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# Poorer, but richer. An ecosystem services account for Campania, Calabria and Sicily

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**Abstract.** Ecosystems deliver value to people and the economy through ecosystem services. The Joint Research Centre of the European Commission has quantified the use of ecosystem services by the main economic sectors and households at EU level. In this paper, we downscaled the extraction of six ecosystem services for three Southern Italy regions in 2012: Campania, Calabria and Sicily. The results show that these regions, that result poorer than the rest of Italy according to a GDP-based indicator, generate higher flows of ecosystem services compared to the national average. The results should be considered as conservative, as many important ecosystem services are unaccounted. This kind of assessment can be useful for a wide range of polices targeting climate change, biodiversity and sustainable agriculture.

**Keywords:** ecosystem, ecosystem services, natural capital accounting.
**JEL codes:** Q56, Q57, Q51.

## 1. INTRODUCTION

According tothe last Country Reportreleased by the European Commission (European Commission 2019), the GDP (Gross Domestic Product) and the productivity gap of all Italian regions are widening compared to the EU average, especially in the South. Around one third of the country's NUTS 2 regions, all located in Southern Italy, remains largely underdeveloped with a GDP per head lower than 75% of the EU average (lower than 59% in the poorest regions). The disparities among regions are high. GDP is one of the most popular indicators generated by the System of National Accounts (SNA) to measure the economic wealth of a country.

The disparities emerge not only from the economic perspective, but also in terms of quality of life, as reported by popular surveys (Saturno, 2019): whenever a ranking is undertaken, regions in Southern Italy likely occupy the latest places. Although an environmental section is processed to calculate the indicators of quality of life, this is mostly based on what Chiarini *et al.* (2019) describe as objective indicators, i.e. environmental quantitative measures, which differ from subjective indicators that referto individual perceptions, i.e. environmental discomfort depending on individuals' exposure to environmental risk. Their sensitivity to exposure may vary a lot across regions and countries (Cummins, 2000). By applying the same logic chain in

an ecological perspective, the nexus is between the driving pressure and its consequences on final beneficiaries: pressures on ecosystems (such as pollutant emissions and land use practices) cause changes in the flow of services that ecosystems provide to economy and society.

The 7th Environment Action Program (EAP) and the EU Biodiversity Strategy to 2020 include objectives to develop natural capital accounting (NCA) in the EU, with a focus on ecosystems and their services. Ecosystem services are defined as the contribution of nature to human well beings (de Goot *et al*., 2002); although their conceptualization has experienced an evolution process (Gòmez-Baggethun *et al*., 2010), their most popular classification systems tends to confirm the notion of services as ecological process, rather than final benefit (Potschin *et al.,* 2018; La Notte *et al*., 2017a). The way to integrate the natural capital domain of information in the SNA is through satellite accounts.The System of Environmental-Economic Accounting (SEEA) proposed and supported by the United Nations since 1993 provides methodological guidelines for setting up satellite accounts concerning natural capital (UN, 1993; UN *et al*., 2003; UN *et al.,* 2014a). Specifically, the UN SEEA EEA (Experimental Ecosystem Accounting) target accounts reflecting the role of ecosystems and their services (UN *et al.,* 2014b; UN, 2017). The Knowledge and Innovation Project on an Integrated system for Natural Capital and ecosystem services Accounting (KIP INCA) was set up by the European Commission (including DG Environment, DG Research and Innovation, JRC and Eurostat) and the European Environment Agency, with the objective to design and implement an integrated accounting system for ecosystems and their services in the EU by testing and further developing the technical recommendations provided by the UN SEEA EEA (EC *et al.,* 2016; La Notte *et al*., 2017b).

In Italy, the issue of ecosystem service started gaining attention since 2009 when the Ministry of the Environment published the study (Giupponi *et al.,* 2009). The project LIFE+ Making Good Natura that took place between 2012-2016 (ref. LIFE11 ENV/IT/000168) promoted the quantification and valuation of a number of ecosystem services in several study areas throughout Italy (ref. http://www.lifemgn-serviziecosistemici.eu/IT/home/Pages/default.aspx).

