Cultural ecosystem services of mountain regions: Modelling the aesthetic value

Uta Schirpke [a,b,*], Florian Timmermann [a], Ulrike Tappeiner [a,b], Erich Tasser [a]

[a] Institute for Alpine Environment, EURAC research, Viale Druso 1, 39100 Bolzano, Italy
[b] Institute of Ecology, University of Innsbruck, Sternwartestr. 15, 6020 Innsbruck, Austria

ARTICLE INFO

ABSTRACT

Mountain regions meet an increasing demand for pleasant landscapes, offering many cultural ecosystem services to both their residents and tourists. As a result of global change, land managers and policy makers are faced with changes to this landscape and need efficient evaluation techniques to assess cultural ecosystem services. This study provides a spatially explicit modelling approach to estimating aesthetic landscape values by relating spatial landscape patterns to human perceptions via a photo-based survey. The respondents attributed higher aesthetic values to the Alpine landscape in respect to areas with settlements, infrastructure or intensive agricultural use. The aesthetic value of two study areas in the Central Alps (Stubai Valley, Austria and Vinschgau, Italy) was modelled for 10,215 viewpoints along hiking trails according to current land cover and a scenario considering the spontaneous reforestation of abandoned land. Viewpoints with high aesthetic values were mainly located at high altitude, allowing long vistas, and included views of lakes or glaciers, and the lowest values were for viewpoints close to streets and in narrow valleys with little view. The aesthetic values of the reforestation scenario decreased mainly at higher altitudes, but the whole area was affected, reducing aesthetic value by almost 10% in Stubai Valley and 15% in Vinschgau. Our proposed modelling approach allows the estimation of aesthetic values in spatial and qualitative terms for most viewpoints in the European Alps. The resulting maps can be used as information and the basis for discussion by stakeholders, to support the decision-making process and landscape planning. This paper also discusses the role of mountain farming in preserving an attractive landscape and related cultural values.

1. Introduction

The ongoing loss of biodiversity and ecosystem services is one of the greatest global challenges faced by decision-makers and society. Recent policies at both national and EU level have included the concept of ecosystem services as tools for better policies and management that counter degradation of ecological systems. Cultural ecosystem services in particular, offering nonmaterial benefits to people, seem particularly vulnerable to global change because they are very difficult to replace (Millennium Ecosystem Assessment, 2005). Along with growing urbanisation and agricultural intensification, the demand for enjoyable environments is rising due to increased leisure time and improved living standards (Pigram and Jenkins, 1999; Guo et al., 2010). Mountain environments offer aesthetically attractive landscapes which are appreciated by residents and tourists (Beza, 2010; Scolozzi et al., 2014). At the same time, mountain ecosystems are very sensitive to climate change and economic driving forces like agricultural competition from other more productive regions, global integration of markets or policy changes, and there are great changes in the provision of ecosystem services, especially at higher altitudes (Briner et al., 2013; Helfenstein and Kienast, 2014).

In the European Alps, land-use changes in recent decades have led to a reduction of managed alpine grasslands and, in some areas, to an intensification of the agricultural areas in valley bottoms (Rutherford et al., 2008; Tasser et al., 2009). The abandonment of traditional land management continues to alter landscape composition and pattern due to natural reforestation, which succeeds many years after the cessation of agricultural activities, and a considerable increase in forest area can be still expected in the future (Schneeberger et al., 2007; Tasser et al., 2007). The decrease in

* Corresponding author at: Institute for Alpine Environment, EURAC research, Viale Druso 1, 39100 Bolzano, Italy. Tel.: +39 0471 055 337; fax: +39 0471 055 399.
   E-mail addresses: uta.schirpke@eurac.edu (U. Schirpke), florian.timmermann@student.uibk.ac.at (F. Timmermann), ulrike.tappeiner@uibk.ac.at (U. Tappeiner), erich.tasser@eurac.edu (E. Tasser).
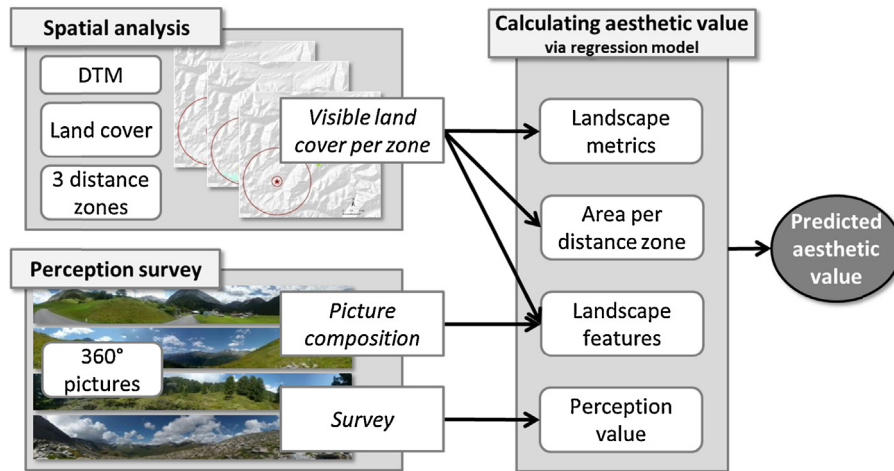
Fig. 1. Study design for estimating aesthetic value in mountain areas of the European Alps.

