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Politics of forests and environmental data: Innovation from above, innovation from below, and conflicts over land use and property in Sweden

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Abstract. This paper offers an exploratory analysis of the links between the politics of forest and struggles over environmental data in Sweden. The term politics of data is used to analyse data production orientated to productivity-oriented forestry and the use of digital technologies that allow ordinary citizens to produce data and knowledge on forests and biodiversity in Sweden. While both processes can be understood as innovation, they differ in terms of drivers and actors. The paper proposes to approach the former process as innovation from above, and the latter process will be understood as innovation from below. In this regard, the main argument to be developed in the paper is that these two forms of innovation reveal the key role of struggles on environmental data in the political interlinkages between contemporary land and property questions in forest and forestry in Sweden. By looking at data production from below, the paper attempts to bring a more dynamic understanding of the production, use and exchange of innovations for data production in environmental conflicts. The empirical analysis of the paper is based on cases where the role of data production in discussions on forestry in Sweden show contestation about the procedures to produce data and its use through digital transformations. These cases will serve to discuss the relations between political struggles over data and knowledge produced through digital tools, how land use and property are politically contested in the context of forestry, and how digital platforms for data production and management also become tools for incipient forms of democratization of knowledge production and innovation in decision making concerning forest and biodiversity.

Keywords: politics of forest, politics of data, forestry, land use, biodiversity, conflicts, digitalization and datafication.
JEL codes: Q23, Q24, Q34, P14.

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HIGHLIGHTS

- Conceptual and empirical analysis of the links between the politics of forest and struggles over environmental data in Sweden.
- Analysis of how land use and property are politically contested in the context of forestry and biodiversity and analysis of structural conflicts in

relation to private property rights on land and forests.
- Possibilities for data innovations from below rearticulate in material and ideological ways conflicts based on divergent interests on forests.

1. INTRODUCTION

The recognition of the role of politics in the production of environmental data has generated an important discussion concerning how this type of data is used, who produces and who controls these data. To such questions it is possible to add that many times the public discussion has to do with the fact that there is data that is not produced or available to the public. On the other hand, the term datafication is widely used today to understand the growing and intensive process of data generation, which is part of and closely related to digitalization. In general terms, the new ways of producing data are related to the massive use of technologies based on sensors, microprocessors, computers, and the Internet. The OECD, an important global actor in the ongoing process of digitalization, defines datafication and data collection as

> […] *the activity of data generation through the digitisation of content, and monitoring of activities, including real-world (offline) activities and phenomena, through sensors. This also concerns the growing capacity of new actors to use digital means to produce data, to control data and also to permanently generate new data* (OECD, 2015, p. 32).

Yet, this phenomenon is not only about the production, storage and use of data, but also about the politics of data and the contestation of data production in specific social and ecological contexts (Dalton *et al*., 2016; Iliadis and Russo, 2016).

All of the above has important consequences for the political discussion on forest and forestry today, and the environmental dimension of land use and management. In this regard, datafication is touted as a new key factor in environmental management, the understanding of the ecological status of forest ecosystems and the modelling of conditions and consequences for the current and future use of forests and land. In the European context, the new EU forest strategy for 2030 has incorporated digitalization and datafication at the center of the new vision about forest and forestry (European Comission, 2021). For this, and among other goals, the EU envisions the establishment of a

> […] *an EU-wide integrated forest monitoring framework, using remote sensing technologies and geospatial data integrated with ground-based monitoring, which will improve the accuracy of monitoring* (pp. 19-20).

At the same time, the EU forest strategy for 2030 aims to develop a citizens' science programme for forest biodiversity, through engaging citizens and civil society in monitoring forest biodiversity. In parallel to these policy goals for forests and forestry at the EU level, large forestry companies have also engaged in developing the potential of datafication and digitalization for their forestry operations. On the other hand, the new possibilities and capacities to produce environmental data are already an important tool for environmental activists and environmental organizations who through producing and accessing environmental data have new means to discuss the state of the environment or specific aspects of forest and land use and forestry. In this regard, the increasing use of data is closely linked to political relations in contexts of environmental conflicts and the very issue of datafication becomes part of the wider politics of forests both at national and cross-national political spheres. Thus, the aim of this paper is to discuss the politics of environmental data in relation to conflicts associated with forests and forestry in Sweden, with a focus on land use and property questions arising from such political context. In addition to this introduction, the paper is divided into four sections and concluding remarks. The first section offers the conceptual background for the paper. The second section presents the case study and the methodology. The third section offers the analysis of the case. The fourth section develops a discussion of the case study with a focus on the relations between property and data production in the case of forestry in Sweden. Finally, concluding remarks are presented.

2. CONCEPTUAL BACKGROUND: THE POLITICS OF DATA AND TECHNOLOGY IN THE SOCIAL CONTEXT OF ENVIRONMENTAL STRUGGLES

From a critical social science perspective on technology, data production through digital transformations cannot be separated from wider questions about the links between knowledge and power, the transformation of social relations associated with digital technologies and the basic dynamics of the development of capitalism (Sadowski, 2019). As Sassen states, digital networks are

> […] *embedded in both the technical features and standards of the hardware and software, and in actual societal structures and power dynamics* (Sassen, 2002, p. 366).

Recognition of power relations in the unfolding of datafication and digitalisation is key to also approach technology in a non-deterministic way and to also approach how different groups in society produce meaning and possible uses for new technologies. As Wajcman argues,

> […] *technological change is a thoroughly contingent and heterogeneous process. Interpretative flexibility refers to the way in which different groups of people involved with a technology can have different understandings of that technology, including different understandings of its technical characteristics. Thus users can radically alter the meaning and deployment of technologies* (Wajcman, 2002, p. 353).