The interest on this issue became formal with the National Law 221/2015 «Environmental measures for promoting green economy and limiting the excessive use of natural resources», by establishing the Italian Natural Capital Committee (INCC), that yearly supervises and publishes the Natural Capital reports, where ecosystem services are acknowledged as crucial to support human activities. A range of ecosystem services are described, quantified and valued at different scales and administrative levels. Specifically, in Chapter 6.2 of CCN (2018), and in Chapter 11 of CCN (2019), maps and accounting tables are extracted from JRC applications concerning INCA and analyzed for the national context.

In this paper, we further downscale mapping and accounting tables extraction by considering six ecosystem services for three Southern Italy regions in 2012: Campania, Calabria and Sicily. After a brief methodological section, the results are presented and discussed. In the conclusion, we would like to highlight how this kind of assessment (from the national to regional perspective) could add important source of information to policy makers.

## 2. ECOSYSTEM SERVICE ACCOUNT: METHODOLOGY

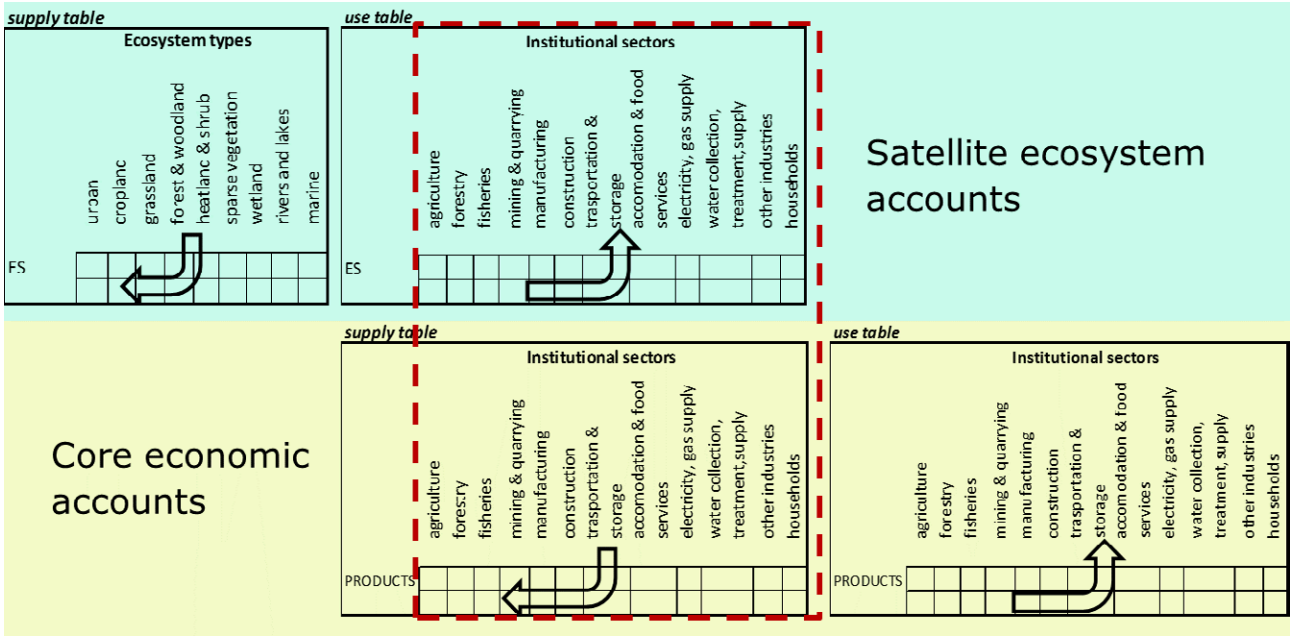
The System of National Accounts (SNA) is the internationally agreed standard set of recommendations on how to compile measures of economic activity in accordance with strict accounting conventions based on economic principles (ref. 1.1(EC) 2009). The System of integrated Environmental and Economic Accounts (SEEA) is a set of satellite accounts that (in its Experimental Ecosystem Accounts modules) interacts between ecosystem and economy through a) supply and use tables in physical and monetary terms showing the flow of services provided by ecosystems and used by the economy; b) asset accounts of ecosystem condition at the beginning and the end of each accounting period and changes therein; c) a sequence of economic accounts highlighting degradation-adjusted economic aggregates; d) thematic accounts on specific issues such as biodiversity, carbon, land (UN *et al*., 2014b).

