THE UNIVERSITY of EDINBURGH

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INTERNATIONAL ASSOCIATION FOR LANDSCAPE ECOLOGY • UK REGION

LANDSCAPE ECOLOGY:
LINKING ENVIRONMENT AND SOCIETY

ialeUK Conference

4–6 SEPTEMBER 2012, THE UNIVERSITY OF EDINBURGH, UK

ABSTRACTS

www.iale.org.uk/conference2012

Foreword

These proceedings contain the 36 abstracts of the 19th ialeUK conference Landscape Ecology: Linking Environment and Society that is held in Edinburgh 4-6 September 2012.

Nearly 100 delegates from 18 countries and four continents will attend the conference, covering landscape science, policy and practice. We hope the conference will offer a stimulating opportunity to learn from each other, and identify ways in which landscape ecology can support necessary shifts in land management to deliver improved and enduring benefits to society and the environment.

The conference is structured in three symposia:

- Think globally: landscape ecology in a globalised world explores how landscape ecology can help in assessing, understanding and adapting our land management to deliver enduring benefits to society and the environment.
- Act locally: landscape ecology exemplars presents a range of exemplary initiatives to illustrate how landscape science, policy and practice can deliver benefits to society and the environment.
- Think global, act local: landscape ecology to balance competing demands will highlight some of these trade-offs and present methods and principles for balancing these competing demands.

A further facilitated interactive session will allow delegates from diverse backgrounds to discuss how landscape science, policy and practice can better work together to ensure sustainable use of land and the services it provides to society.

Following the conference, we hope to publish a special issue in the scientific journal Landscape Ecology, based on the conference papers and on the outcomes of the interactive session. In this way we hope the conference will leave a lasting contribution to the scientific literature.

The ialeUK conference has been made possible by a generous donation from Scottish Natural Heritage, organizational support from The University of Edinburgh and the ialeUK committee, and travel grants from IALE international. We are grateful for this support, which has allowed us to keep the conference fee as low as possible, resulting in the wide range of delegates that will attend the conference.

Further acknowledgements go to the Borders Trust, Historic Scotland, The Scottish Wildlife Trust, Scottish Government and the City of Edinburgh for facilitating the field trips, and to Countryscape for supporting the interactive session, the proceedings and the conference website. Many thanks to you all!

Marc Metzger

Edinburgh, August 2012

ialeUK INTERNATIONAL ASSOCIATION FOR LANDSCAPE ECOLOGY • UK REGION THE UNIVERSITY of EDINBURGH Scottish Natural Heritage Dualchas Nàdair na h-Alba iale

Tues 4 Sept am - Think globally: landscape ecology in a globalised world

Our world is in the midst of unprecedented change, posing major challenges for sustainable land management. This symposium explores how landscape ecology can help in assessing, understanding and adapting our land management to deliver enduring benefits to society and the environment.

The UK National Ecosystem Assessment - responding to the challenges across spatial and temporal scales

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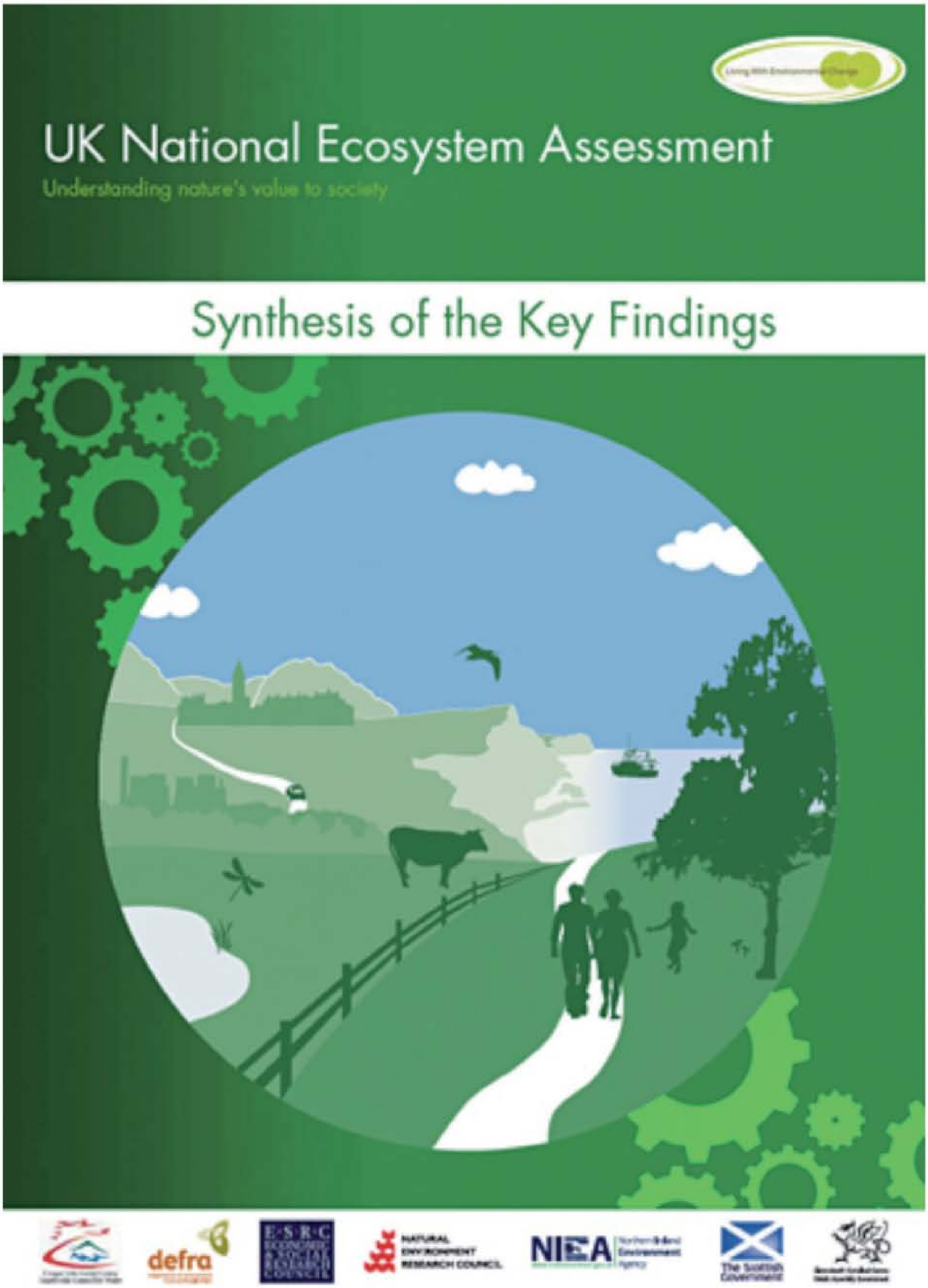
The UK National Ecosystem Assessment was the first analysis of the benefits that the UK's natural environment provides to society and economic prosperity. With a significant proportion of ecosystem services declining and with a challenging future ahead, it is clear that we need to find new, more resilient ways of managing our ecosystems. An important prerequisite for this is a better grasp of the values of the full range of ecosystem services. Integration of the spatial dimension of ecosystem services in local decision making would increase the potential for the true value of these services to be realised.



http://uknea.unep-wcmc.org

Temporal changes in land-use in England vary with regions and pressures

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We cannot be sure how stable the landscapes are in agricultural areas. There are pressures that can be long- or short-term that could cause changes in land-use, which can be permanent or temporary. These changes in land-use will have impacts on the species that live there. It is likely that some areas will change quickly in response to drivers because the agricultural systems there are adaptable, and/or non-profitable, whilst others will be very resilient to outside pressures. Currently, repeated surveys and censuses show changes in land-use, but not in a way that can be used for modelling in a landscape ecology context; the former can seldom identify the pressures that lead to a change because they are widely spaced temporally; and the latter are normally not spatially explicit.

One solution is to develop case-studies using personal observations of the countryside, over a period of decades by people who live there. We use two case studies where the land-use is known in detail from the 1970s and 1990s to the present day, respectively. In the first case, the Cartmel Valley in Cumbria UK, the predominant land use is pastoral with grazing by sheep and cattle. There are areas of forestry, and tourism is an important part of the local economy. Here land-use has changed very little over time but the changes have been permanent (over the period of 30 years). In the second case, the area around Bodsey in Cambridgeshire UK, land use is dominated by arable farming. Some of the land in the case study has some of the highest quality soil in the UK, whilst part of the area is on the edge of the peat and is relatively poor quality clay and gravel. The peat soils are always in arable agriculture whereas the poorer quality soils have gone in and out of production, following the rise and fall of grain prices. Therefore, many of the changes have been of a temporary nature. Permanent changes have included the construction of a golf course and the building of winter storage reservoirs. The latter is the result of the increased cost of water for irrigation.

These case studies have provided an interesting insight into how the stability of land use varies in the UK and what some of the causes in the variation are. The approach could be used for further case studies, utilising the observations of academics to demonstrate a proof of concept, or not. If the concept is proven, then a systematic assessment of the UK could be made to determine whether there are regional, social or ecological patterns. A project of 'citizen science' could achieve this in a way similar to the National Phenological Network or the Big Garden Birdwatch, using the observations of the general public.


Land Use Change in Cambridgeshire Responding to External Drivers
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GREEN BURIAL GR
MIGRANT WORKERS
MILLENIUM WOOD
MISCANTHUS
PADDOCK
REVERSION
SMALL HOLDING
WINTER STORAGE R
DUMP
DISUSED
PIG FARM
LIGHT INDUSTRY
GARDEN

The impact of afforestation on the British Uplands

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Since the WWI, British Government policy has supported forestry in order to build up a strategic reserve of timber. The resultant afforestation has led to the largest land use change in Europe involving a shift from agriculture to forestry and by observation is mainly in the uplands. Until recently the expansion has largely ignored biodiversity and landscape ecological issues although some attention has been paid to landscapes. The paper first considers the history of afforestation in Britain before examining its impact at the landscape level. Forest cover in Britain increased by a quarter between 1870 and 1947, but almost doubled between 1948 and 1995. The distribution also changed from the lowlands of England and Scotland to the uplands, especially in SW Scotland. The balance also shifted from native broad leaves to exotic conifers as expressed by the present dominance of Sitka Spruce. Figures available from Forestry Commission Reports show that the overall increase in woodland area after 1948 is almost linear until c.1994 when the rate of increase in conifer area slowed down whilst broad leaved planting increased in relative terms. Nevertheless, the conifer area still continued to increase even between 2008 and 2010. Conifer cover increased since 1948 by almost 400% whereas broadleaves have increased by only 25%. In 1948 there was more broadleaf than conifer but by 1973 the situation had reversed. Also conifers were mainly planted on open moorland whereas the core of broadleaves has remained much the same, although supplemented by recent planting in the lowlands. In the period after WW2 there was much conversion of broad leaves to conifers, although this has recently been reversed. All the above changes were driven by government policy. An analysis of the patterns of forest cover shows that Lowland England is dominated by broadleaves but still has a significant area of conifers because of the plantations of pine in the south. In Upland England there is twice as much conifer but this is a small area in comparison with Scotland. There are almost no conifers in Lowland Wales but the upland figure is similar to England. Scotland is dominated by plantations of conifers. In Scotland, one third of a million hectares are in the marginal uplands with about half a million in the true uplands. Under 1% of these are native pinewoods, the remainder are exotics. Conifer forest also occurs in relatively narrow altitudinal bands in different landscape types in Britain. Afforestation therefore mainly affects specific parts of the uplands and the national figure therefore underestimates its impact on local landscape ecology. Finally, conifer plantations cause almost complete loss of vegetation cover except for a few bryophytes. In conclusion, in the presented paper suggestions will be made as to how landscape ecology could ameliorate the situation.

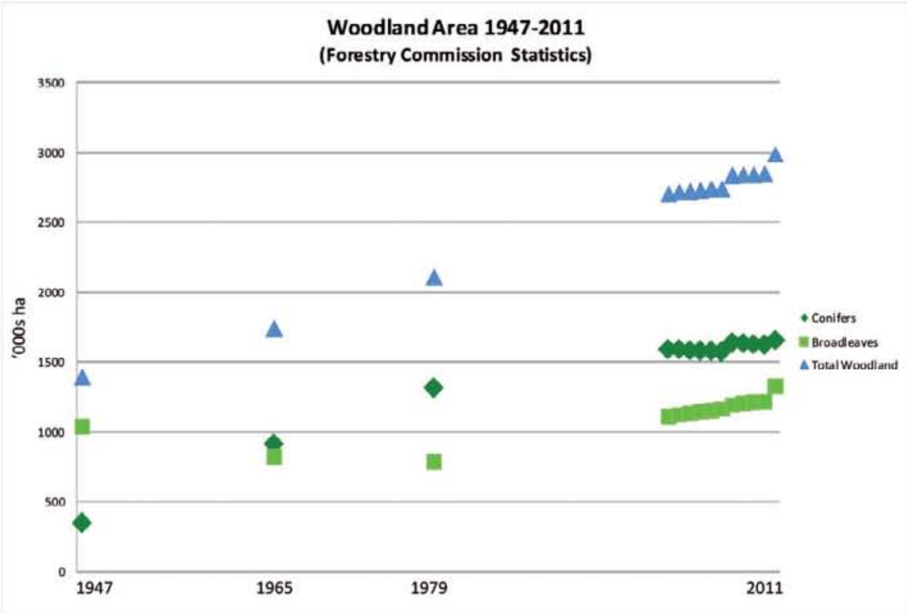

Figure 1. Forestry Commission Woodland Census Data
(1947-49, 1965-7, 1979-82, 2000s)

Conifer plantations, Western Scotland
© Centre for Ecology & Hydrology

	Broadleaf	Conifer
England lowland	941	185
England upland	40	72
Scotland lowland	131	182
Scotland marginal	63	293
Scotland upland	57	481
Wales lowland	84	4
Wales upland	90	102

Table 1. Distribution of Woodland by Environmental Zone ('000s ha). Estimates from Countryside Survey 2007.

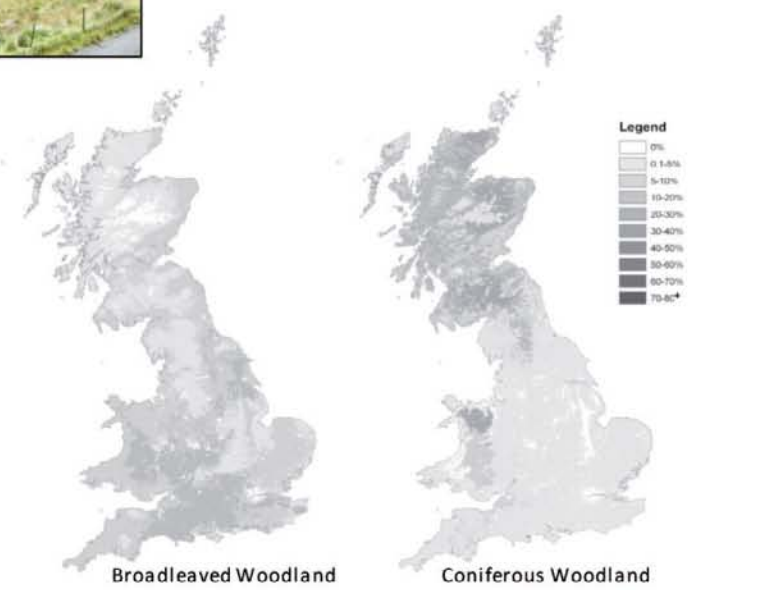

Figure 2. Countryside Survey 2007
% Estimates of Woodland Distribution in GB

Forest ecosystem restoration in the Scottish Uplands

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Scottish upland forests are fragmented, overgrazed and in poor condition. Despite efforts over the last 50 years to create new plantations, at around 12% forest cover, the UK remains one of the least afforested countries in Europe (EU average 37%). Little natural tree regeneration has occurred in Scotland in the past 200 years since the Highland Clearances, introduction of sheep farming, and creation of Highland sporting estates. Historic maps show that since 1860 woodland remnants have become smaller and more open. According to Scottish Natural Heritage's own statistics, around 30% of protected woodlands are in unfavourable condition.

SNH's Native Woodland Model suggests 50% of Scotland's land area could support woodland, yet only 4% is currently covered by semi-natural woodland. Expansion targets within the UK Biodiversity Action Plan, and development of Forest Habitat Networks, are priorities in the Scottish Forestry Strategy, but unsustainably high numbers of herbivores in the Scottish uplands makes delivery of these targets extremely difficult. During the winter, deer shelter in woodland, with locally up to 77 deer/sq km. Deer densities like this make woodland restoration over much of the country almost impossible.

Experience from elsewhere in Europe suggests that when wild herbivores are controlled at around 1 deer/ sq.km, tree regeneration occurs: ecosystem health returns, productivity increases, and with it an amazing associated biodiversity flourishes. Allied ecosystem services include drought and flood mitigation, soil restoration, erosion control, carbon sequestration, and creation of a renewable resource supporting sustainable rural economies.

Existing land-use of Scotland's uplands requires subsidy and contributes very little to the rural economy compared to the potential; furthermore it is leading to an alarming decline in ecosystem health at a landscape scale. SNH's balancing duties present strenuous challenges to resolve these conflicting economic and ecological demands in the uplands. The challenge is urgent however, because restoration of ecosystem health through reducing herbivore impacts is critical to a resilient natural resource base supporting the ecosystem services increasingly needed in a climate challenged future.

Ecosystem restoration within a deer-fenced exclosure at 325m asl in Argyll, Scotland showing flowering plants and ash regeneration 200m above existing woodland.

Estimating two centuries of forest landscape changes at different spatio-temporal scales: pressures vs. mitigation

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Historical perspectives increase our understanding of the dynamic nature of landscapes and provide a framework of reference for assessing patterns and processes. There is a direct relationship between the space and time scales appropriate for observing different aspects of pattern and processes. Interactions between individual plants may be observed on a yearly basis, but the dynamics of forest stands can only be perceived on a scale of tens to hundreds of years.

Nevertheless in order to capture changes of landscapes' "essential characteristics", we can use past land transition information in tandem with environmental variables information. We present a hierarchical approach to understand forest changes and pressures from 1840 up to 2010. Changes analyzed at different temporal scales and at different resolutions provide a general trend to forest changes while providing inputs on structural changes to monitor in detail landscape level dynamics.

We present an example on the French Alps, considered a "hot spot" of biodiversity for Europe and also part of a LTER site. We develop a methodology to: i) provide a real-time, cost-effective evaluation of landscape alterations and changes in the continuity of the natural communities, ii) improve scenario development that has direct application to improve forest management, conservation and mitigation measures, iii) provide a holistic approach that can be considered towards the interplay between biodiversity value and the needs of forestry activities..

Vis-a-vis of results and participatory work, which concepts, methodologies and tools can be validated on strong scientific grounds that can be proposed to the actors charged to implement policies and actions on the ground? One of the most important challenges for future research will be to integrate research across different scales, including spatio-temporal scales within an interdisciplinary and multidisciplinary framework. If we manage to follow this route, science will be able to move from analytical to actionable knowledge.

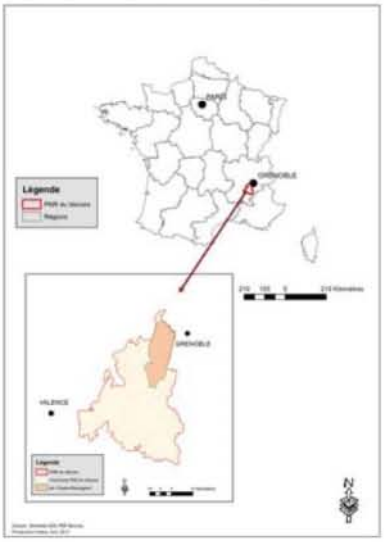

Figure 1: Study area in the French Alps

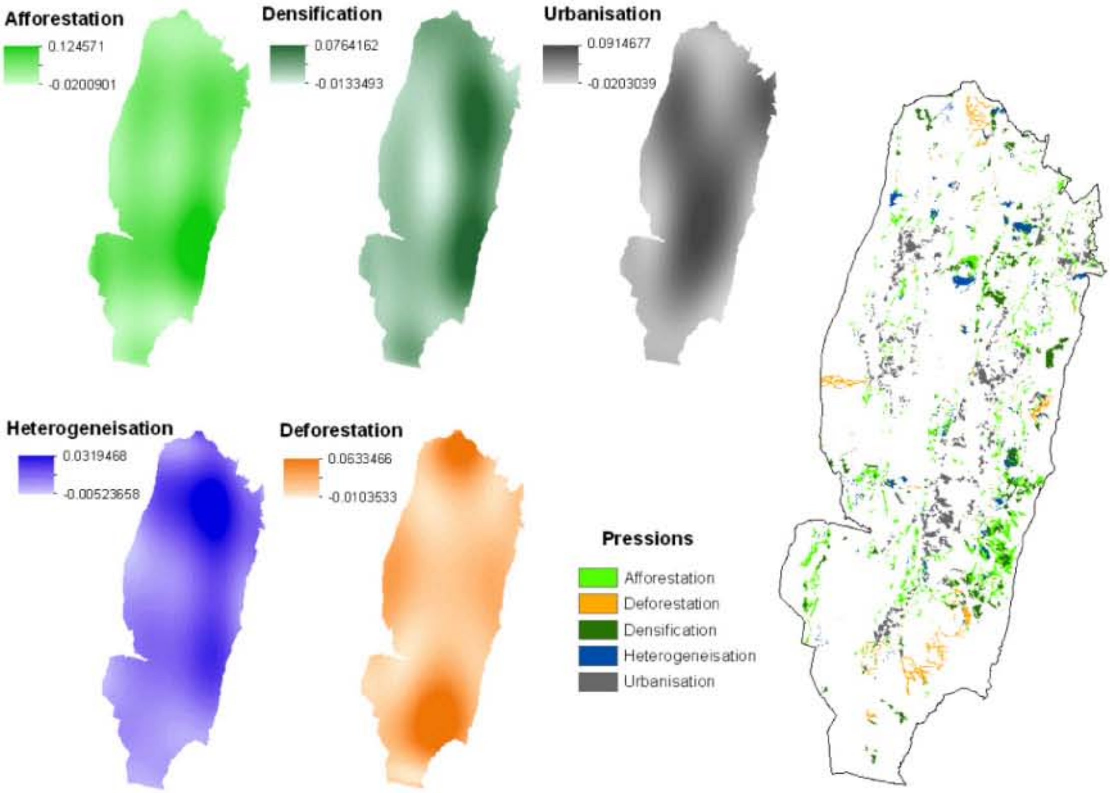

Figure 2. Main pressures due to changes between 1956 and 2009 within the study site in the French Alps

The effect of anthropogenic land-uses on pollinator movement: habitat services outside native habitat

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Global declines in pollinators, associated with land-use change and fragmentation, constitute a serious threat to crop production and biodiversity. Programs to mitigate the potential negative effects of land-use change and fragmentation typically focus on increasing movement of organisms between habitat patches. The probability of movement is usually treated as a function of habitat fragment size, linear distance between fragments, and the resistance of non-habitat areas (matrix) to organism movement. Although variation in matrix resistance is recognized, researchers and managers maintain a functionally binary view of the roles of habitat and matrix, focusing on study species' use of or travel between patches of habitat, with the assumption that the more similar the area between habitat patches is to native habitat, the more likely it is that an organism will travel between them. The possibility that habitat services may be available in areas not apparently similar to native habitat is generally not considered.

We used paternity analysis of seeds and a combination of circuit and general linear models to analyze pollen flow for the endangered tree Gomortega keule (Gomortegaceae) in the fragmented Central Chile Biodiversity Hotspot. Pollination probability was highest over pine plantation, moderate over low-intensity agriculture and native forest, and lowest over clearfells. Changing the proportions of the land uses over one kilometre in the model altered pollination probability up to 7-fold. We explain our results by the novel "Circe Principle[1]." In contrast to models where land uses similar to native habitat promote pollinator movement, pollinators may actually be waylaid in resource-rich areas between habitat patches, and pollinators may move with higher probability between habitat patches separated by some resource-poor land uses. We discuss how the results of this research are being applied in commercial timber plantation management and development of forest certification guidance in Chile.

