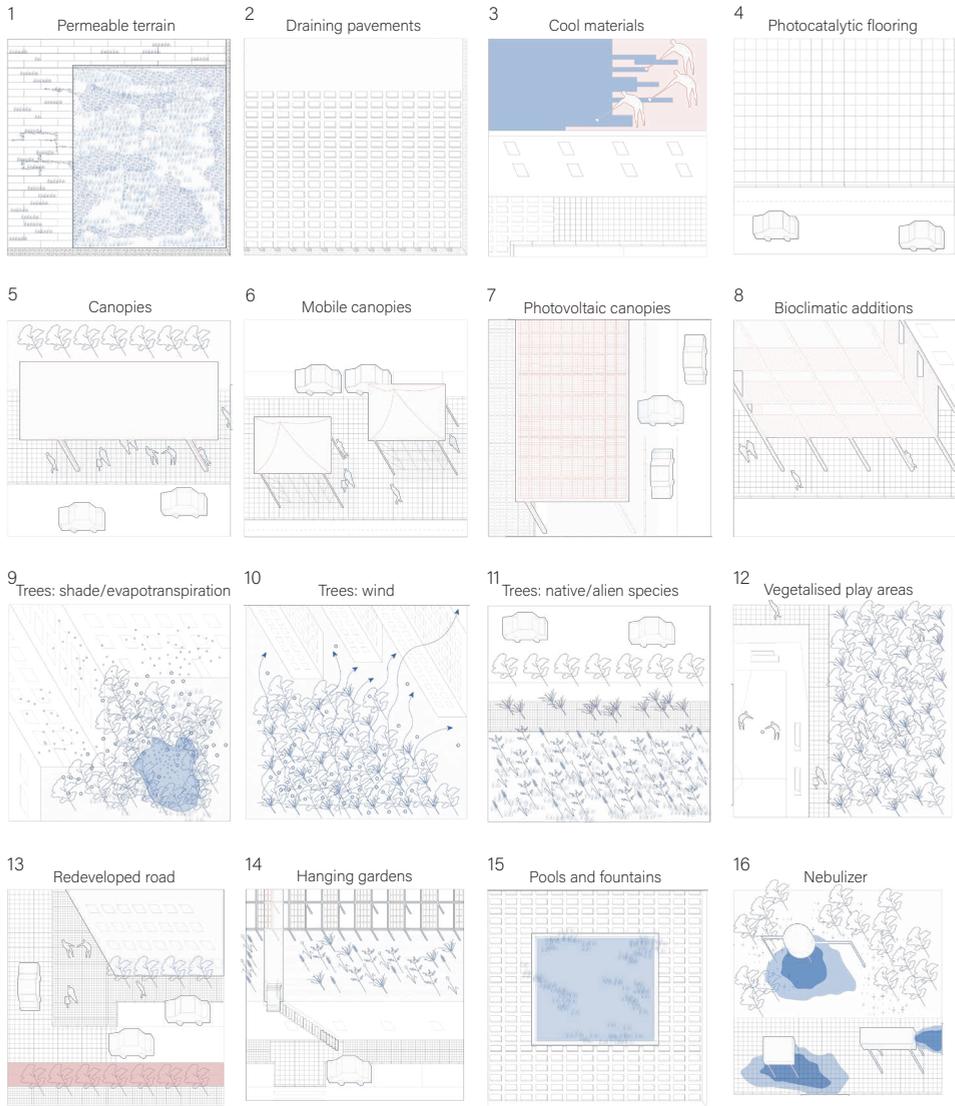
#### Climatic and Morphological Analysis of the Ostiense District

The analyses conducted for the study area highlight the main causes of increasing temperatures in the urban environment. These include the extent of paved and impermeable surfaces, which absorb solar radiation due to their low reflectance. The geometries of the urban fabric, which hinder natural ventilation and the diffusion of the positive effects of vegetation, and finally, the effects related to vehicle traffic and the use of air conditioners during the summer season in the residential context.

The Ostiense district (Fig. 3), in its densest part, is characterized by a predominantly compact block morphology with narrow streets bordered by continuous building fronts that are poorly permeable to ventilation. The analyses conducted on vegetation aim to make visible how its configuration (A), distinguishing between gardens, squares, inner courtyards, cemeteries, riverbanks and uncultivated areas, interacts with the urban morphology. By comparing these elements, the intensity of the blue areas defines the limits of the vegetation's capacity to act as a bioclimatic device (B).

The urban system of Ostiense presents a high incidence of impermeable surfaces. The black and darker grey are areas that are highly irradiated and have a low albedo coefficient<sup>5</sup>(C) (ranging between 0.05 and 0.50) (Fabian,

2019). As shown by the purple colour in the following diagram, this results in significant heat absorption. Using Autodesk Formit software, the most critical thermal zones correspond to surfaces combining high heat storage capacity, constant sun exposure and vegetation inconsistent with the climatic needs of the area (D). The most critical areas are those near the railway to the north and east, the two intermodal hubs of Piramide and Garbatella and Via Ostiense in its less vegetated section, (E). The estimate of energy consumption for cooling, based on energy class and population density, focused on residential buildings, shows that low-efficiency buildings tend to overheat more quickly during hot periods, requiring greater use of air conditioners and fans to maintain comfort conditions. Residential density accentuates this effect, as more occupants generate higher internal loads, making it difficult to maintain thermal comfort. The intersection between low energy efficiency and high density identifies areas of greatest energy and climate vulnerability, characterized by high summer electricity consumption, which are shown on the map as dark purple buildings (F). The mobility system also represents a critical element for the environmental resilience of the area. Despite its strategic location between two intermodal hubs, the northern part of Ostiense, as highlighted by the colour intensity (F), is well served by public transport, both rail and bus. However, private road mo-



## Bioclimatic devices and strategies.

Source: elaboration by Giordana Panella and Giancarlo Scarascia Mugnozza

Fig 4

bility continues to dominate, contributing to air pollution and the overheating of urban surfaces. The district's configuration as a "pass-through place", rather than as an integrated system of public spaces and sustainable mobility strengthens the conditions of microclimatic stress and complicates the implementation of adaptation strategies.

### **Bioclimatic devices and strategies**

In relation to the analyses carried out, a matrix of devices was defined that engages with a dense and historically layered urban fabric, characterized by spatial and social complexity that limits the application of purely technological or economically burdensome solutions. In these contexts, the design challenge does not lie solely in energy efficiency or the technical performance of the devices, but in their ability to adapt to a heterogeneous built environment. The matrix thus becomes a non-prescriptive but interpretative tool, capable of mediating between material conditions, local resources and everyday practices (Fig. 4)

### **Masterplan and climate regeneration**

In continuity, the masterplan (Fig. 5) proposed for the Ostiense area is conceived as a coherent set of interconnected actions aimed at reclaiming urban spatiality capable of generating climatic comfort and social transformation. The strategies developed based on the placement of devices in relation to the morpholog-

ical and climatic criticalities identified in the neighborhood analysis aim at an equitable redistribution of environmental well-being.

Vegetation assumes a central role in the construction of local microclimates and in redefining the relationship between open space and urban density. In consolidated contexts such as Ostiense, its function is not only technical—shading and evapotranspiration—but also spatial and social, as it restores access to thermal comfort and the collective enjoyment of spaces that are currently marginal or impermeable. Trees are uniformly distributed throughout the territory, paying particular attention to streets and public spaces, where the selection of species resistant to pollution, favourably positioned for urban breeze circulation and with wide trees canopies (height over 18m) becomes essential for the creation of climatic corridors. A dense mass of trees is placed as close as possible to the railway to the north and east, to reduce the heat hotspot and along Via Ostiense one of the busiest streets.

To enhance the cooling effect through evapotranspiration on a small scale, it is important to place vegetation in relatively "enclosed" conditions, within almost continuous vertical limits (Scudo, De la Torre, 2003). From this perspective, the courtyards of large residential complexes become vegetated islands, which in some cases are further enhanced by the inclusion of water basins that amplify the cooling effect. The insertion of vegetation in inter-

nal courtyards not only improves microclimatic conditions but it promotes collective management of the microclimate, turning thermal comfort into a common good.

The large areas currently awaiting transformation, such as the former Mercati Generali and former Ex Italgas sites, are considered as potential spaces for temporary climate mitigation interventions, in connection with the uncultivated area near Teatro India on the opposite bank of the Tiber, strengthening the ecological continuity of the neighbourhood (Fig. 6). At the same time, interventions target materials and pavements to counteract heat accumulation in areas that are heavily irradiated and characterized by low albedo, such as the intermodal hubs of Piramide and Garbatella. The aim is to act simultaneously on the environmental and morphological levels, through:

- a) depavement, which restores permeability to surfaces and their capacity to absorb rainwater;
- b) the use of permeable pavements, to implement eco-friendly solutions for the environment;
- c) the introduction of cool materials, capable of reflecting solar radiation and reducing heat absorption;
- d) the use of photocatalytic pavements, which contribute to air purification.

These actions help to reconnect the urban fragments of the neighbourhood and improve local microclimatic conditions.

In areas where streets widen, the installation of light-fabric movable canopies, fixed shelters and photovoltaic coverings is planned, provid-

## Masterplan and climate regeneration.

Source: elaboration by  
Giordana Panella and Giancarlo Scarascia Mugnozza  
Fig. 5

ing shade and producing energy, but above all redefining these spaces as new places for social interaction and urban rest. Building rooftops also take on a new role: they host photovoltaic panels and collective functions, with a view to energy redistribution and the regeneration of urban surfaces.

Alongside strategies for public space, interventions are planned within domestic spaces, such as in the two blocks near Piazza Porto Fluviale owned by ATER<sup>6</sup>. Bioclimatic greenhouses are added to the façades; these elements enhance the mitigating effect of vegetation and restore access to thermal comfort even for people experiencing energy and economic vulnerability (Fig. 7).

### Domestic practices and Paesaggio Elettrodomestico

The continuation of the research within the PED4ALL research allowed the analysis to extend from the urban and morphological level to the dimension of everyday practices related to energy use and domestic comfort.

The investigation involved the residents of three housing units located in different areas of the neighbourhood (Fig. 8), through two co-analysis sessions. The first, dedicated to reconstructing the Paesaggio Elettrodomestico, was conducted using a maquette, revealing the daily use of household appliances. The second session consisted of analysing three climatic conditions, in order to reconstruct the



1. Spazi permeabili  
calore specifico 879 J/kgK,  
densità 1460 kg/mc;  
albedo 0,15-0,20;  
2. Pavimentazioni drenanti  
grigliato di calcestruzzo vibro compresso 50x25 cm,  
permeabilità 40/60% in base alla tipologia,  
albedo 0,20-0,30;

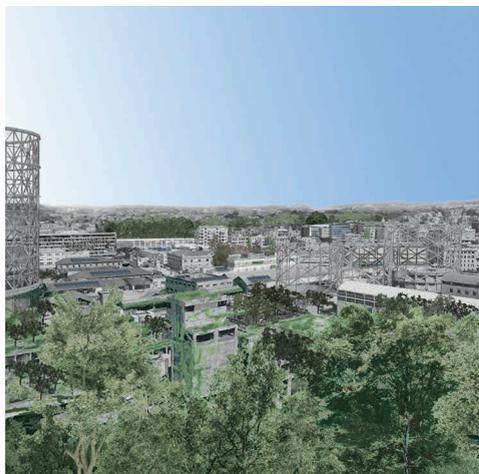
3. Materiali freddi  
albedo 0,90-1,00;  
4. Pavimentazioni fotocatalitiche  
conglomerato bituminoso contenente malta cementizia 50x50cm,  
albedo 0,20-0,30;  
5. Coperture/pensiline  
acciaio composte da lame frangisole e opache,  
albedo 0,70-1,00;

6. Coperture removibili  
tessuto acrilico, impermeabile e autopulente;  
7. Coperture fotovoltaiche:  
fonte energetica,  
albedo 0,05-0,1;  
8. Addizioni bioclimatiche:  
fonte energetica passiva;

9. Alberi:  
ombra ed evapotraspirazione,  
albedo 0,20-0,30;  
10. Alberi:  
brezze urbane con il passaggio del vento,  
albedo 0,20-0,30;

11. Alberi:  
specie autoctone allene,  
alberature stradali > 18m,  
verde urbano 12-18m,  
piccoli giardini < 12m;  
12. Aree gioco vegetalizzate:  
alberi < 12m,  
albedo 0,20-0,30;

13. Sezioni stradali riqualificate: s  
pecie resistenti all'inquinamento,  
alberi > 18m o tra i 12-18m;  
14. Giardini pensili:  
albedo 0,20-0,30;  
15. Vasche e fontane:  
calore specifico 4180 J/kgK,  
50-0,80 sole all'orizzonte;



## Cooling core Ex Italgas.

Source: elaboration by Giordana Panella and Giancarlo Scarascia Mugnozza  
Fig. 6

## Bioclimatic additions in Via del Commercio.

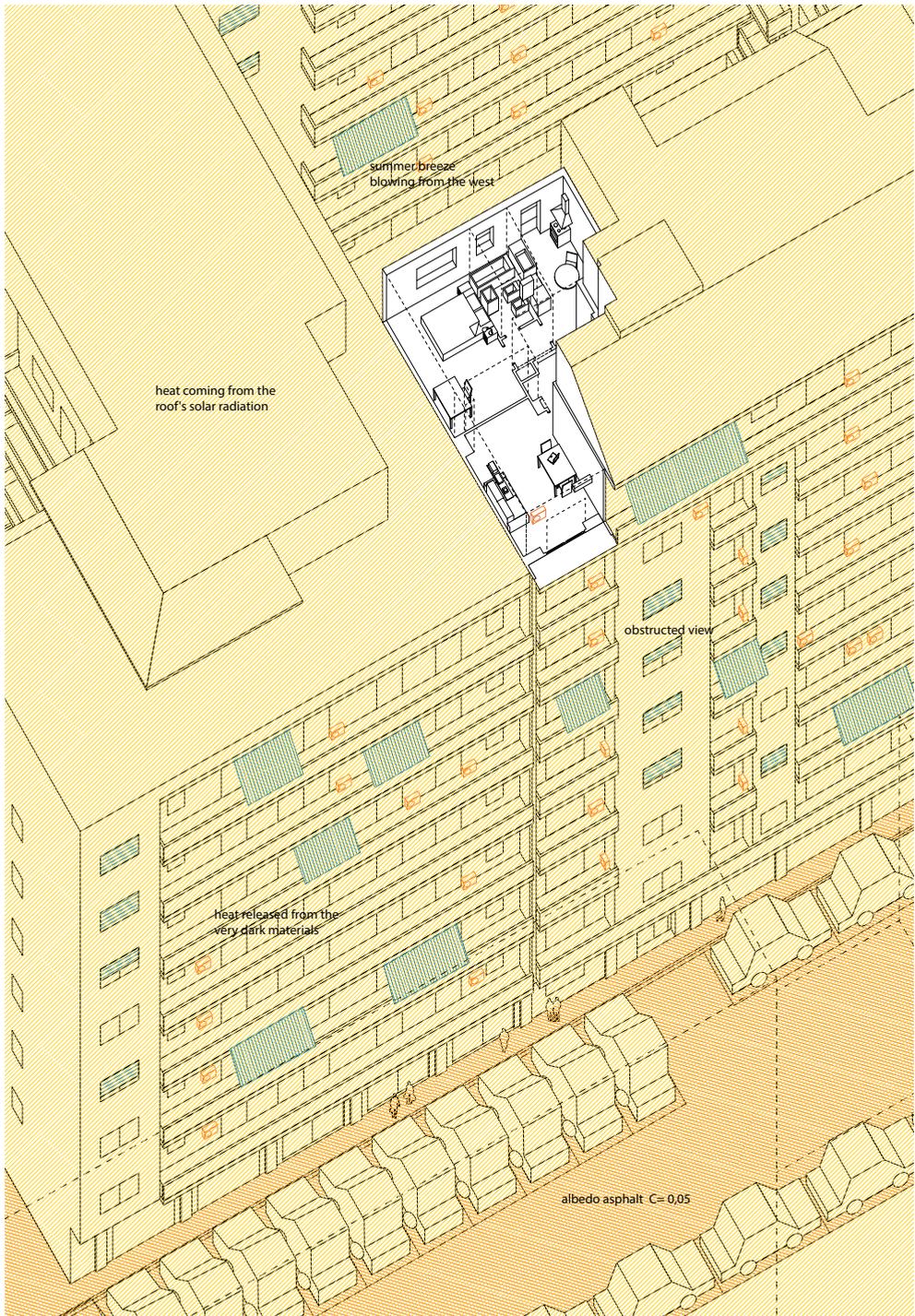
Source: elaboration by Giordana Panella and Giancarlo Scarascia Mugnozza  
Fig. 7

## Placement of the various apartments in the transect.

Source: author's elaboration  
Fig. 8

practices adopted by residents within the domestic space to achieve a state of comfort. One couple lives in dwelling A. This is in a six floors modern building with high energy performances. The 80 square meter apartment is located at the fourth floor. One person lives in dwelling B, a 50 square meter flat, which is

in an historic building at the top floor. Dwelling C, 70 square meter, is at the top floor of a 60s courtyard building. Two people live in this one. From the three situations analysed, a strong interdependence between energy consumption and urban configuration emerges. The apartment C is closest to the railway



## Reconstruction of the context in which apartment C is located.

Source: author's elaboration

Fig. 9

tracks is strongly affected by the urban heat island, while the one near the Tiber (apartment A) benefits from more favourable microclimatic conditions.