However, for the analysis of datafication and digitalization under capitalism it is also important to consider what Burrell and Fourcade (2021) observe about the digital infrastructures: That they operate

> […] *in increasingly totalizing, continuous, and dynamic ways* (Burrell and Fourcade, 2021, p. 227).

In this regard, I argue that a critical analysis of datafication and digitalisation needs to approach both the totalising tendencies but also contingency in these processes of technological change. Also, within the specific contexts of digitalisation and datafication, a growing body of literature that has focused on the understanding of how digitalisation transforms social and ecological relations increasingly points to the link between socioenvironmental conflicts and digitalisation. Below, I present a brief and selective review of some recent perspectives on digitalization and on the use of new data in relation to environmental issues. This will serve to elaborate some conceptual perspectives for the analysis and discussion on datafication and conflicts associated with forestry and biodiversity in Sweden.

Karen Bakker (2022) has recently argued that in terms of biodiversity and conservation, a number of innovations based on data production and digitalization are creating a new context for the understanding of activism oriented toward environmental conservation objectives. For example, she links the technical capacity to discern patterns of communication by non-human species to a deeper knowledge of biodiversity. This would in turn provide possibilities for activists and civil society actors to mobilize large amounts of data in local struggles for environmental justice. In the case of biodiversity struggles, Bakker argues that this new wave of data production can to some extent determine new social arrangements for the preservation and conservation of the environment. In this context, data-led interventions regarding biodiversity and non-human species entail the potential of the political use of these new technological developments and a new form of politicization of datafication thereby. In terms of biodiversity, ongoing processes of datafication are associated with large databases, which are often open access data, and thus available for public use. Also, the availability of technological devises for data collection fosters political possibilities for the empowerment of communities in the preservation of their territories. As the work of Paneque-Gálvez *et al.* (2017) shows, the use of drones by indigenous communities has the potential to allow these communities to produce their own data on the local environment and use it in struggles for environmental justice and sustainability. This line of analysis highlights the possibility of an unprecedented production of knowledge about local ecosystems, which would give new bases for assessing biodiversity. In political terms, the knowledge base created through this use of digitalization and data production has the potential to transform knowledge and power relations (Goldstein and Nost, 2022). The use of drones for community mapping and the use of citizen science to understand local environmental realities are examples of this. In this context, the capacity of a plurality of actors for fostering community science or citizen science at the community level can also be linked to democratic innovations towards greater participation in data production and the democratization of data (Alarcón *et al.*, 2021).

In the more specific case of forestry, Gabrys and and her co-authors (Gabrys, 2020; Gabrys *et al.*, 2022; Urzedo *et al.*, 2023) have analyzed different dimension of what they understand as Smart Forest:

> *By smart forests, we refer to the numerous digital technologies and infra-structures that are now monitoring, networking, managing, and remaking forests as they attempt to observe environmental change, optimize forests for resource management, and intervene in sites of forest loss* (Gabrys *et al.*, 2022, p. 59).

In their view, the rise of Smart Forest brings new political contexts for the discussion about forests, which is also associated with questions concerning access to and production of data to intervene in the management of forest resources. As Gabrys (2020) observes in relation to the datafication of forests,

> *[d]ecisions about what to measure and monitor, the formation of evidence in support of environmental change objectives, and the extent to which this data is able to effect change are part of a complex set of social-political struggles about how to make forests matter* (Gabrys, 2020, p. 6).

For these authors, it is evident that the massive penetration of data production regarding forests entails the possibility that activists, organizations and civil society in the forest context can also make use of these new technological possibilities and even generate platforms to produce or use big data on forests.

In relation to the penetration of digitization and the process of datafication in agriculture, there is an abundant critical literature about digitalization. This is linked to the fact that important antecedents of the datafication of environmental processes as forestry can be found in the first attempts to implement and promote what is known as precision agriculture. Thus, questions concerning the consequences of datafication in agriculture precedes to an important extent the current discussion on data and digitalization of biodiversity and forests. Recently, David Goodman has contributed to this discussion by building on his earlier work on agriculture and biotechnology. Goodman now uses the concepts of appropriationism and substitutionism to analyze what he conceives in terms of a convergence between the digital transformation and the molecular transformation of agriculture. In this perspective, the trends toward using and controlling new data is deeply transforming agriculture at the basic level of the farm and farm practices. In parallel to that process, and hence the argument about a convergence of trends, there are also transformations at the biological level with respect to crops, the species used, and also the control of agricultural production through intervention and transformation of the biological relationship in the production of food or inputs for food production. Goodman's analysis, which places at the center of the discussion the historical commodification of agriculture and the new ways of commodifying agriculture, also focuses on the power relations between actors in agricultural development. This serves to focus the analysis on who has an interest in, and who controls, this molecular-digital convergence. Goodman connects this convergence to the analysis of the relations between datafication of agriculture and the interests of large agribusiness companies. In this sense, Goodman shows that one objective of these companies is to continue using datafication to deepen their efforts toward greater control of agriculture. In his view, this process is to at important degree discursively framed in terms of making compatible greater productivity and environmental goals for agriculture: "The closer, targeted digital control over farm inputs is represented in some quarters as a new paradigm of 'sustainable intensification' that promises not only to raise productivity and farm profits but also to mitigate global climate change and help feed the 9 billion" (Goodman, 2023, pp. 19-20. Kindle edition.). Goodman's analysis of agricultural companies harnessing datafication and digitalization for further commodification of agriculture contrasts with the growing literature briefly addressed earlier which focuses on understanding the use of data by activists who mobilize the capacity to produce new data to innovate in the production of environmental data and knowledge. For the analytical purposes of this paper, one process can be understood as innovation from above and the other as innovation from below.

