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Seasonality, diversity and aesthetic valuation of landscape plots: An integrative approach to assess landscape quality on different scales

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ABSTRACT

The amenity function of landscapes is of growing importance in the Common Agricultural Policy (CAP) of the European Union as well as in the reformed direct payment system of Swiss agricultural policy. This is reflected in a growing amount of direct payments for landscape stewardship, which enhances the need for landscape quality assessments. A good assessment system should be based on sound indicators applicable on different scales.

Diversity indices are often used to evaluate landscape quality. However, the aspect of seasonality is often neglected, although it is a typical quality of landscapes in temperate zones. This paper aims at including the aesthetic valuation (measured as rating scores) and seasonality, as a substitute for quality in a diversity index.

Overall, 27 landscape plots of 1 km^2 size with mapped land-use types were used to calculate diversity indices in two different ways: firstly by using the accumulated area of each landscape element (area-based approach) or the number of landscape elements (number-based approach) per plot, both times weighted by rating scores. Secondly with a "simplified element list" where only the landscape elements with a rating score above the mean of all rating scores were considered as single elements, while the remaining elements were aggregated to one element after weighting their area by the rating score. Furthermore for all types of calculation the accumulated absolute seasonal diversity was calculated.

Plotting the accumulated absolute seasonal diversity on the *x*-axis against the mean diversity index values revealed, that only using the "simplified element list" can mitigate the effect of diversity index calculations where an increasing number of elements in a certain area automatically results in increasing diversity values, irrespective of their impact on aesthetic quality. This presentation in a *x*–*y* plot offers information to interpret the results, and can be applied in national and international monitoring systems.

This novel approach is limited due to its restriction on 27 landscape plots of 1 km^2 size and to the lack of seasonal rating scores for all landscape elements that can be found in Switzerland. Additional data have thus to be provided. However, this should hardly be extra work in assessment projects if the number of fields and area sizes for each element can be taken from farm databases.

Introduction

Agricultural landscapes provide beneficial functions and services to humans that go far beyond agricultural production (Jongeneel et al., 2008). Modern agriculture is defined as multifunctional, comprising food production, ecological functions as well as recreational and aesthetic values (Jongeneel and Slangen, 2004; Jongeneel et al., 2008; Vatn, 2002). In order to sustain a multifunctional agriculture, direct payments for agri-environmental measures and landscape stewardship were established by the Common Agricultural Policy (CAP) of the European Union and by the reformed direct payment system of Swiss agricultural policy. A growing amount of direct payments enhances the need to assess the impact of agri-environmental measures on landscape quality. In terms of a multifunctional agriculture, the assessment should not only be done from an ecological, but also from a societal perspective. How the public perceive, value and assess landscape quality, and how society plans, manages, and uses a landscape

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for productive or non-productive purposes such as recreation and enjoyment are important components of an indicator that can be summarized as "societal appreciation" (Paracchini et al., 2012).

In the frame of the IRENA operation ("Indicator Reporting on the Integration of Environmental Concerns into Agricultural Policy"), a first set of indicators had been developed to assess the integration of environmental concerns into agricultural policy in the European Union (EEA, 2005, 2006). This indicator framework was revised and the number of indicators reduced from 35 to 28 (COM, 2006; Paracchini and Capitani, 2011). Indicator 28 "landscape state and diversity" consists of three sub-indicators of which one refers to societal landscape awareness, which is a novelty since it was not there in the previous IRENA framework of 2001. However, this societal sub-indicator is more concerned with public awareness of agricultural landscapes expressed by, e.g., the number of tourists per year in a region or the consumption of local products than with public appreciation of certain landscape types (Paracchini et al., 2012). Moreover, downscaling of the landscape social awareness indicator from the EU NUTS2 level – which it was designed for – to other levels can be problematic (Paracchini et al., 2012).

An ideal assessment system for agrarian areas should thus encompass indicators for use on regional, national and EU-wide scales as it would enable to use the same dataset(s) and the same analyze(s) to serve monitoring on a regional, national and international scale. Moreover, it should include indicators for the assessment of societal appreciation. As a step in this direction, the special issue of *Land Use Policy* is concerned with indicators able to convey the multiple expectations that society holds about rural agrarian areas.

