



How private are Europe's private forests? A comparative property rights analysis



Liviu Nichiforel^{a,*}, Kevin Keary^b, Philippe Deuffic^c, Gerhard Weiss^{d,e}, Bo Jellesmark Thorsen^f, Georg Winkel^g, Mersudin Avdibegović^h, Zuzana Dobšínskáⁱ, Diana Feliciano^j, Paola Gatto^k, Elena Gorris Mifsud^l, Marjanke Hoogstra-Klein^m, Michal Hribⁿ, Teppo Hujala^{o,p}, Laszlo Jager^q, Vilém Jarskýⁿ, Krzysztof Jodłowski^r, Anna Lawrence^s, Diana Lukmine^t, Špela Pezdevšek Malovrh^u, Jelena Nedeljković^v, Dragan Nonić^v, Silvija Krajter Ostoić^w, Klaus Pukall^x, Jacques Rondeux^y, Theano Samara^z, Zuzana Sarvašová^A, Ramona Elena Scriban^a, Rita Šilingienė^t, Milan Sinko^u, Makedonka Stojanovska^B, Vladimir Stojanovski^B, Nickola Stoyanov^C, Meelis Teder^D, Birger Vennesland^E, Lelde Vilkriste^F, Erik Wilhelmsson^G, Jerylee Wilkes-Allemann^H, Laura Bouriaud^a

^a University Stefan cel Mare Suceava, Faculty of Forestry, Suceava, 720225, Romania

^b Department of Agriculture, Food and The Marine, Forest Service, Dublin, D02WK12, Ireland

^c National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA), Cestas Cedex, 33612, France

^d University of Natural Resources and Life Sciences, Vienna (BOKU), Department of Economics and Social Sciences, Vienna, 1180, Austria

^e European Forest Institute Central-East European Regional Office (EFICEEC), Vienna, 1180, Austria

^f University of Copenhagen, Department of Food and Resource Economics and Centre for Macroecology, Evolution and Climate, Copenhagen, 1958 Frb. C, Denmark

^g European Forest Institute, Bonn Office, Bonn, 53133, Germany

^h University of Sarajevo, Faculty of Forestry, Sarajevo, 71000, Bosnia and Herzegovina

ⁱ Technical University Zvolen, Faculty of Forestry, Zvolen, 96053, Slovakia

^j University of Aberdeen, School of Biological Sciences, Aberdeen, AB24 3UU, Scotland, United Kingdom

^k University of Padova, Department TESAF- Land, Environment, Agriculture and Forestry, Agropolis, Legnaro (PD), 35020, Italy

^l European Forest Institute (EFIMED) and Forest Sciences Centre of Catalonia (CTFC), Barcelona, 25280, Spain

^m Wageningen University and Research, Forest and Nature Conservation Policy Group, Wageningen, 6700AA, The Netherlands

ⁿ Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Prague, 16521, Czech Republic

^o Natural Resources Institute Finland (Luke), c/o Aalto University, Espoo, 00076, Finland

^p University of Eastern Finland, School of Forest Sciences, Joensuu, 80100, Finland

^q Sopron University, Faculty of Forestry, Sopron, 9400, Hungary

^r Forest Research Institute, Sękocin Stary, 05-090, Poland

^s University of the Highlands and Islands, Inverness, IV2 5NA, United Kingdom

^t Lithuanian Research Centre for Agriculture and Forestry, Institute of Forestry, LT-53101, Girionys, Lithuania

^u University Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, Ljubljana, 1000, Slovenia

^v University of Belgrade, Faculty of Forestry, Belgrade, 11030, Serbia

^w Croatian Forest Research Institute, Department for International Scientific Cooperation in Southeast Europe – EFISEE, Zagreb, 10000, Croatia

^x Technical University of Munich, Chair of Forest and Environmental Policy, Freising, 85354, Germany

^y University of Liège, Gembloux Agro-Bio Tech, Department Biose, B-5030 Gembloux, Belgium

^z Forest Research Institute of Thessaloniki, 57006, Vassilika, Thessaloniki, Greece

^A National Forest Centre, Forest Research Institute, Zvolen, 96092, Slovakia

^B Ss. Cyril and Methodius University in Skopje, Forest Faculty in Skopje, 1000, Skopje, Macedonia

^C University of Forestry, Sofia, 1756, Bulgaria

^D Estonian University of Life Sciences, Institute of Forestry and Rural Engineering, Tartu, 51014, Estonia

^E Norwegian Institute of Bioeconomy Research, Ås, 1431, Norway

^F Latvian Forest Research Institute "Silava", Riga, 2169, Latvia

^G Swedish University of Agricultural Sciences, Department of Forest Resource Management, Umeå, 90183, Sweden

^H ETH Zurich, Institute for Environmental Decisions, Natural Resource Policy Group, Zurich, 8092, Switzerland

* Corresponding author at: University Stefan cel Mare Suceava, Universitatii 13, 720225, Suceava, Romania.
E-mail address: nichiforel@usv.ro (L. Nichiforel).

ARTICLE INFO

Keywords:

Property rights

Index;

Private forests

Europe

Comparative analysis

Forest management

ABSTRACT

Private forests are widespread in Europe providing a range of ecosystem services of significant value to society, and there are calls for novel policies to enhance their provision and to face the challenges of environmental changes. Such policies need to acknowledge the importance of private forests, and importantly they need to be based on a deep understanding of how property rights held by private forest owners vary across Europe. We collected and analysed data on the content of property rights based on formal legal requirements existing in 31 European jurisdictions. To allow a comparison across jurisdictions, we constructed an original Property Rights Index for Forestry encompassing five rights domains (access, withdrawal, management, exclusion and alienation). We documented substantial variation of the private forest owners' rights, and notably to i) make decisions in operational management and the formulation of management goals, ii) withdraw timber resources from their forest, and iii) exclude others from the use of forest resources. We identified broad relations between the scope for decision making of private forest owners and jurisdictions' former socio-political background and geographical distribution. The variation in the content of property rights has implications for the implementation of international environmental policies, and stresses the need for tailored policy instruments, when addressing European society's rural development, the bioeconomy, climate change mitigation measures and nature protection strategies.

1. Introduction

Forests account for 32.2% of the European territory (FOREST EUROPE, 2015), providing important environmental services and economic benefits (Mori et al., 2016). Currently, nearly half of European forests are privately owned (Schmithüsen and Hirsch, 2010). Contemporary policy on private forest management is guided by sustainable forest management concepts (Fares et al., 2015). Depending on the region and forest type, these emphasise different aspects of sustainability, such as “sustainable yield” which focuses on sustained timber production, “multi-purpose forestry” which highlights multiple goods and services, or “ecosystem management” which stresses the status and evolution of forest ecosystems (Winkel et al., 2009). At the same time, most European countries are mandated with implementing a plethora of European Union (EU) legislative and policy instruments (Winkel et al., 2013).

Nationally or regionally-based regulatory frameworks influence the *de jure* property rights distribution and hence they impact on the economic and procedural aspects of forest management (Cubbage et al., 2007). A system of property rights is based on “the set of economic and social relations and norms defining the position of each individual with respect to the utilisation of scarce resources” (Furubotn and Pejovich, 1972) and thus depends on institutional decisions (Kissling-Näf and Bisang, 2001; Vatn, 2005). The diversity of national, legal, cultural and historic contexts has led to different levels of restrictions on the management of private forestland, establishing the duties and responsibilities governing forest managers, owners and users (Krott, 2005).

Private forest owners' (PFOs) property rights determine the scope for forest owners to decide individually on the delivery of forest goods and services to the society, subject to the rationale and efficacy of the legal implementation of policies that are related to forests (Bouriaud and Schmithüsen, 2005). These decisions influence the balance that is struck between commercial ecosystem services, like timber, on one hand and non-commercial ecosystem services, such as biodiversity conservation, on the other hand (Lockie, 2013). Hence, a structure of property rights has the potential to influence the entrepreneurial activities of forest owners (Buttoud et al., 2011), the implementation of climate change mitigation and adaptation policies (Lindner et al., 2010), the implementation of nature conservation policies (Winkel et al., 2015) and the delivery of forests products to renewable energy markets (Bouriaud et al., 2014; Kleinschmit et al., 2014; Stupak et al., 2007).

An analysis of property rights based on legal entitlements (Bromley, 1997) is less informative than an approach that considers the bundles of rights (Galik and Jagger, 2015) that are associated with the use of forests. The constitutional setting of the private form of ownership is

based on the legal entitlements conferred on a PFO and does not define *per se* the bundle of rights which determines the scope for decision making and the execution of activities a PFO may wish to perform. Despite its obvious importance, there is an absence of comparative studies investigating across multiple countries the links between property rights distributions and their official regulations relating to sustainable forest management. Existing studies of forest ownership at the European level focus on the overall assessment of forms of ownership (Schmithüsen and Hirsch, 2010) and changes in ownership structure (Živojinović et al., 2015), while studies into the distribution of rights have a primarily regional focus (Avdibegovic et al., 2010; Bouriaud et al., 2013; Glück et al., 2010).

To address this issue, we designed an index of property rights distribution in forestry (PRIF), to provide a structured comparative overview of the impacts of multiple regulatory frameworks on the property rights of PFOs. The PRIF is conceptually based on Schlager and Ostrom's (1992) analytical framework of property rights distribution, which we interpret in the context of private forest ownership. A similar framework is used by the Rights and Resources Initiative (RRI) to assess the impact of national laws that relate to the forest tenure rights of indigenous people and communities in Latin America, Asia and Africa (RRI, 2012). In the RRI study, the unit used to analyse the distribution of the bundle of rights is the community, while our focus is on private forests belonging to individual owners.

The construction of the PRIF is grounded on a systematic and transparent approach required for the formation of indices (Dobbie and Dail, 2013; Voigt, 2013). The use of composite indices is becoming increasingly popular in the assessment of sustainable development determinants (Rogge, 2012) such as economic systems, e.g. the Index of Economic Freedom (Miller et al., 2015), social fulfilment, e.g. the Human Development Index (UNDP, 2016) and environmental performances, e.g. the Environmental Performance Index (Hsu et al., 2016). Many indices are intended to estimate sectoral policy diversity across jurisdictions (Bertelsmann Stiftung, 2016; Hsu et al., 2016; Levy-Carciente, 2016), yet there is no specific index designed for the assessment of forest property rights. The International Property Rights Index (Levy-Carciente, 2016) has a broader scope than the PRIF, serving as a barometer of the security of property rights across the world, and does not specifically target the management of natural resources.

The paper introduces the methods used for setting the PRIF, displays the calculated values in a European scale analysis and identifies regional patterns of the distribution of rights. As with other composite indices, the PRIF can be used in benchmarking comparisons, the evaluation of the evolution of policies or a tool for more effective stakeholder and public communication (das Neves Almeida and García-Sánchez, 2016; Zhou et al., 2006).

2. Methods

2.1. The conceptual framework

The framework of [Schlager and Ostrom \(1992\)](#) has the advantage of transforming a rather abstract understanding of a property rights system into a set of five property rights categories (PRC), which constituted the bundle of rights that were associated with forest attributes that have value to the owner. These PRCs are: 1) access rights (the right of owners to enter their forest land), 2) withdrawal rights (the right to harvest or remove timber, firewood and non-wood forest products – NWFPs), 3) management rights (the right to plan internal forest activities and transform the forest), 4) exclusion rights (legal prescriptions to prevent access and harvesting of wood and NWFPs by external users), 5) alienation rights (the right to sell forestland and forest products).

The index is based on *de jure* applications of property rights. We specifically analysed the formal legal rules ([North, 1990](#)) which influence the PFO's scope for decision making. Only laws and policies pertaining to “normal productive forests” were screened. No scenarios were included for forests in protected areas (e.g. Natura 2000 sites) or forests that were subject to plant health or quarantine measures. The level of restriction (*vis-à-vis* the degree of freedom) in each jurisdiction was assigned using expert analyses of legislation and policy that directly affect PFOs' abilities to benefit from the forest amenities provided by their own forest property. The level of restriction is grounded in the rules of law applying to private forests, and does not assess perceptions of *de facto* situations in implementing these rules.

2.2. The selection of indicators

The selection of indicators was done during three expert meetings that took place in 2013–2014 under the auspices of the FP 1201 FAC-ESMAP COST Action which dealt with forest ownership changes across 30 European countries ([Živojinović et al., 2015](#)). In this context, an initial core group of scientific and professional experts from 18 countries was created, with regular participation in working group meetings. They are considered national experts based on the selection procedures of the COST Action, while their scientific backgrounds are relevant to this specific field of study. Given the systematic and extensive methodological development of the PRIF involving a broad spectrum of expertise across Europe, the selection of indicators covered the practical possibilities that may arise in the day to day interaction of a PFO with their forest property. It also minimizes any possible bias in focus arising from different systems of law across Europe ([Legrand, 1999](#)).