Taking the previous insights into account, one issue that appears to be particularly relevant in the analysis of the politics of data in the context of forests and forestry in Sweden is the type of relationships between the different processes of datafication and the specificity of political processes regarding biodiversity and forestry. In this regard, questions concerning land use and property are a clear example where contemporary environmental conflicts are to an important degree conflicts on and over data. Thus, some conceptual elements for understanding datafication in forestry from the perspective of conflicts over property and in land use are important to guide the analysis of datafication in terms of processes of innovation from above and innovation from below, and for approaching the role of both types of innovation in the context of forestry and biodiversity conflicts. In this regard, I would argue that developing theoretical perspectives on the role of land control and property in conflicts over forest and the production and use of environmental data thereby is a key theoretical challenge for a deeper understanding of the context-specificity of innovation in data production and the political conflicts that this reinforces and/or creates.

Thus, to understand datafication from the perspective of conflicts in forestry, my starting point is historical materialist sociology which by drawing on some basic elements of Marx's theory of capitalism brings as a central theme for the analysis the specificity of social conflicts in capitalism. In this regard, understanding social conflicts means understanding conflicts generated through the structuring of different and divergent social interests. Therefore, as Burawoy and Wright point out, it is not simply a matter of conflicts originating in subjective identities that are related in a conflictive way. This emphasis on the structural dimension of conflicts is also related to a focus on the interests that are socially articulated in a capitalist society (Burawoy and Wright, 2002). Therefore, understanding conflicts implies analysing what the interests that exist in a society with respect to the materiality and meanings of certain resources are, and how interests and agency interplay in the maintenance or the transformation of determined social and

ecological relations. In that sense, social conflicts are related to the reproduction of certain social relations and also to the establishment of new social relations based on the conflicting interests within society. Within this context, the role of property relations is key, and its analysis allows us to understand conflicts in forestry more specifically and contextually. For example, in environmental terms, a conflict can be the result of individual or collective actions that follow the interests of some actors to maintain property relations or land use based on those property relations. But there are also conflicts that can lead to the establishing of property relations as a political definition of a conflict, which in turn can generate other types of conflicts over those property rights.

In this regard, it is important to emphasise that a focus on the social conflicts that are inherent to the social structures of capitalism also means to take into consideration emergent social conflicts in capitalism. In the terms of Nancy Fraser's approach to what she conceives as boundary struggles, the institutional divisions of capitalism

> […] *often become foci of conflict, as actors mobilize to challenge or defend the established boundaries separating economy from polity, production from reproduction, human from nonhuman nature* (Fraser, 2017, p. 164).

Within this context, access, control and use of land is a particularly important foci of conflict. As Harvey M. Jacobs summarises one of the main points of an edited collection on social conflict over property rights in the US context, it is important to recognise

> […] *the complexity of land and how its noneconomic characteristics are so often the source of social conflict* (Jacobs, 1998, p. XV).

This, we can add, is today a fundamental dimension of many of the mounting local and global social-ecological conflicts (See for example: Swyngedouw, 2019, p. 549)

All this calls for an empirical and contextual analysis of the role of conflicts in the social structuring of capitalism, which serves to better understand conflicts as causes and/or consequence of the clash between different interests. In this sense, understanding data in terms of the politics of data and the contestation of data (Beraldo and Milan, 2019; Ruppert *et al*., 2017) leads us to ask important questions about the political relationship between forests and biodiversity and the conflicts around forestry and land use. In fact, it is possible to observe today that particularly in countries with highly technologically developed forestry sectors, there are certain patterns of conflict regarding how the use of forests and land is determined by political struggles over data, which to an important degree are struggles entangled in contestation about property relations in the process of achieving, or redefining, environmental objectives. In this sense, innovation in terms of data production is entangled in sociopolitical contexts where property relations and land policies cannot be separated from historical conflicts that today have repercussions on the ways of understanding land ownership in relation to the environment. In this sense, it is important to highlight that datafication needs to be understood as a political process where we can distinguish different types of innovation and how the plurality of innovation processes interplays with different and conflicting interests and objectives for forests and forestry. Thus, for the argument of this paper, the basic theoretical point of approaching structural conflicts in capitalism, and the specific environmental conflicts within capitalist development, is to attempt an explanation of the relationship between conflict in forestry and datafication and develop an analysis of how this unfolds. As said earlier, this requires contextual analysis to identify the relationship between datafication and conflicts, and to better understand the specific contexts of those conflicts. To discuss the above, the paper will focus on the case of forests and forestry in Sweden.

