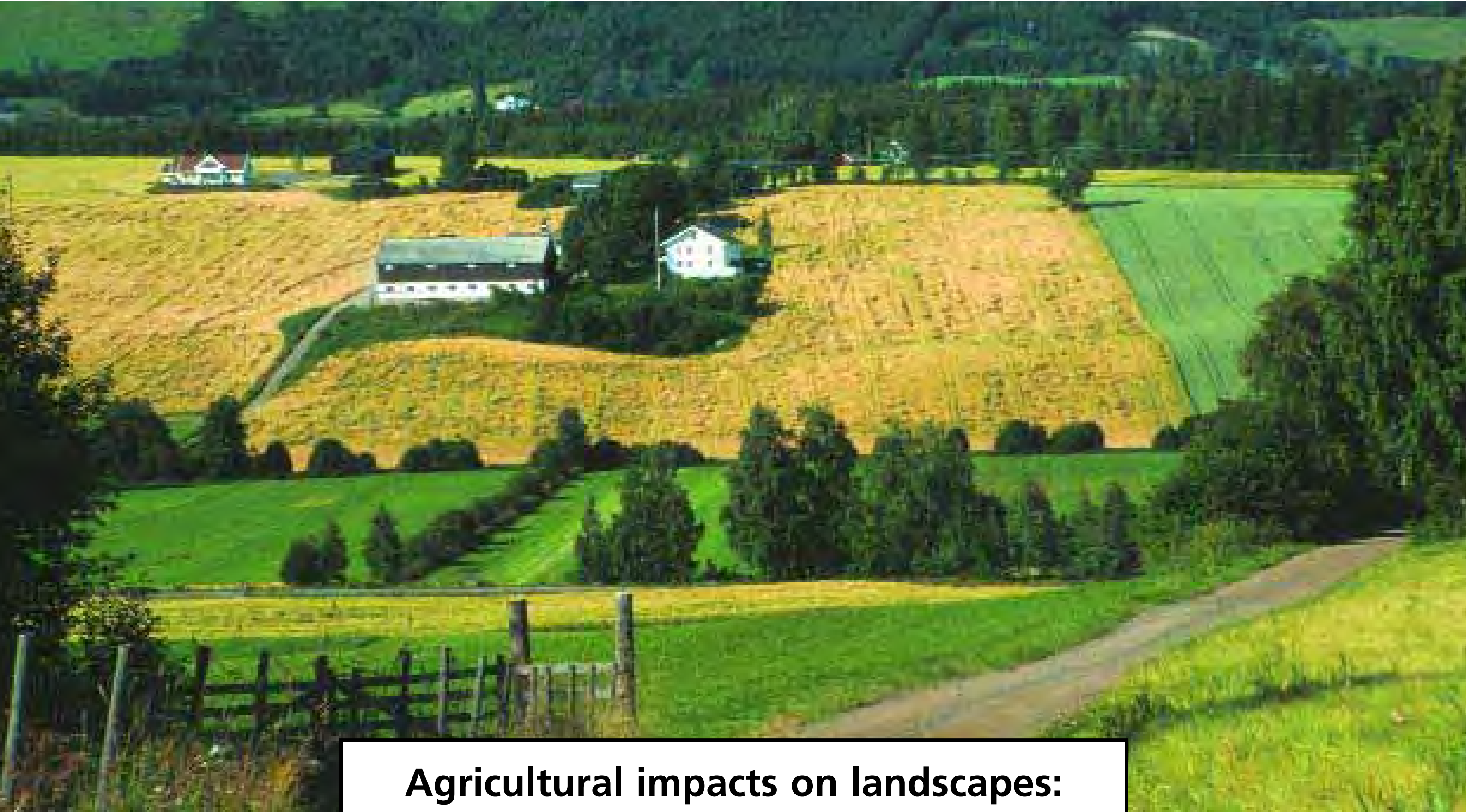

Agricultural impacts on landscapes: Developing indicators for policy analysis

NIJOS
Norwegian Institute of Land Inventory
NIJOS rapport 7/03

Agricultural impacts on landscapes: Developing indicators for policy analysis

Proceedings from NIJOS/OECD Expert Meeting on Agricultural Landscape Indicators in Oslo, Norway October 7-9, 2002.

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Utdrag: Denne rapporten inneholder de artikler som ble presentert på OECDs ekspertmøte i Oslo, 7.-9. oktober 2002, deltagerliste og de anbefalingene møtet kom frem til.
Tema for møtet var utviklingen av landskapsindikatorer, noe som følger opp OECDs arbeid med utviklingen av standardiserte indikatorer for bruk i internasjonal rapportering. I korte trekk anbefaler ekspertmøtet at interesserte OECD medlemsland vurderer å:

- *Investere i vitenskaplig forståelse og videreutvikling av et rammeverk for indikatorer for jordbrukslandskap, som representerer samspillet mellom landskapets struktur, funksjon og forvaltning,*
- *Bygge på eksisterende nasjonal og internasjonale erfaringer i overvåking, evaluering og scenarieutvikling,*
- *Oppmuntre samarbeid, utveksling av informasjon og integrering av metodikk,*
- *Bidra til, og samarbeide med, andre internasjonale initiativer relatert til utvikling av indikatorer for jordbrukslandskapet,*
- *Etablere et ekspert nettverk for å følge opp anbefalinger fra møtet.*

Abstract: This report contains all papers presented at the OECD Expert meeting in Oslo October 7th - 9th 2002, in addition to the list of participants. The topic of the meeting was the development of landscape indicators.
In brief, the Expert Meeting agreed that interested OECD Member countries should consider the following recommendations;

- *Invest in the scientific understanding and further development of an indicator framework for agricultural landscapes, representing the linkages between landscape structure, function and management,*
- *Build upon the existing national and international experiences in policy monitoring, evaluation and predictive scenarios,*
- *Encourage pro-active collaboration, information exchange and methodological integration,*
- *Contribute to, and cooperate with, other international initiatives related to developing agricultural landscape indicators,*
- *Establish an informal expert network to follow up recommendations of the meeting.*

Andre NIJOS publikasjoner fra prosjektet:
Dramstad, W. & Lågbu, R. 2000. "Landscape indicators - where to now", NIJOS document 8/00. Presented as a room document at the OECD JWP meeting, Paris July, 2000.

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Norsk institutt for jord- og skogkartlegging
Postboks 115, 1430 Ås
Tlf.: 64949700 Faks: 64949786
e-mail: nijos@nijos.no

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Appendix 1: List of participants

Foreword

The relationship with agriculture and landscape is a high priority in many OECD countries. Agriculture also plays a key role in shaping the landscape, especially as in most countries farming is the major user of land. In an international context agricultural landscapes are also attracting attention, for example, with the designation of cultural landscapes under the UNESCO World Heritage List in 1993, and the European Landscape Convention was signed in 2000. The challenge for policy makers, because landscapes are often not valued through markets, is to judge the appropriate provision of landscape and which landscape features society values and assess to what extent policy changes affect agricultural landscape.

Againgst this background some OECD countries are developing indicators as a tool to track the current state and trends in agricultural landscapes. In an effort to advance the work on policy relevant agricultural landscape indicators the Norwegian Institute of Land Inventory (NIJOS), on behalf of the Agricultural Ministry, hosted and organised an expert meeting to further develop agricultural landscape indicators. This meeting was part of the OECD work on developing a set of agri-environmental indicators. A number of OECD Member countries have hosted Expert Meetings on specific agri-environmental issues, and it was with great pleasure that the Norwegian Ministry of Agriculture could host an expert meeting

The meeting, held in Oslo, took place 7th-9th October 2002, and included a one-day field trip to se examples of some of the values associated with agricultural landscapes and consider the challenges look at some of the landscape values and their challenges and opportunities in the agricultural landscape around Oslo. It was attended by around 80 participants, drawn form 23 of the 30 OECD Member Countries in addition to one non-member nation. The meeting also involved several international organisations. Twenty-five different papers were presented at meeting. The countries that presented papers were; Australia, Austria, Belgium, Finland, France, Germany, Greece, Japan, Korea, Mexico, Norway, Portugal, Switzerland, United Kingdom, United States of America. All the meeting documentation, presented in this publication, in addition to other relevant information, is also available on the OECD website at: http://www.oecd.org/agr/env/indicators.htm

The Norwegian Ministry of Agriculture would like to thank the invited speakers, Dirk Washer (Landscape Europe), Joan Nassauer (University of Michigan), Ståle Naverud (Agricultural University of Norway) and Bärbel and Gunther Tress (Alterrea Green World Research) for their contributions. We would also like to thank all the countries that presented papers at the meeting, and a special thank you to participants who helped out as Chairs, Rapporteurs and Discussants. We could not have done this without you! Special thank you to Kevin Parris from the OECD secretariat for his helpful advice during the planning of the meeting, and for his participation in drawing out the key recommendations and conclusions from the presented papers during the meeting.

Finally we would like to express our appreciation for the work done by NIJOS, especially Wenche Dramstad who lead the planning and organisation of the meeting including the Norwegian presentations and the field trip. Our thanks also go to her colleagues Oscar Puschmann and Wendy Fjellstad in the planning and organisation of the meeting and to Christina Sogge for organising this report. Our appreciation also goes to Inger-Turid Jahr from the Norwegian Agricultural Extension Service who organised the practical arrangements for the meeting.

PREAMBLE FOR THE REPORT OF THE NIJOS/OECD EXPERT MEETING ON INDICATORS OF AGRICULTURAL IMPACTS ON LANDSCAPES, 2002

The attached report is a summary of the conclusions and recommendations reached by the experts who participated in the joint Norwegian Institute of Land Inventory (NIJOS) and OECD Expert Meeting on Indicators of Agricultural Impacts on Landscapes, held in Oslo, Norway, 7-9 October, 2002, under the auspices of the OECD Joint Working Party on Agriculture and Environment (JWP) and hosted by the (NIJOS), on behalf of the Norwegian Ministry of Agriculture. The JWP in December 2002 agreed that the conclusions and recommendations of the experts should be made available to the wider public as a contribution to the national and international efforts to establish landscape indicators, as part of the development of agri-environmental indicators.

The conclusions and recommendations are those of the participants and do not necessarily reflect the views of the OECD, the JWP or its Member Countries.

The OECD undertakes analysis of agri-environmental policy issues within the JWP. As part of that work, the JWP is developing a set of agri-environmental indicators to measure the environmental performance of agriculture by:

1. providing information to policy makers and the wider public on the current state and changes in the conditions of the environment in agriculture;

2. assisting policy makers to better understand the linkages between the causes and impacts of agriculture, agricultural policy reform, trade liberalisation and environmental measures on the environment, and help to guide their responses to changes in environmental conditions; and,

3. contributing to monitoring and evaluating the effectiveness of policies addressing agri-environmental concerns and promoting sustainable agriculture and natural resource management.

The JWP has identified a number of criteria that agri-environmental indicators need to meet, including:

- *policy relevance* in addressing the key environmental issues faced by governments and other stakeholders in the agricultural sector;

- *analytical soundness* being based on sound science but recognising that their development is an evolving process;

- *measurability* in terms of data availability and cost effectiveness of data collection; and,

- *interpretation* in that the indicators should communicate essential information to policy makers and the wider public in a way that is clear and easy to understand.

In order to help establish policy relevant indicators, a number of OECD Member countries have hosted Expert Meetings on specific agri-environmental issues, in particular, to further develop two of the criteria: analytical soundness and the measurability of indicators. The Expert Meeting on Indicators of Agricultural Impacts on Landscapes, hosted by Norway, was one of the series of these Expert Meetings, and the meeting papers and other related information are available on the OECD website at: http://www1.oecd.org/agr/landscape/index.htm

SUMMARY OF DISCUSSION AND RECOMMENDATIONS

1. MAIN RECOMMENDATIONS

To progress in the understanding and use of agricultural landscape indicators, the Expert Meeting agreed that interested OECD Member countries should consider the following recommendations:

i) Invest in the scientific understanding and further development of an indicator framework for agricultural landscapes representing the linkages between landscape structure, function and management, in order to identify relevant indicators that meet the OECD indicator criteria of policy relevance, analytical soundness, measurability, and ease of interpretation.

ii) Build upon the existing national and international experiences in policy monitoring, evaluation and predictive scenarios when developing agricultural landscape indicators to increase their policy effectiveness, especially when measured against locally, regionally and nationally defined targets for agricultural landscape conservation.

iii) Encourage pro-active collaboration, information exchange and methodological integration between countries and international organisations that have an interest in the development and application of landscape indicators to ensure data compatibility and explore the possibilities of an internationally feasible set of agricultural landscape indicators.

iv) Contribute to, and cooperate with, other international initiatives related to developing agricultural landscape indicators, and continue working in order to promote consistency among OECD countries, and also to share the information and results among OECD Member countries and non-Member countries.

v) Establish an informal expert network, to facilitate the above recommendations (iii) and (iv) and provide the OECD, when available and where relevant, with a set of agricultural landscape indicators that allow to monitor the performance of agriculture and its effects on landscape appearance, function and value and which are linked to actions by farmers and the impacts of agricultural policy.

2. BACKGROUND

The joint Norwegian Institute of Land Inventory (NIJOS) and OECD Expert Meeting on Indicators of Agricultural Impacts on Landscapes was convened to contribute and build on the work in the OECD to develop a set of Agri-Environmental Indicators (AEIs), as one of the “regional” indicators (*i.e.* indicators that are developed by an interested regional group of OECD countries, in contrast to “core” indicators developed by all OECD countries). The meeting was hosted by the NIJOS on behalf of the Norwegian Ministry of Agriculture and was a follow-up of the Norwegian Authority’s role as a lead country on landscape indicators. The meeting was attended by around 80 participants, drawn from 23 of the 30 OECD Member Countries, one non-Member nation and many international organisations.

This summary and recommendations from the meeting includes information drawn from the meeting papers, reports of the Rapporteurs and Discussants and the meeting discussion. *The Agenda, all 25 papers presented at the meeting, including the list of participants, web links and country reports, are also available on the OECD website at:* http://www1.oecd.org/agr/landscape/index.htm

3. SUMMARY OF DISCUSSION

3.1 The Agricultural Landscape Indicator framework

There was wide recognition that there are clear linkages between agricultural policies and practices on the one hand and landscape structures, functions and values on the other hand. A sound understanding of these linkages is considered to form the basis for developing landscape indicators and using them for the assessment of the state and trends of agricultural landscapes. Further, experts agreed that the landscape indicator framework presented in Figure 1 represent the methodological and strategic considerations that have been discussed during the meeting.

While identifying the key elements within an agricultural landscape and relating them to each other, the framework provides in addition an overall context in which to structure and organise national (and sub-national) indicators of agricultural landscapes. The framework points to the many facets of landscape, in particular, its structure, function and value. During the presentations and discussions, it was apparent that various nations have emphasised different aspects of the framework in their work to develop landscape indicators. This diversity of approaches presents both a challenge as well as a rich source for future collaboration.

The meeting recognised that much progress is being made within and between OECD Member states, especially regarding co-operation and interdisciplinary approaches, for better understanding processes in agricultural landscapes and for developing related indicators. Accordingly, the presentations demonstrated a wide range of assessment techniques and landscape specific issues with the identified aim of developing landscape indicators. In addition, the meeting recognised that there exists multiple possibilities to draw on the OECD core set of agri-environmental indicators to develop landscape indicators, in particular, with biodiversity indicators (see Figure 1).

There was a general consensus, that certain key aspects of agricultural landscapes, impacted by agricultural policies, require special attention. The experts agreed that there should be a differentiation *between landscape character* and *landscape appearance*. While the concept of landscape character – as a result of both natural and cultural processes –in essence can offer a neutral, descriptive main frame for identifying the major typological differences between landscapes, landscape appearance is considered to be a variable expression of what is being frequently altered, managed or produced by agricultural activities.

Though several countries have advanced with the development of landscape character assessments and many methodologies are in place to assess the state and trends in landscape appearance, no generally accepted definition exists of the term. Establishing such a definition represents a challenge that cannot be met at the purely national level, but which requires international cooperation at various levels – *e.g.* in research and policy development.

There was a general recognition, however, that there are a number of critical elements that contribute to *agricultural landscape appearance*, including:

- ***Physical structure and composition of landscapes***: the various landscape elements present in a landscape and how they are organised is probably the issue currently receiving most attention in terms of monitoring. This is largely due to data availability and to technological improvements that enable both easier data capture (particularly through use of remote sensing and sampling surveys) and the rapid calculation of a wide array of indices.

- ***Landscape aesthetics***: several countries are taking steps towards identifying agricultural landscape aesthetics, but this is an issue where effort is needed to standardise methods. There was general acceptance that the aesthetics of an agricultural landscape is of importance to many stakeholders, including local residents and farmers, as well as to tourists, and an issue where policies can have a pronounced influence in changing the aesthetics of agricultural landscapes. It was noted, however, that aesthetic values or standards will vary from one location to another and that there may be differences between stakeholders aesthetic preferences, making it difficult to capture in an indicator framework.

- ***Cultural heritage***: while there are varying approaches to produce indicators covering cultural landscape, the meeting suggested the concept of landscape "time depth" (indicating the number of different historical/cultural layers present in the landscape) as something for further consideration.

- ***Demand for landscapes***: as the demand for landscape varies between different stakeholders, it will be important to identify societal landscape demand and preferences in order to enable informed decision-making in terms of landscape provision but reconciling varying societal preferences for agricultural landscapes will present a major challenge for policy makers.

3.2 Areas critical to the development of policy relevant agricultural landscape indicators

Four areas were discussed as of importance in the development of agricultural landscape indicators:

1. Policy context
2. Scale
3. Indicators
4. Supporting data

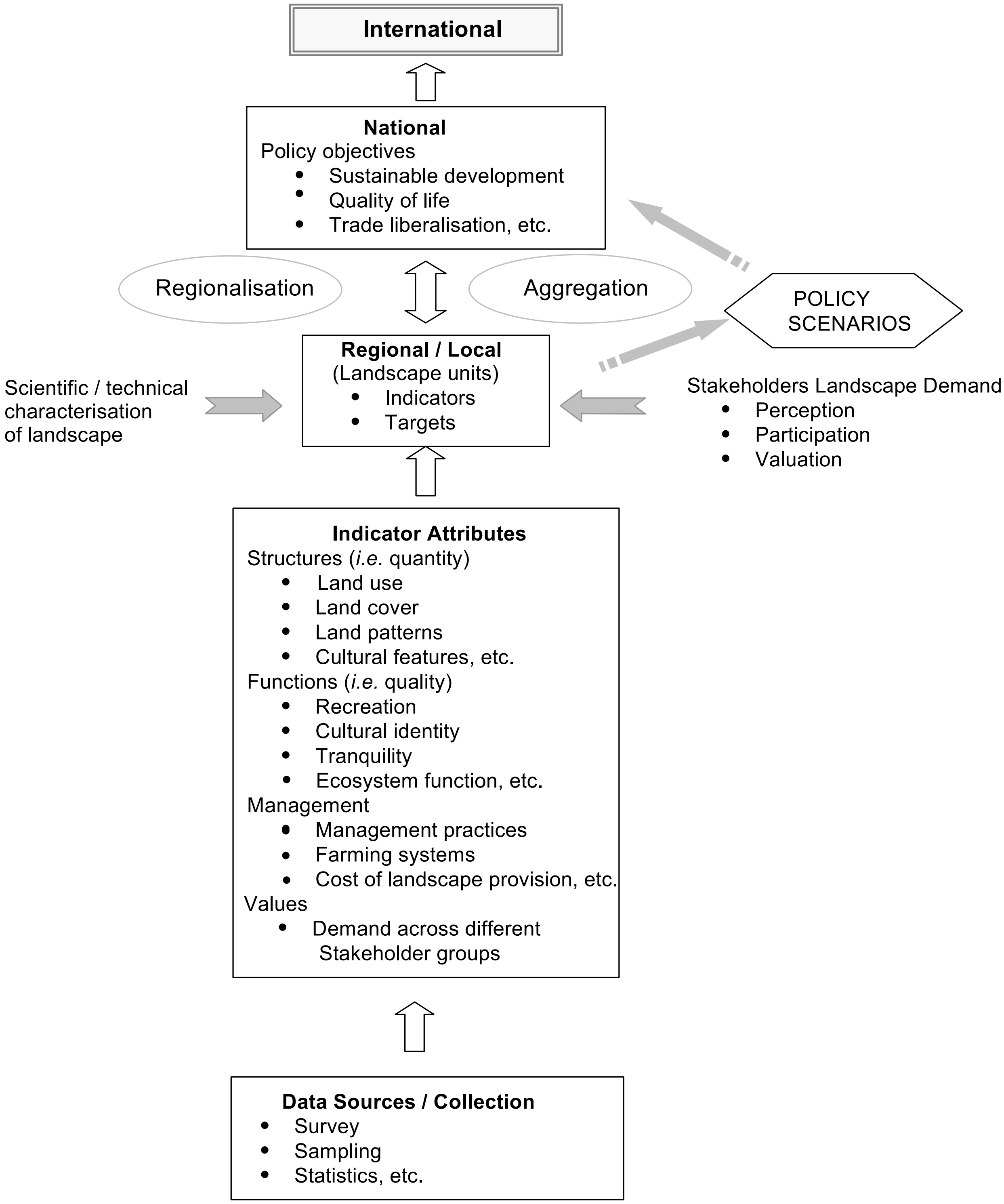
3.2.1 Policy context

Concerning the benefits for policy makers of developing agricultural landscape indicators, the meeting recognised two points:

- ***Landscape indicator development is an iterative process between various players at the regional, national and international level, and between different conceptual entities***. On one hand, developing landscape indicators can help inform the policy making process of landscape patterns and processes that are important considerations for policy (*e.g.* landscapes of high public value). On the other hand the policy making process can inform which landscape indicators are important to develop (*e.g.* expenditure on landscape protection).

- ***Possibilities exist to use indicators in policy scenario and trend analysis***. These techniques will help in understand and communicate what will happen, or has happened, to landscapes under different policy settings, thereby better informing policy makers as well as other stakeholders of the consequences of past or future policy actions.

Figure 1. OECD Agri-La ndscape Indicators Framework



Source: NIJOS/OECD, 2002.

In addition, if trends in landscape indicators are to be assessed it will be important to track progress against specified policy targets related to landscape conservation. At present few OECD Member countries or regions within countries, have clearly defined targets for landscape conservation. Indicators have a major role to play in the development of 'evidence based' policy decisions, which is an increasingly important issue as policy makers are held accountable for their actions.

