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An uncertainty assessment framework for forest planning adaptation to climate change

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ABSTRACT

Uncertainty in forest planning is a prevailing problem affecting decision-making processes, especially those relating to climate change adaptation. Limited knowledge about uncertainty has prompted this empirical investigation of forest planners' understanding of uncertainty related to its recognition, its management and risk perception. We used a comprehensive uncertainty framework to address and test these uncertainties, with data from an online survey, to identify the views of 33 forest planners through Britain. Responses were analysed using non-parametric tests. The results showed that planners have significantly different views on uncertainty among economic, social and climatic categories. Uncertainty in the climatic category was more acutely perceived than in the economic and social categories. Planners preferred to practice active uncertainty management, as the results suggest they feel more able to manage uncertainty in forest models and their outcomes. Forest planners also indicated diverse perceptions of salient risks of change over the next 30 years. The results show they may take action only to pests, drought and wind risks posing a threat to forests even though they perceived these risks potentially to be highly regulated and controlled by forestry policies. The findings provide a better understanding of uncertainty as a source of inertia to climate change adaptation in forestry, identify new research objectives and support the development of forestry policies for climate change adaptation.

1. Introduction

In forest planning and management, uncertainty is one of the main challenges for climate change adaptation (Spittlehouse and Stewart, 2003; Spittlehouse, 2005; Ogden and Innes, 2007; Lindner et al., 2008). This issue of uncertainty has been known across scientific disciplines but with different frames and definitions. Hence, we acknowledge a rich literature identifying and defining uncertainty in a general context (Van Asselt, 2000; van Asselt and Rotmans, 2002; Walker et al., 2003; Newig et al., 2005; Brugnach et al., 2008) and in forest management (Pukkala, 1998; Kangas and Kangas, 2004; Leskinen et al., 2006; Hoogstra and Schanz, 2009; Holopainen et al., 2010). In this study we adopt the following uncertainty definition "the situation in which there is not a unique and complete understanding of the system to be managed" (Brugnach et al., 2008).

Despite the many uncertainties ever present in forest management, forest plan development cycles have progressed. However, climate change brings additional uncertainty to forest planning. We believe that this uncertainty can be a reason for inertia to climate change adaptation in forestry. Climate change uncertainty is recognized both in research (Spittlehouse and Stewart, 2003; Ogden and Innes, 2007; Bolte et al., 2009) and in forestry policies (Forestry Commission Scotland, 2006; DEFRA, 2007; Forestry Commission Wales, 2009) therefore forest planners and managers need to accept that climate change is uncertain and that they have to make decisions despite the uncertainty. However, as Ogden and Innes (2007) highlighted "uncertainties associated with climate change have discouraged forest managers from incorporating climate change into management plans".

This is an important observation, because unless climate change adaptation is implemented in forest management plans, actual change will not take place. And for researchers, such an observation raises the question whether climate change uncertainty should be different from any other type of uncertainty in forest planning. Clearly we need to focus on a decision maker's perspective of uncertainty (Gregory et al., 2006; Gabbert et al., 2010; Bijlsma et al., 2011), not on a modeller's perspective (Walker et al., 2003; Refsgaard et al., 2007; Warmink et al., 2010), because forest planning and management is about decision-making. Studies on forest planning and management have mainly addressed uncertainty from the modeller's perspective (Lindner et al., 2002; Holopainen et al., 2010) but have not addressed planners' uncertainties about for example management goals. Ignoring uncertainty about climate change in forest planning and management, i.e. beyond modelling uncertainty, can lead to a failure in adaptive forest management or inertia to climate change adaptation, and to a misunderstanding of the reasons for such failures.

As yet there is no literature that investigates the different types of uncertainty related to forest planning within a comprehensive

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uncertainty framework, although in other disciplines this has been achieved, for example, in 'technological innovations' (Meijer et al., 2006) and 'environmental modelling' (Warmink et al., 2010). As an example, (Van Asselt, 2000; Meijer et al., 2006) used a typology based on action, yield, political, model and monitoring, and goal uncertainty among others. We propose a new uncertainty analytical framework which addresses salient uncertainties from a decision-maker's perspective in forest planning and consists of uncertainty recognition, management and climate change risk perceptions.

Knowledge exists about these three components in different disciplines but this is limited in forest planning. First, uncertainty recognition studies have provided knowledge about a few types of uncertainty that appear in forest planning and management (Kangas and Kangas, 2004; Holopainen et al., 2010). However, little attention has been paid, and little empirical evidence exists of the types of uncertainty that forest planners recognize in their practice. Second, the management of uncertainty has been investigated in several studies, e.g. describing uncertainty management as active or passive in policy development (Bijlsma et al., 2011), offering strategies for dealing with diverse uncertainty types in water management (Brugnach et al., 2008) or as part of adaptive forest management approaches (Bolte et al., 2009). Although several methods for uncertainty management are available, the uncertainty of climate change relating to forest planning has not been evaluated before. Finally, many studies have investigated risk perceptions in diverse disciplines such as water and environment management (McDaniels et al., 1997; O'Connor et al., 1999), mitigation of wild fire (Martin et al., 2009), or assessment of ecological risks (McDaniels and Axelrod, 1995). Risk is important in decision-making because it may justify the necessity and intention to take action (Adger et al., 2009). However, whether or not forest planners consider risk in their management plans for climate change adaptation should depend on their individual risk perception. Yet there is a knowledge gap about what level of climate change risk perception forest planners have.