Based in the conceptual framework, a total of 37 indicators were identified to cover the entire range of possible restrictions across the five PRCs (Supplementary material Table S1). The indicators are further grouped into 10 sub-categories of rights to closer reflect the forest ecosystem services they refer to: access rights, withdrawal rights for timber, withdrawal rights for NWFPs, rights for land use change, rights for management planning, rights for operational management, exclusion of public access, exclusion for the use of NWFPs, alienation rights for forest land and alienation rights for timber.

2.3. Data collection

The selected indicators were then incorporated into a multiple choice questionnaire designed for the national experts in forest policy analysis to respond to. Each indicator is formulated as a specific question (e.g. is the forest owner allowed to enter the forest, to collect mushrooms, to decide on the species to be planted, to sell the forestland etc). By defining the indicators as specific questions centred on legal provisions regulating owners' actions, the role of the expert respondents was to provide an evaluation of each indicator as addressed *de jure* in the forest regulatory framework. In order to assure the consistency of interpretation of legal provisions, each indicator is allocated with a

predefined category, identified in a deductive process by the core group of experts. A comment box for each indicator was also included in the questionnaire to cater for particular situations that may arise within a participant's jurisdiction, not covered by the initial predefined categories.

The questionnaire was sent to the national representatives participating in the FP 1201 FACESMAP COST Action. Inputs from 27 countries (out of 30 participating countries) were provided between 2015 and 2016 by the national members of the COST Action. Considering that the aim of the multi-national comparative analysis is to cover as many countries as possible at the European level, other experts from outside the action were contacted to provide answers for the missing countries. They were selected from academia, based on their outstanding scientific contribution in the field of forest policy analysis. In the end, 39 experts covering 31 jurisdictions provided answers on the status of applicable legislation on the 1st of October 2015. Thus the description of the rights and the calculation of the PRIF is interpreted as being valid for this date.

2.4. Data processing

Processing of the initial respondents' questionnaires (post-hoc categorisation) was conducted to ensure that each indicator is covered by the full range of relevant alternatives, describing the diversity of legal stipulations identifiable across the 31 jurisdictions. For example, if a particular situation for a jurisdiction was identified as missing in the initial list of alternatives, a new alternative was created, based on the comments recorded in the questionnaires. Similarly, if multiple answers for any indicator were applicable, intermediate categories were created describing more precisely the legal provision for the indicator. In many situations the initial deductive categories have been complemented with additional ones so that each jurisdiction is represented in a category as close as possible to the legal provision. In the case where multiple answers were applicable for an indicator, the category that gave the most freedom to the owners was considered in the assessment (e.g. an owner may be allowed to do the selection of the trees to be harvested but of course he may also use a professional forester for that). In a situation when the legal system did not address a certain indicator at all, the specific category “not-regulated” was used. An internal validation of the post-hoc categorisation was carried out by sending the final inputs back to the national experts for a second time.

2.5. Data weighting

The full range of alternatives were sorted out and weighted to quantify the degree of freedom in decision making. Alternatives for each indicator were presented in the order of an increasing restriction on PFOs and were weighted from “no restrictions” (100% degrees of freedom) to “fully restricted” (0% degrees of freedom) with intermediate levels of restriction being present. Extreme alternative answers were not found to be present in the legislation (e.g. fully restricting owners from entering their property) for some indicators but they were included to facilitate the weighting of the intermediate alternatives. As the scoring distance between the possible alternative answers could not be presumed to be linear for all indicators, a weighting of the intermediate categories was carried out based on inputs from an expert panel. Out of the initial list of 18 core group members, 12 members provided answers for weighting the categories. The members of the expert panel came from four different backgrounds (forest practitioners, forest policy analysis, social sciences and juridical sciences) and covered all the geographical regions identified by [FOREST EUROPE \(2015\)](#).

The role of the experts was to compare the degree of freedom in decision making that a particular indicator may bestow on the PFO in the context of the other possible alternatives for that indicator, on the basis of their interpretation of the rigour of legal provisions. When

scoring the alternatives, experts were provided with 6 background categories that set the limits of restrictions: no restrictions apply (100% freedom); low level of restrictions (75%–99% freedom); moderate level of restrictions (50%–74% freedom); high level of restrictions (25–49% freedom); extremely high level of restrictions (1–24% freedom); fully restricted (0% freedom). The role of the background categories was to link the qualitative observations derived from the legislation with the quantitative assessment of the degree of freedom and thus to assure the consistency among the perceptions of different experts. The members of the panel provided their valuation of alternatives in a double blind weighting process. At first, an individual weight was assigned for each alternative, and then the experts were asked to validate or adjust the answers considering the average weight calculated for each alternative.

2.6. The aggregation of the indicators

All indicators were considered to be equally weighted in the index to allow for comparisons between jurisdictions with different forest policy and regulatory landscapes. The Property Rights Index in Forestry (PRIF) scores for each jurisdiction was the mean of the values for each indicator (q_i) for the set of 37 indicators (n). The value of the index ranges from 0 (when full restrictions apply for all the indicators) to 100 (when owners have a full degree of freedom for all the indicators).

$$PRIF = \frac{\sum_{i=1}^n q_i}{n} \quad (1)$$

Each PRC was assessed using a similar method and represents the mean value of the indicators corresponding to that category. However, the number of indicators in each of the PRCs reflects the influence each category has on the overall PRIF value: access rights accounts for 3% in the PRIF formation, withdrawal rights account for 30%, management rights account for 35%, exclusion rights account for 19% and alienation rights account for 13%. Depending on one's relationship with the forest, viewpoints may differ on the role the various private forests attributes have in the provision of ecosystem services, and consequently on the importance of each of the PRCs which may be perceived differently among stakeholders in terms of their relative importance. Thus, an interpretation of the overall PRIF needs to be made in the context of its constituent PRC's.

2.7. Comparative analysis of PRIF

We applied the index to a European scale comparison across 31 jurisdictions, covering more than 60 million hectares of forest land in individual private ownership (Živojinović et al., 2015). The jurisdictions analysed are national or regional, according to the relevant levels of policymaking. Thus, in 24 cases the legal framework is analysed at the country level (abbreviations of the countries are identified using the ISO 3166), while in seven cases the level of analysis is regional: Wallonia—Belgium (BE-WAL), Baden-Württemberg—Germany (DE-BW), Bavaria—Germany (DE-BY), Veneto—Italy (IT-34), Catalonia—Spain (ES-CT), Aargau—Switzerland (CH-AG) and Scotland—Great Britain (GB-SCT).

In order to compare the distribution of rights among the jurisdictions, a principal component analysis was used as an exploratory data analysis, considering the 10 sub-categories of rights as variables and the 31 jurisdictions as observations. The aim of the component analysis was to identify the patterns of regional differentiation of jurisdictions resulting from the interactions between the PRCs. The FactoMineR package (Lê et al., 2008) of R (version 3.01) was used.

3. Results

3.1. Distribution of access rights

Access rights into forests was assessed based on one indicator, questioning if the owners are free to enter their own property. This right is generally fully permitted to the owners in 17 out of 31 jurisdictions, which are scored with full freedom for owners (100%). Some temporary restrictions may apply for health and safety reasons, prevention of fires or military purposes in 12 jurisdictions (Bosnia and Herzegovina, Bulgaria, Catalonia, Croatia, Czech Republic, France, FYR Macedonia, Lithuania, Serbia, Slovakia, Scotland and Sweden). These restrictions are assessed as giving 90% degrees of freedom to owners since they apply in rare circumstances. Consequently, there are no big disparities in access rights between the jurisdictions analysed, except two cases. In Romania, access restrictions for owners may be imposed under a framework of contractual agreements to prevent illegal logging. Since the owner may choose to decline these restrictions the degree of freedom attained is still high (80%). Legally imposed restrictions are identified in Wallonia during designated hunting days where access to the forest by PFOs is restricted thus Wallonia attains a moderately restrictive score (55% degrees of freedom) in this category.

3.2. Distribution of withdrawal rights

State involvement in determining or supervising the PFOs with regard to what or how much they are permitted to harvest from their forest was assessed based on 6 indicators that make reference to timber products (Table 1) and 5 indicators that make reference to NWFPs (Table 2).

In 13 out of the 31 jurisdictions the amount of timber that may be harvested can be decided by the forest owner, with restrictions imposed on exceptional cases or in a framework of general technical provisions (Table 1a). At the other extreme, in nine countries owners cannot decide on the amount of timber to be harvested, this being set by the provisions of a mandatory management plan. In the remaining nine jurisdictions the amount that can be harvested with owner's self-control is provided for as a quantitative threshold in the relevant legislation. In France and Veneto region (Italy) more detailed regulations are in place that combine the size of the forest and harvesting rates. At the time of the assessment, only Lithuanian law distinguished between the harvesting of timber for "personal" and "commercial" uses.

In most of the jurisdictions forest owners are required to inform authorities or get their approval before harvesting commences. Even in this respect important differences exist from the need to inform authorities only when they planned to commence harvesting in special cases to the need to ask for approval in any situation (Table 1b). In Bulgaria, Greece, Romania and FYR Macedonia the collection of fallen branches from the ground and harvesting of standing timber is treated similarly with regard to regulatory requirements, while in the remaining 27 jurisdictions brushwood collection is at owners' discretion. Regarding the freedom to physically harvest trees (Table 1c) it is observed that in 24 out of the 31 jurisdictions the owner has the right to harvest the trees themselves. In Romania this is possible only for quantities below 20 m³, while in five other jurisdictions this is possible if the owner has a special licence. Only in Greece, the owner is always obliged to contract a specialised firm for harvesting operations.

For NWFPs there are fewer legal prescriptions compared to timber withdrawal (Table 2). Harvesting rights for the private use of mushrooms (an example of a product comparable across jurisdictions) are generally granted to the owner in 27 out of the 31 jurisdictions (Table 2a). Only in Bosnia and Herzegovina, Bulgaria, Croatia and Slovenia are there maximum quantity limits imposed. Rules for the commercial uses of mushrooms do not differ significantly, only in eight countries are specific certificates approvals required if the owner wants to sell the mushrooms (Table 2b).

Table 1
Distribution of withdrawal rights for timber products (based on the expert analysis of the legal provisions applying in the 31 jurisdictions).

Relevant indicators and alternatives	Jurisdictions (Countries/Regions)	Total	
		number	(%)
<p>a. Freedom of owners to decide the amount of timber to be harvested from the property: The owner is allowed to decide the amount, some restrictions being impose in exceptional cases. The owner can solely decide the amount in a framework of general silvicultural restrictions. The owner can decide the amount up to [size of the forest/quantity] provided in the legislation.</p>	<p>FI, NL AT, BE-WAL, DE-BW, DE-BY, DK, IE, LV, NO, PT, ES-CT, SE FR: [4 ha, but maximum 50% of the standing timber] IT-34: [2.5 ha in coppice/ < 100 m³/yr in high forests]; EE: [20 m³/yr], GB-SCT: [5 m³/quarter] BG, CH-AG: [10 m³/yr] CZ, LT, RO: [3 m³/yr] BA, HR, GR, MK, HU, PL, RS, SK, SI</p>	<p>2 11 9</p>	<p>(6) (36) (29)</p>
<p>The amount to be harvested is entirely the result of forest management planning.</p>		9	(29)
<p>b. Approvals needed by owners for timber harvesting: No need to inform or ask for approval before harvesting. Need to ask for approval before harvesting only in special circumstances: [size of clearcuts].</p>	<p>DK BE-WAL, DE-BY: [> 5 ha] DE-BW: [> 1 ha]; AT: [> 0,5 ha] FI, HU, NL, NO, PT, SE EE, LT, GB-SCT</p>	<p>1 4</p>	<p>(3) (13)</p>
<p>Need to inform authorities and take into account the conditions of approval only if required by said authority. No need to get an approval if timber is for personal consumption or below a threshold provided in the legislation. Need to ask for approval before harvesting only for situations when FMP does not apply. Need to ask for approval in any situation and to adhere to the conditions of approval.</p>	<p>CZ, FR BA, BG, ES-CT, HR, GR, MK, IE, IT-34, LV, PL, RO, RS, SK, SI, CH-AG</p>	<p>2 15</p>	<p>(6) (49)</p>
<p>c. Freedom of owners to perform the harvesting of trees: The owner has the right to harvest the trees by him/herself.</p>	<p>AT, BE-WAL, BA, CZ, DE-BW, DE-BY, DK, EE, FI, FR, MK, IE, IT-34, LT, NL, NO, PL, PT, RS, SI, ES-CT, SE, CH-AG, GB-SCT RO: [< 20 m³]</p>	<p>24</p>	<p>(78)</p>
<p>The owner has the right to harvest the trees by him/herself under a [certain quantity] provided by the legislation. The owner has the right to cut by himself only if he/she has a licence proving harvesting skills. The owner is obliged to contract a specialised firm for harvesting.</p>	<p>BG, HR, HU, LV, SK, GR</p>	<p>1 5 1</p>	<p>(3) (16) (3)</p>

Table 2
Distribution of withdrawal rights for non-wood forest products (based on the expert analysis of the legal provisions applying in the 31 jurisdictions).