The accounting format used for ecosystem services is the supply and use tables, which report annual flows of goods and services between different units in the system. In ecosystem services (ES) satellite accounts (Fig. 1): i) the supply table shows the flow of each service provided by different ecosystem types (e.g. cropland, woodland and forest, inland waters); ii) the use table shows the flow of each ecosystem service to the different user (economic sectors or households).

Figure 1 clearly shows the bridge from NCA to SNA: the economic sectors (classified according to NACE nomenclature) that are «users» in the ES accounts become «suppliers» in the SNA accounts.

The calculation of the ecosystem service flows results from the interaction between i) ES potential, where each service can be provided by different ecosys-

**Fig. 1.** Ecosystem services as satellite accounts to the System of National Accounts.

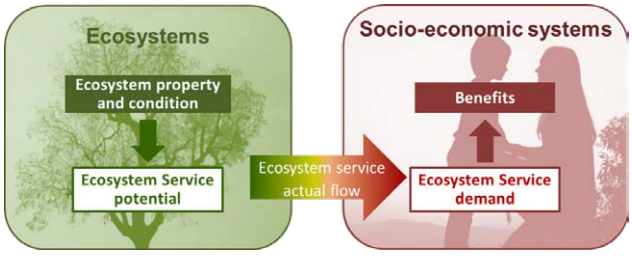



tem types, depending on their properties and condition (providers of the supply table); and ii) ES demand, that reports the need for a specific ecosystem service by economic sectors and households to generate a benefit (users of the use table). The outcome of this interaction is named «actual flow» (La Notte *et al.,* 2019). INCA is based on MAES (Mapping and Assessment of Ecosystems and their Services) an initiative of the European Commission, aiming to improve the knowledge and evidence base for biodiversity policy: decision making is in fact dependent on the availability of spatially explicit information on the state and trends of ecosystems and their services (Maes *et al.*, 2012). MAES current mapping methodologies constitute the starting point to assess the «Ecosystem service potential» represented in Figure 2. INCA turns it into an accounting item by assessing and mapping the actual flow.

The amount of the actual flow depends on ES potential and ES demand. A low actual flow can be recorded even if the ES potential is high, so it does not have negative implication in monetary terms: it just means (in this case) there is low demand. On the other hand, a higher actual flow over time may be due simply to higher demand, without enhanced ES potential. According to the experienced matured in KIP INCA, two approaches are possible to assess ES: a fast-track approach (relatively simple) and a spatially explicit modelling procedure (more complex). For the six ES here presented both approaches were used, as presented in Table 1.

For three ES (crop and timber provision and global climate regulation) we use the fast-track approach that implies: on the one hand to use available statistics and datasets, and on the other hand to estimate how to disentangle ecosystem contribution from human inputs. For the remaining ES (flood control, pollination and nature-based recreation), modelling techniques apply to generate the assessments in physical terms: for flood control the critical variable is the runoff curve number, for nature based recreation the critical variable is the presence of natural sites combined with accessibility networks. Table 1 also presents the valuation techniques applied for each ES. For four ES (crop and timber provision, global climate regulation and pollination) current available values (from market prices to carbon rates) are adapted to reflect ecosystem contribution. For the remaining two ES (flood control and nature-based

**Fig. 2.** Conceptual framework behind ecosystem services accounts.




*Source*: adapted from (Vallecillo, La Notte, Ferrini, *et al.,* (2019).

