Forest Policy and Economics 15 (2012) 108–113

Contents lists available at SciVerse ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Avalanche protection by forests — A choice experiment in the Swiss Alps

Roland Olschewski [a,*], Peter Bebi [b], Michaela Teich [b,c], Ulrike Wissen Hayek [c], Adrienne Grêt-Regamey [c]

[a] Swiss Federal Research Institute WSL, Economics and Social Sciences, CH-8903 Birmensdorf, Switzerland
[b] WSL Institute for Snow and Avalanche Research SLF, Switzerland
[c] PLUS Planning of Landscape and Urban Systems IRL, ETH Zürich, Switzerland

ARTICLE INFO

Article history:
Received 14 March 2011
Received in revised form 29 September 2011
Accepted 3 October 2011
Available online 13 November 2011

Keywords:
Cost–benefit analysis
Environmental services
Public goods
Natural hazards
Risk
Visualization

ABSTRACT

Forests provide a variety of ecosystem goods and services to society, which often have the typical characteristics of a public good: non-excludability and non-rivalry. One of these services is avalanche protection of forests. A monetary valuation of this service would be helpful to provide efficient and effective protection to the local population. We present the results of a case study from the Swiss Alps, where we determined the willingness to pay for avalanche protection based on a choice experiment combined with virtual reality visualizations. Furthermore, we compare these results with the costs of alternative technical measures for natural hazard mitigation as well as with the results of a risk-based evaluation. We conclude that the willingness to pay for avalanche protection of forests is about the same range as the collective risk related to a 300-years avalanche event and within a range similar to the per-household costs of alternative measures. However, willingness to pay is substantially higher than the costs of silvicultural measures to maintain protection forest.

© 2011 Elsevier B.V. All rights reserved.

1. Introduction

1.1. Background

Forests generate a wide range of ecosystem goods and services (ES) to the population (MA, 2005). One of the main ES of forests in mountainous regions is the protection of people and infrastructure against natural hazards, such as snow avalanches (Brang et al., 2006). In Switzerland, about 43% of the forests have a protective function (Brändli, 2010). Since this service is a typical public good, it is seldom marketed and, thus, information about its economic value is lacking.

Planning and maintaining avalanche protection by forests often requires decisions concerning different technical and silvicultural measures, even more, since catastrophic storm events have increased in recent decades (Usbeck et al., 2010). In order to provide a comprehensive basis for decision-making in landscape planning and cost-efficient forest management, alternative evaluation techniques can be applied (Grêt-Regamey et al., 2008; Olschewski et al., 2008).

Recent studies have shown that Choice Experiments (CE) are feasible instruments to value hazard-mitigating services of forests. While some authors focus e.g. on the determination of the value of statistical life (Rheinberger, 2009), others concentrate on particularities such as the impact of small risk changes on the valuation results (Leiter and Pruckner, 2009). Further, Haegeli et al. (2010) used CE to investigate decision-making strategies of different groups of recreational travelers in avalanche terrains. As a novelty, we combine a choice experiment determining the willingness to pay for avalanche protection with risk-based evaluation techniques, virtual reality visualizations, and alternative cost estimations in a comprehensive interdisciplinary analysis. Thereby, our study goes beyond the conventional cost-effectiveness approach of avalanche protection measures by determining benefits based on stated preferences instead of avoided costs (compare e.g. Fuchs et al., 2007).

1.2. Study area

The Swiss municipality Andermatt, Canton Uri, has about 1250 inhabitants with additional overnight accommodation for 1500 tourists, and lies at an altitude of about 1450 m above sea level (m.a.s.l.). Our study area comprises the north facing slope of 'Gurschen' reaching an altitude of about 2000 m.a.s.l. with a gradient continuously above 30°. The annual average temperature is 2.7 °C, with a margin of −6.7 °C in January and 11.8 °C in July. The annual average precipitation is 1280 mm and snow height is 1.7 m on average with extremes of more than 3.0 m (Olschewski et al., 2011).

The protection forest is highly important for preventing avalanche hazards. This has been officially recognized by putting a ban on access and harvesting since the year 1397. Lining and reforestation projects starting from 1874 on led to an expansion of the protection forest from 4 ha to about 24 ha nowadays, which is dominated by Norway spruce (*Picea abies*) mixed with individuals of European larch (*Larix decidua*) and Swiss stone pine (*Pinus cembra*). The core area consists of an about 300-year-old spruce forest surrounded by younger

* Corresponding author. Tel.: +41 44 739 25 62; fax: +41 44 739 22 15.
E-mail address: roland.olschewski@wsl.ch (R. Olschewski).

1389-9341/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.forpol.2011.10.002

afforested areas. The protection forest has partly been destroyed by the storm 'Vivian' in 1990; this area has been reforested with Norway spruce. In the area above the protection forest additional technical linings have been installed since the 1950s (Olschewski et al., 2011).

2. Methodology

2.1. Damage potential and risk analysis

Risk analyses allow for a transformation of the protective function into economic values. To evaluate this function in our study region, we determined the damage potential of an avalanche event with a reoccurrence period of 300 years. The risk of this extreme event has been calculated following the recommended uniform procedure for risk analyses (Bründl et al., 2009; Borter, 1999), where risk is defined as the product of the probability of a damaging event and its consequences

$$R_j = \sum p_j \cdot A_j \tag{1}$$

where R_j is the risk depending on scenario j, p_j is the probability that scenario j occurs, and A_j is the damage potential as the sum of damages to objects and people affected in scenario j.

