Using choice modeling to map aesthetic values at a landscape scale: Lessons from a Dutch case study

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A B S T R A C T

Quantifying and mapping ecosystem services is increasingly employed to guide policies in their search for environmental sustainability. In this study, we present a method for mapping aesthetic values as an ecosystem service, combining insights from landscape research and ecosystem service mapping practices. We review or method through a comparison to existing aesthetic value mapping approaches and verify the results through a comparison to a revealed landscape preferences indicator. Disagreement between the methods arises from many factors, including the type of ecological/landscape features that are assumed to contribute to the provision of aesthetic values, the use of context-specific or generic aesthetic value estimates, the scale of landscape evaluation and the level of integration of the landscape preference analysis. We argue that the approach presented here is a suitable generically applicable methodology for context-sensitive mapping of aesthetic landscape values for a number of reasons: (i) a careful and transparent selection process of landscape attributes, (ii) the use of primary preference data, (iii) an integrated evaluation of landscape attributes introducing trade-offs between specific features in the agricultural landscape and (iv) application of visual landscape scale manipulated photographs for the elicitation of preferences as a surrogate for a real landscape experience.

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1. Introduction

Quantification and mapping the spatial distribution of ecosystem services is increasingly employed to guide policies in their search for environmental sustainability. Traditionally, most mapping and quantification studies have addressed regulating and/or provisioning ecosystem services (Crossman et al., 2013; Martínez-Harms and Balvanera, 2012). Mapping cultural services has been more challenging as these services do not directly relate to physical or ecological processes that may be documented in datasets and observatories, but instead evolve from human interaction with a site and the environmental perception of people (Plieninger et al., 2015). One important cultural service is the aesthetic enjoyment of landscapes, often addressed as aesthetic landscape preferences. The absence of an evident link between physical features of landscapes and aesthetic values complicates the design of effective landscape policies that aim to safeguard this type of services (van Zanten et al., 2014a).

Commonly, approaches to map cultural ecosystem services have been developed using secondary data or expert evaluation. These approaches either use simple look-up tables to relate the value of services to land-cover classes (Burkhard et al., 2009; Jacobs et al., 2015; Kienast et al., 2009), or assume relations between cultural services and indicators that describe the state of an ecosystem or landscape (e.g. naturalness or diversity) (Casado-Arzuaga et al., 2013). These studies have in common that they do not explicitly distinguish between cultural services and the role of aesthetics in these. Next to physical features of landscapes (e.g. land-cover), the benefits that people obtain from aesthetic services depend on individual, cultural and socio-ecological contexts (Chan et al., 2012; Daniel and Boster, 1976; Fagerholm et al., 2012), and therefore, these assessments lose credibility when values are extrapolated (Geijzendorffer and Roche, 2014).

Outside the realm of the ecosystem service approach, a substantial body of methods and data has been developed to study the aesthetic value of landscapes through landscape preferences (Daniel et al., 2012). In these studies, sophisticated methods have been developed to estimate the value of specific landscape features, but often they do not make these aesthetic values spatially explicit in the format of maps (van Zanten et al., 2014b). Typically, landscape preference studies use landscape photographs as a surrogate for a 'real' landscape experience in a particular case study area (Dramstad et al., 2006; Hull and Stewart, 1992; Ode et al., 2009). More recently also virtual reality or eye-tracking techniques are used to study landscape preferences (Smith, 2015). Studies based on landscape photographs measure preferences

using a variation of techniques, mostly using a 'representative' or 'characteristic' landscape picture as a reference (Howley, 2011; Rogge et al., 2007). Yet, these landscape preference studies hold valuable methodologies that relate subjective aesthetic values to specific features of landscapes. Since information on the spatial occurrence of these landscape features is available in spatial datasets, there is a potential to use the results of landscape preference studies to support aesthetic value mapping.

A number of novel approaches were recently developed to bridge the gap between cultural services mapping based on simple indicators and landscape preference research. These approaches specifically consider the scalability of recreational values (Grêt-regamey et al., 2014) and address community values through participatory mapping (Brown and Fagerholm, 2015; Plieninger et al., 2013). However, a mapping method to assess landscape preferences in a way that evaluates the contribution of specific landscape features to the aesthetic value of landscapes has not been developed yet. Including the aesthetic values of landscapes within mapping methods for cultural ecosystems services can further advance the operational value of ecosystem service mapping to inform landscape policy and management.

The aim of this study is to develop a comprehensive method to map aesthetic values across a landscape or region based on preferences for specific features in the visual landscape. We apply this method in an agricultural landscape in the east of the Netherlands where features range from livestock presence to features that describe land-cover structure and composition. To systematically capture landscape users' trade-offs between different features of the agricultural landscape, we apply a choice experiment. Subsequently, we scale-up preferences for (combinations of) landscape features that we find on a visual landscape level to a regional landscape map using generic feature mapping (Alessa et al., 2008). We reflect upon the validity of the proposed method through a comparison to existing generic feature mapping methods for cultural ecosystem services that address aesthetic values on a landscape scale (Burkhard et al., 2009, van Berkel and Verburg, 2014) and by comparing to a landscape preference map based on revealed preferences.