During the intermediate season dual exposure can generate cold drafts. Dwelling B has a free view, so that it can benefit more. Dwelling C, instead, is closely surrounded by high buildings that neglect the effect (Fig.9).

In the winter period, the efficient heating system and the good envelope insulation of apartment A are essential. Where this is not possible, conscious use of clothing becomes relevant.

Recognizing these relationships forms the basis of a situated energy transition, capable of integrating comfort, spatial justice and collective transformation.

### Conclusions

The study shows how the definition of resilience proposed by the Intergovernmental Panel on Climate Change (2007), understood as “the amount of change a system can undergo without changing state”, proves inadequate when applied to complex systems such as cities. The spatial analyses conducted show, in fact, that Rome presents a marked problem of summer heat island, constantly worsening over time, which puts pressure on the electrical grid and amplifies social inequalities, particularly affecting the most vulnerable groups. It is a systemic phenomenon involving infra-

structures everyday practices and housing conditions and one that seems destined to persist. In this context, the Ostiense district represents an emblematic case with an urban fabric in continuous transformation, where social, environmental and spatial dynamics intertwine. Rather than thinking of resilience as the ability to return to an original state, it is necessary to consider an evolutionary resilience, understood as a succession of mutable and transitory states, capable of generating new conditions of equilibrium in response to regime changes and the potential cascading effects deriving from them. The PED4ALL research confirms and deepens the intuition of Ostiense Bioclimatica, highlighting the social and spatial limits of dominant technological strategies. Urban warming, in fact, cannot be reduced to a purely climatic issue: it intertwines with social practices and with the city’s energy organization, contributing to the formation of new spatial vulnerabilities. As Shove (2002) observes, energy consumption is not an abstract fact, but is closely linked to everyday practices. It is the search for an ideal thermal condition that has radically transformed our behaviours and our perception of comfort. Technological evolution has certainly increased levels of well-being, but at the price of a progressive detachment from natural processes and from the direct control of our living conditions. We have delegated to technology and to fossil fuels the regulation of our living en-

vironment, constructing an apparent comfort that has progressively eroded our perceptive and critical awareness. The proposed approach aims to reactivate this awareness, bringing energy, climate and comfort back within a spatial and somatic horizon, in which urban design becomes a tool of relation between bodies, matter and environment. On the theoretical bases addressed, the identified strategies can be translated into flexible and adaptive urban planning tools, such as climate action plans, local building regulations or guidelines for urban regeneration, inspired by experiences already initiated in cities such as Pavia, Venice and Milan (Legambiente, 2020). Interventions such as de-paving, the use of reflective materials, the creation of vegetated courtyards or the activation of threshold spaces could be integrated into municipal policies for the mitigation of urban heat, promoting an energy transition rooted in local contexts.

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call Joint Call for Proposals / MICall 21: Positive Energy Districts and Neighbourhoods for Climate Neutrality. The author conducts this research together with Marco Ranzato, Fabrizio D'Angelo, Silvia Lazzari, and Valeria Volpe.

## Notes

<sup>1</sup> According to Monni, Lelo and Tomassi (2021), the compact city consists of a set of high-density neighbourhoods forming the semi-central ring around the historic core, developed throughout the twentieth century and the post-war period. These urban settlements now accommodate the majority of Rome's population, within a building stock that is generally low-performing and often lacks adequate public spaces and infrastructures.

<sup>2</sup> Legambiente is the leading environmental association in Italy, founded in 1980. It is a non-profit organization, recognized as a public-interest body, operating at both national and local levels through a network of local branches, regional committees, and a national headquarters.

<sup>3</sup> Terna - Rete Elettrica Nazionale S.p.A. is an Italian joint-stock company that manages the transmission and dispatching of electricity throughout the national territory. It is one of the largest Transmission System Operators (TSOs) in Europe.

<sup>4</sup> Areti is the company of the ACEA Group responsible for the distribution and metering of electricity in the city of Rome and part of its metropolitan area.

<sup>5</sup> The albedo coefficient is the ratio between the solar radiation reflected and the incoming radiation. A white surface has an albedo coefficient of 1, while a black surface has an albedo coefficient of 0.

<sup>6</sup> The Territorial Agency for Residential Housing is the entity that manages public real estate assets intended for people facing housing or economic difficulties

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# From Silent Ruins to Resilient Cultural Landscapes.

## Rethinking Heritage, Ecology, and Transformation in the Campi Flegrei case study

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strategies  
risks  
cultural heritage  
socio-ecological systems  
heritage community

### 1. Introduction

The European Union's commitment to achieving climate neutrality by 2050 represents one of the most ambitious environmental undertakings in contemporary policymaking. This transition, outlined in the European Green Deal (EC, 2019), requires comprehensive strategies that extend beyond conventional environmental protection to encompass the complex interplay between cultural heritage, ecological systems, and urban transformation. This multifaceted challenge becomes particularly crucial in historically and environmentally relevant territories, where the imperative for sustainable development must

be reconciled with the preservation of irreplaceable cultural assets (Rodwell, 2007).

In this regard, the intersection of cultural landscapes and resilience thinking represents an emerging and critical frontier in contemporary heritage and urban planning studies, addressing fundamental questions about how we manage uncertainty and guide adaptive transforma-

*The paper explores the interplay between cultural landscapes and ecological systems, by adopting resilience as a unifying concept that bridges the preservation of heritage with sustainable and adaptive urban and territorial transformations. This approach has been developed in the research project carried out by DiARC (UNINA) within the PNRR Extended Partnership n.5 – Spoke 1. The focus is on Campi Flegrei: a highly vulnerable area due to structural factors, given its volcanic*

*nature, and the extractive use of resources where widespread historical assets and archaeological ruins emerge within the settlement fabric, often difficult to access, constantly exposed to risks, and experiencing degradation and abandonment. The research explores the interdependence between ecological-environmental values, history, communities, and ordinary landscapes through mapping activities and photographic campaigns for the activation of heritage communities as a factor of resilience. This allows the study to reveal place-specific resilience with the aim of developing strategies that shift the role of historical traces within the city - from static objects and barriers to contemporary transformation, to catalysts of resilient change.*

tion in historically significant areas. In fact, while landscapes are widely recognized as living and perpetually evolving entities (Antrop, 2005; Russo et al., 2023), the scientific discourse on the relationship between cultural landscape and resilience has only recently gained prominence (Aimar, 2024; Aktürk and Dastgerdi, 2021). A significant gap emerges in current heritage management practices, which tend to prioritize the preservation of static conditions to ensure the continuity of values,

thereby creating a fundamental misalignment with the inherently dynamic nature of environmental challenges and social transformations (Crowley et al., 2022; Harvey and Perry, 2015; ICOMOS, 2019). Nevertheless, the recognition of “cultural landscapes” as comprising not only monumental heritage but also stratified urban fabrics, traditional settlements, and culturally modified natural environments (Council of Europe, 2000) requires focusing on sustainable development as a key aspect for balancing economic, social, and environmental capital in heritage contexts, as also stated by the European Framework for Action on Cultural Heritage (EC, 2018).

The regulatory landscape supporting this transition includes multiple interconnected frameworks. The European Landscape Convention (Council of Europe, 2000) established the foundational understanding of “landscape” as territory perceived by populations, shaped by natural and human factors. This was further reinforced by Agenda 21 for Culture (UCLG, 2004) and subsequently integrated into the UN Sustainable Development Goals, particularly Target 11.4, which addresses the protection of cultural and natural heritage. These frameworks collectively acknowledge that the preservation of cultural landscapes cannot be separated from broader ecological and social sustainability objectives. The concept of resilience, when applied to cultural landscapes, enables the understanding of underlying dy-

namics that drive change while promoting the recognition of landscapes as processes rather than fixed entities. In this sense, this contribution argues that within a resilient framework, historical traces should be reinterpreted not as “silent ruins”, mere vestiges of the past, but as active agents within processes of transformation. The material and symbolic persistence of stratified fabrics – where archaeological ruins may be difficult to access and where the local communities may struggle to recognize themselves due to the perception of degradation and abandonment<sup>1</sup> – offers the ground for adaptive strategies that combine continuity and change. This perspective aligns with urban ecology principles, which emphasize the importance of investigating multiple relationships, such as those between historical-archaeological heritage and territorial contexts, as essential for managing cities’ transition toward more resilient and inclusive settlement models (Alberti, 2008; Pickett et al., 2013). In this regard, resilience provides a lens for identifying gradients of landscape modification where culture and nature must be considered simultaneously, in coherence with the current cultural context of the Anthropocene (Crutzen and Stoermer, 2000), acknowledging that human impact on natural systems has reached unprecedented scales. Nevertheless, there is insufficient understanding of how resilience intersects with landscape and operates within it, particularly concerning its dual

implications of adaptation and identity (Davidson et al., 2016; Stephenson, 2008) and the related acceptable boundaries between persistence and change (Antrop, 2005). In fact, the UNESCO-required systemic robustness and effective management of dynamic transformations imply that planning decisions intervene at different scales through adequate policies and tools, however, this process still has limited practical testing and remains conceptual (Ripp et al., 2024).

While UNESCO’s definition of cultural landscapes as “combined works of nature and man” provides important foundation (1992), this research adopts a broader interpretation originally introduced by geographer Carl Sauer, who defined cultural landscape as landscape shaped by human cultural groups from natural landscape (Sauer, 1925). This expanded definition extends beyond UNESCO’s focus on “universal exceptional value” to encompass “ordinary” landscape – territories not necessarily distinguished by exceptional scenic or historical-environmental values, but rather by stratification of human uses and transformations. This reconceptualization recognizes that cultural landscapes represent expressions of community culture, ways of life, and relationships with surrounding environments, carrying cultural meanings and values that extend far beyond monumental heritage. Such landscapes include public heritage, reserves of natural resources, and local communities

as integral components of territorial identity (Plieninger and Bieling, 2012). Following Folke and colleagues (2006), this paper builds on the premises that, by interpreting local knowledge – both tangible and intangible cultural heritage, traditional know-how, land use practices, construction technologies, etc. – it becomes possible to uncover place-specific resilience comprising both spatial and social dimensions. This approach acknowledges the fundamental connection between cultural aspects and sustainable development, recognizing that both cultural and ecological issues share communal and plural dimensions, as well as conditions of fragility where threats of irreversible loss of finite resources require collective attention and action (UNESCO, 2013).

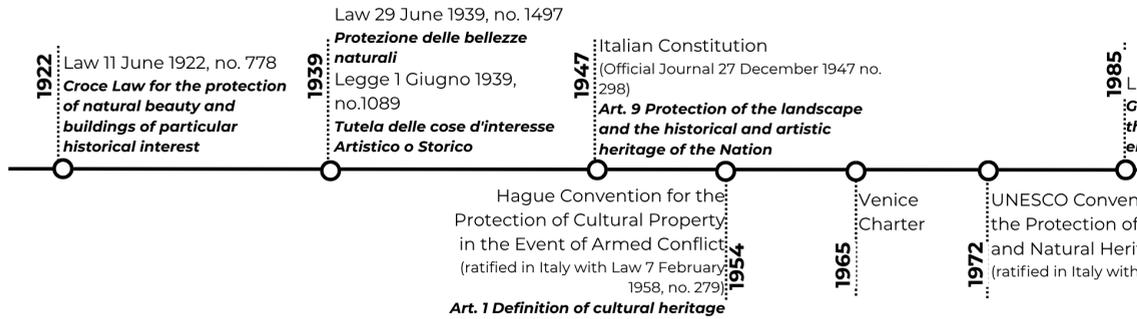
Although scientific and policy realms widely acknowledge these considerations, there is a limited understanding of how resilience, when applied to cultural landscapes, can move beyond conceptual abstraction to inform planning practices and urban policies (Davoudi, 2012). While existing scholarship recognizes the interdependence between cultural and ecological dimensions and the importance of adaptive and participatory approaches (Berkes and Ross, 2012; Walker et al., 2006), methodological pathways capable of translating these principles into effective territorial instruments are still underdeveloped. Few studies explore how resilience can serve as an interpretative and operational lens for understanding land-

scapes as evolving socio-ecological systems, where cultural identity, environmental adaptation, and collective action converge in shaping more sustainable cities (Vale, 2014). Moreover, recent critiques highlight how resilience discourse, when detached from social justice concerns, risks legitimizing neoliberal approaches to urban governance and reducing communities to self-managing units (MacKinnon and Derickson, 2013).

In order to embrace these challenges, this study addresses the following research question: How does the concept of resilience, when applied to cultural landscapes, support their recognition as dynamic processes, and what role does this socio-ecological perspective play in managing urban transition toward more inclusive settlement models?

Through a comprehensive approach, the research aims to demonstrate how “silent” archaeological ruins and historical landscapes can shift from being perceived as passive, residual urban fragments and barriers to contemporary transformation into catalysts of resilient change, fostering new evolutionary trajectories for territorial development.

To contribute to this wide research topic, the study develops a methodological approach that focuses on understanding territorial transformation processes going beyond a single analytical lens. Through the development of community engagement environments in a case study, the research provides knowl-



## Legislative Framework.

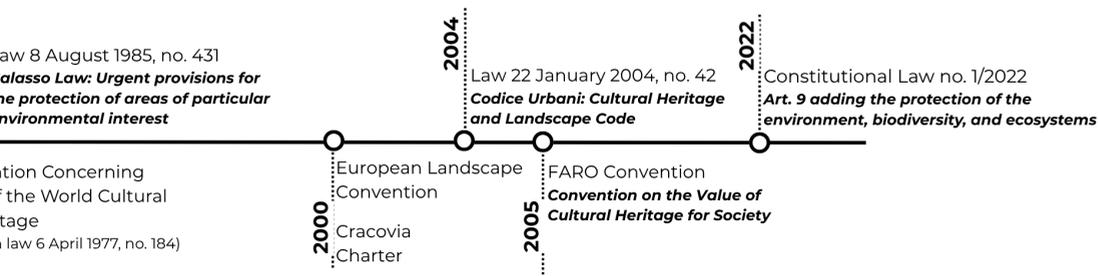
Source: Architectural Sciences Bachelor Thesis Dissertation, entitled "Enhancement strategies between archeology and peri-urban landscapes. The case study of Baias cultural heritage". Student: A. Vigoriti. Supervisor: A. Attademo, Co-Supervisor: M. Simioli. Academic Year: 2024/2025

Fig. 1

edge on how to overcome the building of limited and sectorial knowledge and suggest tools to achieve a strategic integration of quantitative analysis – to measure patterns –, qualitative interpretation – to decode meanings and relations –, and experiential awareness – to capture embodied knowledge and situated perspectives. This approach leads to building sustainable trajectories and scenarios, even though the definition of resilient territorial transformations lies beyond the scope of the data and materials hereby reported.

The paper explores the interplay between cultural landscapes and ecological systems, by adopting resilience as a unifying concept that bridges the preservation of heritage with sustainable and adaptive urban and territorial transformations within the framework of the research project "Strategies4CHANGES - Strategies of interventions on historical landscapes" led by DiARC as part of the Spoke 1 "Historical Landscapes, Traditions and Cultural Identities", in the PNRR Extended Partner-

ship no.5 "CHANGES - Cultural Heritage Active Innovation for Nex-Gen Sustainable Society"<sup>2</sup>. The research focuses on a specific cultural landscape in Campania Region: the Campi Flegrei, representing a highly vulnerable area due to structural factors, given its volcanic nature, and the extractive use of resources. By introducing this territory, this paper highlights the methodological interplay between theoretical principles and spatial analysis. Following this section, the paper examines the conceptual framework linking the concepts of cultural landscapes and resilience (Ch. 2), analyzes the methodology to operationalize the conceptual framework (Ch. 3), presents the outputs of the methodological application to the case study (Ch. 4) and discusses the implications for developing strategies focused on enhancing ecological and archeological networks (Ch. 5). The concluding section (Ch. 6) outlines future research directions and the potential for scaling these approaches to other vulnerable cultural landscapes facing similar challenges.



## 2. Theoretical Background. Cultural Landscape Resilience: a reconceptualization from local to global

The theoretical framework is developed in relation to the recent reconceptualization of landscape's role as a device that intersects protection regulations with the valorization of an increasing number of identity features defining the territories we inhabit (Council of Europe, 2000). In this sense, we start with a specific focus that reinterprets regulatory evolution as a dynamic process of aligning the scope of planning tools with contemporary conceptualizations. This is where the tradition of "landscape" (*landschaft*), rooted in ecology, is seen as a systemic and relational science, capable of a complex reading of the relationships between inhabitants and local contexts (Magnaghi, 2020). Therefore, this section is divided into two subsections, respectively focusing on the evolution of the fundamental concepts of landscape and cultural heritage, then to understand their conjugation in terms of cultural

landscapes, as socio-ecological systems where resilience plays a role not just in the capacity to absorb disturbances and reorganize (Walker et al. 2004), but more in the proactive ability to adapt and co-evolve with nature through dynamic processes (Folke, 2006). In this perspective, resilience is explored as a bridging concept that connects cultural values, ecological adaptation, and governance practices, offering a framework to interpret landscape as a socio-spatial dimension with an evolving and relational capacity that intersects culture and ecology.