3.2.2 Scale

Many contributions to the discussion outlined the importance of being aware of the various scales at which landscape indicators may be relevant as a tool in monitoring and analysing policy, *i.e.* at local, regional, national and international level. The issue of regional differences within countries was raised on many occasions during the meeting, especially in relation to the difficulty of developing a national average landscape indicator. In this respect it was suggested that the most appropriate expression for reporting landscape indicators nationally may be the proportion of regions within a country that had documented either positive or negative change, *i.e.* regions (or localities within regions) where landscapes were considered to be improving or deteriorating.

3.2.3 Indicator areas

Following the landscape framework (Figure 1) the meeting recognised the need for four agricultural landscape indicators areas shown in Table 1.

Table 1. Agricultural landscape indicators areas

Structures (*i.e.* quantity)	Functions (*i.e.* quality)	Management	Value
• Land use • Land cover • Land patterns • Cultural features	• Recreation • Cultural identity • Tranquillity • Ecosystem function	• Farm management practices • Farming systems • Cost of landscape provision	• Demand across different stakeholder groups

Source: NIJOS/OECD, 2002.

It was apparent during the meeting that although the scope of work on developing landscape indicators has been enlarged, there is still a skewed distribution in terms of indicators developed, with the current emphasis on landscape structure indicators. It is important that a set of indicators focusing on agricultural landscape appearance should be able to detect and be suitable for reporting changing trends. To ensure this, the selected suite of indicators will need to be tested thoroughly under a wide range of conditions and across a range of landscapes. It is also worth considering that past changes may not resemble future changes. Focusing solely on indicators that capture current and previous trends of agricultural landscape change may therefore be a too narrow approach. During the meeting it became clear that scenarios for testing landscape indicators for projection of future scenarios holds considerable potential.

3.2.4 Supporting Data

Marked differences exist between OECD Member countries when it comes to data gathering activities, in terms of surveying or sampling landscapes, or collection of statistical data with clear landscape relevance.

There are also differences in respect to access to data that could be used in landscape indicator development or calculation, *e.g.* remote sensing data or agricultural statistical surveys. The recent establishment of sample based monitoring programmes in some countries, collecting land cover/use information related to agricultural landscapes, as well as the longer established mapping efforts in other countries holds promise in the future for the availability of wide ranging compatible datasets.

4. RECOMMENDATIONS

4.1 Organising future work

In organising future work on agricultural landscape indicators the key recommendation of the meeting was to form a voluntary group of interested OECD Member countries that would further develop agricultural landscape indicators, and share their experiences of this work with other countries through the JWP. The meeting recommended that the voluntary group might wish to focus its work on three themes:

- Using indicators as a tool in different policy scenarios.
- Clarifying how to interpret indicators, including linking them to targets.
- Sharing experiences and identifying points of common interest in developing agricultural landscape indicators.

In sharing experiences in developing agricultural landscape indicators, a number of key points were raised during the discussion, including the need to focus on:

- characterisation of landscape and landscape functions;
- survey and data conventions;
- cultural heritage attributes;
- visual attributes;
- valuation and landscape demand;
- linking landscape structure, function, management and value; and,
- development of indicators across different scales from local to national, including policy targets against which to evaluate indicator trends.

The OECD work on related agri-environmental indicators, especially in the areas of land use and cover, biodiversity and farm management, would provide a valuable input into the work on agricultural landscape indicators. A great interest was expressed during the meeting to continue the work on landscape indicators and it was apparent from the discussions, that substantial work is being conducted on a national, and to some extent regional, level. The work on landscape indicators, however, is impeded, to some extent, by its fragmented nature. Hence, it would be efficient if those countries which already have monitoring systems and are further developing their landscape indicators could share their experiences with other countries.

4.2. Recommended Indicators of Agricultural Impacts on Landscapes

Indicators covering a wide range of topics related to landscape were presented at the meeting, and several of these have potential as tools both as descriptors of state, but equally important as tools for recognising, documenting and reporting agricultural landscape change. Where local/regional landscape targets have been defined, the national level landscape indicator could be expressed in terms of the percentage of regions or sub-regions that meet their own targets.

4.2.1 Indicators of Agricultural Landscape Structures

Based on country experiences, the expert meeting recommend four indicators as an expression of agricultural landscape structure:

- Land use (*e.g.* stock and changes in agricultural land)
- Land cover (*e.g.* changes in the openness or closeness of the landscape)
- Land patterns (*e.g.* changes in the heterogeneity/homogeneity of landscapes)
- Cultural features (*e.g.* linear elements such as hedges)

These indicators can be considered complementary, in that changes in the use of agricultural with other land uses (*e.g.* forestry) changes the total stock of agricultural landscapes, while changes in land cover and patterns and cultural features will alter the visual appearance of the landscape. All these aspects may either independently or in combination capture present and future trends in agricultural landscape change.

4.2.2 Indicators of Agricultural Landscape Functions

The indicators recommended by the experts to express agricultural landscape function are:

- Recreation
- Cultural identity
- Tranquillity
- Ecosystem functions

Recreation can be measured through the change in accessibility within agricultural landscapes, and is a function that agricultural landscapes have the potential to fulfil, but is rarely the focus in the development of agricultural landscapes. The importance of providing and securing the *cultural identity,* is also receiving increased attention in many regions as something of interest to tourism and marketing of local products.

Indicators of *tranquillity*, have received attention in some countries. Tranquillity is a human perception value relating to degree of intrusive development, including traffic, noise, odour, lighting and built development. Tranquillity, as well as recreation and cultural identity, is a function that is closely linked to agricultural management and therefore strongly influenced by changes in agricultural policy or management, such as the creation of large intensive livestock units. *Ecosystem functions* are recognised as important functions provided by agricultural landscapes, but the topic is captured within other agri-environmental indicators, such as biodiversity and soil organic carbon.

4.2.3 Indicators of Agricultural Landscape Management

Another function that in many countries has received an increased focus recently is management of cultural heritage within agricultural landscapes. This may be both cultural heritage with a strong link to agriculture, as well as cultural heritage which only happens to be located within agricultural landscapes. While the meeting discussed several examples underlining the importance of agricultural landscape management in the conservation of agricultural landscapes, the topic was not discussed in depth as it is being considered in the context of the farm management group of indicators.

4.2.4 Indicators of Agricultural Landscape Values

This is probably the topic least well developed at present, although as presentations at the meeting showed there seem to be considerable potential for indicator development here. A range of different methods to evaluate agricultural landscapes and services are currently under development. It was outlined at the meeting that while there are methods available that hold a great potential for aiding policy makers, the main obstacle at present to increased policy use of landscape amenity values include methodological issues and the need for further pilot studies in different countries and landscapes.

Agricultural Landscape Indicators in the Context of the OECD Work on Agri-environmental Indicators

Kevin Parris
Policies and Environment Division,
Directorate for Food, Agriculture and Fisheries,
Organisation for Economic Co-operation and Development (OECD)
2 rue André Pascal, 75775 Paris Cedex 16, France
Email: kevin.parris@oecd.org
Tel.: (33) 1 45.24.95.68

Abstract

This paper provides an introductory background to the joint Norwegian Institute of Land Inventory (NIJOS) OECD Expert Meeting on Agricultural Landscape indicators, by addressing six questions:
1. What is the OECD and the OECD Joint Working Party on Agriculture and the Environment? 2. What is the policy background to OECD work on agriculture and the environment? 3. Why and how is OECD developing work on agri-environmental indicators? 4. What is the coverage of the OECD agri-environmental indicators? 5. What has been the progress in developing OECD agricultural landscape indicators? 6. What are the key objectives for this Expert Meeting?

Keywords: agri-environmental indicators, agricultural landscape indicators, OECD, policy

1. What is the OECD and the OECD Joint Working Party on Agriculture and the Environment?

The Organisation for Economic Co-operation and Development (OECD), an intergovernmental Organisation, comprises 30 democratic nations with advanced market economies (see www.oecd.org). It was founded in 1960 with the basic aim of promoting policies to:

- achieve the highest sustainable economic growth and employment of its Members;
- contribute to economic and social welfare throughout the OECD area by facilitating policy dialogue among its Member countries;
- stimulate and harmonise its Members' efforts in favour of developing countries; and
- contribute to the expansion of world trade on a multilateral, non-discriminatory basis.

The scope of the work carried out by the OECD is broad, covering such diverse areas as economic policy, environment, energy, social affairs, financial, fiscal and enterprise affairs, science technology and industry, trade, development and public management. Principal aspects of OECD work include:

- diagnosing the current situation and monitoring trends;
- facilitating discussions among countries and searching for common solutions;
- collecting and analysing data; and
- co-ordinating and harmonising national policies.

The OECD work related to agriculture and the environment has been carried out since 1993 under the *Joint Working Party on Agriculture and the Environment* (JWP). The overall objective of this work is to identify ways in which governments might design and implement policies and promote market solutions to achieve environmentally and economically sustainable agriculture at minimal resource cost to the economy and with least trade distortions.

The JWP's work is undertaken against the background of increasing concern in OECD countries about the effects of agricultural activities and policies on the environment. Agriculture's impact on the environment — whether harmful or beneficial — has become an important consideration in designing new agricultural and environmental policies, modifying existing support programmes, and evaluating agricultural projects (OECD, 2001a).

The achievement of sustainable forms of agricultural production is now widely recognised by governments as a long-term policy objective in agriculture, and many countries are developing sustainable agricultural strategies as part of their national environmental plans.

Global environmental changes and economic activities in other sectors also impact on agriculture. In particular, changes in regulations for food quality and safety, developments in biotechnology and the evolution of animal welfare legislation can have important effects on agriculture and the food industries.

In this changing policy environment, there is a need for a better understanding of the environmental effects of agricultural support, policy reform and freer trade. This concerns primarily the effects of agricultural policies on the environment, but it also applies to the impacts of environmental policies on agriculture, especially as the number of environmental measures affecting agriculture increases. The work in the OECD constitutes an effort to address these issues with a view to improve policy design and implementation, and to facilitate policy coherence between agriculture and the environment.

Since its creation in 1993, the JWP has established a sound working foundation. In particular, it has:

- identify the policy-relevant concepts and issues;
- initiate an exchange of information and policy experiences among OECD countries;
- develop agri-environmental indicators to support policy analysis; and
- examine and begun to evaluate agricultural and agri-environmental policy measures in OECD countries.

2. What is the policy background to OECD work on agriculture and the environment?

Changes in policy settings are a key influence on the environmental performance of agriculture. With the greater public and policy focus on agri-environmental issues emerging over the 1990s, this trend is likely to continue with implications for agriculture and the environment because governments can be expected to:

- reform agricultural policies, especially the level and composition of support;
- further develop agri-environmental measures; and,
- strengthen environmental policies both domestically and multilaterally.

The reform of agricultural policies, by reducing the overall level and composition of agricultural support (currently at US$330 billion for OECD countries 1999–2001, see OECD, 2002), should improve the domestic and international allocation of resources, reduce incentives to use polluting chemical inputs and to farm fragile land.

Such reforms will tend to reverse the harmful environmental impacts associated with commodity and input specific policy measures, including damage to agricultural landscapes. In those cases where environmental effects, both harmful and beneficial, are not taken into account by farmers policy reform may not improve environmental quality, therefore, targeted environmental measures might also be needed (OECD, 2001a).

As part of the agricultural policy reform process many OECD countries started to introduce ***agri-environmental measures,*** beginning around the late 1980s. While the nature of these measures varies across countries, they have mainly focused on altering those farm management practices, sometimes encouraged by high price support levels, incompatible with achieving environmental objectives. These measures include the provision of payments, such as those for the adoption of low-input farming systems and landscape conservation, which at present represent under 10% of total OECD agricultural support (OECD, 2001a).

A few countries have also used taxes to limit the pollution from the use of pesticides and fertilisers, and enforced restrictions on farmers to meet certain minimum standards, such as the disposal of animal waste into watercourses. Also, land diversion schemes, although in most cases originally introduced to achieve supply control objectives, are increasingly including environmental conditions, such as diverting land for habitat use to encourage wildlife and to help reduce soil erosion. A number of countries also use voluntary efforts, including farm advisory services, to address local and community related environmental issues, and raising environmental awareness amongst farmers.

While evidence is still limited, the introduction of agri-environmental measures have helped to alter farm management practices and change land use patterns. These changes have contributed to, for example, the conservation of habitats and the reduction of diffuse pollution. But there is at present insufficient information in many cases to be sure about the extent and permanence of these changes across OECD countries. In some cases improvements have been made, but have been more costly than would have been the case in the absence of production enhancing policies. Also, adverse environmental impacts still remain at relatively high and damaging levels in many cases (OECD, 2001b).

Future ***domestic environmental measures and multilateral environmental agreements*** may also have a greater influence on agriculture mainly because:

1. Progress in reducing ***environmental pollution*** from industrial and household waste has shifted the focus to agriculture as the share of agriculture in total emission loadings for certain pollutants, especially nitrates and phosphates, has been rising.
2. Given that agriculture is the major user of land and water for most OECD countries, environmental policies that address ***resource depletion issues***, and biodiversity, habitat and landscape concerns, inevitably involve agriculture.
3. There are an increasing number of ***multilateral environmental agreements*** with implications for agriculture, some operating regionally (e.g. European Landscape Convention), and others globally (e.g. the Convention on Biological Diversity.

3. Why and how is OECD developing work on agri-environmental indicators?

The key role of agriculture now and in the future is the supply of an adequate and safe supply of food at ‘reasonable’ prices. Over the past 40 years while world population has nearly doubled, food prices have dropped substantially in real terms and food production per capita has increased by nearly 25%. These developm ents have been possible through farmers, scientists and agricultural research investment raising crop yields and livestock productivity and improving farm management practices. The productivity improvements for agriculture have also been achieved through using less labour, inputs and land.

There are concerns, however, that the scale of agricultural expansion is going to place greater pressure on the environment over the coming decades if it is to meet the 1.5 billion growth in the global population expected by 2020. Some consider that current farming practices are leading to the degradation and depletion of the natural resource base upon which farming depends, namely soils, water, natural plant and animal resources (OECD, 2001c).

But others see agriculture launching into a new era of expansion and growth through the 21st century. This scenario sees a continuation of improvements in farm management practices, advances in biotechnology and the revolution in information and communication technologies. Also the process of trade liberalisation and globalisation of the agro-food chain will provide the basis for the investment and continued future growth of agriculture on an environmentally sustainable path.

Understanding the environmental impacts of agriculture requires information on the relationship between agriculture and the environment. Recent OECD meetings of agriculture and environment ministers have emphasised the importance of examining agricultural and environmental policy issues supported by indicators and better information. Against this background OECD has been developing a set of agri-environmental indicators (see OECD 1997; 1999; and 2001b), which aim to provide:

- information of changes in environmental conditions in agriculture; and,
- a tool to help policy makers and other stakeholders in the monitoring and evaluation of the impacts of policies on environmental conditions in agriculture and in future looking scenarios, to improve policy effectiveness in promoting sustainable agriculture.

It is evident from a wide range of activities, now underway both locally, nationally and internationally, that a considerable effort is taking place to provide analysis and develop a set of indicators to help answer and respond to a broad range of questions (OECD, 2001b), including:

- What is the environmental impact of reducing subsidies to the agriculture sector?
- What are the environmental impacts of alternative agricultural policy instruments, such as direct payments versus market price support?
- What are the environmental impacts of extending current policies into the future?
- What are the economic implications for the agriculture sector of meeting environmental targets, such as those set out in international agreements?

In order to help select and develop appropriate indicators to monitor sustainable agriculture, work undertaken by OECD on agri-environmental indicators (AEIs) has suggested that they should possess a number of attributes (OECD, 1997). This implies that indicators must be:

- ***policy-relevant***, that is they should be demand (issue) rather than supply (data) driven, and address the environmental issues faced by governments and others in the agriculture sector;
- ***analytically sound***, based on sound science, but recognising that their development involves successive stages of improvement;
- ***measurable***, that is feasible in terms of current or planned data availability and cost effective in terms of data collection, processing and dissemination; and,
- ***easy to interpret*** and communicate essential information to policy makers and other stakeholders.

The work of the JWP in establishing a set of AEIs is being principally developed through drawing on Member country expertise, i.e. Ministries of Agriculture and Environment, and related centres of research. In addition, OECD is actively involved in the cooperation with other international organisations, ranging from intergovernmental organisations, e.g. the FAO, UNEP and World Bank; to those that represent environmentalists, e.g. IUCN, WWF, Birdlife International, Wetlands International; farmers, e.g. the IFAP; and the agro-food chain, e.g. Unilever, fertiliser and pesticide manufacturers. Much of the work on the OECD set of AEIs is intended for use by national level policy makers, including those representing regional (sub-national) governments. This implies that indicators are mainly expressed as national average values, but where possible the regional variation around the national average value is also being calculated.

4. What is the coverage of the OECD agri-environmental indicators?

Within the context of the OECD Driving force–State–Response framework (OECD, 1997), and building on previous OECD work on indicators (OECD, 2001b; 1999) this has led to considerable progress in both the identification and specification of policy-relevant indicators as listed in Figure 1. In summary, the indicators are being developed in terms of agriculture's role in:

1. ***Protecting the stock of natural resources impacted by agriculture*:** Agriculture plays a critical role in the protection (or depletion) of the stock of natural resources used for production, notably soil and water resources, because for most OECD countries agriculture accounts for the major share in the use of these resources. Farming activities also impact on the quality and quantity of natural plant and animal resources (i.e. biodiversity) and landscapes, both on and off-farm.

2. ***Reducing environmental emissions from agriculture***: Flows of materials into water (e.g. nutrients, pesticides) and emissions into the air/atmosphere (e.g. ammonia, greenhouse gases) are an inevitable part of agricultural production systems. Reducing the flows of these materials and emissions to an 'acceptable' level of risk in terms of human and environmental health is a priority for policy.
3. ***Improving agri-environmental management practices and resource use efficiency***: The quantity of agricultural production is affected by the financial resources available to agriculture (both returns from the market and government support), the incentives and disincentives facing farming, and the kinds of management practices and technologies adopted by farmers. These practices and technologies impact on the productivity of the natural resources (e.g. soil) and purchased inputs (e.g. fertilisers) used by farmers. Depending on the management and productivity of agriculture's use of resources and inputs this will affect the rate of depletion and degradation of soils and water; the flows of harmful emissions into soils, water, air and the atmosphere; and the quantity and quality of plant and animal resources and landscape features.

5. What has been the progress in developing OECD agricultural landscape indicators?

Agricultural landscapes, despite their variety at local, regional, and national levels, can be described in terms of a number of key elements that are relevant to any agricultural landscape (OECD, 2001b):

- ***structure*** *(appearance):* the interaction and relationship between various environmental features (e.g. flora, fauna, habitats and ecosystems), land use patterns and distributions (e.g. crop types and systems of cultivation), and man-made objects (e.g. hedges, farm buildings);

- ***function***: the provision of landscapes functions for farmers and rural communities as a place to live and work, for society at large as a place to visit and space for the enjoyment of various recreational activities, and also the function of landscape in providing various environmental services, such as the provision of biodiversity and ecosystems;
- ***value***: concerning both the value society places on agricultural landscape, such as recreational, cultural, and other amenity values associated with landscape, and also, the costs of maintaining and enhancing landscape provision by agriculture.

There is no unique way in which the various structures and functions of landscapes can be defined, classified and then valued. This will to a large extent depend on who is viewing and using the landscape. Hence, the urban public tends to value the landscape from a general aesthetic, recreational and cultural perspective. The ecologist perceives landscape as primarily a provider of biodiversity and habitats, while farmers, rural communities and ultimately consumers, are interested in, or at least benefit from, the economic value of a landscape related to the production of agricultural commodities and as a place to live and work.

Figure 1. The Current Set of OECD Agri-Environmental Indicators[1]

I. Stock of Natural Resources Impacted by Agriculture

1. **Land Use**: land use changes between agriculture and other land uses, and land use changes between different agricultural uses.
2. **Soil Resources**: soil erosion (both on-farm and off-farm effects), soil organic carbon and soil biodiversity.
3. **Water resources**: total agricultural water use, and groundwater use and recharge.
4. **Biodiversity**: genetic, species and ecosystems levels (including habitats on agricultural land which provide both an ecosystem and landscape role, such as hedges).

II. Environmental Emissions from Agriculture

Water emissions

5. **Nutrient Balances**: nitrogen and phosphorus balances.
6. **Pesticide Use and Risks**: aquatic, territorial and human health risks.
7. **Water Quality**: risk and state indicators of agriculture's impact on water quality.

Air emissions

8. **Ammonia Emissions**

Atmospheric emissions - Climate Change

9. **Agricultural Energy Balance and Greenhouse Gas Emissions**

III. Farm Management Practices and Resource Use Efficiency

10. **Resource Use Efficiency**
11. **Farm Management** (nutrient, pest, soil, water, biodiversity and whole farm management)

[1] *Note and Source*: For a full list and definitions of OECD agri-environmental indicators see OECD (2001b).

Many OECD countries have legislation which recognises the importance of societal values embodied in landscapes and internationally some are also attracting attention, such as the designation by UNESCO of cultural landscape sites. The challenge for policy makers, because landscapes are often not valued, is to judge the appropriate provision of landscape and which landscape features society values, and assess to what extent policy changes affect agricultural landscape.

The current set of OECD agricultural landscape indicators provide a tool to better inform policy makers by: recording the current state of landscape and how its appearance, including cultural features, is changing; establishing what share of agricultural land is under public/private schemes for landscape conservation; and measuring the cost of landscape provision by farmers and the value society attaches to landscapes. This Expert Meeting seeks to further develop these indicators (see section 6 below).

Regarding the *current state and trends in the structure of agricultural landscapes* there does seem to have been a trend towards increasing homogenisation of landscape structures in OECD countries over the past 50 years, including the loss of some cultural features (e.g. stone walls). This trend appears closely related to the structural changes and intensification of production, linked with the degradation of the natural resource base in agriculture. There are signs, since the late 1980s, that the process toward increasing homogeneity of landscapes could be slowing or even in reverse in some regions. Since this period many OECD countries started to introduce a range of agri-environmental measures, including in some cases measures specifically seeking to maintain landscapes (OECD, 2001b).