Tveit et al. (2006) provide a framework comprising nine concepts. Within each concept landscape attributes describing the concept and potential indicators for measuring the dimension of the respective concept are defined. One of these concepts applies to "complexity". The concept of "complexity" includes the diversity and richness of landscape elements and features, but also interspersion and grain size of a landscape. Diversity indices and particularly the Shannon index are often used to evaluate landscape quality (Frank et al., 2013; Hunziker and Kienast, 1999; Plexida et al., 2014). However, Tveit et al. (2006) mention for the concept of "complexity" that it is not yet clear which elements contribute most to "diversity", and that further studies are needed. Moreover, it is not yet clear how much "diversity" is appreciated. Some authors (Hanyu, 2000; Kaplan and Kaplan, 1989) mention that too much "diversity" may be confusing and negatively perceived. This ambiguous meaning of "diversity" can be illustrated with two studies (Dramstad et al., 2006; Ode and Miller, 2011) where the correlation between index values and landscape preferences were tested. Dramstad et al. (2006) found a positive correlation between Shannon index values and landscape preferences, while Ode and Miller (2011) found a negative correlation. As a consequence, it should be advisable for further work to find a way to add quality when calculating "diversity".

"Ephemera" is another concept out of the framework by Tveit et al. (2006). "Ephemera" stands for changes of landscape elements or land-cover types with season and weather (Tveit et al., 2006). The bloom of fruit trees in spring and their colourful leaves in autumn are examples for season-induced ephemera in temperate zones, while changing clouds or water-surface colours are examples for weather-induced ephemera. Seasonal changes in (western) Europe are often taken as granted, resulting in a lack of research on "ephemera" (Brassley, 1998; Jones, 2007). Nevertheless, seasonal changes strongly influence the visual appearance of landscapes in temperate zones (Dodgshon et al., 2007; Thanasis, 2007). Furthermore, the visibility of the seasons is depending on management and land-use types (Stobbelaar and Hendriks, 2007; Stobbelaar et al., 2004). This makes "ephemera" an ideal component of an indicator for the assessment of visual agrarian landscape quality. Furthermore, the visibility of seasons within a landscape could add to diversity; at least on a regional level. Landscapes differing in their seasonal development differ in their visual quality from each other, what increases the diversity of landscape on a regional level.

The present paper aims at answering the question, how an indicator measuring landscape diversity on different scales should be characterized. It particularly aims at including seasonality as a substitute for quality in a diversity index.

Materials and methods

The indicator development was based on two sets of data: (1) data from a Swiss-wide photo survey on the public's aesthetic valuation of landscape elements at different seasonal stages ("ephemera") and (2) data from field surveys in which land use and land-use diversity were mapped in different regions in the Swiss lowlands. By combining these data, not only the concepts of "ephemera" and "diversity" were acknowledged for, but also the aspect of scale, i.e. diversity within regions and diversity between regions.

Basic datasets

(1) The photo-survey was conducted in 2007. The survey was sent to 4000 randomly selected households, and 1538 people participated. Each participant received four landscape elements for evaluation which were randomly selected out of 244 photographs. Participants were asked to rate each landscape element on 7-step scales, ranging from 1: totally dislike it to 7: totally like it (Junge et al., 2015; Schüpbach et al., 2009).

The 244 photographs depicted 14 landscape elements (crops, grasslands, and ecological compensation areas) in four to six different seasonal stages (Junge et al., 2015; Schüpbach et al., 2009). Ecological compensation areas (ECAs) are unique to Switzerland. Since 1998, farmers throughout the country can qualify for area-related direct payments if they meet a number of environmental standards (Flury et al., 2005) One of these standards demands that each farmer has to manage at least 7% of the utilized agricultural land as ECAs. In ECAs, the use of fertilizers and pesticides is restricted, and in the low land hay-meadows are not to be cut before 15 June (Herzog et al., 2001; Jeanneret et al., 2003) Of the 120,000 ha of ECAs (11% of Swiss farmland), three quarters are extensively managed hay meadows (Aviron et al., 2007).

(2) Land-use mapping was carried out in 27 plots of 1 km × 1 km in the Swiss lowlands. Ten plots were mapped in 1996 (Schüpbach, 2000), ten in 2001 (Schüpbach et al., 2008) and seven in 2008 (Hauser, 2008). The plots represented the most common land-use types in the Swiss lowlands (see Maps 1 and 2). For each plot, it was recorded how many and which of the following landscape elements were present: high-input grassland (differentiated into meadows, pastures and grass-clover leys), arable land (differentiated into cereal, maize, rape seed and beets), ECAs (differentiated in low-input meadows and pastures, moist meadows, species-rich field margins and wild flower strips) and three-dimensional elements such as hedgerows and high-stem orchards which in many cases are ECAs as well. In 1996, grassland was only differentiated into low- and high-input meadows and pastures.

In 1996, the Swiss base map 1:25,000 was used for mapping. In 2001 and 2008, mapping was based on aerial photographs. In 2008, additionally a handheld GPS was used. In all mapping exercises, the boundaries of the different landscape elements were digitized and edited with subsequent versions of ESRI ArcInfo. The three mapping techniques differed in spatial accuracy, but not in differentiation of landscape elements.