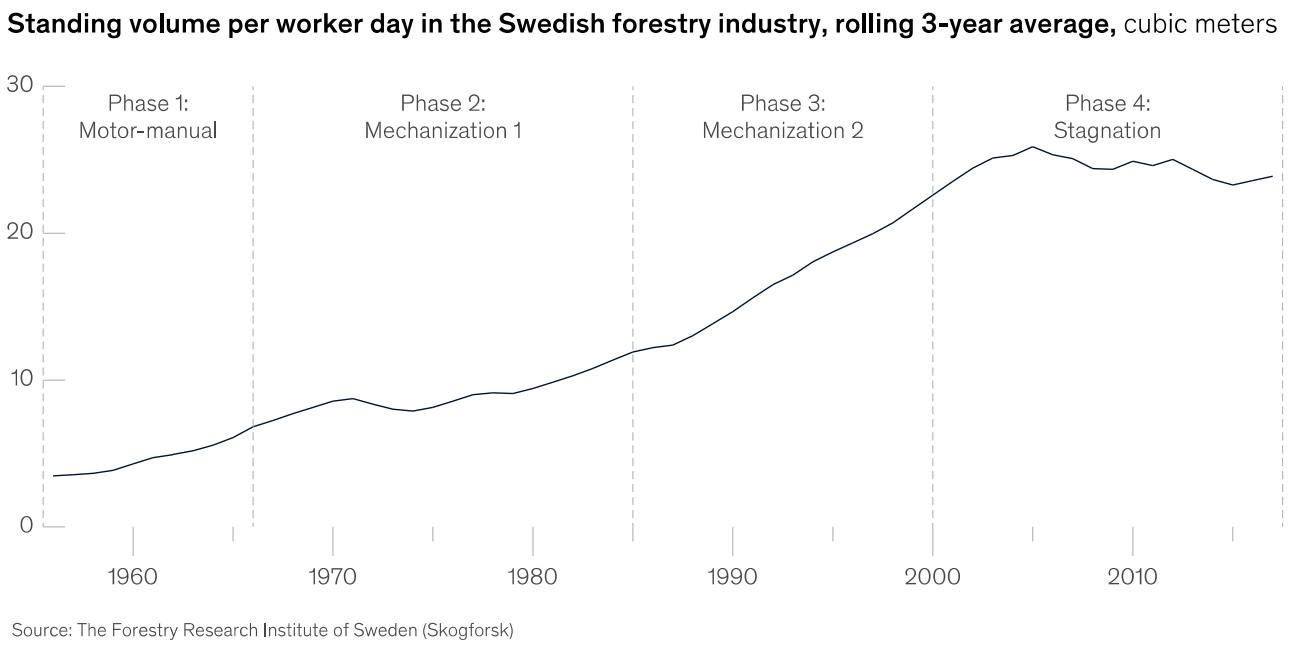
3. CASE STUDY AND METHODOLOGY

Sweden has one of the most developed industrial forest sectors in the world, and a large part of the forest products manufactured in the country are exported to international markets. Mechanization of forestry activities, and technological changes have greatly increased productivity in forestry operations. Yet, recently, there are signs of stagnation in productivity growth within forestry in the country. This is shown in the Figure 1, produced by the consultancy company McKinsey for its report *Data: The next wave in forestry productivity* in 2020, which uses data from the Forestry Research Institute of Sweden (McKinsey and Company, 2020).

Recently, a large new initiative involving forestry companies and universities was established to address and foster the digitalization of forestry in the country. The project has been labelled digital forests and it is organized as a research programme that

> *uses digitalisation to promote sustainable development in forestry* […] *by developing methods, models and digital tools that contribute to a digital forestry value chain that to pave the way for a circular bioeconomy* (MISTRA, 2021, 2020).

Figure 1. Sweden developed its forest-industry productivity through mechanization.



Source: McKinsey & Company report *Data: The next wave in forestry productivity,* 2020. (https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/data-the-next-wave-in-forestry-productivity).

In this context, part of the diagnosis about digitalization in forestry is based on the notion of forestry is a traditional industry which would imply a challenge for digitalization (Torto and Kristofersson, 2023).

The *digital forests* programme takes place in a context where main political aspects of forestry in Sweden concern domestic contestation about the environmental sustainability of the sector and the political tensions unfolding through the interplay between sustainability goals for forests at the EU level and the impact of EU's regulations in Swedish forestry. In terms of contestation of the claims about sustainable forestry in the country, the work of NGOs, activists and academics highlighting sustainable problems associated with forestry play a central role. Environmental activism in this context has taken advantage of, and used, new possibilities for data production and has mobilized data in the discussion about the environmental status of forest in the country. In this regard, citizens' participation in monitoring of forest ecosystems has entered in a new phase of increasing use of public data and also data production. An initiative that has facilitated citizens' involvement in environmental data production is the Swedish Species Observation System (Artportalen), a large infrastructure for citizen science which is considered one of the largest infrastructures for citizen science in the world (Kasperowski and Hagen, 2022).

Based on previous work by Alarcón *et al.* (unpublished paper), we can highlight here some key aspects of the system for citizen science presented above. The Swedish Species Observation System is coordinated by the Swedish University of Agricultural Sciences' Swedish Species Information Centre (SSIC) (Artdatabanken, n.d.), which is tasked by the government and other authorities responsible for working with biodiversity (Alarcón *et al.*, unpublished paper). Thus, the SSIC provides an infrastructure with data and knowledge on biodiversity to support the work of public and private organizations. For over 20 years the SSIC has promoted and hosted the bottom-up development of the Swedish Species Observation System (henceforth SSOS) with funding from the Swedish Environmental Protection Agency (EPA) and Swedish University of Agricultural Sciences (Artportalen, n.d.). The SSOS has a significant number of users with about 11,000 users reporting species observations each year. To date, the database consists of > 80,000,000 observations together with > 2,000,000 images, video or sound files. Over 6,000,000 new observations are reported each year, the majority from the general public and biological societies (Ibid). These data are harvested by the Global Biodiversity Information Facility (GBIF) too, where it comprises almost 10% of the georeferenced data from around the world. The SSOS platform not only gathers biodiversity data from the general public but is also the main reposi-

Table 1. The use of knowledge provided by the Swedish Species Information Centre (SSIC) in relation to environmental governance and public participation in the Gävleborg region, Sweden.