[1] Lander TA, Bebber DP, Choy CTL, Harris SA, Boshier DH, 2011. The Circe Principle Explains How Resource-Rich Land Can Waylay Pollinators in Fragmented Landscapes. Current Biology 21: 1302-1307.

[2] Bartomeus I, Winfree R, 2011. The Circe Principle: Are Pollinators Waylaid by Attractive Habitats? Current Biology 21: R652-R654.

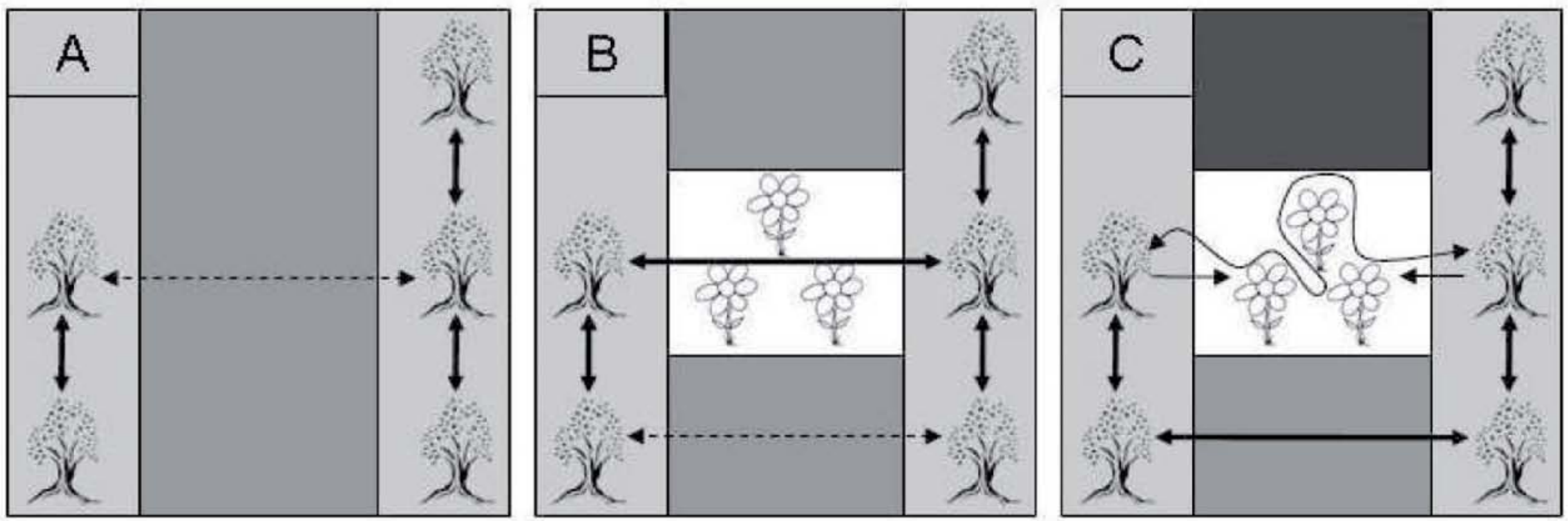

Image adapted from Bartomeus and Winfree (2011)[2]

Pollinator movement in fragmented habitats: pollinator movements (arrows) between focus plant species (trees) across habitat types. Thicker arrows represent greater probability of pollinator movement. (A) Simple Island Biogeography: The landscape may be divided into habitat and non-habitat and pollinator movement through non-habitat is uncommon. (B) The Corridor hypothesis: Different land-use types may be differentially permeable to pollinators, and the land-uses with more resources encourage pollinator movement. (C) The Circe principle: Areas with abundant resources may waylay pollinators rather than encouraging movement, while low-resource areas may enhance connectivity.

How to link policy drivers and landscape change: agriculture abandonment in marginal rural areas in the Alentejo region (Portugal)

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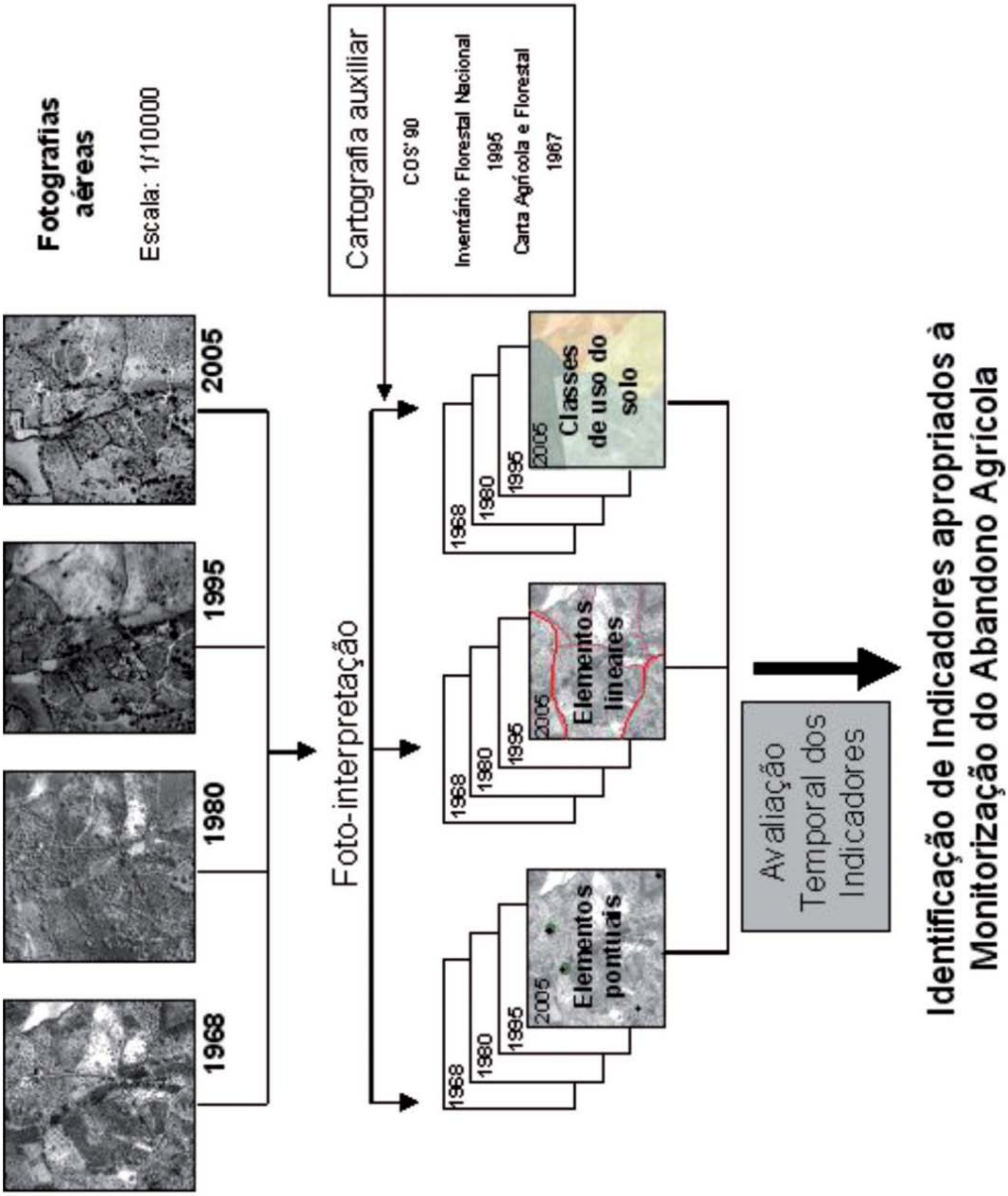
Rural landscapes are changing and these changes are not occurring in an uniform way. Alternating intensification and extensification dynamics in different production systems have had major impact on traditional farming and thereby also on rural landscapes. In many European marginal landscapes agricultural abandonment is on the policy agenda. Nevertheless the process of agricultural abandonment takes shape in multiple forms and at different paces. The diverse nature of the process makes it difficult to identity and thereby also to monitor, as requested by the European Landscape Convention. Typically monitoring systems build on landscape structure indicators to convey change. Nevertheless as a way to better target polices and to meet defined landscape quality objectives it is relevant also to identify the drivers behind those changes. The main objectives of the paper are therefore to quantify the change in agricultural abandonment using the case study of the area of Castelo de Vide as illustrative for the landscape change taking place in marginal rural areas in the Alentejo region (Portugal), and to determine the driving forces of landscape change and agricultural abandonment during the last three decades taking into consideration CAP derived and national policies. Going back to the sixties, there is a wide array of policies put in place from different sectors interacting with each other. Therefore disentangling the effects on landscape of single policies proves not to be a straightforward task. This endeavour becomes even more difficult if multiple scales and levels of policy-making are considered. Methodologically first, at local scale (LAU 1 level – municipality of Castelo de Vide) a set of indicators was chosen based on findings in literature on landscape and land use changes occurring due to agriculture abandonment. These were applied on a stratified sample using areal photographs four historical dates (68, 80, 95, 2005). Landscape transition matrices show the evolution paths towards present abandonment. To understand changes recorded, surveys with the local population and experts familiar with the area. These showed that due to the variance of pathways of agricultural abandonment, landscape structure indicators recorded at this temporal scale prove difficult to identify the whole process, and that the impact of agricultural policy measures policies tends to shaped and eventually buffered by socio-economic dynamics taking place in rural areas. To understand weather these insights are relevant also at a regional scale (NUT 2 – Alentejo region), a follow-up research is aiming at looking of transition of land uses in the last decades and confronting those with a carefully chosen an expert panel of past decision-makers in various sectors. This procedure is expected to make possible to pinpoint key-policies that are identified as main responsible of different pathways of abandonment of agriculture.


Fotografias aéreas
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Cartografia auxiliar
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Carta Agrícola e Florestal
1967
Foto-interpretação
1968
1980
1995
2005
Elementos pontuais
Elementos lineares
Classes de uso do solo
Avaliação Temporal dos Indicadores
Identificação de Indicadores apropriados à Monitorização do Abandono Agrícola

Community-based adaptation to climate change: identifying indicators for the adaptive capacity of the physical landscape.

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Adapting landscapes to reduce impacts from climate change has received increasing scientific attention. However on-the-ground implementation of adaptation measures is still hampered because adaptation plans are insufficiently suitable for application in local planning processes with multiple stakeholders. As a theoretical framework for regional climate proof planning, we apply the social-ecological system[1] and the building of adaptive capacity. We observe that most literature on social-ecological systems consider adaptive capacity as a characteristic of the human community only. This limitation overlooks the fact that the functioning of the physical landscape is influenced by climate change and that human interventions continuously change the landscape pattern and thereby landscape functioning and the provisioning of landscape services[2]. Local communities should be able to diagnose whether climate change will affect the adaptive capacity of their landscape to the extent that intervention is required, and develop measures that strengthen the adaptive capacity of the physical landscape to cope with the impacts of climate change (Fig.1).

We propose three generic spatial principles to determine and enhance the adaptive capacity of the physical landscape for multiple sectors.

Size. The basic principle of adaptive capacity by enlarging a system's size is that it is better able to absorb extremes. A larger system is less vulnerable for the impacts of climate change and remains further away from thresholds below which the provision of services is no longer possible.

Heterogeneity. The heterogeneity of a landscape relates to the variation in physical structures that exist in the landscape. The basic principle of building adaptive capacity with heterogeneity is that it forms a buffer against the impacts of fluctuations. Landscapes which differ in environmental conditions are able to spread the risk of disturbance effects, thus stabilizing the system.

Connectivity. The connectivity of the landscape is the spatial pattern that enhances flows of organisms or material between functionally defined landscape units. By these flows the mosaic of landscape units becomes a higher level system. The basic principle is that connectivity introduces a hierarchy of spatial scales, leading to spreading of risk and recovery.

We use two case studies to learn to what extent these principles could play a role in diagnosis and design of climate-proof multifunctional landscapes by local communities.

[1] Holling C.S., 2001. Understanding the Complexity of Economic, Ecological, and Social Systems. Ecosystems 4:390-405.

[2] Termorshuizen, J.W. & Opdam, P., 2009. Landscape services as a bridge between landscape ecology and sustainable development. Landscape Ecology 24:1037-1052.

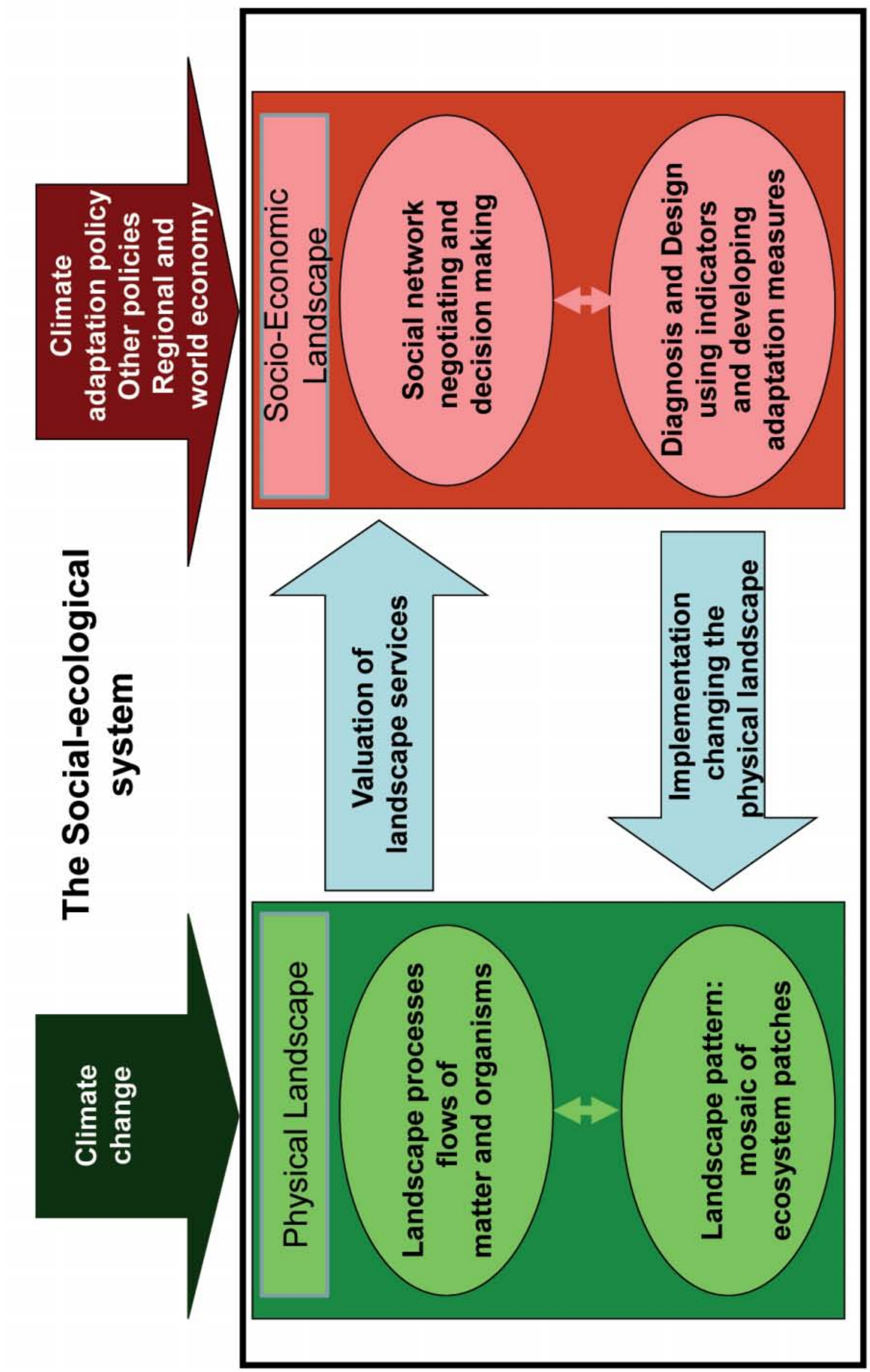

Fig 1. The social-ecological system describes the complex interdependencies between the physical landscape and the socio-economic landscape. Climate change may alter the provision of landscape services provided by the physical landscape (diagnosis phase of landscape planning). Consequently local actors might decide to develop adaptation measures that change the physical landscape (design phase of landscape planning) thus improving the adaptive capacity of the social-ecological system.

Use of canvases to elicit desired future landscapes in stakeholder workshops and crowdsourcing

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Can you imagine what the European landscape will look like thirty years from now? Will Europe be a desirable place to live, eat, work and recreate for all its citizens? These are challenging questions given the highly dynamic economic globalisation and geopolitical change we are facing. Land use changes and associated trade-offs are gaining attention not only among policy and decision makers, academics and NGOs around Europe, but also among ordinary citizens confronted with radical developments in their daily environments. Yet much of the on-going work focuses on the near future and lacks understanding of what European citizens really want in the long term. Answering to this need, the VOLANTE (Visions of Land Use Transitions in Europe) project (http://www.volante-project.eu/) has developed a new software 'canvas tool' to be used in Visions workshops where stakeholders will participate in discussions to create visions on land use in Europe in 2040. Output of such workshops is usually in the form of text and narrative. Moreover it is the result of consensus and the dynamic of the groups, and may lose the valuable meanings of the individuals. The canvas tool is an interactive visualization tool developed using principles of cognitive psychology and designed to stimulate the creativity of the stakeholders. Participants can express with images, graphs and texts their individual visions ('individual canvases') on the way we wish to live, work, do our food shopping and recreate in 2040 (Fig. 1), as well as the future wishes for the sectors they are experts in ('sectoral canvases'), through a guided stepwise set of questions (Fig 2). The 'sectoral canvases' are structured to deliver semi-quantitative information to an integrated land use modelling framework. The canvases preserve these 'collages' and elicit rich visions from the participants and the meanings ascribed to them. Findings obtained when using this novel tool in workshops held in June 2012 will be presented during the symposium. In addition we will introduce a crowdsourcing using the same canvases software, that is expected to engage a much wider range of Europeans and a larger number of people. Results will help to define which new forms of land use policies and management strategies are needed in public and private sectors to balance new sustainability demands and global pressures at all geographical levels.

Fig. 1 Individual canvases: example of two canvases as filled in by one stakeholder in a workshop on the way he will live and do his food shopping in 2040.

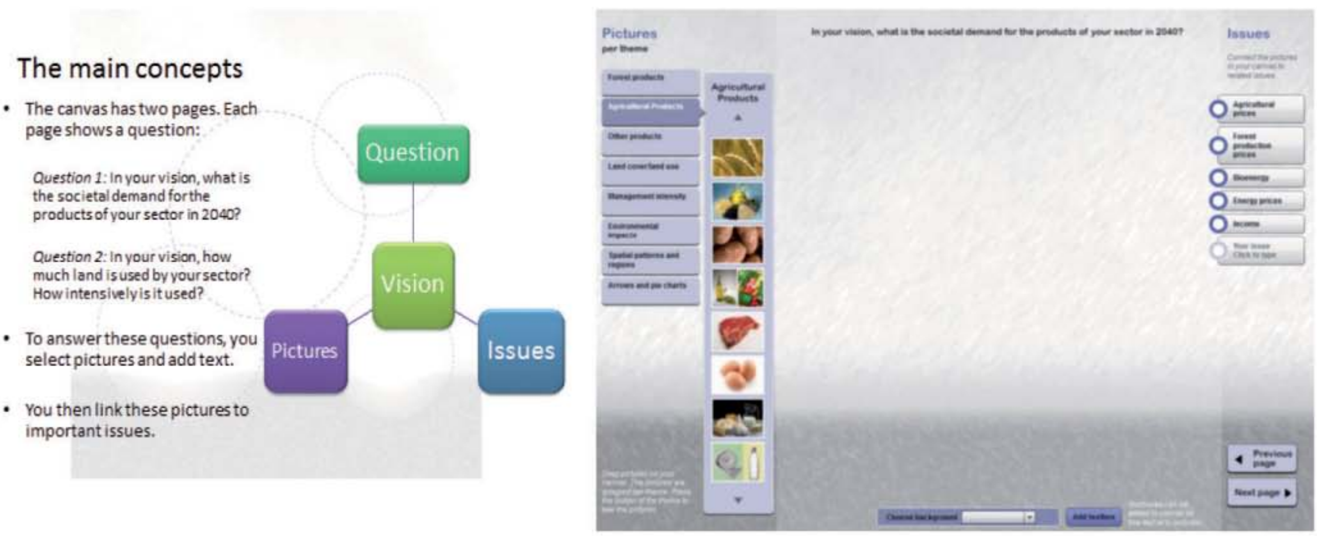

Fig. 2 Sectoral canvases: main design concepts and example of canvas with question 1.

Assessing the impact of land-use change on biodiversity – method development and application

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Land-use change, driven by increasing anthropogenic pressures, is a key determinant of landscape structure and biodiversity dynamics[1]. Measuring and understanding this biodiversity response to changes in landscape structure is essential for sustainable land management. Biodiversity is a complex concept, and while various attempts have been made to quantify biodiversity, including the use of indicator species, robust comprehensive data sets are rarely available, and there is little consensus on which measures to use. Consequently, the use of landscape pattern metrics as surrogate measures of species richness and other components of biodiversity has emerged as a prevalent alternative[2]. However, the relationship between landscape structure and biodiversity is still not fully understood[3].

My research aims to determine how landscape pattern metrics discriminate between different landscape structural components at a range of spatial scales, reflecting species requirements and dispersal abilities. The use of a moving window analysis (MWA) applied to the Land Cover Map (LCM) 2000, facilitates the identification of those metrics showing spatial variability at a scale relevant to assessments of biodiversity. Spatial assessments of biodiversity have been generated from wildlife data obtained for Warwickshire and summarized at a scale of 1km2, a standard resolution for wide-scale biodiversity monitoring schemes.

Butterfly abundance and distribution data, standardized to account for uncertainty and temporal gaps, has been related to landscape diversity and 34 landscape compositional groups, which comprise 1km squares with similar composition of LCM land covers. Logistic regression analysis considering landscape composition and diversity has been applied to identify potential predictor models of butterfly presence/absence within the 1km squares. From this, squares with no records but a high probability of butterfly presence have been identified, and cross-referenced by their suitability for supporting butterflies based on observational patterns within the landscape compositional groups (Figures 1-6). Further monitoring within these squares is required to validate and develop a more reliable model. A similar approach shall be applied using the output from the MWA, and extended to consider other species groups. I will then consider the application of these models for predicting the impact of future land-use scenarios on biodiversity, providing an insight into sustainable land management strategies.

[1]Turner, M.G., 2005. Landscape ecology: Whatis the state of the science? Annual Review of Ecology Evolution and Systematics, 36:319-344.

[2]Rossi, J.P et al., 2010. Towards indicators of butterfly biodiversity based on a multiscale landscape description. Ecological Indicators, 10: 452-458.

[3]Saura, A., et al., 2008. Shape Irregularity as an Indicator of Forest Biodiversity and Guidelines for Metric Selection, Dordrecht, Springer.

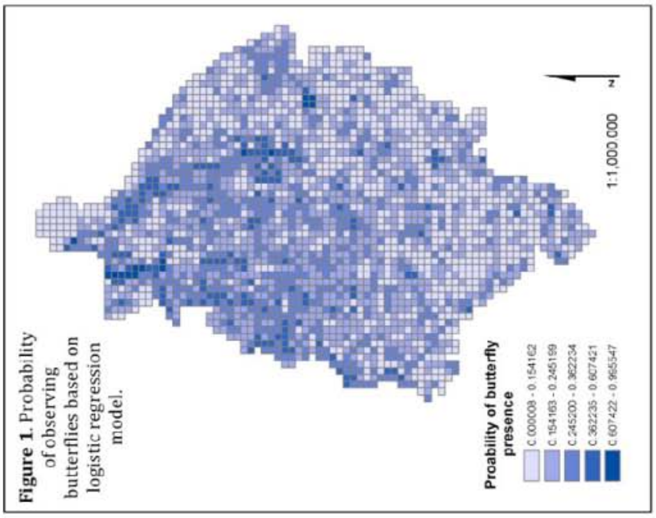

Figure 1. Probability of observing butterflies based on logistic regression model.