### 2.1 The notion of cultural landscape in the Italian legislation

The landscape is a structural dimension of our territories (Poli, 2012; Magnaghi, 2012; 2016; Marson, 2016), aligning with a heritage-based perspective of these areas (Magnaghi, 2012). Its contemporary forms are not just the backdrop of ongoing transformations, but dynamic spaces in evolution, shaped by flows, even if

they are recognizable and classifiable through specific components and relationships (Forman, 1995; 2008). For this reason, an effort to understand its characteristics and invariant rules requires an integrated approach of reading. The landscape is thereby understood simultaneously as a milieu, a complex of cultural values, and a regulatory context within which territorial and urban planning processes are carried out. (Attademo et al., 2022).

In the legislative framework, the concept of “cultural heritage” and “landscape” have evolved significantly over time (Fig. 1).

With a specific focus on Italy, the analysis of the evolution of the legislative framework can start from the Croce Law of 1922 which marked a turning point in Italian environmental law by establishing protections for natural beauty and historically significant sites, with the aim to stop unjustified destruction and to valorize natural and artistic treasures. Later, the Laws n. 1497 and 1089 of 1939 further defined landscape as composed of “things” and “places,” focusing on aesthetic-perceptual values—places distinguished by their beauty and exceptional qualities – listed and protected by the state through cultural and environmental authorities. It is worth noting that these initial laws exclusively considered outstanding natural beauty and monumental assets as worthy of protection. A first relevant turning point should be considered the Italian Constitution’s Article 9, which emphasized that the Republic

promotes cultural development, scientific research, and safeguards the landscape, historical, and artistic patrimony. This statement refers to the landscape as not merely a territorial feature, but a primary and absolute good of the nation.

In the same years, after the definition of Article 1 of the Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict (ratified in Italy with the Law 7 February 1958, no. 279), the concept of cultural heritage was formalized in the 1964 Venice Charter, which recognized that monuments include not only individual architectural works but also urban landscapes with artistic, historical, or cultural significance. The UNESCO 1972 Convention (ratified in Italy with law 6 April 1977, n. 184) expanded this understanding globally, including monuments, sites, and ensembles of universal value, with an update in 2003 adding the “intangible heritage”.

Subsequently, forty years after the first acts in this matter, the legislative framework started to be updated, thanks to legislative provisions promoted by Giuseppe Galasso (culminating in Law No. 431 of August 8, 1985), connecting aesthetics with ecological value and establishing the development of landscape planning, integrating protection with sustainability and territorial design.

As presented in the Introduction, in recent decades, especially following the European Landscape Convention of 2000 (in Italy ratified with

the Law n. 14/2006) and the ICOMOS Cracovia Charter for restoration (2000), landscape has then been interpreted as a part of territory as perceived by communities, shaped by natural and cultural factors and their interactions. This perspective emphasizes that landscape is not only environmental but also a product of human activity and perception, highlighting the importance of community involvement in its preservation. This opens to a strong connection between landscape and inner resilience of communities, as mutually advantageous and self-perpetuating throughout history (Aimar, 2024). The European Convention also marked a shift in the conceptual approach: landscape is considered a “common good”, and its protection involves social participation. It recognizes that even degraded or everyday landscapes are valuable and deserving of safeguarding, between degraded and extraordinary landscapes, including all the intermediate zones, in a dynamic process of redefining identity landscapes—an approach aligned with what was once outlined by the European Landscape Convention.

Following the Convention, in Italy the Legislative Decree No. 42 of 2004 (the Urbani Code) defines landscape as the expressive territory of identity, shaped by natural and human factors. Its protection aims to preserve and recover cultural values expressed through its patterns, which serve as material and visible representations of national identity. The same

code defines cultural heritage as a collection of assets of historical, cultural, and aesthetic importance that constitute the wealth of a place and its people. Cultural Heritage becomes the linking component between cultural and landscape elements, such as sites, customs, and traditions, reflecting societal identity. Coherently, the Faro Convention of 2005 (in Italy ratified with the Law n. 133/2020), emphasizes the societal value of cultural heritage, recognizing it as an inheritance that communities identify with, regardless of ownership. It promotes accessibility and community involvement, through the concept of “Heritage Community”, i.e. the people who take public action to support and transmit specific aspects of cultural heritage (Article 2b).

Historically, landscape protection was narrowly defined by the laws of 1939, focusing only on “exceptional beauty.” This narrow view was only partially superseded in 1985 with the Galasso Law (No. 431), but the real shift belongs to recent years with the ratification of said Convention on landscape and cultural heritage and when the Italian Constitution’s original mandate to protect the landscape and historical heritage (Article 9), was expanded to include the environment, biodiversity, and ecosystems for the interest of future generations (Constitutional Law n. 1/2022). These amendments, along with changes to Article 41 that restrict economic activity detrimental to the environment, solidify a constitutional vision

that, if fully implemented, could mean a major shift toward limiting resource consumption and promoting non-extractive valorization processes (Maddalena, 2020).

The current Italian legislative framework has evolved aligning with a contemporary view of landscape. This modern understanding moves beyond the traditional, purely aesthetic perspective (still rooted for example in the 1922 and 1939 laws) to define landscape as a systemic field of interrelations and dynamic interactions. This shift draws upon the Anglo-American and German tradition of the “*landschaft*” (Formato, 2022), connected to ecology which can use it to orient the coexistence of natural ecosystems and urban habitats.

## *2.2 Resilience at the Crossroads of Cultural Heritage and Socio-Ecological Systems*

### *2.2.1 Landscape resilience interpreted as adaptive condition*

The widely used concept of resilience offers a crucial theoretical framework to reconceptualize the relationship between cultural heritage and ecological sustainability (Jones, 2022). In fact, through the dynamic lens of resilience, historical landscapes can be challenged in the face of anthropogenic and natural risks by considering and developing their potential for change. This perspective fundamentally contrasts with traditional preservation approaches that treat heritage sites as isolated enti-

ties to be protected from changing contexts, by instead embracing the adaptive capacity of complex socio-ecological systems (Walker et al., 2004). The integration of resilience thinking with heritage discourses considers how cultural and ecological systems co-evolve through processes of adaptation, transformation, and reorganization (Folke, 2006). This theoretical foundation has been further developed within political ecology frameworks, where landscapes emerge as contested terrains where power relations, environmental processes, and cultural practices intersect, revealing the inherently political nature of heritage-environment relationships (Robbins, 2012). In this context, ecological values become essential to address the potential of the relationship between resilience and heritage in the face of the political pitfalls of resilience. In fact, while it offers a framework to understand cultural landscapes as evolving systems, recent critiques caution against its instrumentalization as a depoliticized, technocratic narrative that can obscure questions of value, agency, and justice (Zhu and González Martínez, 2022). The process of patrimonialization, whereby certain landscapes are recognized as heritage sites, can inadvertently prioritize elite-driven economic interests over community needs, transforming resilience into a tool for speculative development rather than a means to foster community-led adaptation (Salemme and Horlent, 2018).

Considering the evolution of the cultural landscape concept and resilience approaches, landscape resilience (Schmidt, 2022) is crucial for understanding how human-shaped environments can maintain their historical and identity values while adapting to inclusive changing conditions. Following Schmidt's distinction between "given resilience" – the initial natural conditions of a landscape – and "acquired resilience" – the product of society's interaction with those conditions – cultural practices and heritage formation processes emerge as key drivers in redefining resilience itself. In this view, resilience is not an external element but an intrinsic condition of landscapes arising from their stratified nature and from the dynamic coexistence of heterogeneous elements that allow continuity through transformation. The given resilience framework is therefore essential for understanding the adaptive capacity of cultural landscapes over time where complex systems are made of natural baseline conditions that interact with urbanization processes, cultural practices, and heritage recognition.

Understanding that landscapes are living systems in constant transformation, the concepts of permanence, identity, and memory become integral to landscape planning, alongside change and evolution. This implies a direct correlation between preserving cultural identity and adaptive capacity – extending beyond single monuments to encompass whole

territorial systems. In this perspective, Carl O. Sauer's (1925) foundational idea – that cultural landscapes are the result of human groups acting on natural environments over time – is extended to include the dynamic capacity for adaptation and transformation.

The convergence between landscape resilience and cultural landscape theory is especially apparent in Wu's (2010) argument that culture and nature must be understood simultaneously to improve the relationship between spatial patterns and ecological processes. This aligns with the evolution of the UNESCO Convention, which has shifted from protecting sites of "outstanding universal value" toward recognizing cultural landscapes as integrated systems. This integration requires acknowledging that, in living landscapes, permanence and identity demand the introduction of co-evolutionary resilience concepts in planning: an urgency highlighted by the lack of adaptability found in many UNESCO Cultural Landscape Management Plans, which often overlook these values in the face of new environmental and social challenges (Aimar, 2019). In architectural and urban planning discourse, this theoretical convergence has been operationalized through what Davoudi and colleagues (2012) and Meerow and colleagues (2016) define resilience thinking: an approach that transcends sectoral boundaries and enables integrated strategies addressing heritage conservation, climate adaptation, and social

## Overview of Key Literature on Landscape, Resilience, and their intersection

Tab. 1

equity. Contemporary cultural landscape management increasingly focuses on strengthening landscapes' ability to cope with stress and environmental change. This resilience is supported by key system characteristics such as diversity, redundancy (the presence of multiple elements performing similar functions), network connectivity, modularity (the ability to isolate disturbances), and adaptability over time. In this way, both the natural foundation and the cultural layer of a landscape contribute to its overall resilience through their ongoing interaction and mutual reinforcement (Ahern, 2011; Beagan and Dolan, 2015).

This integrated approach is particularly critical in risk-prone areas, where volcanic, seismic, and human-induced hazards converge. In such areas, comprehensive strategies are needed to treat the entire cultural landscape as an interconnected system of heritage, ecology, and community agency. In recent decades, the resilience approach has progressively expanded from the purely ecological field to the systematization of social, economic, and interconnected socio-ecological field (Pu and Qiu, 2016; Brand and Jax, 2007; Folke, 2006). This refers to the definition of resilience as socio-ecological resilience (Folke, 2016), deepening the influences between resilience and urban and political ecology (Adger, 2000; Peterson, 2000). Thus, "resilient" is an adjective corresponding to the inner characters in which places are organized, shaped, and managed by society

(Schipper et al., 2015).

This perspective is especially relevant in contexts like the Campi Flegrei, where scattered archaeological remains, degraded natural habitats, and vulnerable communities coexist within complex, risk-laden landscapes. These contexts require adaptive co-management, meaning a collaborative governance framework that merges local knowledge with technical expertise (Fabbri et al., 2020). The landscape resilience framework enables a radical re-conception of heritage sites as embedded within broader territorial systems, paving the way for planning strategies capable of regeneration: strengthening existing cultural identity assets and fostering collective adaptive capacity.

### 2.2.2 A socio-ecological resilience: a concept between culture and ecology

The conceptualization of a resilient social-ecological system matches the definition of cultural landscape as first introduced by German geography school as in the work of Carl Ritter (1818), and then more broadly by Carl Sauer, as the landscape shaped from a natural environment by a cultural group (Sauer, 1925), in a dynamic, reciprocal relationship between a community and its land.

In the above-mentioned evolution of concepts, the structural dimension of cultural landscapes continuously interacts with physical and relational changes, across diverse and

Area of Literature	Core Focus	Key Concepts	Basic References
I. Foundational Landscape Studies	The cultural, ecological, and perceptual character of place; the structure of the human-shaped environment.	Landscape Ecology, Cultural Landscape, Perception, Planning, Heritage	Sauer (1925), Tuan (1977), Antrop (2005), European Landscape Convention (2000), Forman (1995, 2008), Magnaghi (2012, 2016), Corner (1999, 2006)
II. Foundational Resilience Studies	The capacity of socio-ecological systems to cope with disturbance and maintain function; adaptability and transformation.	Ecological Resilience, Adaptability, Transformability	Adger (2000), Folke (2006, 2010, 2016), Walker et al. (2004), Walker & Salt (2006), Peterson (2000), Brand & Jax (2007), Davoudi et al. (2012)
III. The Intersection (Landscape Resilience)	How the spatial structure and cultural identity of a place enable adaptive planning and management.	Identity, Resilient Cultural Landscape, Planning Integration, Socio-Ecological Resilience, Heritage Community	Ahern (2011), Plieninger & Bieling (2012), Opdam et al. (2013), Schmidt (2022), Aymar (2019, 2024), Aktürk & Dastgerdi (2021), Beagan & Dolan (2015), FARO Convention (2005)

broadly multiscale temporal perspectives, in a symbiotic connection among societies and nature (Folke, 2006). These are spatialized within an integrated infrastructure of landscape assets and inhabited territories. Cultural landscapes are places in the meaning of Geddes's triadic "places, work, folk", as the integration of people and their livelihood into the environment as the shaping factors of inhabited regions. In this perspective, researchers have interpreted ecology as the key to interpreting and addressing the balance of culture and nature within the landscape itself (Waldheim, 2006). This is especially true with regards to community activism in ecological matters, raising the importance of awareness and education in landscape design, as complementary to addressing contemporary challenges like climate change (Orff, 2016).

Then, landscape design often follows this interpretation focused on new ways of inhabiting the risk, coexisting in resilient communities able to reconnect themselves with the

natural environment by establishing mutual and adaptive strategies (Corner, 2006).

The ways in which landscape is described and represented show a systematic reciprocal relationship between knowledge and intervention. Specifically, the most innovative cognitive strategies and design approaches unite in defining a plural, multi-dimensional concept of landscape that gives form to the various components of the evolving territory. As a planning tool, landscape plans are designed to balance conservation with the regeneration of compromised or at-risk areas, ensuring development aligns with recognized landscape values, especially in rural and UNESCO World Heritage sites. The efforts to gain knowledge also addressed the fragile components, which face high exposure to contemporary risks, where the balance between human action and territorial vulnerability is lost, endangering collective habitability and sustainable transformation, dramatically expanding social inequality. These plans aim to shape the structural di-

mension of inhabited areas, preserving their characteristics and key elements – even at interfaces of the most degraded zones – while also outlining development paths and opportunities for enhancement connected to territorial cultures and ecologies. These perspectives on fragile, vulnerable, and at-risk landscapes can work to reinforce resilient communities, re-interpreting the fragility of these landscapes, not through a prohibitive regulatory approach, but as a driver of development processes. These processes center on local resources, fully recognized by inhabitants, citizens, and local stakeholders.

While global agendas focus on technical efficiency and resilience, often neglecting the everyday lived experiences of the city, alternative practices of inhabiting and shaping space develop, creating novel ecosystems (Marris et al., 2013) that operate in informal, community-based ways (Formato and Attademo, 2025). This shift highlights how components from natural and human processes are increasingly blending, making the boundary between nature and culture more difficult to clearly define, but as a clear sign of co-evolutionary connection in the meantime (Keitumetse, 2017; Crane, 2010).

Therefore, this connection refers to socio-ecological systems that encompass intricate adaptive, multi-level networks of spaces, and the continuous flow of people and resources both within and across systems (Wu,

## Definition of key concepts

Fig. 2

2013; Viganò, 2013). These multi-dimensional environments incorporate identity components, such as cultural heritage, historical and natural reminiscences, and all places systematically organized within a cohesive territorial framework, acknowledged by communities as symbols of their unique local character and as starting point for community-based valorization. In this context, they almost serve as an “archaeological record”, a *resilience*-artifact that proves the combined preservation of the historical and environmental heritage.

Nevertheless, Plieninger and Bieling observe that the terms “landscape” or “cultural landscapes” as coupled to resilience have rarely been employed within the resilient-thinking scientific community (2012): a combined (cultural) landscape and resilience approach should then enhance the understanding of land change processes, emphasizing social values and ecosystem services, while recognizing spatial drivers that can help protect cultural landscapes and promote biodiversity alongside agricultural and forest productivity. An integrated approach can guide effective landscape planning, addressing human-nature coupling at the appropriate scale.

### 3. Methodology

#### 3.1 Research approach

In light of the aim to demonstrate that resilience can serve as a concept encompassing a

## Exploration

### Silent Ruins

“Silent ruins” are traces of the past, made invisible or marginal by historical stratifications and contemporary transformations, yet still active as a material and symbolic resource in the processes of regeneration and redefinition of the cultural landscape.

**Ref.** Research project CHANGES Cultural Heritage Active Innovation for Next Generation Sustainable Society

## Tool

### Heritage community

is a community that shares and identifies with the values of cultural heritage, acting collectively to preserve, enhance, and transmit them. It is an active agent of participation that strengthens identity, cohesion, and local resilience.

