



Adapting forest management to climate change in Europe: Linking perceptions to adaptive responses



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ABSTRACT

Climate change will impact forests and may impair their ability to provide essential ecosystem services in the decades to come. Addressing this challenge requires adjustments to forest management strategies as of now, but it is still unclear to what extent this is already in progress. Using data from surveys of 1131 forest owners and managers from seven European countries, we assessed how they perceive their role in adapting forest management to climate change. The surveys focused on foresters' observations of climate change impacts, the degree to which climate change is a part of their operational and strategic management, and their ability to address related risks and opportunities.

We found evidence of a strong continent-wide climate change awareness among respondents, with 73% foresters convinced that climate change will impact their forest. However, only about one-third (36%) reported having modified their management practices, though figures vary widely between countries, from 14% in Portugal to 57% in Slovakia. Among the constraints limiting their actions, lack of knowledge and information emerged as a major barrier towards forest adaptation. Differences between countries could be linked to their socio-economic and political contexts. Our results further suggest that severely damaging events, such as windstorms, fires and pest outbreaks, present relevant opportunities to engage people with climate change and encourage action. Further work needs to be done in strengthening the relationship between scientific research and practice, working out context dependent measures to foster adaptation to changing climate and disturbance regimes in forest management.

1. Introduction

Forests are of utmost importance for the environment, the economy and the society, as they provide multiple goods and services (Crowther et al., 2015). Climate change, in particular increased temperatures, changes in precipitation patterns, and extreme weather events, will inevitably have widespread impacts on forests and forestry. Among the

known impacts of climate change are changes in tree growth and productivity (Bergh et al., 2003; Jump et al., 2006), changes in tree health and species composition (Allen et al., 2010; Kurz et al., 2008), and damages caused by natural disturbances (Dale et al., 2001; Seidl et al., 2014).

Minimizing the risks and impacts of climate change on forest management outcomes and reducing the vulnerability of forests to

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climate change requires adaptation (Nelson et al., 2016). However, despite the recent research efforts, integration of adaptive forest management measures, taking into account expected climatic change, is a challenge yet to tackle. Unlike other sectors, such as agriculture, adaptation measures for forestry need to account for the long time lags between the establishment and maturity of trees. Forests regenerated today will have to cope with the future climate conditions of at least several decades, often even more than 100 years (Lindner et al., 2008; Wagner et al., 2014).

IPCC defines adaptation as an ‘adjustment in natural or human systems in response to actual or expected climatic changes or their effects, which can be taken to reduce the impact of a particular risk or exploit its beneficial opportunities’ (IPCC, 2014). Adaptation can be classified either as autonomous or planned (Schoene and Bernier, 2012). Autonomous adaptations are usually reactive, drawing on existing knowledge and technology to respond to changing climate conditions. Planned adaptations are anticipatory responses, often multi-level in nature, aimed at altering the adaptive capacity of the forestry system or facilitating specific adaptations. Messier et al. (2015) argue that changing conditions must be anticipated rather than simply recognized as they occur, since a reactive approach may be ineffective when dealing with long-lived organisms such as trees. Planned adaptation thus entails the involvement of the entire community of forest practitioners, from the field managers to the policy makers, to ensure that future forests are better aligned with the needs and preferences of local people (Kolström et al., 2011). Advantages of such involvement include a broader base of policy support and enhanced sharing of information and expertise on how to address climate adaptation needs (Fernandez-Gimenez et al., 2008; Messier et al., 2015).

A multitude of strategies to adapt forest management to climate change have been proposed (e.g., Bolte et al., 2009; Kolström et al., 2011). Some of these measures are not new and have already been used in forest management long before climate change became an issue. One example is the ‘back-to-nature’ approach, which promotes species mixtures and irregular age structures as a response to even-aged plantations (O’Hara, 2016). However, despite its apparent reliance on ecological arguments, the underlying rationale for reintroducing more complex forest stand structures was economic and most ‘back-to-nature approaches’ are still production-oriented (Gamborg and Larsen, 2003). Another example is the systemic silviculture approach. It does not depend on targeted structures or composition, as is generally the case with back-to-nature silviculture, but tends to follow and adapt interventions to the natural response of each stand (Ciancio and Nocentini, 2011; Nocentini et al., 2017). Furthermore, forest management and policy decisions are based on interactions between actors that engage with and react to one another (Nocentini et al., 2017).