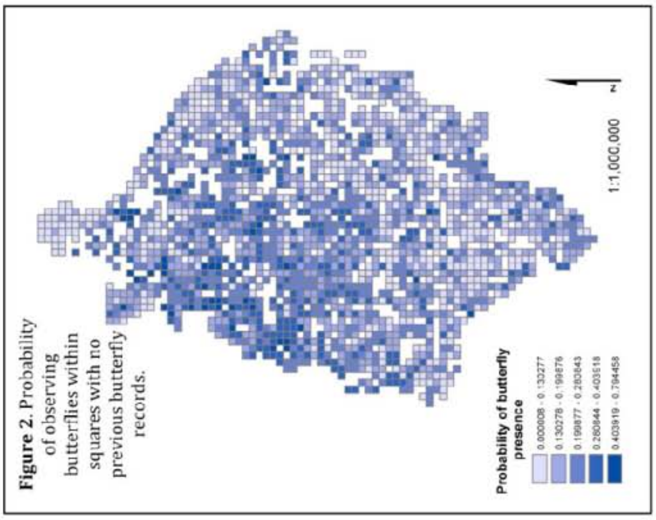

Figure 2. Probability of observing butterflies within squares with no previous butterfly records.

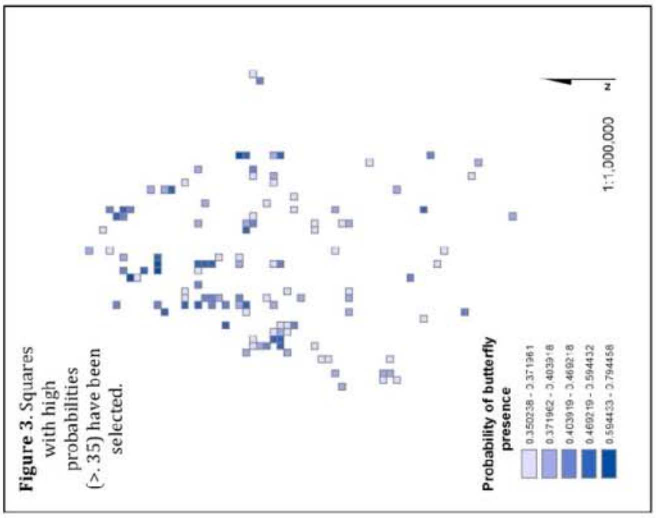

Figure 3. Squares with high probabilities (>.35) have been selected.

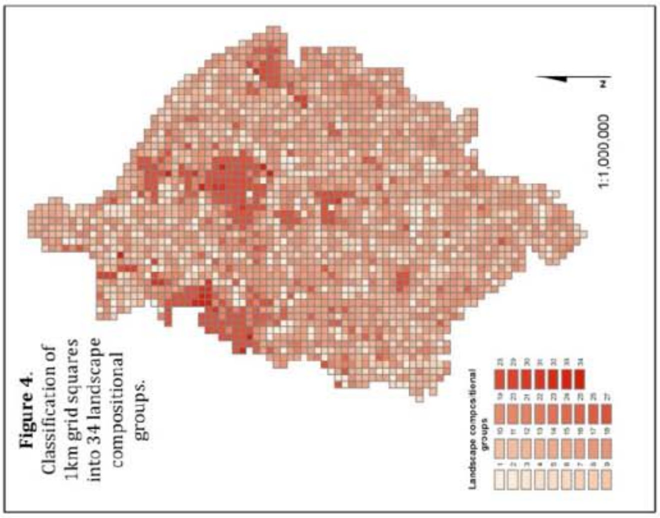

Figure 4. Classification of 1km grid squares into 34 landscape compositional groups.

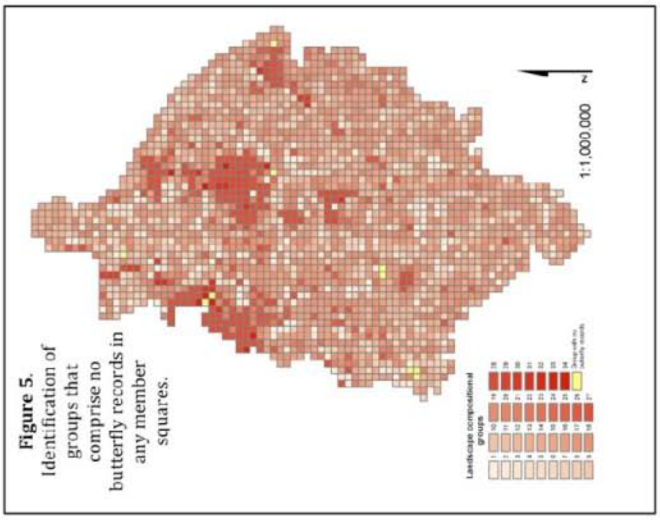

Figure 5. Identification of groups that comprise no butterfly records in any member squares.

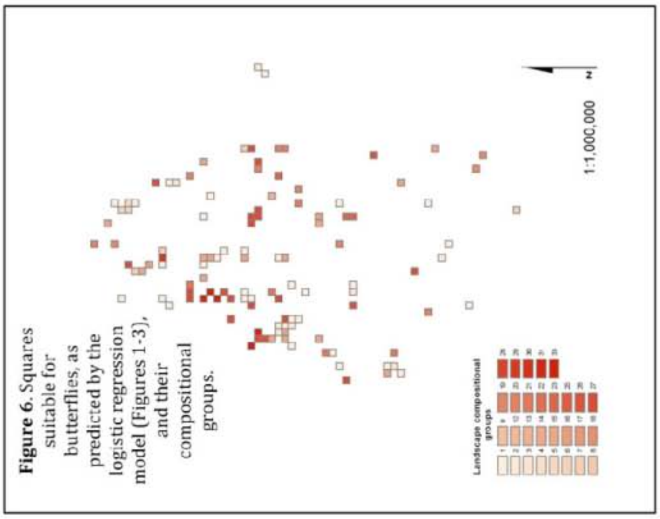

Figure 6. Squares suitable for butterflies, as predicted by the logistic regression model (Figures 1-3), and their compositional groups.

The effectiveness of green infrastructure as a regional climate change adaptation strategy

Authors and Affiliations:

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Green Infrastructure has been frequently named as a strategy for making ecological networks robust against climate change. In the CARE Project (Climate Adaptation for Rural arEas, part of the Dutch Knowledge for Climate Programme), we seek integral adaptation strategies, to cope with climate change from the perspective of agriculture, water management and biodiversity simultaneously, at a regional level, in close collaboration with stakeholders. Green infrastructure (defined here as natural field margins (5m wide) and small patches in agricultural landscapes) has the potential to provide multiple benefits in this context. For example, it could provide habitat for species, reduce nutrient runoff from fields, improve natural pest control and increase the water retention capacity of the landscape. However, knowledge gaps exist with respect to the design of green infrastructure (in terms of amount and density for example), to bring these benefits about. Previous studies showed that green infrastructure can indeed provide biodiversity benefits[1-3], but do not identify thresholds in the amount/density of green infrastructure required for climate adaptation. We ask to what extent additional green infrastructure improves the capacity of species to cope with effects of climate change (i.e. increased frequency of weather extremes and spatial shifts in climate suitability). Using input from stakeholders, we developed multiple landscape scenarios for a case study in the east of the Netherlands, varying the amount (250-500 ha) and location of green infrastructure (see Fig). Next we assessed the viability of a range of species in these different landscapes, under three scenarios of climate change, using a population dynamic simulation model. The species differ in area requirements, dispersal capacity and habitat fidelity during dispersal. The outcomes lead to design criteria of green infrastructure for a range of species living in multifunctional landscapes. As such, this study provides knowledge to local planning processes for climate-proofing the region. In further work we will combine these insights with studies on the willingness of the landowners in the study area to restore green infrastructure, in order to assess the feasibility of this adaptation strategy in practice.

[1]Hodgson JA et al. 2011. Habitat re-creation strategies for promoting adaptation of species to climate change. Conservation Letters 4, 289-297.

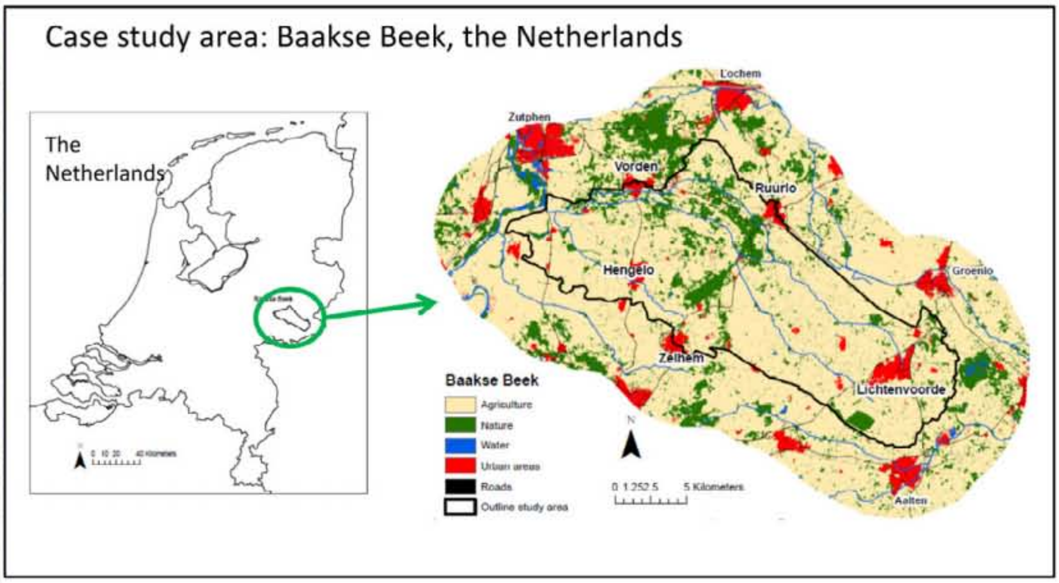
[2]Grashof-Bokdam C et al. 2009. The synergistic effect of combining woodlands and green veining for biodiversity. Landscape Ecology 24, 1105-1121.

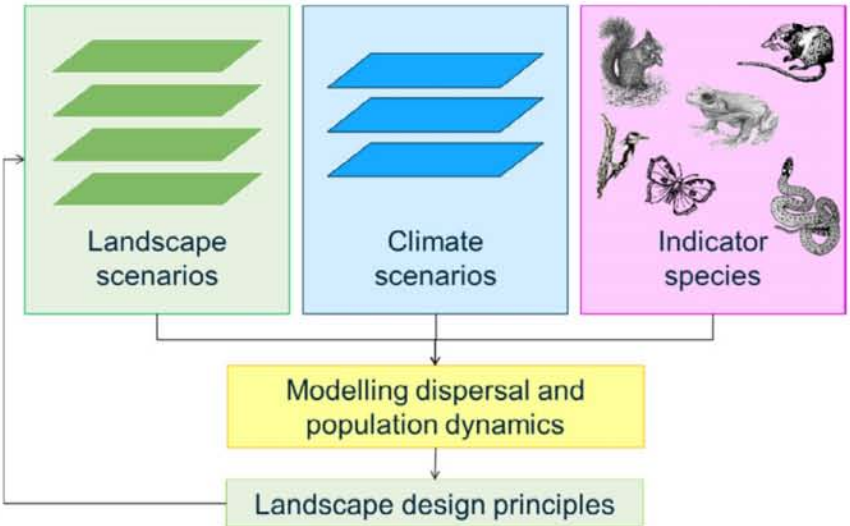
[3]Schippers P et al. 2009. Sacrificing patches for linear habitat elements enhances metapopulation performance of woodland birds in fragmented landscapes. Landscape Ecology 24, 1123-1133.

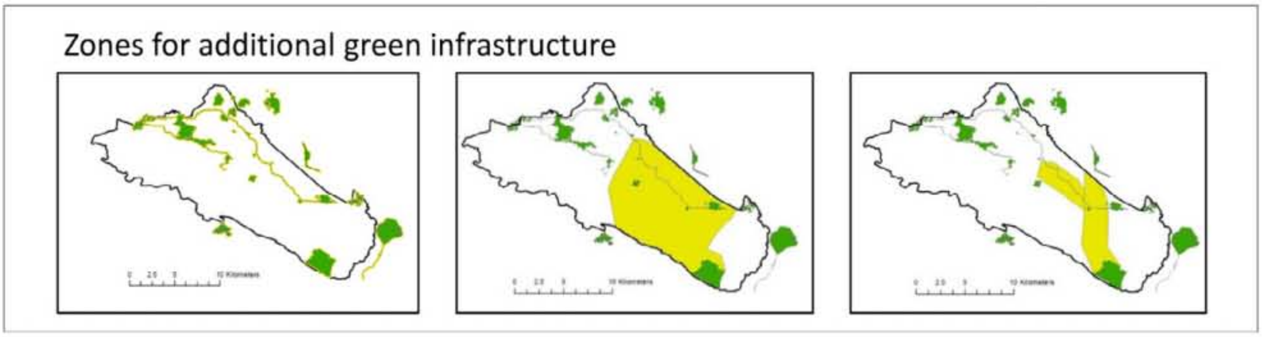
The effectiveness of green infrastructure as a regional climate change adaptation strategy

Astrid J.A. van Teeffelen, Claire C. Vos,
Carla Grashof-Bokdam & Hans Baveco

Climate Adaptation for Rural Areas
Knowledge for Climate







www.kennisvoorklimaat.nl www.knowledgeforclimate.org www.wur.nl

Renewable energy production in Switzerland: an explorative study on competing landscape services

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A sustainable energy future with minimal environmental impacts requires an expansion of renewable energy and a reduction in oil- and nuclear-based energy supply.

In the aftermath of the Fukushima disaster, the Swiss Federal Office of Energy(SFOE) defined a target of 5,400 GWh of electricity to be gained from renewable energy sources by 2030 (SFOE, 2009). In particular, biomass and geothermal energy production should be fostered. However, it is known that (a) renewable energy production is rather surface-intensive and (b) the area where renewable energy production is possible in Switzerland is limited. Hence, the competition of energy production with other ecosystem services (e.g. landscape beauty for tourism) constitutes a great challenge to landscape planning and conflict solving.

In this project, we perform a spatially explicit analysis of competing landscape services that can be used in landscape planning and conflict mitigation. The procedure involves the following steps: 1) generate an inventory of the potential impacts of renewable energy production (wind, solar, biomass, and hydro) on other relevant landscape services, 2) select those impacts that have a considerable conflict potential, 3) gather maps and other spatial information depicting suitable areas proposed by experts, governmental agencies, and environmental organizations, where renewable energy production is most profitable, 4) generate maps of other landscape services and superimpose them with the most profitable areas of renewable energy production, and 5) derive conflict matrices of the main conflicts between renewable energy production and landscape services by using various energy consumption scenarios.

Based on the results of this analysis, a transparent guideline will be worked out for spatial planning managers and decision makers that shows conflict potential as well as mitigation strategies.

The production renewable energy in Switzerland: a spatial analysis of potential conflicts with other landscape services

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Introduction

Renewable energy production (wind power, hydropower, solar power and biomass) is a landscape service with growing importance and high political relevance.

In March 2008, the Swiss Federal Office of Energy defined a goal of increasing the production of electricity from renewable sources to 5400 GWh by 2030 (SFOE, 2009). However, for this small country, the space is limited and renewable energy production competes with other land uses.

The expansion of energy production will have a strong impact on competing landscape services such as agricultural production, recreation, tourism, biodiversity conservation and aesthetics.

Aims

This study has the following aims:

a) Map areas, at the national scale, to evaluate the capacity of the landscape to generate renewable energy

b) Model expected conflicts with other landscape services for different energy production scenarios

Method

1) Selection of energy types and landscape services	Identify the most important renewable enery types in conflict with landscape services Select key landscape services
2) Data	Collect land use, land cover and official protected area maps at different administrative levels Generate models for different energy types and the other selected landscape services
3) Instruments and constraints	Identify main legal instruments and physical constraints for spatial planning
4) Areas of high potential	Determine areas of high potential for the different energy types Determine areas of high potential for the landscape services analised. Model in GIS (Arc GIS ®, Python)
5) Scenarios	Model the different scenarios suggested by the energy agency: 1) solar intensive and 2) equal shares of prominent renewables in a region
6) Conflicts	Detect the conflicts (areas in which the highest potential of renewable energy production and other landscape services occur) Express the results spatially but also as a matrix of conflicts

Results: Wind turbines

Indicators of potential

- Wind speed >4.5 m/s
- Ground steepness < 20°
- Soil type
- Minimal surface for the installation

Physical constraints

- Settlements
- Rivers and lakes
- Forest
- Unstable soil

No Go: Legal constrains

- National inventories of protected areas:
  - -Moorlands,
  - -peatbogs and transition peat bog
  - -Fens
- National Park (Canton Grisons)
- Core areas of nature discovery parks
- UNESCO World Heritage sites

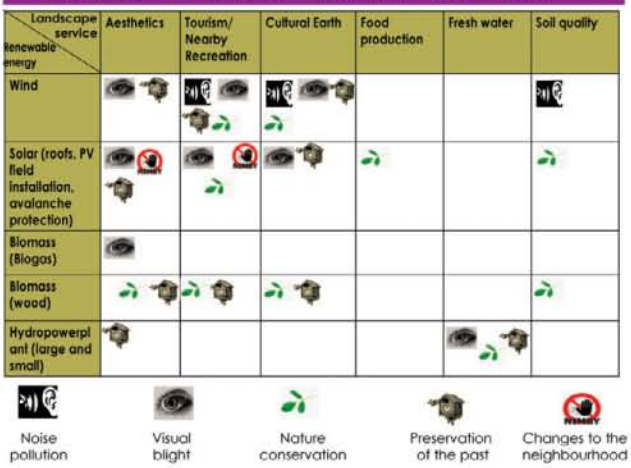
Figure 1. Wind speed map for Switzerland. Source: Meteotest

Go: Expecting conflicts

Federal Inventories:
- Alluvial sites
- Amphibian spawning areas (different protection grade)
- Dry meadows
- Natural Landscape Monuments
- Swiss Heritage Sites
- Swiss Heritage roads
- Prohibited hunting areas
- Wetland
- Bird migration reserves
- Sensitive areas prohibited from hydropower use
- Forest

Cantonal and communal inventories

Results: Identification of conflcits



Conclusion and Discussion

This prototype assessment might play an important role for placing equipment for renewable energy production. This includes the location of hotspots for renewable energy as well as other landscape services at the regional and national scale. Decision makers can benefit from the conflict analysis and minimize landscape conflicts that go along with new installations.

Acknowledgements

Acknowledgements: A sincere thank you to the firm Meteotest, the Federal Office for the Environment (FOEN) for funding, the Swiss Federal Office of Energy (SFOE) for the assessments, and as well to all experts involved.

Tues 4 Sept pm - Act locally: landscape ecology exemplars

Despite continued reasons for concern about the state of our land, there are many examples of good practice and success. This symposium presents a range of exemplary initiatives to illustrate how landscape science, policy and practice can deliver benefits to society and the environment.

From science and policy to real life implementation: exemplars and lessons learnt

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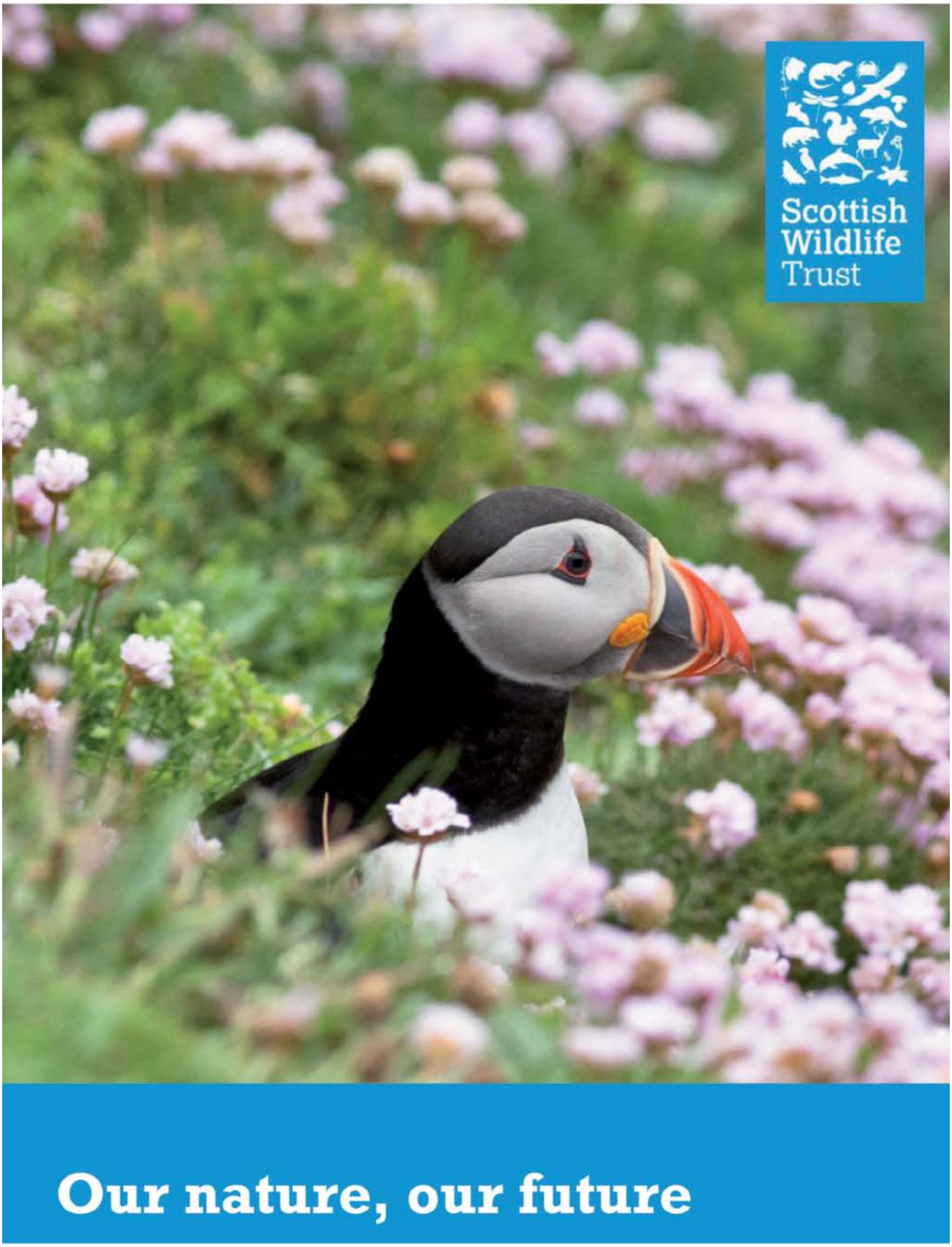
smilne@swt.org.uk

Science can help identify pressures and policy may aim to mitigate impacts, but the actual implementation of successful landscape scale conservation remains a complex struggle. The Scottish Wildlife Trust has 30,000 members throughout the country, and aims to protect Scotland's wildlife for the benefit of present and future generations. SWT is working towards a vision of achieving a network of healthy, resilient ecosystems supporting expanding communities of native species across large areas of Scotland's land, water and seas. Simon Milne will discuss the challenges of working towards this goal, provide exemplars of recent SWT success, and summarise the lessons learnt.



http://scottishwildlifetrust.org.uk

Woodlands, wild land and living landscapes

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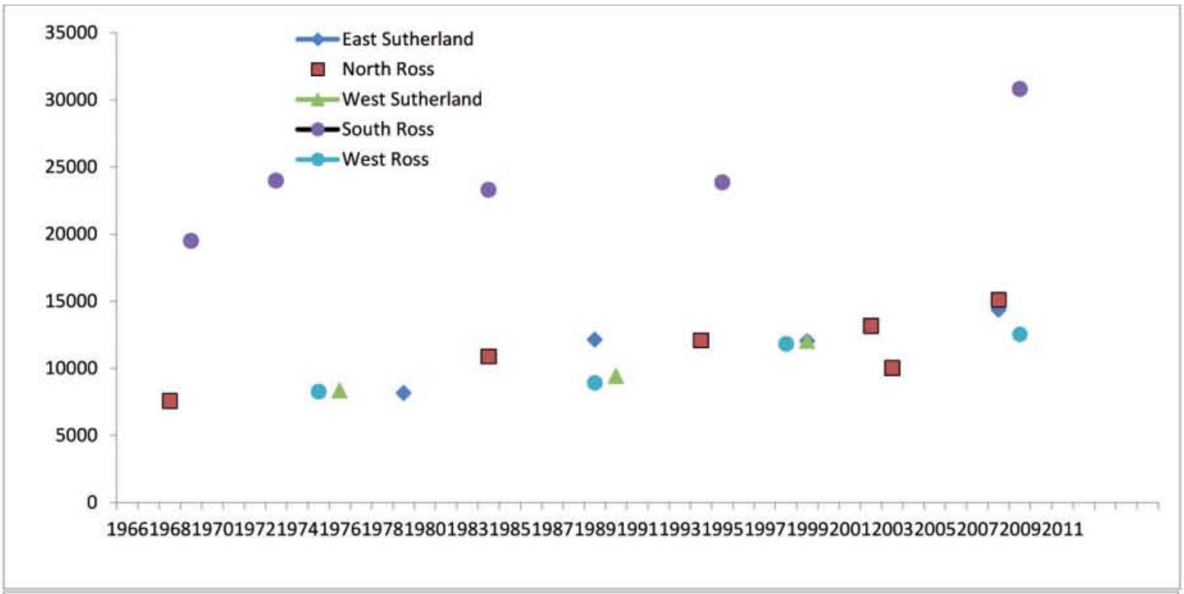
There is widespread recognition that the isolated fragments of protected areas in the UK provided by national and European statutory habitat and species designations are inadequate for conservation or ecological enhancement. National parks and National Scenic Areas are at a landscape scale but are not currently set up to deliver ecological restoration. Instead, NGO led large scale ecological restoration projects – termed 'living landscapes' are being piloted on wild land in Scotland (Figure 1). The focus on these is to enable natural processes to operate, and to increase ecological robustness in the face of climate change. In many of these areas the climax vegetation – and overall indicator of habitat health - is woodland, and so the focus of these projects is woodland restoration.