**Ref.** Council of Europe. (2000). European Landscape Convention. Florence, 20 October 2000.

## Design approach

### Resilient cultural landscapes

Heritage environments capable of evolving through adaptive reuse meaning that they can be enriched with new functions while preserving their cultural and community significance

**Ref.** Köpeczi-Bócz et al., (2025). Resilient cultural landscapes: adaptive management and social innovation in heritage conservation.

socio-ecological perspective on cultural landscape – capable of enhancing historical heritage even in at-risk contexts – the methodology framed by this study focuses on the development of a Living Lab as both a field and an operational instrument for fostering Resilient Cultural Landscapes meaning acknowledging the contributions of communities and local ecologies as key territorial resources for adaptive transformations (Köpeczi-Bócz et al., 2025 in Fig. 2). The research study assumes that cultural heritage is not only an asset to be preserved, but an engine of resilience that acts through the participation of communities, making them more ready, cohesive and capable of facing crises and imagining sustainable futures. The “building” of heritage communities (Bulley, 2013) as complex configurations that activate forms of resilience on local, global and inter-local scales is not just an end goal, but an ongoing process of learning and

adapting to change (Cutter et al., 2008). However, only recently have cultural and social factors linked to heritage become prominent in discussions of resilience, highlighting the importance of building resilience at the community level (Jigyasu, 2013). From this perspective, this study integrates the concepts of Urban Living Labs, cultural landscapes, and territorial resilience in the definition of a Heritage Communities Urban Living Lab (HeCo-ULL), as an operational and research methodology capable of fostering more resilient cultural landscapes through the development of communities that are more aware, heterogeneous, integrated, adaptive, and self-regulating (Rodin, 2014). From the perspectives of possible impacts on the institutional and planning level, new territorial arenas could benefit from expanding place-based, multi-level and cross-domain connections allowing for proactive coalitions and fertile collaborative actions

(Wolfram et al., 2019). The contribution examines the case study of the Campi Flegrei, developed within the framework of this research “Strategies4CHANGES” research project conducted by the Unina team as part of Spoke 1 – WP4, the proposed methodology establishes a Heritage Communities Urban Living Lab (HeCo-ULL): a user-driven environment of actual end-users with common goals, and various competences (Innovation Alcotra, 2013) that acknowledges complex and multidimensional values through co-creation, aiming to generate new locally rooted values (Evans et al., 2017). Recent experiences of Living Labs applied to cultural contexts demonstrate that this methodology is frequently used to support the creative reuse of cultural heritage in virtual environments (Llamas et al., 2025), for the adaptive reuse of buildings in real-world contexts (Fava, 2024), and as a tool to promote participation in decision-making processes (Thees et al., 2020.) also considering its challenges such as inclusiveness (Laborgne et al., 2021) and the effective capacity to inform urban transformations (Wolfram et al., 2019)

The HeCo-ULL methodology introduces an innovative approach by applying systemic thinking to widespread heritage rather than focusing on isolated sites, and by building a permanent community of stakeholders and citizens that continues to interact even beyond the conclusion of the project. This enables a

## Methodological Scheme

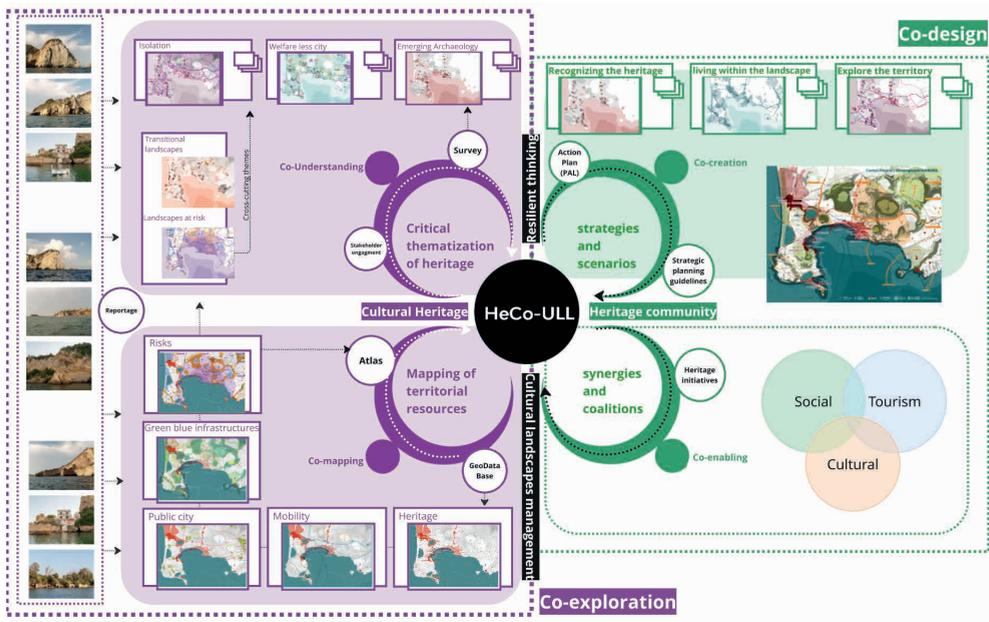
Source:  
Fig. 3

co-evolutionary perspective (van Knippenberg, 2022), attentive to adaptability, flexibility, and the complexity arising from the diversity of community perspectives on heritage. Such a perspective allows for moving beyond the traditional goal- and process-oriented approach (Pace, 2021), favoring instead a practice-based approach in which Living Labs act as catalysts for changes in behaviors and values, fostering interaction between local communities, global heritage communities, and other disciplines through knowledge production.

In particular, Heritage Communities Urban Living Labs can play a crucial role in preserving the relevance of cultural landscapes within rapidly transforming urban environments. They serve as mediators between tradition and innovation, fostering community engagement and contributing to the sustainability and vitality of cities through the safeguarding and enhancement of cultural heritage and its inherent values (Fig. 3).

The HeCo-ULL methodology is structured into structured into tasks that also outline the interaction among the different disciplines involved in the research group. Specifically, a distinction can be made between tasks aimed at co-producing knowledge (co-exploring phase) and those focused on co-designing scenarios for adaptation (co-design phase).

The phases structuring the HeCO-ULL methodology are aimed at building and strengthening community resilience, understood as the



capacity of a collective to recognize and enhance its strengths and available resources, while also identifying weaknesses, vulnerabilities, threats, and risks that affect its stability. The methodology is grounded in situational awareness, enabling the community to critically interpret the context in which it operates. The co-exploring phase constitutes a preliminary stage of critical reconnaissance through the collection, analysis, and correlation of data sources – spatial data and photos – with the aim of developing a nuanced interpretation of territorial and urban evolution.

These data are developed in interpretative and thematic mappings, aimed at integrating the knowledge dimension with processes of shared reading and thematic framing of territorial values.

The research adopts a quantitative approach, developed within a GIS environment, and a multiscale perspective that draws on hard

data (open-access databases) and soft data – collected through photographic surveys and fieldwork – for the creation of analytical-interpretive maps. These maps, together with the photographic campaign, can convey the complexity of the landscape according to a relational logic at the territorial scale. Critical mapping becomes an essential tool for understanding the territory, and bridge to light hidden values and heritage.

The co-design phase is grounded in situational awareness, that promotes integration and coordination among functions, actors, and systems, fostering a systemic approach capable of generating operational synergies. Finally, the resilience pursued through HeCO-ULL is adaptive in nature: the community is able to evolve in response to changing circumstances by developing new strategies, actions, and behaviors within a dynamic process of learning and transformation.

### 3.2 Case Study: Campi Flegrei

The Campi Flegrei represent a territory of inestimable value, shaped over centuries by the interplay between its natural composition and human activity. The history of this area, strategically situated in the Gulf of Naples, is intertwined with episodes of colonization and urban development, as well as a profoundly unstable natural environment punctuated by the numerous archaeological remains scattered throughout the area, including Roman ports, the thermal buildings of Baia, and tunnels and cisterns carved into the tuff. Over the centuries, alternating phases of agricultural development, industrialization, and abandonment have left material and immaterial traces that continue to shape the territory's identity today (Di Liello, 2022). Uncontrolled urban growth in protected and high-risk areas has damaged the landscape, effectively reducing the region's attractiveness (Fralicciardi et al., 2013).

Volcanic activity and bradyseism continue to influence the coastal morphology and settlements, creating a permanent risk condition that coexists with extremely high demographic pressure: over 400,000 inhabitants within an area of approximately 130 km<sup>2</sup>.

Despite these difficulties, Campi Flegrei preserves a cultural and environmental heritage of extraordinary value. The establishment of the Campi Flegrei Archaeological Park has enabled the protection and enhancement of a

## Terme di Baia.

Source: authors

Fig. 4

network of archaeological sites. Alongside the major sites, numerous smaller cultural assets – such as villas, necropolises, and Roman infrastructures – are widespread but often lack adequate conservation and fruition strategies. These smaller sites exist within a complex system of stratifications and overlaps among different historical layers, frequently embedded within modern and contemporary ones, sometimes of illicit origin, rendering the historical-archaeological heritage at times “invisible,” and “silent” (Fig. 4) meaning poorly accessible, and thus insufficiently valorized within cultural, touristic, and economic promotion circuits (Miano et al., 2016). The natural landscape is distinguished by unique environments, including volcanic lakes, craters, and nature reserves, which the Campi Flegrei Regional Park and other protected areas, such as the Monte Nuovo Oasis and the Astroni Nature Reserve, protect. These elements represent a potential resource for a development model that recognizes landscape conservation and the regeneration of widespread heritage as an opportunity for territorial revitalization.

Investigating the relationship between historical-archaeological heritage and the territorial context, also in alignment with the principles of urban ecology, is therefore fundamental for managing and planning the transition of cities toward more sustainable, resilient and inclusive settlement models.



#### 4. Results

The HeCo-ULL methodology involved the participation of numerous stakeholders – around 30 different entities – identified on the basis of three thematic focuses: Planning, including public bodies responsible for planning at different scales (national, regional, metropolitan/provincial, and municipal) and within their respective sectors (urban policies, mobility, conservation, etc.); Heritage, encompassing superintendencies, the Archaeological Park of the Phlegraean Fields, local and regional authorities, and enterprises directly engaged in cultural heritage management policies; and the theme of Protection and Enhancement, which includes associations, cooperatives, and both public and private actors involved in the safeguarding and promotion of the complex system of cultural, landscape, and environmental assets of the Phlegraean Fields.

All the invited institutions and associations took part in the entire co-production process, with an average of 15 stakeholders per event. The four workshop sessions of the ULL Campi Flegrei have the goal to: (1) sharing local knowledge, (2) mapping places through personal memories, (3) visioning scenarios, (4) planning actions based on actor coalitions. During the four meetings with stakeholders,

it was possible to generate new spatial data, both quantitative and qualitative, which enhanced the knowledge and mapping work conducted within the research. The thematic maps, initially developed through desk research, were updated through the identification of new areas and additional themes to be represented, with particular focus on heritage, welfare systems, and mobility. This material was subsequently reprocessed within a GIS environment, enabling the transformation of qualitative data into georeferenced spatial elements and the coherent integration of the various information collected.

This decoding process – from narratives to spatial data – was carried out through focused exercises in which the researchers mediated the collective recognition of significant areas and topics, starting from the collection of individual memories and stories. The improved knowledge implemented the existing mapping categories allowing participants to collectively acknowledge shared cartographies.

Moreover, the methodology employed in this study integrates critical mapping practices with photographic documentation to develop a comprehensive understanding of territorial dynamics in the Campi Flegrei area. This approach recognizes that territorial knowledge

## Knowledge Framework, mapping Campi Flegrei.

Source: Strategies4Change map team

Figg. 5 - 6

cannot be constructed solely through traditional planning documents but requires the co-development of interpretative tools capable of revealing the complex layering of historical, environmental, and social processes that shape contemporary landscapes.

The construction of territorial knowledge begins with a survey of the existing planning framework and the design of an atlas composed of thematic maps (Fig. 5 and 6). The adopted methodology attempts to represent the characteristics of a territory exposed to risk through an interpretative reading capable of revealing existing criticalities and latent potentials within a cognitive perspective oriented toward identifying trajectories for sustainable transformation.

Building upon Corner's (1999) foundational work on mapping as agency, this research positions maps not merely as representational instruments but as tools for study and interpretation, capable of generating new knowledge, facilitating understanding of existing dynamics, and guiding intervention possibilities. Corner's conceptualization of mapping as a creative, projective practice - that "does not simply record existing facts but constructs new realities" - provides the theoretical foundation for understanding maps as active agents in territorial transformation processes. The mapping methodology implemented in this research acknowledges the constructed nature of cartographic knowledge and its role in shaping

spatial understanding (Harley, 1989; Crampton, 2010), treating maps as cultural artifacts that reflect and construct particular ways of seeing and organizing space (Wood and Fels, 1992).

Following approaches developed in landscape architecture and urban planning contexts, the mapping process functions as a form of landscape literacy that reveals hidden processes and potential within territorial systems (Giroto, 1999; Desimini and Waldheim, 2016). Together with the mapping activity, photography served as a fundamental tool for territorial investigation, functioning as both documentation and interpretation device (Rose, 2014).

The research methodology, through critical-interpretative analysis of the territory, identified several conflictual nodes that orient future resilient design strategies in collaboration with local stakeholders. These critical maps reveal five primary territorial conditions that emerge from the intersection of natural processes, historical stratification, and contemporary urban development (Fig. 7):

- *Emerging Archaeologies* represent historical emergencies and settlements that are positioned within stratified systems of "superimpositions" between different historical layers.
- *Isolation of Campi Flegrei* results from infrastructural pressure exerted by commuters, citizens, and tourist flows, determining incisive geographical isolation



# KNOWLEDGE framework

## 1. Heritage



## 2. Public City

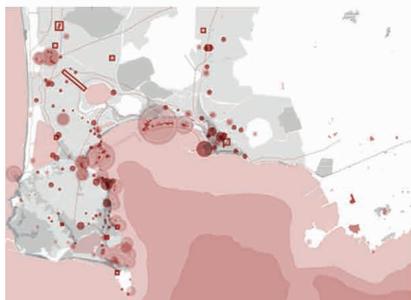


## 3. Mobility



# knowledge THEMES

## 1. Emerging archeologies



## 2. Cities without Welfare



## 3. Isolation



## Emerging Themes and Strategies, mapping Campi Flegrei .

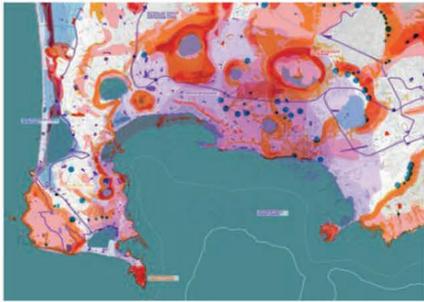
Source: S. Strategies4Change map team, adapted by M. Castigliano  
Fig. 7

conditions affecting both socioeconomic and cultural aspects.

- *Landscapes at Risk* characterize the Phlegraean area through multiple significant risk situations both natural and anthropogenic.
- *Cities without Welfare* as a territory lacking public endowments.
- *Landscapes in transition* encompass the network of interstitial spaces within dense settlement systems, infrastructural buffer areas, margins of large public housing enclaves or archaeological parks.

The integration of critical mapping and photographic documentation creates a comprehensive analytical framework that operates simultaneously at multiple scales and temporal dimensions (Arcidiacono et al., 2021). The mapping process reveals structural relationships and territorial dynamics, while photographic documentation captures phenomenological experiences and material conditions that emerge from direct territorial engagement. This creates the ground for opening discussions through working sessions in living labs, where the local community can participate in

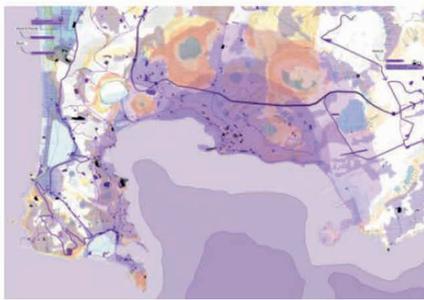
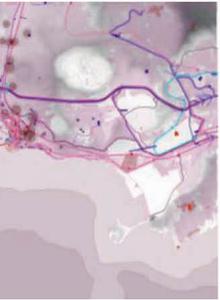
#### 4. Risks



#### 5. Green Blue Infrastructure



#### 4. Landscapes at risk



#### 5. Landscapes in transition



the co-production of knowledge and, subsequently, have a voice in the definition of strategies.

Stakeholder engagement took place through initiatives that include thematic walks focused on heritage in relation to mobility and risk; workshops with international architects addressing intangible heritage; seminars and photographic exhibitions aimed at visualizing the cultural landscape in connection with the thematic maps. These initiatives allowed for testing the effectiveness of the methodology, positioning the community as an active partic-

ipant in the process of change. Moreover, the diversity of events enabled the mobilization of multiple competencies, involving technicians, professionals, and academics, and engaging a heterogeneous audience, including citizens and activists.

#### 5. Discussion. Toward an operational methodology applied to cultural landscapes

Landscapes represent dynamic and continuously evolving entities, where the concepts of permanence, identity, and safeguarding cultural values require the integration of in-

cremental principles into their management strategies. In this sense, the integration between resilience and cultural landscape opens the possibility of interpreting the territory as a socio-ecological system capable of evolving without losing symbolic ties and collective functions (Walker et al. 2006). Through this integration, the cultural landscape is critically interpreted as a dynamic system, where transformation does not necessarily coincide with loss (Till et al., 2024).

From this perspective, it becomes crucial to deepen the understanding of how to manage sustainable development through community involvement as a factor of resilience, to further design landscape strategies with adaptive conditions (Adger, 2000). A combined reading of the two approaches can therefore contribute not only to understanding but also to the active co-management of landscapes in transition. This perspective is particularly relevant in contexts such as the Campi Flegrei, where culture, understood as an active force within communities, shapes the natural environment, integrating the different dimensions of the issue into a unified vision – widespread settlements and architectural heritage, cultivated landscapes and degraded natural systems, practices and communal experiences that coexist within complex and risk-prone landscapes.