Documents, identification of actions, plans, programs or decision-making process where information and knowledge from SIC and its CS platform is used in Gävleborg	Organizations or situations relying on information and knowledge from SSIC and its CS platform with regard to Gävleborg
Action program for sweet grass 2009-2013 (Naturvårdsverket, 2009)	Swedish Environmental Protection Agency, 2009
Traditional management of lower Dalälven's river meadows – economic and ecological opportunities (LEADER Nedre Dalälven., 2015)	Final report from a project with support from LEADER Nedre Dalälven in the context of the regional landscape strategy, 2015
Inventory of meadow fungi in Gävleborg County 2015 (Gävleborg County, 2016)	The County Administrative Board in Gävleborg, 2016
County program for regional environmental monitoring in Gävleborg County 2015-2020 (County Administrative Board in Gävleborg, 2014)	The County Administrative Board in Gävleborg, 2014
Analysis of Siberian jay in Gävleborg using the Swedish Species Observation System (SSOS) ("Lavskrikan i Gävleborg med artportalen - PDF Free Download," n.d.)	Report of a private person (former University professor) in the context of Siberian jay controversy in 2016
Environmental Impact Assessment for extension of concession for electricity power transmission line Stadsforsen - Hölleforsen – Untra (Svenska Kraftnät, 2012)	Assessment elaborated by the Swedish electricity transmission system operator Svenska Kraftnät in 2012
List of state forests worth of protection in Gävleborg (Naturvårdsverket and länsstyrelserna, 2004)	County Administrative Board in Gävleborg and Swedish Environmental Protection Agency in 2004
Information on species protection in Sweden and red listing and protection provided by ENGO The Swedish Society for Nature Conservation working in the municipality of Nordanstig in the Gävleborg region (Naturskyddsföreningen Nordanstig, n.d.)	Online communication informing that SSIC has a page where people can search for individual species
Biosphere nomination for the Voxnadalen area in Gävleborg region (Biosfärområde Voxnadalen, 12.05)	Nomination from 2018 where SSIC data was used for identification of 274 species that are nationally red listed
Natural value inventory regarding biological diversity (NVI) in a housing project outside of Gävle. Inventory ordered by the Municipality of Gävle and realized by a private consulting firm (Ekologigruppen AB, 2015)	Use of SSIC data for identification of red listed species in 2015

Source: Alarcón *et al.* (unpublished paper)

tory of data from professional, nationally financed inventories of biodiversity and other environmental parameters (Ibid). Within this context, the platform Artportalen allows citizens to provide information about species, which can in turn be used by scientist and experts in different forms of evaluation and monitoring of ecosystems at both the national and regional level. As the Tåable 1 shows, Artportalen is widely used at the regional level in the country.

The use of data produced and systematized through *Artportalen* has also been at the center of controversies concerning decisions for forestry operation. In some cases, decisions concerning forestry operations where knowledge from *Artportalen* has served as base for those decisions have imposed restrictions for planned forestry operations of individual forest owners. As we will see below, these cases have been especially relevant in the political discussion about new forms of environmental data production in the context of conflicts over land use and property in Swedish forestry. In what follows, empirical examples where the politics of data and the politics of forests intersect in Sweden are presented and analysed. For this purpose, the article uses and analyses a selection of documentary material to follow and reconstruct through secondary sources those empirical examples where conflicts on land use and property interplay with the different uses and interpretation of environmental data in the evaluation and discussion of forestry, biodiversity, and sustainability in Sweden.

4. DATAFICATION AND CONFLICTS OVER LAND USE AND PROPERTY IN THE CONTEXT OF FORESTRY IN SWEDEN

4.1. National and global ways of generating data on forests and forest use

A first example of the intersections between politics of data and politics of forests centres around the use of field inventories versus remotely sensed data in

the assessment of forests and forestry. In this case, we can focus on the discussion started in Sweden after a scientific paper published in the journal Nature in 2020 assessed the state of forests in Sweden by using remote sensing technologies for data production. The paper was produced by Ceccherini *et al.* (2020) under the methodological premises that:

> *Currently, the combination of high-resolution satellite records and cloud-computing infrastructures that can handle "big data" provides a complementary asset for quantifying harvested forest area that is independent from official statistics and overcomes some of the limitations of national inventories. Using such data streams and information technologies, we assessed the recent changes (2004-2018) in harvested forest area based on the Hansen maps of Global Forest Change GFC), a map product with a 30-m resolution based on Landsat satellite data, which provides yearly estimates of tree cover and tree-cover loss* (Ceccherini *et al.*, 2020, pp. 7273).

For the authors of the paper, one result of the use and analysis of this big data was that,

> *The largest share of variation in harvested forest area during 2016-2018 compared to 2004-2015 among the 26 EU countries was recorded in Sweden and Finland, which together accounted for more than 50% of the total increase in harvested area observed in recent years (*Ceccherini *et al.*, 2020, p. 74).

The paper motivated a scientific debate in the journal Nature. One response to the paper stated that,

> *The GFC Landsat dataset that Ceccherini et al. use for their analysis is based on remote-sensing satellite data that does not give information on changes in forest density beyond a certain threshold. Although this data-collection method records sharp changes in the landscape from year to year, such as clear-cuts and large natural disturbances, it fails to capture the annual incremental growth in forest biomass. Man- aged forests, such as those in Finland and Sweden, deliberately aim for harvest cycles of several decades to maximize the volume of wood growth per hectare of forest. The increase in forest volume beyond tree cover is not captured by remote sensing and relies on estimates from the European Space Agency and other pan-European organizations. Better area estimation from sample data would reduce the discrepancy with national data sources (Wernick et al.*, 2021, p. E13).

As the case of forests in Sweden was at the centre of this discussion on data for the environmental assessment of harvested forest area in Europe, some Swedish researchers reacted to the assessment of forests in Sweden by Ceccherini *et al.* and argued that,

> *This reported dramatic increase in forest harvesting is not consistent with Sweden's national statistics. On the contrary, statistics from The Swedish Forest Agency and the Swedish University of Agricultural Sciences show that the harvested forest area has decreased within the studied time period* (https://www.slu.se/en/ew-news/2020/7/incorrect-figures-on-harvested-forests-in-nature-article/).