Public and private schemes for the conservation of agricultural landscapes are widespread across OECD countries, but mostly publicly funded. Public expenditure on these schemes tends to be a minor share of total agricultural support, but for some countries expenditure has increased rapidly. In many cases the schemes cover multiple objectives, especially concerning biodiversity, habitat and landscape conservation; and focus on the biophysical and cultural features in a local context. Some countries are beginning to include public access requirements in landscape schemes (OECD, 2001b).

Currently information on the *costs incurred by farmers in landscape improvement* is extremely limited. To establish the *value society places on landscape* some countries use public opinion surveys, although as with landscape related consumer expenditure, information is limited. Non–market valuation studies reveal that agricultural landscapes are highly valued in many cases, although there is a large variation in the values estimated.

These studies also reveal that the landscape surveyed today is the preferred landscape, landscape's value decreases with greater distance from a particular site, heterogeneity and 'traditional' elements are given a higher value over more uniform and newer landscapes, while landscapes perceived as overcrowded have a low value (OECD, 2001b).

6. What are the key objectives for this Expert Meeting?

At the OECD's JWP meeting in December 2000, OECD member countries agreed to further develop its work on agri-environmental indicators, including those where the methodology and data are as yet poorly developed, which includes agricultural landscape indicators. The JWP also agreed that the future work on the landscape indicators should be organised by Member countries, where the policy relevance of the indicator was not widespread across all OECD countries. Norway, as a "lead" country on the

OECD landscape indicator effort, offer ed to invite OECD member countries to an expert meeting, to further develop the indicators. The Norwegian Institute of Land Inventory (NIJOS) hosted the meeting on behalf of the Norwegian government, which took place in Oslo on the 7th – 9th October, 2002.

The aim of the Expert Meeting was to explore the extent of research on agricultural landscape indicator development across OECD countries, including drawing on the work of other organisations, to try to reach agreement on how to further develop landscape indicators for use by policy makers. The meeting would seek to address a range of questions, such as:

- What is meant by agricultural landscape, including "cultural" landscape?
- How can indicators be used to reveal changes in agriculture (and policies) and landscape?
- What aspects of the agricultural landscape should be measured?
- Can comparisons of changes in agricultural landscape be made over time and across countries?
- How can trends in landscape indicators be interpreted?
- Which indicators have common features across countries?
- How might indicators be used to determine if specific landscape targets are being achieved?

The objectives of the Expert Meeting are to:

- ***Review current approaches to agricultural landscape indicators*** in OECD Member countries and international organisations.
- ***Make recommendations***, for discussion by the JWP at its meeting in December, 2002, with a view to establishing if any further work should be undertaken in the JWP on developing agricultural landscape indicators to build on the OECD agricultural landscape indicators reported in the chapter "Landscape" in OECD (2001b).
- ***Provide input into the JWP's next report on agri-environmental indicators*** (Volume 4 of the series *Environmental Indicators for Agriculture*, to be published in 2004) and for other related OECD policy work in this area, in particular, the activities of the OECD Working Group on Environmental Information and Outlooks, which is developing environmental indicators. The results of the Meeting are also intended to serve as an input into OECD Member country work on landscape indicators.
- ***Communicate the results*** of the expert meeting to other international meetings and organisations working in this area, notably the Council of Europe (COE) and the UNEP, following their joint Pan-European Conference on "Agriculture and Biodiversity: towards integrating biological and landscape diversity for sustainable agriculture in Europe " hosted by France, in Paris, 5-7 June, 2002 (see http://nature.coe.int/english/cadres/biodiv.htm).

This Expert Meeting offers the capacity to provide a solid basis to further developing agricultural landscape indicators, with 80 participants, drawn from 23 of the 30 OECD Member Countries, one non-Member nation and many international organisations.

The 25 papers presented at the meeting give an excellent overview of recent developments and future prospects of developing agricultural landscape indicators for use in policy monitoring, evaluation and predicative scenarios across most of the OECD Member countries and many international organisations.

For information concerning the Expert Meeting on Agricultural Landscape Indicators, including the set of meeting papers, weblinks, national reports, and other information see the website at: http://www1.oecd.org/agr/landscape/index.htm.

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Overview on Agricultural Landscape Indicators Across OECD Countries

Dirk M. Wascher
Alterra – Green World Research
P.O.Box 47, NL- 6700 AA Wageningen
Tel.: 31/317.477932; Fax: 31/317.424988
E-mail: D.M.Wascher@Alterra.wag-ur.nl

Abstract

With the development of both a conceptual framework and the identification of practical indicator for assessing agricultural impacts on landscapes, the OECD has initiated an operational approach for measuring changes in the structure, management and values of landscapes with clear orientation towards political and economic targets. From this perspective, landscape functions and values are not longer considered to be by-products of coincidental bio-physical conditions and management regimes, but are interpreted as conscious societal demands towards the supplier or producer – namely the local farmer. The paper intends to use the existing experiences of OECD countries for identifying the main directions in landscape indicator research and application with regard to the overall objectives, namely a consistent and operational indicator assessment that allows comparing the impact of agriculture on the landscapes throughout all OECD countries. In order to provide the reader with some points of references, the paper starts off by reviewing the implementation targets for OECD landscape indicators on the basis of recognised landscape definitions and projects with special attention to current experiences in Landscape Character Assessments and the development of national and international landscape typologies. Drawing upon the references provided in the fist part, a comparative analysis of landscape indicator assessments deriving from selected examples from OECD countries provides the basis for final conclusions and recommendations.

Keywords: landscape indicators, monitoring, management, agriculture, agri-environment, landscape assessment

Introduction: Purpose of the Overview

Mainly driven by policy demands such as sustainable development (Agenda 21), multi-functional agriculture (Common Agricultural Policy/Agenda 2000), trade liberalisation (WTO), ecosystem and landscape conservation (Ramsar Convention, European Landscape Convention, UNESCO World Heritage Convention) and on environmental reporting (Wascher, 1995), the development of agri-environmental assessments and indicators is playing an increasingly important role at both the national and international level. In the field of agriculture, OECD had taken an early lead by putting forward a system of indicators that cover a wide range of agri-environmental topics, including the social, environmental and economic aspects of farming. Agricultural landscapes form one of the key policy issues that are part of the OECD agri-environmental indicator framework.

This paper seeks to provide an overview on national initiatives and programmes that have been launched to assess agricultural landscapes with the help of indicators. Since landscape assessments are being undertaken at every possible scale and for a multitude of purposes (Environmental Impact Assessments, regional planning, policy implementation, landscape protection, agricultural management plans, environmental reporting, etc.), the choice of references and examples must focus on nation-wide assessments and selected regional research projects. The main sources of information have been the actual and previous contributions to the OECD agri-environmental indicator process as well as some of those national and international initiatives that appear to provide helpful insights even though they are directed towards policy targets outside of OECD.

An overview on current national initiatives and experiences in the application of landscape indicators among OECD countries cannot and shall not be exhaustive. The main goal must be to highlight the commonalties, differences and peculiarities with regard to the overall goal, namely to assess the environmental impact of agriculture on landscapes. The objective is hence not to undertake a case by case examination for each country or each approach – let alone a ranking or selection of preferable approaches – but to use the examples when exploring possible avenues for future indicator assessments on the basis of the overall scientific context as well as the specific policy angle of the OECD approach.

Despite the obvious limitations that are set by the scope of an introductionary paper, the intention is to use the existing experiences of OECD countries for identifying the main directions in landscape indicator research and application with regard to the overall objectives, namely a consistent and operational indicator assessment that allows to compare the impact of agriculture on the landscapes throughout all OECD countries. Rather than providing as much as possible information on different national approaches (this is much better done in the individual papers), the objective is to identify those key issues that are likely to form the future agenda for the landscape indicator development in most OECD countries and that can help OECD to guide and facilitate this process.

In order to reach this goal, this overview paper is structured along the following four main blocks:

- Review of implementation targets for OECD landscape indicators on the basis of recognised landscape definitions and assessment projects;
- Comparative analysis of landscape indicator assessments on the basis on selected examples from OECD countries;
- Conclusions and recommendations.

While national experiences in OECD countries are playing a central role in this overview, the paper will make frequent reference to results deriving from a few relevant international projects that have contributed to the development of common standards. The author draws mainly upon studies undertaken in the framework former or current European Union projects with the participation of the expert network Landscape Europe.

1. Implementation Targets for OECD Landscape Indicators

1.1 The agricultural landscape – a socio-economic ecosystem

At the beginning of last century, scientists such as zoologists, biologists, botanists, or hydrologists felt increasingly challenged to overcome their disciplinary boundaries by identifying and establishing inter-relations in a more integrated fashion. The two main outflows of these efforts were the concepts of “ecosystem” and “landscape”. Since both terms are frequently being used for very similar environmental phenomena – namely for larger spatial area units of land with characteristic biophysical structures and functions – a sound differentiation between the two concepts has become increasingly relevant for the development of targeted policies or other societal responses.

According to Tansely (1935), 'an ecosystem can be defined as a spatially explicit unit of the Earth that includes all of the organisms along with all components of the abiotic (non-living) environment with its boundaries'. By itself the term 'ecosystem' (short form of 'ecological system') does not connote any specific dimensions (IGBP, 1986), posing technical difficulties to the identification of clearly recognisable boundaries.

In comparison to the 'ecosystem' approach, the landscape concept does not derive from a purely ecological tradition, but is rooted in a wide range of both social and natural disciplines – *including* geographic, ecological and artistic approaches –dating back to the early 1800s. Other than in the English tradition where the term "landscape" is somewhat restricted to "scenery", the Dutch and German meaning of the equivalent terms 'landschap' or 'Landschaft' is of wider scope, namely in the sense of the "total *character* of a region" (Von Humboldt, 1808). Humboldt's definition of landscape became a guiding principle for many landscape scientist across Europe and America when analysing landscapes in an integrated fashion – taking into account social, aesthetic, economic and environmental aspects. Zonneveld (2000) stressed the differences with the English term 'landscape ecology' when defining "Landschaftsökologie" as "the study of the relational system at the surface of the earth that can be recognised by its form and shape".

The aspect of *recognition* is even more directly addressed by Steiner (1991): "Landscape is all the natural features such as fields, hills, forests, and water that distinguish one part of the surface of the earth from another part. Usually, a landscape is that portion of land or territory which the eye can comprehend in a single view, including all its natural characteristics".

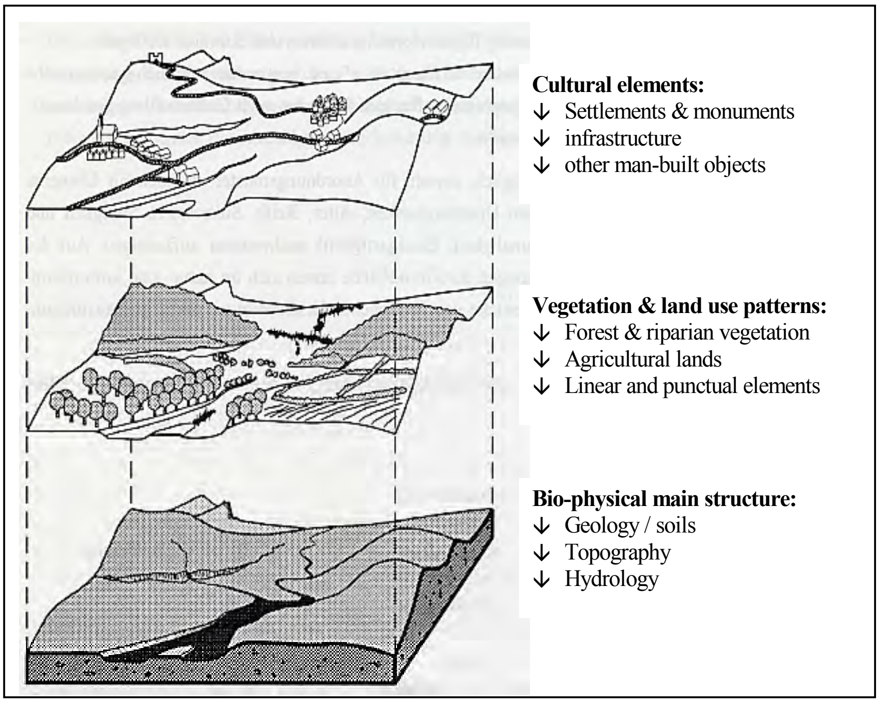
The visual aspects of landscapes have been taken up by OECD which defines agricultural landscapes as "the visible outcomes from the interaction between agriculture, natural resources and the environment, and encompass amenity, cultural, and other societal values." (OECD 2001).

More than other landscape definitions that have been developed during the last decades, the OECD approach is meant to provide the basis for an operational framework for landscape assessment at the international level with clear orientation towards political and economic targets. From this perspective, landscape functions and values are not longer considered to be by-products of coincidental bio-physical conditions and management regimes, but are interpreted as conscious societal demands towards the supplier or producer – namely the local farmer. The most adequate short formula that summarises such a point of view is to define agricultural landscapes as '*socio-economic ecosystems'*.

1.2 An operational approach: Landscape Character Assessment

As complex *socio-economic ecosystems* with regionally distinct configurations of geo-morphology, soil, water, vegetation and human land use, landscapes are the products of both human activities and natural processes that are following the vectors of driving forces such as policies, demography, economy or climate change. The degree to which human activities and natural processes are interacting or have been interacting in the past determines the *character* of a landscape. Landscape character can hence be considered as the land's principle physiognomic profile in terms of climate, geo-morphology, topography, soils and the associated natural vegetation and land use (see Figure 1). Though the character of a landscape can be the object of human perception and evaluation, character is not to be confused with the *quality* of a landscape, which is mainly dependent on the *functions* that have been assigned to it, e.g. aesthetic, recreational, economic and ecological.

Figure 1: Landscape character consisting of three main layers: bio-physical main structure, vegetation & land use patterns and cultural elements
(Wascher after Krause & Klöppel, 1996)



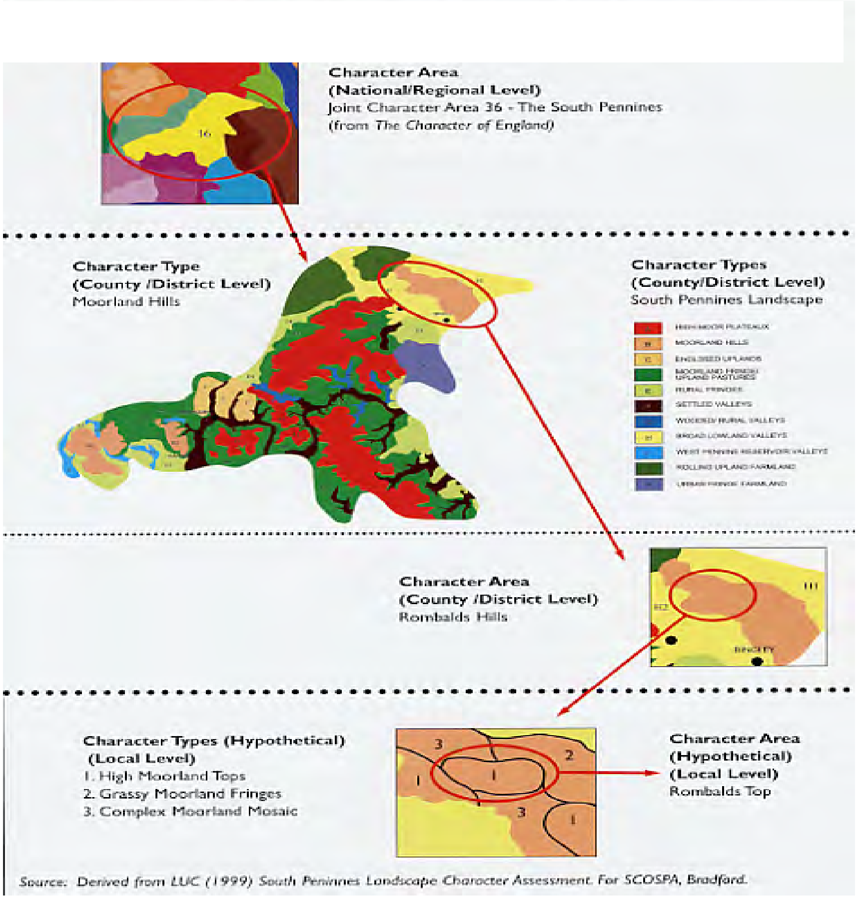
Obtaining a record of the landscape character should hence be considered as a way of identifying the basic *structures* of their biophysical components and cultivation patterns. Understanding the structural character of a landscape is not only a pre-requisite for measuring the *state or quality* of a landscape, but also for identifying the most relevant *pressures* that affect this state. Mainly in the United Kingdom, but also in Sweden, the Netherlands and Austria, different forms of Landscape Character Assessment are being implemented; some of them date back to the early 1970ties. In England, for example, the Countryside Agency developed this technique as a tool to separate the classification and description of landscape character (Steiner's "what makes one area different from another") from landscape evaluation.

The main objectives for such assessments are as follows:

- Identify what environmental and cultural features are present in a locality;
- Monitor changes in the environment;
- Understand a location's sensitivity to development and change;
- Inform the conditions for any development and change.

Directly in line with Humboldt who explained landscapes as "dynamic systems of spatial structures" or with Rosenkranz (1850) who interpreted landscapes as "unit[s] of stepwise-integrated local systems", modern landscape character assessment introduces a hierarchy of spatial-structural levels in which higher units are composed of different sub-units (see Figure 2).

Figure 2: Spatial hierarchy: example for the relation between different levels (LUC, 1999)



1.3 A Key Reference: Landscape Typologies

The most striking aspect of the emerging Landscape Character Assessments implemented in England and Scotland, is the role of the spatial units that are being identified and which are developed into landscape typologies that form a reference basis for future landscape evaluations. Landscape typologies or classifications are of significant importance for both character as well as state assessment, because:

- Landscape character units provide the opportunity to identify policy issues at a region-specific and socially as well as economically relevant level;
- Landscape character units provide a functional and methodological link between the bio-physical main structure and the (agri-)cultural and social-economic ‘expression’ of a landscape;
- The use of Geographic Information System in connection with statistical information stored in relational databases allows spatial-analytical assessments;
- The development of different hierarchical layers that discern landscape attributes of various kinds allows to link up with both administrative as well as other environmental typologies;
- Landscape character areas provide practical tools for communicating landscape issues to stakeholders and policy makers;
- Addressing the matter of fine scale assessment linked to coarse-scale (top-down) assessments.

This is the reason that many OECD countries have – independently from landscape character assessments – developed agricultural landscape classifications that serve as a reference basis for indicator assessments.

In the light of increasing policy demands at the international and national level, more and more landscape classifications projects have been launched on request from national and international agencies. While earlier attempts have been mainly driven by scientific interest of historical geographers, landscape ecologists or regional planners, recent initiatives are much more integrated in wider national monitoring frameworks and are targeting at concrete policy implementation in field of sustainability, natural resource management and environmental assessments. Table 1 provides a brief overview on selected classifications. More initiatives are know to exist, such as in Portugal, Spain, Poland and Slovak Republic. However, detailed information was not available.

Table 1: Selected classifications in use for landscape indicator assessments at the national level of OECD countries

Country	Classifications	Attributes
England	Map of Landscape Character Areas Land Description Units (LDUs)	111 Character Areas, 587 Countryside Character Types (1 km^2) 7 midland counties
Scotland	Natural Heritage Futures	21 Areas
Netherlands	Landscape Types	9 Main types, 21 sub-types
Norway	Agricultural Landscape Regions	11 main, 45 regions, 444 sub-units
Sweden	Cultural Landscapes	(1 km^2)
Hungary	Taxonomic distribution of Natural Landscape Units	6 macro regions, 35 meso regions, 75 micro regions and more than 200 sub-groups
Germany	Spatial Structure of Cultural Landscapes German Landscape Types	77 Units 30 main types, 850 sub-units (1 km^2)
Austria	Map of Austrian Cultural Landscapes (SINUS)	12 main / 37 sub-types (1 km^2)
Australia	Ecosystem - Subregions	354 sub-regions
United States	Farm Resource Regions	9 Regions

While the classifications in England, Scotland (and Wales), are more and more refined to meet monitoring objectives, and started to merge their approaches in the light of cooperation needs, other countries as Austria and lately Germany have only recently developed more operational approaches. Though a great deal of similarities can be recognised, there are still differences in national approach with regard to methodology and data that is in use.

Though bio-physical and land cover data sets play also an important role in most European initiatives, the American classification for indicator assessment is based on a coarse division of large agricultural units, while the Australian classifications relies entirely on an ecosystem approach. Both references lack the type of fine-scale differentiation of socio-cultural patterns and regional identity that mark many European typologies.

Austria
The Austrian SINUS Cultural Landscape project stands central to these efforts. It is based on land cover classification (Landsat) and identifies “cultural landscapes” (16.000 polygons). In its latest version it differentiates 12 main and 37 sub-types of Cultural Landscapes, using their farming names for identification. At the local level, a scale of 1:10.000 is available. Inspired by the British Countryside Survey, a series of 200 ground samples of 1 km² have been taken, examining biodiversity issues (e.g. character species) as well as the degree of urbanisation (fragmentation, distance from roads, etc.). The methodology had been developed as part of the pre-project “Cultural Landscape Typology of Austria on the basis of 16 test sites.

England
As part of the “Living Landscape” initiative, a framework of Land Description Units (LDUs) is being developed for a study area covering 7 midland counties of England. The LDUs are derived through a process of overlay mapping, which draws out the relationship between the natural and cultural dimensions of the landscape. Using contour and geological overlays the study area is divided initially into broad physiographic units (e.g. river valleys, glacial plateau, etc.). By overlaying soils and farm type information these units are then subdivided, where appropriate, to distinguish the broad pattern of vegetation and land use. This in turn is used as a framework for understanding and mapping the historic pattern of enclosure and settlement (Countryside Commission, 1993; Countryside Agency 2000).

Germany
The Federal Agency for Nature Conservation (BfN) is just in a final phase of completing a project of mapping landscapes types on classifying, mapping and evaluating the landscape types of Germany. Using the digital boundaries and data of CORINE Land cover in combination with the natural area system and regional planning documents, the project resulted in the identification of 6 main landscape types (coastal, forests, highly structured agricultural lands, poorly structured agricultural lands, mining restoration areas), that have been sub-divided into 30 types (plus two zonal types, namely hedgerow and riparian landscapes). Below this level, a total of 850 units have been identified from which about 60 urban areas have been cut out. Minimum size of each unit was 1 km². The evaluation which is still continuing depends on land use intensity (hemerobie) and rareness, running two separate a assessment procedures (types + objects).

