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Institutional and Actor-Oriented Factors Constraining Expert-Based Forest Information Exchange in Europe: A Policy Analysis from an Actor-Centred Institutionalist Approach

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Abstract: Adequate and accessible expert-based forest information has become increasingly in demand for effective decisions and informed policies in the forest and forest-related sectors in Europe. Such accessibility requires a collaborative environment and constant information exchange between various actors at different levels and across sectors. However, information exchange in complex policy environments is challenging, and is often constrained by various institutional, actor-oriented, and technical factors. In forest policy research, no study has yet attempted to simultaneously account for these multiple factors influencing expert-based forest information exchange. By employing a policy analysis from an actor-centred institutionalist perspective, this paper aims to provide an overview of the most salient institutional and actor-oriented factors that are perceived as constraining forest information exchange at the national level across European countries. We employ an exploratory research approach, and utilise both qualitative and quantitative methods to analyse our data. The data was collected through a semi-structured survey targeted at forest and forest-related composite actors in 21 European countries. The results revealed that expert-based forest information exchange is constrained by a number of compound and closely interlinked institutional and actor-oriented factors, reflecting the complex interplay of institutions and actors at the national level. The most salient institutional factors that stand out include restrictive or ambiguous data protection policies, inter-organisational information arrangements, different organisational cultures, and a lack of incentives. Forest information exchange becomes even more complex when actors are confronted with actor-oriented factors such as issues of distrust, diverging preferences and perceptions, intellectual property rights, and technical capabilities. We conclude that expert-based forest information exchange is a complex and challenging task. It is driven by actors' preferences/interests, perceptions, and capabilities, and is shaped by formal rules and social norms.

Keywords: actor-centred institutionalism; expert-based forest information exchange; forest policy

1. Introduction

In public policy, the sharing of access to reliable expert-based information and sound evidence are important for policy and decision makers in order to make informed policies and decisions, shape the definition of a problem, and advocate proper solutions and actions [1–3]. Expert-based information is defined as content generated by professional, scientific, and technical methods of inquiry. The information sources include the social and natural sciences, policy analyses, government reports, and

research coming from universities, think tanks, and consultancies [1]. Since expert-based information is an important part of policy and decision-making processes, the need for its exchange is obvious [4].

In broader terms, the concept of "information exchange" originates in the field of information science and knowledge management. It refers to the flow or transfer of information between organisations, and encompasses all facets of information production, sharing, access, storage, mobilisation, and use [5]. Yet, information exchange is not only limited to the technical flow of information. It involves complex social interactions between groups of actors (individuals or organisations) who collaborate in order to exchange information with the purpose of achieving their individual or common interests [6,7]. As such, information exchange is considered a complex socio-technical phenomenon that can be constrained by a number of compound and interlinked technical, institutional, and actor-oriented factors [8–10]. Thus, a complete picture and profound understanding of the constraining factors is critical in order to ensure the development of informed policies, proper actions, and proper decisions, as well as to establish and maintain collaborative relationships.

In European forest policy, decision and policy makers rely on different types of technical, scientific, and professional forest information (e.g., aggregated forest data, descriptive statistics on forest resources and forestry, model and scenario forest studies, opinions and practical experiences of relevant stakeholders, status and updates on current political issues and processes, etc. [4]. The use of expert-based forest information is an important aspect not only in the forest, but also in other forest-related (e.g., climate and energy, biodiversity, agriculture) policy and decision-making processes at the European, national, regional, and local levels. This is the case because adequate and relevant forest information assists the forest and forest-related policy and decision makers in their efforts to address complex policy issues and consider the economic, social, and environmental dimensions of forests, as well as create new opportunities for an innovative sustainable and inclusive bioeconomy in Europe.

The role and importance of expert-based forest information in European forest policy and decision-making processes was first acknowledged by the 1990 Ministerial Conference on the Protection of European Forests (MCPEF) Strasbourg Declaration [11] and the 1998 European Union (EU) Forestry Strategy [12]. Having access and exchanging reliable information was viewed as a prerequisite for informed decisions and collaborative relationships at the different levels and across the different sectors. Most recently, this has been reflected in policy statements such as the 2013–2020 EU Forest Strategy for forests and the forest-based sector [13], and the 2015 MCPEF Madrid Ministerial Declaration [14]. In the EU forest strategy, for example, "forest information" is described as a means to better understanding, and a better management of, the complex policy, social, and environmental challenges that are related to utilising forests as key natural resources in the EU.

Over the past two decades, as a response to political developments and increasingly diversified forest information requirements, national and European bodies have concentrated their efforts on increasing the supply of forest information and improving the quality and harmonisation of data collection and reporting (e.g., European National Forest Inventory Network).

Presently, there are many providers and sources of expert-based forest information available at the different levels. However, the primary sources of forest information are national forest technical, scientific, and policy assessments, inventories, and other monitoring activities [15]. These provide data and generate information that is required to guide and support national decision and policy-making processes in forestry as well as related sectors. At the same time, the sources also provide important information to various international/European processes (e.g., Forest Europe) and data collection systems and services, e.g., the Eurostat Forestry Statistics, the European Environment Agency (EEA), the European Forest Data Center (EFDAC), the European Commission's Joint Research Centre (EC JRC) database, etc. [15].