Within this context, the group of researchers added that,

> *According to the National Forest Inventory, a survey conducted in the field with objective statistical methods, the area of harvested forest in Sweden has been around 200 000 hectares per year during the past decade, while the volume of harvested wood has increased steadily during the same period.* (https://www.slu.se/en/ew-news/2020/7/incorrect-figures-on-harvested-forests-in-nature-article/).

In replying to the comments and doubts about their study, Ceccherini *et al.* argued that considering several issues raised by their critics, the

> […] *additional validation exercise for Sweden and Finland, — even if not conclusive for the large uncertainties in the estimates — supports our conclusions on the increasing area of clear-cuts* (Ceccherini *et al.*, 2021, p. E21).

Also, Ceccherini *et al.* closed their reply by stating that:

> *In conclusion, the comments by Palahí et al. and Wernick et al. gave us the opportunity to assess the effect of the change in the GFC algorithm on our results and to clarify several misunderstandings that led to interpretations of our study that were beyond our original intentions. We believe that these clarifications strengthen the main messages from our study — that is, that Earth observation and big-data analytics are very promising tools for a detailed and spatially explicit monitoring of forest resources (provided that a temporally consistent tree-cover map is available), and that an increase in clear-cut harvest has been observed in recent years in the EU. We are approaching a revolution for the integration of Earth observation in the monitoring of forest resources. The success of this integration, which is essential to the European ambitions on biodiversity conservation and climate-change mitigation, depends not only on the combination of ground surveys with modern satellites — such as the Copernicus Sentinel-1 and Sentinel-2 sensors that have up to 10-m spatial resolution — but also on the continued and effective cooperation among the various scientific communities involved, the national agencies responsible for forest surveys and the European institutions* (Ceccherini *et al.*, 2021, p. E23).

Within the context of this paper, this example shows two important things concerning the politics of

data in relation to forest and forestry in Sweden. First, a main issue in the discussion is the possibility of relying upon big data produced through high-resolution satellite records, versus in site national inventories. The second issue has to do with recent political responses to the problem of discrepancies between diverging environmental assessments of forests, a response that has been framed in terms of harmonisation of forestry data. In relation to the latter, in 2023, and under the context of Swedish EU Council presidency, a workshop in Sweden continued with the effort to advance harmonised forest monitoring and reporting for the EU. One of the conclusions of the workshop was that,

> *It was concluded that many biophysical features of forests could only be monitored through field inventories. For several features, however, the combination of field inventories and remotely sensed data would allow for more accurate and frequent statistical estimates, as well as for mapping. Furthermore, field-collected data have an important role to verify remotely sensed data* (Towards harmonised forest monitoring and reporting for the EU, 2023).

This conclusion clearly resonates in the debate concerning the Ceccherini *et al.* paper from 2020 summarised above. One issues that becomes clear from the attempts to reach harmonised forest monitoring and reporting for the EU is the effort to reinforce the role of field collected data for forest assessment. That the Ceccherini *et al.*'s study led to strong criticism in Sweden cannot be disconnected from the fact that their assessment became entangled within political discussions on the state of forest in the country and the role of industrial forestry in the loss of biodiversity associated with forestry and industrial forestry practices. In this context, this discussion adds to the overall assessment of Sweden's Environmental Quality Objectives and the specific goal of Sustainable Forests, objectives that according to the 2023 assessment will not be reached (Skogsstyrelsen, 2022).

As emphasised in recent public debates about sustainability and forestry in Sweden, a main environmental problem of industrial forestry in the country is the impact on biodiversity of the extensive use of clear-cutting as logging method, which is the logging method in almost 97% of the forest lands used for forestry in the country (Arnqvist *et al.*, 2023). Though there are efforts to also use continuous cover forestry as a forestry approach, research has found that the forest sector predominantly and extensively continue using clear-cutting as logging method and also use tree plantations to maximize production:

> […] *sectoral culture, forestry education, legislation, research, timber market, and single-layered forest structure are both shaped by and reinforce a forestry sector that is heavily invested in clear-cut- forestry* (Hertog *et al.*, 2022, p. 11).

In this regard, one can observe that the way in which the forest industry is structurally and ideologically organised becomes a fundamental driver of local conflicts between the interests for the expansion and also intensification of logging on the one hand, and the interests for biodiversity goals on the other hand. Thus, in explaining the fact that the Environmental Quality Objective Sustainable Forests will not be reached, a key factor to be considered is the combination between forest policies oriented to increasing production of forest raw materials and the predominant role of clear-cutting as logging method within the forest industry. In this regard, the assessment of Ceccherini *et al.* contributed to strengthen the arguments about unsustainable patterns within forestry in Sweden. That the data leading to that conclusion generated a conflict of interpretations is not only a methodological discussion, but it is basically a discussion about the politics of data. In this case, datafication and efforts to harmonise forest monitoring and reporting must also be understood in the general context of the politics of forest in Sweden. In that regard, what needs to be understood here is that arising from the contradictions associated with forest management in Sweden, these new discussions and conflicts generated around and through the production of data are constitutive part of the politics of environmental data production and also the politics of forest in Sweden.

4.2. Use of citizen science to assess biodiversity in forest and its contestation

The second example of the interlinkages between the politics of data and the politics of forests centres around the role of citizen science in decisions on forests and forestry. As explained above, Sweden has a well-established digital infrastructure for citizen science (Alarcón *et al.*, unpublished paper). Yet, in a context of contestation about forestry, data produced through citizen science has become part of conflicts between different interests on forests as well. One relevant example of this is a Court ruling concerning a decision of the Swedish forestry service which did not authorize tree felling by private forest owners on their own property because of data about the presence in those properties of the Siberian Jay, which is a bird with significance in terms of biodiversity. One part of the Court ruling stated:

> *Information provided by private individuals can hardly be used as a basis for a decision to ban felling…* (Östersunds tingsrätt, 2019).

