Testing Public Preferences for Future Land Uses and Landscapes

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Summary: Public policy for adaptation to climate change includes assessing potential impacts of future land uses, using an Ecosystem Approach. Visualisation tools have been used to test for public preferences for scenarios of future land use, suggesting preferences for visual diversity, sound stewardship and perceived naturalness. A virtual reality environment was used to elicit a scenario of preferred future land use from audiences familiar and unfamiliar with the study area. Findings showed agreement in developing amenity woodland adjacent to a village, and environmental protection, but differences arose in relation to proposals for medium-sized windfarms.

KEYWORDS: Land use change, landscape visualisation, scenarios, woodland, windfarms

1. Introduction

The Climate Change Scotland Act (2009) provides a framework for reducing 80% of greenhouse gas emissions by 2050. It includes a Land Use Strategy which identifies principles for sustainable land use and visions for delivering multiple land use benefits. It promotes use of an ecosystem approach (EA) as a means of integrated management of land, water and living resources (UNEP, 2010). An EA comprises a cycle of public engagements to identify planning issues, develop scenarios, consider options, make choices, implement and monitor, and identify further planning issues. This paper presents roles for landscape visualisations within an EA for considering impacts on landscapes under scenarios of public policy and land management.

2. Background

The European Landscape Convention (Council of Europe, 2000) promotes integrated perspectives on landscapes including visual, cultural and social qualities with ecological functions. Fry et al. (2009) showed that landscape characteristics (e.g. stewardship, coherence, naturalness, complexity, scale/openness, historicity) have common conceptual ground with ecological concepts, allowing the definition of indicators based on quantifiable measures of land cover and land-use features. Theoretical underpinning of such concepts is provided by the Biophilia hypothesis, that humans have affiliations with nature rooted in our biology (Kellert and Wilson, 1993), evolutionary influences on landscape preferences (Falk and Balling, 2010), and use of information aiding environmental understanding (Kaplin and Kaplin, 1989).

Ode et al. (2009) describe tests of public preferences for landscapes with respect to visual concepts, using landscape visualisations of different representations of vegetation succession, and interpreting findings in terms of, for example, stewardship and perceived naturalness. This demonstrated scope for testing public responses to future landscapes in relation to landscape preferences.

The National Ecosystem Assessment and UK Climate Impact Programme (UKCIP) present socio-economic scenarios which might drive land use change (e.g. maximising biodiversity opportunities, opening agriculture to world markets, promoting national enterprises, and local stewardship). These provided the basis for exploring public responses to resulting landscapes and assessing associated public policies.

3. Methodology

3.1 Approach

Methodological steps were:

(i) compilation of spatial datasets comprising land cover and use, and terrain;
(ii) generation of alternative land use datasets using stochastic modelling (Castellazzi et al., 2010), based upon scenarios, and an option of riparian management reflecting local importance of flood management;
(iii) creation of 3D models using existing land use, and modifications reflecting alternative land uses driven by scenarios;
(iv) development of a survey of landscape preferences using visualisations of each scenario from different viewpoints;
(v) elicitation of public opinions on future land uses using a virtual reality environment.

3.2 Study area

The study area is the Tarland Basin (52 km^2) in the River Dee catchment, Aberdeenshire. Current land use is 70% agriculture, 21% woodland, 8% moorland and 1% built. Employment is 3% in agriculture, 26% in tourism, 30% in the public sector, and 15% in financial services. Therefore, few local people have employment linked to land use, but gain indirect benefits through landscapes managed for recreation and tourism, and residential quality of life.

3.3 Model creation

3D models used Ordnance Survey 1:10,000 Digital Elevation Model (DEM), MasterMap for extruding buildings and land use units, ground photographs for textures of crop types. Detailed cropping systems at field scale were derived from Integrated Agricultural Control System data (2000-2007).

Stochastic spatial modelling accounted for constraints and aims of each scenario (e.g. maximising biodiversity scenario prevents change in semi-natural habitats and prime agricultural land but introduces woodland in all other suitable areas), for the year 2050. The output datasets were rendered in Virtual Nature Studio (VNS) for use in preference modelling, and converted for use in Octaga virtual reality (VR) software in the Virtual Landscape Theatre (VLT; www.macaulay.ac.uk/landscapes).