One thing that all these approaches have in common is that planning for climate adaptation requires a longer-term perspective that must be effectively communicated and perceived. Perception is recognized as an active process of understanding, through which individuals construct their own version of reality (Pickens, 2005) and therefore influences decisions. Increasingly, the importance of foresters’ perception of climate change and options for adaptation is being recognized (Blennow et al., 2012; Lawrence and Marzano, 2013; Yousefpour and Hanewinkel, 2015; Sousa-Silva et al., 2016), since they play a fundamental role in the development and implementation of adaptation strategies, policies, and actions (Keenan, 2015).

Therefore, to further support the design and implementation of adaptation measures and policies in forest management, the purpose of this paper is to assess the level of adaptation of forest owners and managers, and the constraints that hinder or prevent adaptation. Although previous studies have shown that the capacity of forest owners to adapt to climate change is strongly dependent on the individual’s strength of belief in climate change and in the adaptation measures (e.g., Blennow et al., 2012; Yousefpour and Hanewinkel, 2015), direct comparisons between countries based on studies already

carried out are not feasible as the data are based on different questionnaires, methodologies and reference years. Here we seek to fill this gap by conducting a large-scale survey across Europe addressing three questions: (1) *to what extent are forestry practitioners aware of climate change*; (2) *what adaptation strategies do they practice to mitigate the impact of climate change, if any*; and (3) *what are the major factors which account for the success or failure of forest adaptation in each country*.

As such, this study provides a unique overview across countries of the perceptions of forest owners and managers, in order to develop the most appropriate recommendations for adaptive forest management under climate change.

2. Methods

This study is based on surveys carried out among forest owners and managers in seven European countries: Belgium, Estonia, France, the Netherlands, Portugal, Romania and Slovakia. Countries were chosen according to the following criteria: (1) to be representative of different biogeographical regions in Europe; (2) a large variation in extent of their forested area (as a percentage of total land area of the country); and (3) differences in socio-economic, political and cultural context. By including countries from Southwestern, Central and Eastern Europe, this assessment covers, therefore, different forests, climate conditions, and divergent governance-policies and strategies to support adaptation of forests to climate change (Appendix A).

The first survey was carried out between April 2013 and June 2014 in Romania and the second one between April 2015 and June 2016 in the other six surveyed countries. For detailed information on the survey design and sampling procedures see Appendix B. Questionnaires were formulated in English, on the basis of similar previous published surveys, and translated into the native languages of respondents in each respective country. Minor changes were made in the translation for a better adjustment to the targeted countries. A total of 1131 respondents completed the surveys, which included information on demographic factors, climate change awareness and self-reported adaptive measures taken. The main questions are shown in Table 1 (additional information is detailed in Appendix B). All respondents did not answer every question. The number of respondents to each question is reported for each table or chart.

The surveys were launched online and disseminated through email lists and social media targeting organizations active in the forest sector in the surveyed countries. Respondents were asked to forward the questionnaire to other colleagues and to any network in which they were involved to expand the snowball sample. Surveys were also

Table 1
Beliefs, experiences and ability of forest practitioners to contribute to climate change adaptation. *N* is number of responses.

General beliefs in climate change (<i>N</i> = 1131)
Do you think that climate change is happening?
Do you think that forest management must change in order to cope effectively with climate change?
To what extent are you concerned about climate change?
General experiences of climate change impacts (<i>N</i> = 1131)
Have you experienced any extreme weather event that you interpreted as caused by climate change?
If yes, which changes have you observed?
Beliefs of potential impacts (<i>N</i> = 1131)
Do you think that climate change will affect your forests?
If yes, which changes are you expecting?
Implementation of adaptation actions (<i>N</i> = 885)
Have you adapted your forest management in response to climate change?
If yes, what changes have you made to your management?
What are the greatest constraints limiting your ability to implement climate change adaptation actions?
What assistance would you require to address climate change in your forest?

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