aesthetic values is mainly linked to an intensification of use in the valley bottom and to the abandonment of alpine meadows and pastures in the alpine and subalpine belt which leads to reduced landscape diversity and a loss of viewpoints caused by natural reforestation (Schirpke et al., 2013b). The maintenance of a managed alpine landscape has not only positive effects on cultural ecosystem services (Daugstad et al., 2006), but also numerous benefits in terms of biodiversity and regulating services (e.g. flood mitigation, erosion control, nutrient cycling, etc.) (Briner et al., 2013; Lamarque et al., 2014).

To maintain mountain landscapes as aesthetically attractive, land managers and policy makers have to cope with both present landscape transformations and the effects of former land-use changes. Human perceptions and attitudes should be considered in landscape management, allowing the identification of suitable and timely interventions (Bauer et al., 2009). Efficient evaluation techniques for cultural ecosystem services are therefore needed to support decision-making and landscape planning in an effective way (Hunziker and Kienast, 1999; Plieninger et al., 2015). Although the development of ecosystem services indicators is progressing rapidly, the assessment of cultural ecosystem services continues to be difficult because of their subjective and intangible character (Daniel et al., 2012). Most studies including cultural ecosystem services have focused on recreation and tourism, and only a few studies quantified aesthetic values by using indicators such as visual quality, number of scenic roads or house prices (Hernández-Morcillo et al., 2013; Zoderer et al., 2016b). While studies mapping aesthetic values in spatial terms rely mainly on indicators referring to specific landscape features or pattern (e.g., Germino et al., 2001; Fry et al., 2009; Szücs et al., 2015), studies about people's judgements are generally based on questionnaires or interviews (Hunziker et al., 2008; Soliva and Hunziker, 2009; Sherrouse et al., 2011). The spatial dimension can be included via participatory mapping exercises (Plieninger et al., 2013; van Berkel and Verburg, 2014), but this is very time consuming. The aesthetic value of mountain regions has been evaluated in some local and regional studies using specific questionnaires (Grêt-Regamey et al., 2007; Schirpke et al., 2013b, 2014) or spatial models (Grêt-Regamey et al., 2008, 2014; Zoderer et al., 2016b). However, these studies are only representative of a small area and efficient procedures to quantify cultural ecosystem services in spatial terms are still rarely developed to map diverse landscape perceptions for a generalised understanding of aesthetic values.

To contribute to the emerging research field of cultural ecosystem services, we focus in this study on aesthetic value, which is also related to other cultural ecosystem services such as recreation, tourism and cultural heritage, in terms of the maintenance of traditional cultural landscapes (Plieninger et al., 2013). To map aesthetic landscape values, we propose an advancement of the work of Schirpke et al. (2013c). In the presented modelling approach an automated GIS-based model was related to human perceptions through a regression model, achieving a good level of prediction ($R^2 = 0.72$, adjusted $R^2 = 0.69$). While landscape pattern were analysed by the spatial modelling approach and described by landscape metrics, human perceptions were assessed using a photo-based questionnaire. However, the methodology suffered from some weaknesses. Firstly, the small number of pictures used in the photo-survey was not representative of most Alpine landscapes and showed a restricted view instead of full 360° panoramas. Secondly, the approach quantified landscape patterns, but disregarded information about landscape features influencing positively (water, glaciers) or negatively (artificial elements, urbanisation) perceived aesthetic values (Jessel, 2006; Ode et al., 2009; Schirpke et al., 2013a). Furthermore, the study of Schirpke et al. (2013c) estimated the scenic beauty for the entire study areas by placing observer points every 500 m, but to support regional planning and decision-makers in a more practical way, specific applications should be addressed, e.g. analysing the aesthetic value along roads or hiking trails which are of touristic interest.

The aim of this study was to improve the GIS-based model of Schirpke et al. (2013c) for generalised mapping of aesthetic values and to analyse the aesthetic value and the impacts of abandonment along hiking trails of two representative study regions. To allow the prediction of the aesthetic value for the European Alps, we first carried out an extensive perception survey with panoramic pictures representing the most frequent land cover types in the Central Alps. Secondly, we improved the regression model by including additional land cover information using available results from the spatial model (Fig. 1). We applied the enhanced model in two study areas in the Central Alps estimating the aesthetic value along hiking trails. Finally, this study aimed to identify locations of high aesthetic value which are likely to disappear without human intervention due to natural reforestation by applying a simple reforestation scenario in order to provide an information basis for land use policies and decision makers.

2. Materials and methods

2.1. Study area

We selected two areas in the Central Alps through which to estimate aesthetic value: the 'Stubai Valley' (Austria) and