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Mixed forests and ecosystem services: Investigating stakeholders' perceptions in a case study in the Polish Carpathians

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ABSTRACT

Mixed forests are thought to provide a wide range of ecosystem services for human well-being and their effectiveness, compared to monocultures, is broadly recognized in the literature. Mixed forests may increase the multifunctionality, providing a wide range of ecosystem services such as hazard protection, carbon sequestration, nature conservation and landscape values. Before undertaking a process of conversion of monocultures into mixed forests it is important to learn about perceptions of local stakeholders for mixed forests in comparison to monocultures, in order to understand their needs and identify possible sources of conflicts. In the present work, we investigate the personal perceptions about the effectiveness of mixed forests when compared to monocultures, in terms of provisioning of ecosystem services, with the aid of an ordered logit model. In addition, we highlight the fact that belonging to a particular category of organized stakeholders contribute to perceive mixed forests positively, compared to non-organized local dwellers. Results show that people acknowledging the importance of some non-productive forest ecosystem services are more likely to prefer mixed forests. Moreover, personal attitudes towards ecosystem services seem to be much more related to the degree of preference for mixed forests than other socio-economic variables, such as gender and education. Finally, another evidence of this contribution is that belonging to a precisely defined group of stakeholders considerably increases the probability to prefer mixed forests, compared to ordinary citizens.

1. Introduction

European forests have been widely exploited during the last centuries, mainly for timber purposes, until the middle of the 20th century. Timber primacy and the related sustained yield doctrines were the most used approaches to forest management (Glück, 1987). These two prescriptions acquired popularity because of the need of maximizing timber revenues, in a period in which timber market was affirming and growing. Several natural forests have been converted into monocultures and managed with new techniques (such as fertilization, introduction of alien species and artificial regeneration), which allowed forest owners to maximize the amount of harvested timber and to increase the logs quality (Vos, 1996). Pure stands were believed to ameliorate the timber yield both in quantitative and qualitative terms (Le Master and Schmithüsen, 2006; Pregernig and Weiss, 1998). Monospecific and even-aged forests were also more adapt to mechanized harvesting (Spinelli and Maganotti, 2007), so that forest activities were easier and faster (Agnoletti, 2006; Huffaker, 2012). This process contributed to income generation for forest owners but, on the other hand, had a considerable impact on the quality of forest ecosystem and its biodiversity. Nowadays, the way of managing natural resources is changing and the provision of goods is not anymore the only objective that forest managers should achieve (Notaro et al., 2008; Notaro and Paletto, 2011). Multi-functional management and local participation are important issues to be addressed (Saarikoski et al., 2010), in order to make sustainable choices and reduce possible conflicts (Gritten et al., 2013; Ravikumar et al., 2013). The change in mentality created the idea that it is important to manage the ecosystem with a multi-functional approach (Brun, 2002; Buttoud, 2002; Gustafsson et al., 2012), so that the entire set of goods and services provided by forests could be preserved and, where possible, maximized (de Groot et al., 2002; Hein et al., 2006). After the introduction of the concept of ecosystem services (ES) multifunctional management gained even more consensus. The ES concept acknowledges that the benefits provided by forests, and more generally by all ecosystems, are not only given by the marketable goods but also by a series of intangible services that people cannot live without (MEA, 2005). Within this context, mixed forests are thought to be particularly effective in providing a wide range of ES (Carnol et al., 2014). Recently, an official definition of mixed forests has been proposed: "A mixed forest is a forest unit, excluding linear formations,

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where at least two tree species coexist at any developmental stage, sharing common resources (light, water, and/or soil nutrients). The presence of each of the component species is normally quantified as a proportion of the number of stems or of basal area, although volume, biomass or canopy cover as well as proportions by occupied stand area may be used for specific objectives. A variety of structures and patterns of mixtures can occur, and the interactions between the component species and their relative proportions may change over time" (Bravo-Oviedo et al., 2014, p. 525).