However, despite the increasing availability of expert-based forest information at the different levels, experience has shown that forest information exchange, particularly in relation to use and

access, remains a challenging task. In particular, previous research has indicated that forest information is scattered, partially incomplete, and difficult to access [4,15–20].

For example, Janse [4,16,21] studied forest communication at the science–policy interface, and explored the information search behaviour of European forest policy makers. The findings revealed that an excess of available information, complexity of websites, and restricted access to online journals and databases are major factors constraining the exchange and acquisition of e.g., scientific forest information.

In 2007, Requardt [15] utilised the network analysis approach to develop criteria and indicators (C&I) data flow charts representing the complex interconnectivity among and between international organisations and relevant data sources. The results indicated that the main challenges lie in the improvement of the technical and financial capacities for managing and processing the large datasets from various sources for various purposes.

Wardle et al. [18] conducted a supply and demand assessment to identify technical forest information needs and gaps at the European level. The study revealed that data about socio-economic aspects such as employment, wood consumption, and prices were problematic or missing. In other areas (e.g., resources and land use, production and trade), forest information was inaccessible or not available in forms that met user needs.

In 2010, Clarke et al. [20] analysed the availability, accessibility, quality, and comparability of monitoring data for European forests for use in air pollution and climate change science. The findings showed that one major challenge is obtaining an overview of what data is available, where to find it, and how to improve access, while also safeguarding both intellectual property rights (IPR) and publicly-funded data collection.

In 2016, Vidal et al. [19] revealed that despite agreements on definitions, the national forest inventory data that was provided for international reporting still lacked comparability, and was partially incomplete.

In summary, these studies revealed that the major challenges that are associated with forest information exchange refer to the use and access of forest information, and the restriction of such use and access is mainly due to technical and/or financial factors (e.g., data quality, completeness, technical capacities for managing data, intellectual property rights). However, considering that information exchange can be constrained not only by technical and financial aspects, but also by institutional and actor-related aspects, the complete picture of the factors constraining the use and access of forest information remains rather vague.

Having a comprehensive overview of institutional and actor-oriented factors would contribute to an increased understanding of forest information exchange, and could be used as a basis to identify potential measures to address the constraints. This will lead to better knowledge on forest resources, as well as their socio-economic and environmental importance, and help inform management strategies to ensure their sustainable future supply.

Building upon previous research, we aim to fill in the empirical gap, and provide a simultaneous overview of the most salient constraining institutional and actor-oriented factors of the expert-based forest information exchange in Europe. Considering that the major challenges associated with forest information exchange relate to the use and access of forest information, in our paper, we focus mainly on the user perspective. More specifically, we aim to analyse the *perceptions* of major forest and forest-relevant actors (organisations and their members) that use or are likely to use expert-based forest information in national forest and forest-related policy and decision-making processes. Examples include state authorities, public organisations, forest owner companies, industry associations, environmental/social non-governmental organisations, research institutions and universities, etc. Since little knowledge exists regarding the institutional and actor-oriented factors affecting forest information exchange, we employ an exploratory (inductive) research approach. Such an approach is mainly used when little is known about the phenomenon in question [22]. In our study, we address the following research questions:

(1) What are the most salient institutional factors that constrain expert-based forest information exchange, as perceived by different forest and forest-relevant actors at the national level across European countries?
(2) What are the most salient actor-oriented factors that constrain expert-based forest information exchange as perceived by forest and forest-relevant actors at the national level across European countries?

Departing from the observation that information exchange is a socio-technical phenomenon that involves complex social interactions, we draw upon the actor-centred institutionalist (ACI) framework [23] and the literature of information science and knowledge management. This approach enables us to answer the research questions and yields general analytical insights into the institutional and actor-oriented factors that are perceived as constraining expert-based forest information exchange in a national context.

2. Analytical Underpinnings

Shaped by the different notions of the new institutionalism (rational choice, as both sociological and historical), the central idea of the ACI framework is that social interactions between actors are structured, and their outcomes are shaped, but not determined, by the characteristics of the institutional settings in which they take place [24]. In this context, Mayntz and Scharpf [23] identify two key elements of explaining social phenomenon: institutions and actors. Following the analytical underpinnings of the ACI framework and building upon research in information science and knowledge management, we identify major categories (e.g., formal rules) and sub-categories (e.g., policy and legislation) of institutions and actors in relation to information exchange. These categories and sub-categories are presented in Table 1, and are used to guide us in structuring, organising, analysing, and interpreting the collected data.

Table 1. Institutional and actor-oriented factors that influence information exchange.

Factors	Category	Sub-Category	Description/Specification
Institutional	Formal rules	Legislation and policy	Internal data protection/privacy policies, codes of conduct, inter-organisational agreements
		Incentives	Rewards, recognition
	Informal rules	Organisational culture	Shared values, goals, attitudes; trust
Actor-oriented	Preferences and perceptions	Beliefs and interests	Strategic utilisation of information
	Capabilities	Rights	Intellectual property rights
		Technical capabilities	Information systems; data standards, definitions and formats, information quality; communication and dissemination

2.1. Institutional Factors Influencing Information Exchange

In the context of the ACI, institutions are defined as "a system of formal and informal rules and procedures that structure social interactions and shape the courses of action that actors may choose" [24] (p. 38).