Such projects have the potential to be a win win for the environment and for local rural communities. Safeguarding and enhancing the ecosystem should generate truly sustainable economic development whilst protecting the natural capital on which ecosystem services essential to wildlife and valued by people are dependent. Yet to get to this point, large scale ecological restoration projects face many challenges.

The current deer management framework, essentially a voluntary system controlled by private owners with an interest in high numbers for hunting, has allowed most red deer populations to steadily increase since data collection began (Figure 2). Whilst regional and overall population estimates must be treated with caution, it is suggested that the total populations has risen from around 150,000 red deer in 1960 to around 400,000[1]. Current deer densities in virtually all of upland Scotland are too high to allow natural regeneration to occur. Native woodland has been squeezed into isolated pockets. Montane scrub (consisting of species such as dwarf birch, juniper and the montane willow species) has become virtually extinct in Scotland, and there are less than two kilometres of natural tree line in the entire country.

Tackling ecological restoration under the current deer management regime generates significant costs and conflict with private estates where deer stalking is the primary objective. It is suggested that a statutory system of deer management is the only way to ensure public objectives, including landscape scale restoration involving woodland, are achieved.

[1]Clutton-Brock, TH et al., 2004. Red deer stocks in the Highlands of Scotland. Nature 429: 261-262.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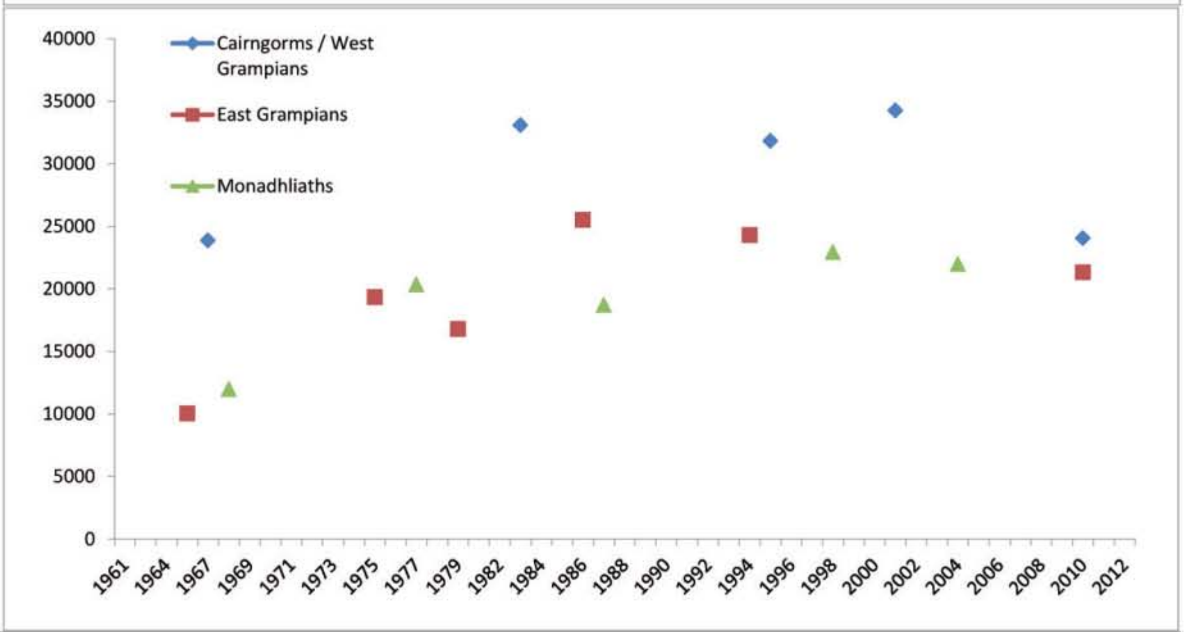
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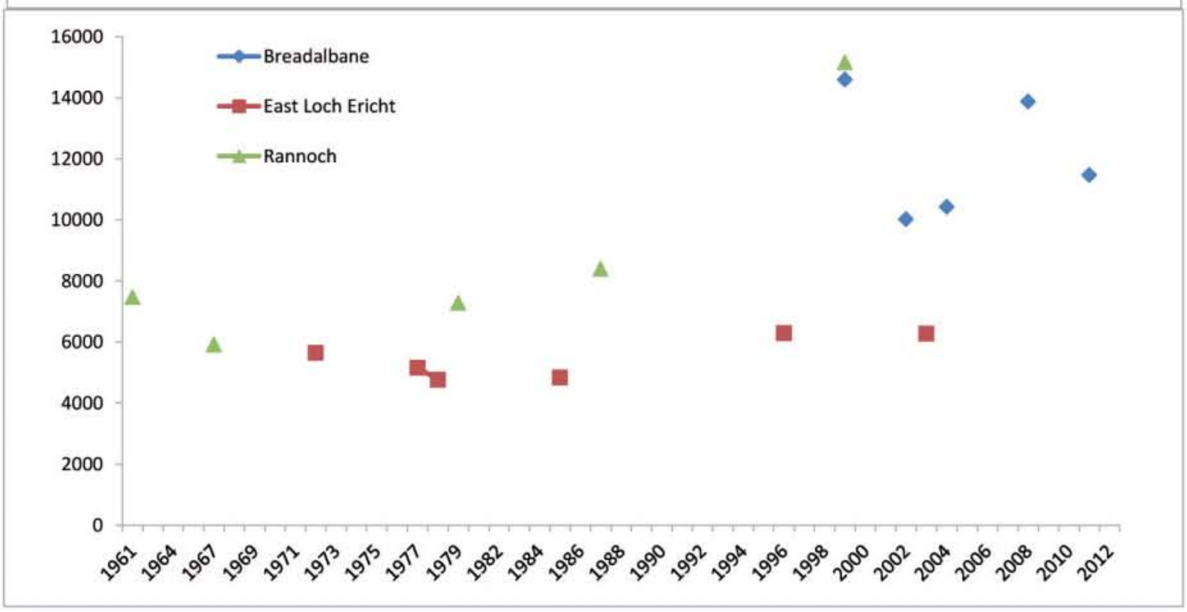
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Carrifran Wildwood: ecological restoration in the Southern Uplands of Scotland

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The Southern Uplands of Scotland, along with most of upland Britain, have been denuded of their natural vegetation by a millennium or more of grazing by domestic sheep, goats and cattle, as well as fire and felling. In 1993 a group of local people had the idea of acquiring an entire catchment in order to restore the native woodland and moorland ecosystem. They located Carrifran, an outstanding 650 ha site in Dumfriesshire with an altitudinal range of 160 to 820 m. The group raised £400,000 (80% from private individuals) enabling Borders Forest Trust (BFT) to purchase the valley in 2000 without use of public money.

A key feature of the project is its grass-roots base. It has been conceived, planned and brought to fruition largely by dedicated volunteers from diverse backgrounds, with free assistance from ecologists, foresters and other specialists. Management decisions are taken by the Wildwood Group, a volunteer element within BFT. However, a part-time professional project officer has managed grant-aided contracts for fencing, tree planting and deer control, as well as supporting volunteers on site. Trees are funded by a benefactor and donations from private individuals play a fundamental role.

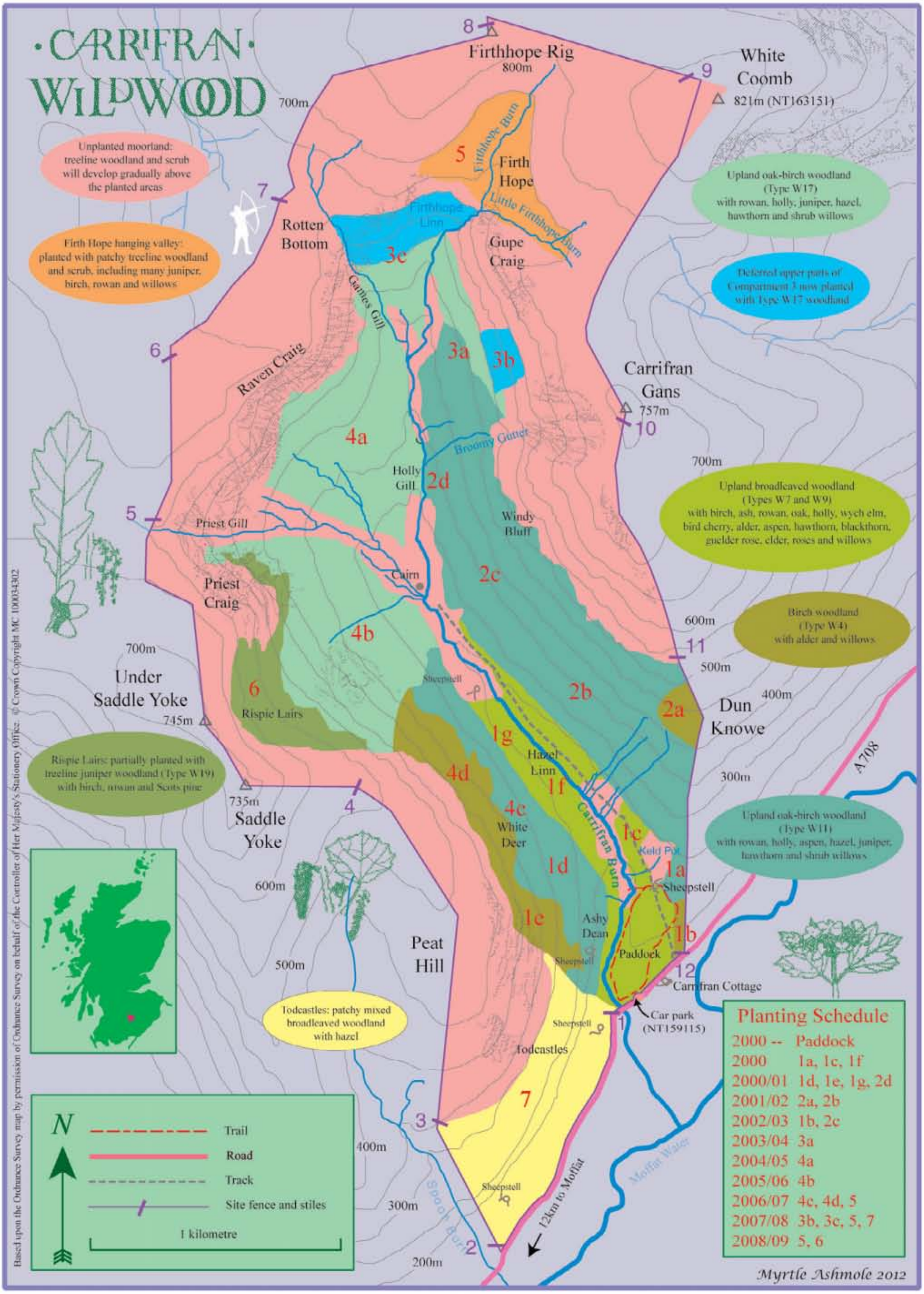
Over 13 years >500,000 native trees and shrubs have been planted, nearly one fifth of them by volunteers, who have also collected all the seeds. About 300 ha of deciduous forest, interspersed with open grassland and moorland habitats, are now established in the main glen and in a hanging valley between 600 and 750 m. In the latter, the aim is to restore treeline woodland and scrub, habitats largely lost from Britain, in which juniper and montane willows are well represented.

The diversity of life at Carrifran is increasing through natural colonisation by mobile animals, plants and fungi, while translocation of missing woodland herbs is commencing. Large predators are absent, so culling of deer is needed, along with maintenance of a perimeter stock fence, but other human intervention is declining as the ecosystem matures.

The instigators of the Wildwood intended the project to be exemplary, demonstrating the power of individuals, harnessing public support, to enhance their local environment. Carrifran already offers a rare opportunity to enjoy a place where nature is re-asserting control.

Mission Statement of the Wildwood Group

The Wildwood project aims to re-create, in the Southern Uplands of Scotland, an extensive tract of mainly forested wilderness with most of the rich diversity of native species present in the area before human activities became dominant. The woodland will not be exploited commercially and the impact of humans will be carefully managed. Access will be open to all, and it is hoped that the Wildwood will be used throughout the next millennium as an inspiration and an educational resource.


·CARRIFRAN·
WILDWOOD
Unplanted moorland: treeline woodland and scrub will develop gradually above the planted areas
Firth Hope hanging valley: planted with patchy treeline woodland and scrub, including many juniper, birch, rowan and willows
Upland oak-birch woodland (Type W17) with rowan, holly, juniper, hazel, hawthorn and shrub willows
Deferred upper parts of Compartment 3 now planted with Type W17 woodland
Upland broadleaved woodland (Types W7 and W9) with birch, ash, rowan, oak, holly, wych elm, bird cherry, alder, aspen, hawthorn, blackthorn, guelder rose, elder, roses and willows
Birch woodland (Type W4) with alder and willows
Upland oak-birch woodland (Type W11) with rowan, holly, aspen, hazel, juniper, hawthorn and shrub willows
Rispie Lairs: partially planted with treeline juniper woodland (Type W19) with birch, rowan and Scots pine
Todcastles: patchy mixed broadleaved woodland with hazel
Firthhope Rig
800m
White Coomb
821m (NT163151)
Firth Hope
Firthhope Burn
Little Firthhope Burn
Firthhope Linn
Rotten Bottom
Gupe Craig
Games Gill
Raven Craig
Carrifran Gans
757m
Broomy Gutter
Holly Gill
Windy Bluff
Priest Gill
Priest Craig
Cairn
Under Saddle Yoke
745m
Rispie Lairs
Sheepstell
Hazel Linn
White Deer
Carrifran Burn
Keld Pot
Dun Knowe
A708
Saddle Yoke
735m
Ashy Dean
Paddock
Carrifran Cottage
Peat Hill
Car park (NT159115)
Todcastles
Moffat Water
Spoon Burn
12km to Moffat
700m
600m
500m
400m
300m
200m
5
3c
3a
3b
4a
2d
2c
4b
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7
1
2
3
4
5
6
7
8
9
10
11
12
N
Trail
Road
Track
Site fence and stiles
1 kilometre
Planting Schedule
2000 -- Paddock
2000 1a, 1c, 1f
2000/01 1d, 1e, 1g, 2d
2001/02 2a, 2b
2002/03 1b, 2c
2003/04 3a
2004/05 4a
2005/06 4b
2006/07 4c, 4d, 5
2007/08 3b, 3c, 5, 7
2008/09 5, 6
Myrtle Ashmole 2012
Based upon the Ordnance Survey map by permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright MC 100034302

Linking environment and society in Wild Ennerdale

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Ennerdale is a remote valley situated on the western fringes of the Lake District National Park. It is a spectacular mountain landscape with dramatic ridges and exposed rock outcrops, extensive mixed woodland and forest, dynamic natural rivers, a glacial lake and highly valued flora & fauna. Established in 2002, Wild Ennerdale is a partnership of people and organisations led by the principal landowners in the valley: The Forestry Commission, National Trust and United Utilities, with additional support from Natural England.

The partners vision is to "allow the evolution of Ennerdale as a wild valley for the benefit of people, relying more on natural processes to shape its landscape and ecology". The partnership boundary covers an area of 4,711ha.

Wild land is a relatively new concept in the UK and involves giving natural processes greater freedom to develop our future landscapes. Nature conservation in England is generally focused on small-scale interventions. Wild Ennerdale is one of the largest wild land initiatives in England allowing ecosystems throughout the valley to evolve with greater freedom.

Ennerdale is highly significant for its rich legacy of archaeological remains being described as the one of the best remaining example of a settled medieval valley in the Lake District. It is also home to diverse habitats of flora and fauna, which range from regional to international importance. Over 40% of the area is designated as 'Site of Special Scientific Interest' and 'Special Area of Conservation'. The continuous transition of vegetation types; from lakeshore, through woodlands to open heathland, to mountain summits is spectacular.

Community involvement is an essential part of the process of change towards a wilder valley both to guide and inform the Partnership and to ensure that the benefits of Wild Ennerdale reach far beyond the geographical 'valley boundary'. The partnership approach recognises that people are a significant part of a 'wild' landscape and that the extent to which people can interact, and indeed become part of a natural process, is dependant upon appropriate levels of access and types of activities permitted. Without some intervention to regulate access however, there is a danger of destroying the very qualities we look for in a 'wild' place: untamed nature, solitude, adventure and the quiet enjoyment of spectacular landscapes.

This Autumn, Wild Ennerdale celebrates a decade of facilitating change towards a wilder valley in this beautiful corner of the Lake District. We cannot (nor wish to) predict exactly how the landscape may change, ecosystems develop and people interact as natural processes are given greater freedom into the future. However, being able to observe these processes at work, over generations, will be one of the marvels of change in Ennerdale and we are working to ensure that the lessons learnt will have a resonance far beyond the boundaries of the valley.

wild water forest mountains ennerdale

Looking up the valley from Anglers Crag with Ennerdale Water in the foreground.

The River Liza and Pillar mountain

Learning about extensive cattle grazing

Volunteers repairing the Liza Path.

National Trust United Utilities Forestry Commission England NATURAL ENGLAND

Landscape planning in an urbanising landscape to enhance landscape complexity and wildlife diversity

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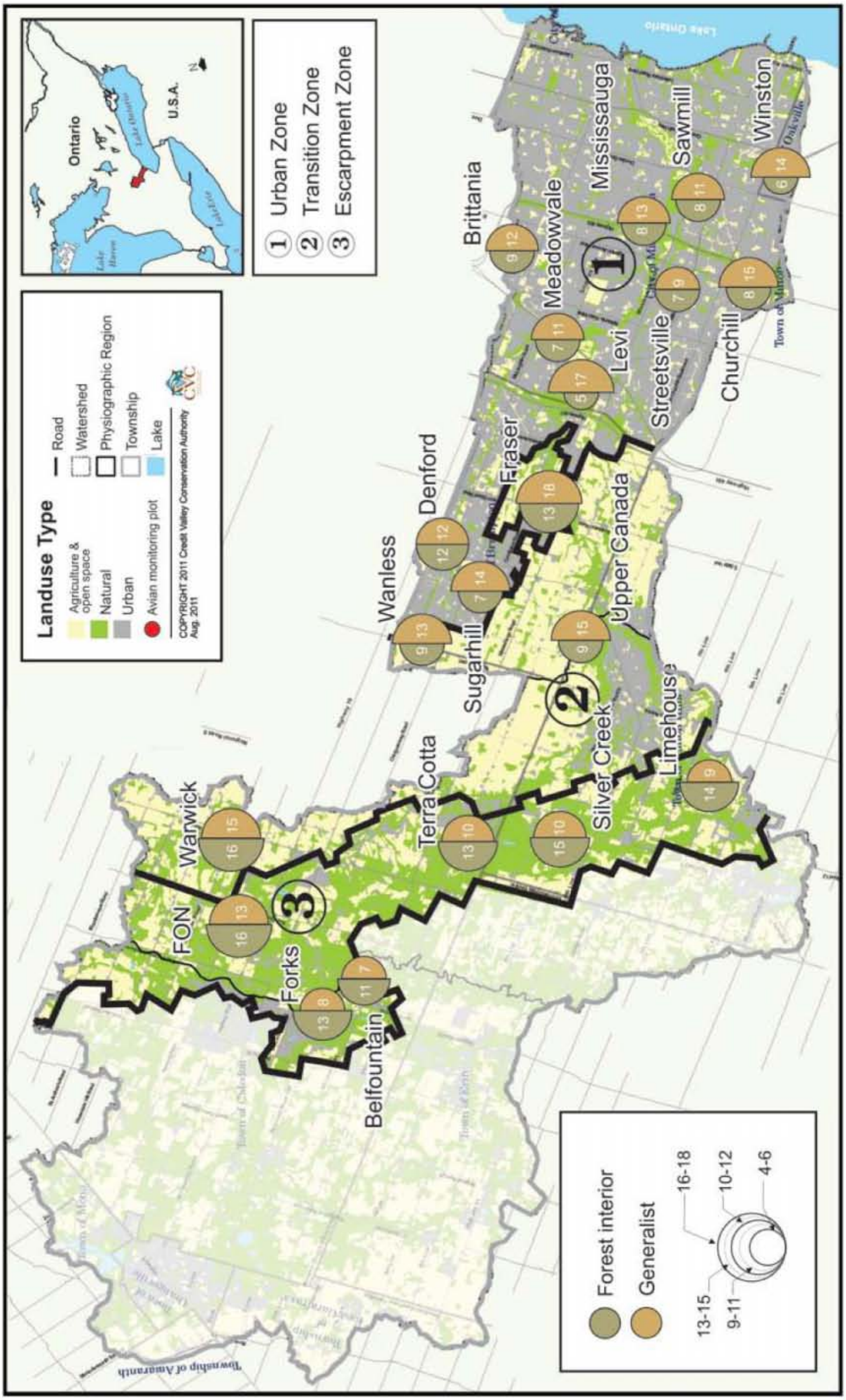
Urbanization and related fragmentation of natural habitats is a major cause of forest bird decline. Effective landscape planning requires a better understanding of the relationships between forest interior species and the complexity of landscapes in urbanizing landscapes. A case study from southern Ontario, Canada is presented that examines landscape planning concepts to improve avian diversity in a region transitioning from agriculture to urban land cover.