Relevant indicators and alternatives	Jurisdictions (Countries/Regions)	Total	
		Number	(%)
a. Freedom of owners to harvest mushrooms for personal use from the property: The owner can harvest as much as he/she wants without any form of restrictions.	AT, BE-WAL, CZ, DK, FI, FR, GR, MK, HU, IE, IT-34, LV, NL, NO, PL, PT, RO, RS, SK, ES-CT, SE, CH-AG, GB-SCT	23	(74)
The owner can harvest without any approval and planning but general restrictions are provided in the legislation.	DE-BW, DE-BY, EE, LT	4	(13)
The owner can harvest a certain amount of mushrooms provided in the legislation without any approval or planning.	BA, BG, HR, SI	4	(13)
b. Special requirements needed by owners to harvest mushrooms for commercial use: The owner can harvest as much as he/she wants without any form of restrictions. The owner can harvest without any approval but general restrictions are provided in the legislation. The owner needs an approval/certificate to pick mushrooms or a management plan.	AT, BE-WAL, DK, FI, FR, GR, MK, HU, IE, LT, NL, NO, PL, PT, SK, SE, CH-AG, GB-SCT EE, IT-34, LV, SI, ES-CT BA, BG, HR, CZ, DE-BW, DE-BY, RO, RS	18 5 8	(58) (16) (26)
c. Freedom of owners to decide the amount of game that can be hunted from his/her property: The owner can decide as much as he/she wants to be hunted without any form of approval. The owner can decide the amount of game to be hunted in the framework of an imposed limit or state approval.	DK AT, DE-BW, DE-BY, ES-CT, GB-SCT	1 5	(3) (16)
State decision on big game, the owner can decide only for specific species [i.e. small game]. The amount of hunted game is negotiated between different interest groups and the owner/forest owners association.	EE, FI, LV, LT, FR, NL	4 2	(13) (6)
The hunting association/the state (i.e. agency) decides the hunting quota – owner cannot influence it.	BE-WAL, BA, BG, HR, CZ, GR, MK, HU, IE, IT-34, NO, PL, PT, RO, RS, SK, SI, SE, CH-AG	19	(62)
a. Freedom of owners to decide on how grazing activities can take place in his/her property: The owner can legally decide how grazing activities can take place on his/her forestland based on legal provisions. No legal provisions regulating grazing activities exist The owner can decide on grazing activities taking place in his/her forest but general legal limitations apply. Grazing activities are allowed only if considered in the Forest Management Plan/or when special forest management and nature protection goals are pursued/or based on permits. Grazing activities are forbidden by the legislation.	BG, NO, ES-CT, GB-SCT EE, FI, LV, NL, PT AT, MK, IE, IT-34, LT, RO, SE BA, HR, DE-BW, DE-BY, DK, FR, GR, RS, SI BE-WAL, CZ, HU, PL, SK, CH-AG	4 5 7 9 6	(13) (16) (23) (29) (19)

Game for hunting is not owned by the PFOs in any of the countries analysed and thus the assessment considers a highly restrictive scope for decision making exists with respect to the legal provisions pertaining hunting activities in all jurisdictions. Differences exist in the formulation of the legal provisions which is shown by the fact that in 15 out of the 31 jurisdictions the game belongs to nobody (*res nullius*) and in 14 jurisdictions to the state, which has the right to transfer the ownership of said game. In only two jurisdictions the game legally belongs to a hunting association (Wallonia and Bosnia-Herzegovina). Regarding the decision on the amount of game to be hunted (Table 2c), in 19 out of the 31 jurisdictions the owner cannot influence the hunting quota, this being decided by hunting associations and approved by a state authority. Only in Denmark can the owner decide on the hunting quota without any form of approval. In the remaining 11 jurisdictions, various different legal scenarios exist given a different scope for decision making to the PFOs.

Grazing may impact forest regeneration and thus this activity is regulated in most European jurisdictions, with the exception of five countries where no specific regulations exist (Table 2d). In 15 out of the 31 jurisdictions grazing activities are legally forbidden or permitted only in special conditions, while in the remaining 11 jurisdictions, the owners can decide on how or if grazing activities can take place in their forests.

With relation to the 11 indicators evaluated under the withdrawal rights category, substantial differences between the jurisdictions are identified, the withdrawal rights index ranging from 27 degrees of freedom in Greece to 84 degrees of freedom in Denmark (Fig. 1), with an average of 61 degrees of freedom and a standard deviation of 16.8 (Table 6).

3.3. Distribution of management rights

The right to plan and transform the forest has been assessed based on 13 indicators divided in 3 subcategories: rights for land use change (3 indicators), rights for management planning (8 indicators) and rights for implementing forest management operations (2 indicators).

In all jurisdictions, there are restrictions imposed on forestland management particularly regarding land use change, e.g. a change from forest use to an agricultural or other land use (Table 3a). Forest land use change is permitted in 22 out of the 31 jurisdictions, but PFOs have to undergo some procedural steps or are allowed to change only a limited area. In Catalonia, forest use change is only permitted for agricultural purposes subject to a ploughing authorisation, but any land use change is forbidden in burnt forests all over Spain for a period of at least 30 years. On the contrary, PFOs in nine jurisdictions are not allowed to change the forest land use except in cases relating to the public interest. Rules on forest regeneration oblige PFOs to reforest the land after final felling in all cases except Wallonia, Portugal and Catalonia. However, two contrasting approaches exist here: in 12 of the 31 jurisdictions, reforestation can be subsidised or be subject to grant applications while in 15 jurisdictions owners have no or few opportunities to access financial support for reforestation.

Many differences between jurisdictions exist with regard to the regulation of the forest management planning and the subsequent treatment of timber harvesting. Forest Management Plans (FMPs) are not compulsory in 12 out of the 31 jurisdictions (Table 3b), but can be required for specific situations (e.g. qualification for financial subsidies in Austria and Scotland, “a plan of works” in Ireland and in case of clear-cuts over 5 ha in Wallonia). In nine other jurisdictions, a FMP is

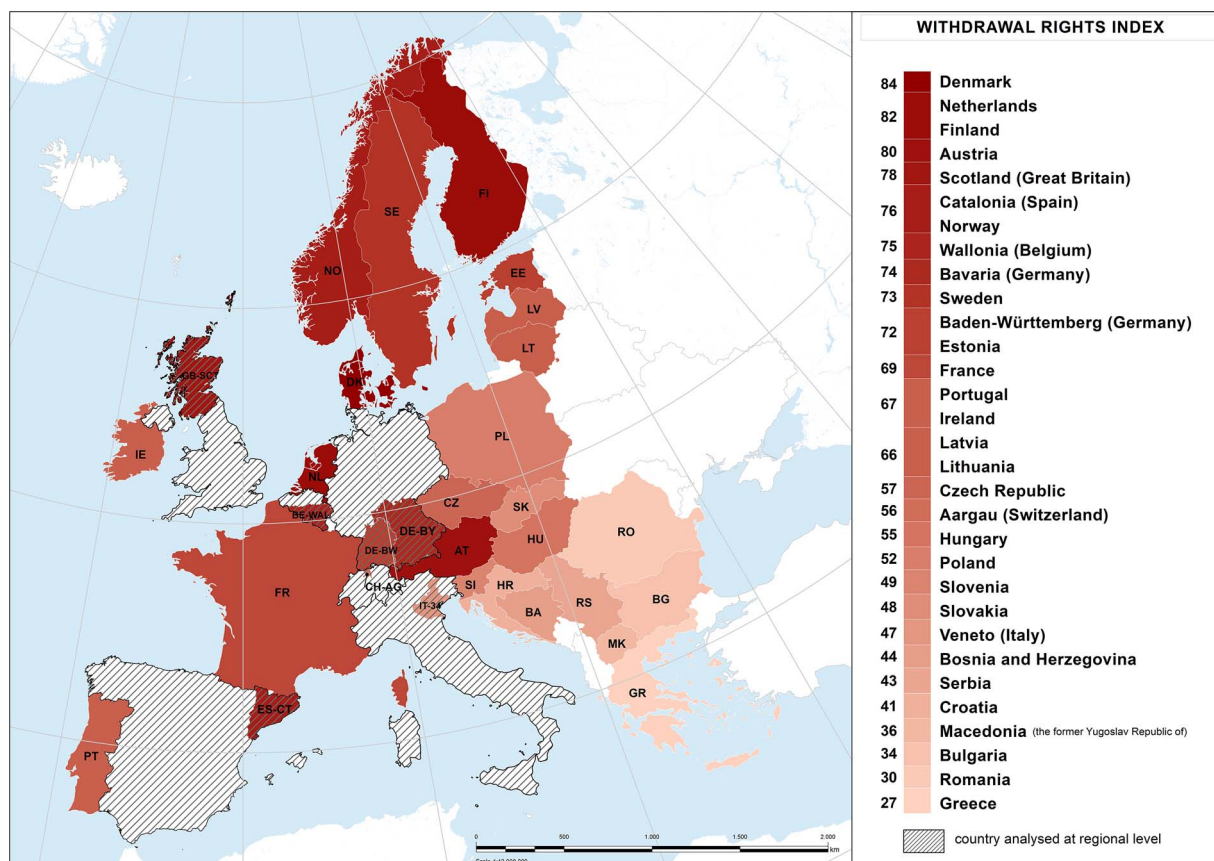


Fig. 1. Geographical distribution of withdrawal rights across the analysed jurisdictions. The figure is compiled from the data we collected for 11 indicators. Each indicator was assessed on a scale ranging from 0 (“right fully restricted”) to 100 (“no restrictions apply”). The withdrawal rights index is the mean value of the 11 indicators. The gradient of the colour varies from a lighter colour (low degree of freedom in decision making) to darker colours (high degree of freedom in decision making).

Table 3
Distribution of management rights (based on the expert analysis of the legal provisions applying in the 31 jurisdictions).

Relevant indicators and alternatives	Jurisdictions (Countries/Regions)	Total	
		Number	(%)
<p>a. Freedom of owners to decide on the change of the property from forestland to other land uses: The owner is allowed to change the forest land use with some procedural requirements. The owner is allowed to change the forest land use only for a limited area and/or with compensations. The owner is not allowed to change the land use but some exceptions may apply (i.e. for public interest). The owner is not allowed to change the land use under any circumstances.</p>	AT, BA, CZ, DE-BW, DE-BY, EE, FI, FR, NO, PT, RS, SI, ES-CT, SE BG, HU, IE, LV, LT, NL, RO, SK BE-WAL, HR, DK, GR, MK, IT-34, PL, GB-SCT CH-AG	14 8 8 1	(45) (26) (26) (3)
<p>b. Obligations of owners to have a forest management planning (FMP): No form of FMP is legally required in any case, including subsidies (except the voluntary requirements brought by certification). FMP is required only if special conditions (e.g. if the forest owner wants to access financial support) otherwise no form of FMP is needed. FMP is not required but forest inventory data are requested for all forest. FMP is required only if the owner wants to perform final feeling. FMP is always mandatory for forests above [a certain area].</p>	DE-BW, DE-BY, FI, NO, SE AT, BE-WAL, DK, GR, IE, NL, ES-CT, GB-SCT EE, IT-34, LV LT BG, CZ, MK: [50 ha] FR, PT: [25 ha] CH-AG: [20 ha] RO, PL: [10 ha] BA, HR, HU, RS, SK, SI	5 8 3 1 8 6	(16) (26) (10) (3) (26) (19)
<p>c. Freedom of owners to choose forest management goals: Forest owners can freely choose the management goals. Forest owners can choose the management goals within some technical limits (e.g. the size of clear cuts). Forest owners can bring their management goals in the planning process, but they have not the freedom of decision. Forest owners' interest are only informative and not relevant in planning process, however their interests are mentioned in the finalised FMP. Forest owners' interests are not considered at all in the planning process.</p>	DK, FI, NL, NO, ES-CT, SE AT, BE-WAL, DE-BW, DE-BY, EE, FR, IE, LV, LT, PT, CH-AG, GB-SCT BG, HR, CZ, GR, HU, SK, SI IT-34, PL, RO, RS BA, MK	6 12 7 4 2	(19) (39) (23) (13) (6)
<p>d. Freedom of owners to select the trees to be harvested: The owner can do the selection of the trees to be harvested. The owner can do the selection, based on the evidence that he has general technical knowledge/or based on authority approval. An authority/technical expert has to do the selection free of charge. An authority has to do the selection and owners have to pay.</p>	AT, BE-WAL, DE-BW, DE-BY, DK, EE, FI, IE, NL, NO, PT, SE, CH-AG, GB-SCT CZ, FR, LV, LT, ES-CT HR, GR, PL, SI BA, BG, HU, IT-34, MK, RO, RS, SK	14 5 4 8	(45) (16) (13) (26)
<p>e. Freedom of owners to decide on the type of species to be used for reforestation: The owner can decide the species with no constraints. The owner can decide it based on general technical provisions provided in the legislation (i.e. limitation of certain species). The species are decided by the forest management planner but can be adapted according to owner needs. The species are decided by the forest management planner/administrator and the owner cannot influence the process.</p>	AT, DK, NL, GB-SCT BE-WAL, DE-BW, DE-BY, EE, FI, FR, GR, IE, LV, NO, PT, ES-CT, SE, CH-AG BA, HR, CZ, MK, HU, IT-34, LT, PL, RS, SK, SI BG, RO	4 14 11 2	(13) (45) (36) (6)

required only if the size of property is above a certain area. On the contrary, in six former-socialist countries, an FMP is always required, regardless of the size of the property and regardless of the forestry works the owner intends to carry out.