European Landscape Character Assessment Initiative (ELCAI)
The goal of this European Union funded Research Project is to review the state-of-the-art landscape character assessments for 17 European countries as well as international approaches by Joint Research Centre, Eurostat and the EEA/ETC TE with special focus on the development of a common European landscape typology, map and core set of indicators;

- to review existing landscape policies at the national and international level;
- to initiate inter-agency cooperation in support of sectoral integration and stakeholder involvement when developing and applying new assessment tools;
- to organise an international workshop for cross-disciplinary exchange and stakeholder input;
- to disseminate the key products (report, map and indicators) by means of a scientific report, a policy brochure and an internet database, providing guidance for future landscape assessments.

2. Overview of Landscape Indicators in OECD Countries

2.1 Brief review of the OECD approach

Table 2 illustrates OECD’s indicator framework consisting of four main themes on socio-economy and policy, farm management, use of input and resources and environmental impacts. The field of “landscape” constitutes one out of seven environmental impact areas for which indicators have been identified. By discerning other agri-environmental impact areas such as biodiversity, habitats, soil and water as separate indicator fields and due to the limitation on *agricultural* landscapes and on *agricultural* impacts, the required OECD landscape indicators should reflect landscape characteristics that are both original in terms of the identified policy issues and complimentary regarding to other indicator fields.

Table 2: OECD Agri-environmental indicators (OECD, 2001)

Agriculture in the Broader Economic, Social, Environmental and Policy Context	**Farm Management and the Environment**	**The Use of Farm Inputs and Natural Resources**	**Environmental Impacts of Agriculture**
➢ Contextual Information and Indicators ➢ Farm Financial Resources	➢ Farm management	➢ Nutrient Use ➢ Pesticide Use and Risks ➢ Water Use	➢ Soil Quality ➢ Water Quality ➢ Land Conservation ➢ Greenhouse Gases ➢ Biodiversity ➢ Wildlife Habitats ➢ Landscape

The indicators fields that have been proposed to assess agricultural landscapes in the context of OECD are:

- the main components that are commonly associated with agricultural landscape *structure* (appearance):
- the extent to which public/private *management* schemes have been introduced to maintain and restore these landscapes; and,
- the *value* society places on landscapes and the costs for farmers of maintaining or enhancing them.

Table 3 demonstrates that the suggested approach is actually not restricted to "Environmental Impact from Agriculture" – as suggested by the title – but are also assessing the role of legal and financial schemes in response to agricultural impacts on landscapes (*response* indicators). Only the indicators on landscape structure provide information that allow observing the impact of agriculture on these structures (*state* and *impact* indicators).

Obviously, the four main agri-environmental themes are not exclusive in terms of their objectives but that a certain amount of redundancy between the themes cannot only be tolerated but also desired. The second landscape indicator field on *management* schemes, for instance, could be considered as being closely related to the second main theme on "Farm Management and the Environment". A closer look at those indicators (see Table 3) that have been proposed for "Farm Management and the Environment" show indeed that they include soil and land management aspects – two topics that are also playing a distinctive role from the landscape perspective (Wascher, 2000).

Equally, the aspect of 'costs of maintaining landscapes' could also be associated with the economic context of agriculture (1. Theme). However, the selection of landscape-specific indicators for both landscape management and landscape structure are likely to resolve these apparent redundancies. The overview on existing national approaches in OECD countries offers the opportunity to examine the question, to which degree the different landscape indicator fields can actually be populated with national data and which methodological refinements have been developed to implement OECD landscape indicators.

Table 3: OECD indicators for agricultural landscapes (OECD, 2001)

1. Landscape Structure	2. Landscape Management	3. Landscape Value
1.1 Environmental features and land use patterns 1. *Environmental features*, encompassing mainly landscape habitats and ecosystems; 2. *Land use patterns*, including changes in agricultural land use patterns and distributions. *1.2 Man-made objects* Key indicative man-made objects (cultural features) on agricultural land resulting from human activity.	*2.1 The share of agricultural land* under public and private schemes committed to landscape maintenance and enhancement.	*3.1 The cost* of maintaining or enhancing landscape provision by agriculture. *3.2 The public valuation* of agricultural landscapes.

2.2 Indicator field Landscape structure

As pointed out in Chapter 1, landscape structure can be considered as one of the key attributes of landscape character. Landscape structure can manifest itself at a wide range of scales and in the context of a large variety of shapes and forms related to basic bio-physical aspects such as geo-morphology, topography, natural vegetation cover and surface hydrology. From the perspective of agricultural landscapes, cultivation patterns deriving from agricultural land use such as land use types, field shapes and colours, but also boundary types, length and forms form the structure that can be measured by indicators (see Figure 3). It should be noted, however, the an assessment of structure without recognising the principle landscape character of an area – or to say in another way: replacing a landscape quality assessment by a reduced landscape character assessment (neglecting the bio-physical main structure), is likely to produce statistical results on landscape attributes that are difficult to interpret in the context of the visible or real landscape.

The agro-environmental indicators for landscape structure that have been put forward by OECD are:

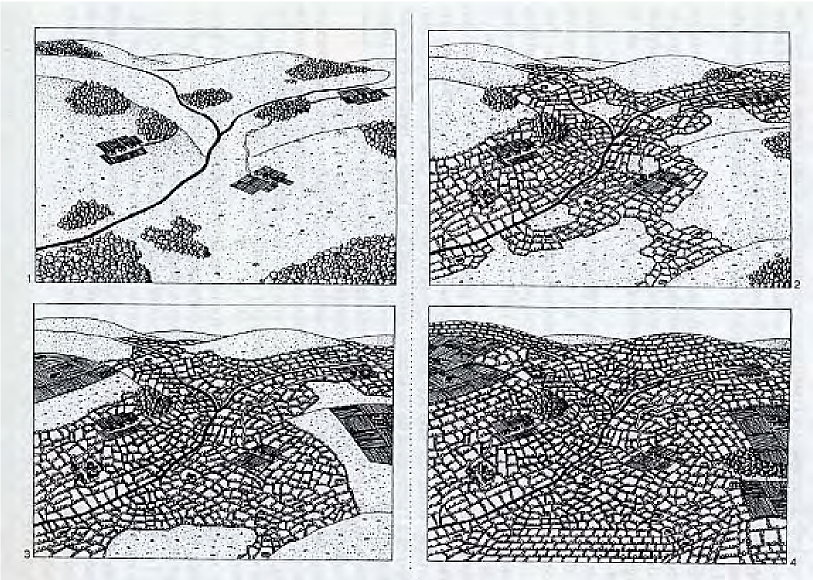
1.1 Environmental features and land use patterns

- Environmental features, encompassing mainly landscape habitats and ecosystems;
- Land use patterns, including changes in agricultural land use patterns and distributions.

1.2 Man-made objects

- Key indicative man-made objects (cultural features) on agricultural land resulting from human activity.

Figure 3: Changes in landscape structure for the example of an expanding bocage landscape (Burel & Baudry 1999).



After analysing the current approaches on developing landscape indicators for 1.1. on 'Environmental features', it can be noted that the main focus of most approaches is on land use/land cover and changes in land use pattern, as well as on man-made objects, rather than on landscape "*habitats and ecosystems*". The latter form a combination of terms that reach out to other indicator areas such as 'biodiversity' and 'wildlife habitat' and should hence not be measured in terms of their quality and state, but mainly in their role as structural components of the wider agricultural landscape (e.g. diversity indices, boundaries).

The main assessment criteria for the overview on landscape structure are:

- Coverage: e.g. does there exist a national assessment or is the example from regional case studies? This difference deems relevant with regard to the value of the presented case for wider national monitoring activities in the framework of OECD indicator reports, and of course on the probability of regional studies to be extended to national surveys.
- Methodological scope: is the indicator assessment based on several types of patterns, such as land use/land cover and cultural attributes such as infrastructure, settlements, historical features and linear or punctual elements.
- Scale: is there a link between fine scale and coarse scale assessment. As Joan Nassauer points out in her contribution: "Resolving the tension between using available land cover/land use data interpreted from satellite images and representing perceived fine-scale and regional variation in landscape is a key methodological challenge for agricultural landscape indicators".
- Visibility: One of the key assessment criteria that has been laid down in the OECD definition for agricultural landscapes is their visibility. Though visibility can be interpreted in many different ways – per satellite imagery from space or from an individual observer standing the landscape – it seems worth to examine how the different approach have dealt with this aspect.
- Focus: Given the difficulties in the availability of landscape-specific data especially regarding cultural features, and given the wider OECD agri-environmental indicator framework that request indicators for environmental issues such as soil erosion and pesticides, the proposed indicators should target at core landscape issues rather than overlap with other areas.

Table 4: Comparative overview on Landscape Structure according to five criteria

([dark] = indicates clear significance)
([light] = indicates restrictions)
([white] = indicates less significance)

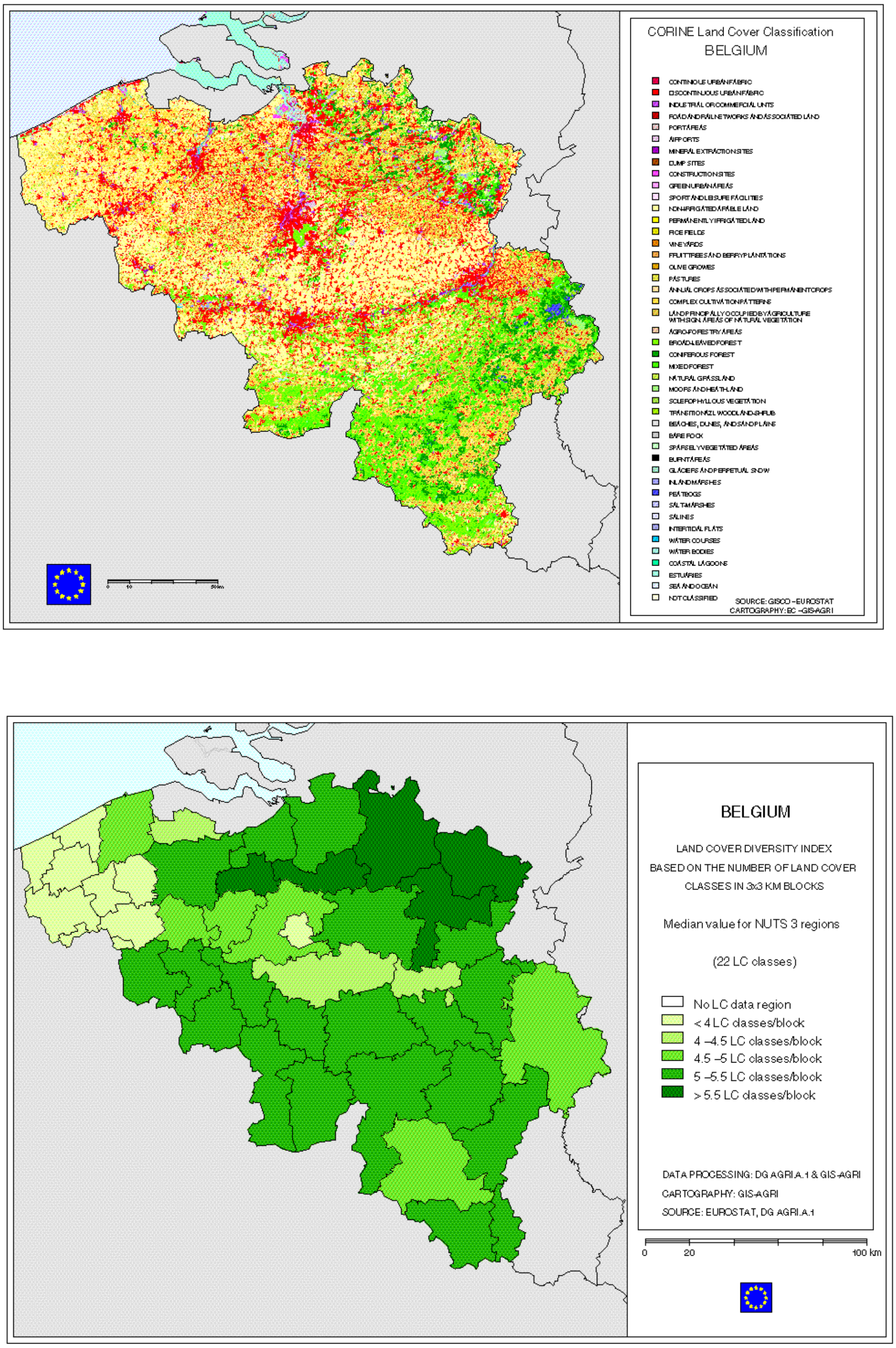
	National Coverage	Wide Scope	Fine Scale	Local Visibility	Landscape Focus
Austria (SINUS)	clear significance	clear significance	clear significance	clear significance	restrictions
Belgium	restrictions	restrictions			
Denmark*		clear significance	clear significance		clear significance
Finland				clear significance	clear significance
France (TerUti)	clear significance		clear significance		restrictions
Germany*	restrictions	clear significance			clear significance
Greece		clear significance			
Netherlands*	clear significance	clear significance	restrictions		clear significance
Norway	clear significance	clear significance	clear significance		clear significance
Sweden*	clear significance		clear significance	clear significance	clear significance
Switzerland		clear significance	clear significance	clear significance	clear significance
United Kingdom*	clear significance	clear significance	restrictions	restrictions	clear significance
Australia	clear significance		restrictions		
United States	clear significance			restrictions	
Korea	clear significance	restrictions	clear significance		clear significance
Japan	restrictions				clear significance

*** Countries initiatives outside the OECD process**

Though the analysis is not neither exhaustive nor representative, it may provide some basic insights into the general trends of landscape assessment through the examined OECD countries:

- National landscape assessments that encompass true indicator-driven approaches are performed in 9 out of 16 countries. It should be kept in mind that there might exist more national indicator projects based on analysing land cover data or other statistical materials. Belgium for example has used CORINE land cover data for differentiating three main landscape types, but a specific landscape-monitoring programme is not in place.
- In terms of the assessment scope and fine scale approaches, the situation is similar, with Australia and the US lacking the type of detail that is being reached by some of the European countries.
- Whether local visibility has actually been taken into account is difficult to judge. Most large-scale assessment procedures using remote sensing or random sampling methods apply data aggregation methods that make local visibility aspect difficult to capture. Some of the regional project are more equipped to measurer these aspects. The fine scaling in the English and Scottish approaches appear to capture local visibility.

Figure 4a/b: CORINE Land Cover diversity assessment (EEA, 2001)

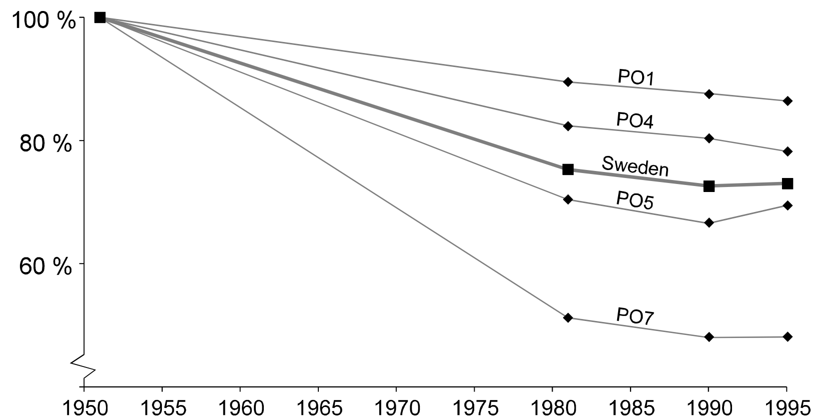


Belgium: Structural complexity
One of the key quality aspects of diversity in agricultural landscapes is a high level of structural complexity. Since land use patterns are closely linked to biophysical (e.g. geo-morphology) and to socio-economic (production method) factors, structural complexity is changing with these factors over time. These changes not only address the spatial distribution, dimension and type of farm structural components, but also include the complexity of the spatial resource and energy flow systems. In the past, high richness of agro-morphological forms and patterns were characteristic of many rural landscapes. Such agricultural landscapes exhibited diverse habitat mosaics with a high proportion of edges between different habitat types (e.g. forest – crop, crop – grassland, or pasture – meadow). Figure 4a/b illustrates how information on structural diversity deriving from land cover can be interpreted in the context of administrative boundaries.

Sweden & Korea: Changes of agricultural processes
The proposed OECD indicators are also suggesting to record changes of landscape and land use pattern over time. Sweden and Korea are countries that have established such a structural landscape indicators for measuring critical national-wide agricultural processes that affect landscape, (see Figure 5):

- Expansion-Contraction in the total area of agricultural land.
- Intensification-Extensification of agricultural production.
- Concentration-Marginalisation of farm holdings.

Figure 5: National and Regional Physical Landscape Indicators: A Swedish Approach, 1951 to 1995 (OECD 2001)



Expansion – contraction

Change in area of agricultural land in Sweden and in four different regions.

Area 1951 = 100 %.

2.3 Indicator field Landscape Management
The proposed indicator for landscape management is the "share of agricultural land under public and private schemes committed to landscape maintenance and enhancement" – hence representing a response indicator.

The suggested method of calculation is as follows:
- share of the total agricultural land area (or number of farms), covered by public/private management/conservation schemes.
- objectives and annual expenditure (lump sum payments)
- public/private initiatives intended to maintain/enhance agricultural landscapes that are based on regulatory measures and those using community/voluntary approaches.

International conservation schemes
At the level of the European Union, specifically designed agri-environmental measures targeting among other at landscape enhancement and conservation have been put in place since about 10 years. A DG Agriculture Working Document (CEC, 1998) reviewed the implementation of the Council Regulation No (EEC) 2078/92 that applies to 900.000 farms and 27 million hectares, or 20% of the EU farmland. The Commission's report recognised 'sub-national environmental benefits from programmes' and noted that the establishment of an 'evaluation culture' in programme management is successful in many cases. Furthermore it is recommended using the 'landscape system' approach for the implementation of measures.

Regarding the overall situation of agricultural land management and landscape conservation in Europe, the European Union's Agenda 2000 marks a new stage in the continuing reform process, which aims to bring about a farm sector closer to market realities, to consumers and to the environment. In addition, year 2000 was the start of the adoption to the first new generation rural development programmes for the period 2000-2006. One of the main outcomes was the establishment of a new Rural Development Regulation (RDR). The RDR supports rural development and agri-environment schemes designed to diversify rural economies, to encourage farmers to look to markets and diversified forms of income to reduce their dependence on subsidy, and enhance the environment.

For the first time, EU funding is now available for rural development programmes everywhere in the Community, instead of being only available in designated regions, as was the case in the past. Another new feature is that agri-environmental schemes, which used to be optional, now have to be included in all programmes. These schemes are to compensate farmers for income losses they might suffer as a result of managing their farms in more environmentally- friendly ways.

Future agri-environmental on landscape management in OECD countries are likely to take up these type of international policy schemes in support of environmental and landscape conservation.

National landscape conservation schemes
Especially in Europe, landscape conservation and also management schemes have a rather long history. Landscape conservation schemes play a significant role in many European countries and are covering larger surface areas than most other conservation schemes. Though landscape conservation is not as restrictive than area protection for the purpose of biodiversity conservation, there are principle rules of agricultural management and planning in place.

The European Landscape Convention (opened for signature in October 2000)
According to the Explanatory Report of the Draft European Landscape Convention (Council of Europe 2000), the general purpose of the Convention is to encourage public authorities to adopt policies and measures at local, regional, national and international levels for protecting, managing and planning landscapes throughout Europe so as to maintain and improve landscape quality and bring the public, institutions and local and regional authorities to recognise the value and importance of landscape and to take part in related public decisions.

2.4. Indicator field Landscape values
The indicator field 'landscape values' appears to be somewhat related to the field on 'landscape management', as it is supposed to measure

1. The cost of maintaining or enhancing landscapes provisions by agriculture.
2. The public valuation of agricultural landscapes.

Measuring the costs of landscape provision can help policy makers determine the outlays by farmers in maintaining and/or restoring certain landscape elements. These costs may relate to cultural and heritage features, such as spending by farmers on the conservation of historic sites and/or buildings on farmland. However, expenditure could also involve costs incurred in hedge or stone wall maintenance that, while providing a positive externality in terms of the landscape may also generate benefits for the farmer, for example, by providing a windshield for crops and livestock.

The use of Contingent Value Methods (CVM and the development of landscape scenarios, could provide useful tools assessing public appreciation of landscape values.

In comparison with the previous two indicator fields, 'landscape value' indicators are scarce. The Australian example (see Table 5) is the only one that illustrates the great potential of semi-administrative data in measuring the societal values that have been attributed to cultural and landscape values. Even though more countries might be inclined to explore these assessment methods in the future, it will be necessary to reach a high level of harmonisation in order arrive at internationally comparable data.

Table 5: Cultural value indicators for Australia (Pearson *et al*., 1999)

Issue or element	**Indicator**	**State (S) Pressure (P) Response (R)**
Knowledge of the Heritage resource	▪ Number and distribution of identified heritage (places and objects) ▪ Number of heritage places assessed	S/R R
Culturally appropriate directions in conservation and management of heritage places	▪ Number of places where indigenous people are involved in heritage management decision making by" i) indigenous land ownership ii) joint management iii) recognised custodership iv) direct consultation ▪ Number of government agencies that provide procedures and consultations to community groups ▪ Number of trained heritage professionals	S / R S / R S / R
Cultural heritage maintenance	▪ Number of indigenous communities/organisations establishing i) 'keeping places' ii) cultural centres iii) site / place data bases iv) heritage tours, trails, walks	S / R

3. Conclusions and Recommendations

3.1 Conclusions

The multi-sectoral approach taken OECD for developing agri-environmental indicators has proven to be the adequate response towards a complex interface between the agriculture, the environment and emerging policy requirements. The process of developing a conceptual framework for agri-environmental indicators has demonstrated the need to bridge the gap between existing models (such as *pressure/driving force – state – response*) and the functional links that characterise actual agri-environmental processes.

The objectives laid down in recent policy documents addressing issues such as rural development, cultural landscapes and regional identity, have made clear that future agri-environmental assessment can no longer be based on strictly mono-analytical approaches but must apply methods of integration. Throughout all these issues socio-economic considerations play a vital role when defining environmental objectives.