The study area is located in the Credit River watershed and covers three landscapes including a) an urban core, b) agricultural land that is rapidly urbanizing and c) a forested landscape within a biosphere reserve. The greatest concern for land planning should be the rapid loss of natural lands and related wildlife within the transition zone as the urban core expands. To maintain the ecological functions of these natural lands requires planning that considers the habitat requirements of area-sensitive and forest species and changing patterns of landscape patches and corridors. Credit Valley Conservation, the local conservation authority, initiated the Integrated Watershed Monitoring Program in 2002 to track patterns in avian populations at forested sites at 25 plots. To determine landscape pattern and avian relationships, bird populations were classified using cluster analysis. The populations were further assessed by guilds such as forest interior and generalists. Landscape parameters of patch size and fragmentation were also examined.

There were five associations classified separating the populations into forest interior, transition and urban groups as well as two that were riparian based. Guild analysis, displayed in figure one, reveals forests in the urban core had the lowest richness dominated by generalist species, although diversity was improved in complex landscapes with riparian corridors and upland forests. The protected forests of the biosphere reserve had high diversity and a stronger presence of area-sensitive species. However, the transition zone had the greatest richness with a mixture of generalists and forest interior species.

The transition zone provides the greater opportunity to reduce human impact on the environment through improved landscape planning. Despite the higher scores of richness, this zone is a population sink and without proper management avian populations will decline as urban encroachment continues. The patches and riparian corridors need to be linked to allow for complex forest complexes. It is also recommended that these patches should have buffer zones and protection to diminish the impact of human activity. There also needs to be a better integration of planning at the regional level that combines the activities and planning policies of regional agencies.


Landuse Type
Agriculture & open space
Natural
Urban
Avian monitoring plot
Road
Watershed
Physiographic Region
Township
Lake
COPYRIGHT 2011 Credit Valley Conservation Authority
Aug. 2011
Ontario
U.S.A.
1 Urban Zone
2 Transition Zone
3 Escarpment Zone
Brittania
Mississauga
Meadowvale
Sawmill
Winston
Levi
Streetsville
Churchill
Fraser
Denford
Wanless
Sugarhill
Upper Canada
Silver Creek
Limehouse
Terra Cotta
Warwick
FON
Forks
Belfountain
Forest interior
Generalist
16-18
10-12
4-6
13-15
9-11

Habitat restoration at the landscape scale mitigates the negative impacts of habitat loss and fragmentation on biodiversity- an example at the Stonehenge World Heritage Site, UK.

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As part of the Stonehenge World Heritage Site (WHS) Management Plan, over 500 hectares of chalk grassland are currently being restored in Wiltshire, UK with the aim to re-connect the isolated fragments of ancient chalk grassland. This provides an opportunity to investigate the ecological benefits of landscape restoration and the factors that facilitate or impede the re-colonisation of target taxa. Additionally, the world renowned, open-access site provides conservation and management challenges as well as opportunities as this site acts as a high-profile example of the benefits of landscape restoration for both nature and people.

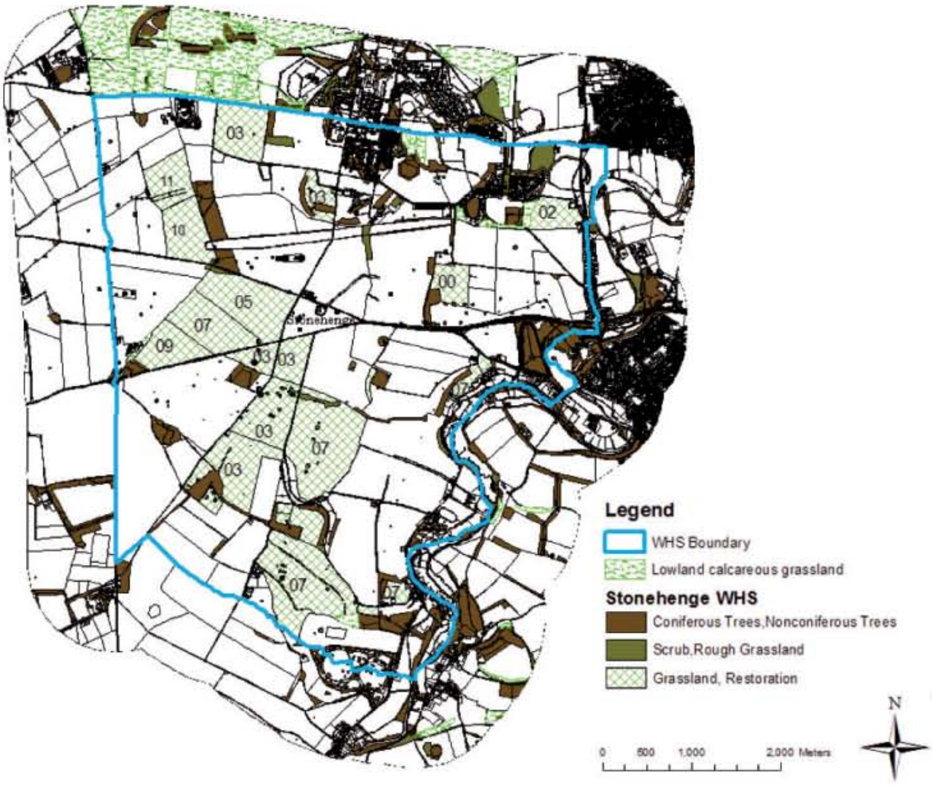
In collaboration with the National Trust, field surveys were undertaken from 2010-2012 using Lepidoptera (Butterflies and day-flying moths) as bio-indicators of restoration success. Surveys located within and across the edges of the different habitat types showed that restored grasslands can approach the ecological conditions of the target ancient chalk grassland habitat and increases in biodiversity values within 10 years. Additionally, results suggest that even recent restoration (1 or 2 years old) can affect the edge crossing behaviour of Lepidoptera at habitat fragment edges and may potentially reduce the functional isolation of ancient chalk grassland fragments.

The ancient chalk grassland fragments showed higher Lepidoptera densities compared with adjacent habitats of different types, and specialist species, such as Lysandra bellargus (Adonis blue) and Cupidi minumus (Small blue), restricted to ancient chalk grassland fragments and were absent from restoration grasslands.

These results suggest firstly that quite rapid restoration success is achievable for some habitats and some species, secondly; however, they show that additional management will be needed to assist the re-colonization of specialist species. Unique factors of this high profile, open-access landscape at the WHS may provide both conservation opportunities and challenges. Despite this, habitat restoration at the landscape scale is an effective, long term approach to enhance biodiversity and to restore landscape connectivity

Grace Twiston-Davies, IALE UK 2012

(Above) Location of the Stonehenge World Heritage Site (WHS), where the calcareous grassland restoration project has been implemented since the year 2000.



(Above) Map of the areas of calcareous grassland restoration at the Stonehenge WHS in relation to existing lowland calcareous grassland within a 1 km buffer of the site. Restoration from 2000 (00) to 2011 (11).

(Left) Grassland restoration at a site restored in 2003 at the National Trust Stonehenge Landscape (photo by Lucy Evershed). (Right) The specialist species Adonis Blue (*Lysandra bellargus*), Male and female butterflies courting (Photo by Nigel Cope).

Restoration ecology for a diffuse corridor: the RAMPE project in Pieve Emanuele Municipality (Lombardy, Italy)

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A diffuse corridor[1] can be defined as "a mosaic of suitable land use connecting natural elements in the landscape". This paradigm may be useful in human dominated landscapes, like agricultural landscapes and suburban fringe areas. The diffuse corridor model allows to join nature conservation, agriculture production and environmental education activities.

To apply the model of diffuse corridor in Lombardy contest we need a plan of restoration of small woodlots, wetlands, hedgerows in order to increase the quality of the overall quality of the matrix.

In 2008[2] we started a project of restoration, called RAMPE (Riqualificazione AMbientale Pieve Emanuele, Restoration Ecology in Pieve Emanuele) financed by the CARIPLO bank foundation, the local municipality and coordinated by our Research Unit of Landscape Ecology. The project is still continuing with a new financing.

The project is based on the restoration of different biotopes in a small municipality located 15 km south of Milan. In particular wetlands have been restored using bioengineering techniques, and new hedgerows and forested woodlots have been planted.

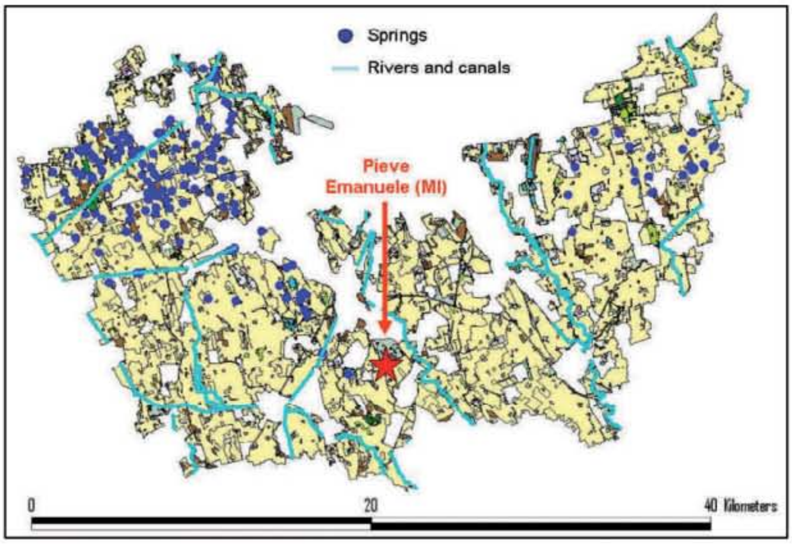
In order to help and reinforce the biodiversity of the area we carried out different actions: we restored an abandoned building (for bats and barn owls), we carried out an eradication of alien invasive species (both animal[3] and vegetal: Procambarus clarkia, Myocastor coypus, as an example) and we reintroduced endangered amphibians.

The last part of the program concerns the relationship with society and local stakeholders. Several activities of environmental education have been organized in order to explain the project and to involve local people.

[1]Padoa-Schioppa E., Baietto M., Massa R., Bottoni L. (2005). Cultural landscape conservation: diffuse corridors in Lombardy Region (Italy). In: Planning People and Practice - The Landscape ecology of sustainable landscapes. p. 157-166,

[2]Padoa-Schioppa E, Digiovinazzo P, Ficetola GF, Ripanti F, Baietto M, Bottoni L (2009). Beyond ecological networks: diffuse corridors in agricultural and urban fringe landscapes. In: Ecological Networks: Science and Practice. Edimburgh, 2009, p. 175-182.

[3]Ficetola GF, Siesa ME, Padoa Schioppa E, De Bernardi F (2012). Wetland features, amphibian communities and distribution of the alien crayfish, Procambarus clarkii. ALYTES, vol. 29, p. 75-87



The area of Pieve Emanuele, the water system, and (in yellow) the Agricultural Park South Milan

Restoration of a wetland using bioengineering techniques

Eradication of an invasive species: the the alien crayfish, *Procambarus clarkii*

Guiding models for adaptation planning

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Affecting several land use related sectors, climate change will create new spatial demands. There is a growing sense that, especially at the local scale, spatial planning has a key role in addressing the causes and impacts of climate change[1].

Commissioned by the Dutch Ministry of Infrastructure and Environment and the Province of Gelderland we have used guiding models as a design tool for adaptation planning during 15 workshops with municipalities. The concept of guiding models has been developed in the nineties by Tjallingii[2] to translate the principles of integrated water management in urban planning. The concept is based on the principle of the layer approach in which the natural is guiding the more dynamic strata of networks and occupation[3]. To see the natural substratum as an ordering and guiding system rather than a subject of ecological concern or reserve is the main principle of the layer approach. Here we demonstrate how the layer approach is also relevant in a context of adaptation planning by introducing the principles of adaptation to climate change into climate adaptation guiding models.

We will demonstrate how the construction of climate adaptation guiding models took place in participatory context and how the use of climate adaptation guiding models can contribute to the information needs of policy makers at the local sale, leading to an increasing sense of urgency and integral adaptation planning process.

Evaluation of the workshops clearly shows that the success of the climate adaptation guiding model depends on how a policy maker frames the context of adaptation planning. Based on the frame-based guide to situated decision-making on climate change of the Boer et al[4] we introduce an Information Visualisation Framework which links information needs to framed perceptions of adaptation planning and corresponding decision strategies by providing spatial impact information indicators and a corresponding visualisation technique. The Information Visualisation Framework is aiming at systematically clarifying, identifying and visualising user needs for adaptation planning. The development of the Information Visualisation Framework is part of a PhD research and will be further elaborated, applied and tested in the coming two years.

[1]Parry, M.L., Climate Change 2007: impacts, adaptation and vulnerability: contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. 2007: Cambridge Univ Pr.

[2]Tjallingii, S.P., Ecological conditions: strategies and structures in environmental planning. 1996: Wageningen: IBN-DLO.

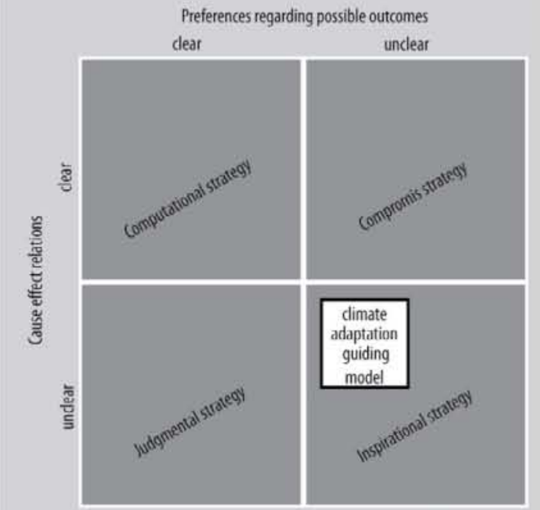
[3]Priemus, H., System innovation in spatial development: current dutch approaches. European Planning Studies, 2007. 15(8): p. 992-1006.

[4]de Boer, J., J.A. Wardekker, and J.P. van der Sluijs, Frame-based guide to situated decision-making on climate change. Global Environmental Change, 2010.

Guiding models for adaptation

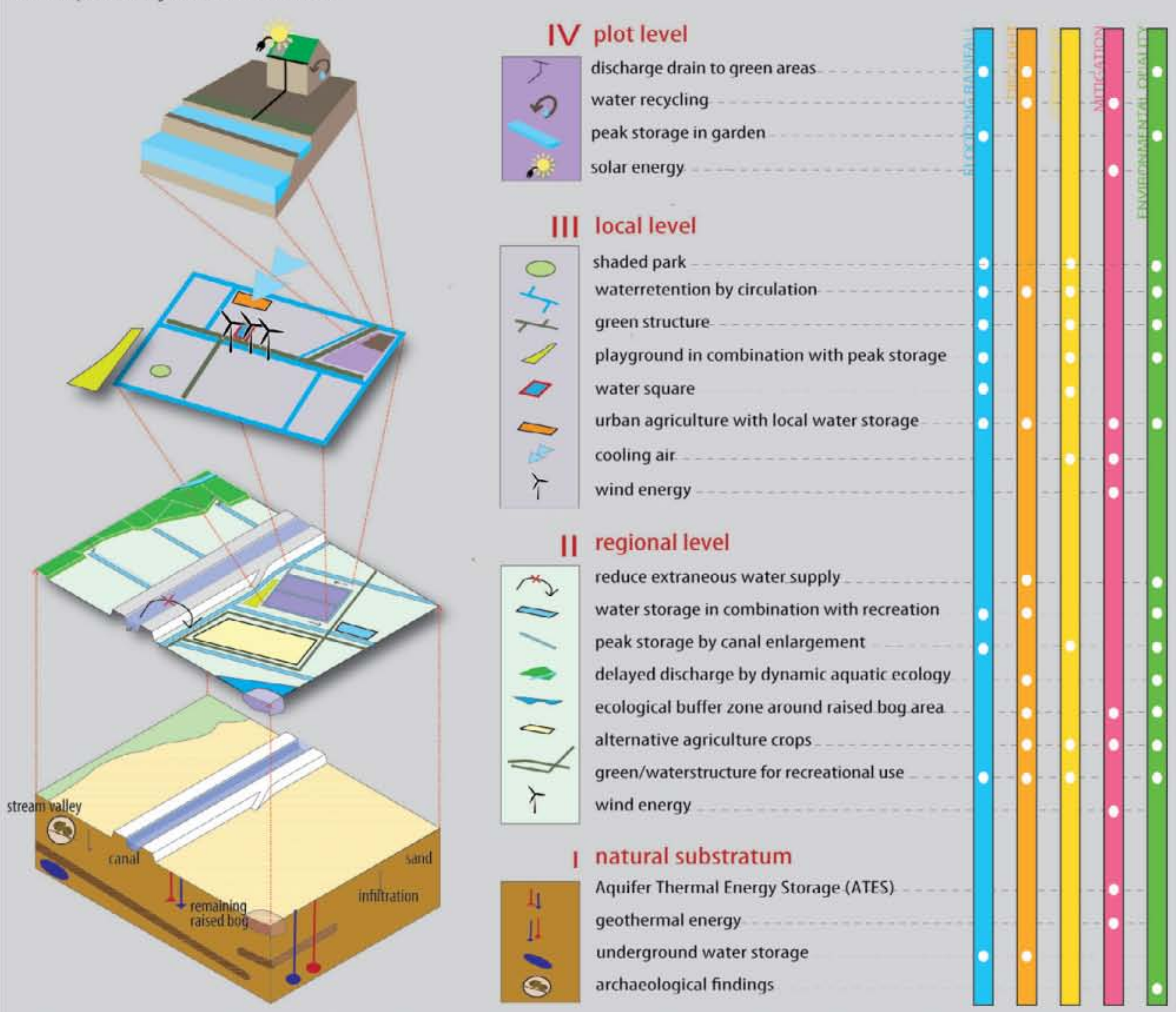
Groot - Reichwein, M.A.M. de, H. Goosen, R. van Lammeren and V. Grond

Information Visualisation Framework



After de Boer et al, 2011

Climate Adaptation Guiding Model for the Peat district area



Scotland's Land Use Strategy - a sustainable future

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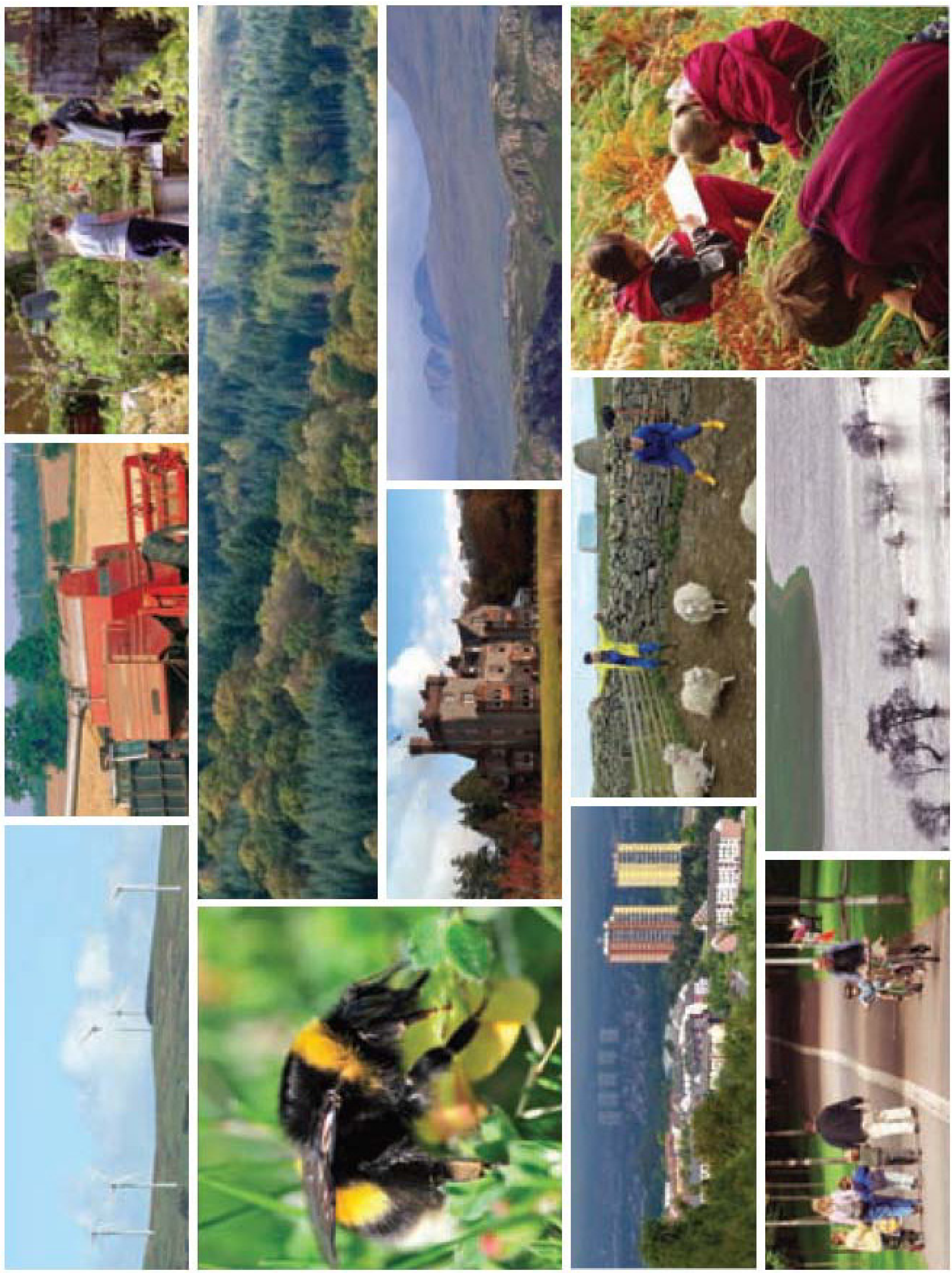
Scotland's first Land Use Strategy was born out of the Climate Change (Scotland) Act 2009 and outlines a strategic approach to achieving sustainable land use. Published in March 2011, the Strategy sets out a vision for a Scotland that recognises, understands and values its land use resources, along with 3 high level Objectives relating to economic prosperity, environmental quality and communities. The presentation will look at the work that has been done since the publication of the Strategy, the approaches being taken and what is expected in the future.

The Strategy relies upon a partnership approach across the public, private and third sector. Business, communities and Government are encouraged to adapt their thinking and decision-making. The Strategy promotes businesses working with nature in order to make positive contributions to Scotland's prosperity, deliver responsible stewardship of Scotland's natural resources, and ensure that communities are better connected and are involved in the future of the land. The Strategy introduces for the first time 10 Principles for Sustainable Land Use which reflect Scottish Government policies and should inform land use choices and significant decisions affecting the use of land. A research project is being undertaken to assess how effectively the Principles are being incorporated into decision making across Scotland.

The Strategy also contains 13 Proposals which represent the key priorities for action during the life of this first Strategy. Delivery of the Proposals is outlined in the Land Use Strategy Action Plan, published in December 2011, with progress towards delivery of the Strategy monitored in an annual Progress Statement the first of which was published June 2012.

One of the proposals seeks to demonstrate how an ecosystem approach could be taken into account in relevant decisions to deliver wider benefits. The Government wishes to integrate the principles of an ecosystem approach into decision-making processes affecting land use. Since the Strategy's publication the Woodland Expansion Advisory Group have been working on another of the proposals and submitted their report to Cabinet Secretary for Rural Affairs and Environment, Richard Lochhead MSP in June 2012. Recommendations in the report included the use of a regional and sub-regional view for some land management decisions. This links in with current Government's adoption and promotion of an ecosystem approach to land management. Both ideas will be important to the future thinking surrounding sustainable land use as we look to achieve the Strategy's long term Vision for Scotland.



Local resilience mapping and action planning

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Susan has worked with Sustaining Dunbar to design and facilitate a Community Mapping process to develop a framework and action plan for a low carbon locality by the year 2030. The Dunbar and District Local Resilience Action Plan (LRAP download here), is based on a survey of over 1500 area residents. The surveys evidence that local people strongly want more local food, more energy efficient homes, neighbourhoods which are safe and attractive, more walking and cycling and more local jobs but that there are a number of barriers which currently exist. Essentially findings show that it is difficult for people to act in more sustainable ways because the infrastructure is not in place to make it easier and possible to make positive changes.