Large disparities also exist between countries in the area of FMP formulation (Table 3c). Whereas PFOs were free to choose the management goals in six out of the 31 jurisdictions, the forest owners' interests were not considered at all in the planning procedures in Bosnia-Herzegovina and FYR Macedonia. Beyond these two contrasting situations, forest owners' participation in the definition of FMP goals varied from an active involvement in setting the management goals within the limits of the law (in 13 jurisdictions) to a formal consultation with limited possibilities of influencing the forest management goals (in nine jurisdictions). Forest policies give priority to timber production in six countries where timber production cannot be abandoned as the main management goal (Austria, FYR Macedonia, Hungary and Poland) or has to be kept at a level defined as "sufficient" by the legislation (Sweden and Aargau- Switzerland).

Private forest owners can directly manage their own forests in 19 out of the 31 jurisdictions. However, in the former socialist countries (except the Baltic countries) the state requires that the implementation of management activities in private forests are executed by professionals, employed by the owner (Hungary, Bulgaria, Romania, Serbia, Slovakia, Czech Republic), compensated by the authority without costs to the owner (Croatia, Slovenia, Poland and in Czech Republic for owners without FMP) or imposed by the authority at the owners' cost (Bosnia and Herzegovina and FYR Macedonia). These variations are reflected in operational management issues such as who is entitled to select the trees for harvesting (Table 3d) and to decide on the type of species to be used for reforestation (Table 3e).

The 13 indicators that constitute the management PRC, point to substantial differences across the jurisdictions with respect to the regulation of private forest management. The values of the management rights index vary from 12 degrees of freedom in FYR Macedonia to 84 degrees of freedom in Bavaria in Germany (Fig. 2), with an average of 54 degrees of freedom and a standard deviation of 23.6 (Table 6). Here former socialist countries form a compact group with high levels of restriction while forest owners from Western and Nordic countries generally have more freedom to decide on operational matters (Fig. 2).

3.4. Distribution of exclusion rights

The regulation of exclusion rights concerns the forest owners' legal ability to allow or prevent the general public or other public forest user categories from entering and benefiting from the forest resource (Table 4).

In 16 out of 31 jurisdictions public access into private forests cannot be restricted, with some exceptions in specific situations. In four countries access has to be allowed only on designated pathways (Table 4a). In contrast, only nine jurisdictions permit public access into the forest to be legally restricted. Camping in forests can be restricted by the owner in 20 jurisdictions while in only four cases, camping was considered an "everyman's right" (Table 4b). In Greece and FYR Macedonia public access into the forest and the right to restrict camping is not regulated.

Regarding the more tangible assets such as non-wood products, there were fewer legal restrictions in comparison to timber products: mushroom picking for recreational purposes can be restricted in 16 jurisdictions, while in five jurisdictions, restrictions on the quantity of mushrooms that can be harvested are provided for in the legislation

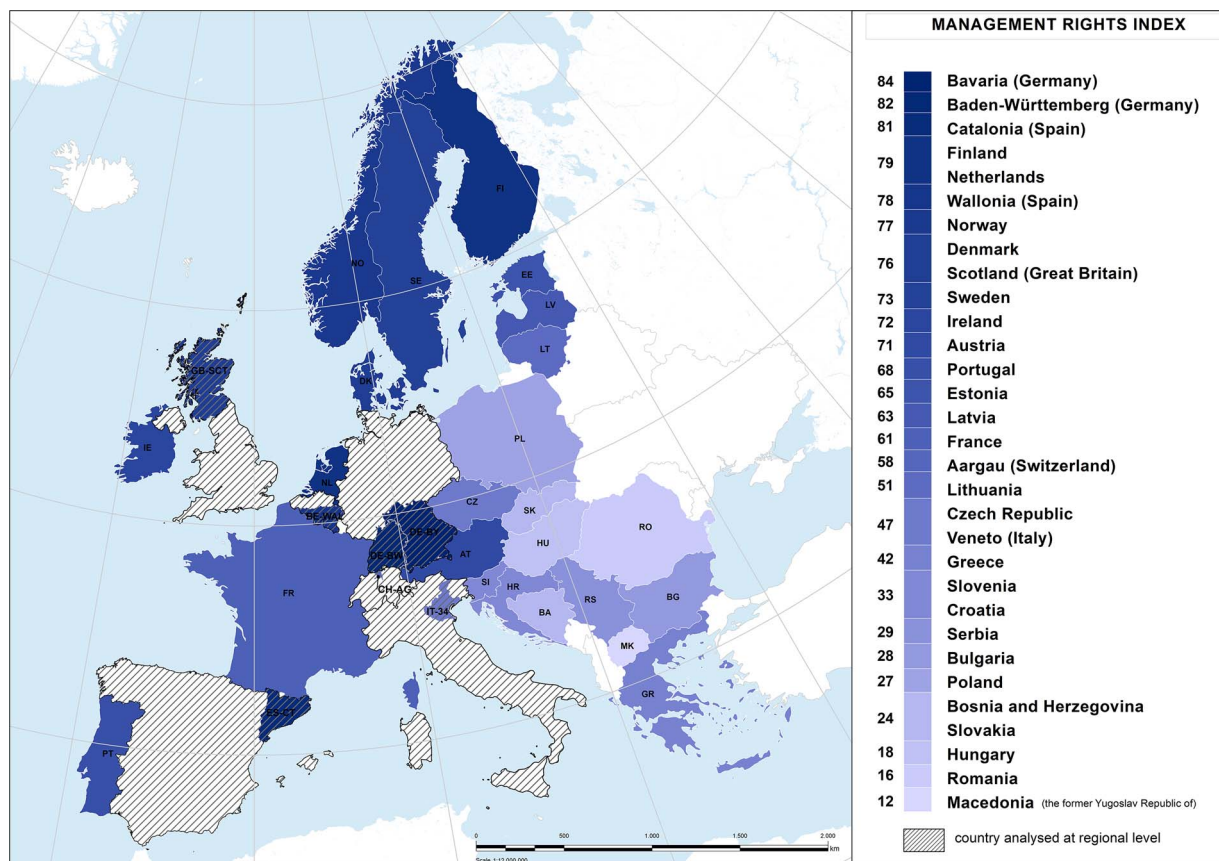


Fig. 2. Geographical distribution of management rights across the analysed jurisdictions. The figure is compiled from the data we collected for 13 indicators characterizing management rights. Each indicator was assessed on a scale ranging from 0 ("right fully restricted") to 100 ("no restrictions apply"). The management rights index is the mean value of the 13 indicators. The gradient of the colour varies from a lighter colour (low degree of freedom in decision making) to darker colours (high degree of freedom in decision making).

Table 4
Distribution of exclusion rights (based on the expert analysis of the legal provisions applying in the 31 jurisdictions).

Relevant indicators and alternatives	Jurisdictions (Countries/Regions)	Total	
		Number	(%)
a. Freedom of owners to restrict the public access into his/her property: Public access in private forests is restricted by the provision of the law. The owner can fully restrict the public access if he/she wants. The owner has to allow access only on marked pathways for recreational purposes free of charge. Not regulated. Everyman's right: the owner cannot restrict the public access for recreational purposes.	PT	1	(3)
	BE-WAL, EE, FR, IT-34, LV, NL, PL, ES-CT	8	(26)
	BG, DK, RO, IE	4	(13)
	GR, MK	2	(6)
	AT, BA, HR, CZ, DE-BW, DE-BY, FI, HU, LT, NO, RS, SK, SI, SE, CH-AG, GB-SCT	16	(52)
b. Freedom of owners to restrict the camping in his/her property: Camping in private forests is restricted by the provision of the law. The owner can restrict the camping if he/she wants by putting special signs/authorise. Not regulated. The owner has to allow camping in special designated places. Everyman's right: the owner cannot restrict camping.	AT, CZ, DE-BW, DE-BY, DK, FR, NL, PT, SK	9	(29)
	BA, HR, EE, HU, IE, IT-34, LV, PL, RO, RS, ES-CT	11	(35)
	GR, MK, CH-AG	3	(10)
	BE-WAL, BG, LT, SI	4	(13)
	FI, NO, SE, GB-SCT	4	(13)
c. Freedom of owners to restrict the collection of mushrooms from his/her property: The collection of mushrooms in private forestry is restricted by the provision of the law. The owner can restrict the collection if he/she wants by putting special signs/authorise. The owner can partly restrict the collection to certain quantities/categories of public/certain periods of time. Everyman's right: the owner cannot restrict the collection of mushrooms for recreational purposes.	FR, HU, IT-34, NL, RO	5	(16)
	AT, BE-WAL, HR, EE, MK, IE, LV, PL, PT, RS, ES-CT	11	(35)
	BA, DK, LT, CH-AG, SI	5	(16)
	BG, CZ, DE-BW, DE-BY, FI, GR, NO, SK, SE, GB-SCT	10	(33)
	BE-WAL, EE, FI, IE, LT, NO, PT, SE, GB-SCT	9	(29)
d. Freedom of owners to decide who is allowed to hunt in his/her property: The owner can solely decide who is allowed to hunt in the property regardless the size of the property. The owner can solely decide only if he/she has a certain size of the property. The owner always has to accept hunting activities taking place on his/her land and is compensated for this. The owner always has to accept hunting activities taking place on his/her land and is not compensated for this.	AT, HR, CZ, DE-BW, DE-BY, DK, FR, NL, RO, SK, ES-CT	11	(35)
	BG, HU, LV	3	(10)
	BA, GR, MK, IT-34, PL, RS, SI, CH-AG	8	(26)