Formal institutions are legal and/or policy procedures reflecting official "rules of the game" that affect actors' behaviour by specifying required, prohibited, or permitted actions. In the context of information exchange, researchers indicate the critical role that legislation and policy have on information exchange activities between actors [5,8–10]. For example, actors adopt their own internal rules of procedure, codes of conduct, and data protection policies; they also establish

inter-organisational agreements in order to govern the exchange of information. All of these contain specific procedures and provisions for handling and requesting information, and requirements for interaction with other actors [25]. However, legislation and policies can also create barriers in information exchange, e.g., by prohibiting actors from sharing sensitive or privacy-related information [9,10]. Formal institutions can also constitute "structures of incentives" that increase or decrease the payoffs that are associated with given behavioural strategies [24] (p. 39). In the academic literature regarding information science and knowledge management, researchers very often emphasise the important relationship between incentives and information exchange. Considering that information exchange is associated with time, energy, and resources, the role of incentives is important in promoting information exchange activities. Actors have to believe that they will maximise their own benefits and interests in a rational manner by sharing and exchanging information [26]. For example, a lack of incentives (e.g., political, social, economic) can lead to a lack of motivation, and an unwillingness of individuals to share information [8,27–34].

In view of the ACI framework, informal rules such as social norms and cultures play an important role in shaping the interactions and behaviour of actors. The actors will likely respect these informal rules, because their violation can be sanctioned by loss of reputation, social disapproval, or the withdrawal of cooperation and rewards [24] (p. 38). In the context of information exchange, an organisational culture can have a significant influence on the behaviour of actors. Generally, organisational culture is defined as the shared assumptions, values, goals, attitudes, and behaviours that are present in an organisation [32,33]. Actors that embrace similar organisational cultures are more likely to exchange information among each other, and restrain from sharing information with actors that have competing interests [3,34]. In particular, researchers in the field indicate that actors possessing different cultures usually view and treat information differently. For example, owning information can be viewed and interpreted as an important source of power [10,27,35]. Accordingly, some actors have the belief that information sharing leads to a loss of power, social influence, valuable assets, and/or competitive advantages [10]. Also, actors with different organisational cultures can have competing interests; hence, there is less trust as to the use of shared information or the quality of received information [9,10,36,37]. Thus, trust is considered an important attribute in organisational culture that has a strong influence on information exchange.

2.2. Actor-Oriented Factors Influencing Information Exchange

Within the ACI framework, the actor-oriented factors that are influenced by the institutional settings include the proximate determinants that shape actors' behaviours and interactions. These factors relate to actors' orientations and capabilities.

Actors' *orientations* refer to their preferences and perceptions. Actors' preferences are defined by either individual or organisational interests. Interests include the calculated reasoning of actors in relation to particular predicaments, as well as to the cost and benefits of the available courses of action [24] (pp. 63–66). Perceptions are the cognitive orientations of an actor, or in other words, their subjective perception of reality. In this context, actors apply different causal interpretations to phenomena based on their beliefs and values [24] (p. 62).

The use of information in policy and decision-making processes may be biased due to the preferences and perceptions of the actors [38–40]. This occurs when actors involved in policy and decision-making strategically use information in order to legitimise prior beliefs or interests [1]. When actors use information to legitimise previously made decisions, information is politicised and used as a discursive weapon towards opponents. This entails the selective use or misuse of information and a distortive interpretation of information [1,2]. Therefore, actors with closer preferences or perceptions are more likely to send and receive valuable information among each other. Contrarily, actors with competing interests will hide such information from opponents.

Whereas orientations are related to actors' preferences and perceptions, capabilities are all of the action resources that allow an actor to directly influence an outcome produced in a given interaction

(e.g., physical and financial resources, social capital, technical capabilities) [24] (p. 43). In the context of information exchange, researchers suggest that technical capabilities and the know-how of participating actors form the foundation for information sharing [9,10,36,41]. These usually involve information system construction as well as communication and dissemination activities. However, challenges can occur when actors do not coordinate, i.e., utilise different types of information systems and technologies. It is difficult to integrate information systems that have different platforms, data standards, and definitions [9,10]. In addition, poor data quality (e.g., reliability, accuracy) is also considered an important barrier in information exchange interactions. Generally, uncertainty about information reliability and accuracy leads to distrust issues, and hence constrains collaborative relationships, as well as coordination and information exchange. Information users must be able to trust that the information obtained from a provider is of the best quality and the highest accuracy. In return, the providers must be able to trust the users in using the information in an appropriate manner [42].

However, what matters most in the context of policy research are the action resources, which are created by institutional rules that define competencies and grant or limit rights [24] (p. 43). In the field of information science and knowledge management, intellectual property rights (IPRs) are legal tools that are often introduced to protect and specify information and data ownership [43,44]. However, there are controversial findings regarding their role and impact in information exchange activities. Even though they are adopted in order to stimulate innovation by protecting creative work and investment [45], IPRs are often viewed as a constraining factor and thus a barrier in information exchange [43,45].

3. Material and Methods

3.1. Data Collection

In order to achieve the research aim and objectives of our study, we collected data through a semi-structured questionnaire, which was a part of a large-scale research project, "Distributed, integrated and harmonised forest information for bioeconomy outlooks" (DIABOLO). The project (http://diabolo-project.eu/) aims at producing better knowledge of forest resources and the supply forest ecosystem goods and services, as required by a broad range of stakeholders, in order to create new opportunities for an innovative, sustainable and inclusive bio-economy in Europe.