3.3.1 Landscape preference model

Detailed, static, landscape visualisations are created to test public and stakeholder preferences for alternative future landscapes (Figure 1). These reflect different scenarios of land use in 2050, using species-specific representations of crops, woodlands, moorland and pasture, enabling visualisation level-of-detail to be matched with purpose (Schroth, 2010). Viewpoints were selected following prototyping using still images and VR environment with different audiences (public and professional). These viewpoints provide distant and close views, representing each of the alternative patterns of land use occupying small or large proportions of the view, at eye-level (1.8m), looking horizontally.

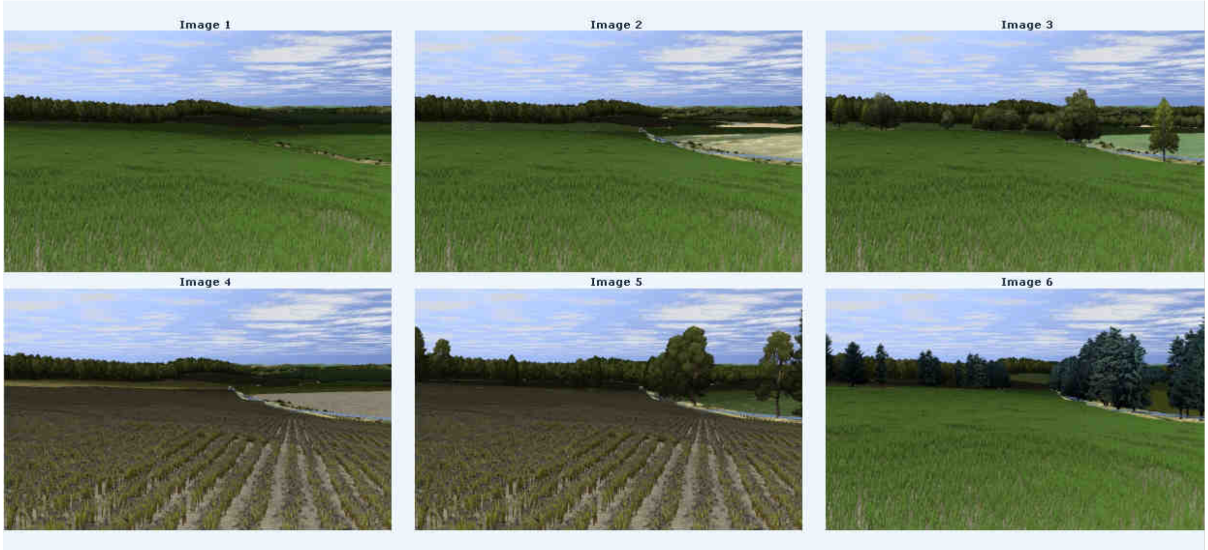

Figure 1. Set of visualisations for a viewpoint for testing people's landscape preferences
(http://surveys.hutton.ac.uk/index.php?sid=22947).

3.3.2 Eliciting opinions on future land uses

Models representing alternative land uses were used in the VLT in events designed to elicit public aspirations and concerns regarding future land uses, and to develop scenarios driven by local input. The software interface enabled:

(i) switching between data layers (i.e. current and future land uses) using 'hotkeys';
(ii) audience selection of land uses they like or dislike, using icons for wind turbines, housing, trees, access, vehicles, car parking, and conservation areas, colour-coded green (i.e. more/good) or red (i.e. fewer/bad). Icons were 'dragged and dropped' to audience selected positions, with VRML code 'ground clamping' them to the terrain surface.

Sessions comprised:

(i) introducing drivers of land use change (e.g. economic, environmental), and electronic voting;
(ii) audiences recording preferences for landscapes from different viewpoints;
(iii) audiences voting to prioritise land use topics for in-depth discussions;
(iv) discussion and voting on land use issues (e.g. windfarm location/ size; woodland location/type).

Figure 2 shows the VLT in Edinburgh (Figure 2(a)), with an icon of green trees, representing new woodland, visible left of the village, and a younger audience in Ballater (Figure 2(b)), which proposed woodland in the same location as that of Edinburgh.