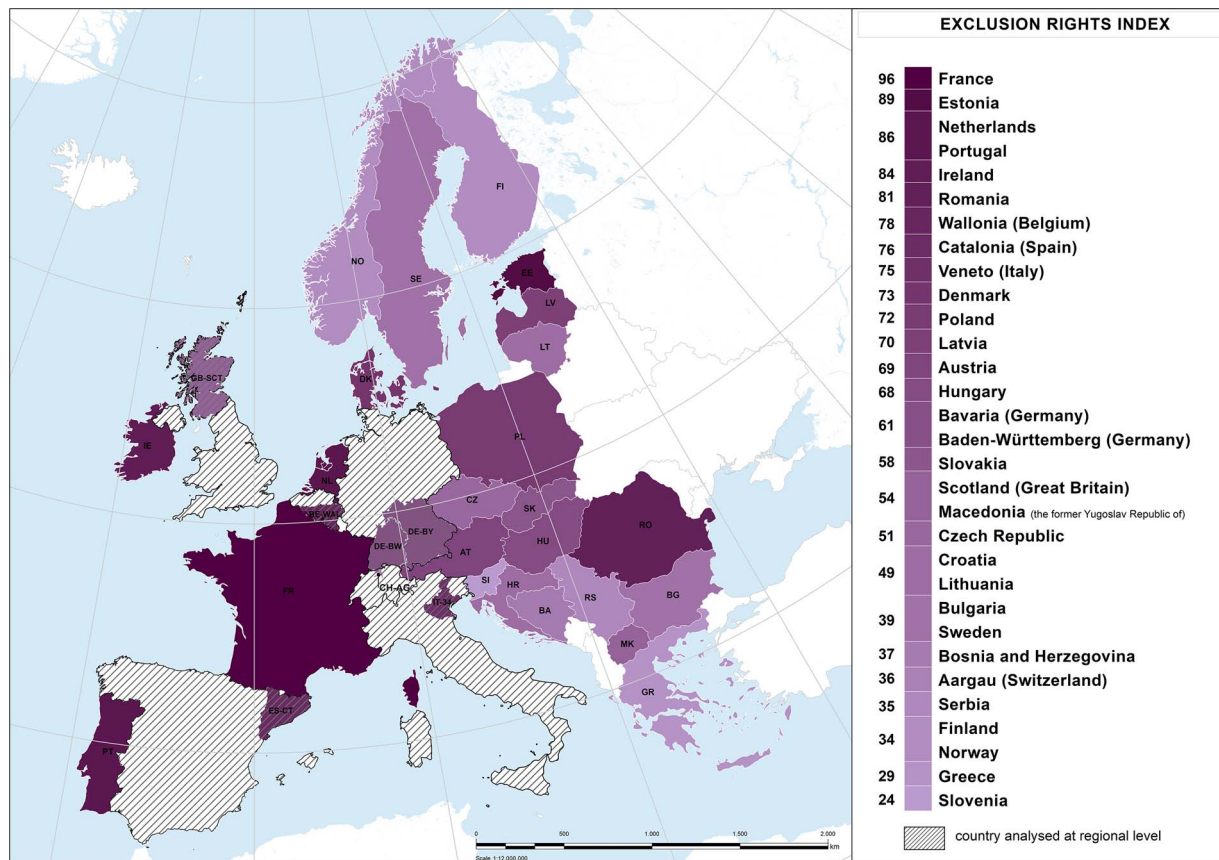


Fig. 3. Geographical distribution of exclusion rights across the analysed jurisdictions. The figure is compiled from the data we collected for 7 indicators. Each indicator was assessed on a scale ranging from 0 (“right fully restricted”) to 100 (“no restrictions apply”). The exclusion rights index is the mean value of the 7 indicators. The gradient of the colour varies from a lighter colour (low degree of freedom in decision making) to darker colours (high degree of freedom in decision making).

(Table 4c). In contrast, in 10 other jurisdictions the owner cannot restrict the collection of mushrooms for recreational purposes. Regarding the harvesting of mushrooms for commercial purposes, in 24 jurisdictions owners had the right to restrict commercial mushroom harvesting. In only four countries this activity remains an “everyman’s right” (Finland, Norway, Sweden and Greece). With regard to hunting activities (Table 4d), in nine out of 31 jurisdictions the owner can decide if and who is allowed to hunt on their property regardless of the size of the forest, while in 11 jurisdictions the owners can decide, subject to a minimum forest size threshold. On the contrary 11 jurisdictions require the owner to accept hunting activities taking place on their forestland, either with or without financial compensation.

The degrees of freedom for the seven indicators that characterise the exclusion rights vary between 24 degrees of freedom in SI to 96 degrees of freedom in FR (Fig. 3), with an average of 59 degrees of freedom and a standard deviation of 20.4 across the analysed jurisdictions (Table 6). The exclusion rights did not produce any clear pattern of geographical distribution (Fig. 3).

3.5. Distribution of alienation rights

In all jurisdictions, the owner has the right to sell forest land and forest products. Nevertheless, full alienation rights for forest land are permissible in only nine jurisdictions (Table 5). The right to sell could be altered in 13 jurisdictions by a pre-emption right in favour of the state or in favour of neighbours while in four other jurisdictions a notification to the authority is required which may restrict the selling in special conditions. Uniquely in FYR Macedonia, the state always purchases the land so the owners cannot decide on the purchaser.

In all jurisdictions, there are no restrictions imposed on the owners

in setting the price for forest land or the price for timber. Only in Finland there are some restrictions that can apply to the methods for timber selling. Hence, the distribution of alienation rights is quite uniformly distributed across the jurisdictions. The average degree of freedom for alienation rights is 91 and the standard deviation is 7 (Table 6).

3.6. Property rights index in forestry (PRIF)

The PRIF and the five PRCs facilitates the comparative analysis of the distribution of property rights across jurisdictions. An overview of regulatory frameworks across the 31 European jurisdictions, as quantified by the PRIF, shows a clear variation in the PFO’s scope for decision making relating to their forests and their interaction with same. PRIF values ranged from 38.4 in FYR Macedonia to 84.7 in the Netherlands (Fig. 4), with a mean of 63 degrees of freedom and a standard deviation of 15 degrees of freedom (Table 6).

Access and alienation rights are only restricted in exceptional cases. The combination of withdrawal, management and exclusion rights makes for a very diverse policy landscape across the European jurisdictions (Fig. 5). The jurisdictions with the highest PRIF (the Netherlands, Denmark, Wallonia) have attained high degrees of freedom for all five PRCs. Even though they score high degrees of freedom in the withdrawal and management PRCs, the Nordic countries (Finland, Norway, Sweden) do not achieve PRIFs as high as the aforementioned due to the lower scores achieved for the exclusion PRC given the “everyman’s right” rule regarding the public access and harvesting of NWFP’s.

In order to identify the components of the index that explained most of the variation that exists between jurisdictions’ PRIF values, a

Table 5
Distribution of alienation rights (based on the expert analysis of the legal provisions applying in the 31 jurisdictions).

Relevant indicators and alternatives	Jurisdictions (Countries/Regions)	Total	
		Number	(%)
Freedom to decide to whom to sell the forestland:			
The owner can freely decide to whom to sell the forestland.	BE-WAL, CZ, DK, IE, LV, NL, PL, PT, CH-AG	9	(29)
The owner can decide to whom to sell the forestland in the framework of some restrictions without informing the authorities.	HR, EE, SK, GB-SCT	4	(13)
The owner has to inform the authority, which accepts the buyer in special conditions e.g. if selling in rural areas, pre-emption rights in favour of municipality etc.	DE-BY, FI, NO, SE	4	(13)
A pre-emption right is always applied: the owner has to inform the authority/neighbours about the intention to sell and they have the right of first buyers at equal conditions.	AT, BA, BG, DE-BW, FR, GR, HU, IT-34, LT, RO, RS, SI, ES-CT	13	(42)
The owner cannot choose the buyer, the state will always purchase the land in its name.	MK	1	(3)

Table 6
Regional comparative analysis of PRIF. The values for PRCs are presented as a mean \pm 1 standard deviation (SD). The percentage of private ownership is calculated as the mean percentage of private ownership from each jurisdiction, based on the data reported in Živojinović et al. (2015). The values in parenthesis present the coefficient of correlation between PRCs and the percentage of private ownership. Values in bold are different from 0 with a significance level $\alpha = 0.05$.

Regions	Analysed jurisdictions	Private ownership	Access rights index	Withdrawal rights index	Management rights index	Exclusion rights index	Alienation rights index	PRIF
European jurisdictions (N = 31)		53 \pm 24.5	94.3 \pm 9.2 (0.200)	60.5 \pm 16.8 (0.698)	53.9 \pm 23.6 (0.672)	59.5 \pm 20.4 (0.238)	90.9 \pm 7.0 (−0.025)	63.0 \pm 14.9 (0.670)
Differentiation based on socio-political background								
Former socialist (N = 14)	BA, BG, CZ, HR, HU, EE, LV, LT, MK, PL, RO, RS, SI, SK	38 \pm 20.4	92.9 \pm 6.1 (0.372)	49.6 \pm 12.6 (0.493)	33.5 \pm 16.6 (0.419)	55.4 \pm 18.7 (−0.019)	90.2 \pm 7.2 (0.089)	51.7 \pm 11.5 (0.381)
Western (N = 17)	AT, BE-WAL, CH-AG, DE-BY, DE-BW, DK, ES-CT, FI, FR, GR, IE, IT-34, NL, NO, PT, SE, GB-SCT	65 \pm 21.0	95.0 \pm 11.2 (0.080)	69.6 \pm 14.5 (0.583)	70.7 \pm 12.3 (0.502)	62.8 \pm 21.7 (0.294)	91.4 \pm 7.1 (−0.232)	72.4 \pm 10.3 (0.552)
Differentiation based on Forest Europe 2015 group of countries								
North (N = 7)	DK, FI, EE, LV, LT, NO, SE	66 \pm 13.8	97.1 \pm 4.9	74.0 \pm 7.0	69.1 \pm 10.2	55.2 \pm 22.0	91.6 \pm 6.9	71.7 \pm 6.5
Central-West (N = 9)	AT, BE-WAL, CH-AG, DE-BY, DE-BW, FR, IE, NL, GB-SCT	59 \pm 18.0	92.8 \pm 14.8	72.4 \pm 8.0	73.4 \pm 9.2	69.4 \pm 18.6	93.2 \pm 7.3	75.5 \pm 6.7
Central-East (N = 5)	CZ, HU, PL, RO, SK	35 \pm 16.6	92.0 \pm 8.4	48.5 \pm 10.6	26.2 \pm 12.2	66.0 \pm 12.0	93.2 \pm 7.7	51.2 \pm 5.8
South-West (N = 3)	ES-CT, IT-34, PT	84 \pm 16.1	96.7 \pm 5.8	63.3 \pm 14.6	65.1 \pm 17.3	78.8 \pm 6.0	90.0 \pm 8.7	71.4 \pm 11.0
South-East (N = 7)	BA, BG, GR, HR, MK, RS, SI	32 \pm 24.1	92.9 \pm 4.9	39.2 \pm 7.4	28.7 \pm 9.0	38.1 \pm 10.5	85.9 \pm 4.8	43.1 \pm 3.2

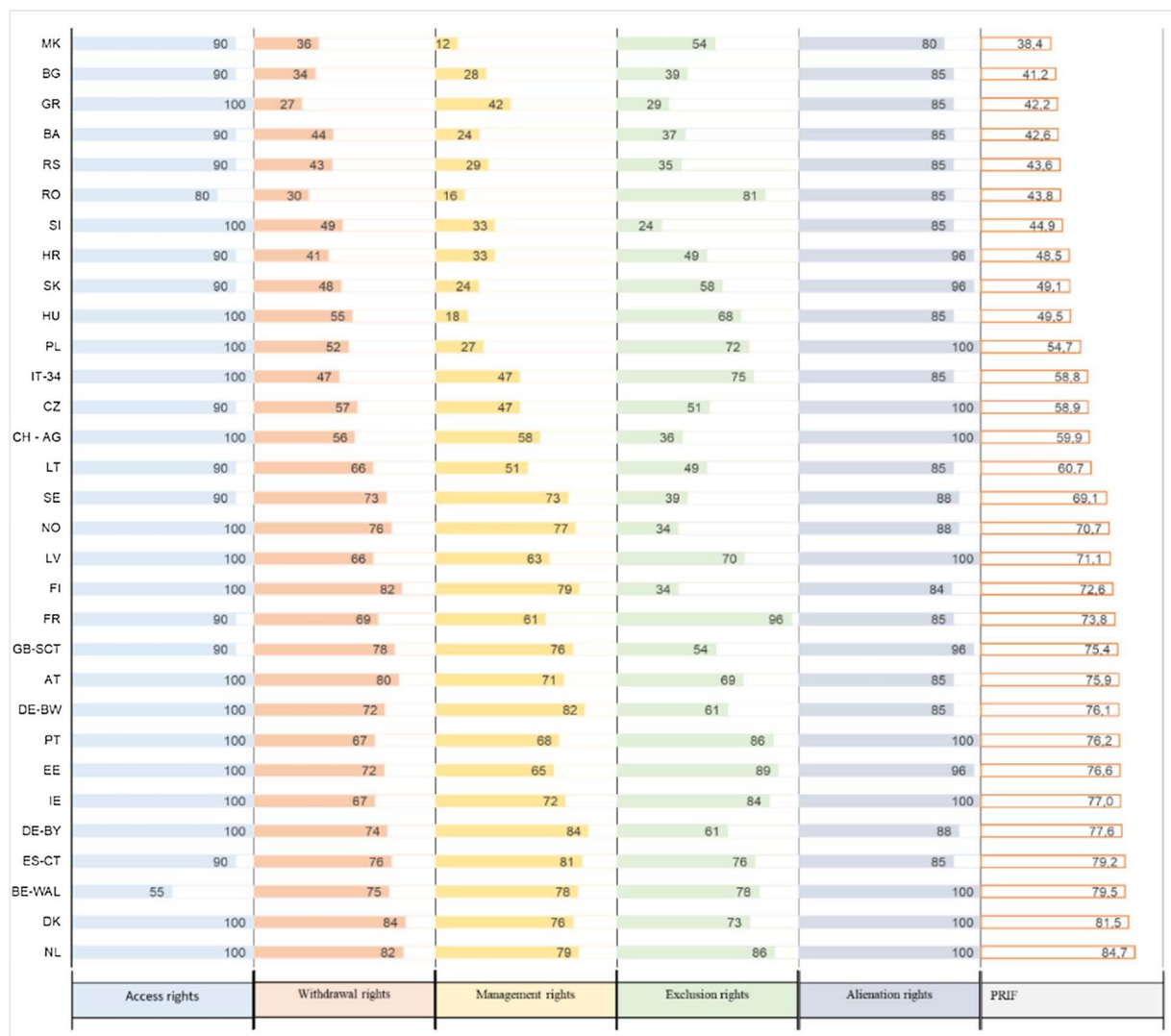


Fig. 4. Overview of the Property Right Index in Forestry (PRIF), with results per jurisdiction. The figure is compiled from the data we collected for 37 indicators, grouped into five property rights categories (PRCs). Each indicator was assessed on a scale ranging from 0 (“right fully restricted”) to 100 (“no restrictions apply”). The property rights index is the mean of the 37 indicators. The jurisdictions are oriented along the vertical axis and are sorted in order of increasing PRIF from the top down.

principal component analysis was performed (Fig. 6). The analysis considers the values assigned to the 37 indicators as variables and they are grouped into the 10 sub-categories of rights (Fig. 6a). The 31 jurisdictions are plotted according to first two principal components (Comp. 1 and Comp. 2) which together explain 72% of the variance (Fig. 6c).