The questionnaire was distributed to a broad range of forest and forest-relevant (e.g., climate change and energy, nature conservation biodiversity, agriculture and rural development) actors and their members, who either use or are likely to use and exchange expert-based forest information. These include:

(i) state forest and forest-relevant authorities and public organisations (St),
(ii) private sector, including forest owner and industry associations (Pr),
(iii) civil society, e.g., environmental/social non-governmental organisations (Cs),
(iv) scientific community (research and academia) (Ro), and
(v) other relevant forest and forest-relevant actors (Oth).

In 2015–2016, we sent the questionnaire to 788 respondents in 21 European countries from six European regions: (i) Northwest (Belgium, France, Ireland); (ii) Nordic/Baltic (Denmark, Finland, Latvia, Lithuania, Norway); (iii) Eastern Europe (Ukraine); (iv) Southeast Europe (Greece, Serbia); (v) Southwest Europe (Italy, Spain); and (vi) Central Europe (Austria, Czech Republic, Hungary, Slovakia, Slovenia, Switzerland). The DIABOLO project partners across the different counties assisted us in conducting the survey. In particular, they supported us by selecting the respondents in their respective country based on the actor groups identified above and guidelines from the authors of this paper, translating the survey from English to the respective native language, distributing the survey, sending reminders, and collecting and translating the completed surveys into English (when necessary).

The questionnaire included both open-ended and closed questions, and consisted of four different sections, focusing on: (i) *Background information* such as gender, age, academic background, and area of work; (ii) *The use and role of forest information* in relation to the work of the respondents; (iii) *Information sharing and exchange*; and (iv) *Mapping specific forest information demands*, which focused on the needs of specific indicators in the work of the respondents.

In total, we received 424 responses (54% response rate) from 19 countries. However, considering the objectives of our study, we focused only on Section 3, *Information sharing and exchange.* In this case, the total number of responses considered in our analysis amounted to 223 (*N*). In order to explore the perceptions of the forest and forest-relevant actors on the constraining institutional and actor-oriented factors, we centred on the following open-ended question:

(i) According to your experience, what are the most significant challenges (maximum three) associated with forest information exchange?

Challenges are understood here as factors that constrain expert-based forest information exchange, in particular its use and access. In order to complete and better understand some of the responses, we referred also to three other questions (which were both closed and open-ended):

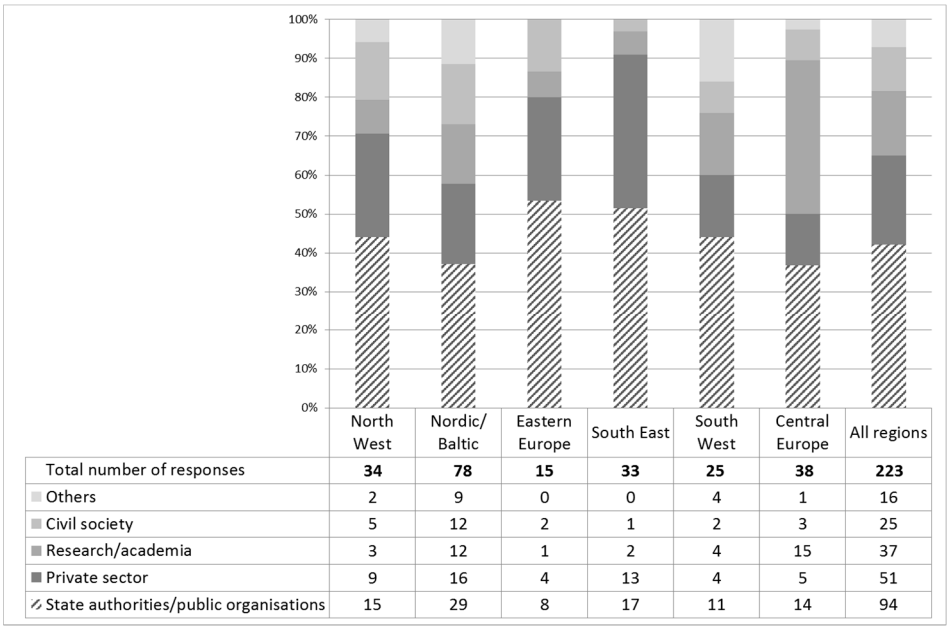
(ii) Are you aware of any formal rules that affect the exchange of forest information in your organisation? If yes, please elaborate.
(iii) In your organisation, is there a shared/collective expectation or an accepted routine to share forest information with other organisations? If yes, please elaborate.
(iv) Are you aware of any conflicts between your organisation and other organisations regarding forest information exchange (e.g., misused/misinterpreted forest information; forest information accessibility versus data protection rights)? If yes, please elaborate.

As illustrated in Figures 1 and 2, the proportion of the 223 responses varied substantially between the different European regions, actor groups (stakeholder categories), and policy areas of work. In regard to the distribution of received questionnaires per European region, the numbers ranged from 15 from Eastern Europe to 78 from the Nordic/Baltic region. Similarly, the distribution of respondents among the targeted actor groups was unequally spread. The majority of the respondents came from the Northern/Baltic or Central European region, and worked in a governmental organisation (94), the private sector (51), or in research and academia (37) (Figure 1).

In regard to the policy areas, a majority of the respondents primarily worked in the area of forestry (ca. 30% for all of the European regions), whereas nature conservation/biodiversity (ca. 18% for all regions) was the second most common policy area of work (Figure 2).