**Tab. 1.** Main features of the six ecosystem services accounted for Campania, Calabria and Sicily.

| Ecosystem services | Description | Accounting approach | Valuation method |
|---|---|---|---|
| PROVISIONING | | | |
| Crop provision | Ecological contribution to the growth of cultivated crops that can be harvested and used as raw material | Fast-track (disentangling ecosystem contribution) | Market values (price of the crop) |
| Timber provision | Ecological contribution to the growth of timber that can be harvested and used as raw material | Fast-track (disentangling ecosystem contribution) | Market values (stumpage price) |
| REGULATING AND MAINTENANCE | | | |
| Global climate regulation | Sequestration of CO2 from the atmosphere by ecosystems | Fast-track (based on LULUCF) | Market values (carbon rates) |
| Flood control | Regulation of runoff by ecosystems that mitigates or prevents potential damage to economic assets (i.e., infrastructure, agriculture, residential blocks) | Spatial model | Avoided damage cost based on a probability function |
| Crop pollination | Presence of suitable habitats that support pollinators that maintains or increases the crop production | Spatial model | Market values (price of the crop) |
| CULTURAL | | | |
| Nature-based recreation | Opportunity for residents to enjoy naturalistic attractions on a daily basis | Spatial model | Zonal travel cost method |

recreation) economic modelling is applied to translate the outcomes of biophysical modelling into monetary terms. Please refer to JRC technical reports (Vallecillo *et al.,* 2018; Vallecillo *et al.,* 2019a) and to Vallecillo *et al.* (2019b) for more details about data input, methodological procedure and technical steps.

Campania, Calabria and Sicily are three of the eight Italian regions that are part of the macro-region named «Southern Italy». These regions are characterized by Mediterranean climate, especially along coastal areas, and by continental climate in the inner zones. 51% of the total area in Campania is hilly, 34% mountainous and 15% is made up of plains. One of the main economic pillars of Campania is the agro-food industry with high production in fruit and vegetables. Almost half of the total area in Calabria is mountainous, only 9% is made up of plains and rest of the region is hilly. Food and textile industries are the most developed sectors in the region. Being the largest island in the Mediterranean Sea, Sicily is mostly hilly and is intensively cultivated. Two out the three industrial districts in the region are based on food industries. One common feature of the three regions is a high unemployment rate (about 20%).

Based on the methodology and assessment undertaken for all EU countries, data for the three case study regions are extracted. The main limitation of this exercise concerns the scale: results are derived from models calibrated at EU level that do not report territorial peculiarities that could be captured only at local scale. However, this ensures comparability of outcomes. Few modifications are applied. Firstly, for crop provision and pollination crop data are retrieved from the national statistical office (ref. https://www.istat.it/it/agricoltura?dati), and not from Eurostat database. This allowed more details to be available at NUTS 2 level. Please keep in mind that this ES is only applied to a limited number of crops, namely soft and durum wheat, barley, oats, maize, rape, protein crops, sugar beet, potatoes, sunflower and fodder maize. The basic principle for the assessment of crop provision is that the ES is the contribution of ecosystems to the total yield and thus does not consider human inputs such as fertilizers and fossil fuels. The *emergy* approach (Perez-Soba *et al.*, 2019) is used to disentangle ecosystem input from human input in total yield. Secondly, for timber provision, data are retrieved from the Forest National Inventory (ref. https://www.sian.it/inventarioforestale/jsp/dati_introa.jsp?menu=3) with some correction factors meant to extract only forest available for wood supply (by considering the extent of protected areas in each region). For crop pollination, ratios are recalculated *ad hoc* for the three regions using original spatial layers. Please keep in mind that this ES is only applied: for a limited number of pollinator-dependent crops, namely apple, pears and peaches, cit-

**Tab. 2.** Supply Use table for Campania. Supply is delivered by ecosystems and the use broken down over different sectors. Data in euro for the year 2012.