As observed by several actors, a decision in that regard becomes an important barrier for citizen science efforts to be a more relevant input in sustainable forest management regionally, and possibly nationally (Roos *et al.*, 2019). It was also argued during the public controversy concerning this case that the 2019 Court judgment went against a government policy that explicitly promotes the use of citizen science in Sweden. In fact, citizen science has been identified as a valuable source of data in an official investigation (SOU/Swedish Government Official Report) to provide basis for policies concerning environmental monitoring and assessment in the country. As one reads in the official investigation entitled *Sweden's environmental monitoring – its task and organization for good environmental management,*

> *Non-profit organizations such as ornithological societies, botanical societies and diving clubs are important resources for gathering information about the state of the environment. Within national and regional environmental monitoring, interest associations contribute with expert knowledge and inventories. Within some sub-programmes, the non-profit efforts via interest associations or the knowledge and commitment of individuals are absolutely decisive, e.g. within Swedish bird assessment and butterfly monitoring* (SOU, 2019, p. 454).

The case of the Siberian Jay is not the only case where the use of citizen science has been contested in the country. In 2022 a columnist of a national newspaper launched a harsh critique against environmental activists who, in his view, planned the production of data through citizen science using the Artportalen platform (Wennblad, 2022). For this purpose, the columnist identified a group of citizen activists who frequently report and deliver data for *Artportalen* and argued that these activists were in fact deciding about the forests and imposing their interests against the interests of the forest owners. This intervention led to a series of reactions where the role of citizen science was defended (Marissink, 2022). The argument against the role of environmental activists in providing data *Artportalen* echoed arguments expressed in a magazine of the forest owners association where a similar critique has been articulated (Aronsson, 2021). This critique of citizen science and the digital platform *Artportalen* also show that scientists and academics have counter-argued in defence of citizen science and the information and observations provided by ordinary citizens. These counterarguments are often based on recognizing that this type of data is generated from citizen action but given the quality of the infrastructure for this type of environmental science in Sweden, it is argued that this data and its use does not imply that only the interests of those citizens are reflected in the data.

In explaining the case of the local conflicts around the protection of the Siberian Jay, the role of civil society actors is key. On the one hand, a non-for-profit local bird club was among those providing information about the species observation, which in turn was taken as base for decisions by the Swedish forestry agency. But it is important to observe that in the view of participants of that local bird club, their activities were not primary oriented to stop forestry operations (Dagens Nyheter, 2020). What they argued is that they provide information for public use and then it is the role of the authorities to take decisions based on that information. The point is relevant because from the perspective of a forest owner involved in the case, the local bird club had become "a sort of authority in the case" (Landlantbruk, 2018). The two contrasting views on the role of the local bird club in this conflict shows how both the politics of forest and the local politicization of data production became integral parts of these local conflicts. Within this context, it is also important to pay attention to how another civil society actor, namely, BirdLife Sverige, which is larger non-for-profit association concerned with bird biodiversity, actively acted in the Court litigation motivated by the stopping of a forestry operation due to the protection of the Siberian Jay. In their public statements and in the appeal to higher Court, BirdLife Sverige argued for the validity of the data provided by the local bird club, and used by the authorities in their decision. BirdLife Sverige also argued that stopping the logging operations was necessary to preserve the Siberian jay and that it was the state that should have more responsibility in finding ways for making more attractive to forest owners to avoid logging of forests of significance for biodiversity (BirdLife Sverige, 2019a, 2019b) . Thus, it is important to highlight that the actions of these civil society actors are often framed as a call for state regulation and action in the protection of biodiversity. Within this context, both everyday observation of species and active participation in litigation can be seen as an important aspect of civil society mobilization for biodiversity and the key role that production of data play thereby.

These examples of citizen science data and its contestation in the context of the politics of forest and biodiversity shows again that the discussion about the validity of data becomes a public discussion about how the data is produced, who produces the data, and why the data is produced. This is further amplified when, as in the Court

decision mentioned above, this data have an impact on administrative decisions regarding the management and private use of forests. In these cases, we can observe the increasing political relevance of how data is produced and used to make decisions on land use and how these interplays with property relations on forests. While this example shows that there are innovative ways to produce and use environmental data on forests and biodiversity, it is also important to understand that these innovations become entangled in a context where forest conflicts and the politics of data are interlinked. As I will discuss below, these are cases where we can also see that the key role of property rights in the discussion about how these new forms of data production are used in the context of forestry. In fact, to an important extent, producing and using environmental data on forests and forestry create new political contexts for the discussion about private property rights on land. As I will discuss below, it is analytically important to place these conflicts over property rights on land in the political context created by the defence and contestation of property rights on forests and their impacts on biodiversity, and how this runs today in parallel with the ongoing datafication and digitalization of forests and forestry in Sweden.