The dominance of stakeholders representing the 'traditional' forest sector and governmental organisations is likely a result of the networks of the DIABOLO project partners at national levels. As the majority of the project partners are associated with National Forest Inventories (NFIs), they are likely to have been used to working particularly with governmental organisations, and thus likely to receive better response rates due to pre-existing contacts. However, these differences in the distribution of responses per European regions, actor groups, and policy areas could be also explained by the regional and country differences in forest cover and forest types, as well as in social, cultural, and economic structures. This implies that the European forest sector(s) today is a heterogeneous assembly of national, institutional, and strong sector interest, which emphasises different forest paradigms, values, cultures, and advocates for different forest policy and management regimes and knowledge production traditions [46].

However, as we are interested in the *perceptions* of forest and forest-related actors from an actor-centred intuitionalist perspective, we reproduce Europe as one entity in our paper. Therefore, we acknowledge regional or country differences, but did not consider them in our analysis. What mattered in our analysis was minimising the standard deviation (variance) by using a larger data set ($N = 223$). As a consequence, the results in relation to the actors' *perceptions* on the major constraining factors of forest information exchange became more significant.



	North West	Nordic/ Baltic	Eastern Europe	South East	South West	Central Europe	All regions
Total number of responses	**34**	**78**	**15**	**33**	**25**	**38**	**223**
Others	2	9	0	0	4	1	16
Civil society	5	12	2	1	2	3	25
Research/academia	3	12	1	2	4	15	37
Private sector	9	16	4	13	4	5	51
State authorities/public organisations	15	29	8	17	11	14	94

Figure 1. Number of received responses (N = 223) distributed according to actor groups and European regions.

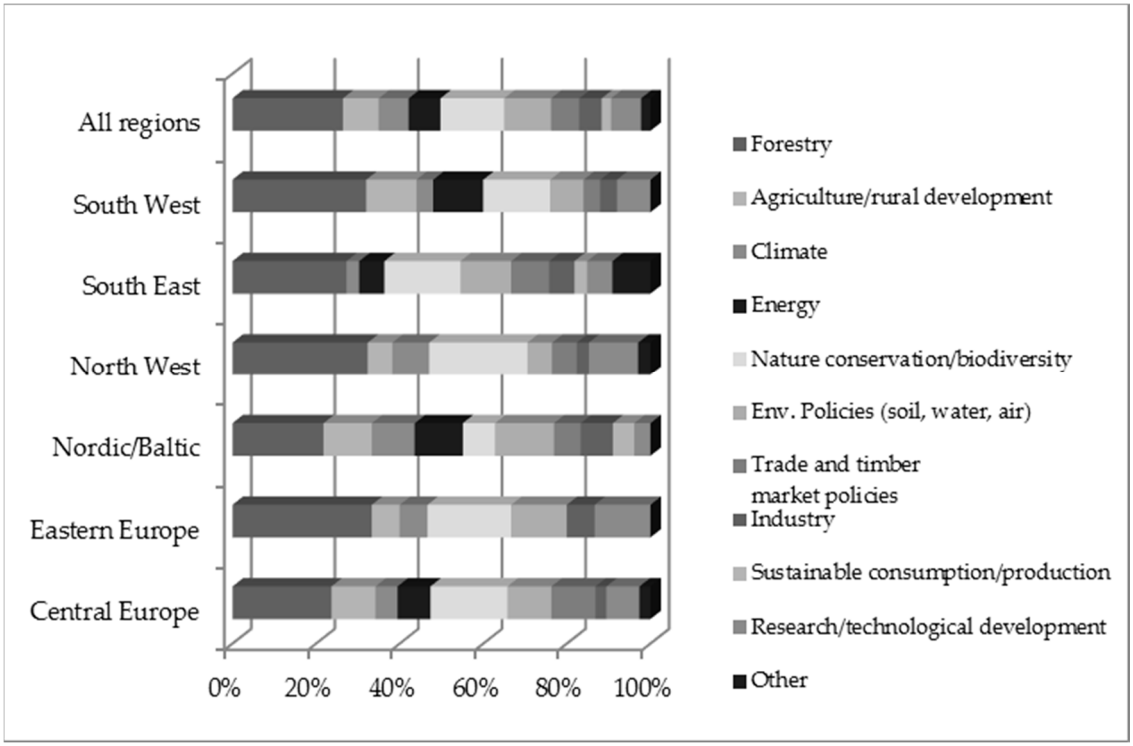


Figure 2. Number of received responses (N = 223) distributed according to European regions and policy areas.

3.2. Data Analysis

Considering the explorative nature of our study and the rich amount of collected qualitative data, the actors' *perceptions* of institutional and actor-oriented factors were subjected to a qualitative analysis (i.e., data reduction, interpretation) based on Miles and Hubermann's [47] framework. Following their

approach, we applied both descriptive and pattern coding (Table 2). Descriptive coding is the first step in analysing qualitative data. It uses descriptive, low inference codes, in order to summarise segments of data and provide the basis for the next level of coding. In our analysis, we used keywords to label and identify what was in the data. Then, we applied pattern coding, which involves interpreting and/or interconnecting and/or conceptualising/categorising data [47,48]. Here, in order to identify the key institutional and actor-oriented factors constraining forest information exchange, we organised our data according to the categories and sub-categories presented in Table 1. Even though this approach risks "forcing" the data into different categories/sub-categories, such a "start list" [47] nevertheless allows new inquiry perspectives that build on previous insights in the field. It rather serves as an analytical framework that can be used to structure and organise the collected data. During our analysis, we identified interlinkages and overlaps between some of the categories/sub-categories. Therefore, some of the responses were placed in more than one category/sub-category.