The following conclusion are meant to cast more light on the future choices and implementation targets for landscape indicators by addressing some of the most relevant findings of this overview:

- Many OECD countries haven taken a rather pro-active approach towards the implementation of indicator-based landscape assessments. Over the last years, a series of countries have developed more refined methodologies in terms of spatial resolution and policy orientation, resulting in impressive monitoring and reporting products at the national level.

- Landscape structure is the indicator field that is most commonly in use and where an increasing number of sophisticated techniques (e.g. Geographic Information Management) are being developed. Most of the large-scale (national) assessments on landscape structure focus on land cover and land use analysis – frequently based on remote sensing data, random sampling techniques involving aerial photography or agricultural statistics. Fine-scale structural elements such as linear and point forms, cultural patterns and materials relevant for the local visibility and a landscape perception that is not restricted to satellite perspectives, are limited to regional and local case studies

- The analysis of landscape structures is most consequently performed in countries that are undertaking 'Landscape Character Assessments" and where national landscape typologies as references for indicator assessments and interpretation are being developed. Landscape Character Assessments based on landscape typologies take are more region-specific approach than pure structure-analytical techniques.

- The indicator fields on landscape management and value are clearly less strongly developed. This comes, as a surprise since national statistics on response mechanisms such as landscape conservation, management and education is very likely to be available in relatively great detail for most countries. It can be assumed that a target approach towards the population of these indicator fields with existing data could provide the most substantial advances in terms of cross-national comparisons. It only requires a systematic approach when identifying the main types of management schemes and the accompanying financial structure.

- National activities are increasing supported by international projects such as the European Landscape Character Assessment Initiative (ELCAI, co-ordinated by Landscape Europe), the Environmental Risk Assessment for European Agriculture (ENRISK, co-ordinated by the European Centre for Nature Conservation), the Land Use and Land Cover Area Sampling

- (LUCAS, co-ordinated by the European Statistical Office) and the Millennium Assessment that includes a section on cultural landscapes.

3.2 Recommendations

In order to foster future support for sustainable agricultural landscapes, it is recommended that OECD:

- Provides considerable support and takes action to further the development and targeting of monitoring activities in the field of landscapes on the basis of the identified indicator core sets.

- Supports the development and application of national landscape typologies that can be linked to existing international classifications;

- Refines the conceptual framework and the identified indicators by developing consistent scales and references for gathering, analysing, presenting and interpreting data. Here the work is still at an initial stage and requires a combination of consistent OECD guidance and integration from bottom up approaches;

- Further extends its information and policy network beyond the national level to facilitate dialogue between decision makers at the international, national and the sub-national level. Regional specification will open new perspectives on sustainable agriculture;

- Establishes a step-by-step procedure for initiating data collection activities at the national level;

- Establishes a long-term monitoring and reporting system that links state, driving force, risk and response indicators into one integrated framework for sustainable agriculture in OECD countries.

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Methodological Challenges for Defining and Measuring Agricultural Landscape Indicators

Joan Iverson Nassauer
School of Natural Resources and Environment, University of Michigan,
Ann Arbor, MI, USA 48103-1115
nassauer@umich.edu

Abstract

The decision of the Organization for Economic Co-operation and Development (OECD) to investigate landscape indicators creates many opportunities and ground-breaking challenges. The explicit opportunity is to develop a means to monitor intrinsic landscape quality across political boundaries. Implicit opportunities may prove to be equally important. They include:

- *The opportunity for policy-makers to monitor and manage the aspect of environment that is experienced most broadly and directly by local people and the body politic, that is, the landscape.*
- *The opportunity for policy-makers to anticipate public response to future landscapes.*
- *The opportunity to link landscape indicators with related biogeochemical functions, population and economic phenomena.*
- *The opportunity to examine cross-scale effects between fine-scale landscape phenomena and global and regional phenomena, data, and indicators.*

Challenges are also abundant, and will require policy-makers, planners, and scholars to be inventive. Among the challenges:

- *Defining landscape indicators adequately: in a way that accurately conveys the experience of landscape and that also is amenable to monitoring across political boundaries and ecological regions.*
- *Determining what information constitutes an adequate baseline for monitoring agricultural landscape change.*
- *Determining what data are available, or practically could be gathered, to build that baseline and maintain a monitoring system.*
- *Articulating the value of landscape meaningfully in the context of other agricultural indicators that are more widely understood and valued in the scientific and policy communities.*

This paper describes and details these opportunities and challenges, and relates them to some ongoing work in the USA.

Introduction

Because the agricultural landscapes of the OECD nations are increasingly a product of policy, an indicator approach to monitoring and directing landscape change is particularly appropriate and likely to be productive. Agricultural means human management of fields, and agricultural landscapes – even those that are perceived as "natural" – are inherently the result of human choices. In addition, agricultural landscape indicators are likely to be practical for policy because of the relatively large extent of agricultural land management units compared with urban land uses– whether the unit we consider is a field (a homogenous area of a particular management regime) or a farm (an area of multiple fields which is managed by a single entity, e.g., a farm family and/or a corporation). Finally, changing international trade, environmental, and agricultural policy, diffusion of new agricultural technologies and practices across the globe, and global ecological and climate change are creating new agricultural landscapes at a rate that is noticeable, and jarring, to local farmers and the broader public in many locales. Surprising landscape effects of climate change, habitat loss, and unintended effects of policy and technology make it difficult to predict the appearance of future landscapes. In the face of such difficulty, there is a widely felt need to establish baseline data with which to anticipate the future. An indicators approach to agricultural landscapes is not only needed but can be practically and productively applied to guide agricultural, environmental, and trade policy to produce future landscapes of value.

I have been asked to identify methodological challenges for developing agricultural indicators. In describing these challenges, I often will refer to my own work with others over the past 25 years, in which we have measured and mapped agricultural landscape perceptions and developed prospective future scenarios for agricultural landscapes. References within the papers to which I refer here describe a much larger, and very rich set of literatures in landscape perception, farmer perception and behavior, landscape assessment, landscape ecology, geographic information systems, and future landscape scenario design. My intent here is to refer to works in which my co-authors and I have drawn on and summarized those literatures in the context of agricultural landscape measurement.

Landscapes can influence public perceptions to achieve valued landscape functions

As defined by the European Landscape Convention of the Council of Europe (2000), "landscape means an area as perceived by people…" (Chpt.1, Art. 1). Further, member nations of the Council have agreed to establish procedures for the public to participate in defining and implementing landscape policies (Chpt.2, Art. 5). These two articles clarify that public perception is of the essence to landscape quality. In the United States, public perception of landscapes has been recognized somewhat less broadly, as essential to management decisions for projects on federally-owned land and for federally-funded projects on private land (Nassauer 1989, Nassauer 1992). Numerous states, and some local laws, have emulated federal landscape quality protection procedures, e.g. (USDA 1995). As defined in Volume 3 of the OECD Environmental Indicators for Agriculture (2001), agricultural landscapes are the "visible outcomes resulting from the interaction between agricultural commodity production, natural resources and the environment…" (p. 368) (emphasis mine).

I have argued elsewhere that this defining characteristic, visibility, or appearance, is both an opportunity to strategically manage agricultural landscapes to achieve public support for invisible or sometimes unattractive beneficial ecological functions, and a pitfall for environmental policy when the visible characteristics of landscape are managed in a way that obscures hidden ecological costs (Nassauer 1989, Nassauer 1992, Nassauer 1997). This argument depends on understanding that the appearance of landscape is separable from its function; any given commodity can be produced in many different landscape patterns. The pattern of agricultural landscapes is a matter of policy and farmer choice, constrained by ecological characteristics of the place, technological choices, and broader cultural values and patterns, like land division and ownership patterns (Nassauer, Corry, and Cruse 2002).

Understanding that appearance is separable from these other variables points to strategic opportunities for policy to intentionally link public perceptions with distinct, but valuable, ecological and production functions. Without this intentional link, agricultural policy runs the risk of producing landscapes that may be "good" ecologically or for production, but not be seen as "good". Alternatively, without this link, agricultural landscape indicators could suggest the protection or creation of landscapes that look "good" but are not "good" ecologically or for production. This disjunction between what is visible and landscape functions must be recognized from the outset if we wish to propose intellectually defensible and strategically effective agricultural landscape indicators.

Indicators will track selected aspects of landscape, and much of what we will discuss during this workshop will be what to select. Our recommendations must pragmatically consider data availability and data management, but they should first consider which potential landscape indicators can join valued visible landscape characteristics with function. We should set our sights on enabling policy to strategically link the realm of appearance with the realm of function.

Present and past landscapes have only sometimes been valued for their appearance, as well as ecologically healthy, and agriculturally productive. To guide future landscape change, indicators should be sufficiently conceptually broad to measure the value of innovative landscape patterns that may not exist (Nassauer, Corry, and Cruse 2002). ome innovations may be beneficial and some may be destructive of some values. Adequate indicators may not forecast the particular patterns, but they should be able to measure their value.

How the public perceives value in future agricultural landscapes will depend in part on whether they contain patterns that are familiar and valued in present landscapes. This doesn't necessarily mean that future landscapes must look the same as present landscapes. It does mean that selected presently valued pattern characteristics might be employed in future appearances to maintain landscape value even as landscapes change. For example, in our survey of perceptions of alternative future scenarios for Cornbelt USA agriculture, the future landscape pattern that Iowa, USA, farmers valued most highly was purely our digital invention (Nassauer and Corry 1999). It had never been seen before. However, it included a vivid, familiar contour strip pattern that farmers recognized from the strip-cropping practices that were introduced in the Cornbelt in the 1930's, and that farmers find very attractive.

These ideas present the following questions for this workshop: How can we construct indicators that validly convey what is perceived as valuable in agricultural landscapes? How can we select indicators and monitor agricultural landscapes to help policy makers "take the pulse" of public opinion of landscape appearance? How can we develop indicators that will measure future, novel landscape appearances as well as past and present landscape characteristics?

Cross-scale effects between fine-scale landscape phenomena and global and regional phenomena should influence the selection of landscape indicators.

While landscapes are experienced at a very fine grain (people notice and value landscape characteristics smaller than a weed in a field or a dying tree), agricultural landscape indicators may be assumed to demand coarse-grained data in order to monitor extensive areas. This scale disjunction could lead us to monitor broad-scale phenomena that do not validly reflect landscape perception. At the same time, fine-scale landscape changes can have surprising cumulative broad-scale effects. In everyday life, people often literally "can't see the forest for the trees". For example, while people may notice the loss of certain types of valued agricultural landcover locally (e.g., grazed meadows), they may not be concerned about that loss until they know that the landcover type is becoming relatively rare across their entire region or begin to notice it's ecological effects. In these cases, it is important to link fine-scale perceptual phenomena with broader landscape changes as well as biogeochemical, population, and economic phenomena that constrain fine-scale landscape patterns. Finally, some fine-scale local landscape changes may be the unintended, displaced consequences of policies, international business decisions, or technologies in other parts of the world. For example, changes in US agricultural and trade policy may promote unintended changes in agricultural practices and landscape quality in other regions – including developing countries. If we define and measure agricultural landscape indicators across scales and link them to global or regional indicators of other phenomena, we can avoid methodological problems of:

- Invalid measures at the wrong scale
- Failure to notice cumulative effects of local landscape changes
- Displaced local landscape effects of national, multi-national, or technological change in other parts of the world.

These ideas present the following questions for this workshop: What data are relevant for monitoring the fine-scale phenomenon of landscape perception? How might data be efficiently collected to describe this phenomenon? What coarse-scale data describing broad scale phenomena should be linked to fine-scale landscape indices?

Landscape indicators should allow policy-makers to anticipate interactions between visible landscape change and biogeochemical, production, population, and economic phenomena.

Economic indicators have long been accepted as a tool for policy-formation. In the United States, agricultural and demographic/housing indicators also are widely available. The federal Census of Agriculture provides data for tracking selected production, economic, and demographic characteristics at 5-year intervals, and the Census of Population provides data for tracking housing, economic, and demographic characteristics at 10-year intervals. A recently completed system of ecosystem indicators for the United States by the Heinz Center (2002) responded to a lack of similar indicators for the nation's ecosystems. It identifies a wide array of indicators by landcover and land use types and establishes a baseline from which to monitor change. Data availability was a fundamental limitation for selection of US ecosystem indicators. Production of food and fiber in agricultural landscapes are indexed by drawing on data from the US Department of Agriculture. However, the report offers no indicators for landscape quality in any ecosystem type – including farmlands or grasslands. Outdoor recreation indicators, including "viewing activities" are called out for several ecosystem types, but such viewing activities are limited to immediately quantifiable characteristics like "hours spent watching wildlife". The Heinz Center Report notes that data for tracking so-called intangible values are dramatically lacking, and very much needed. However, "landscape quality" is NOT explicitly included among the intangible ecosystem services for which indicators are needed – despite the powerful federal mandate to measure "presently unquantified aesthetic qualities" that has been in place since 1969. Despite the thousands of environmental impact statements and assessments that have been filed in response to the US National Environmental Policy Act, federal agency organic acts, and analogous state acts, and the well-articulated policies and hundreds of plans of the federal land holding and advisory agencies (e.g., USDA 1995), no single, consistent data base for landscape quality exists for the United States.

Quantified landscape indicators would allow scientists, planners, and policy-makers to look for the following types of potential relationships:

- Landscape indicators may sometimes be surrogates for potential ecological indicators, predicting landcover or land use change that has implicit ecological implications.
- Landscape indicators may sometimes act as independent variables, predicting ecological indicators.
- Landscape indicators will sometimes be illuminating intervening variables – explaining landscape patterns that are initiated by demographic or socio/economic changes.
- Landscape indicators may sometimes be dependent variables, predicted by ecological change.

These ideas present the following questions for this workshop: What other agricultural indicators will be recommended by the OECD? What potential relationships can be identified between these other indicators and landscape indicators? How can the measurement of landscape qualities be calibrated to illuminate these relationships? What strategic relationships should be constructed among indicators to enhance their effectiveness?

Summary of opportunities for agricultural landscape indicators

Overall, developing agricultural landscape indicators presents several opportunities to monitor and manage landscape quality:

- Because of its inherent value as an "essential component of people's surroundings" (Chapt. 2, Art. 5, Council of Europe, 2000).
- Because of its power to influence public perception of and support for ecological quality and agricultural production and related policies.
- To guide and demonstrate the potential for innovative, new landscape patterns to be valued by the public.
- To directly affect landscape quality phenomena that are apparent at broad scales, but may not be immediately apparent at fine scales
- To directly affect or respond to biogeochemical, production, population, and economic phenomena that are may be monitored at broader scales.

Responding to the scope of these opportunities raises formidable methodological challenges – most of which relate to data classification, cost, and management.

Define landscape indicators adequately: in a way that accurately conveys the experience of landscape and that also is amenable to establishing a shared baseline for monitoring across political boundaries and ecological regions.

An adequate definition of landscape indicators first depends upon validly reflecting the phenomenon of landscape perception, answering the question, "What do people notice and value?" To validly measure what people notice, we should present people with visible landscapes (in situ or in images, like photographs or simulations) to measure their response. Presenting respondents with words that describe or point to landscapes is not adequate for measuring landscape quality, and especially, for anticipating response to change. To anticipate change, we should pay attention to characteristics that could be visible in future landscapes, not only what people notice now. To measure change, we must consider the spectrum of value: What people perceive as being undesirable, as well as what they regard as desirable. And we must assume that different communities may have different values. For example, professional design and planning communities have consistently been shown to value landscape differently from the general public (e.g., Zube, et al. 1974) In Environmental group members value the landscape differently from the general public (Nassauer 1993). Farmers may value agricultural landscapes differently from the general public (Nassauer 1988). Local people may have different values than tourists. Different national or ethnic values for landscape may amplify these differences (Kaplan 1989).

Amidst what could be a bewildering array of differences, there are unifying concepts. The evolutionary and information-processing theorists of landscape perception would suggest that savannah like landscapes will be broadly valued (Nassauer 1995). Landscapes that exhibit recognizable signs of human care will be broadly valued, but the particular signs may vary across cultures and regions (Nassauer 1988, Nassauer 1995, Nassauer 1997, Beedell and Rehman 1999, Cary 1999, Gobster 1999, Menzies 2000). Furthermore, different policy or activity contexts may provoke different perceptions – increasing similarity among groups. For example, Cornbelt USA farmers have told me that this landscape wouldn't be attractive to farm, but it would be a place they would go to enjoy the view on a

Sunday drive (Nassauer 1989). In a more recent interview survey, a young farmer told me that he would have to choose a monoculture corn landscape alternative for it's production value, but he found an alternative of native perennial grass strip intercropping more attractive and would choose it if he could make money doing it (Nassauer and Corry 1999).

Whatever landscape characteristics people notice and value, data classification must be sufficiently rich to include or at least imply those characteristics. To pursue linkages with ecological and production indicators, it also must include classes that are relevant for those linkages. A hierarchical data classification can link coarse-grained data, describing conceptually-broad landscape quality classes across a continent, with relatively few classes extending over a large region, to fine-grained data with more classes, describing much smaller areas (Allen and Hoekstra 1987). Such small areas might be conceived as sample points or even limited to "hot spots" of landscape change. This structure could allow monitoring of many data classes to capture fine-scale characteristics and to allow for fine-scale variation in data classes among regions and communities at levels in the hierarchy where cross-boundary comparisons are not needed.

Very fine scale perception data might be measured as nominal scales, including many landcovers and landscape features. Coarser scales in the hierarchy should allow for interval scale data and could employ unifying conceptual constructs, like desirability, attractiveness, or care. Anchoring interval measurement scales for landscape perception data requires scale end-points that are shared by all respondents. Cross-boundary comparisons might usefully focus on establishing perception scales with enpoints defined by anchor reference landscape that are recognized by all cultures and population groups for cross-boundary comparisons. Using multiple scales for these coarse-scale comparisons will help to validate ratings and to allow for multiple dimensions of landscape value to be measured.

Since data classification and resolution limit what is "conceivable" for any data set, fine-grain data needs should inductively determine coarse-scale data classes within a hierarchical data structure. Hierarchical data structures, sampling of fine-grain phenomena, and novel data gathering techniques should all be considered to both practically and validly measure landscape quality across the OECD nations.

Addressing the dilemma of spatial and classification scales can help to identify baseline data for landscape indicators. Following from a hierarchical concept of landscape classification, baseline data might incorporate existing local data sets of many classes at a fine scale, and these local data sets need not be uniform across regions. Comparisons across regions might occur with interval scale data of measures like desirability, scenic beauty, attractiveness, care, apparent ecological quality, naturalness, etc., which can be compared across regions. A local, fine-scale spatial data baseline for a sample landscape in Cornbelt USA might include nominal landcover classes like strip-cropping, corn/soybean rotation, or herbaceous riparian buffer strip, nominal landcover classes for a sample agricultural landscape. Across regions, these landscapes might be described by their interval scale ratings as: highly attractive, or moderately unattractive. The montado landscape in the Alentejo region of Portugal might include very different nominal landcover classes like, cork oak with cereal understory, or holm oak with grazed pasture understory. However, these landscapes, too, might be described by their interval scale ratings as: highly attractive, or moderately attractive. These are very different landcovers and agricultural systems could be compared on regional residents' ratings of conceptual dimensions of landscape perception. To allow for international and regional comparisons, baseline data sets could focus on experiential concepts rather than only particular landcovers.

Determine what data are available, or practically could be gathered, to build a baseline and maintain a monitoring system.

Costs of data-gathering and management are formidable barriers to applying indicators across wide areas. For this reason, the Heinz Center (2002) built indicators for farmland ecosystems for the United States solely with currently available data. However, there are not currently available data for directly monitoring landscape quality across the United States, or across the OECD nations. Resolving the tension between using available landcover/land use data interpreted from satellite images and representing perceived fine-scale and regional variation in landscapes is a key metholological challenge for agricultural landscape indicators. Building interval scale, quantitative indicators that can encompass a variety of local nominal landcover/land use scales should be considered. Certain adjectival scales (operationalized as bi-polar adjective scales, Likert scales, or emerging from Q-sort analyses) have repeatedly proven their validity in landscape perception studies over the past thirty years (e.g., Zube , et al. 1974, Fairweather and Swaffield 2000). Employing these scales redundantly, as multiple measures, will be useful to establishing a landscape indicator baseline. As landscape indicators are constructed from responses to enormously varied local landscapes, as they are applied to spatial data sets that are limited in resolution and classes, and as they are strategically linked with other indicators – certain scales may prove to be more pragmatically useful than others. A baseline landscape indicator set should offer alternative interval scale measures that will allow opportunistic trials for their fit with other data and indicators.

New technologies, like web-based landscape perception surveys can dramatically increase the efficiency with which such interval scale measurement can be applied to a wide variety of landcover/land use combinations in local landscapes (e.g., Wherrett 2000, Bishop 1999). With an adequate respondent sample size, a relatively large number of landcover/land use landscape combinations can be measured. With an adequate repeat measures respondent sampling strategy, such an approach also lends itself to monitoring over time. Where web-based surveys cannot reach all people who should be sampled, traditional landscape perception survey techniques can augment web-based data gathering.

Articulate the value of landscape meaningfully in the context of other agricultural indicators that are more widely understood and valued in the scientific and policy communities.

While landscape indicators must necessarily begin with nominal data representing a large number of classes or types, interval scale quantitative data may be more useful for making comparisons across political boundaries and regions, across changing landscapes over time, and in relationship to other quantified indicators for biogeochemical, population, and economic phenomena. Agricultural landscape indicators that nest measurement of fine-scale local landscapes within broader conceptual categories of perception and within broader spatial classes at lower resolutions will not only ameliorate methodological problems. Such an approach also will "speak the language" of science and policy. Interval scale data on landscape perception will allow for quantitative comparisons and speak the language of science and policy. These conceptual data should be constructed to allow them to be linked to spatial data in geographic information systems (GIS). Ultimately, indicators should be mapped to allow comparisons across regions and nations, and over time.

Too often in the past, managing landscape value has been misunderstood as hopelessly intractable, subject to the arbitrary whims of individual taste. Results of empirical landscape perception research and recent thought in environmental aesthetics correspond in their conclusions: community values underpin landscape values, and are subject to measurement and mapping (e.g., Eaton 1990, USDA 1995, Eaton 1997, Nassauer 1997). High level generalizations are not only possible but "natural" to the experience of landscape. Explaining what makes for landscape value is challenging, and it is our challenge in this workshop, but experiencing landscape value is a commonplace of everyday life across cultures. Our work in recommending agricultural landscape indicators is to go the next step: to show how indicators can be selected and developed so that they will be widely understood tools for affecting the future of landscapes.