| | Supply (euro) | Use (euro) by different sectors | | | | |
|---|---|---|---|---|---|---|
| | Ecosystems | Primary | Secondary | Tertiary | Households | Global Society |
| Crop provision | 35,007,461 | 35,007,461 | | | | |
| Timber provision | 63,166,491 | 63,166,491 | | | | |
| Crop pollination | 42,830,987 | 42,830,987 | | | | |
| Global climate regulation | 46,279,795 | | | | | 46,279,795 |
| Food control | 5,019,352 | 246,211 | 1,073,183 | 623,693 | 3,076,265 | |
| Nature-based recreation | 564,975,168 | | | | 564,975,168 | |
| Total | 757,279,255 | 141,251,151 | 1,073,183 | 623,693 | 568,051,433 | 46,279,795 |

**Tab. 3.** Supply Use table for Calabria. Supply is delivered by ecosystems and the use broken down over different sectors. Data in euro for the year 2012.

| | Supply (euro) | Use (euro) by different sectors | | | | |
|---|---|---|---|---|---|---|
| | Ecosystems | Primary | Secondary | Tertiary | Households | Global Society |
| Cropprovision | 17,719,192 | 17,719,192 | | | | |
| Timberprovision | 61,240,419 | 61,240,419 | | | | |
| Croppollination | 18,709,354 | 18,709,354 | | | | |
| Global climateregulation | 74,863,357 | | | | | 74,863,357 |
| Food control | 1,436,300 | 70,454 | 307,094 | 178,471 | 880,281 | |
| Nature-basedrecreation | 126,817,582 | | | | 126,817,582 | |
| Total | 300,786,204 | 97,739,419 | 307,094 | 178,471 | 127,697,863 | 74,863,357 |

rus, protein crops, oilseeds, rape, soya, sunflower, fiber plants and tomatoes; and for a limited number of pollinators: wild bees and bumblebees.

## 3. ECOSYSTEM SERVICE ACCOUNTS: RESULTS

When reading the accounts region by region, it is important to consider that only six ecosystem services have been assessed. For example, there are a few ecosystem services contributing to the primary sectors here not reported such as: animal husbandry, soil retention, pest control, water purification, and several others. As already mentioned, the service «crop provision» accounts only for the ecosystem contribution and not for the biomass growth derived from human inputs. In addition, crop provision only covers part of the cultivations, for example vineyards and olive trees are not included; the service «crop pollination» considers wild bees and bumblebees and not (for example) insect pollination. The estimates here reported are only partial and thus the outcomes should be taken as conservative values.

### *3.1. The accounting tables: reporting the numbers*

Table 2 reports the supply and use tables for the Campania region, which shows remarkable flows for each ES.

Table 3 reports the supply and use tables for the Calabria region, which shows lower flows compared to Campania for all ES but Global Climate Regulation, where its contribution is much larger than any other region. This is largely due to the coverage of «woodland and forest» in the region: in fact, those ES (i.e. timber provision and global climate regulation) that more than others are directly linked to «woodland and forest» record high value for the service flow.

Table 4 reports the supply and use tables for the Sicily region, which shows the highest and the lowest values across these three regions: the highest value for nature-based recreation and the lowest value for flood control.