5. DISCUSSION: THE POLITICS OF DATA AND FOREST CONFLICTS

The examples analysed above suggest that interlinkages between datafication and the politics of forest can be seen in terms of conflicts between different interests in forests and forest management in Sweden. These examples also show new political terms through which different processes of environmental data production concerning forests are articulated in a context of growing datafication and digitalisation of and for forestry and forest assessments. In the case of data produced through citizen science and its contestation, we see how this makes visible conflicts deeply entangled in the clash between forest landowners' property rights on forests and environmental activists' use of various mechanisms to produce data and question the use of forest resources as a matter of private decision making. Within this context, in a comprehensive analysis of property rights in relation to forestry and agriculture published by Royal Swedish Academy of Agriculture and Forestry in 2020 one reads that:

> *The Forestry Agency's routines for supervision also include follow-up of felling carried out and rejuvenation measures. Rejuvenation felling is the occasion when the forest owner reaps the fruits of the investments made in the forest stock. At the same time, the forest environment is changing drastically. It is not surprising that contradictions can then arise and that the forest owner can feel that his right of use has been curtailed. The web publication of logging notifications opens up opportunities for a wide circle of stakeholders to, for example, make their own inventories and report any findings to the Forestry Agency. This can be perceived as violating privacy and creates uncertainty for the forest owner about the possibilities of getting income from the forest. The fact that new key biotopes are sometimes registered in connection with the review of logging notifications contributes to this uncertainty. So do checks against the Artportalen, where anyone, amateur or expert, can enter species finds. The quality of the reports can therefore vary greatly and the registration of findings is affected by how many committed reporters there are in an area. The biggest point of concern is logging bans based on the species protection ordinance because the authorities have so far not considered that such bans give the right to compensation.* (Pettersson, 2020, pp. 88-89).

In the case of the scientific and methodological discussion about big data and national inventories of forests which are based on in site and field inventories, we can observe a tension between the traditional link between nationally produced data and political assessment of forest resources and sustainability based on new global technologies for data production. In more general terms, the examples analysed above show that the politics of data and forests are entangled in the already problematic relation between private decision on forest use and forestry and how they interplay in sustainability questions in Sweden. This question is today to an important degree mediated by data-driven information about the state of the forests and what are the possible consequences of industrial forestry development in the country. In this sense, the proliferation of innovations to produce and use data also brings possibilities for transformation in the terms of the discussion about forestry, biodiversity and property. Here, one could argue that while datafication operates within forestry development as a mean to intensify forestry operations and the use of forests, data production outside the logic of industrial forestry development also takes place in innovative ways. This ongoing transformation of the procedures for environmental assessment of forestry development and the state of the forests shows that the use of new data and the aggregation of existing data with new data is both part of the agenda for a new stage in industrial and productivity-oriented forestry development and it is also part of more democratic production and use of environmental data concerning forests and forestry. While datafication from below broadens the potential for democratic use of data, datafication is also basic to the development of what

might be called innovation from above. This process of innovation concerning the environmental assessment of forestry brings new conflicts over data. Thus data-driven development of forestry and forest digitalization cannot escape political questions about land use based on private land ownership. This is especially relevant when one thinks of conflicts at the structural level, and which lead to constant politicization of data in these conflicts. In this sense, these conflicts shape and are shaped by the different interest in datafication and how this develops politically in areas such as forestry. In these contexts, possibilities for data innovations from below rearticulate in material and ideological ways conflicts based on divergent interests on forests, and this also interplays with new forms of land control. In these cases, I would argue, it is possible to observe the reproduction of a historical tension between private property as an articulating social relation in forestry management and the interests of actors that articulate a critical perspective on private property on forests.

At this point, it important to note that along with the existence of different interests in the forests, a key aspect in these conflicts is how property in land as a social and structural relation is defended and contested. In line with the conceptual framework elaborated above, material interests in the access and use of forests and land, and conflicts arising from the clash between these different interests are deeply associated to the social structure of private property rights on land and forests. Thus, and notwithstanding contingent elements in these conflicts, such conflicts arise from, and are inherent to, the structures of private property relations on land and forests. Finally, I would argue that understanding the process of datafication and data innovation from below and above in relation to forests, land and biodiversity in Sweden requires analysing how these processes shape and are shaped by the structural conflicts that characterise the development of capitalism in general, and the role of private property relations thereby.

6. CONCLUDING REMARKS

This paper has explored the process of datafication and digitalisation of forests and forestry in Sweden to show some key political dimensions and conflicts associated with that process. The empirical examples used to explore the intersection between the politics of environmental data and forests show that data production and their use is particularly contested in the context of forestry and biodiversity in the country. In this regard, environmental data production shows a plurality of actors innovating in data production, and claiming validity for data in a context where there are emergent conflicts concerning forestry development and the assessment of the consequences of forestry development on biodiversity and sustainability. Here, what is referred to as digital forests cannot be understood simply as the opportunity to move forestry into a new phase of capitalist development with the goal of increased productivity and new sources of growth. In fact, the struggle over environmental data concerning forestry in Sweden shows that efforts to increase digitalisation and datafication for forestry development run in parallel with civil society actors' participation in data production, which gets entangled with new tensions and conflicts over forests and forestry. As the example of citizen science shows, interests in forests and biodiversity are in practice a process of innovation in the production of data that comes from below. In this context, the understanding of datafication and digitalization within forestry need to be also understood by taking into consideration both the historical trajectory of capitalist forestry, where data production is today part of a process of qualitative change and quantitative increase in the use of forest, and also, the movements and actors that reclaim forests as a matter of public concern and in doing so put into question private property rights on land and forests.

Finally, and based on the nature of the cases analysed in this paper, I would like to highlight some important avenues for future research. First, more research is needed to add knowledge about the capacity of civil society actors' engagement on environmental data production to influence environmental policy in effective ways. Second, it is important to gain a deeper understanding of the different strategies for environmental data production that different actors employ today and to assess whether these strategies can also lead to wider participation and democratic innovations that contribute to sustainability transitions. Third, and considering that the cases presented in this paper are from a context where civil society actors have comparatively more possibilities to engage in environmental data production, context-specificity is important to be considered in future research about the intersection between the politics of data and the politics of forest across different geographical and socio-economic contexts.

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