Recent studies have highlighted that mixed forests usually have higher growth rates (Piotto, 2008), improve soil conditions (Davidson et al., 1998) and create a better habitat for biodiversity (Carnus et al., 2006). Mixed forests are also more resilient, being less affected by damages from game and pathogens and also less sensible to wind and fire outbreak (González et al., 2006). From the economic point of view, many mixed forests seem to be also more valuable: Knoke et al. (2007) demonstrated that mixing broadleaf forests and coniferous forests may lead to a reduction in the financial risk. Moreover, some kind of mixed forests are also more productive. As Pretzsch et al. (2010) pointed out, in fact, mixing Norway spruce and European beech produce, on average, 20% of biomass per unit area more than monocultures of each of these two species. Moreover, Pretzsch et al. (2015) compared the growth of monoculture of Scots pine and European larch with the mixture of the two, finding in the latter higher basal area, stand volume and density. Finally, in some cases socio-economic studies highlighted that mixed forests have a higher recreational value for tourists (Grilli et al., 2014; Norman et al., 2010). Given these evidences, the process of conversion of pure stands into mixed forests could be an effective strategy to increase the provision of a wide range of forest ES for the society. Such decisions about forest management should also be shared with the local inhabitants and stakeholders, living close to the natural resources and being affected by policy and management choices (Paletto et al., 2014; Seppelt et al., 2011). Stakeholders are the actors who may be affected in a negative or positive way, because of a certain management action (Grimble and Wellard, 1997). Social acceptance is a key factor for the success of the planned activities (Mill et al., 2007), for this reason it is important to understand the beliefs and perceptions of the stakeholders about forest management, in order to avoid conflicts (Paletto et al., 2015). Given these considerations, the present study introduces an analysis of stakeholders´ preferences and perceptions about mixed forests, compared to pure stands, in the Zywiec Beskid range, in the Polish Carpathians. The underlying idea of this paper is that stakeholders may have the idea about how useful are certain ES, such as protection against natural hazards, biodiversity, aesthetic beauty and carbon sequestration, because they interact with natural environment and may be able to acknowledge their importance for human well-being. Conversely, the perception about how much mixed forests are effective in providing this range of ES is less clear, because it foresees at least a basic knowledge of the environmental sciences or forestry, which is not obvious for every stakeholder (Carnol et al., 2014). For this reason, this contribution tries to understand if the perceived importance for the stakeholders of some ES affects their perception about the effectiveness of mixed forests in providing ES. Data were collected though a questionnaire survey, administrated to a sample of local respondents. An ordered logistic model has been used to account for possible factors affecting respondents´ preferences for mixed forests, when compared to pure stands. Such an approach is very important to understand the social acceptance of the future forest management planning in the Zywiec Beskid range.

2. Material and method

2.1. Study area

Beskid is the traditional name used to identify some portions of the Carpathians Mountains. In particular, Zywiec Beskid range is a territory of about 60,000 ha of the Silesian region (southern Poland) composed by three forest districts: Jeleśnia, Ujsoły and Węgierska Górka (49°23′42″–49°38′54″ N; 18°58′29″–19°27′16″ E). Zywiec Beskid has a vast forested territory, covering around 33,000 ha. Around 17,000 ha of the forested area is composed by semi-natural mixed forests, while the remaining part is characterized by Norway spruce forests. The main tree species are Norway spruce (*Picea abies* L.), European beech (*Fagus sylvatica* L.) and Silver fir (*Abies alba* Mill.). Other tree species are much more limited in space and include European larch (*Larix decidua* Mill.), Sycamore maple (*Acer pseudoplatanus* L.), Scots pine (*Pinus sylvestris* L.) and Douglas fir (*Pseudotsuga menziesii* Mirb.). The Zywiec Beskid range is part of the Katowice State Forest Directorate and it is particularly suitable for such analysis, because the current prevalence of Norway spruce stands undergoes a large-scale forest disintegration due to the bark beetle outbreaks. Katowice state forests are now under a reorganization process into forest functional sub-regions, each with one or more leading forest functions to be preserved (Szabla, 2009). Since the leading functions of Zywiec Beskid will be biodiversity maintenance, hazard protection and outdoor recreation, a gradual switch to mixed forests may be very effective to meet the aforementioned challenges (Petriţan et al., 2011). Understanding stakeholders´ preferences for mixed forests may represent a starting point for a winning strategy, to enhance the social acceptance of the decisions.

2.2. Stakeholders identification and questionnaire survey

At first, a brainstorming session has been held up among researchers and local foresters, in order to list the most relevant categories of stakeholders in the area (Prell et al., 2009). The final list of stakeholders included: representatives of public administration, non-governmental organizations (NGOs), local dwellers, tourists, regional governmental agencies, representatives of the Babia Góra National Park, forest managers and workers in the forest-wood chain. Due to the difficulty of reaching an adequate number of respondents belonging to NGOs, regional governmental agencies and the representatives of Babia Góra National Park, it was decided to delete these categories, because it was difficult to make comparisons. Results are supposed not to vary substantially, thanks to a still adequate number of collected questionnaires. The final identified categories were local dwellers, public administrators (representing policy-makers), forest managers (technicians with a deep expertise in forestry), forest workers and tourists. Once the stakeholders were identified, a semi-structured questionnaire has been administrated; the questionnaire was home delivered randomly to the local dwellers and collected after approximately 15 days. In order to reach the tourists, the questionnaire was delivered to hotels and other strategic tourist places within the destination. Such questionnaire administration did not follow a particular sampling scheme, we tried to be as close as possible to the simple random sampling, which is considered to be unbiased for statistical analyses (Thompson, 2012). The questionnaire was composed by three sections. Section A was compiled only by tourists, because it aimed at gathering information about local tourism characteristics. There were questions about the number of visits in the last year and in the last 5 years, the number of km travelled, mean of transport, the reason of visiting the destination, number of night overstays and holiday motivation. Results of this section are not discussed in the present paper. Section B had the two main objectives: the first one was collecting information about peoples' preferences for some environmental aspects that may explain their attitudes towards mixed forests. The second objective was capturing stakeholders' perceptions about the effectiveness of mixed forests in providing ES for humans' well-being. The ES we considered were mainly taken from the literature (Ekins et al., 2003; Hein et al., 2006; Fisher et al., 2008; de Groot et al., 2002), the full list included in the questionnaire is available in Table 1. Data were collected on 5-point-Likert scales and coded from 0 to 4. In particular, the question "based on your knowledge, how much do you think that mixed forests may improve the provision