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Adaptation of forest management to climate change among private individual forest owners in Sweden

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ABSTRACT

Available climate change scenarios indicate that climate change will affect elements of the Swedish climate, and that the exposure and sensitivity of the forest to climate change will differ between regions. Adaptation to climate change is conceptually closely linked to the reduction of the risk of disasters. Based on contemporary theory in behavioural risk research, the aim was to improve the knowledge on the process of adaptation of forest management to climate change among Swedish private individual forest owners. The responses from two questionnaires from 1999 to 2004, respectively, were analysed. Adaptation of forest management to climate change by private individual forest owners in what is currently the hemiboreal bio-climatic zone of Sweden was quantified and shown to increase over the five year period. In 2004 adaptive measures had been taken on a limited fraction of the forest land owned by private individuals in three study areas located along a latitudinal gradient ranging from the nemoral to the boreal bio-climatic zones in Sweden. Adaptive measures were more frequent in two southern study areas than in a northern study area. Measures taken to adapt were similar in all three study areas, except for those strongly conditioned by the current local climate. Among forest owners who had taken measure to adapt, perceptions of much higher risk due to climate change was more frequent for the risk of damage by wind, drought, fungi, and insects than for other risk factors. Further improvement of the knowledge on how the individual forest owners' learn and perceive of climate change, its impacts on risks and options for adaptation is required to develop and successfully implement adaptive climate change policies.

1. Introduction

Climate scenarios for Sweden for the 21st century indicate that expected changes in climate will affect forest ecosystems and that the exposure to change will be larger in the north than in the south (SCCV, 2007). Northern Sweden is currently part of the boreal and alpine bio-climatic zones, while southern Sweden is currently part of the hemi-boreal and temperate bio-climatic zones (Ahti et al., 1968) (Fig. 1). By 2020 the average warming is expected to be approximately 2 °C, mostly during winter (SCCV, 2007). Some scenarios indicate that by the 2080s warming will be approximately 3–5 °C. The precipitation is expected to increase in almost all of Sweden during winter while the summer precipitation is expected to decrease in southern Sweden. Possibly also the frequency and intensity of extreme events will increase (SCCV, 2007). The future wind climate at a century scale for Sweden is uncertain but a windier climate seems more likely than not (Christensen et al., 2007).

With respect to responses to climate change, often a distinction is made between mitigation and adaptation where mitigation refers to efforts to mitigate climate change itself while adaptation refers to adapting to the expected impacts of climate change (e.g. Baede et al., 2007). Adaptation to climate change is conceptually closely linked to reduction of the risk of disasters (Moench, 2007). The fourth and most recent assessment report by the Intergovernmental Panel on Climate Change (IPCC) (Adger et al., 2007) relies on the theory of adaptation as laid out in IPCC's previous third assessment report. According to this theory, adaptation may be seen as a response to reduce vulnerability where vulnerability to climate change is "the extent to which a natural or social system is susceptible to sustaining damage from climate change" (Schneider et al., 2001, p. 89). The vulnerability of a system is seen as a function of i/the degree to which the system is exposed to environmental variability and change, ii/its sensitivity – the degree to which the system will respond to external change, and iii/its adaptive capacity – the ability to adjust and take opportunities. Indeed, the vulnerability approach to adaptation has developed from hazard and risk reduction research (Moench, 2007), and has its roots in behavioural decision theory where loss reduction is seen as the root cause of action (Kahneman and Tversky, 1979; Burton et al., 1993; Peters and Slovic, 2000).

Climate change in Sweden is expected to result in increased growth potential for native and introduced tree species (SCCV, 2007). To take full advantage of the expected increase a change in tree species may be needed. For example, spruce and birch are expected to become more competitive compared to pine in northern Sweden,

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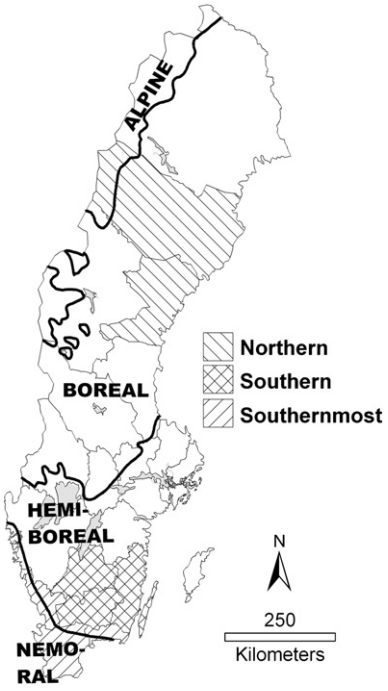

Fig. 1. Three study areas for a 2004 questionnaire study in a north to southerly gradient across Sweden and their location in current bio-climatic zones based on Ahti et al. (1968).

while the reverse is expected for southern Sweden (SCCV, 2007). In addition to opportunities, climate change in Sweden is expected to result in increasing risk of wind damage, damage from droughts, fire, insect plagues, more difficult and expensive logging operations and transportation due to reduced ground frost (SCCV, 2007). Many of the expected negative impacts are possible to be, at least partly, alleviated through adaptation of forest management.

