



Vulnerability of cross-country skiing to climate change in Finland – An interactive mapping tool



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ABSTRACT

Cross-country skiing is one of the most popular recreational activities in Finland, but it is now becoming clear that it will be severely affected by climate change. In this paper we introduce an interactive vulnerability mapping tool that has been developed to raise awareness of the possible implications of climate change for cross-country skiing. Users of the tool are able to map indicators of exposure to climate change, characterising municipal-scale snow conditions under a warming climate, together with indicators of sensitivity and adaptive capacity, which are based on a national survey of 769 cross-country skiers aged 15–74 years from 2010. The indicators can be combined to produce composite vulnerability indices that can also be mapped. The mapping tool is designed to assist stakeholders in planning and developing skiing services and in studying the challenges of future regional cross-country skiing demand. It is available at: <http://www.iav-mapping.net/U-C-IAV>.

MANAGEMENT IMPLICATIONS

The U-C-IAV mapping tool can help to make the complexities of climate change impacts more recognisable, increase communication and awareness of climate change among decisions-makers and the general public and improve understanding of possible adaptation responses. The public sector still holds a key role in providing ski services for the population in Finland, and the tool could provide insights into the factors influencing vulnerability to climate change. This may assist stakeholders' decisions for designing strategies or developing policies to reduce vulnerability. The tool showcases cross-country skiers, representing an example of recreationists who already have experiences of adaptation to a changing climate and are expected to be affected even more in the future. As such, this study provides information that is potentially applicable or can serve as an example when investigating adaptation options for other winter activities in response to changing climate.

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1. Introduction

Climate change is likely to be one of the crucial environmental determinants of outdoor recreation demand and the behaviour of those seeking recreation (recreationists) in the future. Ski-tourism in general, and ski resorts in particular, are expected to face negative impacts of climate change (IPCC et al., in press, pp. 20–21; O'Brien, Eriksen, Sygna, & Naess, 2006; Scott and McBoyle, 2007), including monetary losses (e.g. Moen & Fredman, 2007; Elsasser &

Messerli, 2001). Such impacts are also of importance in the Nordic countries (Saarinen, 2014), but systematic research on the topic is scarce (IPCC et al., in press, pp. 20–21, Scott, McBoyle, & Minoque, 2007). For example, little is known about climate change impacts on skiing demand (e.g. Dawson, Scott, & Havitz, 2013), and most research that has been conducted focused on downhill rather than cross-country skiing (Landauer, Sievänen, & Neuvonen, 2009). Climate change impacts on cross-country skiing demand have been evaluated at the population level in Finland by Pouta, Neuvonen, and Sievänen (2009), who projected a reduction in participation that could be expected particularly among females, individuals with a lower socioeconomic status, and inhabitants of

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urban environments. Some of the previous research has identified skiers' adaptation strategies in response to climate change (Dawson et al., 2013; Landauer, Pröbstl, & Haider, 2012; Landauer et al., 2009; Scott and McBoyle, 2007; Behringer, Buerki, & Fuhrer, 2000). Although “supply-side” research indicates a range of potential outcomes for ski resorts (e.g. Scott & McBoyle, 2007), there is a growing sense, at least in Finland, that information on adaptation to climate change is currently lacking for the tourist industry and that innovative research activities are called for (Tervo-Kankare, 2011).

In Finland, cross-country skiing is an important leisure activity, with a participation rate of over 40 percent of the adult population surveyed in 2009–2010 (Sievänen & Neuvonen, 2011). Cross-country skiing is regarded as both a physical activity – a popular way of exercising and of gaining health benefits – as well as part of the cultural identity of Finns (Landauer et al., 2009; Landauer, Haider, & Pröbstl, 2014). Participation in physical exercise and an active lifestyle are known to have positive health effects (World Health Organization, 2010; Kaczynski & Henderson, 2007; De Vries et al., 2003). Traditional cross-country skiing in Finland relied on natural snow over extensive areas, with trips often made for the activity. Hence, compensating for poor snow conditions through artificial snow making is not a viable proposition over such large areas. Moreover, recreational facilities for cross-country skiing represent one of the most important local municipal sports infrastructural services. Ski tourism (offering both downhill and cross-country skiing) is also a significant business in Finnish Lapland where the largest ski resorts are located.

On the supply side, the majority of ski tourism enterprises so far do not have any particular adaptation strategy to account for warming winter conditions, although the issue of climate change – adaptation and/or mitigation – was generally included in development plans as a component of their sustainable development targets (Tervo-Kankare, 2011). In Finland, many ski tourism and sport enterprises as well as municipal agencies have some experience of coping with adverse weather conditions, such as snow-making, transporting snow from ice hockey halls, storing snow from the previous winter, and providing indoor ski halls and ski tunnels (e.g. Lépy et al., 2014).