The first principal component (Comp. 1) has the highest correlation values employing indicators relating to operational management rights (0.64) and management planning (0.56). These indicators contribute the most to the variation in the PRIF values amongst the jurisdictions (Fig. 6a). Thus, the main source of variation amongst the jurisdictions is the degree of freedom to make decisions in operational management and the formulation of the management goals. The first component clearly differentiates between the former socialist countries jurisdictions (left-hand quadrants) and the western jurisdictions (right-hand quadrants). The Baltic countries differ from the group of other former socialist countries and are located in a right hand quadrant, while Veneto and Greece are jurisdictions with westernized political backgrounds that nevertheless appeared in the left-hand quadrants (Fig. 6c). The second principal component (Comp. 2) has the highest correlation values with two indicators relating to forest owner’s public access exclusion rights (−0.74) and the exclusion of the public use of NWFPs (−0.60). These categories differentiate the jurisdictions in the upper

quadrant which have less exclusion rights than those in the lower quadrant which have more exclusion rights.

The second principal component explains differences inside the group of former socialist countries and the western jurisdictions. By combining the two main components, different patterns of property rights distribution may be identified combining the private interest in timber products and the public interest in recreation and NWFPs: in the Nordic jurisdictions, PFOs have limited exclusion rights on forest products other than timber (Finland, Norway, Sweden) while the countries located in the lower right hand quadrant have granted both management and exclusion rights to private owners (France, the Netherlands, Denmark). In some former-socialist countries PFOs have less rights for timber removal but more rights to exclude public access and public harvesting of NWFPs (Romania, Poland) while in contrast the countries located in the upper-left hand quadrant have important restrictions in both management and exclusion rights (Bosnia and Herzegovina, Serbia, Greece, Slovenia).

The regional differentiation of PRIF (Table 6) shows that PFOs in jurisdictions with enduring westernised socio-political backgrounds have greater degrees of freedom in which to make and implement decisions on their forest lands in comparison to PFOs from former socialist countries. In westernised socio-political jurisdictions the assignment of property rights to PFOs are significantly greater. This has the effect of

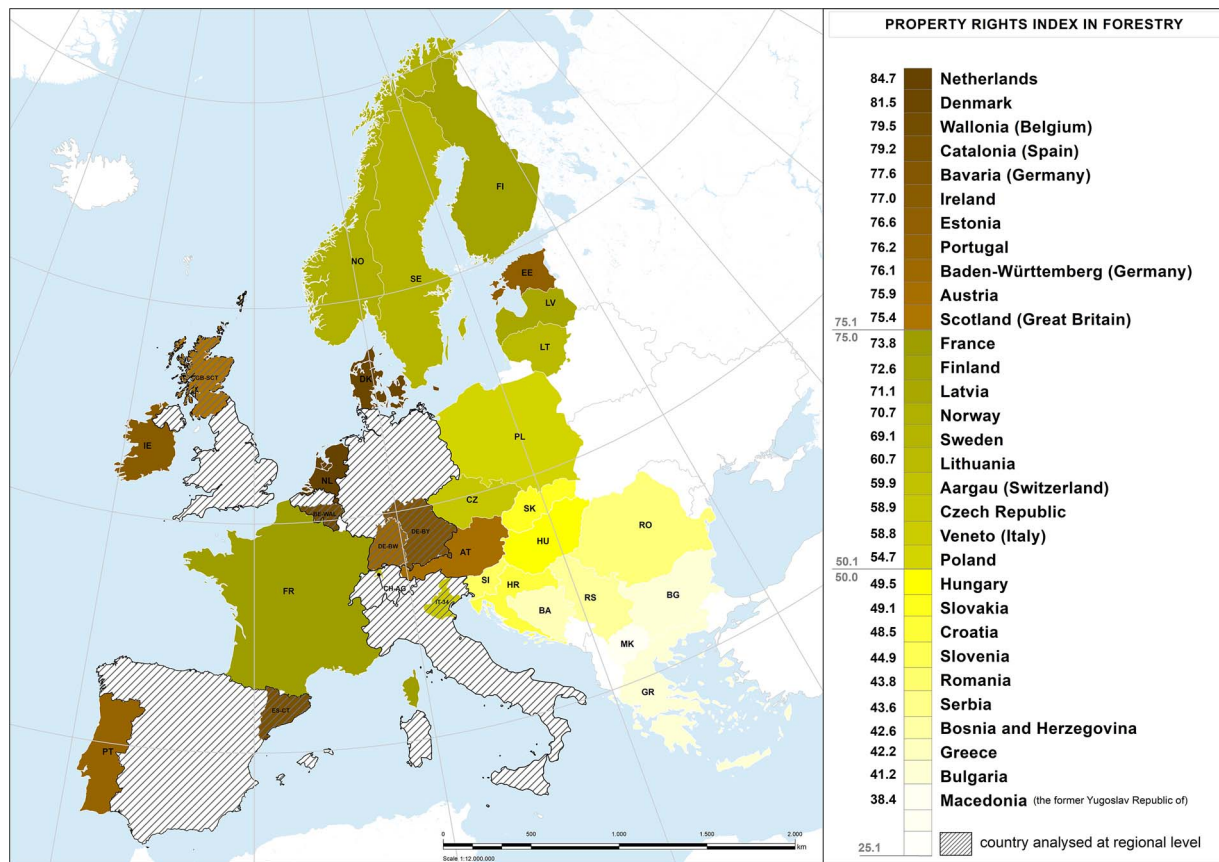


Fig. 5. Geographical distribution of the Property rights index in forestry (PRIF). The scale for the PRIF is divided according to the following categories: jurisdictions with extremely limited freedom in decision making have a PRIF between 0 and 25.0 (no observed instances in this category), jurisdictions with highly restrictive freedom in decision making have a PRIF value between 25.1 and 50.0, jurisdictions with a moderate degree of freedom in decision making have a PRIF value between 50.1 and 75.0 and jurisdictions with higher degree of freedom in decision making have a PRIF between 75.1 and 100.0.

empowering their constituent PFOs, while the rules regulating forest owners' actions in many former socialist jurisdictions are rather strict, particularly for harvesting and management rights.

Looking at the regional division of countries according to [FOREST EUROPE \(2015\)](#), the analysis shows that PFOs in the South-Eastern region have the lowest degree of freedom in decision making, in comparison to Central-Eastern Europe (a former socialist region) which has greater ownership rights, particularly in the category of exclusion. The Central-Western European jurisdictions have higher scores for most of the rights compared with North-European countries, Baltic countries included in the latter. South-Western European countries do not appear to adhere together in a common pattern as Veneto (Italy) has higher restrictions on PFOs than Catalonia and Portugal.

Finally, we tested the correlation between the percentage of private property in each of the jurisdictions and the values for the PRIF and its constituents PRCs. The percentage of private ownership was found to be significantly (significance level $\alpha = 0.05$) and positively correlated with indicators relating to operational management (Pearson's $r = 0.65$, $p = 0.0001$), management planning (Pearson's $r = 0.61$, $p = 0.0003$), withdrawal rights for timber products (Pearson's $r = 0.63$, $p = 0.0001$) and withdrawal rights for NWFPs (Pearson's $r = 0.57$, $p = 0.0008$). Furthermore, the PRIF correlates positively and significantly with the share of private ownership (Pearson's $r = 0.67$, coefficient of determinants = 0.45, $p < 0.0001$), inferring that the larger the area of private forests existing within a jurisdiction, the higher the PRIF is, i.e. the more freedom PFOs have regarding making decisions relating to their forests. Nevertheless, the correlations remain significant only for Western group of countries where a higher area of private ownership is associated with a higher degree of freedom for

withdrawal rights, management rights and the overall PRIF ([Table 6](#)). In former socialist countries the area of private property does not significantly correlate with any of the PRCs, thus countries with a higher area of private forest ownership do not necessarily have higher degrees of freedom. No correlations between PRC values and the area of private forest ownership are displayed when jurisdictions have been grouped according to their Forest Europe categories. When one considers that the number of observations for each group gets smaller, it is statistically dubious to discuss the significance of the correlations e.g. only 3 observations in South-West Europe.

4. Discussions and conclusions

What can be learned from our assessment of PFOs' property rights in Europe? The most remarkable finding of this paper is the striking differences in the degree of freedom that PFOs experience in different European countries and regions. Owning a forest in FYR Macedonia obviously means something different from owning a forest in the Netherlands. These differences manifest themselves in a number of different ways ranging from the way PFOs are allowed to put forest products on to markets, to the imposition of environmental regulations and to the governance of forests in general. Regarding the latter, the diversity in European forest owners' freedom to make decisions calls for an assessment of how international and EU policies are implemented and how they affect privately owned forests. In other words, the statutory provisions at the national level may strongly shape the efficacy of higher-level policies. This has implications for multi-level policy interrelationships where policy-makers and policy-programme designers have to take account of the differences in property rights across the

