

Analysing the relationship between landscape composition and preference – the combination of GIS and visualisations

Åsa Ode¹, David R. Miller²

¹*Dept. of Landscape Architecture, Swedish University of Agricultural Sciences, PO Box 58, SE 230 53 Alnarp, Sweden. Tel. (0046)40415428 Fax (0046)40465442 Email asa.ode@ltj.slu.se*

²*Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK*

KEYWORDS: Landscape preference, spatial analysis, visualisations, landscape complexity

1. Introduction

The rural landscape provides a valuable resource supporting multiple functions, and changes in the structure of the landscape will mean that supported functions are likely to change accordingly (e.g. Van Eetvelde & Antrop, 2004). With the prospect of climate change the landscape will meet new challenges through for instances changes in agricultural productions and the production of renewable energy, which will have an impact on other functions in the landscape. However, although many drivers of change are global or regional, their manifestation at a local level will vary, and it is at this level these changes will relate to the general population and planners (Antrop, 2004; Dockerty et al., 2005). For management, planning and policy purposes it is desirable to be able to analyse the effects of landscape change. The increased urbanisation is changing our demand on the rural landscape as not only as primary production landscape but also as a service provider for the society at large. These new services include biodiversity, tourism, health and other amenity functions, and are not just limited to the peri-urban landscape. A large extent of these functions is dependent on the landscape as a scenic resource.

Within the VisuLand framework, a range of visual indicators based on theory have been suggested (e.g. Tveit et al. 2006; Ode et al. 2008). The framework is based on nine visual concepts found across a range of literature covering landscape aesthetic, environmental psychology and landscape characterisation. Though put forward in the literature, few of the indicators have so far been through any systematic testing on their relationship with landscape preference. In landscape preference surveys, photographs have traditionally been used as a surrogate for the real environment (e.g. Hagerhall, 1999). However, one of the limitations with the use of photographs in preference surveys is the lack of control of the content of the image that may impact on the observer's perception. With the development of computer visualisations new possibilities of evaluating landscapes under different scenarios has arisen (Daniel and Meitner 2001; Appleton and Lovett, 2005). Ode et al. (in press) means that the use of visualisations in order to test between relationship between preference and landscape composition holds two advantages: i) the use of a controlled environment, enabling changes to be made only to the indicators to be tested in a survey; ii) a direct link between the three-dimensional and two-dimensional data (*i.e.* visualisations can be derived from map-based data).

The concept of complexity is one of the concepts put forward by Tveit et al. (2006) as contributing towards visual quality and for which several indicators has been suggested and applied. However, as put forward for instance by Stamps (2004) there is within preference surveys limited suggestion on how to objectively measure what constitute complexity. Within

landscape ecology, a range of measurements for complexity have been developed. These measurements could be divided into:

1. Composition Complexity Indices – different form of diversity, evenness, richness and dominance indices. These do generally lack any spatial references and are therefore mainly focusing on the composition of the landscape and not on the configuration. E.g. Shannon Diversity Index (SDI) and Shannon Evenness Index (SEI).

2. Patch Complexity Indices – different form of indices related to the complexity of shapes, and relation between edge and interior area. This group does also cover degree of complexity regarding variation in these values. E.g. Area Weighted Mean Shape Index (AWMSI), Number of Patches (NumP).

3. Pattern Complexity Indices – different forms of indices to describe the spatial pattern of the landscape. These are both presenting arrangement of polygons as well as for the arrangement of cells of similar class within a grid. E.g. Contagion (CONTAG).

The presented study will together with outlining a method for testing visual indicators, present some initial findings on the linkage between preference and visual complexity indicators.

2. Method

In order to test the linkage between landscape complexity and preference, a methodology was developed combining spatial analysis and visualisations (based on the methodology developed by Ode et al. in press).

The base landscape was an area in the highlands of Scotland, which comprised of a general hilly landscape with few different types of land cover. For this landscape 6 different scenarios of land cover composition was developed based on altering the amount of land cover types present and the distribution between them, creating six scenarios of land cover composition, as presented in Figure 1.