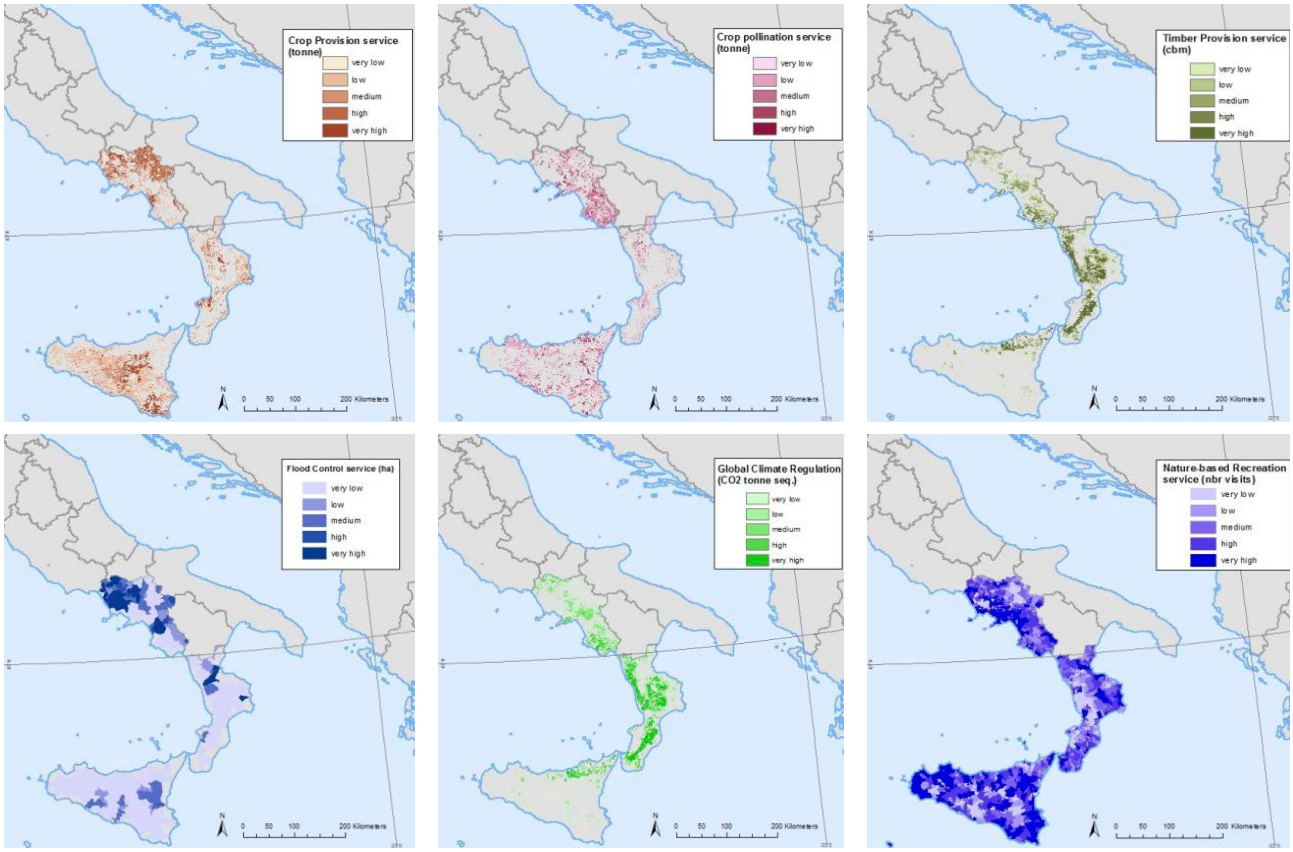
### *3.2. The maps: visualizing the spatial distribution*

Total aggregation on the supply and use tables provides information about where and how much the ser-

**Tab. 4.** Supply Use table for Sicily. Supply is delivered by ecosystems and the use broken down over different sectors. Data in euro for the year 2012.

| | Supply (euro) | Use (euro) by different sectors | | | | |
|---|---|---|---|---|---|---|
| | Ecosystems | Primary | Secondary | Tertiary | Households | Global Society |
| Cropprovision | 49,009,689 | 49,009,689 | | | | |
| Timberprovision | 12,263,251 | 12,263,251 | | | | |
| Croppollination | 33,456,630 | 33,456,630 | | | | |
| Global climateregulation | 28,454,170 | | | | | 28,454,170 |
| Food control | 23,336 | 23,336 | 101,719 | 59,115 | 291,575 | |
| Nature-basedrecreation | 660,853,240 | | | | 660,853,240 | |
| Total | 784,060,316 | 94,752,906 | 101,719 | 59,115 | 661,144,815 | 28,454,170 |

**Fig. 3.** Spatial distribution of the six ecosystem services in Campania, Calabria and Sicilia. Data in physicalterms for the year 2012.




vice is distributed throughout the territory. Figure 3 shows the maps reporting each ES for the three regions in physical terms.