In this study we are concerned about the vulnerability of cross-country skiing as an activity under a changing climate in Finland. In general, vulnerability has emerged as a central concept in framing climate change impacts on human–environment systems (Adger, 2006; Füssel, 2007), though its definition and interpretation have evolved over time (e.g. see Lavell et al., 2012). The most recent definition by the Intergovernmental Panel on Climate Change (IPCC) describes vulnerability as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.” (IPCC et al., 2014, p. 5).

One of the most common methods of representing differences in regional vulnerability to climate change is through the use of maps. Such maps typically depict sets of indicators that are believed to be contributory factors in the overall vulnerability to climate change of the system under study (such as a population, institution or ecosystem). Indicators are measured or modelled attributes for which data are available for geographical units across a region. The indicators are commonly combined into a vulnerability index, a composite measure that can also be mapped (Malone and Engle, 2011; Preston, Yuen, & Westaway, 2011; Polsky, Neff, & Yarnal, 2007). Many examples of vulnerability maps at various geographical scales have been documented, ranging from global (e.g., Füssel, 2010b), through continental (Metzger, Schröter, Leemans, & Cramer, 2008; Lung, Lavalle, Hiederer, Dosio, & Bouwer, 2013), to national (O'Brien, Sygna, & Haugen, 2004) and

sub-national (Rød et al., 2012). However, vulnerability mapping has also been challenged as a credible analytical method, due to the subjective nature by which indicators are selected (commonly based on subjective inference of causality), and the often arbitrary manner by which they are combined into indices (Füssel, 2010a; Hinkel, 2011). While recognising this critique, we argue here that as long as the underlying purpose, data and assumptions are fully transparent to the target audience, such mapping exercises can still offer a potentially useful and informative analytical method. In particular, mapping can provide a means of visualising those different factors thought to influence vulnerability to climate change, which so far may have received little attention, and may not otherwise be accessible to decision-makers facing the challenge of responding to climate change (Carter et al., 2014).

In the present study, the vulnerability of cross-country skiing in Finland has been assessed by combining indicators derived from survey information on the attitudes and intentions of cross country skiers (Landauer, Sievänen, & Neuvonen, submitted for publication) with indicators of prevailing and projected snow conditions. Our study focuses on skiing as a “close-to-home” activity, and the likely responses of skiers in different Finnish regions to changing conditions as winters become warmer. The study introduces a mapping tool for exploring the possible impacts of changing winter climate on skiing conditions and skiing behaviour. It is intended to be used by actors involved in cross-country skiing as business and service providers as well as professionals and decision makers concerned with policy and planning of land use and natural resources, with a view on helping these groups to assess adaptation needs and actions, and to promote discussion among different actors in their respective regions.

In the following sections we first outline the methods used to select, combine and map indicators of vulnerability to climate change for cross country skiing in Finland. Second, we describe the measured, modelled and survey-based data used to quantify the indicators. Third, we present an interactive web-based tool (U-CIAV) that allows users to map the indicators and to combine them into vulnerability indices. Next, we illustrate the types of results that can be visualised using the mapping tool and finally, we offer some conclusions on the utility of the web tool and its possible application and further development in the future.

2. Selecting indicators of vulnerability and potential impact

Following Metzger and Schröter (2006), vulnerability to climate change can be defined as a function of exposure, sensitivity and adaptive capacity. In the case of cross country skiing, the exposure (E) is defined as the expected change in skiing conditions under a changing climate, sensitivity (S) is the degree to which skiing participation would be affected by a given change in skiing conditions, and adaptive capacity (AC) describes the willingness of skiers to adapt, using different options, to anticipated changes in conditions.

Sets of indicators have been identified that describe exposure, based on estimates of future snow conditions using a hydrological model, and sensitivity and adaptive capacity, based on responses from a national survey of outdoor recreation. Sensitivity is characterised by a single indicator – the proportion of the population between 15 and 74 who skied during the previous 12 months, which varies regionally. The adaptive capacity set is sub-divided into indicators of technical adaptation (describing skiers' willingness to upgrade their equipment), indicators of locational adaptation (reflecting skiers' willingness to use indoor ski areas such as ski tunnels or halls), and indicators of activity-level adaptation (describing skiers' anticipated responses to deteriorating snow conditions or actual behaviour). The specific indicators

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