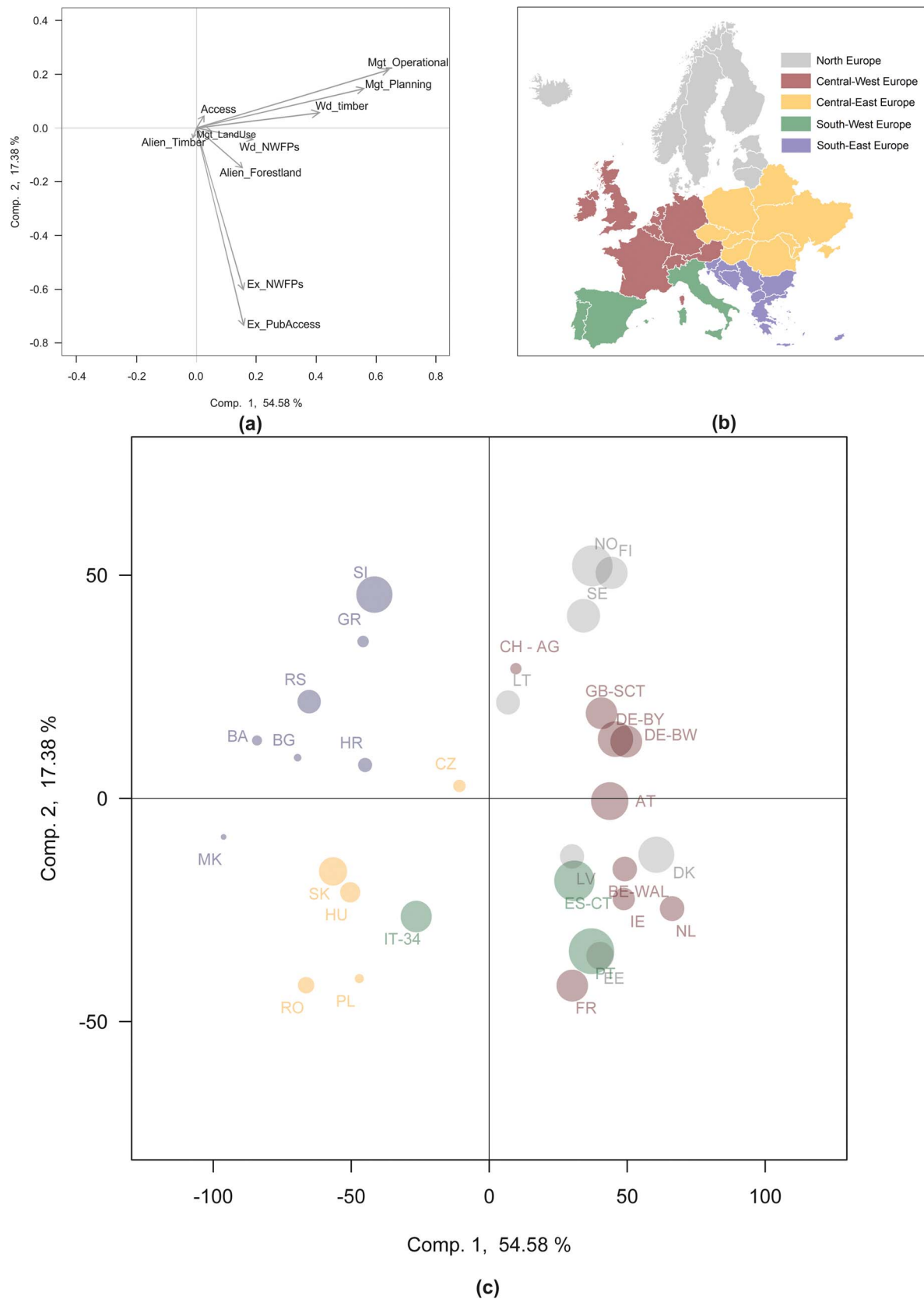


Fig. 6. Principal component analysis of the property rights distribution in forestry. The analysis considers the values identified for the 10 sub-categories of rights as variables access rights (*Access*), withdrawal rights for timber (*Wd_Timber*), withdrawal rights for non-wood forest products (*Wd_NWFPs*), rights for land use change (*Mgt_Land use*), rights for management planning (*Mgt_Planning*), rights for operational management (*Mgt_Operational*), exclusion of public access (*Ex_PubAccess*), exclusion for the use of NWFPs (*Ex_NWFPs*), alienation rights for forest land (*Alien_Forestland*) and alienation rights for timber (*Alien_Timber*) (a). The different sizes of dots in the jurisdiction dot plots relate to the percentage of private forest property in the respective jurisdictions, while the different colours are assigned to the five country groups (FOREST EUROPE, 2015) (b). The first factor (Comp. 1) is the *freedom to make decisions in operational management and to formulate management goals* and tends to increase from left to right, while the second factor (Comp. 2) depicts the owners' *freedom to restrict public access and to restrict withdrawal of NWFPs* which decreases upwards (c).

regions where policies are supposed to operate.

For example, the remarkable differences in forest owners' property rights will have important impacts on the implementation of international policies relating to timber legality (Leipold et al., 2016). The analysis shows that certain management practices in European private forestry may be considered as responsible forest management in one jurisdiction, while in other jurisdictions they may appear to infringe laws. Thus, with respect to legal compliance in the timber trade across European countries, due regard must be given to existing regulatory frameworks when assessing whether PFOs from one jurisdiction are more liable to introduce illegal timber into EU timber markets than another jurisdiction. Furthermore, if a particular jurisdiction's laws such that PFOs in that jurisdiction may face higher burdens to comply with different international legal requirements, it may create difficulties in gaining access to international markets in comparison to PFOs from other jurisdictions.

The analysis shows that each jurisdiction in the analysis has a different approach to regulating the interplay between the private and the public use of forest ecosystem services. The results of the principal component analysis (Fig. 6) and the regional comparative analysis (Table 6) provide insights into the relationship between the PRCs, illustrating some interesting PRIF patterns amongst in the relationship between the private owner's interest in timber products and the public's interest in recreation and NWFPs. The benefit of PRIF is to deconstruct the content of the property rights metric into its components, making it possible to identify from which PRC or constituent indicator the restrictions or freedoms originate. Some rights are defined at the constitutional level (access and exclusion rights are usually regulated by civil code or a primary forest act) and thus may have strong political and cultural provenance and consistency. Other rights like the quantity of timber that can be withdrawn or rules for mushroom collection tend to be grounded in technical or scientific norms and by-laws. Diverse regulations may even exist in a country in respect to the harvesting of specific NWFPs e.g. in Portugal cork and cork oak stands are highly regulated and private forest owners have strict limitations in terms cork harvesting while mushrooms collection is at owners' discretion.

A major implication of the identified variation in property rights is that the formulation of a common EU forest policy may be fraught with difficulties. As shown by our analysis, the restrictions on operational and management rights present a clear differentiation between the participant jurisdictions. More specifically, the process of management planning seems to be crucial in both increasing and constraining the degree of freedom for PFOs as FMPs tend to be considered as "key instruments in delivering multiple goods and services in a balanced way" (European Commission, 2013). Yet the nature of FMPs as instruments varies considerably across Europe from a hierarchical implementation of governmental designed technical norms (Bouriaud et al., 2013; Brukas and Sallnäs, 2012; Lawrence, 2007) to a space for negotiation or learning between the State and its constituent forest owners (Mermet and Farcy, 2011) routed in the "freedom with responsibility" principle (Löfmarck et al., 2017).

The PRIF focuses on *de jure* governance. However, while regulatory instruments set permissible regimes and thresholds, these may not coincide with actual practices; a rigid regulatory framework may even be correlated with a rather lax implementation of laws (Sotirov et al., 2015). Furthermore, the implementation of regulations is often open to interpretation. Thus, a jurisdiction's PRIF may differ from the actual degree of freedom a PFO may experience. For example, forest owners may be legally entitled to totally forbid public access into their forests but it may rarely or never be strictly applied (Vedel et al., 2015) or even feasible in practice. To overcome this intrinsic limitation of the PRIF, it would be highly interesting to complement the research carried out in this paper with research into the *de facto* degree of freedom perceived by PFOs across Europe, and how both translate into management practices of Europe's privately owned forests.

The fact that PRIF only reflects the distribution of rights as

determined by the "formal laws" makes the index insensitive to restrictions in property rights that may arise from non-state, market-driven governance structures, or cultural-historical institutions and norms. For example, in the countries where forest management plans are not compulsory, sustainable management practices are documented by forest certification schemes. The certification bodies define new standards or "soft laws", in the form of contractual and sanction based agreements that may in actuality be more coercive than official legal rules. Of course, forest owners are free to adhere or not to these certifications schemes. However, adhesion is often implicitly unavoidable if market access for forest derived goods and services are to be secured. This new trend in rights and regulations is sometimes interpreted as a privatization of forestry governance (Cashore et al., 2005; Pattberg, 2005) or as a substitute for deficient forest authorities (Contreras-Hermosilla and Peter, 2006). A similar approach is brought to the fore by the use of economic instruments such as subsidies or grants to direct the forest owners to certain policy outcomes. In such cases the degree of freedom in property rights may be renegotiated and sometimes even limited by the financing bodies, and because of this limitation PFOs in Europe may approach subsidies with caution (Church and Ravenscroft, 2008).

A significant advantage offered by the use of the PRIF index is the structured overview it provides, revealing substantial differences in terms of how legal frameworks shape the PFO's property rights. As compared with other indices on property rights e.g. the International Property Rights Index (Levy-Carciente, 2016) and the Index of Economic Freedom (The Heritage Foundation, 2017) that aggregate various sources of data into a single overarching concept (Ginsburg, 2011; Voigt, 2013), the PRIF's construction is highly focused: the bundle of rights is made up of five constituent PRCs which are in turn made up of 37 indicators. The PRIF is also one-dimensional in character (Rossiter, 2010) measuring the level of restriction for each indicator.

The PRIF represents a real methodological advance, in that the answers for each indicator are grounded in the provisions of law. Expert judgements are used for the selection of appropriate indicators and for the interpretation of the rigorosity of the law when assessing the level of restriction for each indicator. Thus, PRIF aims at presenting an "objective evidence" of statutes, while the interpretative nature of defining freedom levels for each situation is acknowledged and mitigated with robust, transparent, and iterative procedure. The methodology behind PRIF can complement the construction of barometer-type indices, employed to measure institutions, which are built on expert or stakeholder perceptions only, and thus may lack specificity and transparency (Mungiu-Pippidi, 2017).

This structured overview, combined with the realities of *de facto* rights and "soft laws" such as certification, provides a solid grounding for future research. Despite the fact that the current application of PRIF is restricted to private forest ownership, the indicators can be re-defined and re-categorised using a similar methodology to carry out analyses of other forms of ownership and other land uses. The PRIF can be employed both to assess regional differences at sub-national level or at a larger international scale and to track the historical development of institutional decisions. It also can be employed to establish a benchmark of jurisdictions by correlating the values of PRCs and PRIF with relevant economic, environmental and social indicators characterizing forest management (Winkel et al., 2009). Finally, it also offers plenty of scope for the identification of drivers behind the variation between these jurisdictions, based, *inter alia* on historic discourses and path dependencies (Pukall and Dobler, 2015), discursive-institutional analysis (Arts and Buizer, 2009) and entrepreneurial property rights changes (Nichiforel and Schanz, 2011).

Future comparative analyses using the PRIF index may focus on private forests that are managed under different nature conservation regimes (e.g. National Parks, Natura 2000 sites etc.). Additional indicators, arising from environmental and nature conservation legislation, may be added to reflect the rights and duties of regulatory bodies

and owners with regard to forest ecosystem services such as water quantity, water quality, soil erosion and carbon sequestration. These issues could be integrated into an index and make the argument for ecosystem services payments to forest owners (Zhang, 2016). While these additional indicators are outside the scope of this paper, this study has highlighted the potential for their inclusion in the construction of new indices that have a different focus.

Concluding, it is important to note that the PRIF index is not designed to derive normative assumptions about jurisdictions depending on whether they have higher or lower scores. The degree of freedom in each jurisdiction has to be interpreted within a larger set of formal and informal institutional settings. Thus, the use of the index offers the possibility to contextualise the relationship between the governed individuals (forest owners), the mechanisms of governance and the desired policy outcomes. Empirical insights as those presented here will safeguard policy and decision makers against erroneous assumptions about the variation in property rights distribution when assessing the opportunities for vertical and horizontal integration of forest and environmental policies.

Acknowledgements

The study was conducted in the framework of the FP1201 FACESMAP COST Action (Forest Land Ownership Change in Europe: Significance for Management and Policy) which is supported by the EU Framework Programme Horizon 2020. LN and LB have been supported by Romanian National Authority for Scientific Research, CNCS-UEFSCDI (PN-II-RU-TE-2012-3-0304 and PN-II-RU-TE-2014-4-0017); VJ and MH by the Czech Ministry of Education, Youth and Sport (COSTCZ LD 14083 and COSTCZ LD 15126). ZS and ZD have been supported by the Slovak Research and Development Agency (APVV-0057-11 and APVV-15-0715). BJT acknowledge the support of the Danish National Research Foundation for the Centre for Macroecology, Evolution and Climate (DNRF96). DF acknowledges to Rosario Alves (FORESTIS). SKO acknowledges Croatian Union of Private Forest Owners' Associations. TH acknowledges the support by the Saastamoinen Foundation. TS acknowledges to Mr. Oikonomou president of Greek Private Owners' Association.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.landusepol.2018.02.034>.