Biological systems are dependent on climate, and hence individuals involved in sectors directly depending on these systems are expected to be sensitive to climate change. Furthermore according to Schneider et al. (2007), the adaptation potential of biological and geophysical systems is much less than for social or market systems. The need for planned adaptation would consequently be particularly large for those directly dependent on biological systems, especially within the forestry sector where the time period between planting and extracting extends over multiple decades.

Forestry is a vital component of the Swedish national economy. In the Swedish Forestry Act, there are two equally prioritised goals for forest management; sustained production of timber and wood, and the maintained biodiversity (in SFA, 2003). Although the Swedish forests are considered to be a national resource, 51% of the Swedish productive forest land is owned by private individuals (SFA, 2004). The management policy is thus shaped by the interplay between welfare economic interests and the interests of private owners (Blennow, 2008). The forest provides owners with diverse services such as timber production and cultural identity. Consequently, while on average only 12% of the household income of the Swedish private forest owner comes from forestry (Mattsson et al., 2003) other services may be at stake from climate change while concurrently new opportunities may arise.

While variation in exposure and sensitivity to climate change is expected across Sweden, significant aspects of the social system are the same, such as the legislative framework for forestry and the dominance of one silvicultural system based on clear-felling harvesting and regeneration. This is important since, as noted by Adger (2006, p. 270), "vulnerability to environmental change does not exist in isolation from the wider political economy of resource use". Increasingly, the importance of the individual's perception of climate change and options for adaptation is being recognised. For example, Blennow and Persson (2009) and previously Weber (1997) show that the capacity to adapt to climate change in a planned way is strongly dependent on the individuals' strength of belief in climate change and in ways to adapt.

In 1999 11% and in 2004 19% of the forest owners responding to questionnaires stated that they had adapted their forest management to climate change (Blennow and Sallnäs, 2002; Blennow and Persson, 2009). In the present study, the data on adaptation to climate change in 1999 and 2004, respectively, was revisited and used to test for change in adaptation over time. Furthermore, based on data from the 2004 questionnaire, explorations were made of i/the extent to which adaptive measures in forest management had been taken among private individual forest owners in three different study areas of Sweden along a latitudinal gradient, ii/the measures they had taken to adapt to climate change, and iii/ their perceptions of climate change risks.

The responses from one 1999 questionnaire sent to 402 Swedish private individual forest owners and one 2004 questionnaire sent to 1950 Swedish private individual forest owners were used. The results were discussed with respect to policy implications.

2. Methods

2.1. Questionnaires

2.1.1. 1999 questionnaire

A questionnaire was sent in November 1999 to owners of forest holdings of at least 15 ha each (Table 1). This questionnaire was sent to 402 forest owners sampled randomly by the Regional Forestry Boards from the forest data register among forest owners acting as contact persons towards Swedish authorities for their holding. The forest owners were distributed equally between two municipalities: Gislaved and Nybro in the counties Jönköpings län and Kalmar län, respectively. These municipalities are located in the southern study area in what is currently the hemiboreal bio-climatic zone in Sweden (Fig. 1). Forty percent of the forest owners responded.

2.1.2. 2004 questionnaire

A questionnaire was sent in April 2004 to owners of small forest holdings, each holding corresponded to a taxation value of at least 11,000 EUR in 2003 (Table 1). This questionnaire was sent to a total of 1950 forest owners sampled among forest owners acting as contact persons towards Swedish authorities for their holding in the Swedish forest data register. Sampling of 650 forest owners was conducted randomly by the National Statistics Office of Sweden in each of three Swedish study areas (Fig. 1): the northern counties of Västerbottens län and Västernorrlands län (in the boreal bio-climatic zone), the southern counties of Kronobergs län, Jönköpings län, and Kalmar län (currently mainly in the hemiboreal bio-climatic zone), and the southernmost study area including the counties of Hallands län, Blekinge län, and Skåne (mainly in the nemoral bio-climatic zone). In the northern study area, the threshold minimum taxation value of 11,000 EUR corresponded to approximately 20 ha of productive forest land, and in the two southern study areas this taxation value corresponded to approximately 5 ha of productive forest land, based on data by the Swedish Forest Agency (SFA, 2004). Fifty-seven percent of the forest owners responded. A subset of 307 respondents to the questionnaire was used that included owners of holdings of at least 15 ha of forest in the southern study area. This sub-set was used for comparison with the results of the 1999 questionnaire that had been sampled in this southern study area located in what is currently the hemiboreal bio-climatic zone.