We also learned

- Local awareness of climate change is already high but not a particularly strong driver in behaviour change.
- Local awareness of Peak Oil is much lower but is likely to be a much more potent driver in encouraging behaviour change.
- Most people feel that there is a need for more information about the local implications of peak oil and climate change.

The Local Resilience Action plan sets out a framework for meeting future challenges such as local impacts of extreme weather events, peak oil and economic change by becoming less reliant upon fossil fuels for food, energy, transport, health, enterprise, skills and education. The LRAP documents the situation now in terms of barriers and the current state of play and the aims for 2030 and what needs to be done to get there, who needs to be involved, what they can do, and milestones to achieve in the short term (5 years), medium term (10 years) and long term (15+ years). It also sets out how the Local Authority and the Scottish Government will have helped and supported the process.


Maps can help to show us where we are ...a good map can also show us where we want to go, and how to get there.
mapping our future?
use this map to mark where you live, and share your knowledge about the past...
do you know where our food comes from, before the supermarkets sell it?
what foods were grown and produced locally during the war?
and map your ideas for the future.
where will we get our food in the future when we can't rely on cheap oil for transport?
how will we generate energy to heat and run our homes and businesses?
what needs to be done to make it easier to use public transport, walk or cycle?
have your say ...map it and post it!
www.sustainingdunbar.org
contact us at: 2025 Team, 16 Westport, Dunbar, EH42 1BU
tel: 01368 866 920
email: philip@sustainingdunbar.org
Good stuff here!
DUNBAR
EAST LINTON
West Barns
Tyninghame
Preston
Traprain
Stenton
Spott
Innerwick
Skateraw
Thorntonloch
Oldhamstocks
where do we get our food water energy ?

Assessing the potential of mountain forests for ecosystem services

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The objective of this study was to assess the potential of 6 mountain forests for ecosystem services based on landscape analyses. The ecosystem services considered in this study were the forest functions including aesthetics, ecological environment, timber production, cultural/historical heritage and recreational use (Figure 1). The potentials of the mountain forests to provide the ecosystem services were assessed based on the relative importance and/or value of the functional components of the forest landscape. The spatial characteristics of mountain forests were analyzed using GIS and the major landscape indices were estimating using FRAGSTATS. In order to quantify the potentials, the functional components or indicators as well as their relative importance, needed in quantifying the potential of ecosystem services, were chosen and measured through intensive surveys among general public, forest experts and stakeholders. According to the results of this study, the potentials of mountain forests were different one another and all the 6 mountain forests revealed strong and/or weak points associated with the type of ecosystem services (Figure 2).

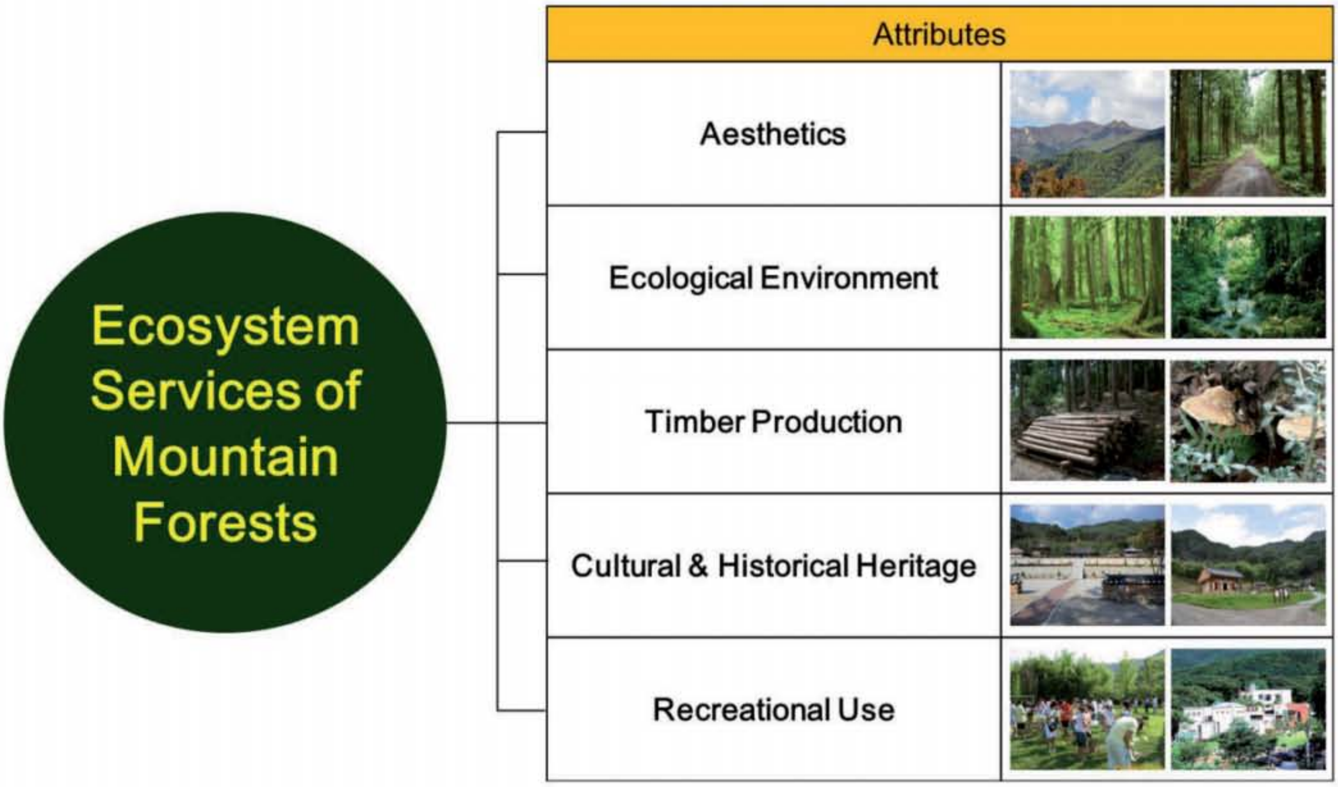

Figure 1. The attributes of ecosystem services for mountain forests in Korea.

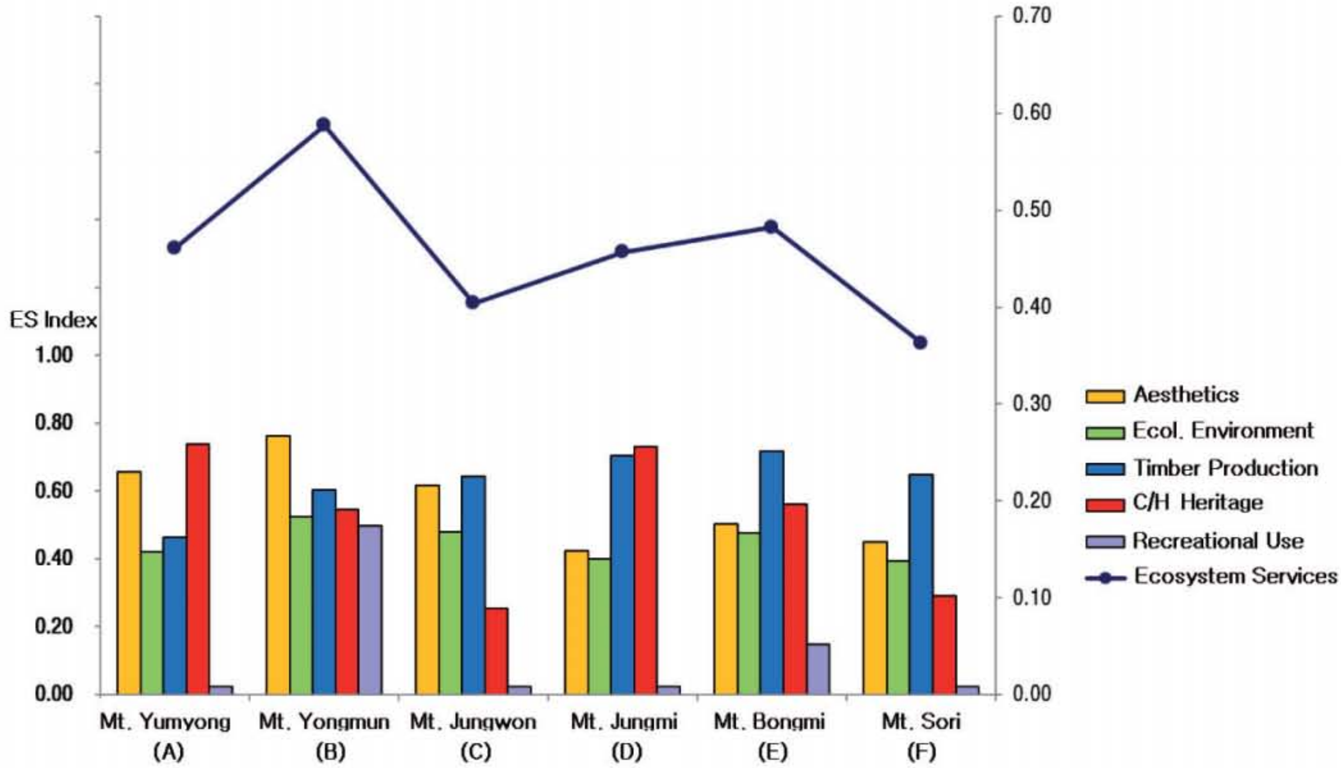

Figure 2. The potential of mountain forests for ecosystem services in study area.

Engaging people with landscape benefits

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The Aarhus Convention (1998), Convention on Biological Diversity (1992), European Landscape Convention (2000) and Water Framework Directive (2000) require that all sectors of society are engaged in planning future landscapes. The Local Government in Scotland Act[1] provides the statutory basis for community planning in Scotland and places a duty on local authorities to initiate, maintain and facilitate community planning of public services. Scottish Natural Heritage is adopting an ecosystems approach[2] that involves communities in decision making by valuing people's knowledge, helping people to participate, and giving people greater ownership and responsibility.

Countryscape was commissioned by Scottish Natural Heritage to produce a web-based toolkit to help communities to consider their place and to help influence decisions shaping their landscape. The project included an initial review of community planning projects and engagement technique and the toolkit development was guided by a steering group including members from government agencies, local government and non-governmental organisations. The toolkit was designed to be used independently by communities as well as by local authorities and other agencies.

The toolkit, called 'Talking about Our Place[3]', comprises guidance and resources that help communities to learn about their landscape; promote and celebrate their place; comment on plans and strategies; or develop projects to help improve their landscape. The toolkit adopts an ecosystem approach and contains information adapted from the UK National Ecosystem Assessment[4]. The phrase 'landscape benefits' was used to help communicate the link between ecosystem services and human wellbeing.

The toolkit provides resources to support a four stage process: project planning; understanding local distinctiveness; considering landscape benefits; and planning for the future. Some communities may use the toolkit to celebrate local distinctiveness while others may follow the entire process. The toolkit is publicly available5 and will be reviewed and updated in response to feedback from several pilot communities across Scotland.

[1]Scottish Government, 2003, Local Government in Scotland Act 2003 (asp1).

[2]Scottish Natural Heritage, 2012, Sustaining Nature's Services: How Scottish Natural Heritage is adopting an ecosystem approach, Scottish Natural Heritage.

[3]Porter, J.R., Brookes, J.T., Harman, D.A., Jagota, L. and Mahony, P.D., 2012, Talking About Our Place, Scottish Natural Heritage.

[4]UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge.5 http://countryscape.org/TalkingAboutOurPlace, accessed 6 August 2012.

Talking About Our Place

Step By Step Guide

A5

Stage 1

Planning your Place Project

- Put together a working group and agree roles
- Agree aims, outputs and timescales for the project

Stage 2

What is special about our place?

- Agree and plan events and activities to engage the wider community
- Run engagement events and activities
- Summarise what is special about your place

Stage 3

What are the benefits from your landscape?

- Read the Topic Fact Sheets and information about benefits from your landscape and carry out any further research
- Agree and plan events and activities to engage the wider community in talking about benefits from your landscape
- Run engagement events and activities
- Summarise the benefits from your landscape which exist and which are valued in the community

Stage 4

Shaping the future

- Agree and plan events and activities for discussing any next steps with the wider community
- Run engagement events and activities
- Set out next steps

Outputs

Stage 1	Stage 2	Stage 3	Stage 4
The formation of a working group to plan and drive the Place Project forward	Learning about and celebrating your place	Understanding the landscape benefits to you and your community	Improving your place and developing projects

Wed 5 Sept pm - Think global, act local: landscape ecology to balance competing demands

Trade-offs between beneficiaries' demands for conflicting services will ultimately determine future land use. This symposium will highlight some of these trade-offs and present methods and principles for balancing these competing demands. Act locally: landscape ecology exemplars.

Competing claims: science, policy and land management challenges in Scotland

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Our land and is a finite resource, and is set to come under increasing pressure as the century unfolds. Balancing these competing claims on the land, whilst ensuring improved and enduring benefits for society will be a major challenge. Scottish Natural Heritage is funded by the Scottish Government to promote its sustainable use, now and for future generations. Des Thompson will provide an overview of some of the major challenges for Scottish land use, with examples of research, policy and on the ground activities to support land management and ensure enduring benefits to society and the environment.

Linking Caledonian pinewood remnants in Lochaber, Scotland: bridging the gaps between science and decision-making

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This paper reports on research being carried out to support forest landscape restoration in the Scottish Highlands. Despite the increasingly sophisticated range of models available to land-use policy-makers and planners, scientific evidence often plays a relatively minor role in decision-making. Regional strategies for woodland expansion remain indicative, with little influence on land managers' decisions, while impact assessments are often merely seen to justify decisions already made. The paper focuses on efforts to overcome this gap between science and decision-making through applied interdisciplinary research in Lochaber District, where Forestry Commission Scotland (FCS) and its partners seek to restore the region's ecologically important Caledonian pinewoods.

Forest Research is supporting this initiative at two spatial scales. In Glen Garry, FCS are establishing a 1000 hectare mosaic of semi-natural woodland across open moorland providing a transition from commercial plantations in the valleys to scattered patches of montane scrub at higher elevations. The scheme forms part of a wider strategic vision to expand commercial and semi-natural woodland cover across the District on existing FCS land and new land leased or purchased under its acquisitions programme. Habitat connectivity is being enhanced through targeted planting of Scots pine (Pinus sylvestris) and other native species, and by diversifying the structure of existing pine and spruce (Picea spp.) plantations.

At both scales, Forest Research is supporting decision-makers to identify opportunities for woodland expansion through: a) suitability mapping using a spatially-explicit Ecological Site Classification (ESC) model; b) connectivity analysis of woodland and non-woodland habitat networks; c) identification of land-use constraints such as prime agricultural land and protected areas, and d) management constraints such as proximity to roads for timber extraction. A further step involves assessing the impacts of alternative planning scenarios, and balancing trade-offs and synergies in the provision of ecosystem services. The challenge is to meet the competing demands of multiple stakeholders, in particular those representing biodiversity, tourism, timber and community interests.

A key objective will be to evaluate the impacts the project has on decision-making, for example by recording iterative changes made to spatial plans, and financial savings made to planting operations and by better targeting of land acquisitions. The overall aim is to develop and test a generic framework for forest restoration that brings together scientists, land managers and stakeholders in ways that enhance both the quality and legitimacy of the decisions being made, and that can be applied elsewhere in Scotland and internationally. The project is a case study within the Global Partnership for Forest Landscape Restoration (GPFLR) and the focus of collaboration between FC and the Indian Forest Service.

Trade-offs in long-term forest ecosystem management: timber, birds and deer

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Managed forest ecosystems are expected to provide timber, wildlife habitat and recreation opportunities (e.g., deer hunting). In many managed forests, including the northern hardwood forests of North America, selection harvesting intends to mimic natural small-scale canopy disturbances by removing single to small groups of trees. These removals create gaps in the forest canopy, increasing resources to the understory and encouraging the regeneration of shade-tolerant tree species such as sugar maple. However, several factors, including deer that browse these tree species, can limit recruitment of understory tree saplings to the forest canopy, threatening the sustainability of forest market (timber) and non-market (wildlife habitat) values. Spatial variability and interactions across landscapes of these factors influencing regeneration lead to dynamics that can hinder management. Tools which help managers coordinate timber and wildlife management regimes to be compatible with these dynamics are therefore important for ensuring forest sustainability.

Here, we investigate the combined long-term impacts of variable tree regeneration and timber management on forest stand structure, bird occupancy probabilities, and timber production in the northern hardwood forests of Michigan's Upper Peninsula. We develop species-specific relationships between bird occupancy and forest stand structure from field data. We integrate these bird-forest structure relationships with a forest simulation model that couples a forest-gap tree regeneration submodel developed from field data with the US Forest Service Forest Vegetation Simulator. When simulated over a century, we find that when regeneration is poor (e.g., 25% or less of trees succeed in regenerating), timber harvest prescriptions have a greater relative influence on bird species occupancy probabilities than on the volume of merchantable timber harvested (see Figure 1 in attachment). We explore how this model can be used to investigate spatial interactions between factors influencing tree regeneration in the Great Lakes region (i.e., deer and snow) and how these factors may change and be managed in future.

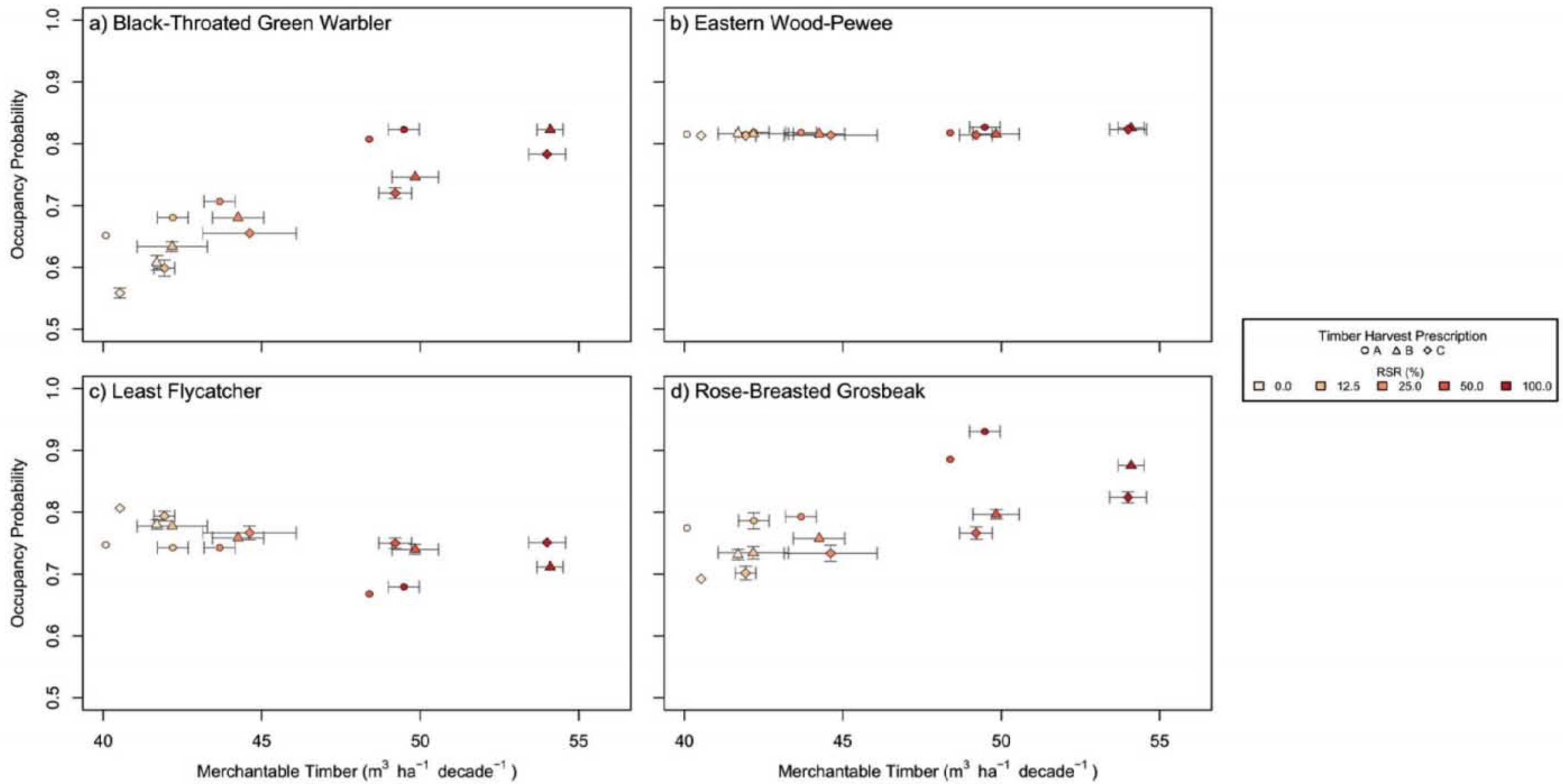

Figure 1. Mean stand occupancy probability and merchantable timber removed by regeneration success rate (RSR) and timber harvest prescription for four forest canopy-dependent songbirds: a) black-throated green warbler , b) eastern wood-pewee, c) least flycatcher and d) rose-breasted grosbeak. Removed-timber volumes are decadal means for 100 simulated years and occupancy probabilities are for year 100 of simulations. Simulations assume 100% of regeneration is sugar maple. Prescriptions vary by residual stand basal area (higher to lower from A to C) and Q factor (specifies the ratio of the tree density in each diameter size-class to its neighbouring, larger, size-class; higher to lower from A to C). Error bars are 95% confidence intervals from the standard error of three simulation replicates for each treatment.

This figure is a reproduction of Figure 4 in Millington *et al.* (2011) Forest Ecology and Management **262** 718-729.

Ecological and green networks and the demand for ecosystem services

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The role of ecological networks for the conservation of biodiversity is well established (Pahl-Wostl & Ulanowicz, 1993). Ecological networks have contributed not just to the conservation of natural species and habitat but to the evidence regarding the importance of nature to human health and well-being (Pretty, 2011). Health and well-being are driving the demand for outdoor leisure activities and the green infrastructure to support those activities. The ambitions for the recently created Central Scotland Green Network (CSGN) are based on the recognition that natural areas, in particular ecological and green networks, are important for sustainable development. It is to provide an infrastructure to support healthier lifestyles, to support the adaptation to climate change, as well as transforming Central Scotland "into a place where the environment adds value to the economy and where people's lives are enriched by its quality" by 2050 (CSGN, 2011).

A key challenge to achieving sustainable development has been the bias in decision making towards those components in socio-ecological systems with an economic value. The concept of ecosystem services (MEA, 2005) allows the non-economic and intrinsic values of natural resources to be included in decision making and the trade-off process. Progress in the application of ecosystem services (ESS) has focused on the development of indicators and methods of mapping ESS (Burkhard et al 2012). The key challenges for application of ESS in policy decision making are the extent to which we can measure and monitor ESS and assess trade-offs effectively (Haines-Young et al, 2012) as well as our ability to manage the spatial and temporal nature of ecosystem services for continued delivery of ecosystem services and increases resilience and adaptibility to change (Syrbe & Walz, 2012).

This paper will use the CSGN as an example to explore the role of ecological and green networks in landscape character and the delivery of demands for ESS from multifunctional landscapes dominated by large urban centres.

Burkhard, B, Kroll, F, Nedkov, S and Müller, F 2012 Mapping ecosystem service supply, demand and budgets. Ecological Indicators 21, 17-29

Central Scotland Green Network 2011 The Vision. CSGN

Haines-Young R, Potschin M & Kienast F 2012 Indicators of ecosystem service potential at European scales: Mapping marginal changes and trade-offs. Ecological Indicators 21, 39-53.