The allocation of the actual flow to ES users is clearly visualized in Figure 3. Crop provision and pollination are located where the 13 crops and 12 pollinator-dependent crops fields are (i.e. agriculture). Timber provision is located where forests are (i.e. forestry). Flood control needs careful interpretation. In chapter 6 of Vallecillo *et al.* (2019a) it is clearly described that service providing areas (mostly forests) differ from service benefiting areas (wherever human settlements and economic activities are located): in Campania and Calabria the actual flow is higher where the largest human settlements are located (e.g. Naples and Cosenza). In the same zones, we cannot see a high value for the actual flow of nature based recre-

ation because, although there is a high demand (number of residents), the ES potential might be low.

## 4. AN INITIAL DISCUSSION

The results obtained for Campania, Calabria and Sicily can be put in an Italian context to start the discussion on the aggregated value of six ecosystem services (Tab. 5).

The total annual flow of ecosystems to the regional economies is estimated at 301 million euro for Calabria and over 750 million euro for Campania and Sicily.

Campania and Sicily contribute more to the national total than can be expected based on their land area. Particularly Campania contributes proportionally more (land area is 4.5% but total services are 9% of the national total).

The GDP in Campania is 6% of GDP in Italy. The six ES in Campania are 9% of the same ES in Italy. Campania provides proportionally more ecosystem services. The GDP *procapite* in Campania is lower (about 64%) than the average GDP in Italy. The six ES *procapite* in Campania are in line with the value *procapite* in Italy.

The value per hectare for the six ecosystem services in Campania is 51% higher than the value per hectare in Italy. The contribution of Campania to Italian Climate Change mitigation operated by ecosystems is 5.16% of Italian Climate Change mitigation operated by ecosystems.

Calabria is a peculiar case.On the one hand,the value per hectare for the six ecosystem services in Calabria is 38% lower than the value per hectare in Italy. On the other hand, this region outperforms other regions with respect to carbon sequestration: about 8% of the Italian Climate Change mitigation operated by ecosystems is provided by Calabria (with a surface area of 5%).

Overall, land cover composition characterizes each region in terms of the most relevant ecosystem services: Sicily has more nature-based recreation and crop provision, Campania shows a certain equilibrium among them, while Calabria ES is dominated by forests.

The GDP in Calabria is 2% of GDP in Italy. The six ES in Calabria are 4% of the same ES in Italy. Calabria provides proportionally more ecosystem services. The GDP *procapite* in Calabria is lower (about 61%) than the average GDP in Italy. The six ES *procapite* in Calabria are almost 10% higher than the value *procapite* in Italy.

The GDP in Sicily is 5% of GDP in Italy. The six ES in Sicily are 9% of the same ES in Italy. Sicily provides proportionally more ecosystem services. The GDP *procapite* in Sicily is lower (about 64%) than the average GDP in Italy. The six ES *procapite* in Sicily are 11% higher than the value *procapite* in Italy. The value per hectare for the six ecosystem services in Sicily is 10% higher than the value per hectare in Italy. The contribution of Sicily to the Italian Climate Change mitigation operated by ecosystems is 3.17%.

The global climate regulation service clearly contributes to the issue of tackling Climate Change. Crop and timber provision and pollination directly connect to the issue of sustainable and resilient management practices, because they assess the amount of ecosystem contribution compared to human input. Flood control and nature-based recreation are among the services which assess the role of ecosystemsin protecting and enhancing life for human society (economic sectors and households).

From a policy perspective, the role of the primary sector remains very important in most of the regions in South Italy. In 2020 the Commission is going to present a strategy called «From Farm to Fork». Among the objectives of this strategy: to protect the environment, to preserve biodiversity, to tackle climate change and increase organic farming. From the tables here reported, it is possible to measure how ecosystems in these three regions in South Italy contribute to each of the listed goals; a systematic accounting would enable to measure

