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Owner mapping for forest scenario modelling — A Lithuanian case study

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ABSTRACT

Ample research on private forest owners (PFOs) has established high heterogeneity in owners' objectives, motivations and management decisions. Such heterogeneity is, however, rarely taken into account in forest scenario modelling. This study, in contrast, conducts a detailed forest owner mapping that feeds into simulations of ecosystem services (ES) under alternative future scenarios. First, we identify four private forest owner types (FOT) – Forest Businessmen, Household Foresters, Passive Forest Lovers, and Ad Hoc Owners through in-depth interviews and qualitative analyses on a case study area in western Lithuania. Next, each forest estate and forest compartment is assigned a FOT by combining the property registry and forest characteristics with opinions of two types of local experts: state forest managers and inspectors from the State Forest Service. Third, a set of forest management (FM) programmes is specified using field interviews and desktop research, FM records, and expert judgement for each forest compartment. Finally, ES provision is projected using a behavioural matrix combining management styles of FOTs with details of FM programmes. We simulate the dynamics of profits from forestry activities, accumulated carbon in live biomass and tree species diversity under a reference scenario without substantial changes; and a policy intervention scenario. The study demonstrates that treating forest owners as a homogenous group overestimates profits from timber and underestimates the provision of the other analysed ES, potentially misinforming policy decisions.

1. Introduction

Human beings have always sought to predict the future. However, their predictive capacity is limited by incomplete information about system conditions and underlying dynamics, the prospect of innovation and surprise, and the intentional nature of human decision-making (Dreborg, 1996; Robinson, 2003). To reduce uncertainty one must account for involved actors' behaviour.

Forest management (FM) decisions are driven by both the preferences of owners and managers and the characteristics of their forested estates (e.g. Amacher et al., 2003; Beach et al., 2005; Joshi and Arano, 2009; Favada et al., 2009; Andersson and Gong, 2010; Ma and Kittredge, 2011; Musshoff and Maart-Noelck, 2014). The heterogeneity of private forest owners (PFOs) is often depicted through typologies which classify their objectives and motivations through quantitative or qualitative approaches (e.g. Dhubhain et al., 2007; Van Herzele and Van Gossum, 2008; Urquhart and Courtney, 2011; Ficko and Boncina, 2013). Quantitative typologies elaborated through surveys and traditional statistical techniques are most common. For recent examples see Lidestav and Lejon (2012) and Häggqvist et al. (2014). Applications of qualitative methods are scarcer, but provide deeper understanding of the linkages between owner objectives, behaviour and contextual factors (Kurtz and Lewis, 1981; Hugosson and Ingemarson, 2004; Lähdesmäki and Matilainen, 2014; Stanislovaitis et al., 2015). Types of forest owners and their behaviour are usually addressed outside the context of forest and forest sector modelling. On the other hand, forest modelling without considering the heterogeneity of owners and managers risks significant biases, impeding the development of sound forest policy (Pattanayak et al., 2004). Examples of integrating owner-specific characterization into a Decision Support System (DSS) are rare and their theoretical basis is weak (Rinaldi et al., 2015). As one of potential solutions, a methodological framework for incorporating FM behaviour into alternative FM solutions was suggested by Trubins (2014). It is based on a two-dimensional "behavioural matrix" constructed so that the rows refer to the management style of a specific owner type and the columns refer to specific FM programmes. Each cell of the matrix is associated with a specific management programme within a management style, which may be simulated in a DSS. However, the owner types and their links with FM behaviour remain quite hypothetic in this and related studies (Eggers et al., 2015; Rinaldi et al., 2015).

This study addresses the gap between owner typologies and forest resource modelling in a case study area (CSA) in western Lithuania. Nearly a half of the forestland in Lithuania is managed by state forest enterprises, while the share of private forests is 39% (State Forest Service, 2014). The remaining 11% are reserved for restitution,

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i.e. such forest lots remain unmanaged but are expected to be returned to pre-WW2 landowners or their heirs. State and private forests differ in terms of estate size, fragmentation and stand parameters (State Forest Service, 2014) as well as in terms of the profile of managers or owners. Despite this heterogeneity, all management is shaped by a legal framework that applies uniformly to all forestland no matter the ownership (Brukas and Sallnäs, 2012). State forest management is focused on sustainable timber production, strictly following conventional practices elaborated in FM plans by foresters sharing similar professional backgrounds and values (Brukas and Weber, 2009; Brukas et al., 2011). Private forestry, on the other hand, is characterized by a wide diversity of management objectives and practices (Mizaraitė, 2001; Pivoriūnas and Lazdinis, 2004; Mizaraitė and Mizaras, 2005a, 2005b; Mizaraitė et al., 2010). Stanislovaitis et al. (2015) have broken this diversity into four PFO types based on qualitative analyses linking owner objectives, management behaviour and contextual factors. Predicting the future behaviour of such diverse actors is of course difficult. This may explain why previous simulations of forest resource development in Lithuania focused on only state owned commercial forests or assumed that PFOs will act the same way as state forest managers (Petrauskas and Kuliešis, 2004; Brukas et al., 2011).