References

- Arts, B., Buizer, M., 2009. Forests, discourses, institutions: a discursive-institutional analysis of global forest governance. *For. Policy Econ.* 11, 340–347.
- Avdibegovic, M., Nonic, D., Posavec, S., Petrovic, N., Maric, B., Milijic, V., Krajter, S., Ioras, F., Abrudan, I.V., 2010. Policy options for private forest owners in Western Balkans: a qualitative study. *Not. Bot. Hort. Agrobot. Cluj-Napoca* 38, 257. <http://dx.doi.org/10.15835/nbha3814691>.
- Bertelsmann Stiftung, 2016. The Bertelsmann Stiftung's Transformation Index (BTI).
- Bouriaud, L., Schmithüsen, F., 2005. Allocation of property rights on forests through ownership reform and forest policies in Central and Eastern European countries. *Schweiz. Z. Forstwes.* 156, 297–305. <http://dx.doi.org/10.3188/szf.2005.0297>.
- Bouriaud, L., Nichiforel, L., Weiss, G., Bajraktari, A., Curovic, M., Dobrinska, Z., Glavonjic, P., Jarský, V., Sarvasova, Z., Teder, M., 2013. Governance of private forests in Eastern and Central Europe: an analysis of forest harvesting and management rights. *Ann. For. Res.* 56, 3.
- Bouriaud, L., Nichiforel, L., Nunes, L., Pereira, H., Bajraktari, A., 2014. A property rights-based analysis of the illegal logging for fuelwood in Kosovo. *Biomass Bioenergy* 67, 425–434. <http://dx.doi.org/10.1016/j.biombioe.2014.05.028>.
- Bromley, D.W., 1997. Property regimes in environmental economics. *Int. Yearbook Environ. Res. Econ.* 1998, 1–27.
- Brukas, V., Sallnäs, O., 2012. Forest management plan as a policy instrument: carrot, stick or sermon? *Land Use Policy* 29, 605–613. <http://dx.doi.org/10.1016/j.landusepol.2011.10.003>.
- Buttoud, G., Koupelavskaya-Buttoud, I., Slee, B., Weiss, G., 2011. Barriers to institutional learning and innovations in the forest sector in Europe: markets, policies and stakeholders. *For. Policy Econ.* 13, 124–131. <http://dx.doi.org/10.1016/j.forpol.2010.05.006>.
- Cashore, B., Van Kooten, G.C., Vertinsky, I., Auld, G., Affolderbach, J., 2005. Private or self-regulation? A comparative study of forest certification choices in Canada, the United States and Germany. *For. Policy Econ.* 7, 53–69. [http://dx.doi.org/10.1016/S1389-9341\(03\)00011-X](http://dx.doi.org/10.1016/S1389-9341(03)00011-X).
- Church, A., Ravenscroft, N., 2008. Landowner responses to financial incentive schemes for recreational access to woodlands in South East England. *Land Use Policy* 25, 1–16. <http://dx.doi.org/10.1016/j.landusepol.2007.02.003>.
- Contreras-Hermosilla, A., Peter, E., 2006. Meilleures pratiques pour l'application des lois dans le secteur forestier. *Etude FAO Forêts*.
- Cubbage, F., Harou, P., Sills, E., 2007. Policy instruments to enhance multi-functional forest management. *For. Policy Econ.* 9, 833–851. <http://dx.doi.org/10.1016/j.forpol.2006.03.010>.
- das Neves Almeida, T.A., García-Sánchez, I.-M., 2016. A comparative analysis between composite indexes of environmental performance: an analysis on the CIEP and EPI. *Environ. Sci. Policy* 64, 59–74. <http://dx.doi.org/10.1016/j.envsci.2016.06.011>.
- Dobbie, M.J., Dail, D., 2013. Environmental indices. *Environmetrics*. <http://dx.doi.org/10.1002/9780470057339.vnn157>.
- European Commission, 2013. European Forest Strategy. <http://ec.europa.eu/agriculture/forest/strategy/>.
- FOREST EUROPE, 2015. State of Europe's Forests 2015 Report. pp.314.
- Fares, S., Scarascia-Mugnozza, G., Corona, P., Palahi, M., 2015. Five steps for managing Europe's forests. *Nature* 519, 407.
- Furubotn, E.G., Pejovich, S., 1972. Property rights and economic theory: a survey of recent literature. *J. Econ. Lit.* 10, 1137–1162.
- Galik, C.S., Jagger, P., 2015. Bundles, duties, and rights: a revised framework for analysis of natural resource property rights regimes. *Land Econ.* 91, 76–90. <http://dx.doi.org/10.3368/le.91.1.76>.
- Ginsburg, T., 2011. Pitfalls of measuring the rule of law. *Hague J. Rule Law* 3, 269–280. <http://dx.doi.org/10.1017/S187640451120006X>.
- Glück, P., Avdibegović, M., Čabaravić, A., Nonić, D., Petrović, N., Posavec, S., Stojanovska, M., 2010. The preconditions for the formation of private forest owners' interest associations in the Western Balkan Region. *For. Policy Econ.* 12, 250–263. <http://dx.doi.org/10.1016/j.forpol.2010.02.001>.
- Hsu, A., et al., 2016. Environmental Performance Index. Yale University, New Haven, CT.
- Kissling-Näf, I., Bisang, K., 2001. Rethinking recent changes of forest regimes in Europe through property-rights theory and policy analysis. *For. Policy Econ.* 3, 99–111. [http://dx.doi.org/10.1016/S1389-9341\(01\)00059-4](http://dx.doi.org/10.1016/S1389-9341(01)00059-4).
- Kleinschmit, D., Lindstad, B.H., Thorsen, B.J., Toppinen, A., Roos, A., Baardsen, S., 2014. Shades of green: a social scientific view on bioeconomy in the forest sector. *Scand. J. For. Res.* 29, 402–410. <http://dx.doi.org/10.1080/02827581.2014.921722>.
- Krott, M., 2005. Forest Policy Analysis. Springer Science & Business Media.
- Lê, S., Josse, J., Husson, F., 2008. FactoMineR: an R package for multivariate analysis. *J. Stat. Softw.* 25, 1–18.
- Löfmarck, E., Ugglä, Y., Lidskog, R., 2017. Freedom with what? Interpretations of responsibility in Swedish forestry practice. *For. Policy Econ.* 75, 34–40. <http://dx.doi.org/10.1016/j.forpol.2016.12.004>.
- Lawrence, A., 2007. Beyond the second generation: towards adaptiveness in participatory forest management. *CAB Rev.: Perspect. Agric. Vet. Sci. Nutr. Nat. Resour.* 2, 1–15. <http://dx.doi.org/10.1079/PAVSNNR20072028>.
- Legrand, P., 1999. John Henry Merryman and comparative legal studies: a dialogue. *J. Comp. Law* 47, 3–66. <http://dx.doi.org/10.2307/840997>.
- Leipold, S., Sotirov, M., Frei, T., Winkel, G., 2016. Protecting first world markets and third world nature: the politics of illegal logging in Australia, the European Union and the United States. *Glob. Environ. Change* 39, 294–304. <http://dx.doi.org/10.1016/j.gloenvcha.2016.06.005>.
- Levy-Carciente, S., 2016. The International Property Rights Index. Property Rights Alliance. Available at <http://internationalpropertyrightsindex.org/>.
- Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., Seidl, R., Delzon, S., Corona, P., Kolström, M., 2010. Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. *For. Ecol. Manage.* 259, 698–709. <http://dx.doi.org/10.1016/j.foreco.2009.09.023>.
- Lockie, S., 2013. Market instruments, ecosystem services, and property rights: assumptions and conditions for sustained social and ecological benefits. *Land Use Policy* 31, 90–98. <http://dx.doi.org/10.1016/j.landusepol.2011.08.010>.
- Mermet, L., Farcy, C., 2011. Contexts and concepts of forest planning in a diverse and contradictory world. *For. Policy Econ.* 13, 361–365. <http://dx.doi.org/10.1016/j.forpol.2011.03.006>.
- Miller, T., Kim, A.B., Holmes, K., 2015. 2015 Index of Economic Freedom. The Heritage Foundation, Washington DC.
- Mori, A.S., Lertzman, K.P., Gustafsson, L., 2016. Biodiversity and ecosystem services in forest ecosystems: a research agenda for applied forest ecology. *J. Appl. Ecol.* 54, 12–27. <http://dx.doi.org/10.1111/1365-2664.12669>.
- Mungiu-Pippidi, A., 2017. The time has come for evidence-based anticorruption. *Nat. Hum. Behav.* 1, 0011.
- Nichiforel, L., Schanz, H., 2011. Property rights distribution and entrepreneurial rent-seeking in Romanian forestry: a perspective of private forest owners. *Eur. J. For. Res.* 130, 369–381. <http://dx.doi.org/10.1007/s10342-009-0337-8>.
- North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press.
- Pattberg, P., 2005. The institutionalization of private governance: how business and nonprofit organizations agree on transnational rules. *Governance* 18, 589–610. <http://dx.doi.org/10.1111/j.1468-0491.2005.00293.x>.
- Pukall, K., Dobler, G., 2015. Discursive struggles over the handling of forests-analysis of historical and actual discourses with relevance for forest legislation. *Allg. Forst- Jagdztg.* 186, 187–202.

- RRI, 2012. What Rights? A Comparative Analysis of Developing Countries' National Legislation on Community and Indigenous Peoples' Forest Tenure Rights. Rights and Resources Initiative, Washington DC.
- Rogge, N., 2012. Undesirable specialization in the construction of composite policy indicators: the environmental performance index. *Ecol. Indicators* 23, 143–154. <http://dx.doi.org/10.1016/j.ecolind.2012.03.020>.
- Rossiter, J.R., 2010. Measurement for the Social Sciences: The C-OAR-SE Method and Why It Must Replace Psychometrics. Springer Science & Business Media.
- Schlager, E., Ostrom, E., 1992. Property-rights regimes and natural resources: a conceptual analysis. *Land Econ.* 249–262. <http://dx.doi.org/10.2307/3146375>.
- Schmithüsen, F., Hirsch, F., 2010. Private Forest Ownership in Europe. United Nations Economic Commission for Europe & Food and Agriculture Organization of the United Nations, Geneva pp.314.
- Sotirov, M., Lovric, M., Winkel, G., 2015. Symbolic transformation of environmental governance: implementation of EU biodiversity policy in Bulgaria and Croatia between Europeanization and domestic politics. *Environ. Plann. C: Govt. Pol.* 33, 986–1004.
- Stupak, I., Asikainen, A., Jonsell, M., Karlton, E., Lunnan, A., Mizaraité, D., Pasanen, K., Pärn, H., Raulund-Rasmussen, K., Röser, D., 2007. Sustainable utilisation of forest biomass for energy—possibilities and problems: policy, legislation, certification, and recommendations and guidelines in the Nordic, Baltic, and other European countries. *Biomass Bioenergy* 31, 666–684. <http://dx.doi.org/10.1016/j.biombioe.2007.06.012>.
- The Heritage Foundation, 2017. Index of Economic Freedom. Available at <http://www.heritage.org/index/>.
- UNDP, 2016. Human Development Report 2016. United Nations Development Programme, New York.
- Vatn, A., 2005. Rationality, institutions and environmental policy. *Ecol. Econ.* 55, 203–217. <http://dx.doi.org/10.1016/j.ecolecon.2004.12.001>.
- Vedel, S.E., Jacobsen, J.B., Thorsen, B.J., 2015. Forest owners' willingness to accept contracts for ecosystem service provision is sensitive to additionality. *Ecol. Econ.* 113, 15–24. <http://dx.doi.org/10.1016/j.ecolecon.2015.02.014>.
- Voigt, S., 2013. How (not) to measure institutions. *J. Inst. Econ.* 9, 1–26. [10.1017/S1744137412000148](http://dx.doi.org/10.1017/S1744137412000148).
- Winkel, G., Kaphengst, T., Herbert, S., Robaey, Z., Rosenkranz, L., Sotirov, M., 2009. EU policy options for the protection of European forests against harmful impacts. Part of the tender: implementation of the EU forestry strategy: how to protect EU forests against harmful impacts. Tech. Rep. No. OJ 2008/S 112–149606. pp.142.
- Winkel, G., Aggestam, F., Sotirov, M., Weiss, G., et al., 2013. Forest policy in the European Union. In: Pülzl (Ed.), *European Forest Governance: Issues as Stake and the Way Forward*. European Forest Institute, pp. 52–63.
- Winkel, G., Blondet, M., Borrass, L., Frei, T., Geitzenauer, M., Gruppe, A., Jump, A., de Koning, J., Sotirov, M., Weiss, G., 2015. The implementation of Natura 2000 in forests: a trans-and interdisciplinary assessment of challenges and choices. *Environ. Sci. Policy* 52, 23–32. <http://dx.doi.org/10.1016/j.envsci.2015.04.018>.
- Zhang, D., 2016. Payments for forest-based environmental services: a close look. *For. Policy Econ.* 72, 78–84. <http://dx.doi.org/10.1016/j.forpol.2016.06.017>.
- Zhou, P., Ang, B., Poh, K., 2006. Comparing aggregating methods for constructing the composite environmental index: an objective measure. *Ecol. Econ.* 59, 305–311. <http://dx.doi.org/10.1016/j.ecolecon.2005.10.018>.
- Živojinović, I., Weiss, G., Lidestav, G., Feliciano, D., Hujala, T., Dobšínská, Z., Lawrence, A., Nybakk, E., Quiroga, S., Schraml, U., 2015. Forest Land Ownership Change in Europe. COST Action FP1201 FACESMAP Country Reports. University of Natural Resources and Life Sciences, Vienna (BOKU) p. 693.