Recommendations

In summary, agricultural landscape indicators should be developed to be cognizant of their capacity to:

1. Monitor and protect landscape quality.
2. Anticipate innovation and novel future landscape characteristics.
3. Anticipate how changing landscape quality may effect and be affected by changing ecological, production, population, and economic phenomena.
4. Anticipate cumulative effects of fine-scale local landscape changes.
5. Anticipate displaced landscape effects beyond the boundaries of OECD member nations.
6. Strategically anticipate how public perception of landscapes may affect opinions of policy and ecological, population, and agricultural change.

Landscape indicator data structures should grow from considering the following recommendations:

1. Establish baseline data in a nested hierarchy of scales – validly reflecting the fine scale of landscape perception and pragmatically setting up links to coarser, more extensive spatial data.
2. Establish a system for regularly monitoring the indicators selected.
3. Employ regional representational cluster sampling or “hot spot” samples to assure that fine-scale perception data are linked to broad scale spatial and conceptual data.
4. Base fine-scale indicators on responses to landscape images – direct representations of visible characteristics.
5. Use available technologies (e.g., web-based surveys) to set up cost-efficient systems for regularly gathering perception data.
6. Facilitate comparisons across regions, nations, and over time by gathering interval scale data that measures experiential concepts.
7. Link landscape indicator data with biogeochemical, population, and economic data.
8. Look for and model relationships between landscape indicators and other agricultural indicators.
9. Link perception data (describing response to small spatial extents at fine scales) to GIS spatial data (describing broad spatial extents at coarser scales).
10. Link interval scale conceptual data with nominal scale landcover/land use and landscape type data.
11. Map landscape indicators at broad spatial extents, and possibly, at small extents.

My recommendations are not comprehensive. They are offered as a part of our discussion at this workshop, where our many experiences and perspectives will allow us to think together about recommendations to the OECD. Our opportunity is to assure consideration of landscape, the essential fabric by which we understand what is happening in our worlds and in which we seek invaluable lifetime satisfactions.

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Indicators for the Value of Agricultural Landscapes

Ståle Navrud
Department of Economics and Social Sciences
Agricultural University of Norway
e-mail: stale.navrud@ios.nlh.no

1. Sustainability and Physical versus Economic Indicators

There are two distinct ways of introducing the sustainability concept in decision-making, either as an exogenous variable in the form of physical indicators or as an endogenous variable in economic models, i.e. economic indicators. These two approaches are here termed strong sustainability and weak sustainability, respectively. The Strong Sustainability approach is advocated mainly by (landscape) ecologists, and the Weak Sustainability approach by economists.
In scholarly usage the term sustainability originally referred to harvesting regimen for specific reproducible natural resources that could be maintained over time (e.g. sustained-yield fishing). Ecologists have considerably broadened that meaning in order to express concerns about preserving the status and function of entire ecological systems. Economists, on the other hand, usually have emphasised the maintenance and improvement of human living standards, in which natural resources and the environment may be important but represent only part of the story. Other disciplines, notably geography and anthropology, bring in concerns about the condition of the social and cultural systems (e.g. preservation of aboriginal knowledge and skills).
Even between economists there are significant differences in the interpretation of this concept. Some treat sustainability as not much more than another way of espousing economic efficiency in the management of services derived from Nature (e.g. Dasgupta and Mäler 1991), which in itself would be no small accomplishment given the current inefficiencies of resource use throughout the world. Others claim that conventional economic efficiency criteria are inadequate for addressing sustainability concerns (e.g. Norgaard 1988, Daly and Cobb 1989 and a number of essays in Constanza 1991). Meanwhile, Solow (1993a, 1993b) acknowledges the significance of intergenerational equity in sustainability, but largely emphasises conventional efficiency criteria.

Despite the lack of 'textbook' definitions of sustainability which command widespread acceptance, two issues are agreed to be central: i) intergenerational equity and ii) resource substitutability. The first issue reflects a concern for the well-being of future generations in the face of the growing pressure on the natural environment to provide a range of services (extractable materials, waste absorption, ecological system resilience, landscape aesthetics and recreational opportunities). Hence, the definition of sustainable development presented in the report of the World Commission on Environment and Development (1987, p. 43) emphasises: "development that meets the need of the present without compromising the ability of future generations to meet their own needs". The second key aspect of defining sustainable development is the capacity of the economic system to substitute other man-made capital for natural capital in order to maintain the welfare of future generations constant. Natural capital is the total repository of service capacities from the natural environment, and man-made capital can be viewed as the sum of manufactured capital, cultural and human capital.

Thus, the substitutability between different forms of resources or capital is closely related to the question of the carrying capacity of natural ecosystems. Given potential non-substitutability between services derived from natural and man-made capital, a complete sustainability criterion must address the flow of natural capital services as well as intergenerational fairness. Concepts of defining and measuring sustainable development can broadly be placed in four categories, ranging from very weak to very strong sustainability (Klassen and Opschoor 1990).

1.1 Very Weak Sustainability

This sustainability rule merely requires that the overall stock of capital assets should remain constant over time. The rule is, however, consistent with any one asset being reduced as long as another capital asset is increased to compensate. This concept is based on mainstream neo-classical economic theory and assumes that natural and man-made capital are close substitutes.

1.2 Weak Sustainability

Some UK based environmental economists have modified the very weak sustainability approach by introducing an upper bound on the assimilative capacity assumption, as well as a lower bound on the level of natural capital stocks that can support sustainable development (Barbier and Markandya 1990, Pearce and Turner 1990). The concept of critical natural capital (e.g. keystone species and processes) has also been introduced to account for non-substitutability of certain types of natural capital (e.g. environmental support services) and man-made capital.

This implies a sustainability constraint which will restrict, to some degree, resource-using economic activities. The constraint will be required to maintain populations/resource stocks within bounds thought to be consistent with ecosystem stability and resilience. A set of physical indicators will be required in order to monitor and measure biodiversity and ecosystem resilience. As yet there is no scientific consensus on how biodiversity should be measured. For some commentators sustainability constraints of this type represent expressions of the precautionary principle (O´Riordan 1992) and might be related to safe minimum standards as developed by Ciriacy-Wantrup (1952), and Bishop (1978).

Figure 1 illustrates the Weak Sustainability-approach. The vertical line depicts the critical level of natural capital (K). Substitution between natural capital and man-made capital is possible only to the right of this line. To get increased economic growth (i.e. increased man-made capital) natural capital must be reduced. The Very Weak Sustainability approach, on the other hand, assumes there is no such critical level, and that substitution is possible over the whole range of natural and man-made capital. The World Commission on Environment and Development (1989) argues that the two forms of capital are complements, rather than substitutes. In Figure 1 a straight line drawn from origin to the upper right corner of the diagram could illustrate this. Substitution between natural capital and man-made capital is possible only to the right of K, which is the critical level of natural capital. The complementarity hypothesis implies that increased economic growth (i.e. increased man-made capital) leads to an increase in natural capital, since poverty could lead to short term planning and over-utilisation of natural resources. This hypothesis might describe the situation in developing countries, while the ‘trade-off’ (substitution) hypothesis in Figure 1 gives a better picture of developed countries. However, if developed countries have reduced their natural capital to the left of K, natural capital and man-made capital could be viewed as complimentary (i.e. an increase in natural capital would be necessary to get increased economic growth).

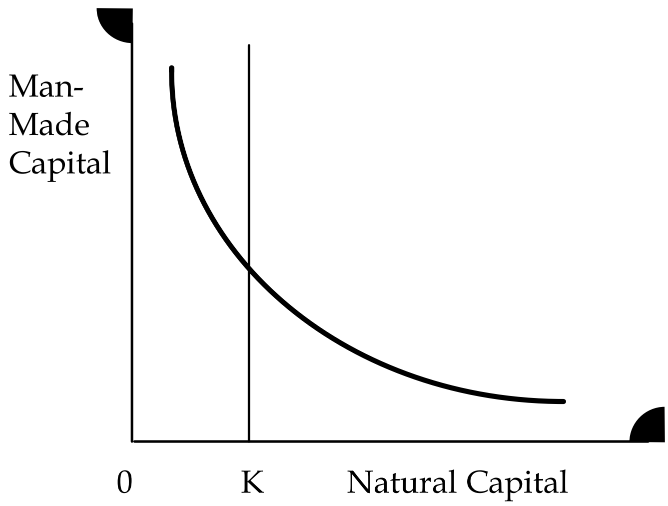

Figure 1. The Weak Sustainability View.

1.3 Strong Sustainability

The weaker sustainability rules assume that monetary values can be attached to all parts of natural capital. Many ecosystem functions and services can be adequately valued in economic terms, but others may not be amenable to meaningful monetary valuation. Critics of conventional economics have argued that the full contribution of component species and the processes provided by ecosystems for life support are beyond capture in economic values (Ehrlich and Ehrlich 1992). This sustainability view, which might be termed the ecological economics approach, requires that natural capital be constant, and the rule be measured via physical indicators.

While akin to safe minimum standards, Strong Sustainability is different. Safe minimum standards says conserve unless the benefits foregone (social opportunity costs) are very large. Strong Sustainability says, whatever the benefits foregone, some "critical", natural capital losses are unacceptable. Strong Sustainability need not imply a steady-state, stationary economy, but rather changing economic resource allocations over time which are insufficient to affect the overall ecosystem parameters significantly. A certain degree of economic growth should therefore be possible via investment in technical change, substitution of intermediate natural capital for natural capital, and environmental restoration.

In practice, the difference between Weak Sustainability and Strong Sustainability will probably be less clear-cut, becoming more a difference in motivation and psychology. Given the social, economic and scientific uncertainties, a safety margin mentality with respect to "critical" and "other" natural capital would be dominant.

1.4 Very Strong Sustainability

This criterion defines a Stationary State Sustainability. A steady-state economic system is based on thermodynamic limits and the constraints they impose on the overall scale of the macro-economy. Daly (1991) has defined the ‘scale effect’ as the scale of human impact relative to global carrying capacity. To Daly the greenhouse effect, ozone layer depletion, and acid rain all prove that we have already gone beyond a prudent "plimsoll line" for the scale of the macro-economy. Zero economic growth and zero population growth are required for a zero increase in the "scale" of the macro-economy.

In practice, these various sustainability paradigms are less clearly defined and overlapping. However, to simplify, one could say that the weak sustainability criteria use monetary indicators (i.e. economic valuation of environmental impacts), while the strong criteria use physical indicators (e.g. critical loads of pollutants).

2. Overview of economic valuation techniques for agricultural landscape

Economists have developed a variety of techniques to value non-market environmental and cultural amenities like agricultural landscapes, which are consistent with the valuation of marketed goods; i.e. based on individual preferences. These techniques are based upon either observed behaviour (revealed preferences; RP) towards some marketed good with a connection to the non-marketed good of interest, or stated preferences (SP) in surveys with respect to the non-marketed good; see table 1, part I for an overview of these techniques. While RP and SP techniques are based on individual preferences, and are rooted in welfare economics, other methods for economic valuation of environmental and cultural amenities have also been proposed. These methods are based on the preferences of policy makers, scientific experts or specific interest groups. I will first review some of these techniques, before focusing on methods based on individual preferences, which is the basis for most policy uses of environmental valuation techniques, including cost-benefit analysis (CBA) and externality adders/environmental costing.

Table 1, part II gives an overview of these alternative techniques to environmental valuation. The method of Implicit Valuation (IV) derives values that are implicit in policy decisions. IV assumes that the policy makers had complete information about the impacts on the environmental goods, and that we are able to sort out these values from other considerations implicit in the decision; see Carlsen et al. (1994) for an empirical application of the IV technique. This technique can be viewed as an indirect, revealed preference method, but reveal policy makers´ preferences rather than individual preferences. (Democratically elected policy makers could be said to represent individual preferences, but policy makers might pursue own interests that could conflict with individual preferences). In spite of the potential biases of IV, the method could serve as a corrective to policy makers by making them aware of the economic values they implicitly assign to environmental and cultural goods through the decisions they have made. The method can also be used to make policy makers aware of implicit values from decisions they are about to make, e.g. by pointing out the values they would implicitly attach to unvalued environmental impacts in a CBA dependent upon the project alternative they choose.

Delphi methods can be used to solicit the opinions of experts. Most Delphi exercises administer one or more questionnaires interspersed with information to a group of experts. Typically, the experts are polled one or more times; and between pollings, information about the opinions of the group of experts as a whole is disseminated among the group (Ziglio 1996). In the case of valuing environmental goods and environmental related health impacts, the experts could be natural scientists and health experts as in Navrud (1997), or environmental economists as in (Carson et al 1997). Carson et al (1997) asked a panel of 30 European environmental economists familiar with contingent valuation (CV) to estimate the economic value of a global public good; the Fes Medina in Morocco (which was put on the UNESCO World Cultural and Natural Heritage list as early as 1980). In this case the experts were asked not about their own opinion concerning the value of the restoration of the Fes Medina, but rather for their professional judgements as to what they would expect the estimate of the non-market economic value to be in their respective countries and in Europe as a whole if a contingent valuation (CV) study concerning restoration of Fes Medina were to be considered. Thus, in this case experts provide one number representing public value for a given good when the value is measured in a certain way, making the results verifiable in principle. (This exercise can be viewed as each respondent performing a simple value transfer exercise in the first phase, but then in the second phase, which is typical of a Delphi exercise, they are asked whether they will reconsider their values having seen the results the others gave.). This sort of Delphi study can be viewed as indirectly reflecting individual preferences, since experts are not asked about their own preferences, but to predict individual preferences.

Multi Criteria Analysis (MCA) involves identifying decision criteria (one of which could be a monetary measure), a scale for each criteria and different alternatives that scores differently for the different criteria. Then, the experts are asked to choose between the alternatives. A software packages is used to calculate the implicit weights for each criteria (which their choices imply), the scores for each criteria of the different alternatives are changed, and the experts are asked to make a new choices. After a number of iterations, a set of criteria weights can be calculated. This is only one approach of weighting and scoring under MCA. It is also possible to calculate the implicit tradeoffs between units of each criterion in terms of the units of a specified criterion. If e.g. the cost of alternative measures to preserve the agricultural landscape is one of the criteria, this procedure can be used to calculate the willingness-to-pay for changes in the aesthetic beauty of agricultural landscape (assuming that marginal changes in this environmental good could be identified and measured in a meaningful way). This specific MCA technique has much in common with the indirect stated preference methods known as choice experiments (CE), but elicit preferences of decision makers, experts or interest groups rather than the preferences of a random sample of the affected individuals.

In many cases there will be differences between individual preferences and the preferences of interest groups/decision makers, and question then becomes: Whose preferences should count?

Welfare economics and its applied tool, CBA, are based on individual preferences, and will secure that these preferences are taken into account when decisions are made. Experiences from both Europe and USA (Navrud and Pruckner 1997) have shown that CBA and other uses for environmental valuation techniques are used as an input in environmental decision-making, but not as a stand-alone decision-making device. Even though cost effectiveness plays a major role in establishing landscape preservation programmes, the decision makers also considers other criteria (e.g. equity considerations, administrative cost, and "political acceptability"). However, to be consistent with the basic welfare economic principles underlying CBA, environmental valuation techniques based on individual preferences should be used. Techniques based on preferences of decision makers, interest groups or experts can be used as an alternative or complementary decision tool to CBA.

Table 1. Classification of Environmental Valuation Techniques

I) Methods based on individual preferences

	Indirect	**Direct**
Revealed Preferences (RP)	Household Production Function (HPF) Approach - Travel Cost (TC) method - Averting Costs (AC) Hedonic Price (HP) analysis	Simulated markets Market prices Replacement Costs (RC)
Stated Preferences **(SP)**	Choice Experiments (CE)	Contingent Valuation (CV)

II) Methods based on decision makers´/experts´/interest groups´ preferences

- Revealed Preferences
Indirect
- Implicit Valuation (IV)

- Stated Preference
Direct
- Delphi Method

Indirect
- Multi Criteria Analysis (MCA)

3. Strengths and weaknesses of valuation techniques based on individual preferences

Revealed Preference techniques can be divided into direct and indirect methods. Direct methods include **simulated market exercises** (i.e. constructing a real market for a public good). This is most often not possible to do, and when possible, it´s usually very time-consuming and costly. Some environmental impacts can be valued using dose-response functions and **market prices**, e.g. impacts on crops, forests and building materials (corrosion and soiling) from air pollution. This approach uses only the physical or biological dose-response relationship to estimate the response to a change in some environmental parameter. The observed market price of the activity or entity is then multiplied by the magnitude of the physical or biological response to obtain a monetary measure of damage. Thus, neither behavioural adaptations nor price responses are taken into account. Simple multiplication provides an accurate estimate of economic behaviour and value – in this case changes in gross revenue – only if economic agents are limited in the ways in which they can adapt to the environmental effect and if the effect is small enough to have little or no impact on relative prices. This combination of circumstances is very unlikely. If e.g. crop damages from air pollution is large enough to change prices, changes in consumer and producer surpluses have to be calculated. If farmers undertake preventive measures, e.g. switching to crops that are less sensitive to air pollution, the simple multiplication approach will overestimate damage costs. Thus, other approaches should be used, see Adams and Crocker (1991).

The **replacement cost method** (also termed restoration cost method) has been used to estimate economic damages from soil erosion, by using market prices for soil and fertilizers to calculate what it would cost to replace the lost soils. This approach has also been used to calculate loss of ecosystem functions. Restoration costs are, however, just arbitrary values that might bear little relationship to true social values. Individuals` willingness-to pay for the restoration of environmental and cultural amenities may be more or less than the cost of replacement.

The greatest advantage of these direct RP methods are that they are relatively simple to use. But as noted earlier, the methods ignore the behavioural responses of individuals to changes in the environmental amenities. They also obscure the distinction between benefits and costs – there is no guarantee that people are actually willing to pay the estimated cost.

The indirect RP methods entails two main groups of methods; the household production function approach (including the popular Travel Cost method and averting cost method; and the hedonic price analysis.

The **household production function** (HPF) approach involves investigating changes in consumption of commodities that are substitutes or complements for the environmental attribute. The *Travel Cost (TC)* method, used widely to measure the demand for recreation, is a prominent example. The costs of travelling to a recreation site together with participation rates, visitor attributes, and information about substitute sites are used to derive a measure for the use value of the recreational activity at the site. Travel can be used to infer the demand for recreation, only if it is a necessary part of the visit, or in economic terms is a *weak complement*. TC models builds on a set of strict assumptions, which are seldom fulfilled, and the results are sensitive to the specification of the TC model, the choice of functional forms, treatment of travel time and substitute sites etc. However, they can be relatively cheap to perform (compared to SP methods), and give reasonably reliable estimates for *use* values of natural resources (e.g. recreational fishing, hunting and hiking) for the *current* quality off a site.

Another example of the use of the household production function approach is the use of *Averting Costs* (AC) (also known as defensive or preventive expenditures) to infer value. Averting inputs include air filters, water purifiers, noise insulation, and other means of mitigating personal impacts of pollution. Such inputs substitute for changes in environmental attributes; in effect the quality of a consumer´s personal environment is a function of the quality of the collective environment and the use of averting inputs. We measure the value of changes in the collective environment by examining costs incurred in using averting inputs to make the personal environment different from the collective environment. A rational consumer will buy averting inputs to the point where the marginal rate of substitution between purchased inputs and the collective environment equals the price ratio. By characterizing the rate of substitution and knowing the price paid for the substitute, we can infer the price that consumers would be willing to pay for a change in the environment. The common element in household production methods is the use of changes in the *quantities* of complements to estimate the value of a change in quality.

The HPF approach uses actual behaviour as the basis for valuation, but is limited to *use value.* Non-use values, that do not entail direct consumption, cannot be estimated by looking at complements or substitutes. HPF approaches have mostly been used to value recreational activities, health and material damages.

Hedonic Price (HP) analysis refers to the estimation of implicit prices for individual attributes of a market commodity. Some environmental goods and services can be viewed as attributes of a market commodity, such as real property. For example, proximity to noisy streets, noisy airports and polluted waterways; smell from hog operations, factories, sewage treatment plants and waste disposal sites; exposure to polluted air, and access to parks or scenic vistas of agricultural landscapes are purchased along with residential property. Part of the variation in property prices is due to differences in these amenities. HP data can be quite costly to get, as there is often no database of residential properties, which have data on all attributes, including environmental amenities that could affect property prices. The HP function is very sensitive to the specification and functional form, and it is often difficult to find a measure for the environmental amenity where data exist, and which the bidders for residential properties can recognize marginal changes in and has complete information about at the time they bid for the property. Two examples: (i) There is often no data on traffic noise levels, and using the annual average number of vehicles on the nearest road or distance to this road is as a proxy variables for noise levels, could easily value all road traffic related externalities (including accident risks, health impacts from air pollution, barrier effects and soiling). (ii) Properties are shown to potential buyers on Sundays when there is little traffic on the nearby road, and thus they place their bid on the property with incomplete information about the road traffic noise level. For an application of the HP method on landscape aesthetics, see Tyrväinen (1997),

While (indirect) RP methods are based on actual behaviour in a market for goods related to the environmental good in question (and thus the value for the environmental goods is elicited based on sets of strict assumptions about this relationship), SP methods measure the value of the environmental good in question by constructing a hypothetical market for the good. The hypothetical nature is the main argument against SP methods. However, no strict assumptions about the relationship between marketed complements or substitutes, or attributes of a marketed good and the environmental good have to be made. SP methods also have the advantages of being able to measure the Total Economic Value (TEV), including both use and non-use value (also termed passive use value), derives the "correct" Hicksian welfare measure, and can measure *future changes* in environmental quality.

The Stated Preference methods can be divided into direct and indirect approaches. The direct Contingent Valuation (CV) method is by far the most used method, but over the past few years the indirect approach of Choice Experiments (CE) have gained popularity. The main difference between these two approaches is that while the CV method typically is a two-alternative (referendum) approach, CE employs a series of questions with more than two alternatives that are designed to elicit responses allowing for estimation of preferences over attributes of an environmental state.