This paper demonstrates an approach to detailed mapping of forest owners that enables more nuanced simulations of forest resource development and ES provision at the landscape level. This is pursued through a multidisciplinary analysis, combining qualitative interviews of PFO and forestry experts, quantitative forest inventory and real estate register data, and ES simulations by an advanced decision support system (DSS) under alternative future scenarios. Our study also elaborates on the "behavioural matrix" approach by Trubins (2014), by demonstrating how to allocate each forest estate to specific owner types and FM regimes.

2. Material and methods

2.1. Study area

The CSA is located in western Lithuania, in the Varniai and Žarėnai elderships of Telšiai municipality. The area totals 379 km^2, including nearly 140 km^2 of forests, half of which is privately owned. Many of the private forests are relatively small parcels within the hilly agrarian landscapes, while the state forests are concentrated in larger continuous forest tracts. Prevailing tree species are birch (*Betula pubescens* Ehrh. and *Betula verrucosa* Ehrh.), Norway spruce (*Picea abies* (L) Karst.) and Scots pine (*Pinus silvestris* L.). PFOs and state forest managers face additional management restrictions due to the presence of Varniai Regional Park which encompasses 32.5 km^2 of state forest and 33.5 km^2 of private forest land.

2.2. Mapping forest owner types

Four types of PFOs were identified by Stanislovaitis et al. (2015) to be acting in the CSA: (*i*) Forest Businessmen typically owning the largest estates (>100 ha) and regarding forest as an investment for long-term financial returns; (*ii*) Household Foresters primarily using timber for own needs, (*iii*) Passive Forest Lovers aspiring to recreational or environmental values and largely uninterested in timber harvesting and (*iv*) Ad-Hoc Owners that usually are small-scale, have vague goals and rarely engage in FM. The classification was based on the background and goals of forest ownership, implemented management practices and owners' future plans revealed in in-depth interviews and qualitative analyses (Stanislovaitis et al., 2015). All state forests are managed by the Telšiai state forest enterprise and considered a separate owner type. A crucial step in our study is to associate each forest compartment with a specific forest owner type (FOT) and FM regime.

Detailed stand-level information on CSA forests was retrieved from the State Forest Cadastre (State Forest Service, 2015), including the borders of forest compartments and forest stand characteristics. The records indicate whether a forest parcel belongs to the state, a PFO or is reserved for restitution. To associate each forest stand compartment with specific forest owner behaviours, we combined information from available data sets, our expert knowledge and opinions of local informants.

Based on information from the Real Estate Register (Centre of Registers, 2015) and State Forest Cadastre, we first categorised each estate into several classes by size and owner:

- Private forest under 5 ha
- Private forest 5–20 ha, agricultural land is less than twice the area of forest land
- Private forest 5–20 ha, agricultural land is at least twice the area of forest land
- Private forest above 20 ha, the owner owns only one estate in the country
- Private forest above 20 ha, the owner owns more than one estate in the country
- State owned and managed forest
- State owned forest reserved for restitution.

We also extracted the State Forest Cadastre information on four types of forest groups:

- Group I: strict forest reserves
- Group II: special purpose forests encompassing ecosystem protection and recreational use, with severe forest management restrictions
- Group III: protective forests usually aimed at protection of soil or water, with some additional management restrictions compared to production forests
- Group IV: production (commercial) forests.

See Brukas et al. (2013a) for a description of the permissible management regimes in the respective forest groups.

Large paper maps were printed containing detailed topographic information on the area with the borders of estates and forest compartments coloured according to the type of estate. Two types of experienced local experts were asked to identify the likely FOT of each mapped estate. The two expert types were:

- Local state forest managers from the Varniai (head forester and forest ranger) and Žarėnai (head forester) forest districts and the manager from the central headquarters of the enterprise responsible for consulting PFOs. Even though their focus is the management of state forests, managers of state forest districts also engage in extension and support to PFOs
- Two local inspectors of State Forest Service that regulates all forestry activities in the area.

All informants have held their positions for several decades so they are knowledgeable about the forest restitution processes and subsequent ownership transfers and have thorough knowledge of local PFOs. These experts were involved in all stages of the research. First, they were interviewed to develop the forest owner classification (Stanislovaitis et al., 2015) and later acquainted with the detailed characterization of FOT. Next, they attended the landscape development scenario workshops (Anonymous, 2014), where PFO typology was thoroughly discussed. The experts knew the majority of the forest owners from their professional activities. During the final stage, they were asked to consider each forest estate on the map and determine the most likely FOT, aided by the following supporting questions:

- What is the owner's relation to the forest? What is the purpose of their forest?

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