The case study – through co-mapping structured according to a dichotomous reading of

heritage in relation to territorial components such as ecology, settlements, infrastructure, and risks – reveals the necessity of jointly considering culture and nature to understand and enhance the relationships between spatial patterns and ecological processes (Wu, 2010). These relationships are increasingly threatened by anthropogenic and natural risk factors, which endanger many forms of heritage and pose the risk of an irreversible loss of collective memory and community values.

This awareness prompts a reflection on how a resilience-based approach to cultural landscapes allows for action across multiple temporal and spatial dimensions. The temporal dimension is expressed through an incremental and provisional approach – rather than a rigidly evolutionary one – capable of envisioning interconnected scenarios of prevention, emergency management, and post-event recovery. The spatial dimension, in turn, calls for critical engagement with the irreversible processes affecting territories, which often result in geographies of abandonment and underuse. These conditions demand a circular and adaptive design strategy that recycles spaces, reuses buildings, and reimagines landscapes.

This is particularly relevant when considering the risk that resilience thinking is applied to oversimplify urban complexity and depoliticize risk management (Walker and Cooper, 2011), with its projects triggering or accelerating processes of social exclusion for the most vulner-

able groups and increasing the value of assets (Anguelowski et al., 2018). To avoid this, it is fundamental that the design of transformative conditions in terms of resilience already embeds social protection policies (e.g. financial incentives, revenue controls, support for local businesses, etc.) to manage the transition and prevent the increase in asset values from resulting in exclusion. Resilience needs to be fully shaped by the communities inhabiting the territories, to ensure that projects respond to their real needs and not just to a generic, top-down transition agenda.

In this view, this contribution goes beyond theoretical reflection by proposing a methodological framework – the HeCo ULLs – conceived as an operational mechanism applied to cultural landscapes to enhance effective long-term community empowerment in the active care and management of cultural landscapes. The interconnections between resilience and cultural landscapes offer a lens through which the landscape can be recognized as the foundation around which the community itself is formed and thus reasserted as a primary carrier of social, place-based, and contextual values (Tuan, 1977), while acknowledging the pivotal role of communities in confronting and navigating contemporary challenges.

By introducing the concept of HeCo ULLs as participatory territorial laboratories, this study positions the creation of Heritage Communities as a strategic asset for reinforcing terri-

torial resilience, particularly within contexts characterized by crises and accelerated transformation (Berkes et al., 2013).

The methodology developed in the research (Fig. 3) can be transferred into other similar cases, particularly considering that it is still very rare that ULLs are used to jointly develop actions and design strategies for vulnerable, risk-prone contexts that are characterized by the overlapping of different risks, multiplying their impact through compound or cascade interactions. Nevertheless, research proves that it is precisely in these contexts, often characterized by conflicts of interest between different stakeholders, that Urban Living Labs can represent an innovative approach, capable of integrating knowledge from different disciplines and social roles (Laborgne et al., 2021) by creating inedited partnerships between different sectors, empowering actors in a long-term perspective other than just building for mitigation and disaster risk response (von Wirth et al. 2018; Marciano et al., 2024).

Indeed, the nexus between culture and the adaptive capacities of communities is increasingly central to European policy discourse and is formally acknowledged in international frameworks such as the 2030 Agenda and the United Nations Disaster Risk Reduction Strategy. As previously mentioned, this is also coherent with the Faro Convention (2005), emphasizing the active role of people in recognizing, valuing and passing on their cultural her-

itage to future generations, which becomes fundamental to building a "resilience of the heritage community", understood not only as the capacity to withstand shocks, but also as an evolutionary process that strengthens the sense of belonging, social cohesion and local innovation (Mulligan et al., 2016). Cities, as complex socio-ecological systems, draw strength from conscious and active communities, capable of learning, adapting and transforming in the face of challenges. In the urban context, communities are therefore considered as dynamic actors capable of transforming resilience itself from an abstract and static concept to a concrete and continuous practice (Folke et al., 2010), fueled by social capital, participation, inclusive institutions and shared culture (Davoudi et al., 2012).

## 6. Conclusions

The paper investigated the relationship between cultural landscapes and ecological systems, spacing from a recent re-conceptualization of resilience as a unifying framework – interpreted as the background connection of heritage valorization with sustainable and inclusive development – to developing an operationalization of the concept through the creation of an ULL-based community.

The theoretical and methodological framework for the paper has been granted by the research project "Strategies of Interventions on Historical Landscapes," led DiARC (Department of Ar-

chitecture, UNINA), as part of Spoke 1 "Historical Landscapes, Traditions and Cultural Identities," under the PNRR Extended Partnership no. 5 "CHANGES - Cultural Heritage Active Innovation for Nex-Gen Sustainable Society".

The methodology has been validated through the case study of Campi Flegrei (Campania Region), which has been chosen due to the presence of cultural assets and of particularly critical factors, namely its volcanic origin and the spread of unregulated human activities.

With regards to the theoretical state of art, the result of the project reflects the creation of an open environment in which the results of scientific research, usually shared only within the scientific community, could be properly conveyed to non-experts to increase community's awareness and perception of their potential role (Abarquez and Zubair, 2004).

Positioning itself regarding the traditional definition of resilience, the project refers to disasters as longer-term chronic stresses due to disrupted ecologies, rather than acute shocks as in the multi-hazard perspective, as it wants to address the process of social innovation that can start in a community constantly exposed to man-made conditions. That is why, the chosen case study is relevant, because even if it is clearly characterized by acute shocks due to natural aspects (e.g. the current bradyseism crisis), it has always been characterized by an attitude to co-living with the natural risk (the typical, mere emergen-

cy condition) and, at the meantime, the inability to counteract extractive economic supply chains and de-regulation in urban and landscape planning and design.

To finalize the perceptive reading and the valorization of the immaterial relationships that exist between the tangible elements of the places, the analytical-interpretative phase has seen, in addition to the quantitative method of analysis (GIS database) the qualitative methodology which results consist in the outputs of the workshop activities developed in the four meetings. Moving from desk-research, the HeCoULL outlined an original Manifesto shaping the resilient “Cultural Landscape” composed by the stakeholders involved. This has been the foundation for the establishment of real-world strategical goals that the “constituent” Heritage Community of Campi Flegrei decided to pose itself to move forward to activate its full potential through objectives such as re-imagining the relationship with its latent assets and resources, promoting and improving communication in tangible and intangible infrastructures, curating and valorizing all forms of natural and cultural heritage, etc. (Mazzarella et al., 2023)<sup>3</sup>. Interpreting local knowledge, tangible and intangible cultural heritage, traditional know-how, land use, construction technologies, the research *Strategises4Changes* establishes a place-specific resilience, to involve the local Heritage Community in the drawing up of and management pro-

cess of scenarios for heritage care, preservation and dissemination to future generations, paying attention to being active in the care of the contexts in which they invest their public action (Hillier, 2005; Holtorf, 2018). Their local knowledge becomes fundamental to developing shared visions of future changes, because here the knowledge and the production of knowledge equal the social opportunity to act, therefore, to perform their agency of mapping resources, assets, cultures in society. From community involvement and co-exploration/co-design, next steps provide cultural resilience initiatives, under the lead of HeCo participants, that can reinvigorate feedback loops for the LL learning phase, acquisition of wider awareness on project limitations and then reiterate in long-term sustainability plan the whole process.

Limitations of this research study refer to time-bound processes of community engagement constrained to four collaborative encounters, which may prove insufficient to capture the full complexity of community dynamics and territorial knowledge. Furthermore, while the methodology aspires to integrate experiential and local knowledge, the translation of qualitative data into cartographic representations remains mediated by scientific expertise, potentially reinforcing epistemic hierarchies rather than fully democratizing knowledge production. Perhaps most significantly, the “constituent” community lacks a

structured management plan due to limited technical and financial resources.

Central to the described tool/processes is the recognition of the value of cultural landscapes and their inner ecologies, especially in layered and compromised contexts like those of the case study, as an indicator of their potential in decreasing established socio-ecological vulnerability (Magis 2010; Chelleri et al., 2016). In the case emerged the difficulty of cataloging emerging, hidden, or forgotten components, but in the meantime, “silent ruins” can be re-traced as the foundation of a cognitive and relational dimension of a new cultural landscape in need to “speak”, revealing itself in the territory, projected to enhance the Community Resilience (Mulligan et al., 2016) in the creation of the place-based Heritage Community (Berkes and Ross, 2013; Chaskin, 2008).

## Notes

<sup>1</sup> Colavitti defines it “silent territory” as opposed to a “speaking” one, that is already part of communities identity (Colavitti, 2018).

<sup>2</sup> Changes “Cultural Heritage Active Innovation for Sustainable Society”. “PE5. Humanities and cultural heritage as laboratories of innovation and creativity” Spoke 1 – Historical Landscapes, Traditions and Cultural Identities. Codice progetto MUR: PE00000020 – CUP E53C22001650006. Mission 4 Component 2 Investment 1.3, NextGenerationEU (01/12/2022-30/11/2025).

The Work Package 4 “Strategies of interventions on historical landscapes” is a collaboration between partners: UniNa (leader), PoliBa, UniTo, UniPi.

<sup>3</sup> Further impacts will be assessed in the near future, as the research activities have just been concluded (last edit: Nov 2025). HeCoULL activities for a potential research spin-off are already planned (Dec, 2025 – Feb, 2026) in collaboration with other national institutions and the local stakeholders already involved

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# The Palingenesis Of Brownfields Through Nature.

## A comparative case analysis

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#### Introduction

In an era marked by increasingly evident and interconnected environmental crises, the regeneration of degraded ecosystems is no longer merely a desirable option but an urgent necessity (EU, 2024)<sup>1</sup>. The intensification of climate change, the progressive loss of biodiversity, and the alteration of ecological balances are placing Territorial and Urban Planning before unprecedented challenges. In this scenario, the quest for sustainable regeneration strategies, combining environmental resilience, social inclusion, and territorial enhancement, becomes a priority. To strengthen resilience, planning must engage with ecosystems' inherent ability to self-transform and adapt. It

also requires acknowledging the ecological memory embedded in landscapes—their capacity to retain, rework, and rearticulate past interactions into new ecological trajectories, often beyond human foresight.

The recent Nature Restoration Law (2024), approved at the European level, represents a strong institutional signal in this direction<sup>2</sup>. It establishes a binding obligation for Member States to imple-

*The research proposes a critical reflection on the self-regenerative potential of brownfields thanks to spontaneous rewilding, envisioning them as laboratories of experimentation capable of triggering alternative and adaptive forms of urban regeneration. Guided by the concepts of urban palingenesis, spontaneous ecologies and common goods, the contribution investigates how episodes of prolonged abandonment can cause unexpected processes of ecological rebirth and civic mobilization. A comparative*

*analysis of three emblematic cases*

*- Carvey Wick (UK), La Goccia (Italy) and Bullicante Lake (Italy)*

*- shows how local communities, associations and informal actors can redefine landscapes, functions and values of brownfields.*

*The comparison highlights a constant tension between top-down models of reclamation and bottom-up approaches of care and re-appropriation, suggesting a paradigmatic shift: moving from technical and standardized interventions to open, relational, multi-species and situated processes.*

ment concrete measures for the restoration of ecosystems, placing ecological regeneration at the center of environmental and territorial policies for the first time in history. This measure is not just about protecting existing nature but it proposes activating real processes of ecological reconstruction, even in the most apparently compromised and anthropized areas, profoundly rethinking urban and territorial practices as well as the concepts of degradation, abandonment, and value.

Within this framework, brownfields – former industrial, productive, military, or infrastructural areas in a state of abandonment – emerge as both critical nodes and potential resources. According to data provided by the European Environment Agency (EEA) and the

European Observation Network for Territorial Development and Cohesion (ESPON), tens of thousands of disused sites exist across Europe, mostly concentrated in urban, peri-urban areas or post-industrial regions. These spaces are often viewed as “urban voids” or “scars on the landscape” (BenDor, Metcalf, Paich, 2011), difficult to reintegrate into economic and settlement cycles due to pollution, functional fragmentation, or regulatory misalignment.

The contribution intends to offer a critical and operational reflection on a hypothesis that overturns the dominant narrative: what if abandonment were not only an urban and economic pathology, but also an ecological and social resource?

Starting from the concept of “palingenesis”, understood as a profound and transformative regeneration of the territory, an alternative interpretation of brownfields is proposed: no longer seen as spaces to be remediated and converted according to predefined models, but as adaptive laboratories capable of hosting non-conventional, often unplanned, yet deeply sustainable forms of regeneration.

The paper focuses on those brownfields in which local communities have recognized—and actively defended—the ecological and symbolic value of spontaneous habitats that emerged during periods of abandonment. These experiences have attempted to move beyond the functional and market logic behind urban redevelopment and to overcome the normative and

procedural boundaries imposed by conventional regeneration processes—usually solely led by institutions—opening up to more situated, inclusive, and transformative visions of the relationship between space, nature, and citizenship. Within these practices lies a radical reversal of the urban paradigm: planning is no longer seen as a top-down imposition, but as the operation of active listening to what territory has already become and what is becoming.

The purpose of this article is therefore to shift the focus away from traditional brownfield recovery—based on technical, regulatory, and economic interventions—toward a broader understanding of regeneration, capable of embracing the complexity of living systems and the potential inherent in abandonment. This also means questioning the political, social, and cultural implications of such a perspective, evaluating how to recognize, valorize, and—in some cases—not intervene at all.

Two fundamental research questions emerge:

- Can the product of abandonment represent ecological and social value? How can brownfields be reinterpreted as fertile spaces, capable of generating new balances between humans and nature?
- How can spontaneous rewilding be recognized and integrated into brownfield regeneration processes? What tools, approaches, or visions can allow a transition from a logic of reclamation to one of accompaniment of natural processes?

Answering these questions corresponds to expanding the field of brownfields regeneration by including Nature-based Solutions (NbS), community management forms, and non-anthropocentric approaches to spatial transformation: recognizing, above all, that in many cases, the rebirth of brownfields depends on its ability to be left alone and to regenerate according to its ecological rhythms and logics.

The following work is part of the Italian National Recovery and Resilience Plan (NRRP) research project RETURN (multi-Risk science for resilient communities under a changing climate<sup>3</sup>, strengthening research chains on environmental, natural and anthropic risks at a national level in a multi-risk dimension, and is based on a comparative analysis of case studies selected from different peri-urban and urban contexts across Europe. The case study analysis also contributes to the RETURN network by supporting the transfer of knowledge and practices toward concrete application, to informing the regeneration of targeted sites, like the Bagnoli-Coroglio SIN (Site of National Interest) (Naples, Italy), nationally designated contaminated site identified by law for reclamation (L. 426/1998 - Italian national law on contaminated sites).

Starting from these successful experiences in terms of protection of brownfield spontaneous naturalization, the aim is to identify effective and transferable practices and replicable models to activate a new form of “territory

rial palingenesis”, founded on the synergy between communities, abandonment, spontaneity, and regeneration. It is only by embracing the complexity and unpredictability of these processes that a new territorial imaginary can be built—one that finds value even in the unfinished, the temporary, and the wild.

Six sections define the structure of the contribution: (1) Introduction; (2) State of the Art and Theoretical Framework: Brownfields Spontaneous Rewilding in Europe, a field still to investigate; (3) Materials and Methods: from Abandonment to Palingenesis; (4) Spontaneous Ecologies in Brownfields: a comparative analysis of practices of reappropriation and alternative development visions; (5) Discussion; (6) Conclusions and prospectives.

### **State of the Art and Theoretical Framework: Brownfields Spontaneous Rewilding in Europe, a field still to investigate**

The paragraph provides a reflection on ‘operative’ etymologies, starting from the notion of brownfield, framing *palingenesis* and finally understanding the concept of spontaneous rewilding, to construct the theoretical framework of reference and simultaneously laying the groundwork for the methodological body and future application developments. Furthermore, the state-of-the-art analyses of pioneering studies in the spontaneous rewilding of brownfields identifies a research gap.

Acknowledging that there is no common offi-

cial definition of brownfields in Europe (Morar et al. 2021; Rey, Laprise, Lufkin, 2022), this study embraces the EEA definition of brownfield as ‘land within the urban area on which development has previously taken place’ (EEA Glossary), in compliance with the UK tradition in framing these sites as previously developed land (PDL) (Oliver et al. 2005). The EEA description does not address the aspect of contamination, which brownfields have usually been identified with – examples of direct connections between brownfields and real or potential contamination are Canadian and United States official definitions (Canadian Brownfield Network; U.S. Environmental Protection Agency, 2021) or, in the European panorama, Bulgarian, Danish, Polish and Italian legislation (University of Mining and Geology, Sofia; Danish Environmental Protection Agency; Polish Ministry of Environment; L. 426/1998 - Italian National Law on contaminated sites; Italian Ministry of Environment, 1999). This perspective underlines the role of land-use history over soil contamination as the primary defining criterion, shifting attention toward spatial legacies and the structural imprint of past development, e.g. heavily anthropogenic uses. EU Member States adopt different frameworks for brownfield identification—some strictly linked to signs of contamination. The absence of a univocal definition is one of the factors hindering the construction of a European common dataset on brownfields, which

is still lacking (Thornton et al. 2007; Bez, Ash, Boyce, 2024), notwithstanding the prominence of these sites in European policies regarding sustainable urban development. The fragmentation of data is linked to both EU and national states deficiencies: on one side no EU soil legislation exists, on the other each State should monitor contamination on land and manage historical contamination but not all of them have developed georeferenced nationwide brownfield databanks – only 12 states have detailed registers on potentially contaminated sites (Paya Perez, Rodriguez Eugenio, 2018; EEA, 2022). So, detailed quantification of the phenomena cannot be reconstructed (APAT, 2006). This is why an inclusive approach is essential in order to collect official data on brownfields across Europe. The EEA definition thus allows for a wider and heterogeneous territorial scouting of brownfield sites, including abandoned infrastructures and manufactures not strictly affected by pollution issues. Moreover, such a broad-spectrum perspective allows the recognition of neglected spaces that, despite lacking immediate economic value or formal recognition, often host dynamic ecological processes. These landscapes—frequently omitted from planning agendas—have revealed, in various contexts, a latent regenerative capacity and an unexpected biodiversity richness, particularly through spontaneous rewilding phenomena. Acknowledging these emergent ecologies is a crucial step toward re-

framing brownfields as potential laboratories for socio-ecological innovation.

