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# Using conjoint analysis to gain deeper insights into aesthetic landscape preferences

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ABSTRACT

Enjoyable landscapes are important resources for recreational activities and the socio-economic development of tourism destinations. A profound understanding of landscape preferences can support landscape management and planning. Despite the increasing integration of the socio-cultural perspective in landscape preferences research, little is known about the links between landscape characteristics and individual landscape preferences. In this study, we aimed to estimate landscape preferences at the individual level based on a set of landscape indicators, allowing us to measure the preferences of each person. We thereby evaluated the suitability of conjoint analysis to identify the relative importance of selected landscape indicators and the corresponding part-worth utilities of their characteristics. We further examined whether the preferences are homogeneous or if we can identify groups with largely different preferences. We related the picture ratings from a photo-based survey of landscapes in the Central Alps to a set of 11 landscape indicators, measuring the landscape pattern and features of each picture. Each indicator was divided into two or three levels and used to calculate importance scores and part-worth utilities by hierarchical Bayes analysis for individuals. In our study area, 11 indicators were sufficient to predict the individual choice between two landscapes for ~90% of the respondents. Our results indicate non-linear relationships between some landscape indicators and landscape preferences and revealed considerable heterogeneity for the vectors of part-worth utilities, suggesting some methodological problems when applying aggregated linear prediction models. Our findings may therefore enhance predictive models and support landscape planning and management, but further research is necessary to understand the driving forces behind the observed differences.

## 1. Introduction

Mountain environments provide many opportunities for enjoying nature and practising outdoor recreational activities (Schirpke et al., 2016, 2018). In addition to the positive effects on human physical and mental health (Romagosa et al., 2015; Triguero-Mas et al., 2015), an appealing landscape contributes to socio-economic development by attracting tourists (Bonzanigo et al., 2016; Chhetri et al., 2004). However, the landscape in the European Alps is changing due to past and current land-use changes, which include intensification of agricultural use and increasing urbanisation in favourable areas in the valley bottoms, as well as the abandonment of steep meadows and subalpine and alpine pastures (Egarter Vigl et al., 2016; Price et al., 2015). Subsequent reforestation processes on abandoned grassland have already increased forest cover in many parts of the Alps (Schneeberger et al., 2007; Tasser et al., 2007). Despite lower rates of land-use changes, forest regrowth will remain an issue due to slow succession (Tasser et al., 2017) but is expected to transform patchy landscape mosaics into more homogeneous patterns through the closing of open pasture patches (Garbarino et al., 2014). The result is fewer viewpoints and reduced landscape diversity, which leads to lower aesthetic landscape values (Schirpke et al., 2013b; Weinstoerffer and Girardin, 2000). In the light of these current and expected landscape changes in mountain regions, it is important to understand human preferences for landscape characteristics to be able to evaluate influencing factors and adapt landscape management and planning.

Landscape preferences involve both the biophysical characteristics of the natural environment and human perceptions and have been assessed through a variety of approaches based on different underlying concepts. An important conceptual distinction can be made between

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perception-based and expert-based methods (Daniel, 2001). Expert-based approaches consider visual landscape quality as an intrinsic attribute of the landscape and examine visual landscape properties by quantitative methods (Tveit, 2009). In contrast, perception-based approaches regard landscape quality as a subjective value (Lothian, 1999) and rely on on-site interviews or use visual representations, such as photo-based questionnaires (Hunziker et al., 2008; Junge et al., 2015). Furthermore, approaches describing the landscape through cognitive and physical landscape attributes can also be distinguished. Cognitive attributes describe the landscape by coherence, complexity, visual scale and naturalness, among others, arising from evolutionary theories in environmental psychology (Kaplan and Kaplan, 1989; Tveit et al., 2006). Studies using physical attributes relate to directly measurable landscape features, for example, land cover types or single elements (Arriaza et al., 2004; Hunziker et al., 2008). Generally, perception-based assessments reach a high level of reliability (Daniel, 2001) and have been used to examine human landscape preferences for different landscapes, such as agricultural landscapes in lowland regions (Arriaza et al., 2004; Gao et al., 2014) or in mountain areas (Hunziker et al., 2008; Junge et al., 2015; Lindemann-Matthies et al., 2010; Schirpke et al., 2013a; Soliva and Hunziker, 2009).