Our main objective is to investigate uncertainty in forest planning within a structured analytical framework. We address and answer the following three research questions: a) identify which types of uncertainty forest planners recognize in forest planning b) determine how forest planners prefer to manage uncertainty associated with forest models and their outcomes, and c) analyse how forest planners perceive climate change risks over time. Using a survey method, the study explores views and perceptions about uncertainty and risk in forest planning in Britain. The objects of analysis are the forest planners who decide about the future states of forests. We next describe the method for data collection, the uncertainty analytical framework and the data analysis. The subsequent section presents achieved results, and finally the last section summarizes and discusses the key findings.

2. Materials and methods

2.1. Data collection

The target population consisted of forest planners working for the Forestry Commission (FC), responsible for the management of the 812,000 ha of the national forest estate, representing 27% of the forest area in Britain with 7% in England, 4% in Wales, and 16% in Scotland (Forestry Commission, 2012). We surveyed two groups of planners, district planners who are responsible for strategic decisions at a district level and design planners who are responsible for operational decisions at a local forest block level. In addition since forestry is a devolved function in Britain, we expected forest planners to have a diverse uncertainty understanding due to different forestry policies in the three countries of Britain, i.e. England, Scotland, and Wales, which are affected by different climatic and edaphic conditions with diverse risks. Based on the research questions we selected purposive sampling (see (Babbie, 2010 p. 193)) as a suitable sampling method. The sample included all 25 forest district planners with one design planner for each district, making a total sample size of 50. In each district, a district planner randomly chose one design planner. We received in total 38 responses. After filtering out incomplete responses the response rate was 72% for forest district ($n = 18$) and 52% for forest design planners ($n = 12$), with two forest districts without design planners and three responses from planners having both roles. For the countries, the number of planners were for England ($n = 12$), for Wales ($n = 5$), and for Scotland ($n = 16$).

To collect views about uncertainty among planners we used an online survey, which has shown to be a suitable method in similar studies (Stedman et al., 2004; Bellamy and Hulme, 2011). We conducted the survey using SurveyMonkey (SurveyMonkey, 2011). The online survey method was a more practical solution for data analysis, it was easily accessible by the planners and it had the ability to effectively reach the survey group simultaneously. We pre-tested the survey with a pretesting protocol (Fowler, 1995) using four experts from Forest Research, UK and one forest planner working at a National FC Planning Office. The survey consisted of four sections: 1) statements about the recognition of uncertainty, 2) statements about the management of uncertainty, 3) statements about climate change risk perceptions, and 4) general questions about respondents. All statements were on a 7-point Likert scale. For uncertainty recognition and management the scaling ranged from strongly disagree to strongly agree, but specific scaling was used for risk perceptions (see details in Section 2.2.3). Statements included a "Don't know" option. To measure different types of uncertainty, we scrutinized statements in terms of their face and content validity. Additionally, statements were in a random order within each section to avoid leading information from the previous statements. The general section of the survey included information about job title, forest district name, length of time the respondent had worked in the current role, age category, and the highest achieved qualification. Data were collected between October and November 2011 for a period of 5 weeks, giving respondents sufficient time to fill out the survey which required about 20 minutes to complete. After the initial two weeks we sent an email reminder, which increased the response rate.

2.2. Uncertainty analytical framework

Our framework consisted of three key components. The first component was the recognition of different types of uncertainty with respect to social, economic and climatic (environmental) categories, the three pillars of sustainable forest management (Forestry Commission, 2007). If climate change uncertainty was not recognized or it was recognized differently to other types of uncertainty in forest planning and management, we would have a first indication for the inertia about climate change adaptation. The second component was about uncertainty management. If forest planners were to take a passive rather than an active attitude towards uncertainty management, we would have a second indication for the inertia about climate change adaptation. The third component was risk perception, i.e. a quantitative representation of uncertainty (Van Asselt, 2005) as perceived by forest planners. In forest planning risks are valued, interpreted, avoided, or accepted. We accept the conventional definition of risk as a combination of the hazard and the impact (Blaikie, 1994) but also expand our risk understanding to the non-technical risk definition of "intuitive judgments" (Slovic, 1987). In the following three sections we describe these components.

2.2.1. Recognition of uncertainty

A generic method for uncertainty recognition was applied (Table 1) based on the knowledge from previous studies in other domains (Van Asselt, 2000; van Asselt and Rotmans, 2002; Walker et al., 2003; Meijer et al., 2006; Brugnach et al., 2008). Table 1 presents the assessed uncertainty types along with their definitions. A set of statements addressing uncertainty in economic, social and climatic categories is in the Appendix A (Table 12). These categories represent the main problems that forest planners deal with in practice. The economic category measures the uncertainty of monetised goods and services in forestry, e.g.