Action on brownfields today is fully recognized across Europe as a priority among strategies adopted in response to objectives such as limiting soil sealing and urban sprawl, contrasting ecosystemic degradation, particularly with respect to soil ecosystems, and implementing biodiversity (CLARINET, 2002; EC, 2012; EC, 2021). PDLs are considered strategic resources for their proximity to urban areas or their location within urban fabrics, which often means direct access to main infrastructures and services. These factors contribute to the global identification of brownfield redevelopment as a vehicle towards long-term urban sustainability (Wang et al. 2021; Sessa, Russo, Sica, 2022); still, international collaborations are quite limited (Jaceck et al. 2022) and most of these sites remain today neither remediated nor transformed.

The reasons behind process stagnation are connected to both technical, economic, environmental and social dimensions: brownfields are predominantly redeveloped through environmental remediation projects using traditional remediation techniques (*soil washing, thermal desorption, etc.*), which are often highly costly, slow and invasive processes. Moreover, brownfields are stigmatized as unsafe spaces for human permanence, raising the issue of safeguarding public health because of contamination. Focusing on the

first theme, conducting large-scale remediation techniques with traditional technologies heavily dependent on chemical reagents, heat and electricity, results in huge social, economic and environmental costs (USEPA, 2008; Hou et al. 2014; O'Connor et al. 2019), which impact both territories and communities. Besides, institutions are not always prepared to manage such complex projects, missing funds, competence, or vision for brownfield redevelopment. So, brownfields still constitute an extensive percentage of underused urban areas, in most cases abandoned and marginalized for years since the end of their productive lifecycle. The apparent immobilization of these areas corresponds to a stasis in the contribution to the surrounding economy and human community, leaving nature “room for *manoeuvre*”. Non-human agents govern the decommissioning lifecycle (suspended phase – see Fig.1), generating autonomous ‘ecological regeneration’ (Coppin & Bradshaw, 1982). Still, this spontaneous rewilding is usually not investigated and is often destroyed in canonical remediation to remove contaminants, following the ‘*tabula rasa*’ model which aims to restore the original ‘clean’ condition. This approach implies a myopic view of urban regeneration, which prefers profit to protecting existing values and heritage and is not interested in experimentation: nature has an extraordinary ability to regenerate spontaneously (Bradshaw, 2000) and spontaneous reclamation, which relies on nat-

ural solutions, allows ecosystems to recover biodiversity without direct human intervention, fostering innovative solutions. Spontaneous rewilding is not intended to replace necessary remediation; where human-health or environmental risks are present, remediation remains essential. Still, when conditions allow, spontaneous, low-energy ecological processes can be integrated as evidence-based alternative or complementary pathways, thereby avoiding indiscriminate ‘*tabula rasa*’ approaches.

In this paper, ecological regeneration is framed as palingenesis—from Greek gr. *παλιγγενεσία*, comp. of *πάλιν* «again» and *γένεσις* «generation», “remade according to genesis”–, known in ancient philosophy as the innovation or transformation of the individual or the cosmos, a process of progressive purification and liberation of the soul according to the Orphism and the Pythagorean; finally, the lemma in question means regeneration, renaissance, renovation, renewal, purification and rebirth in both its figurative and literature declinations (Treccani, 2022). Palingenesis is intended as renaissance through nature, a gentle accompaniment that does not aspire to restore a ‘preconstituted pure state’; on the contrary, it proposes an ecological and adaptive alternative to the dominant narrative, based on spontaneous rewilding. Spontaneous rewilding is also known as auto-rewilding (Tsing, 2017) or passive rewilding (Pereira & Navarro, 2015), un-

like active rewilding, it is not related to human activity or the aspiration to rewild a no longer living ecosystem: 're-wilders' – animals, plants, and other organisms – proceed on their own in reconquering spaces, managing ecological succession and generating «“novel ecosystems”, feral spaces, wastelands or the third landscape» (Guetté, Carruthers-Jones, 2022). As a matter of fact, spontaneous rewilding in brownfields defines novel ecosystems, understood as systems composed of biotic, abiotic and social elements and of their interactions, that tend to be self-organizing and exhibit new qualities, differing from historically prevalent ecosystems (Hobbs et al. 2013).

Considering that ecosystems resulting from spontaneous rewilding are less described and documented (Guetté, Carruthers-Jones, 2022), it's not surprising that transnational or even national data on spontaneous rewilding in brownfields have not been elaborated yet. The role of nature in brownfield self-regeneration is not central in contemporary debate, except for some pioneering studies (Mathey et al. 2018; Masood & Russo, 2023; Wolff et al. 2023; Jin, Qian, Yuan, 2024; Ludovici & Pastore, 2024). In particular, Mathey et al. (2018) and Masood and Russo (2023) focus on brownfields perception collecting data through surveys; Wolf et al. develop an evidence base-support system for land use decision uncovering the role of brownfields in UTS (Urban Tree Systems) connectivity; Jin et

al. (2024) structure an approach to identify urban rewilding opportunity spaces (UROS) in urbanized areas; finally, Ludovici and Pastore (2024) map Milan Metropolitan Area informal urban biodiversity to unravel the capacity of spontaneous nature's agency in reclaiming urban brownfields. Even if some of these studies are not precisely targeted towards the study of brownfield regeneration, they constitute an innovation in the field. While Masood and Russo (2023) explore the public's opinion-according to results widely supportive-on brownfield regeneration through rewilding projects in the UK, Mathey et al. (2018) investigate innercity brownfields and their spontaneous vegetation uses and perceptions by the urban population in Dresden and Leipzig (Germany), revealing their ecological and social potential for users. The two German cities were selected for both their industrial legacy-deindustrialization and urban shrinkage produced many brownfields-and their growing population and economic power: in cities experiencing demographic growth, what is the future of brownfields colonized by spontaneous vegetation? Working in the same direction and context, Wolf et al. (2023) develop a replicable model in Leipzig for prioritizing re-naturalized brownfields in strengthening green infrastructure connectivity; the tool can be used to assess and compare implementing NbS elsewhere. In Chongqing (China), Jin, Qian and Yuan (2024) evaluate and map UROS at the city-scale; among

the results of this extended analysis, «the unused lands within urban core areas», namely brownfields, have been identified as crucial elements for advancing urban rewilding. These spaces are Ludovici and Pastore's focus in their mapping of informal biodiversity in Milan Metropolitan region: starting from a database on existing and potential spontaneous rewilding in the region, the study intercepts "leftover urban areas", e.g. contaminated sites, former agricultural areas and urban voids, with awareness regarding their possible future ecological succession growth and the social conflict between public and real estate interest in development projects.

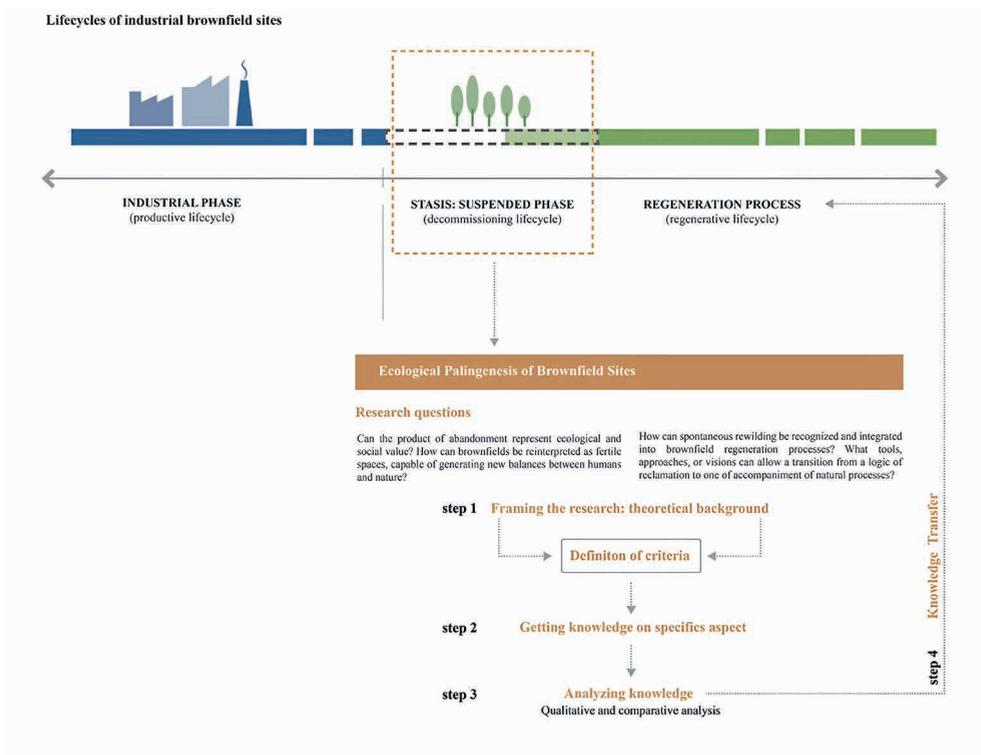
The aforementioned studies advance the field by raising awareness, addressing methodological approaches, and constructing a situated atlas and dataset, but they do not describe, analyze, or compare existing practices. The contribution proposes a pilot comparative analysis focusing on three emblematic European case studies.

### **Materials and Methods: from Abandonment to Palingenesis**

The investigation is grounded in a qualitative and comparative approach conceived as a critical tool for developing interpretative and operational categories. The methodological framework builds upon urban political ecology and ecological autopoiesis, recognise brownfields (with ecological value) as self-organizing sys-

tems shaped by human and non-human interactions. In this sense, the study is closer to the traditions of interpretative research in urban studies and landscape ecology than to standardized protocols of quantitative assessment, and it adopts the logic of case-based reasoning (Yin, 2014; Flyvbjerg, 2011) to read specific urban situations as bearers of paradigmatic values. The three cases examined – Canvey Wick (Canvey Island), La Goccia (Milan), and Bullicante Lake (Rome) – were selected because they are emblematic of the same phenomenon: the transformation of abandoned industrial areas into spaces of ecological and civic regeneration through spontaneous rewilding, in urban or peri-urban contexts exposed to speculative pressures and institutional conflicts.

The study takes the time of decommissioning—the suspended interval between the cessation of productive uses and any subsequent redevelopment—as a critical window in which spontaneous ecologies take shape. Within this frame, we examine the civic recognition of these emergent natures, understood as a process of reading, care, and public legitimation capable of steering alternative pathways of regeneration. The term *palingenesis* is adopted to imply an evolutionary process of transformation and adaptation, that can be seen as a self-healing process of the territory in ecological terms: nature reoccupies abandoned spaces and transforms them into vital habitats. This perspective aligns with theories such as



Gilles Clément’s “Third Landscape” or “urban wilding”, which assign value to transitional and evolving landscapes arising from the interaction between abandonment and biological spontaneity.

In methodological terms, the research adopts the case study method in its comparative and multi-case form (Stake, 1995; Yin, 2014). Each site—Canvey Wick, La Gocchia, and Bullicante Lake—is treated as an autonomous unit, defined by spatial boundaries, actors, and trajectories of use and abandonment. The comparative design follows a logic of replication, where findings from one case are confronted with others to refine hypotheses and highlight both convergences and divergences. Rather than aiming at statistical generalization, the study pursues transferability: cases are interpreted as critical and emblematic, capable of

generating insights applicable to similar contexts. The analytical framework integrates seven coding categories (ecological processes, level of environmental contamination, history of abandonment, main ecological process, governance and conflict, political-economic interests, institutional recognition, symbolic values) and is supported by triangulation of data sources (scientific literature, institutional reports, and civic narratives). This methodological approach aligns with interpretative traditions in urban and landscape studies, and with grounded theory logics, where theoretical assumptions are continuously revised in light of empirical evidence.

The collected material draws on a plurality of sources, ranging from the international scientific literature on rewilding and brownfield regeneration (Bradshaw, 2000; Mathey et al.,

## Research methodology framework.

Source: from authors

Fig. 1

2018; Ludovici & Pastore, 2024) to regulatory and technical documents produced by European and national institutions (EU Regulation 2024/1991 on the Nature Restoration Law; EEA, 2022; APAT, 2006), and what can be defined as grey literature: reports from environmental NGOs such as Buglife and Land Trust for the UK case, civic dossiers and materials produced by associations such as Osservatorio La Goccia in Milan or Forum Territoriale del Parco delle Energie in Rome, together with press articles, websites and statements from local movements. The use of these non-academic sources responds to a deliberate choice: to include the narratives and discourses that communities have constructed around these places, which represent key instruments of symbolic and political activation.

Given the scarcity and uneven indexing of peer-reviewed evidence on the spontaneous rewilding of brownfields, we mapped cases through an exploratory search spanning the open web (Google), scholarly databases (Scopus, Google Scholar, Web of Science), and institutional/NGO repositories. We employed bilingual (EN/IT) Boolean queries—e.g., (“brownfield rewilding” OR “spontaneous rewilding”) AND (“urban” OR “peri-urban”)—covering 2000–2025. Inclusion criteria targeted European urban/peri-urban brownfields with (i) documented decommissioning, (ii) evidence of spontaneous ecological processes (species lists, monitoring reports, expert assess-

ments), and (iii) traces of civic engagement; we excluded greenfields and cases driven exclusively by engineered remediation. Screening (title/abstract to full text) was followed by triangulation against institutional documents and NGO materials to mitigate discovery bias. These materials were read and cross-related through a comparative coding grid, not intended to flatten the singularities of the cases but to highlight their recurring features. Seven main categories emerged: the ecological dimension (processes of spontaneous succession, biodiversity, ecosystem functions); the history of use and abandonment (with the related levels of contamination and institutional marginalization); governance and conflict dynamics (negotiations, resistances, cooperation among communities, institutions and private actors); political-economic interests (real estate pressures, urban plans, strategies of economic valorization); institutional recognition (legal protections, remediation or ecological restoration programs); and social and symbolic value (civic narratives, artistic and cultural practices, processes of collective appropriation. This comparative synthesis across the three brownfield case studies illustrates how spontaneous rewilding produces distinct trajectories of ecological and civic regeneration under different governance and socio-ecological conditions. This articulation enabled the construction of a comparative matrix that highlights analogies and divergences, showing

<b>Criteria</b>	<b>Canvey Wick (Canvey Island, UK)</b>	<b>La Goccia (Milan, Italy)</b>	<b>Bullicante Lake (Rome, Italy)</b>	<b>Abstracted Insights / Transferable Patterns</b>
<b>Previous use of the site (productive lifecycle)</b>	Former oil refinery (never operational) located in an industrial zone characterized by the presence of petrochemical plants	Former industrial site for gas and coal production	Former industrial excavation turned into a lake	Industrial origins—whether through failure, decommissioning, or disaster—shape both symbolic narratives and perceptions of risk
<b>Period and forms of abandonment</b>	Disused since the 1970s; no later redevelopment.	Progressive abandonment since the 1980s; full closure until 2011.	Post-war abandonment and industrial decline culminating in a groundwater flooding event in 1992, which led to the formation of the lake.	Duration and nature of abandonment critically influence both ecological succession and civic mobilization
<b>Level of environmental contamination</b>	Residual hydrocarbons and heavy metals	Contamination by hydrocarbons and metals	Presence of an unconfined aquifer and potentially contaminated sediments (incomplete data)	Contamination thresholds define the boundary between spontaneous rewilding and the need for technical remediation
<b>Recognition of main ecological processes</b>	“Open mosaic” habitats with high invertebrate diversity	Mature urban woodland rich in native and pioneer species	Hybrid lake-woodland ecosystem with high avian biodiversity	Spontaneous ecologies demonstrate self-organizing capacity and the ability to provide complex ecosystem services
<b>Type of regeneration</b>	Initially spontaneous, later managed by NGOs and communities	Partially spontaneous, later managed by community and currently under EU restoration project	Fully spontaneous, self-managed by local community	The different governance trajectories show how rewilding can evolve from informal care to institutional recognition
<b>Civic participation</b>	Volunteering, environmental education, observation	Active citizens’ committee, partial co-design	Strong civic activism, ongoing territorial stewardship	Civic participation acts as a catalyst for the legitimacy of environmental rewilding and regeneration processes
<b>Conflict and governance</b>	Long negotiation, now institutionalized and NGO-led	Initial conflict with institutions, now partially integrated	Ongoing open conflict with private owners and institutions	Conflict acts as a structuring force, shaping trajectories of governance and recognition
<b>Institutional recognition</b>	Yes – Site of Special Scientific Interest (SSSI)	Partially – EU-funded ERDF project	Partial – Nature Monument status excluding 3 hectares	Institutional recognition comes after civic mobilization
<b>Ecological value</b>	Over 2,000 invertebrate species, specialized habitats	Valuable for pollinators and native species	350 spontaneous plant species, 89 bird species (9 protected), 4 bat species	The biodiversity of rewilded brownfields can surpass that of designed green spaces
<b>Symbolic and social value recognized by communities</b>	Environmental education and entomological research	Resilient urban renaturalization	Emblem of environmental justice, right to nature, and civic resistance	The recognition of their value transforms marginal areas into cultural arenas that become central to community interest
<b>Political-economic interests</b>	Initial business park redevelopment projects, later abandoned	Ongoing real estate pressures and university expansion plans	Persistent speculative interests, fragmented ownership and contested land uses	Spontaneous rewilding is generally tolerated as long as it does not conflict with dominant market logics or economic valorization strategies

## Comparative matrix of the three case studies

Tab. 1

how the same factors – abandonment, spontaneity, conflict – generate different outcomes depending on socio-institutional contexts and prevailing economic pressures.