**Tab. 5.** Aggregated annual ecosystem service flows for base-year 2012.

| | Land area (%) | Value of six ES (million euro) | Contribution of ES to the national total (%) | Contribution to the national carbon sequestration (%) | Value of ES (euro/capita) | Value of ES (euro/ha) | GDP (%) | GDP (euro/capita) |
|---|---|---|---|---|---|---|---|---|
| Campania | *4.51* | 757 | *9.16* | *5.16* | 131 | 554 | *6.24* | 16,705 |
| Calabria | *5.00* | 301 | *3.64* | *8.35* | 154 | 198 | *2.03* | 15,998 |
| Sicilia | *8.53* | 784 | *9.49* | *3.17* | 157 | 304 | *5.46* | 16,799 |
| Italy | *100* | 8,266 | *100* | *100* | 139 | 274 | *100* | 25,991 |

*Source:* Land area is based on Eurostat Total and land area by NUTS 2 region [TGS00002].

how this contribution progresses over time as a result of the implemented policy actions.

## 5. INSIGHTS FOR FUTURE ANALYSIS

The analysis reported in the discussion is only the starting point for a work that should go more indepth; a work that would require to consider more variables and to frame a more structured analysis.

On the economic side, GDP represents a high level aggregation of the economic activities: other variables should be selected from regional economic accounts that consider the peculiarities of the territory and can in turn interact more directly with the ES provided by local ecosystems.

On the environmental side, other elements from ecosystem accounting, such as ecosystem extent and ecosystem condition extracted at regional level could further support ES supply and use table to better frame the ecological context. While extent and condition accounts are still work in progress within INCA, data on land cover and land use could in the meantime be used as proxy for the extent component.

On the social side, demography parameters would enrich the analysis. This component of the analysis needs to be entirely developed by considering the multifaced role of residents, e.g. as final users and/or driver of change.

What is undoubtedly shown by this preliminary assessment is the primary role played by agri-food system and forestry as managers and users of most ES. Ideally, employing ES accounts to frame an integrated analysis able to capture the three pillars of sustainability (economy, environment and society) could be a precious source of information for both policy makers at high strategic level, and local planners of the territory. However, to be effective this framework needs appropriate structure (variables and indicators to be chosen), feasibility (possibility to replicate over time), and robustness check procedures. Such an ambitious goal was out of the scope of this paper. Nevertheless, this paper is meant (more humbly) to suggest an initial path for integrated analyses.

## 6. CONCLUSION

The preliminary analysis reported in this paper shows that although the three regions (Campania, Calabria and Sicily) do not record high performance in terms of GDP *procapite*, and although they remain low in economic ranking at national level, they provide important flows of ecosystem services. This awards a higher level of resiliency to all the activities that directly or indirectly dependon ecosystems.

As stated, this analysis is only preliminary: the analytic framework to appropriately explore this new source of information, especially at regional level, needs to be developed and eventually implemented for a fair and correct assessment of ecological and economic richness of different territories. This source of information would greatly help policy makers in what the European Commission identifies as some of the key strategies for the future: «climate action» and «from farm to fork» strategy.

Last, we would like to further support the specific role of ES accounts in this analytic framework. The principle of building territorial accounts to establish a cause-effect relationship between land use, management practices and environmental impacts is not new (e.g. the transition matrix, Bernetti *et al.,* (2013)). Territorial multi-functionalityand hydrogeological risk are in fact very sensitive issues especially for the primary sector (agriculture and forestry). The use of ES accounts can facilitate to identify this linkage by entering the details of each individual service flow: they offer in fact the opportunity to provide measurements of ecosystem contribution to economic sectors, households and (in some cases) to the global society. By linking directly to the SNA, a direct comparison with SNA traditional indicators becomes more meaningful and harmonized, since the same accounting mechanism and rules are employed. This logic, applied to ecosystems, is the same pointed out by Sardone and Monda (2019) when stating that agricultural diversification activities cannot be treated as one homogeneous product, and that traditional categorization (in terms of classification items and their accounting) is not suitable to correctly report the diversification process. In fact: natural environment cannot be treated as one homogeneous service, because a wide range of services needs to be assessed, valued and accounted to properly represent the ecosystem contribution to the economy and the society.

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