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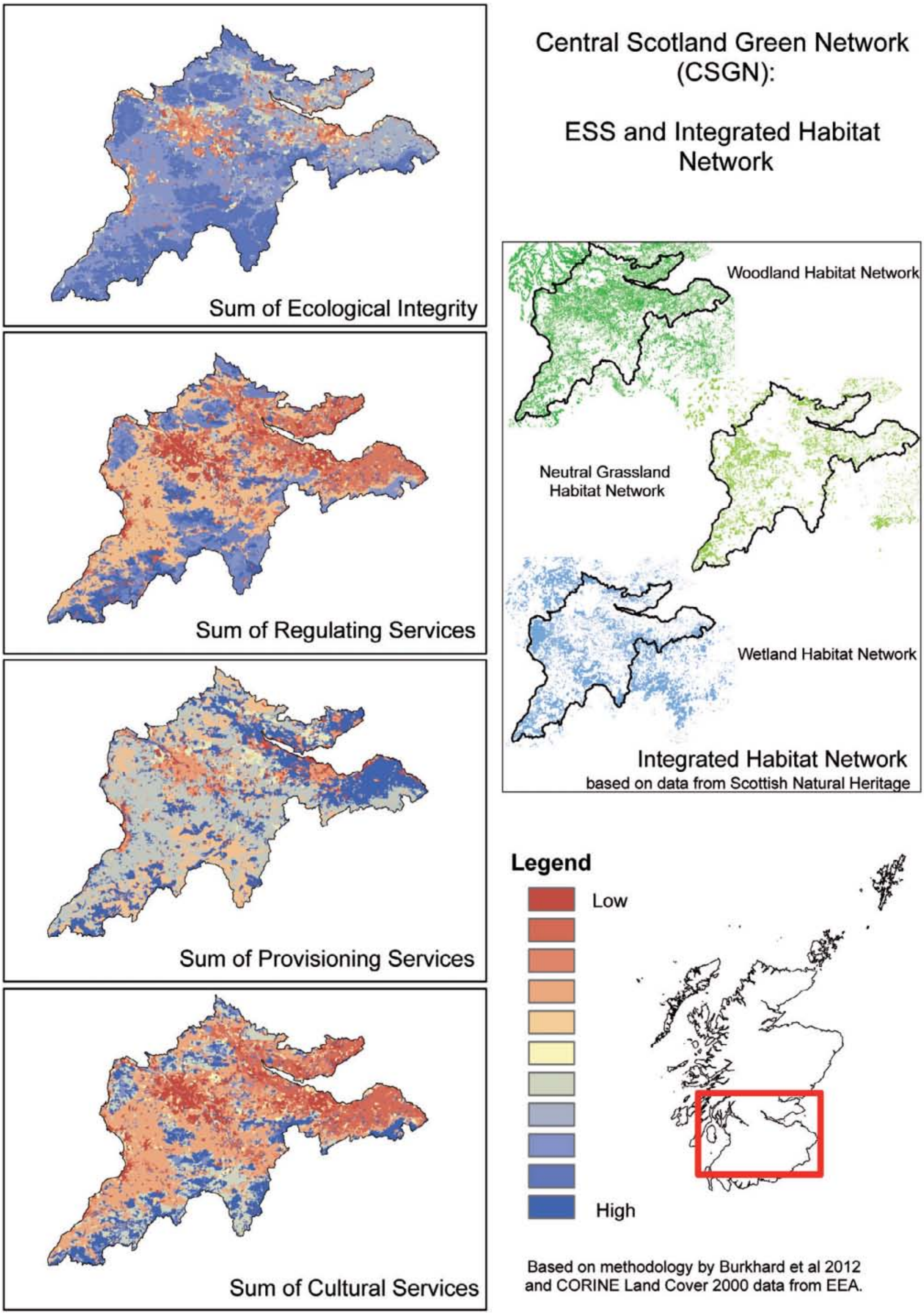
Pretty, J 2011 Health Values from Ecosystems, in UK NEA.

Pahl-Wostl C & Ulanowicz Re 1993. Quantification of species as functional units within an ecological network. Ecological Modelling 66, 65-79.

Syrbe Ru & Walz U 2012 Spatial indicators for the assessment of ecosystem services: Providing, benefiting and connecting areas and landscape metrics. Ecological Indicators 21, 80-88.


Central Scotland Green Network (CSGN):
ESS and Integrated Habitat Network
Sum of Ecological Integrity
Sum of Regulating Services
Sum of Provisioning Services
Sum of Cultural Services
Woodland Habitat Network
Neutral Grassland Habitat Network
Wetland Habitat Network
Integrated Habitat Network
based on data from Scottish Natural Heritage
Legend
Low
High
Based on methodology by Burkhard et al 2012
and CORINE Land Cover 2000 data from EEA.

Adapting to a changing climate at a landscape scale

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We need to prepare today and act now for a changing climate. Climate change means we will have to adapt how we use our land and the services it provides to society. From coping with flooding to supplying homes with water, from growing crops to conserving wildlife - everything needs to be viewed in the light of a changing climate.

In 2013 the Scottish Government will publish a statutory Adaptation Programme. This is a requirement of the Climate Change (Scotland) Act 2009 and will set out Government's plans for how Scotland adapts to a changing climate. Scottish Environment LINK has proposed 5 Principles for Adapting to a Changing Climate[1] and recommends that they are followed during the development and implementation of the Programme.

Scotland's important wildlife and habitats are vulnerable to climate change. Many are in a damaged condition and exist in a fragmented landscape. This threatens their survival and deprives them of the ability to shift to areas as the climate becomes more suitable. It also threatens the supply of ecosystem services to society.

To help plan adaptation in the natural environment LINK also proposed 5 guidelines. These include a recommendation for '..conservation action at a landscape scale'. This aims to provide wider areas of the urban, rural and marine environment that are more resilient to change and permeable to wildlife providing diverse environmental, social and economic benefits. Action at this scale must provide a network of ecologically coherent key habitats which sustain ecological processes and increase connectivity of habitats, surrounded by an environment managed with nature in mind.

The RSPB's Inner Forth Futurescape[2] has a vision for large-scale habitat creation around the Inner Forth that has the potential to restore lost intertidal habitats and increase biodiversity. It can also deliver other benefits ranging from sustainable flood management to improved access provision, and help wildlife and people adapt to the impacts of sea-level rise and climate change. The Inner Forth Futurescape works in partnership with other organisations and within the Inner Forth Landscape Initiative, a programme that is even wider in scope, scale and potential benefits.

Landscape-scale conservation can help biodiversity and people adapt to the challenges presented by a changing climate. It can also help us fulfil the objectives of Scotland's Land Use Strategy[3] - Delivering multiple benefits; Partnerships with nature; Linking people with the land.

[1]Scottish Environment LINK, 2012. 5 principles for adapting to a changing climate http://www.scotlink.org/files/policy/PositionPapers/LINK5_ClimateAdaptPrinciples.pdf

[2]RSPB Scotland, 2011. Futurescapes: Space for nature, land for life http://www.rspb.org.uk/Images/futurescapes_scotland_tcm9-261752.pdf

[3]Scottish Government, 2011. Getting the best from our land: A land use strategy for Scotland

Putting landscape science into strategy

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The Warwickshire, Coventry and Solihull Green Infrastructure Strategy combines the strands of Landscape, Biodiversity and Accessibility to 'Create a Connected Landscape for People and Wildlife'. It is Local Authority driven Strategy and based on Landscape Character, Landscape Ecology and Accessible Green Space practices.

The ecological aspects of the GI Strategy is evidenced on current and accurate Phase 1 habitat data and modelled by the University of York using the incidence function model measure of inter-patch distance, employing a negative exponential dispersal kernel (Molianen & Neiminen, 2002).

The Strategy used average dispersal distances of 1000m and 500m to give each polygon an estimate of the functional connectivity. These parameters were used for Woodland, Grassland and Wetland habitat categories. The resulting six Connectivity Maps formed the GI Strategy's Biodiversity Priorities:

Priority 1) - Connect individual sub-regional GI Biodiversity assets (polygons) to create large functional clusters.

Priority 2) – Connect the large functional clusters.

They were also used to identified the three strategic area classifications for the sub-region's Defra Biodiversity Offsetting Pilot:

- Strategic Areas –where habitat enhancement or creation will connect polygons or functional clusters.
- Semi-Strategic Areas –where habitat enhancement or creation will expand existing polygons or functional clusters.
- Non-Strategic Areas - where habitat enhancement or creation will not expand existing polygons or functional clusters.

Conclusion: the sub-regional GI Strategy through Biodiversity Offsetting will place "the right habitat in the right place" to form a functional Ecological Landscape.

PUTTING LANDSCAPE SCIENCE INTO STRATEGY

David Lowe (Principal Ecologist - Warwickshire County Council)

$$S_i = \sum \exp(-\alpha d_{ij}) A_j$$

Si is the connectivity of habitat polygon *I*; *dij*, is the distance between polygons *i* and *j*; *α* is the inverse of a species average dispersal distance; *Aj* is the suitable habitat area of polygon *j*; [Note: linear features were given a width to create polygons and unsuitable habitats were allotted a zero for the area term.

Figure 1: incidence function model measure of inter-patch distance, employing a negative exponential dispersal kernel (Molianen & Neiminen, 2002)

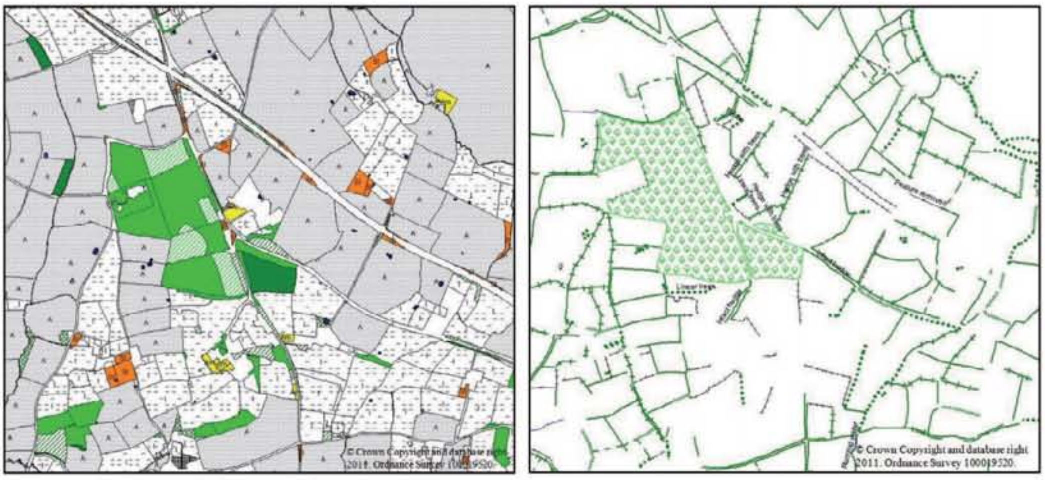

Figure 2: Phase 1 data – Polygon and Linear

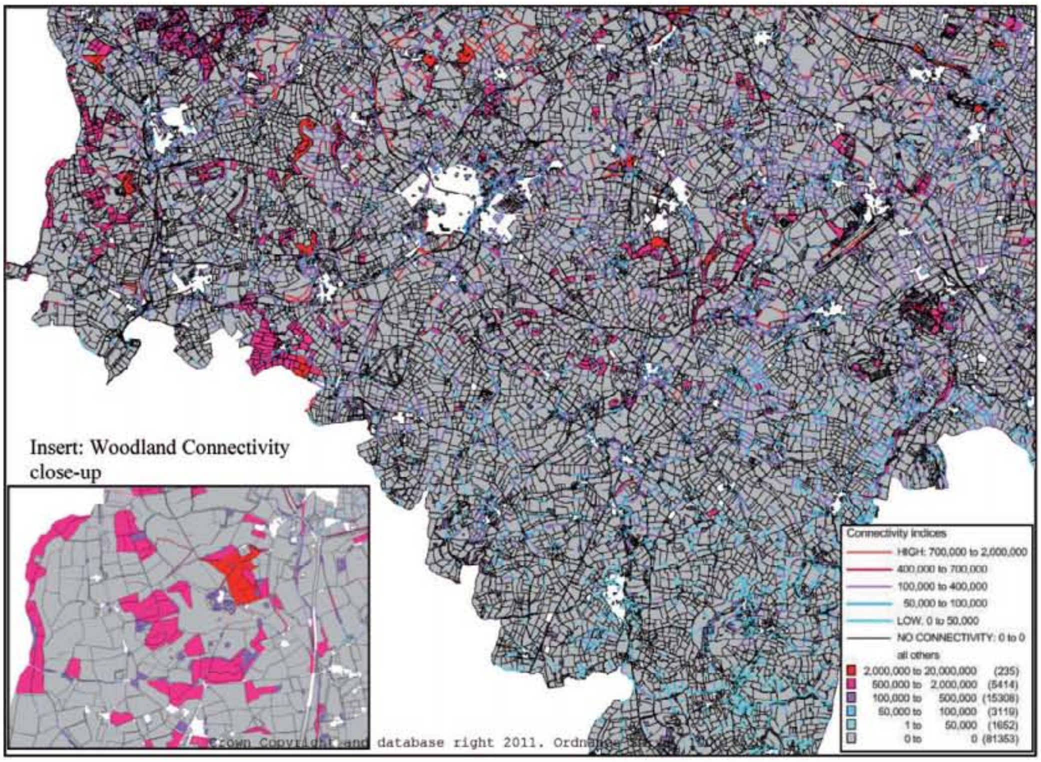

Figure 3: Woodland Connectivity Map for average dispersal distance characteristics of 1000m.

'The model ecosystem framework': testing a decision tool for ecosystem-based adaptation and risk management

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Recent progress reports have emphasised the importance of a place-based context to apply the Ecosystem Approach in practice. The Model Ecosystem Framework (MEF) was developed to provide a flexible decision-making structure that identifies key interactions between humans and ecosystems in a landscape context. Its flexibility was designed to be able to accommodate a range of different conceptual frameworks and to complement high-level initiatives such as the UK National Ecosystem Assessment. Here we report on some of the lessons learned during a case study application of the MEF to woodland expansion in NE Scotland, featuring a transect across the so-called 'Squeezed Middle'.

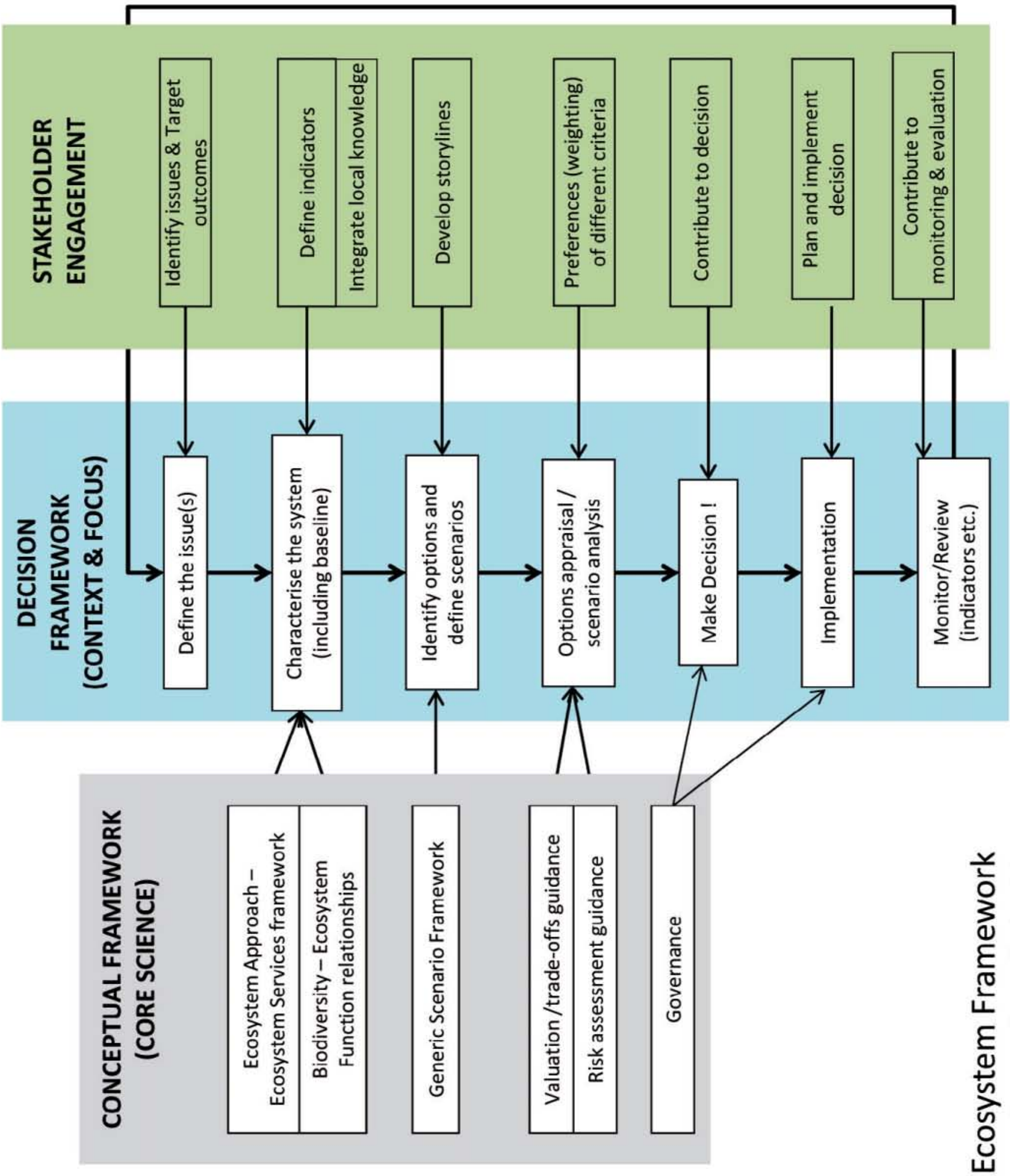
The MEF is based upon a cyclic and tiered structure. The tiered process can accommodate variations in data availability, which can subsequently be improved by more detailed analysis. Scale is a key issue throughout, in particular scaling of empirical site data to the landscape level. The benefits of a cross-scale approach are highlighted (spatial and temporal).

Characterisation of ecosystems in the case study has initially utilised broad habitat data followed by assessment of more specific (priority) habitat and soils data to enable a more in-depth understanding of ecosystem functioning based upon both above-and below-ground processes (e.g. water cycling). This has been complemented by an assessment of the role of social and cultural capital in sustaining the landscape, which identifies the key role of land ownership in woodland expansion objectives. By linking natural capital with social/cultural capital, we aim to more clearly define 'ecosystem services' in practice, including current trends. We also highlight some of the challenges and potential biases that may be involved.

With regard to decision making, options are identified and appraised following a risk-based method. The process aims to identify whether current use of natural resources is sustainable based upon different decision pathways and changing drivers (particularly climate change). As ecosystems are typically highly complex, the challenge is to provide an acceptable level of simplification. Scenario analysis is used to capture uncertainties in key drivers of change that may modify the outcomes for different options, including potential threshold effects. In addition to scale, uncertainty assessment is a key issue throughout.

Our case study experience suggests that 'optimisation' is a false goal because of fundamental uncertainties and differences in stakeholder perspectives. Robust adaptive management based upon landscape ecology concepts of resilience and adaptive capacity represents a more realistic goal, linking both natural and human components through land use systems. But how do we implement this in practice and what are the key indicators?

In addition to Scenarios we will highlight the role of other innovative tools such as participatory GIS, Bayesian Belief Networks, meta-Modelling, spatial Multi-Criteria Assessment, and typologies in delivering the ecosystem approach.



Model Ecosystem Framework
- Linking science & stakeholders

Developing a GIS toolkit to map ecosystem services at a county scale: including wildlife watching and nature experience in local decision making and strategic planning

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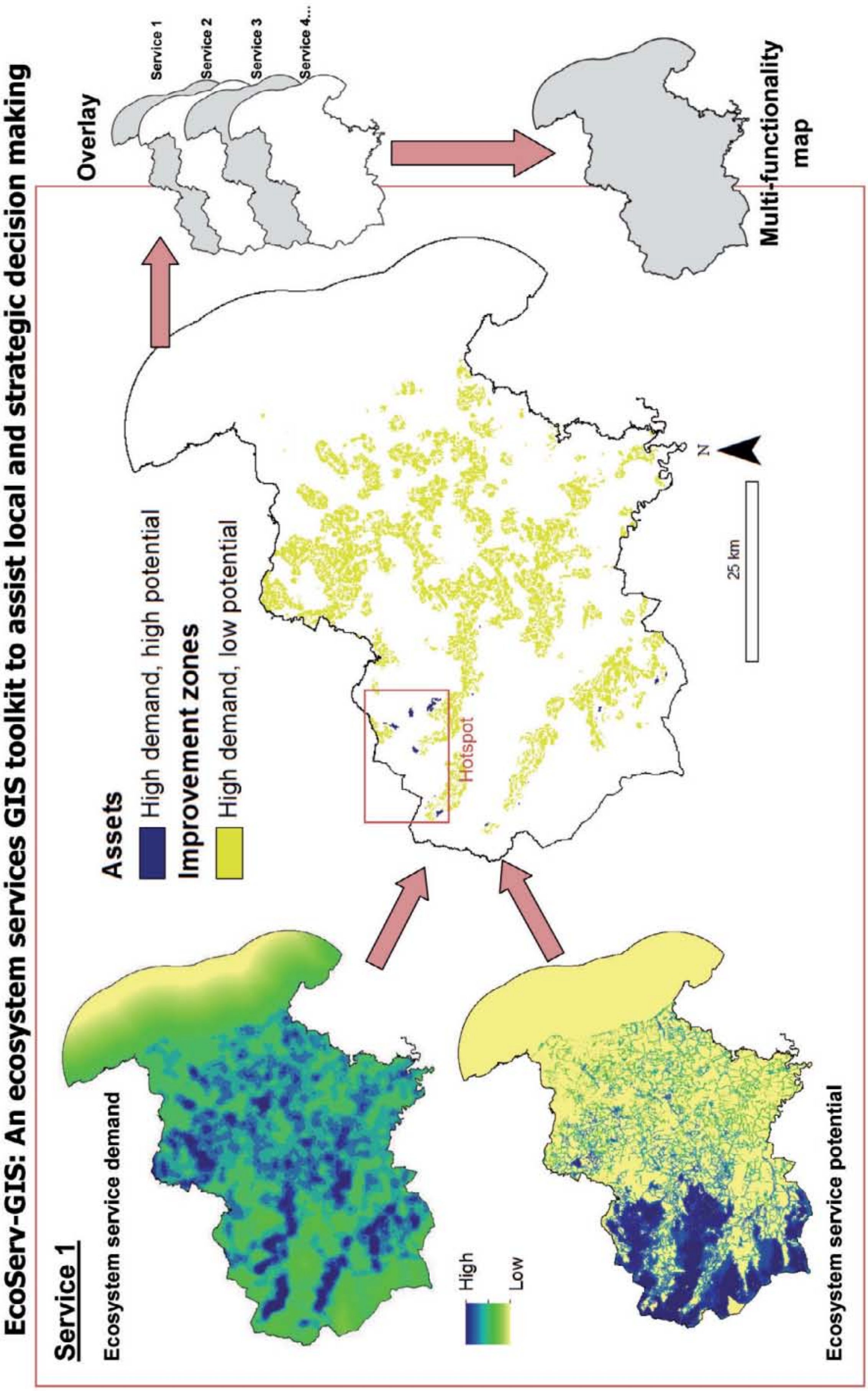
To facilitate the implementation and mainstreaming of the ecosystem approach, we need tools to identify and map the multiple benefits provided to us by our natural environment at decision-making scales. Geographic Information Systems (GIS) provide a powerful platform for the visualisation and spatial analysis of ecosystem services at multiple scales, allowing service provision and demand to be evaluated and monitored in a spatially-explicit, quantitative manner, using data-driven and rule-based models. We developed a GIS toolkit that utilises widely accessible data to map a range of provisioning, regulating and cultural services, including tools to estimate the quality of greenspace for accessing nature and watching wildlife. Our mapping technique was piloted using the Durham Biodiversity Action Plan area, a large region (~3,000 km2) covering multiple local authorities and a wide range of habitats (including marine). The toolkit and user's guide will be made available at the end of 2012, providing a transparent, standardised, easily implemented and geographically transferrable method for mapping ecosystem services at a county scale. The resulting fine resolution (≤50 m) maps provide quantitative tools for local and regional decision making, helping to ensure that networks of greenspace, and the range of services they provide, are protected, enhanced and connected at a landscape scale by informing strategic decisions, targeting conservation strategies, and stimulating innovative landscape planning. By estimating the probability of service occurrence over a continuum of environments, from protected areas to urban fringe grassland, the maps provide important information for those non-designated sites where data is currently lacking and whose importance is frequently underestimated in the planning process. These continuous service maps clearly illustrate the value of the multiple services delivered from our landscapes, ecosystems and wildlife sites, promoting sustainable development and providing a decision assisting tool to integrate ecosystem service assessments within the planning system.