From a methodological standpoint, the research adopted a process of triangulation (Denzin, 1978), constantly comparing scientific data, technical documents, and civic testimonies. The goal is not so much cross-verification, but the construction of a plural discourse capable of holding together different forms of knowledge: ecological, normative-institutional, social, and symbolic. Triangulation is thus interpreted as a critical practice, useful to convey the complexity of places that are not only physical spaces but also arenas of conflict and collective imagination.

Nevertheless, there are intrinsic limitations to this approach. The research does not rely on direct environmental surveys (for instance, soil chemical analyses), but on existing studies and institutional reports; grey literature, while rich and valuable, inevitably conveys the partiality of militant narratives; temporal coverage is uneven, concentrated mainly in the last two decades. Despite these limitations, the combination of academic, institutional, and civic sources allows for the delineation of a robust and culturally meaningful framework, one that emphasizes not only ecological processes but also the dynamics of meaning and power accompanying the rebirth of brownfields.

Finally, the comparison between the three cas-

es has not been conceived as a classificatory exercise, but as a critical device for interrogating the role of abandonment in the production of new urban forms. In this sense, the methodological analysis is aligned with theoretical reflections on the landscape as a “third” space (Clément, 2004) or on spontaneous ecologies as producers of collective imaginaries (Cooper et al., 2024), suggesting that brownfields should be read not only as objects of technical regeneration, but as laboratories of cultural and political transformation.

### **Spontaneous Ecologies in Brownfields: a comparative analysis of practices of reappropriation and alternative development visions**

Starting from the methodological framework, this section explores how spontaneous ecologies have taken on a regenerative role in three selected brownfields, helping to silently reactivate marginalised territories and reformulate their meanings and uses. Within this lens, we treat the period of stasis—the suspended interval between decommissioning and any formal project—as an analytical hinge. It is in this window that spontaneous assemblages consolidate ecologically and, crucially, become legible to publics: walks, counts, mappings and everyday uses translate biophysical change into civic recognition and claims. The timing and strength of this recognition are not neutral: they are filtered by contamination thresholds, ownership regimes and market

## Spontaneous rewilding and industrial ruins of the former Canvey Wick refiner

Source: <https://newgeographies.uk/event/david-blandy-2/>

Fig. 2

pressures, which together condition whether emergent ecologies are preserved, selectively integrated, or erased. Reading the cases through this temporal hinge clarifies how similar drivers (abandonment, spontaneity, conflict) can produce divergent governance pathways and values, as synthesized in Table 1 and elaborated in the Discussion. The comparative reading applies the analytical grid introduced in the Methods section, translating qualitative descriptions into shared interpretative dimensions. Each case is analysed along eleven coding categories – level of environmental contamination, recognition of main ecological processes, conflict and governance, political-economic interests, institutional recognition, symbolic and social value, etc. – to identify convergences and divergences. This systematic approach ensures that narrative accounts correspond to explicit analytical parameters.

The focus is not on design outcomes or institutional planning tools, but rather on bottom-up processes of recognition, valorisation, and claim-making that have turned abandoned landscapes into contested spaces with renewed centrality.

In each case analysed, spontaneous ecologies - emerged in the time of waiting for traditional planning - acted as transformative devices, capable of interrupting the inertia of abandonment and opening up new readings, practices and imaginaries. Not mere voids, but places where practices of care, conflict, presidium

and production of meaning have been activated, questioning value hierarchies and functionalist visions of urban space.

The analysis aims to restore the variety of these civic trajectories, highlighting how the emergence of unplanned ecologies has sustained alternative narratives of urban regeneration, based not on the annihilation of the existing landscape, but on its recognition as a living, cultural and ecopolitical resource.

### Canvey Wick: a brownfield rainforest

Situated on the Isle of Canvey in the Essex region of the United Kingdom, the Canvey Wick area is a prime example of how spontaneous ecologies, emerged on a disused and contaminated industrial site, can become an object of institutional and collective recognition.

The area of approximately 93.2 ha, originally marshland, was destined to house an oil refinery, never completed due to the global oil crisis of the 1970s. The soil showed traces of pollution due to the presence of chemical residues and polluting materials. Despite the compromised ecological condition of the site, the soil slowly favoured the establishment of adaptable life forms, triggering a process of spontaneous recolonisation led by pioneer vegetation. The soil, consisting of sandy and nutrient-poor materials from free-draining dredging carried out for the construction of the refinery, has, in fact, transformed into a well-drained and dry one. These characteristics, combined with



strong sun exposure and the presence of open surfaces, have generated a warm and dry microclimate ideal for many thermophilic invertebrate species (McGill, 2018). In the absence of anthropogenic disturbance, this ecological mosaic has favored the spontaneous establishment of new habitats with over 2,000 invertebrate species, many of which are rare and endangered<sup>4</sup>.

Today, Canvey Wick is recognised as the “rain-forest of Britain” and what makes it interesting is not only the ecological richness that has emerged, but the way in which it has been discovered, narrated and defended by a network of local actors. As described by Land Use Consultants (2007), groups of naturalists, conservationists, volunteers and citizens began to frequent the site, documenting the presence of rare species, organising collective observation and environmental education. This bottom-up ecological reading work performed a fundamental function: it made visible what appeared invisible or insignificant, trans-

forming a seemingly empty brownfield into a shared ecological heritage.

The residents of Canvey together with Buglife, after years of various industrial development projects, embarked on a three-year campaign to protect the site from the threat of a business park development<sup>5</sup>. Only after years of campaigning and negotiation the site was formally designated as a Site of Special Scientific Interest (SSSI) in 2005, one of the highest forms of ecological protection in the UK context<sup>6</sup>.

The area is currently managed by Buglife and the Royal Society for the Protection of Birds (RSPB) on behalf of the Land Trust, responsible for monitoring the soil, limiting the spread of contaminants and protecting this unique natural community (Fig. 2).

Canvey Wick shows how environmental renaissance can activate new forms of community belonging and management. Ecology here is not an aesthetic or technical framework, but has become a cultural, educational, relational

## Writing on the wall enclosing the former refinery site: “Behind this wall lies the Goccia forest” — a message that reclaims visibility and recognition for a spontaneous urban woodland hidden from view.

Source: <https://perimetro.eu/gennaio2021/bosco-la-goccia/>

Fig. 3

engine. The former abandoned industrial site is now a living landscape, not designed but observed, narrated and guarded: a laboratory of coexistence between humans and non-humans, in which ecological spontaneity becomes a lever for constructing new territorial meanings. While in Milan and Rome rewilding remains a contested terrain, in Canvey Wick civic action has already found institutional resonance: what began as local observation and care has become an officially protected landscape, showing that recognition can grow from the ground up.

### **La Goccia Park: experimenting with the care of a spontaneous urban forest**

In the heart of the Bovisa district, in the northern part of the city of Milan, the former gasometers area - named ‘La Goccia’ after its distinctive drop-like spatial configuration - is an extraordinary example of a brownfield transformed by the slow action of spontaneous nature into an unexpected urban forest.

On about 42 ha - part of an industrial area abandoned between the 1980s and 1990s - a spontaneous urban forest has developed, consisting of more than 2,000 trees (plane trees, ash trees, poplars, lime trees) and a rich fauna including birds, hedgehogs, foxes and birds of prey such as the eagle owl<sup>7</sup>. This area, closed and fenced off until 2011, remained invisible to the public eye for a long time. Thanks to the pressure of local associations, including La

Goccia Observatory and Terrapreta association, the forest has begun to be explored, mapped and narrated. Many of the species that have colonised the site are indigenous or adapted to harsh environmental conditions. La Goccia’s floristic composition is the result of a long process of spontaneous regeneration that took place on land polluted by hydrocarbons and heavy metals, residues of disused industrial activities. In order to preserve the ecosystem generated while starting remediation activities, NbS, such as phytoremediation, have been experimented on small portions of the site to assess the ability of certain plant species to absorb or stabilise pollutants in the soil. In the meantime, the Municipality of Milan and the Polytechnic University of Milan (POLIMI), among the main actors involved in the urbanisation of the area, have promoted a redevelopment plan that envisages the demolition of part of the forest to create new university buildings and urban services, including residences and offices. This prospect generated a strong conflict between institutions and active citizenship, which claimed the value of the forest as an ecological, cultural and symbolic heritage. The forest has thus been reinterpreted as an “urban common” and an experimental laboratory of alternative urban regeneration, based on conservation rather than redevelopment (Fig. 3). Among the most significant initiatives is the creation of the “Sculpture Forest”<sup>8</sup>: a site-specific public art project with in-



stallations that preserve the landscape while enhancing its legibility and identity as a living place. Together with walks, collective readings and educational workshops, these artworks have helped to strengthen the link between community and territory, generating a process of civic appropriation and ecological care.

Today, the area is part of the GOCCIA project ("Green Opportunities to Clean-up Contaminants through an Interspecies Alliance"), financed by ERDF (European Regional Development Fund) and led by the City of Milan with partners including POLIMI, Terrapreta and Open Impact. The strategy involves ecological remediation, participatory co-planning and the maintenance of spontaneous biodiversity as a common good. The project, running from 2024 to 2028, aims to transform the area into an urban living lab, accessible to the citizens<sup>9</sup>.

In conclusion, La Goccia is at the centre of a still open process, suspended between eco-

logical enhancement and building pressure, in which the recognition of the forest as a spontaneous and resilient urban landscape is confronted with strongly profit-oriented development logics. The experience of La Goccia reveals how civic activation can transform a marginalised urban void into a contested landscape, charged with meaning and capable of suggesting alternative imaginaries for the future of the city.

### **Bullicante Lake: an unexpected landscape, recognised and reclaimed by the community**

In the eastern quadrant of Rome, within the dense fabric of the Prenestino-Pigneto district, the former Snia-Viscosa industrial area represents one of the most emblematic cases of spontaneous ecological regeneration and civic mobilisation for territorial defense in an urban context. Decommissioned after World War II and long left in a state of neglect, the

## Bullicante Lake – Civic activism and spontaneous nature within an abandoned industrial site in Rome.

Source: <https://animaloci.org/lake-bullicante/>

Fig. 4

site underwent an unexpected transformation in 1992, when a building excavation for the construction of a private car park intercepted an aquifer, generating the formation of a natural lake of significant surface area and depth<sup>10</sup>. This unexpected event triggered, over time, a process of spontaneous renaturalisation that led to the development of a rich and articulated ecosystem within a highly urbanised context.

The so-called Bullicante Lake now covers an area of about 14 ha and has a high degree of biodiversity: according to monitoring conducted by local associations and scholars, there are more than 350 plant species - many of them indigenous - and almost 90 bird species, including birds of prey, passerines and protected species such as the kingfisher. There are also species of amphibians, reptiles and mammals (including hedgehogs, foxes and bats), as well as around 30 species of dragonflies and damselflies. This variety is made possible by the coexistence of wet and wooded, which have developed without planned human intervention, but through a slow and progressive process of biological colonisation (Gatti, 2021).

However, the ecological value of the area has been ignored by institutions for years, and the site has repeatedly risked being the object of speculative projects. Starting in the 2000s, a network of associations, committees and informal groups - including the Permanent Territorial Forum Parco delle Energie, supported by

entities such as Terrapreta and Fridays for Future - initiated a bottom-up process of claims, demanding the recognition of the area as an ecological common good and actively opposing building plans (Fiocca, 2022). The mobilisations have included awareness-raising campaigns, signature collections, garrisons, legal actions and environmental education activities. In this context, spontaneous nature was reinterpreted not as a mere urban anomaly, but as a generator of ecological, social and symbolic value. As Do and Fassari (2023) point out, Bullicante Lake can be interpreted as a “hybrid nature-vein”, in which industrial remains and ecological processes intertwine, generating a liminal landscape, neither totally natural nor completely artificial, capable of nourishing new practices of civic use and collective appropriation (Fig. 4).

The civic action obtained its first institutional recognition in 2020, with the designation of the area as a Natural Monument by the Lazio Region<sup>11</sup>. However, there are still critical issues related to incomplete statehood, urban planning restrictions that have not been fully implemented, and pressure from private parties claiming building rights<sup>12</sup>. The lake and its surrounding landscape are today at the centre of a permanent conflict between opposing visions: on the one hand, that of development based on urbanisation and real estate development; on the other, that of an ecological urban regeneration, which recognises the value of



spontaneous transformations and promotes participatory processes of care and protection. The case of Bullicante Lake clearly shows how bottom-up ecological recognition practices can produce new forms of landscape signification and open up new spaces for negotiation between citizens and institutions. The emerging landscape is neither designed nor planned, but rather the result of self-organised ecological relations.

### Discussion

The comparative analysis of the three case studies offers a key insight: abandonment does not inherently equate to emptiness or decline, but can act as a latent infrastructure for regeneration. In specific conditions, it can instead become a catalyst for regeneration, activating unforeseen ecological, social, and symbolic dynamics. Far from being inert or dysfunctional, brownfields emerge as com-

plex terrains where alternative visions of urban transformation can take shape, especially in times marked by ecological precarity and growing socio-spatial inequalities.

Across the cases of Canvey Wick, La Goccia, and Bullicante lake, spontaneous rewilding processes have led to the emergence of rich and multilayered ecosystems—sometimes more biodiverse than those planned through institutional green infrastructure. This demonstrates that regeneration can, at times, unfold without direct human intervention, relying instead on the autonomous resilience of ecosystems. Yet this spontaneity is rarely absolute. Rather, it is embedded in layered socio-political contexts, shaped by interactions between civic actors, scientific communities, and institutions, each contributing to the construction of meaning and legitimacy. A common thread in all three sites is the tension between top-down remediation frameworks and bottom-up

## Spontaneous rewilding in the Bagnoli Coroglio SIN, Naples, Italy.

Source: S. Piccirillo, May 2025

Fig. 5

processes of care, defense, and reinterpretation. Regeneration, in this sense, is not a technical fix or a definitive state, but a negotiated and ongoing process of spatial re-signification. Here, the notion of palingenesis acquires particular relevance: not as a nostalgic return to a presumed original condition, but as a situated reconfiguration of space, guided by partial, contingent, and evolving practices. Within this dynamic field the examined cases unsettle dominant vocabularies of remediation, calling instead for relational, inclusive and gentle approaches to ecological and urban transformation (Bizzotto, Raimondi, 2024). Moreover, the role of communities appears central, not merely as stakeholders, but as co-producers of ecological value and stewards of urban commons. The resistance surrounding Bullicante lake goes beyond the protection of a habitat; it embodies broader claims for the right to nature and environmental justice. Similarly, the struggle for La Goccia has shown how civic imagination can shift institutional agendas and produce alternative forms of planning, anchored in care, memory, and collective agency. At the heart of these experiences lies a redefinition of value itself. Ecological richness is not limited to biological indicators, but extends to symbolic, affective, and cultural registers. The very presence of unwanted species, informal uses, or decaying infrastructures becomes generative—capable of hosting novel forms of life, meaning, and attachment. These

cases argue how what is often framed as failure, waste, or error may instead serve as a substrate for unexpected ecologies and relational forms of inhabiting space. Emerging ecologies call for a fundamental shift in planning perspectives, urging contemporary governance to embrace the unexpected, the unconventional, the out of the norm and recognizing difference as a fully legitimate form of sustainability. This means moving beyond rigid models and energy-intensive projects, and instead reorienting policies toward lighter, more adaptive forms of coexistence that can value what escapes conventional urban regeneration frameworks. It also invites a reconsideration of human-centered logic: not all regeneration must translate into human use or access. In some cases, safeguarding ecological processes may require leaving areas untouched, acknowledging that their value lies not in what they offer people but in their ability to exist and thrive on their own terms.

The examples of Canvey Wick and La Goccia particularly emphasize this shift: degraded soil, leftover materials, or even illegal practices (such as motocross and unauthorized walking) have unintentionally supported biodiversity and social experimentation. Such dynamics reveal a dissonance between anthropocentric planning frameworks and the complex, often non-linear, logics of ecological regeneration. Ultimately, this discussion points to a broader paradigm shift—from regeneration as a goal



to regeneration as a continuous, open-ended process; from prescriptive planning to dialogic, adaptive, and multi-actor approaches. In this light, brownfields are not merely remnants of industrial decline, but testbeds for envisioning just, resilient, and multispecies futures. The challenge ahead is not simply to “green” these landscapes, but to attune planning and institutional policies to the ecologies, practices, and meanings that already inhabit them. In this perspective, the conclusions that follow do not mark an ending but a passage from observation to proposition. They gather the main findings and translate them into possible di-

rections for action, policy and research. What emerges is an invitation to consider spontaneous rewilding not just as a natural process but as a way of imagining regeneration itself: open, adaptive and shared.