Table 2. Frequency distribution of the most salient institutional factors that forest and forest-relevant actors perceived as constraining forest information exchange (N = 135).

Institutional Factors	Respondents' Perceived Major Issues/Concerns	No. of Frequencies (N)	Ratio of Total No. of Frequencies (%)
Information sharing policies and legislation	Strict and/or ambiguous policies; lack of coordination	N = 62	46%
Lack of incentives	Lack of motivation and willingness due to lack of political, social, and/or economic incentives for data collection, processing, provision, and dissemination	N = 39	29%
Different organisational goals and competing interests	Different organisational goals and/or competing interests (e.g., forestry vs nature conservation); lack of cross-sectoral coordination and cooperation	N = 34	25%
Total		**N = 135**	**100%**

Finally, we conducted a descriptive statistical analysis in order to identify the most salient institutional and actor-oriented factors that actors perceive to constrain forest information exchange. For this, we assigned numerical values to each of the institutional and actor-oriented factors, and hence calculated their frequency distribution [49], i.e., the associated number of times each factor occurred in the text (frequencies).

4. Results

In this section, we present the most salient institutional and actor-oriented factors that constrained expert-based forest information exchanges, as perceived by forest and forest-relevant actors at the national level across European countries. The quotation marks in the text below are used to give examples, which represent similar and/or particular views on the factors constraining forest information exchange.

4.1. Perceived Institutional Factors Constraining Expert-Based Forest Information Exchange

In total, the number of responses (frequencies) that were categorised into institutional factors amounted to 135 (N).

As shown in Table 2, the most frequently recurring institutional factor constraining the exchange of forest information related to information sharing policies and legislation (46%). In particular, the respondents referred to internal data protection/privacy policies regarding inter-organisational information arrangements (e.g., multilateral and/or bilateral cooperation

agreements or memorandums of understanding). In this context, more than half of the respondents pointed out that very often, these formal internal rules and inter-organisational arrangements represent a significant barrier towards access to and the exchange of forest information. They are either too restrictive, or not explicit and clear enough, in particular in relation to "what data shall be shared ormade public, and under what conditions" (Ro). The lack of coordination and differences between the data protection policies and legislation of different organisations (e.g., state forest authorities and environmental non-governmental organisations) was also emphasised as an issue by nearly one-third of the respondents.

The lack of incentives (29%) was the second most frequently recurring institutional factor that respondents perceived as inhibiting forest information exchange. Almost half of them stated that some organisations lacked the (political) "willingness", "motivation", or "interest" to provide the requested information, e.g., due to a lack of political, social, and/or economic incentives for data collection, processing, provision, and dissemination" (Pr).

Organisational culture (25%) was the least frequently mentioned factor that was perceived to constrain forest information exchange. The most important issue in this regard was that the different organisational goals and/or interests (e.g., forestry versus nature conservation) across the different levels and sectors acted as a barrier to forest information exchange. More than half of the respondents pointed out that forest information was exchanged mainly within trusted social networks, which were made up of member organisations and partners with similar values and beliefs, particularly in the context of joint research and development projects. In this context, the lack of cross-sectoral cooperation and coordination was emphasised a few times. In particular, the lack of cooperation between environmental non-governmental organisations and forestry state authorities, and the synchronisation between different information sources was also explicitly mentioned, i.e., different information was provided on the same topic e.g., "land inventory data versus forest inventory data" (St).

4.2. Perceived Actor-Oriented Factors Constraining Expert-Based Forest Information Exchange

In total, the number of responses (frequencies) in relation to actors' orientations and capabilities amounted to 264 (*N*).

As shown in Table 3, data quality was the most frequently mentioned actor-oriented factor that was perceived as constraining the use of expert-based forest information (36%). Out of this, more than half of the respondents referred to issues related to data accuracy and reliability. In some countries, key data parameters (e.g., ecosystem services, dead wood, forest ownership, employment) were either not produced regularly, or were not produced at all. As a few respondents mentioned, this was because they were "not relevant in the national context" (St), were not among the priorities of specific countries, or were "difficult or costly to measure" (Cs). More than one-third of the respondents also referred to the lack of coherent definitions and data collection or measurement techniques, at sub-national as well as at national levels. Only a few respondents emphasised the slow provision of forest information and the lack of regular up-to-date information as barriers of forest information exchange.

Table 3. Frequency distribution of the most salient actor-oriented factors that respondents perceived as constraining forest information exchange (N = 264).