The approach for valuing the impact of the assumed wind-throw area as well as of different forest structures on the annual collective risk of the municipality Andermatt is based on the methodical framework presented in Teich and Bebi (2009). In addition to the classical risk analysis, this procedure of a GIS-based risk evaluation contains a classification of forest structures based on aerial photographs, the calculation of potential avalanche release areas within the forest and the prediction of avalanche run-out distances using the two-dimensional numerical avalanche dynamics program RAMMS (Christen et al., 2010).

The damage assessment includes the identification of endangered objects located in the run-out areas of the simulated avalanches. Thus, the damage potential consists of expected damages to exposed buildings and the expected loss of lives in these buildings (Bründl et al., 2009).

2.2. Choice experiment

We determined the willingness to pay (WTP) for avalanche protection by applying a choice experiment. This stated preference technique aims at determining, which factors or attributes are most important for the choice decision (Train, 2003). It is assumed that the choice decision depends on the utility derived from the different attribute levels: the higher a positive attribute level, the higher the utility, and consequently, the higher the probability to be chosen. The approach is based on random utility theory, where the utility of individual n from alternative i can be expressed as

$$U_{ni} = V_{ni} + \varepsilon_{ni} \tag{2}$$

with U being the utility function, V the observable component given by the attributes, and ε the unobserved random component (Louviere, 2001). We assumed this component to be independently and identically 'extreme value' distributed, which allows to apply a multinomial logit model for data analysis. While this seems to be a rather restrictive assumption, according to Train (2003) it can also be interpreted as a 'natural outcome of a well-specified model', when the target is to specify the utility function well enough, so that the logit model is the appropriate one. Furthermore, a possible violation is supposed to be more problematic when substitution patterns are to be forecasted instead of estimating average willingness to pay as done in our case (compare Train, 2003).

One of the acknowledged caveats of a logit model is that respondents' preferences are supposed to be homogeneous. In contrast, a mixed-logit model would allow to take heterogeneous preferences into account. This is especially useful in case that the sample consists of several segments, each of which with a unique and specific choice preference (Train, 2003). However, we refrained from using a mixed-logit model and the respective segmentation, given the small sample size and the relatively low response rate.

Special emphasis has been put on a clear and concise wording of the questionnaire. As questions related to the valuation of natural hazards might lead to misunderstanding and distorted answering, we conducted expert interviews, focus groups and pre-tests to clarify possible ambiguities.

In our basic scenario we assume that a wind throw has damaged about 1 ha of the protection forest. This scenario is particularly appropriate for our study region, because most of the population in Andermatt is still familiar with the consequences of the storm Vivian in 1990. Furthermore, it enables us to determine, which aspects or attributes of avalanche protection are actually important to the population. To do this, alternative measures to restore avalanche protection were introduced and described by five different attributes: type of measure, starting time, duration, damage avoidance and costs (compare Table 1).

Different level labels have been assigned to the same attribute in order to reflect particularities of the respective technical measures. According to Hensher et al. (2005) this does not cause any problems, as long as the labels for quantitative attributes are equally spaced within each attribute. In our example the costs of logs but also their potential to avoid damages is supposed to be lower than that of grills, bridges and nets. Additionally, life time differs due to earlier natural decomposition of wooden materials. Note that the attribute 'Type' has four different level labels, which are held constant. The payment vehicle has been designed as a one-time (lump-sum) payment. Thus, costs (in USD) were supposed to be added to the households' income tax bill of the specific year, in which the protection measure is implemented.

Different combinations of attribute levels are combined in choice sets consisting of three options (compare Table 2). Each respondent was asked to choose one out of three options from 10 subsequent choice sets.

When deciding which experimental design to apply, we focused on two basic requirements: (i) a minimal overlap between options and (ii) a balance of level attributes, whereas orthogonality was given minor importance (compare Johnson et al., 2007). We opted for the so-called 'short-cut design', developed by Sawtooth (2008). This design ensures that each option within a choice set is built by choosing attribute levels used least frequently in previous options for a specific respondent with the aim to minimize overlap, i.e., to keep the options in any task as different from one another as possible (Sawtooth, 2008). Additionally, the design takes into account that one-way frequencies of the attribute levels are balanced, which is appropriate for our analysis given that we aimed at estimating main

Table 1
Attributes and levels of protection alternatives.

Attributes	Levels			
Type (TY)	Logs	Grills	Bridges	Nets
Damage avoidance (DA, in %)	50/60/70	60/70/80	70/80/90	70/80/90
Duration (T, in years)	15/20/25	20/25/30	60/70/80	60/70/80
Starting time (ST, in years)	1/3/5	1/3/5	1/3/5	1/3/5
Costs (CO, in USD)[1]	100/150/200	200/250/300	400/500/600	400/500/600

[1] All calculations have been made in CHF. For publication, CHF values have been transformed into USD based on a 1:1 exchange rate (CHF/USD), which approximately reflects the average exchange rate throughout 2010.

Download English Version:

https://daneshyari.com/en/article/91417

Download Persian Version:

https://daneshyari.com/article/91417

Daneshyari.com