A **Contingent Valuation (CV)** survey constructs scenarios that offer different possible future government actions. Under the simplest and most commonly used CV question format, the respondent is offered a binary choice between two alternatives, one being the status quo policy, the other alternative policy having a cost greater than maintaining the status quo. The respondent is told that the government will impose the stated cost (e.g. increased taxes, higher prices associated with regulation, or user fees) if the non status quo alternative is provided. The key elements here are that the respondent provides a "favour/not favour answer" with respect to the alternative policy (versus the status quo), what the alternative policy will provide, how it will be provided, and how much it will cost, and how it will be charged for (i.e. payment vehicle), have been clearly specified. This way of eliciting willingness-to-pay is termed binary *discrete choice*. An alternative elicitation method is *open-ended* questions where respondents are asked directly about the most they would be willing to pay to get the alternative policy (with or without the visual aid of a payment card, i.e. randomly chosen amounts ranging from zero to some expected upper amount). One of the main challenges in a CV study is to describe the change in the environmental or cultural amenity the alternative policy will provide in a way that is understandable to the respondent and at the same time scientifically correct.

Concerns raised by CV critics over the reliability of the CV approach led the US National Oceanic and Atmospheric Administration (NOAA) in to convene a panel of eminent experts co-chaired by Nobel

Prize winners Kenneth Arrow and Robert Solow to examine the issue. In January 1993, the Panel, after lengthy public hearing and reviewing many written submissions issued a report which conclude that “CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resources damages – including lost passive use value” (Arrow et al. 1993). The Panel suggested guidelines for use in Natural Resource Damage Assessment (NRDA) legal cases to help ensure the reliability of CV surveys on passive use values including the use of in-person interviews, a binary discrete choice question, a careful description of the good and its substitutes, and several different tests should be included in the report on survey results. Since the Panel has issued the report, many empirical tests have been conducted and several key theoretical issues have been clarified. The simplest test corresponds to a well-known economic maxim, the higher the cost the lower the demand. This price sensitivity test can easily be tested in the binary discrete choice format, by observing whether the percentage favouring the project falls as the randomly assigned cost of the project increases, which rarely fails in empirical applications.. The test that has attracted the most attention in recent years is whether WTP estimates from CV studies increase in a plausible manner with the quantity or scope of the good being provided. CV critics often argue that insensitivity to scope results from what they term “warm-glow”, by which they mean getting moral satisfaction from the act of paying for the good independent of the characteristics of the actual environmental good. There have now been a considerable number of tests of the scope insensitivity hypothesis (also termed “embedding”), and recent review of the empirical evidence suggests that the hypothesis is rejected in a large majority of the tests performed (Carson 1997).

Producing a good CV survey instrument requires substantial development work; typically including focus groups, in-depth interviews, pre-test and pilot studies to help determine how plausible and understandable the good and scenario presented are. The task of translating technical material into a form understood by the general public is often a difficult one. Adding to the high costs of CV surveys is the recommended mode of survey administration being in-person interviews (Arrow et al 1993). Mail and telephone surveys are dramatically cheaper, but mail surveys suffer from sample selection bias (i.e. those returning the survey are typically more interested in the issue than those who do not) and phone surveys have severe drawbacks if the good is complicated or visual aids are needed. CV results can be quite sensitive to the treatment of potential outliers. Open-ended survey questions typically elicit a large number of so-called protest zeros and a small number of extremely high responses. In discrete choice CV questions, econometric modelling assumptions can often have a substantial influence on results obtained. Any careful analysis will involve a series of judgmental decisions about how to handle specific issues involving the data, and these decisions should be clearly noted.

According to Carson (2000) the recent debate surrounding the use of CV is, to some degree, simply a reflection of the large sums at stake in major environmental decisions involving passive use and the general distrust that some economists have for information collected from surveys. Outside of academic journals, criticism of CV has taken a largely anecdotal form, ridiculing the results of particular CV studies, many of which use techniques known to be problematic. The implication drawn is that all CV surveys produce nonsense results upon which no reasonable person would rely. In an academic context, however, the debate over the use of CV has been more productive. The spotlight placed upon CV has matured it; its theoretical foundations and limits to its users are now better understood. The CV method has still not reached the routine application stage, and all CV surveys should include new research/tests. Carson (2000) concludes that perhaps the most pressing need is on how to reduce the costs of CV surveys while still maintaining a high degree of reliability, and suggests combination telephone-mail-telephone surveys to reduce survey administration costs and implementation of research programs designed at solving some of the more generic representation issues such as low level risk and large scale ecosystems.

Choice experiments (CEs) have been employed in marketing, transportation and psychology literature for some time, and arose from conjoint analysis, which is commonly used in marketing and transportation research. CEs differ from typical conjoint methods in that individuals are asked to choose from alternative bundles of attributes instead of ranking or rating them. Under the CE approach respondents are asked to pick their most favoured out of a set of three or more alternatives, and are typically given multiple sets of choice questions. Because CEs are based on attributes, they allow the researcher to value attributes as well as situational changes; see e.g. Santos (1998) for a CE valuing different attributes of agricultural landscape. Furthermore, in the case of damage to a particular attribute, compensating amounts of other goods (rather than compensation based on money) can be calculated). An attribute-based approach is necessary to measure the type or amount of other "goods" that are required to substitute for losses in natural resource services, which is now a much used approach in Natural Resource Damage Assessments (NRDAs) (Adamowicz et al 1998). This approach can provide substantially more information about a range of possible alternative policies as well as reduce the sample size needed compared to Contingent Valuation (CV). However, survey design issues with the CE approach are often much more complex due to the number of goods that must be described and the statistical methods that must be employed.

Both types of SP methods have been successfully applied to value agricultural landscape, see e.g. Dubgaard et al (1994), Pruckner (1995), Bergland (1998) and Santos (1998). OECD (2001, Annex table 2) provides an overview of results from selected SP studies, mostly CV studies, of agricultural landscape and wildlife conservation. SP methods has also been applied to cultural heritage objects, some of which could be part of the agricultural landscape; see Navrud and Ready (2002) for an overview of empirical studies.

4. Use of valuation techniques in policy

Environmental valuation studies have four main types of use (Navrud and Pruckner 1997):

I. Cost-benefit analysis (CBA) of investment projects and policies,
II. Environmental costing in order to map the marginal environmental and health damages of e.g. air, water and soil pollution from energy production, waste treatment and other production and consumption activities. These marginal external cost can be used in investment decisions and operation (e.g. as the basis for "green taxes")
III. Environmental accounting at the national level (green national accounts), local level (community green accounts) and firm level (environmental reporting), and
IV. Natural Resource Damage Assessment (NRDA); i.e. compensation payments for natural resource injuries from e.g. pollution accidents

Environmental valuation techniques have been used mostly in CBAs, but are now increasingly used also in NDRAs in the US; environmental costing of electricity production from different energy sources in both the US and Europe (see e.g. Rowe et al (1995), Desvousges et al (1998) and European Commission – DG XII (1995, 1999)); and green national accounting exercises, e.g. the Green Accounting Research Project (GARP) of the European Commission (Tamborra 1999, GARP II 1999). The accuracy needed increase, and thus the applicability of benefit transfer techniques decrease, as we move down the list of potential policy uses of valuation studies (Navrud and Pruckner 1997).

CBA has a long tradition in the US as a project evaluation tool, and has also been used extensively as an input in decision making ever since President Reagan issued Executive Order (EO) 12292 in 1981, necessitating a formal analysis of costs and benefits for federal environmental regulations that impose significant costs or economic impacts (i.e. Regulatory Impact Analysis). In Europe, CBA has a long tradition in evaluation of transportation investment projects in many countries, but environmental valuation techniques were in most cases not applied. There seems to be no legal basis for CBA in any European country, but the UK Environment Act requires a comparison of costs and benefits. Some countries have administrative CBA guidelines for project and policy evaluation, and in a few cases these includes a section on environmental valuation techniques.

Paragraph 130r of the Maastricht Treaty, which focuses on EU´s environmental goals, environmental protection measures and international cooperation in general, says that the EU will consider the burden and advantage of environmental action or non-action. Furthermore, the "Fifth Activity Programme for Environmental Protection Towards Sustainability" (1993 – 2000) says: *In accordance with the Treaty, an analysis of the potential costs and benefits of action and non-action will be undertaken in developing specific formal proposals within the Commission. In developing such proposals every care will be taken as far as possible to avoid the imposition of disproportionate costs and to ensure that the benefits will outweigh the costs over time* (European Community 1993, p. 142). The 1994 Communication from the Commission to the Council of the European Parliament, entitled: "Directions for the EU on Environmental Indicators and Green National accounting - The Integration of Environmental and Economic Information Systems" (COM (94)670, final 21.12.94) states a specific action for *improving the methodology and enlarging the scope for monetary valuation of environmental damage*. More recently, the EC´s Green Paper, entitled:" For a European Union Energy Policy", states that *internalisation of external costs is central to energy and environmental policy*. During the last few years the European Commission has performed CBAs of two new regulations; the large combustion plant directive and the air quality standards. Both analyses rely heavily on the work done within the EC Directorate General (DG) XII´s ExternE project (European Commission - DG XII 1995, 1999). The Environment Directorate (DG XI) of the EC has also started training courses in CBA for their administrative staff to promote better priority setting. Thus, there is an increased interest in using environmental valuation both for CBA, environmental costing and environmental accounting.

International organisations like the OECD, the World Bank and regional development banks and UNEP (United Nations Environment Program) have produced guidelines on environmental valuation techniques; e.g. OECD (1989, 1994, 1995); Asian Development Bank (1996), and UNEP (1995, chapter 12). In many cases they have used valuation techniques as an integral part of CBA of investment projects, e.g. the World Banks evaluation of water and sanitation projects (Whittington 1998). UN´s statistical division UNSTAT has also actively supported the development of resource accounting systems (e.g. the Handbook on Integrated Environmental Economic Accounts). Even though there have been numerous environmental valuation studies in the US and in Europe (see Navrud (1992, 1999) for an overview of European valuation studies), the policy use of valuation studies seem to have concentrated on air and water pollution impacts and policies (Navrud & Pruckner 1997).

Increased use of valuation estimates for agricultural landscape as indicators would mean increase need for more original landscapes valuation studies, and improved techniques for transferring value estimates from one geographical area and context to another area and context; i.e. benefit transfer techniques.

5. Benefit transfer approaches and their reliability

There are two main approaches to benefit transfer:

I. Unit Value Transfer
   a) Simple unit transfer
   b) Unit Transfer with income adjustments
II. Function Transfer
   a) Benefit Function Transfer
   b) Meta analysis

5.1. Unit value transfer
Simple unit transfer is the easiest approach to transferring benefit estimates from one site to another. This approach assumes that the well being experienced by an average individual at the study site is the same as that which will be experienced by the average individual at the policy site. Thus, we can directly transfer the mean benefit estimate (e.g. mean WTP/household/year) from the study site to the policy site.

For the past few decades such a procedure has often been used in the United States to estimate the recreational benefits associated with multipurpose reservoir developments and forest management. The selection of these unit values could be based on estimates from only one or a few valuation studies considered to be close to the policy site, or based on mean values from literature reviews of existing values. Walsh et. al (1992, table 1) presents a summary of unit values of days spent in various recreational activities, obtained from 287 CV and TC studies. More recently the US Oil Spill Act recommends transfer of unit values for assessing the damages resulting from small "Type A" spills or accidents using the National Resource Damage Assessment Model for Coastal and Marine Environment. This model transfers benefit estimates from various sources to produce damage assessments based on limited physical information from the spill site.

The obvious problem with this transfer of unit values for recreational activities is that individuals at the policy site may not value recreational activities the same as the average individual at the study sites. There are two principal reasons for this difference. First, people at the policy site might be different from individuals at the study sites in terms of income, education, religion, ethnic group or other socio-economic characteristics that affect their demand for recreation. Second, even if individuals´ preferences for recreation at the policy and study sites were the same, the recreational opportunities might not be.

Unit values for non-use values of e.g. ecosystems from CV studies might be even more difficult to transfer than recreational (use) values for at least two reasons. First, the unit of transfer is more difficult to define. While the obvious choice of unit for use values are consumer surplus (CS) per activity day, there is greater variability in reporting non-use values from CV surveys, both in terms of WTP for whom, and for what time period. WTP is reported both per household or per individual, and as a one-time payment, annually for a limited time period, annually for an indefinite time, or even monthly payments. Second, the WTP is reported for one or more specified discrete changes in environmental quality, and not on a marginal basis. Therefore, the magnitude of the change, should be close, in order to get valid transfers of estimates of mean, annual WTP per household. Also the initial levels of environmental quality should be close if one should expect non-linearity in the benefit estimate or underlying physical impacts.

On the issue of units to transfer, one should also keep in mind that often the valuation step is part of a larger damage function approach, where we are trying to find values for the endpoints of dose-response and exposure-response functions for environmental and health impacts, respectively, due to changes in e.g. emission of air pollutants. Thus, a linkage has to be developed between the units the endpoints are expressed in, and the unit of the economic estimates. This has been done successfully for e.g. changes in visibility range (Smith and Osborne 1996), but is more difficult as complexity of changes in environmental resources increase.

The simple unit transfer approach is not fit for transfer between countries with different income levels and standard of living. Therefore, unit transfer with income adjustments have been applied, by e.g. using Purchase Power Parity indexes. However, this adjustment will not take care of differences in preferences, environmental conditions, and cultural and institutional conditions between countries. Very few studies have tested for the impacts on valuation of these other factors. Ready et al (1999) conducted the same CV study in five European countries (the Netherlands, Norway, Portugal Spain and United Kingdom). They found that the transfer error in valuing respiratory symptoms was ±38% in terms of predicting mean willingness-to-pay (WTP) to avoid the symptom in one country from the data of the

other countries. The WTP estimates were adjusted with PPP indexes (for the cities the studies were conducted in, since national PPP indexes were not representative for these specific cities). Thus, the remaining differences are due to other factors than income/ purchase power.
These results relates to valuation of respiratory symptoms that can be linked to air or water pollution, and might not be transferable to environmental goods. Thus, we should perform similar types of validity tests of international benefit transfer for both use and non-use value of environmental goods.

5.2 Function transfer

Benefit Function Transfer

Instead of transferring the benefit estimates, the analyst could transfer the entire benefit function. This approach is conceptually more appealing than just transferring unit values because more information is effectively transferred. The benefit relationship to be transferred from the study site(s) to the policy site could again be estimated using either revealed preference (RP) approaches like TC and HP methods or stated preferences (SP) approaches like the CV method and Choice Experiments (CE). For a CV study, the benefit function is:

$$WTP_i = b_0 + b_1 G_{ij} + b_2 C_i + e \qquad (1)$$

where WTP_i = the willingness-to-pay of household i, Gij = the characteristics of the environmental good and site j, and Ci = characteristics of household i , and b_0 , b_1 and b_2 are parameters and e is the random error.

To implement this approach the analyst would have to find a study in the existing literature with estimates of the parameters b_0, b_1, b_2, b_3 and b_4. Then the analyst would have to collect data on the four independent variables at the policy site. The values of these independent variables from the policy site and the estimates of b_0, b_1, b_2, b_3 and b_4 from the study site would be replaced in the CV model (1), and this equation could then be used to calculate households´ willingness-to-pay at the policy site.

The main problem with the benefit function approach is due to the exclusion of relevant variables in the bid or demand functions estimated in a single study. When the estimation is based on observations from a single study of one or a small number of recreational sites or a particular change in environmental quality, a lack of variation in some of the independent variables usually prohibits inclusion of these variables. For domestic benefit transfers researchers tackle this problem by choosing the study site to be as similar as possible to the policy site. The exclusion of methodological variables makes the benefit function approach susceptible to methodological flaws in the original study. In practise researchers tackle this problem by choosing scientifically sound original studies.

Meta-analysis

Instead of transferring the benefit function from one valuation study, results from several valuation studies could be combined in a meta-analysis to estimate one common benefit function. Meta-analysis has been used to synthesize research findings and improve the quality of literature reviews of valuation studies to come up with adjusted unit values. In a meta-analysis original studies are analysed as a group, where the results from each study are treated as a single observation into new analysis of the combined data set. This allows us to evaluate the influence of the resources´ characteristics, the features of the samples used in each analysis (including characteristics of the population affected by the change in environmental quality), and the modelling assumptions. The resulting regression equations explaining variations in unit values can then be used together with data collected on the independent variables in the model that describes the policy site to construct an adjusted unit value. The regression from a meta-analysis would look like equation (1), but with one added independent variable C_s = characteristics of the study *s* (and the dependent variable would be WTP_s = mean willingness-to-pay from study *s*).

Smith and Kaoru's (1990) and Walsh et al (1990, 1992) meta-analyses of TC recreation demand models using both summary of TC and CV studies for the US Forest Service's resource planning program, were the first attempts to apply meta-analysis to environmental valuation. Later there have been applications to HP models valuing air quality (Smith and Huang 1993), CV studies of both use and non-use values of water quality improvements (Magnussen 1993), CV studies of groundwater protection (Boyle et al 1994), TC studies of freshwater fishing (Sturtevant et al (1995), CV studies of visibility changes at national parks (Smith and Osborne 1996), CV studies of morbidity using Quality of Life Years (QUALY) indexes (Johnson et al 1996), CV studies of endangered species (Loomis and White 1996), CV studies of environmental functions of wetlands (Brouwer et al 1997), and HP studies of aircraft noise (Schipper et al 1998). Only the last two studies are international meta-analyses, including both European and North American studies. All the others, except Magnussen (1993), analyse US studies only.

Many of these meta-analyses of relatively homogenous environmental goods and health effects are not particularly useful for benefit transfer even within the US, where most of these analyses has taken place, because they focus mostly on methodological differences[1]. Methodological variables like "payment vehicle", "elicitation format", and "response rates" (as a general indicator of quality of mail surveys) in CV studies, and model assumptions, specifications and estimators in TC and HP studies, are not particularly useful in predicting values for specified change in environmental quality at the policy site. This focus on methodological variables is partly due to the fact that some of these analyses were not constructed for benefit transfer (e.g. Smith and Kauro 1990, Smith and Huang 1993, and Smith and Osborne 1996), and partly because there were insufficient and/or inadequate information reported in the published studies with regards to characteristics of the study site, the change in environmental quality valued, and income and other socio-economic characteristics of the sampled population. Particularly, the last class of variables would be necessary in international benefit transfer, assuming cross-country heterogeneity in preferences for environmental goods and health effects.

In most of the meta-analyses secondary information was collected on at least some of these initially omitted site and population characteristics variables or for some proxy for them. These variables makes it possible to value impacts outside the domain of a single valuation study, which is a main advantage of meta-analysis over the benefit function transfer approach. However, often the use of secondary data and/or proxy variables introduces added uncertainty, e.g. using income data for a regional population in lack of income data for fishermen at the study site. On the other hand, this secondary data are more readily available at the policy site without having to do a new survey.

Most meta-analyses caution against using them for adjusting unit values due to potential biases from omitted variables and specification/measurement of included variables. To increase the applicability of meta-analysis for benefit transfer, one could select studies that are as similar as possible with regards to methodology, and thus be able to single out the effects of site and population characteristics on the value estimates. However, it is a problem that there are usually so few valuation studies of a specific environmental good or health impact, that one cannot to do a statistically sound analysis.

[1] Carson et al (1996) is an example of a meta analysis of different environmental goods and health effects, which was performed with the sole purpose of comparing results from valuation studies using both stated preference (CV) and revealed preference methods (TC, HP, defensive expenditures and actual market data).

6. Potential for increased policy use of original and transferred value estimates

Results from validity tests indicate that the uncertainty in benefit transfers could be potentially large, and in the order of ± 20-40 % for recreational values, water quality and morbidity (Bergland et al 1995 Downing and Ozuno 1996, Brouwer and Spaninks 1999, Ready et al 1999). Therefore, benefit transfer should be applied in policy uses where this level of accuracy is acceptable. This means using benefit transfer in cost-benefit analyses (CBA) of projects and policies, since CBA will most often only be a part of the information upon which decisions are made. One should be more careful in using transferred values in environmental costing and accounting exercises where the results will be used directly to determine the size of e.g. green taxes and the green adjustment factors to systems of national accounts, respectively. Natural Resource Damage Assessments (NRDA) demand an even higher level of precision since these results (more or less directly) are used to calculate compensation payments to be paid by an identified polluter. Thus, one should be even more careful in using benefit transfer in NDRAs (Navrud and Pruckner 1997)

Benefit transfer is less than ideal, but so are most valuation efforts in the sense that better estimates could be obtained if more time and money were available. Analysts must constantly judge how to provide policy advice in timely manner, subject to the resource constraints they face. Benefit transfer methods may be particularly useful in policy contexts where rough or crude economic benefits may be sufficient to make a judgement regarding the advisability of a policy or project. Therefore analysts should compare the benefits of increased accuracy of the benefit estimates (when going from a benefit transfer exercise to a new, original valuation study) with the costs of making the wrong decision based on the benefit transfer estimate.

7. Conclusion

This paper has reviewed environmental valuation techniques, which can be used to value landscape and other amenity values of multi-functional agriculture. Recreational (use) value of rural amenities can be estimated using several valuation methods; both revealed (observed, actual) preferences and stated (expressed) preferences techniques. Unit values, i.e. use value per activity day, for different recreational activities can be transferred from one geographical location to another with transfer errors which in most cases would be acceptable in cost-benefit analyses. Non-use values of rural amenities expressed as willingness-to-pay to preserve e.g. aesthetic beauty and biodiversity of agricultural landscape have to be based on stated preference techniques, and is in general more difficult and uncertain both to value, transfer and aggregate. The main obstacles to increased policy use of rural amenity values include methodological issues of stated preference methods, lack of valuation studies constructed with benefit transfer in mind, high cost of doing new, original valuation studies, and lack of guidelines for applying benefit transfer approaches and for determining the size of the affected population (which is needed to calculate aggregate benefits). These challenges should be met by:

I. Performing new state-of-the-art valuation studies of all functions of agricultural landscapes, to establish a set of representative values for these functions in each country. These valuation studies should be designed with benefit transfer and policy use of the estimated values in mind.
II. Developing improved benefit transfer techniques and a protocol for benefit transfer, including guidelines on how to determine the “size of the market”(i.e. the number of households affected by the policy that is valued in order to estimate total benefit/costs)
III. Establishing a database of environmental valuation studies (also containg studies worldwide of all functions of agricultural landscapes)

Recently, some progress has been made on the last two issues.