Actor-Oriented Factors	Major Issues/Concerns as Perceived by Respondents	No. of Frequencies (N)	Ratio of Total No. of Frequencies (%)
Data quality	Different definitions and measurement techniques; data accuracy and reliability; slow provision of data; data not up to date	N = 94	36%
Strategic utilisation of information	Selective/strategic use of forest information	N = 78	30%
Intellectual property rights/data ownership	Copyrights, confidentiality and data ownership; free access to forest information funded by public resources; difficulties to access a certain type of information	N = 55	21%
Information communication and dissemination	Technical forest information lacked simplicity and easy communicability; lack of financial resources for IT systems	N = 37	13%
Total		**N = 264**	**100%**

The strategic utilisation of forest information, particularly in the context of forest-related policy and decision making, was the actor-oriented factor with the second highest frequency of occurrence (30%). More than half of the respondents perceived forest information misuse and/or misinterpretation as a major constraining factor, particularly in relation to the cross-sectoral use and exchange of forest information in a national context. This was due to the different actors' interests and perceptions across the different sectors. For example, forest policy makers (and managers), climate and energy policy makers, and nature conservationists lacked a "common understanding of reality" (Pr), and had "different perceptions about the ecological status and role of the forests". Hence, the same data was interpreted very differently (Cs). In this context, a few respondents emphasised that forest information can be also misused/misinterpreted due to a conflict of interests, e.g., between forest industry associations and environmental non-governmental organisations. In such cases, forest information could be perceived as "inconvenient and/or contradictory towards the (political) agendas or interests of some decision makers and organisations" (St), and hence could be "wrongly interpreted and purposively transferred into the context of the user to achieve a goal" (St). Further, research organisations in a few European countries often encountered the problem of e.g., "non-judgmental communication of scientific findings to national and local administrations, as in their view the findings need to be in line with their political agenda" (Ro). Only a few respondents indicated that the misuse/misinterpretation of forest information could be due to a "lack of technical knowledge or training" (Pr).

Data ownership, in particular intellectual property rights (IPRs), was the third most frequently mentioned actor-oriented factor (21%). Nearly half of these respondents referred to copyrights and the confidentiality of information as major obstacles that restricted access to forest information. About one-third of the respondents emphasised the lack of e.g., "free access to forest information financed by public resources"(Cs). A few respondents reported difficulties in accessing a certain type of sensitive information (e.g., forest ownership, forest management plans, timber harvest, Natura 2000 territories). The access is either fully restricted, or possible only by request for e.g., "a short list of people with authorised access" (Pr). A few times, respondents also emphasised the restricted availability of national forest inventory raw data for research purposes as a problem. The least frequently mentioned factor was information communication and dissemination (13%). In this context, more than half of the respondents pointed out that the technical forest information lacked simplicity and easy communicability; it was e.g.,

"too technical", "forestry-centric", and was difficult to understand by non-forestry stakeholder groups, sectors, and the society. Others mentioned problems with the dissemination of forest information due to e.g., a "lack of technical equipment" (Ro), "high costs for information technology" (Pr), or "insufficiently developed information systems in forestry" (St).

5. Discussion and Conclusions

The present analysis laid the groundwork for the first empirical account of the institutional and actor-oriented factors that are perceived to constrain the exchange of expert-based forest information in both a national and a European context. The analysis showed that the use and access of expert-based forest information is constrained by a number of compound and closely interlinked factors that reflect the complex interplay of institutions and actors.

5.1. Perceived Institutional Factors Constraining Expert-Based Forest Information Exchange at a National Level

The most salient institutional factor that has reportedly constrained expert-based forest information exchange referred to restrictive or ambiguous data protection policies and legislation. Other prominent factors included different organisational cultures, a lack of incentives, and difficulties regarding coordination at different levels and across sectors.

Generally, information sharing policies and legislation (i.e., internal data protection/privacy policies and inter-organisational information agreements) provide the institutional framework for inter-organisational cooperation and the exchange of information. They can facilitate collaborative relationships, and the development of trust in information exchange interactions, but only when clearly defined rights and specific guidance are in place [50–53]. However, this is not always the case with regard to forest information exchange at a national level, as the results of our study demonstrated. Internal data protection/privacy policies and inter-organisational information arrangements are often perceived as either too restrictive or ambiguous, particularly in relation to the public domain of forest information sharing. In this case, they represent a significant formal barrier to forest information exchange, and are a source of diverse interpretations, giving rise to uncertainties and, as a consequence, overly cautious forest information exchange activities. Also, as the analysis showed, a lack of coordination between different actors (e.g., state forest authorities and environmental non-governmental organisations) in regard to data protection policies and legislation is perceived as another constraining factor. This points towards differences in how different actors view forest information and the issue of data privacy.

Similarly, different organisational goals and/or competing interests (e.g., forestry versus nature conservation) across the different levels and sectors also are viewed as a barrier to forest information exchange. That may explain the lack of cooperation in the exchange of forest information between actors from different sectors and competing organisations (e.g., forestry and nature conservation sectors or agricultural versus forestry sectors). This implies that forest information is collected, utilised, and presented in many different ways. Consequently, this leads to the existence and use of various forest and forest-relevant information sources, which provide different information on the same topic. This results in uncertainty regarding the reliability and accuracy of forest information, and leads to issues of distrust. This aforementioned point appears rational, as actors with different interests, values, and beliefs tend to not trust each other. In particular, if forest information is perceived as a means of power, actors will be reluctant to share forest information due to concerns of information misuse. This can explain why forest information exchange occurs within a trusted social network, e.g., among member organisations and cooperation partners or in the context of joint projects and publications. This poses significant challenges to informal sectoral and cross-sectoral cooperation, and creates barriers to forest information exchange and collaborative relationships.

Furthermore, our results imply that the lack of adequate political social and economic incentives for actors is perceived as another major barrier of forest information exchange. Consequently, the

actors lack the motivation, desire, and willingness to collaborate. Those who perceive information as a power resource would withhold rather than share forest information in order to maximise their benefits. Such behaviour leads to competing rather than collaborative relationships, thus restricting open and effective forest information exchange.