2. Methods

2.1. Overview of the Methodology

The first step of the analysis comprises the selection of relevant landscape features that are included as landscape attributes in the choice experiment. This selection is based on a synthesis of existing literature (van Zanten et al., 2015) and engagement with local stakeholders to identify a shortlist of those landscape attributes that contribute to the provision of aesthetic values in the case study area. Second, spatial data are collected from existing datasets to assess the spatial variation of the selected landscape attributes in the case study area. Third, the observed spatial variation of landscape attribute levels in the area is used to determine the attribute levels of the choice experiment. Fourth, based on the choice experiment a choice model was estimated and the predicted probabilities are used to estimate the aesthetic value in a spatially explicit manner for the landscapes in the case study region as a whole. After the production of this map we compare the thus produced map of aesthetic values to other mapping approaches that have used different methodologies (Burkhard et al., 2009; van Berkel and Verburg, 2014). We also compare our results to the density of uploaded Panoramio photo's in the area (Casalegno et al., 2013), which we use as an indicator of revealed aesthetic landscape preferences.

The method is designed to be generically applicable. We test the method in the context of Winterswijk National Landscape, located in the east of the Netherlands (Fig. 1a). The area is recognized for its distinctive rural landscape in the Netherlands and is protected under Dutch law as a National Landscape. Agriculture is the dominant land use in the area. Throughout the National Landscape, the agricultural system is oriented towards the production of dairy products with mostly grazing livestock (grasslands) and corn fodder crops grown. Past socio-economic processes and poor soil conditions have largely shaped agricultural activities in Winterswijk, with farmers constrained to small and dispersed agricultural plots (Wildenbeest, 1989). The resulting land-use pattern is a relatively well preserved traditional characteristically scattered agricultural landscape (Fig. 1b), with small plots enclosed by hedgerows (Coulisse landscape). As a consequence,
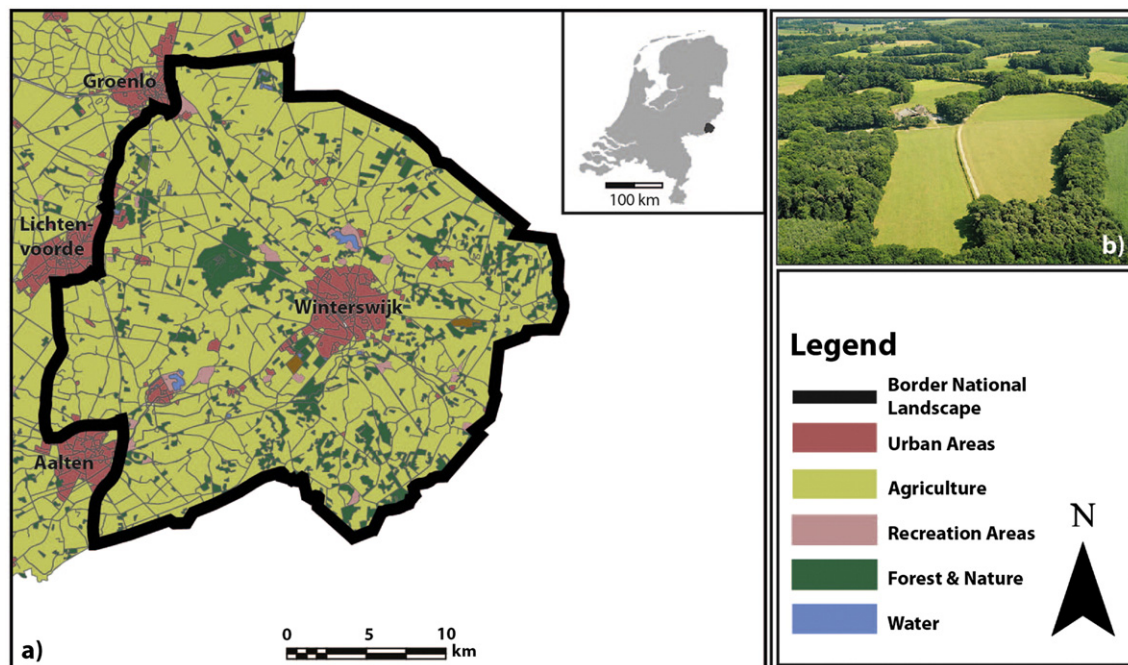

Fig. 1. (1.5 column): The case study area. a) Shows a land use map of the study area. b) Shows a bird's eye perspective of the Winterswijk agricultural landscape.