For these perception-based approaches, the methods used to assess landscape preferences range from picture ratings or rankings (Hunziker et al., 2008; Lindemann-Matthies et al., 2010; Schirpke et al., 2013a) to monetary valuation methods, such as willingness-to-pay (Grêt-Regamey et al., 2008; van Berkel and Verburg, 2014). To explain landscape preferences, some of these studies have linked the perceptions to GIS-based landscape indicators. These indicators are used to describe the visual character of the landscape in a quantitative way by measuring the physical attributes and features of landscapes as well as their spatial arrangement (Ode et al., 2008). However, these studies usually analyze the preferences of all respondents or defined subgroups rather than for individual persons and may not reveal complex relationships between preferences and indicators. Hence, the indicators used may be limited in their usefulness for predictive models and landscape planning. Here, we hypothesise that it is possible to connect the attributes and features of a landscape not only to general preferences but to the individual perception of the landscape, supposing that a person's preference for one landscape over another can be explained by a limited number of landscape indicators. Thereby, the landscape indicators are implicitly weighted in an overall index, i.e., the same weight is assigned to indicators without the interviewee having to make specific statements, and the higher the index, the more the landscape is preferred. The weighting vector is constant for one person for any comparison of two landscapes but different between individuals. Hence, it may be possible to identify groups of individuals with similar preferences.

One method to uncover the influence of landscape patterns or landscape elements on human preferences is conjoint analysis, which has been applied in landscape studies. For example, it has been used to evaluate the importance of selected landscape attributes to landscape enjoyment (Sayadi et al., 2005, 2009) and to identify landscape quality parameters, including different land use types, for selected recreational activities (Goossen and Langers, 2000). More specific applications include the assessment of preferences for and impacts of wind power plants (Álvarez-Farizo and Hanley, 2002; Zaunbrecher et al., 2017) and the influence of the landscape on perceived wine quality (Tempesta et al., 2010). Conjoint analysis originates from socio-economic research, where it has mainly been used for marketing strategies. It aims to quantify the overall preference of a person based on underlying attributes, providing a quantitative measurement of the relative importance of certain attributes with respect to others (Rao, 2014). Most applications of conjoint analyses in landscape perception studies rely on aggregated or group preferences (latent class method). Only recently have hierarchical Bayesian methods been implemented, allowing for the estimation of the weighting vector at the individual level, which offers the opportunity to evaluate the quality of the underlying model (Rao, 2014).

Usually, surveys for conjoint analysis are designed to confront respondents with different levels of selected attributes. This study instead used conjoint analysis a posteriori on data from overall picture ratings to evaluate whether this method provides deeper insights into stated landscape preferences. Our specific objectives were as follows:

- To examine whether the landscape preferences stated by a person can be predicted by only 11 landscape indicators. A high prediction accuracy corroborates the hypothesis that the important landscape indicators have been chosen and that the individual is consistent in her/his judgment.
- To control whether the relationship between landscape indicators and landscape preferences is mostly linear or not. This is important because many estimation methods assume linear relations.
- To analyze whether the implicit weights used to combine the landscape indicators into an overall index for aesthetic landscape preferences are very similar between individuals (homogeneity) or if they are very different. In the first case, an expert-based approach could also be used or a very small sample could be sufficient for estimating the aesthetic preferences of a landscape. In the latter case, a landscape is perceived differently by different groups and may be appreciated by one but not by another group. In this case, the mean preference may be a poor approximation of the preference structure. Consequently, the preferences for the same landscape again cannot be estimated in a simple way.
- To analyze whether differences between landscape preferences can be explained by a few socio-demographic variables if preferences are heterogeneous.

To achieve these objectives, we used a photo-based survey of the landscape in the Central Alps, including 24 panoramic pictures, and examined the stated preferences based on a set of landscape indicators, measuring the landscape pattern and selected landscape features (settlements, roads, forest and water) of each picture.

## 2. Materials and methods

### 2.1. Study area

To capture the variety of landscapes in the greater region of the Central Alps, we selected four study sites (Fig. 1): 1) Lech Valley (Austria), 2) Stubai Valley (Austria), 3) Puster Valley (Italy) and 4) Vinschgau (Italy). In all study sites, land cover includes mainly forest, grassland with different management intensities (intensively used grassland in lower regions, lightly used meadows and pastures mostly in regions above the tree line), abandoned grassland and rocky areas, although the land cover distribution differs among the sites (Fig. 1). Lech Valley, Stubai Valley and Pustertal belong to the Northern Central European climate zone, whereas Vinschgau is part of the Central Alpine arid climate zone (Fliri, 1984). In all sites, tourism is an important factor for the socio-economic well-being and development of the local communities.

### 2.2. Conceptual approach

To analyze landscape preferences through conjoint analysis, we applied four conceptual steps (Fig. 2):

1) Landscape preferences of 967 observers were assessed by a photo-based survey with 24 photographs (Section 2.3).
2) For each picture, a set of landscape indicators was calculated to measure the landscape pattern and features of each picture and coded with two or three levels (Section 2.4).
3) Conjoint analysis, using hierarchical Bayes analyses, was applied to assess relative importance scores and part-worth utilities (Section