All of the above supports previous findings in the forest policy literature regarding the institutional fragmentation, coordination, and competition in the European multi-level system of forest governance [46].

5.2. Perceived Actor-Oriented Factors Constraining Expert-Based Forest Information Exchange at the National Level

Expert-based forest information exchange becomes much more complex when actors are confronted with issues related to actors' orientations and capabilities, e.g., preferences or interests, perceptions, rights, and technical aspects such as data quality, harmonisation, communication, and dissemination.

Our analysis showed that one of the most salient actor-oriented factors constraining the use of forest information refers to the technical capabilities of the actors, i.e., data quality. In particular, data accuracy and reliability are perceived as major obstacles due to e.g., different measurement techniques, a lack of common definitions and understandings of the multifunctional role of the forests, and the existence of only partial data for some key forest parameters. In this case, these issues reduce not only the quality, but also the credibility of forest information. Although these results support prior research findings [15,19,20,54–56], we suggest that further research is needed towards the unexplored linkage between forest information quality and credibility. In addition, the dissemination and communication of forest information is intimately related to data quality in regard to the comprehension and presentation of data. Our results indicated that forest information, in particular technical forest information, lacks simplicity and easy communicability, and is difficult to understand, particularly for non-forestry actors. Consequently, key forestry issues are often not properly conveyed, yielding ambiguous interpretations of forest information by different actors across different levels and sectors.

Most prominently, we found that the actors' preferences and perceptions play a fundamental role in forest information use and interpretation. In particular, our analysis revealed major concerns regarding information misuse and/or misinterpretation by actors from different forest-related sectors (e.g., nature conservation, climate, and energy) in order to legitimise priori policy interests and beliefs. This is what is referred to in the academic literature as the strategic utilisation of information, which entails the selective use and distortive interpretation of information. In this case, we suggest that in some cases, forest information is used as a political asset rather than a neutral and objective form of technical data. This explains why some actors exchange forest information mainly within a trusted group of actors such as partners, member organisations, or organisations with common interests and/or belief systems (e.g., within the forest sector). As König & Bräuniger [3] stated, actors with closer interests and beliefs are more likely to send and receive valuable information among each other, as they are equally likely to hide it from opponents or actors with competing interests in order to maintain power (e.g., forest management versus nature conservation).

All of the above also supports previous findings in the forest policy literature regarding the diversity of policy and socio-economic interests and beliefs in the European multi-level system of forest governance [46,57,58].

Further, our results demonstrated that intellectual property rights and data ownership are perceived as other major obstacles to expert-based forest information exchange in a national context. Although public information is generally associated with free access [59], the results showed that still there are cases where the access to publicly funded forest information is not free of charge. Similarly, the access to a certain type of forest-related information (e.g., forest ownership, forest management plans, timber harvest, Natura 2000 territories) is either fully restricted, or access requires authorisation.

Although some forest information may have remained inaccessible in order to respect actors' legal rights and legitimate interests, there is an innate conflict in the application of IPRs to the provision of publicly funded forest information. Therefore, current IPRs might prove inappropriate in balancing the treatment of forest information as a tradable/exchangeable commodity rather than a public good, and thus create obstacles for forest information exchange. Thus, in view of the "forest information as a power source" perspective, the use and role of IPRs can be considered as another way of maintaining power over policy and decision-making processes.

5.3. Limitations and Outlook

Our paper departed from the general observation that information exchange is a socio-technical phenomenon that involves complex social interactions between actors. In our analytical approach, we built upon the ACI framework and the academic literature of information science and knowledge management. We identified major categories and sub-categories to guide us through our exploratory study, in particular our data analysis and interpretation. Although the analysis took only the user perspective into account, our study provided interesting insights and an overview of the most salient institutional and actor-oriented factors that are perceived as constraining to the use and access of expert-based forest information in a national context. However, future research needs to dwell deeper into the interlinkages between these factors and the perceptions, views, and preferences of the specific actor groups, taking into account the specific regional and country characteristics, forest information types (e.g., technical, scientific), and their specific use in national and/or European forest policy and decision-making processes. Future research also needs to investigate how to build cross-sectoral trust (e.g., closer cooperation, communication, and shared responsibility) and design incentives in order to further facilitate forest information exchange. In addition, we applied the ACI framework rather descriptively as a heuristic research tool to help us identify the major categories of institutional and actor-oriented factors. Therefore, this research could be expanded by applying the ACI framework with the aim of checking/enhancing its explanatory power, particularly in relation to the linkages between and among the different institutional and actor-oriented factors.

Although it was beyond the scope of this study to provide policy or management recommendations, the present results could be used in future attempts to strengthen and facilitate expert-based forest information exchange across different sectors and levels. By having a clear and comprehensive understanding of the factors that constrain forest information exchange, in particular its use and access, policy and decision makers, managers, and other forest-relevant actors can focus on the most critical aspects of this complex phenomenon, i.e., trust. Trust and incentives are the cornerstones that are required to establish and maintain collaborative relationships that facilitate the exchange of forest information. Therefore, policy and decision makers and organisational managers across different levels and sectors could focus on providing/improving the institutional environment (e.g., by providing clear and specific data protection policies and legislation, incentives, and organisational cultures) that enables and facilitates the development and maintenance of trusting relationships, collaboration, and expert-based forest information exchange.

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