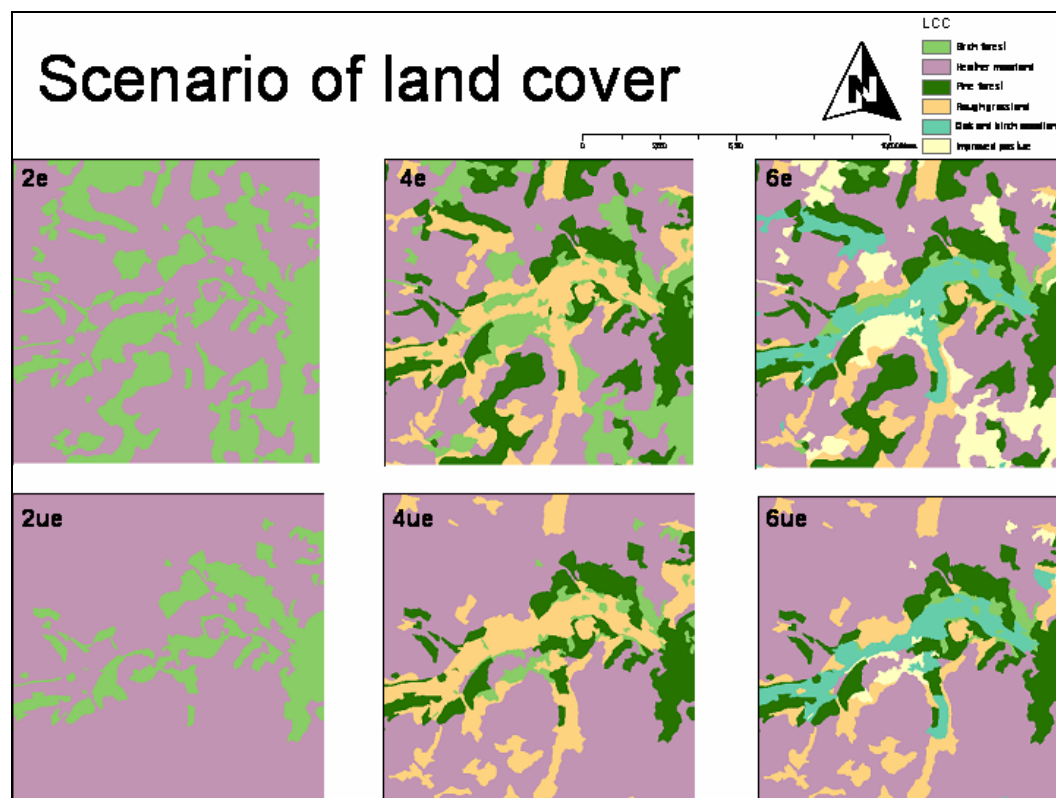


Figure 1. The six scenarios of land cover distribution. The top scenarios are having an equal distribution between open land and forest, while the bottom scenarios are having more of an unequal distribution.

For the six scenarios, indicators of different form of complexity were calculated, with the result as shown in Table 1.

Table 1. Complexity values for selected indicators

| Scenario | <i>SDI</i> | <i>SEI</i> | <i>NumP</i> | <i>AWMSI</i> | <i>Contag</i> |
|----------|------------|------------|-------------|--------------|---------------|
| 2e | 0.66 | 0.95 | 71 | 6.23 | 42.98 |
| 2ue | 0.44 | 0.64 | 47 | 4.37 | 62.54 |
| 4e | 1.3 | 0.94 | 145 | 3.55 | 45.00 |
| 4ue | 0.97 | 0.7 | 101 | 3.20 | 54.46 |
| 6e | 1.52 | 0.85 | 165 | 3.20 | 50.92 |
| 6ue | 1.12 | 0.62 | 117 | 3.09 | 64.18 |

Within the landscape two viewpoints that were representative for the changes in land cover between the scenarios were selected. For these two viewpoints visualisations were generated for all six scenarios, resulting in 12 images. The visualisations were generated using Visual Nature Studio, VNS, with ecosystem created to represent the 6 type of land cover present in the landscape and automatically allocated for the GIS layers showing land cover for each scenarios. Examples of the images generated are presented in Figure 2.

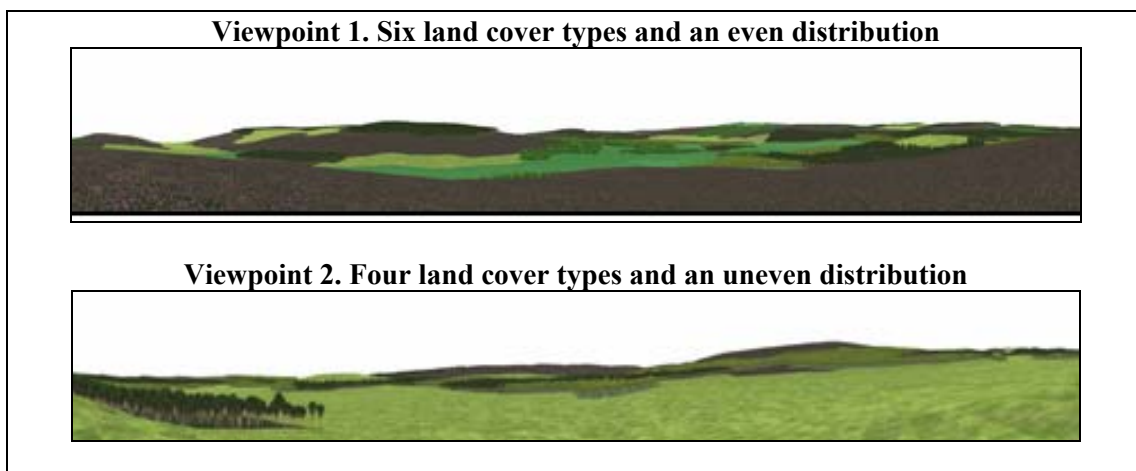


Figure 2. Examples of the visualisations generated and used in the survey.