Figure 2. Eliciting public opinions on alternative future land uses in the Virtual Landscape Theatre with audiences from: (a) Edinburgh, (b) Ballater, north-east Scotland.

Votes on preferences for landscape scenarios were recorded, and analysed with respect to the nature and proportion of visible features. Audience priorities for future land uses were recorded together with type and location of new features, familiarity with the area, and audience type (e.g. school, public, foresters, farmers).

4. Results

Preliminary findings suggest positive responses for landscapes with a visible mix of land uses, sound stewardship, elements of perceived naturalness and visual diversity. The emphasis of each factor varies by participant background.

From consultation events, commonality between audiences showed desires for amenity woodland adjacent to the village, quality recreation within the village, conservation interests, and recognition of risks to water quality with increased agricultural activity. Edinburgh and Ballater audiences were positive towards smallscale wind turbines associated with farming or communities.

Significant differences between audiences related to medium-sized windfarms on hills north of the village. Those unfamiliar with the area (Birmingham and some in Edinburgh) argued that renewable energy was a priority and highlighted open hilltops as opportunities for maximising energy return. Those familiar with the area, even if not residents, were conscious of the local significance of prominent hills and previous rejections of windfarm proposals.

Feedback on the VR environment was strongly positive. Over 80% reported it effective for capturing views on priorities for future land uses. Positive comments included ease of representation of alternative future land uses, and the opportunity to discuss benefits and disbenefits. Negative comments related to static content of models and lack of texture in ground vegetation.

5. Discussion

The development of objective scenarios of future land uses into representations of landscapes provided a basis for effective exploration of options for land use and management with stakeholders and the public. Feedback from elected representatives and planners suggests that the tools have roles in planning adaptation to climate change (e.g. flood alleviation measures), public policy (e.g. increasing woodland cover), and exploring public expectations for land use and landscapes. This fits the profile of an EA for landscape planning and management.

Limitations of VLT tools included constraints on using higher levels-of-detail in imagery (i.e. limits to texturing), which would be overcome with improvements to computing hardware and software. Development of tools currently includes the use of animated features to test impacts of changes in land cover features on landscapes due to disturbance caused by movement.

6. Acknowledgements

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7. References

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8. Biographies

Gillian Donaldson-Selby is a landscape modeller in the Information and Computational Sciences group. She has a background in 3D computer based modelling and visualisation. Her research interests include the application of landscape visualisation in public participation and environmental problem solving, including landscape and river rehabilitation.

Chen Wang is a Landscape and Visualisation Scientist. He received his BEng at Soochow University, and a PhD at University of Bradford. His research interests include 3D modelling of landscapes; urban environment modelling and reconstruction; character and traffic animation; 3D real time flood simulation.

David Miller is the leader of the Realising Land's Potential Research Theme, studying natural resources, land use and landscapes. His background is in spatial modelling and remote sensing, with 27 years experience the development and application of tools for monitoring rural and urban land use, and assessing impacts of change.

Paula Horne has a background in handling digital map and satellite data and has extensive experience in the use of Geographic Information Systems (GIS) and image analysis software for studying changes in urban and rural landscapes. She navigates stakeholders through landscape models in the VLT, explaining land use change.

Marie Castellazzi is a researcher in integrated environmental modelling group, working on modelling land use scenarios at the landscape scale. Her background is in environmental science and GIS, with 7 years experience in spatio-temporal modelling of land uses and crops.

Iain Brown is a research leader at the James Hutton Institute, leading the Adaptation Workstream of the Scottish Government Climate Change Centre of Expertise. He has worked extensively on land use and land systems, climate change, ecosystem services and the modelling and use of scenarios.

Jane Morrice is a researcher with expertise in spatial analysis and applications in landscapes and Environmental Impact Assessments. She has worked on mapping natural resources using GIS and remote sensing, modelling impacts of renewable energy and developing tools for spatial planning.

Åsa Ode-Sang is a landscape architect at the Swedish University of Agricultural Sciences, at Alnarp. She has expertise in landscape theory and preference studies and has worked on the development of spatial models of landscapes, and their characterisation, and application of GIS tools for analysing ecosystem services.