### **Conclusions and perspectives**

The comparative study of selected European cases does not only fulfill a knowledge-building function but also serves as a key step in transferring knowledge within the RETURN research project. Observing how, in different contexts yet marked by similar structural conditions—long-term abandonment and exclu-

sion from both planning agendas and everyday urban life—, spontaneous ecological and civic dynamics have taken shape, offers valuable tools for rethinking the case of Bagnoli-Coroglio in Naples. In Bagnoli too, more than three decades of stasis and neglect have allowed the emergence of unexpected and resilient biodiversity, which remains largely ignored or dismissed by official narratives of remediation and urban transformation. Observing other trajectories helps reframe the gaze toward this landscape—often perceived as marginal—and recognize its ecological, symbolic, and cultural potential (Fig.5).

The analyzed cases do not offer prescriptive models, but rather interpretive frameworks useful for imagining alternative forms of urban transformation, more attentive to ecological contingency and civic activism. Recognizing spontaneous ecologies as a living and evolving heritage does not mean contrasting regeneration, but rather reorienting it toward more inclusive, situated, and non-anthropocentric forms of coexistence. It means embracing incompleteness and ecological improvisation as legitimate components of planning, valuing what arises outside conventional frameworks. At the same time, this research invites a redefinition of traditional categories of urban regeneration: no longer based on functionalist logics and linear temporalities, but on hybrid, adaptive, and participatory processes capable of valuing what already exists. In this light,

brownfields emerge as true territorial laboratories, where cities can be reimagined starting from what grows at the margins—unexpectedly and often outside the scope of formal planning. This requires not only a shift in perspective but also a deeper transformation of planning paradigms: moving from design as imposition to regeneration as a practice of listening, care, and negotiation. Ultimately, what emerges is a call for more sensitive and inclusive regeneration as an opportunity to radically question the very foundations of urban value: to ask for whom and for what we regenerate, and how new forms of territorial recognition—including multispecies alliances—can take shape.

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## Notes

<sup>1</sup> The European context is particularly relevant, as the continent's long industrial history and high urban density have produced a large number of derelict sites. At the same time, EU environmental and territorial policies have made brownfield regeneration a strategic component of the ecological transition.

<sup>2</sup> Under its previous biodiversity strategy, the EU had set itself a voluntary target to restore by 2020 at least 15 % of degraded ecosystems, in line with the global commitment under the UN Convention on Biological Diversity (Aichi Target 15). This target was not met. Studies indicate that restoration activities did take place in all Member States, but at a level that was significantly lower than required to reach the goal set.

<sup>3</sup> This study was carried out within the framework of the Extended Partnership RETURN, funded by the European Union – NextGenerationEU under the National Recovery and Resilience Plan (PNRR), Mission 4, Component 2, Investment 1.3, D.D. 1243 of August 2, 2022 (Project Code: PE0000005).

<sup>4</sup> <https://www.canveyisland-tc.gov.uk/canvey-wick> (accessed on 15 July 2025)

<sup>5</sup> <https://www.buglife.org.uk/our-work/buglife-england/canvey-wick/canvey-wick-the-journey-so-far/> (accessed on 16 July 2025)

<sup>6</sup> <https://thelandtrust.org.uk/space/canvey-wick/> (accessed on 15 July 2025)

<sup>7</sup> <https://www.parcogoccia.com/> (accessed on 12 July 2025)

<sup>8</sup> <https://www.rigeneriamoterritorio.it/un-ponte-trai-parchi-nord-di-milano/> (accessed on 13 July 2025)

<sup>9</sup> <https://www.comune.milano.it/aree-tematiche/pnrr-fondi-europei-e-nazionali/progetti-ue/progetti-in-corso/goccia> (accessed on 13 July 2025)

<sup>10</sup> <https://animaloci.org/it/il-lago-bullicante/> (accessed on 11 July 2025)

<sup>11</sup> [https://www.ansa.it/sito/notizie/magazine/numeri/2022/11/28/rischia-di-morire-il-lago-bullicante-miracolo-di-roma\\_50be2812-fb52-48c3-860c-52661f337cb1.html](https://www.ansa.it/sito/notizie/magazine/numeri/2022/11/28/rischia-di-morire-il-lago-bullicante-miracolo-di-roma_50be2812-fb52-48c3-860c-52661f337cb1.html) (accessed on 16 July 2025)

<sup>12</sup> <https://ilgiornaledellambiente.it/pericolo-lago-bullicante-miracolo-naturalistico-roma/> (accessed on 16 July 2025)

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# **Lecture** Readings

# A Biocentric Critique of Urban Time: Huxley's Time Must Have a Stop.

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### keywords

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*Aldous Huxley's Time Must Have a Stop (1944) is here re-read in the light of the topics addressed within Contesti's special issue Urban and Territorial Resilience. Urbanism Facing Crisis. In order to address the multiple crises, the hidden paradigms are explored and urbanism's relation to time spans is problematised in order to re-centre the role of life and ecosystems, unavoidably representing the foundations of any human activity. This scientific commentary also serves as an introduction to the book excerpts offered in the next pages.*

Reading the following excerpt from *Time Must Have a Stop* by Huxley alongside the debates gathered in this special issue may make visible an older, yet still unresolved, paradox at the core of urbanism and territorial governance: the persistent belief that spatial planning can out-think uncertainty. Such a claim falls within a wider economically-biased growthist paradigm based on which human activities would out-think the actually wider social and ecological systems in which they are framed, upon which they necessarily depend, and by which they are necessarily limited, and that the technique would be able to control and solve major complex issues involving within the larger socio-ecological systems.

Huxley dismantles this belief with disturbing clarity. «*Thought's the slave of life*», he writes, reminding us that human reason is never autonomous, never abstract, and never outside the metabolic and political conditions that shape it. And if «*life's time's fool*» then our models, forecasts, and long-term plans are necessarily undone by the elapsing of time itself—by the proliferation of variables that no system can fully anticipate.

This is precisely what the

definitions of *resilience* try to frame within academic discourse, yet they often struggle to internalise or operationalise it. Urbanism historically aligned itself with the promise of mastery: progress as inevitability, development as linear ascent, «*the bigger and better Future*» as both horizon and justification. Huxley would call this a form of idolatry—«*Progress towards Utopia*» as a secular religion—built not on empirical foresight but on faith in what the future is expected to deliver. In this sense, many crises we now face are not merely environmental or socio-economic phenomena, they are the consequences of a civilisation trained to sacrifice the present to an imagined future.

It is precisely this faith in predictability and control that resilience theory, at its origins, sought to unsettle. Holling (1973) demonstrates that systems designed to maximise stability and optimise specific functions often reduce variability and adaptive capacity, thereby becoming more vulnerable to disturbance. Building on this insight, Davoudi (2012) shows how planning and governance systems grounded in assumptions of predictability, equilibrium and linear futures struggle to engage with uncertainty, complexity and multi-risk conditions, and may even reproduce vulnerability.

In contrast, the contributions collected in this issue repeatedly show that ecosystems do not share this temporal obsession. Nature is neither “*slave of thought*” nor “*slave of life*” in the

human sense; rather, it reorganises, adapts, and evolves. Urban systems, however, continue to treat land, water, and species as resources—predictable, subordinate, optimisable. Huxley calls out the incoherence of this logic: «*we sacrifice a pretty accurately predictable future to present greed*». Contemporary environmental degradation may then not be the result of insufficient foresight but of the refusal to act on the foresight we already possess.

Another passage could speak directly to territorial risk: «*Victims have long memories – a fact which oppressors can never understand*».

In spatial terms, we could state that landscapes *do* have long memories. They register extraction, contamination, infrastructural violence, and centuries of uneven development. Some of the case studies in this special issue – Ostiense, Terra dei Fuochi, Bagnoli – are not merely risk-prone territories (at least, not *per se*: we know that risk is the product of hazards – which wicked spatial planning choices can also yield and/or amplify –, exposition – i.e. the collection of people, building, and infrastructures to which spatial planning also directly gives a major contribution –, and the vulnerability of what is exposed – and the relation of what is placed where with what is placed or done elsewhere: «that if we massacre the forests our children will lack timber and see their uplands eroded, their valleys swept by floods»); they are the sedimented record of exploitation, metabolic disruption, and spatial

injustice. A territorial system cannot be resilient if it continues to suppress these memories or refuse accountability for their origins. Ultimately, the excerpt from Huxley (1944), invites us to think beyond chronocentric planning, beyond the obsession with future optimisation. He proposes an alternative orientation: «*taking the fact of eternity into account*»—not as metaphysics, but as a reminder of the limits, continuities, and interdependencies that exceed human temporal frameworks. In a secular urbanistic vocabulary, this might translate as the requirement to anchor planning in ecological time, biophysical cycles, and the slow variables that actually sustain life – life that cannot be transcended by any social or economic *desideratum*.

### **Attributions**

Concept: I.T. & S.C.; first draft: I.T.; review and editing: I.T. & S.C.; supervision: S.C.

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# Time Must Have a Stop.

## Aldous Huxley, 1944

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But meanwhile, where was the note he had made by way of commentary on those lines in Hotspur's final speech? He flicked through the pages. Here it was.

If you say absolutely everything, it all tends to cancel out into nothing. Which is why no explicit philosophy can be dug out of Shakespeare. But as a metaphysic by implication, as a system of beauty-truths, constituted by the poetical relationships of scenes and lines, and inhering in the blank spaces between even such words as 'told by an idiot, signifying nothing,' the plays are the equivalent of a great theological Summa. And, of course, if you choose to ignore the negatives that cancel them out, what extraordinary isolated utterances of a perfectly explicit wisdom! I keep thinking, for example, of those two and a half lines in which the dying Hotspur casually summarizes an epistemology, an ethic and a metaphysic.

*<<But thought's the slave of life, and life's time's fool,  
And time, that takes survey of all the world,  
Must have a stop. >>*

Three clauses, of which the twentieth century has paid attention only to the first. Thought's enslavement to life is one of our favourite themes. Bergson and the Pragmatists, Adler and Freud, the Dialectical Materialism boys and the Behaviourists – all tootle their variations on it. Mind is nothing but a tool for making tools; controlled by unconscious forces,

either sexual or aggressive; the product of social and economic pressures; a bundle of conditioned reflexes. All quite true, so far as it goes; but false if it goes no further. For, obviously, if mind is only some kind of nothing-but, none of its affirmations can make any claim to general validity. But all nothing-but philosophies make such claims. Therefore they can't be true; for if they were true, that would be the proof that they were false. Thought's the slave of life – undoubtedly. But if it weren't also something else, we couldn't make even this partially valid generalization.

The significance of the second clause is mainly practical. Life's time's fool. By merely elapsing time makes nonsense of all life's conscious planning and scheming. No considerable action has ever had all or nothing but the results expected of it. Except under controlled conditions, or in circumstances where it is possible to ignore individuals and consider only large numbers and the law of averages, any kind of accurate foresight is impossible. In all actual human situations more variables are involved than the human mind can take account of; and with the passage of time the variables tend to increase in number and change their character. These facts are perfectly familiar and obvious. And yet the only faith of a majority of twentieth-century Europeans and Americans is faith in the Future – the bigger and better Future, which they know that Progress is going to produce for them, like rabbits out of a hat. For the sake of what their faith tells them

about a Future time, which their reason assures them to be completely unknowable, they are prepared to sacrifice their only tangible possession, the Present.

Since I was born, thirty-two years ago, about fifty millions of Europeans and God knows how many Asiatics have been liquidated in wars and revolutions. Why? In order that the great-greatgrandchildren of those who are now being butchered or starved to death may have an absolutely wonderful time in a.d. 2043. And (choosing, according to taste or political opinion, from among the Wellsian, Marxian, Capitalistic or Fascist blueprints) we solemnly proceed to visualize the sort of wonderful time these lucky beggars are going to have. Just as our early Victorian greatgreat-grandfathers visualized the sort of wonderful time we were going to have in the middle years of the twentieth century.

True religion concerns itself with the givenness of the timeless. An idolatrous religion is one in which time is substituted for eternity – either past time, in the form of a rigid tradition, or future time, in the form of Progress towards Utopia. And both are Molochs, both demand human sacrifice on an enormous scale. Spanish Catholicism was a typical idolatry of past time. Nationalism, Communism, Fascism, all the social pseudo-religions of the twentieth century, are idolatries of future time.

What have been the consequences of our recent shift of attention from Past to Future? An intellectual progress from the Garden of Eden

to Utopia; a moral and political advance from compulsory orthodoxy and the divine right of kings to conscription for everybody, the infallibility of the local boss and the apotheosis of the State. Before or behind, time can never be worshipped with impunity.

But Hotspur's summary has a final clause: time must have a stop. And not only must as an ethical imperative and an eschatological hope, but also does have a stop, in the indicative tense, as a matter of brute experience. It is only by taking the fact of eternity into account that we can deliver thought from its slavery to life. And it is only by deliberately paying our attention and our primary allegiance to eternity that we can prevent time from turning our lives into a poindess or diabolic foolery. The divine Ground is a timeless reality. Seek it first, and all the rest – everything from an adequate interpretation of life to a release from compulsory self-destruction – will be added. Or, transposing the theme out of the evangelical into a Shakespearean key, you can say: 'Cease being ignorant of what you are most assured, your glassy essence, and you will cease to be an angry ape, playing such fantastic tricks before high heaven as make the angels weep.'

A postscript to what I wrote yesterday. In politics we have so firm a faith in the manifestly unknowable future that we are prepared to sacrifice millions of lives to an opium smoker's dream of Utopia or world dominion or perpet-

ual security. But where natural resources are concerned, we sacrifice a pretty accurately predictable future to present greed. We know, for example, that if we abuse the soil it will lose its fertility; that if we massacre the forests our children will lack timber and see their uplands eroded, their valleys swept by floods. Nevertheless, we continue to abuse the soil and massacre the forests. In a word, we immolate the present to the future in those complex human affairs where foresight is impossible; but in the relatively simple affairs of nature, where we know quite well what is likely to happen, we immolate the future to the present. 'Those whom the gods would destroy they first make mad.'

For four and a half centuries white Europeans have been busily engaged in attacking, oppressing and exploiting the coloured peoples inhabiting the rest of the world. The Catholic Spaniards and Portuguese began it; then came Protestant Dutch and Englishmen, Catholic French, Greek Orthodox Russians, Lutheran Germans, Catholic Belgians. Trade and the Flag, exploitation and oppression, have always and everywhere followed or accompanied the proselytizing Cross.

Victims have long memories – a fact which oppressors can never understand. In their magnanimity they forget the ankle they twisted while stamping on the other fellow's face, and are genuinely astonished when he refuses to shake the hand that flogged him and manifests no eagerness to go and get baptized.

But the fact remains that a shared theology is one of the indispensable conditions of peace. For obvious and odious historical reasons, the Asiatic majority will not accept Christianity. Nor can it be expected that Europeans and Americans will swallow the whole of Brahmanism, say, or Buddhism. But the Minimum Working Hypothesis is also the Highest Common Factor.

Three prostrate telegraph poles lying in the patch of long grass below my window at the inn – lying at a slight angle one to another, but all foreshortened, all insisting, passionately, on the fact (now all of a sudden unspeakably mysterious) of the third dimension. To the left the sun is in the act of rising. Each pole has its attendant shadow, four or five feet wide, and the old wheel tracks in the grass, almost invisible at midday, are like canyons full of blue darlaiaess. As a ‘view,’ nothing could be more perfectly pointless; and yet, for some reason, it contains all beauty, all significance, the subject-matter of all poetry.

Industrial man – a sentient reciprocating engine having a fluctuating output, coupled to an iron wheel revolving with uniform velocity. And then we wonder why this should be the golden age of revolution and mental derangement. Democracy is being able to say no to the boss, and you can’t say no to the boss unless you have enough property to enable you to

eat when you have lost the boss’s patronage. There can be no democracy where . . .

Sebastian turned over a page or two. Then his eye was caught by the opening words of a note that was dated, ‘Christmas Eve.’

# Adesso

## Mariangela Gualtieri, 2020

Adesso è forse il tempo della cura.  
Dell'aver cura di noi, di dire  
noi. Un molto largo pronome  
in cui tenere insieme i vivi,  
tutti: quelli che hanno occhi, quelli  
che hanno ali, quelli con le radici  
e con le foglie, quelli dentro i mari,

e poi tutta l'acqua, averla cara, e l'aria  
e più di tutto lei, la feconda,  
la misteriosa terra. È lì che finiremo.  
Ci impasteremo insieme a tutti quelli  
che sono stati prima. Terra saremo.  
Guarda lì dove dialoga col cielo  
con che sapienza e cura cresce un bosco.

[...]

Diremo io o noi? E quanto grande il noi  
quanto popolato? Che delicata mano  
ci vuole ora, e che passo leggero, e mente  
acuta, pensiero spalancato al bene. Studiamo.  
Impariamo dal fiore, dall'albero piantato,  
da chi vola. Hanno una grazia che noi  
dimentichiamo. Cura d'ogni cosa,  
non solo dell'umano. Tutto ci tiene in vita.  
Tutto fa di noi quello che siamo.