In order to analyse for preference of the six landscapes, a preference survey was developed using forced choice. The study was run as an internet based survey, where the respondents were asked to choose which image the preferred in a random generated pair of images.

3. Results and discussion

The result of the survey was analysed together with the complexity measurements for the six scenarios using REML in order to establish relationships.

The preliminary results of the analysis, as presented in Table 2, show that all four of the tested indicators has a relationship to preference that is statistical significant. Shannon Diversity

Index is suggested to be the strongest predictor of preference while Contagion is the weakest of the indicators tested for this study. However, all indicators are of the same order.

Table 2. Results from theREML analysis for the five indicators of complexity.

| Metrics | Wald Statistic | Chi pr | Table of effects | Standard error |
|---------|----------------|--------|------------------|----------------|
| SDI | 53.10 | <0.001 | 74.82 | 10.268 |
| NumP | 50.19 | <0.001 | -0.7572 | 0.10688 |
| AWMSI | 46.01 | <0.001 | -3.176 | 0.4682 |
| SEI | 40.67 | <0.001 | 61.36 | 9.621 |
| CONTAG | 38.04 | <0.001 | 0.5601 | 0.09082 |

Both SDI and SEI show a strong positive trend between indicator value and preference, suggesting an increase in preference for landscape with high diversity and evenness. For AWMSI and NumP this relationship, though less strong. This would suggest that an increase in AWMSI and NumP would have a slight negative influence on preference. This slight negative correlation was also found within a previous study on naturalness indicators (e.g. Ode et al. in press), which showed that the highest preference scores was for landscape with a low-medium AWMSI while the images with high AWMSI had a relatively low predicted mean preference score. However, this results is preliminary and further statistical analysis is needed which include a broader range of complexity indicators.

In order to draw any more general results with regards to indicators of complexity and their relationship with preference for landscape there is a need for further research This could include the testing of additional complexity indicators, the running of the study for a range of different landscape types and the investigation into new methods for indicator application, e.g. visual topology.

4. Acknowledgements

The research was conducted during the main authors Post doc period at the Macaulay Institute which was funded through the Swedish Research Council FORMAS.

References

- Antrop M (2004) Landscape change and the urbanization process in Europe *Landscape and Urban Planning* **67** pp9-26
- Appleton K and Lovett A (2005) GIS-based visualization of development proposals: reactions from planning and related professionals *Computers, Environment and Urban Systems* **29** pp321-339
- Daniel TC and Meitner MJ (2001) Representational validity of landscape visualizations: The effects of graphical realism on perceived scenic beauty of forest vistas *Journal of Environmental Psychology* **21** pp61-72
- Dockerty T, Lovett A, Sünnerberg G, Appleton K and Parry M (2005) Visualising the potential impacts of climate change on rural landscapes *Computers, Environment and Urban Systems* **29** pp297-320
- Hagerhall C, (1999) The Experience of Pastoral Landscapes. Doctoral thesis, *Acta Universitatis Agriculturae Sueciae, subserie Agraria no 182*
- Ode Å, Fry G, Tveit MS, Messenger P and Miller D (in press) Indicators of perceived naturalness as drivers of landscape preference *Journal of Environmental Management*

Ode Å, Tveit M and Fry G (2008) Capturing landscape visual character using indicators - touching base with landscape aesthetic theory. *Landscape Research* **33** pp89-117

Stamps AE (2004) Mystery, complexity, legibility and coherence: A meta-analysis *Journal of Environmental Psychology* **24** pp1-16

Tveit M, Ode Å and Fry G (2006) Key concepts in a framework for analyzing visual landscape character *Landscape Research* **31** pp229-255

Van Eetvelde V and Antrop M (2004) Analyzing structural and functional changes of traditional landscapes – two examples from Southern France *Landscape and Urban Planning* **67** pp79-95

Biography

Dr Åsa Ode is a postdoctoral fellow at the Dept. of Landscape Architecture at the Swedish University of Agricultural Sciences in Alnarp. Her current research focuses on linking the experience of landscape with the spatial structure of landscape in order to develop landscape indicators.