EcoServ-GIS: An ecosystem services GIS toolkit to assist local and strategic decision making
Service 1
Ecosystem service demand
High
Low
Ecosystem service potential
Assets
High demand, high potential
Improvement zones
High demand, low potential
Hotspot
25 km
N
Overlay
Service 1
Service 2
Service 3
Service 4...
Multi-functionality map

Sustainable principles for resource-efficient landscapes

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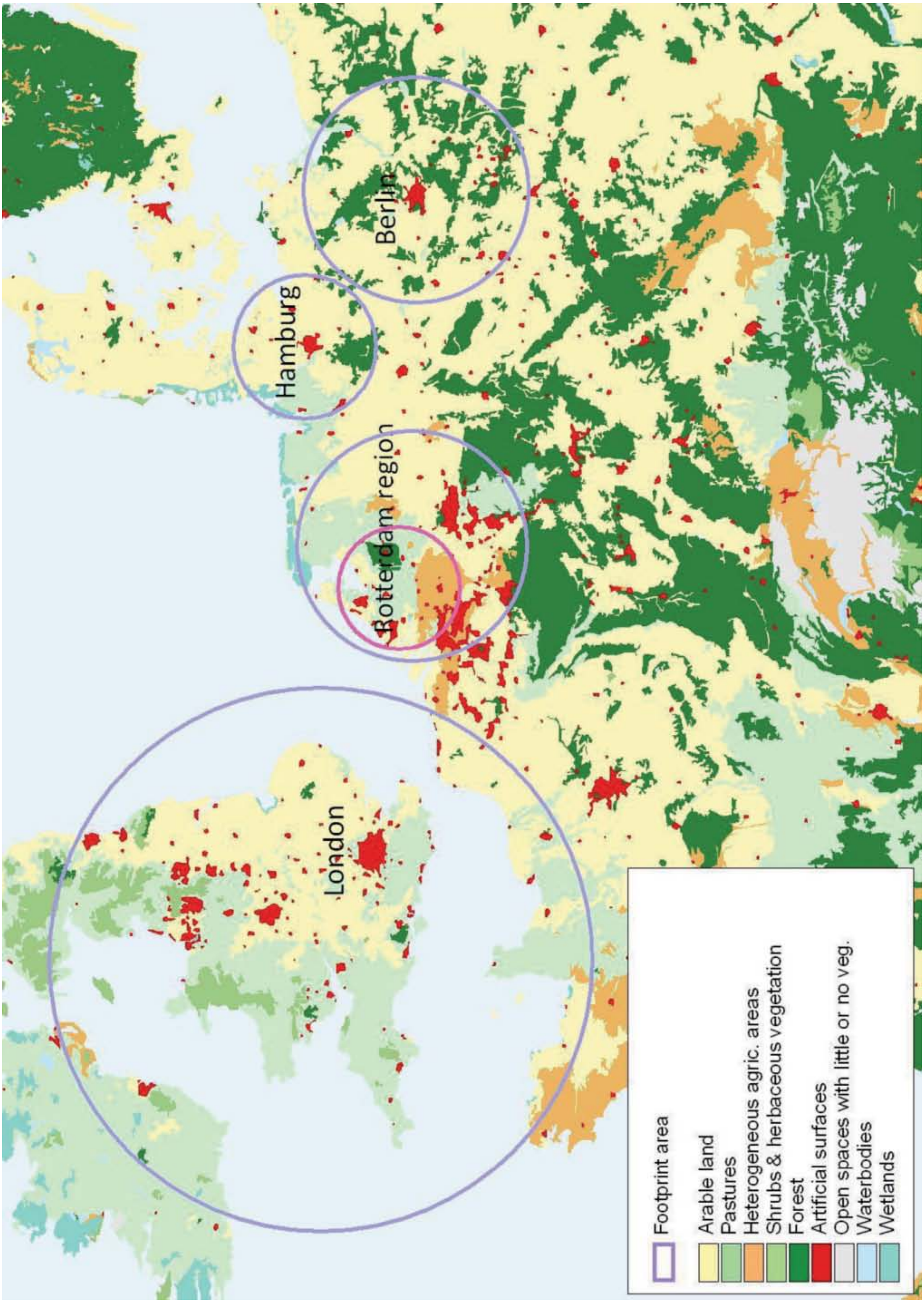
As disciplines, resource management and landscape management have more or less comfortably co-existed in a complementary relationship and seemed to even pursue similar objectives: the maintenance and wise use of goods and services of the land for the people. On the other hand, its strong links to hard economic objectives puts resource management frequently into competition with landscape ecological goals which emphasize many functions and values of which many are difficult to measure in economic terms. Due to the recent emergence of more ambitious resource efficiency strategies and policies at the European and at national levels, the once comfortable relationship between resource and land management has come under pressure. Current trends in Dutch agriculture indicate that tremendous changes have already occurred in the wider countryside around metropolitan centres. Among scientists, regional planners and stakeholders there is hence a growing awareness that rural areas as we know them are undergoing substantial transformations. The Netherlands, with the traditional segregation between nature conservation on the one hand (spatially manifested in the implementation of the Ecological Main Structure) and highly intensive agricultural land use on the other hand (high livestock densities, large-scale glasshouse productions and high-tech farm management) can be considered as a point in case when developing sustainable principles for more resource efficient landscapes. Other than traditional landscape management approaches, such principles are based on making use of the ecological footprint as a key reference for sustainability. Drawing upon the example of food planning in metropolitan regions and with special focus on the SUSMETRO project, this presentation will highlight the method and implications of integrating a wide range of land use interests into new concepts for resource-efficient landscapes around metropolitan areas.


Berlin
Hamburg
Rotterdam region
London
Footprint area
Arable land
Pastures
Heterogeneous agric. areas
Shrubs & herbaceous vegetation
Forest
Artificial surfaces
Open spaces with little or no veg.
Waterbodies
Wetlands

Scenarios for the spatial distribution of landscape services in a rural landscape: implications for local spatial planning

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People use and modify the landscape to obtain landscape services that are beneficial for society, such as food production, recreation, and water regulation. Spatial planners direct their plans to provide and strengthen desired landscape services. However, besides the benefits also undesired consequences do occur. To support the establishment of these spatial plans, maps showing the spatial patterns of landscape services are essential. It is also essential to obtain insight about potential negative consequences of their plans. A key method to deal with the uncertainty of possible future outlooks and consequences of (spatial) plans is scenario development. The objective of this study is to develop scenarios for the spatial distribution of landscape services in a rural landscape to analyse plausible future outlooks and their consequences. We combine the concepts of landscape services and scenarios, through a participatory process. Using the case study area southeast Brabant in the Netherlands, we developed two scenarios (based on the Intergovernmental Panel on Climate Change; Fig. 1a) together with key stakeholders and jointly evaluated the suitability of existing policy strategies. We focused on three landscape services that play an important role in the study area: recreation for hikers, water quality, and water storage. The scenarios are exploratory and consist of both qualitative and quantitative data. Spatial planners are predominantly concerned with nearby futures (up to 10 years), therefore, we developed scenarios at a short term (up to 2025). The scenarios are developed during a workshop to stimulate interaction and social learning between scientists and local spatial planners. The workshop was divided into four steps: 1) identifying of events; 2) placing events on a timeline; 3) recognising spatial distribution of events; and 4) evaluating existing policy strategies. The stakeholders chose to develop scenarios A2 and B1. The results of the mind map are shown in Figure 1b. In total, 67% of the policy strategies were compatible with both scenarios. Moreover, the evaluation of the policy strategies induced an insightful discussion. Through combining the scientific methods of participatory scenario development and landscape services, we can engage spatial planners in considering the complexity and uncertainties that lay ahead.

M.M.C. Gulickx, K. Kok, J.J. Stoorvogel, 2012. Scenarios for the spatial distribution of landscape services in a rural landscape: implications for local spatial planning. 19th ialeUK conference 4-6 September 2012, The University of Edinburgh.

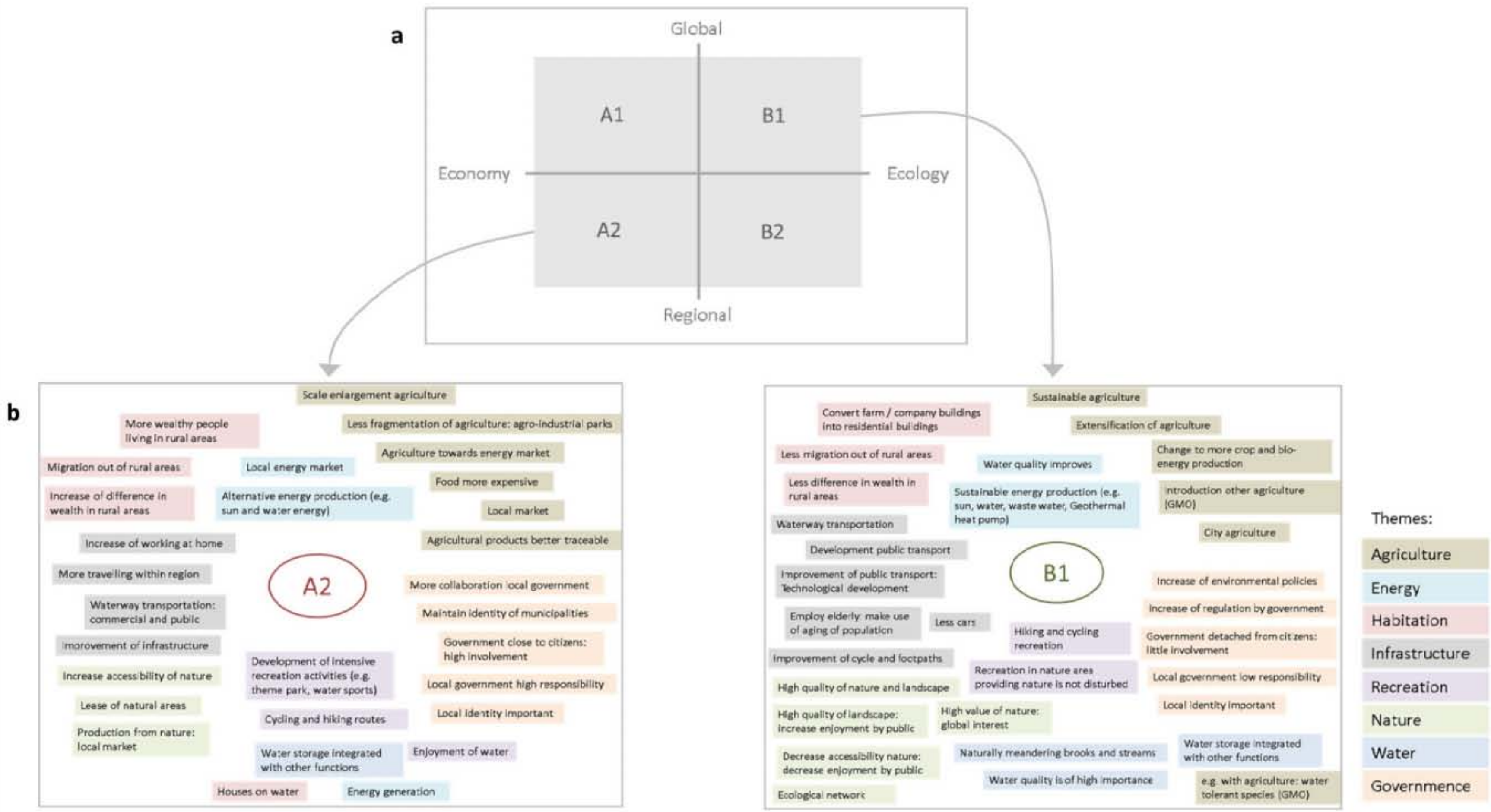

Fig. 1 a) Scenarios A2 and B1 are developed. The scenarios are based on IPCC (Intergovernmental Panel on Climate Change).
b) Results of the mind maps for Scenario A2 and B1. The events are clustered by themes using colour coding shown at the right hand side.

Assessing the impact of land-use change on biodiversity and other ecosystem services

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Assessing the impact of land-use change on biodiversity is currently of great political interest, but there appears to be little consensus on what measures of biodiversity to consider, and obtaining appropriate data on species distributions is challenging. A common approach is to use measures of landscape structure, notably landscape heterogeneity and habitat connectivity, as surrogates for biodiversity, though there is little strong evidence to support this assumed relationship. Research presented by Charlotte Carter at this conference is aiming to address this evidence gap.

We developed approaches for measuring landscape heterogeneity (based on the approach of Dramstad et al.[1]) and habitat connectivity (considering a number of approaches, including that of Catchpole[2]) using pixelated land cover map data, to assess the simulated impact on landscape pattern (and hence biodiversity) of different strategies for introducing biomass crops into the UK agricultural landscape, summarising these indices at a landscape level.

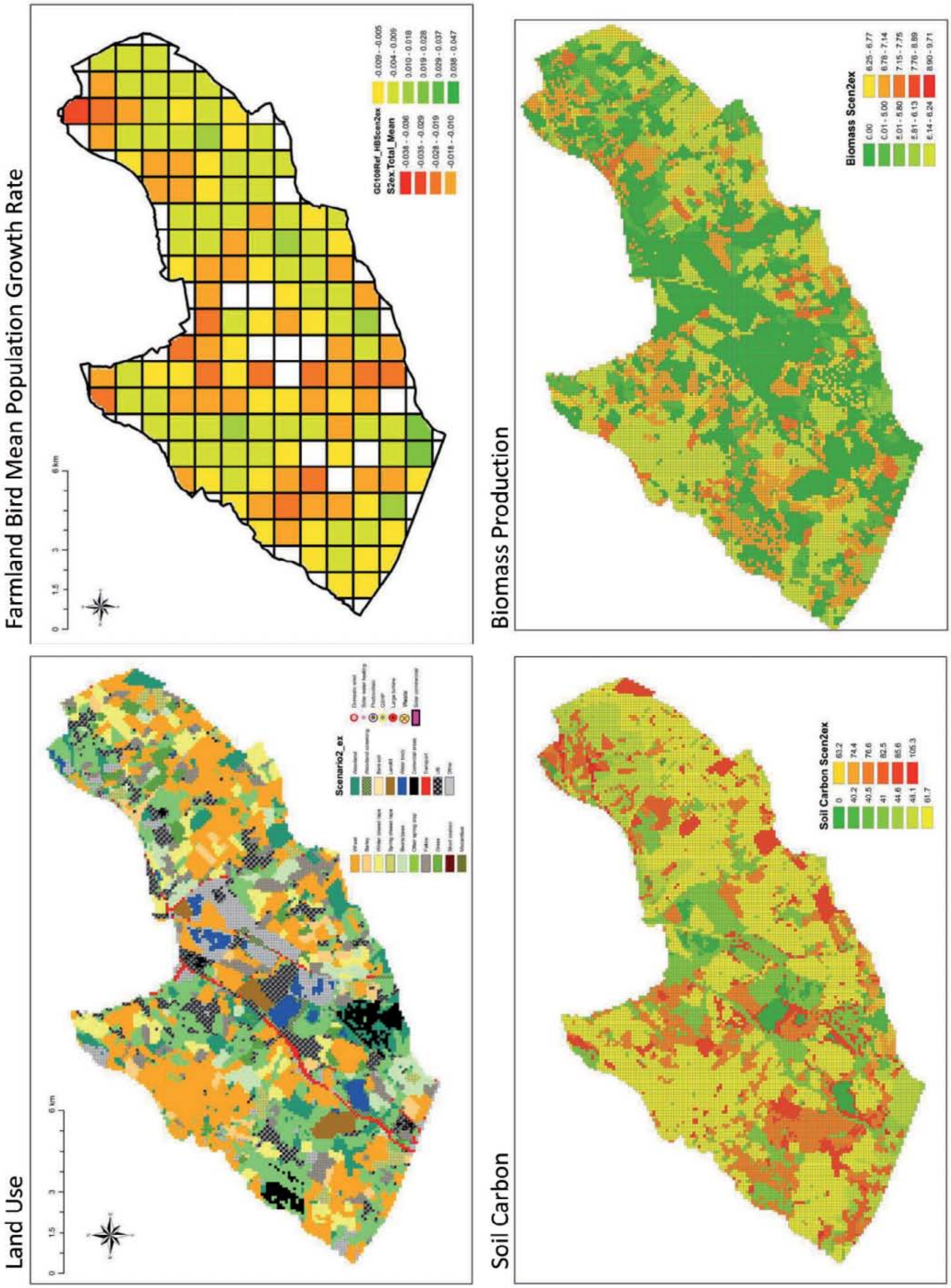
More recently we have extended the approaches for measuring landscape heterogeneity to consider local scale variability in landscape heterogeneity, which through spatial aggregation allows assessment at a range of spatial scales. These approaches are being applied in a current study assessing the impact of economic and policy-driven factors on land-use choices made by land-owners for agricultural land parcels, and the subsequent impact on landscape composition and hence biodiversity. Interest is in considering the relationships between environmental impacts and the economics associated with growing particular crops, potentially identifying the policy or economic incentives/penalties that are needed to encourage land-use choices to protect the wider environment while continuing to provide the food, fibre and fuel that society requires.

A recent project focussed on the introduction of sources of renewable energy into a landscape, combined these measures of local landscape heterogeneity with the spatial distribution of other ecosystem services within the landscape (see figures). This allows the assessment of the relationships among these different measures of land-use, and how these relationships change with different land-use decisions, in this case driven by demands to produce different quantities and types of renewable energy within the landscape.

An interesting challenge is how to combine habitat connectivity measures across multiple generic species, and how to combine measures of landscape heterogeneity and habitat connectivity to provide an overall assessment of the impact of different strategies for land-use change at a range of spatial scales.

[1]Dramstad, W. E., et al., 2001. Integrating landscape-based values – Norwegian monitoring of agricultural landscapes. Landscape and Urban Planning 57: 257-268

[2]Catchpole, R.D.G. (2007) England Habitat Network Information Note. Natural England.


Farmland Bird Mean Population Growth Rate
Biomass Production
Land Use
Soil Carbon

Typologies and adaptive co-management for cooperation and coordination in ecosystem services delivery

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Social research and stakeholders' participation are both crucial in the implementation process of ecosystem services. From a social perspective and based on a case study we present key drivers and barriers to the implementation of an ecosystem approach. We focus on biodiversity provision to show the spatial and temporal scale that many other ecosystem services imply as well as the interaction between humans and ecosystems. Landscape ecologists have proposed the ecological networks as a tool for biodiversity conservation[1] since habitat fragmentation and destruction are the principal causes of species extinction[2].

A focus on biodiversity conservation through the implementation of ecological networks (EN) allows to investigate the issues of cooperation and collaboration needed for any other ecosystem service at the landscape scale. This paper will present the results of a research on the hypothetical case of implementation of EN in the Dee valley, North East Scotland. The research took two approaches: 1) typologies of land managers as a tool for the study of land managers' attitudes to conservation, AES participation and existing cases of cooperation; and 2) exploring the potential of adaptive co-management (ACM) as a framework for the delivery of EN.

The results show that some typologies are a useful tool to identify land managers' preferences. In this study we found that the role of land ownership (land tenure) is one of the key variables that cluster views on conservation, motivation to participate in AES and patterns of land managers' cooperation. Adaptive co-management is a framework to link natural and social/cultural capital that allows putting in practice the ecosystem services. Although we did not find cases of ACM across the entire valley, we did find cases that echo ACM at smaller scales within the Dee catchment.

[1]Turner MG et al., 2001. Landscape Ecology in Theory and Practice: Pattern and Process. New York: Springer.

[2]Fischer J et al., 2007. Landscape modification and habitat fragmentation: a synthesis. Global Ecology and Biogeography 16: 265-280.

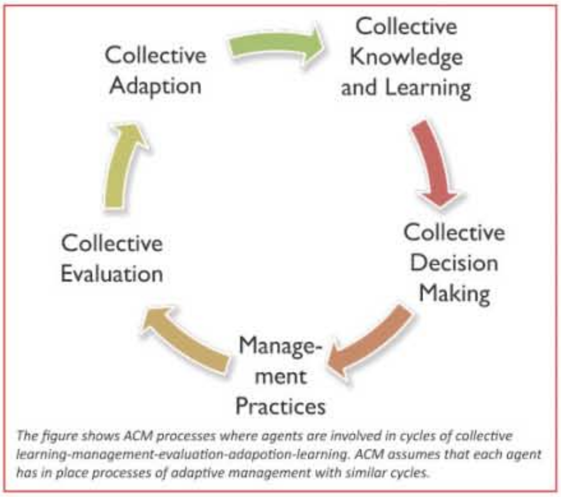

Figure 1 Feedback loops of 'adaptive collaborative management'.

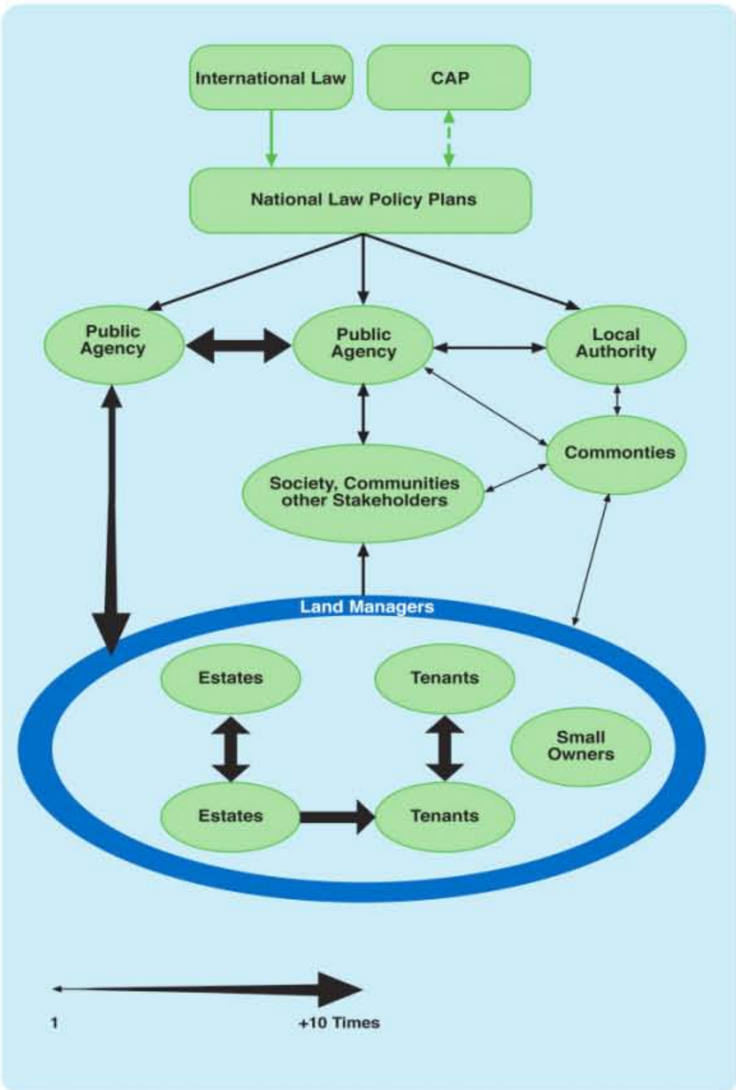

Figure 2. Recurrent symmetric and asymmetric relationships between and amongst groups of interviewees.