- Based on a review of value transfer studies and validity tests of transfer, Brouwer (2000) propose a seven-step protocol for good practice when benefit transfer is used in CBAs.
- The web-based database EVRI (Environmental Valuation Reference Inventory, www.evri.ec.gc.ca/EVRI/) now contains about 700 valuation studies. The majority of these studies are from North America, but the number of European and Asian studies captured in this database is steadily increasing (see also Navrud 1999 for a favourable evaluation of the suitability of EVRI for capturing European valuation studies).

To conclude, for the EVRI data base to be useful in economic valuation of functions of agricultural landscapes, there is a need to increase the number of existing valuation studies presented in this database, but the most pressing need is for new, original valuation studies, designed with benefit transfer in mind.

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Shaping Future Landscapes: The Scenario Approach

Bärbel Tress & Gunther Tress
Alterra Green World Research, Landscape Centre
P.O. Box 47, NL-6700 AA Wageningen, The Netherlands
Phone: (+31) 317-474616, Fax: (+31) 317-419000
tress@tress.cc, www.tress.cc

Abstract

European landscapes change rapidly due to increasing pressure of urbanization on agricultural land. Thus, there is a large interest from policy and public on the future shape of landscapes. The interest is putting high demands on individuals that are involved in the decision-making and research process. Landscape indicators get increasing importance in current studies on landscapes change, but—as well as countryside-monitoring activities—they are focused on illustrating past and present changes. This paper would like to propose a supplementary approach to research the future shape of landscapes. A scenario approach is suggested to cope with identification and integration of interests in future agriculturally used landscapes. Future alternatives for development in rural areas are presented for a rural area in Denmark. With the help of four distinctively different paths of future development of the area—industrial agriculture, recreation and tourism, nature conservation and residential expansion—scenarios were designed, visualised, presented to, and discussed with stakeholders in the sample area. The stakeholder responses were used to design additional future alternatives integrating the different interests of the stakeholders. The paper argues for combining monitoring and scenario techniques for linking landscape changes of the past with demands for future developments.

Keywords: landscape scenarios, visualization techniques, stakeholder participation, future landscapes

Introduction

Over the last few decades, landscapes in some parts of Europe have come under increasing pressure. Although, agricultural land use has predominated for many centuries and still counts for large parts of national territories, coinciding functions are now demanding a place of their own and are ready to take over. As urbanization takes place in the countryside, the influence of urban agglomerations extends far beyond town limits (Antrop, 1998b, 2000a, 2000b). In other parts of Europe, decrease of agricultural areas result in marginally agriculturally used landscape and abandoned areas. Landscapes change rapidly, however, agriculture is still one of the main instruments to manage the landscape. As a result of rapidly changing landscapes, there is substantial interest in the outcomes of present policy decisions, actual land use changes, and the shape of our future landscapes. The large interest is putting high demands on individuals that are involved in the decision-making and research process.

Researchers develop indicators to monitor and classify landscape changes. They aim at supporting policy and decision-making on landscape development. Currently, indicators were investigated that can characterise not only the material dimensions of landscape change, but also mental and cultural aspects of landscape development and landscape change. This is of crucial importance because landscape changes result from interactions between people and landscapes. Landscapes influence people and vice versa (Tress & Tress, 2001). Therefore decisions for future development have to been made that apply to landscapes as a whole. Indicators are supposed to have an important function in the research and decision-making process. However, what is the role of indicators for shaping future landscapes? Indicators might tell us the characteristics of agriculturally used landscapes or how these landscapes have changed over time, but indicators can hardly tell us how future landscapes will develop. Since the end of the 1970s, countryside-monitoring programs are carried out in several European countries. They provide estimates of actual changes in land use that have occurred within the last decades. They collect data about the land cover and land use and thus can demonstrate the changes that have occurred over a certain time, but work on a national level, not on an European level. Interpretation of aerial photos and field surveys are combined in order to record the current situation in the countryside. The interpretation and the surveys are regularly repeated and are a valuable tool for illustrating the changes in the landscape. However, they only cover the past and present state and cannot illustrate future developments.

Researchers face the challenge of coping with the future perspective either by attempting to predict the future shape of landscapes or recommending a certain set of criteria for future development based on indicators only. Planners and decision-makers then have to decide whether to follow up on research results or set independent guidelines for landscape development. Indicators seem to be a helpful tool for the policy side. But we see a couple of unanswered questions when reflecting about predicting future landscapes with the help of indicators. Who can predict future development with any accuracy? And given the many variables affecting development, who should decide how future landscapes should be shaped? Of course, landscape researchers have considerable expertise that is immensely helpful in designing landscapes, but they can hardly make reliable predictions because environmental change is not driven solely or even primarily by science, but rather by policies based on public preferences, values, and politics. And how are the interests of society represented in this process?

This paper would like to propose a supplementary approach to cope with the challenge of shaping future landscapes: the scenario approach. The paper focuses on the crucial question of how stakeholders, the local community, and other interest groups can be involved in the process of shaping the landscapes that are home and livelihood. How can scientific expertise support broad participation in landscape development and management? How can planning derive benefit from the cooperation between science and society in regard to the future shape of our landscapes? The proposed scenario approach combines stakeholder participation with visualisation techniques of landscape scenarios in order to identify and illustrate the interests of different stakeholders in an agricultural area. The paper will present an example of the application of such an approach.

The scenario approach

Future landscapes are a product of individual choice (Nassauer, 1997). The scenario approach enables research and policy to face the variety of different choices. It enables to work with alternatives for future development instead of predicting a certain future development. The stakeholder participation allows consideration of individual choices in future development and visualisation of alternative landscape scenarios communicates both well from research to policy and from research to stakeholder.

At present, the term “scenario” is used to describe very different kinds of future-oriented studies: trend analyses, prognoses, forecasts, variant analyses, sensitivity analyses, or snapshots of what might be (Schoute et al., 1995, Van den Berg & Veeneklaas, 1995, Emmelin, 1996, 2000, Wollenberg et al., 2000). By contrast, we propose to follow Van den Berg & Veeneklaas’s (1995) definition of a scenario as a description of the current situation, of a possible or desirable future state as well as a series of events that could lead from the current state of affairs to this future state. Scenarios present stylized constructions of possible future developments, “sometimes quite deliberately in the form of stereotypes, archetypes, optimum or doomsday situations, or other extremes" (Van den Berg & Veeneklaas, 1995, p. 12). Following this definition, scenarios do not present the most realistic future state; they are not prognoses, predictions, or forecasts.

In contrast to prognoses, the scenario approach we propose allows the development of several alternative future landscapes while being aware of the uncertainties. Scenarios focus on "what will happen if" and not on "what will happen." The change from "what will happen" to "what will happen if" illustrates the shift from the purely scientific-oriented approach to a participatory scenario approach for future landscapes. Scenario approaches are built on general sets of assumptions and rules covering distinct environmental, social, economic, political, and administrative developments.

The case study: Future alternatives for rural areas in Denmark

For illustrating the application of the approach, we guided a study for future development in two rural areas in Denmark (see figure 1). One of the two areas is the area around the small village of Kravlund in Southern Denmark with about 50 inhabitants, 5 km north of the Danish-German border. It is a characteristic agricultural area in Denmark, where most of the area belongs to few large farms, specialized in milk production. Pastures and meadows cover large parts of the area. The municipality is not among the booming areas in Denmark. Its population rate has been relatively stable over the last 20 years, though decreasing slightly. House and land prices are low and people who are attracted by the countryside's natural beauty and intact neighborhoods can find a good and safe environment here.

Figure 1: Map of sample areas

The study was conducted in three phases (Tress et al., 1999). In phase 1, we created four extreme scenarios, four distinctively different developments for the area. The extreme scenarios show how the landscape would appear in the year 2020 if each of four land uses were to dominate. Four extreme scenarios were developed to illustrate the possible future state of the countryside in 20 years. Each of the scenarios was based on a specific land use that influences the development of the Danish countryside. Included were (1) industrial farming, (2) recreation and tourism, (3) nature conservation, and (4) residential expansion. The extreme scenarios do not visualize the most realistic situation in the year 2020. They describe how the sample area could look if a certain land use were to dominate future development. We decided to realize four scenarios because these four land uses already place great demands on the countryside and compete with each other in Denmark as well as in other European countries (Coeterier, 1994, Antrop, 1998a, 2000b, Vos & Meekes, 1999). In general, all possible interests in the countryside in Denmark can be subordinated to these four land uses, and all can be seen as processes spreading from urban to rural areas. Industrial farming means the transference of processes that govern efficient and lucrative urban production to agricultural production in rural areas. The demands of recreation and tourism are deeply connected to social development of urban societies, specifically, the nineteenth century working class' introduction of a distinction between work and leisure and the resulting clamour for vacation in urban—and now rural—areas. Nature conservation developed as a reaction to the pollution of the environment, initiated by distinct groups within urban societies. Residential expansion, finally, results from the enlargement of urbanized areas as urban population and architecture expand to the countryside. The developed scenarios are not utopian but rather illustrate developments that could happen around the sample area. Therefore, the set of assumptions made within each scenario builds on logic, coherence and consistency. None of the scenarios was designed to be more realistic than others. We avoided a "business-as-usual" scenario, that is, a further development of present conditions (O'Riordan et al., 1993). This scenario could attract people more than others, as it is closest to the present state.

In phase 2, the scenarios were presented to, and discussed with, different interest groups or stakeholders in a meeting in the area (see figure 2). Photo design software was used to prepare photorealistic visualizations of each landscape scenarios. We regarded photorealistic visualizations based on aerial and land photos as most suitable for the study as they address the targeted audience best: charts and tables, maps, plans, or GIS-based visualizations may accurately portray the extent of change that should be realized with the scenario but are less accessible; artists' renderings are accessible but lack concreteness (Orland, 1994, Lange, 2001, Karjalainen & Tyrväinen, 2002). Since photographs are a very close representation of reality, little interpretation is needed to convey the message to stakeholders (Al-Kodmany, 1990, Orland et al., 2001). A higher degree of abstraction leaves an empty, unknown area that is filled by people's own imaginations, which could easily lead to misinterpretations and consequently complicate communication.

Figure 2: Stakeholder meeting

All stakeholders with interests in the area were invited to the meeting: local farmers, inhabitants, members of environmental organizations, hunting clubs, sporting clubs, or other leisure-time organizations; and representatives from administration and planning agencies. In the meeting, we explained the setting and purpose of the scenario study to the participants and then described each extreme scenario in detail. After the scenario presentation, all participants were supplied with questionnaires asking for comments on each scenario. The questionnaire surveyed individual details and general evaluations of each scenario as well as data about the respondent. Respondents could assess eight landscape elements that changed in each scenario as positive, neutral, or negative. The corresponding elements were explained in our presentation of the scenarios. Additionally, they could add comments on each scenario. The survey was followed by an open discussion about the presentations and about participants' wishes, ideas, and fears for future development in the sample area. Aspects that could not be expressed in the questionnaires could be aired here.

In phase 3, we developed integrated scenarios based on stakeholders' comments and reactions. The stakeholders were considered as important actors in the process of shaping future landscapes. Therefore, we decided to consult them and to discuss with them future possibilities. The scenario visualizations that were produced in phase 3 illustrate different scenarios with integration of different land uses and landscape elements.

Visualization of alternative future landscapes

Starting point for the scenario visualisation was a picture of the area around Kravlund taken in 1999 from the bird's eye view (figure 3). In the first scenario (figure 4) industrial farming, the countryside in the Kravlund area has become a resource for intensified industrialization in agriculture. In the second scenario (figure 5), recreation and tourism, the area has a primarily recreational function. In the nature conservation scenario (figure 6) the countryside is regarded as a resource for the realisation of nature conservation. In the fourth scenario (figure 7), residential expansion, the Kravlund area is regarded as a resource for housing and habitation.

Figure 3: Kravlund in 1999

Figure 4: Industrial agriculture scenario

Figure 5: Recreation and tourism scenario

Figure 6: Nature conservation scenario

Figure 7: Residential expansion scenario

The stakeholder participation

The scenario approach combined with photorealistic visualization proved to be a helpful tool for discussing the alternatives for future landscapes with the stakeholders in the area and also with the representatives from planning and administration authorities. The atmosphere at the stakeholder meeting was friendly and we had the impression that most of the participants felt comfortable with their decision to participate. But not all felt immediately comfortable with the scenarios or future development of the sample area. The reason for this is the drastic changes evident in the photorealistic visualization of the scenarios to an area they knew intimately. Such drastic implications of daily changes had not been anticipated. People find it difficult to imagine a future that is different from the present (Nassauer et al., 2002). The photorealistic visualisation techniques make it easier for stakeholders to imagine future changes in landscapes. Photorealistic visualitations can illustrate the changes that could happen in the area if certain developments would proceed in the next 20 years in a way that communicates well to the addressed stakeholders.

Experiences from the stakeholder meetings and results from participant questionnaires show several results: They demonstrated that the communication process among researchers, planners, decision-makers and stakeholders has shortcomings. The stakeholders were not used to be contacted by planners and decision-makers when discussing the future landscape development of the area. Stakeholders expressed doubt that planning authorities would consider their interests. We identified a lack of confidence in academia and in planning authorities in general. Academics were perceived as overly distanced from the problems and focused on the single issues taken out of the context. Stakeholders suspected the landscape researchers of working in the interests of planning authorities only, not in the interests of the stakeholders. The future of their landscapes was an issue that stakeholders never had reflected upon and they did not believe or did not understand their own potentially influential role in future planning decisions.

The landscape scenario evaluation

To better understand stakeholder responses, we assessed group composition. Participants represented all invited groups. One-third of the stakeholders lived in the area (local stakeholders), one-third of the participants were from nearby areas (nearby stakeholders), and one-third of the participants lived more than 10 km from the sample area (regional stakeholders). Nine of the participants were representatives from administration and planning authorities. In the questionnaire, participants were asked how they felt about the scenarios. Every respondent could rank each of the four scenarios on a scale between very good and very bad. As could be seen from these rankings, we could identify different interests among different groups of stakeholders.

The industrial farming scenario as a future perspective was evaluated most positively by local stakeholders and got the lowest support from representatives from authorities. The recreation and tourism scenario was evaluated most positively by nearby stakeholders, but got lowest support from local stakeholders. The nature conservation scenario was most welcome among all stakeholders, but got the lowest support from local stakeholders. The residential scenario got the highest ranking from nearby stakeholders, but lowest support from regional stakeholders. The most eye catching result of the evaluation of the scenarios was that the measures that led to environmental improvement such as increase of forest and natural areas, were assessed positively by a wide majority of all analyzed groups. However, the local stakeholders were a bit more reserved than the others. All measures that would increase the recreational value of the area were assessed also positively by a wide majority of all groups, but again with least support from the local stakeholders. In their comments many of the stakeholders stated their interest in the development illustrated by the nature conservation scenario, but expressed doubt that the authorities would give their support. The wide support for nature conservation measures, however, diminishes the closer people live to the area. To those who are directly affected by major changes, the nature conservation scenario becomes less attractive. Unaffected outsiders can far more easily see the advantages of such development. The residential expansion scenario got the lowest support from all four scenarios.

The same picture can be seen in all four scenarios: Changes—no matter of what kind—seem to be easier to accept if one is not personally involved. In comments on the questionnaires and in the discussion, many stakeholders expressed their desire for no change, for the status quo. But in reflecting on past development they realized that landscapes had changed and that they certainly would continue doing so. A need for communication among decision-makers, researchers and stakeholders came clearly to the fore.

Integrated alternative future landscape scenarios

Whereas phase 1 and phase 2 of the study aimed at identifying different interests for future landscape development in the agricultural area of Kravlund, phase 3 focused on an integration of the different interests for future development. Based on the results from the stakeholder responses to the four presented scenarios we designed a scenario that aimed at integrating as far as possible the different interests. In the questionnaire survey that was conducted at the stakeholder meetings, the participants had not only the chance to rank the four scenarios as a whole, but also they could assess single elements that were changed in each scenario. The integrated scenario that we designed are based on these assessments.

None of the participants preferred future development towards one of the presented extreme developments—industrial agriculture, recreation and tourism, nature conservation, and residential expansion—only. And it can hardly be considered as realistic that one of the four developments would dominate future development alone. If the stakeholders could design their own future landscapes they would take some elements from each of the four scenarios. Integration of interests is therefore the challenge for future planning in the sample area.

When looking at the scenario evaluation as a whole, all participants in the stakeholder meeting ranked nature conservation highest. An integrated future landscape scenario should also consider mainly the development proposed in the nature conservation scenario, however, supplemented with most appreciated elements of the recreation and tourism scenario and the industrial agriculture scenario, and a few elements of the residential expansion scenario. Measures to increase forest areas and hedgerows were appreciated throughout all scenarios and are therefore part of any integrated alternative for future development. Figure 9 illustrates one alternative for such an integrated development in the Kravlund area as all stakeholders together would appreciate it. Figure 8 illustrates the present state from 1999 again.

Figure 8: Kravlund in 1999

Figure 9: Integrated alternative landscape scenario for Kravlund in 2020, based on the preferences of all stakeholder responses

As can be seen from the evaluation of the four scenarios in phase 2 of the study, the stakeholder responses are not homogeneous. When looking at the different support of the groups of stakeholders to each scenario (table 1) the potential for integration is different. Local stakeholders give, for instance, highest support to industrial farming, then nature conservation, then to recreation and tourism and they give lowest support to residential expansion. Nearby stakeholders, regional stakeholders and representatives give highest support to nature conservation, but evaluate the other three scenarios differently. Differences in attitude between the groups of stakeholders on the one hand, and the group of representatives from planning and administration authorities on the other, are most pronounced among local stakeholders and representatives.

Table 1. Support to the four landscape scenarios by stakeholder group (n = 69)

	Industrial agriculture	*Recreation and tourism*	*Nature conservation*	*Residential expansion*
Local stakeholders	72.2 %	38.9 %	47.3 %	27.8 %
Nearby stakeholders	59.1 %	72.7 %	86.4 %	40.9 %
Regional stakeholders	57.2 %	14.3 %	100 %	14.3 %
Representatives from planning and administration authorities	33.3 %	66.7 %	88.9 %	33.3%

For illustrating the diverging attitudes towards future development of local stakeholders and representatives from planning and administration authorities, we designed two additional future landscape scenarios. Figure 10 shows an alternative future scenario for the Kravlund area if the different interests of the local stakeholders would be considered and integrated. Here, the industrial agriculture scenario of phase 2, which was ranked highest by the locals, was the starting point for integrating other interests. In contrast, figure 11 illustrates the alternative future scenario for the same area if the different interests of the representatives would be considered and integrated. This time, the nature conservation scenario is basis for the integrated scenario.

The findings from the different integrated scenarios support the necessity of giving special consideration to a clear communication strategy among local stakeholders, representatives and the other actors and groups of interest involved in the process of planning and designing future landscapes. Obviously, representatives from planning and administrative authorities do indeed represent different interests than local stakeholders. To include other interests than the one's from representatives a participatory approach is suitable. However, the question has to be addressed what the optimal degree of stakeholder participation in a real decision-making process is. Participation means delegation of power and responsibility, but can have different degrees (Warburton, 1998). The participation process cannot avoid that decisions have to be made. Also, it does not necessarily mean that it will be always the opinion of the majority that will be realised. However, the scenario approach presented here can help bringing the interests of different groups closer together and illustrate the consequences of proposed and preferred developments of the policy side, of research and of stakeholders. Participation won't be the key to solve every problem, but it contributes to more transparency in the decision-making process. We have to be aware that not all interests in the development of a future landscape can be integrated at the same time, because different interests might exclude or contradict each other and then, decisions have to be taken on a solid ground. The presented scenario approach stresses the realisation that future landscapes are a question of human choices. We have to decide on ourselves which scenario ever we would like to become reality. Research can support the decision-making process and also the information of stakeholders, but cannot take the decision.

Figure 10: Integrated alternative landscape scenario for Kravlund 2020, based on the preferences of local stakeholders

Figure 11: Integrated alternative landscape scenario for Kravlund 2020, based on the preferences of representatives from planning and administration authorities

Combining scenario and monitoring techniques

The challenge for future research will be to combine different approaches and techniques for the benefit of planning for future landscapes and coping with the huge changes in agriculturally used landscapes. Whereas monitoring activities are directed towards the past and present, scenario approaches deal with the present and future perspectives. Both approaches work fine, but it is necessary to bring the experiences from landscape monitoring and participatory scenario studies together and communicate the results to planners, decision-makers, and stakeholders. For the research part this means to take the data from the monitoring programs, to produce land use/land cover maps based on them and produce maps of future land use/land cover. The future maps are based on sets of assumptions that explain societal development towards the alternative future states. From these maps areas can be chosen for scenario visualization. The making of photorealistic scenario visualisations then enables a discussion with stakeholders and decision-makers. The benefit of such a combined approach is that the missing link between past and future can be filled.

Conclusion

Landscapes have been changing rapidly over the last decades and it can be assumed that the changes will continue in future. Until now, landscape monitoring activities and the setting up of indicators for landscape change can mainly cope with the illustration of changes that have happened. It is therefore reasonable to reflect about approaches that can support the efforts of monitoring programs to include the future perspective. A scenario approach combined with stakeholder participation and visualisation of landscape scenario is a promising tool to deal with the challenges of future landscapes and the different alternatives of development. The scenario approach deals with the question of "what will happen if" and not with "what will happen". Therefore, landscape scenarios do not predict certain developments but can illustrate a variety of possible futures. Consequences of different alternative scenarios illustrate future landscape change and communicate to a broad group of end-users: policy people and decision-makers, stakeholders , and researchers. Decision-makers can benefit from a cooperative research approach of researchers and stakeholders. The involvement of stakeholders can increase the support for decisions and actions. Although a scenario approach illustrates future options and stakeholder preferences—it does not prepare certain decisions. The decisions still have to be made by those who have the responsibility and vote for making them. The researcher's task is to inform both stakeholders and decision-makers on the consequences of alternative landscape scenarios. Shaping future landscapes needs a communication process among all actors and groups of interest involved.

Acknowledgments

The case study was a part of the interdisciplinary research initiative "Value, Landscape and Biodiversity" under the programme "Man, Landscape and Biodiversity" financed by four Danish research councils. We would like to thank Jesper Brandt and our colleagues at the Centre for Landscape Research and the Department of Geography and International Development Studies in Roskilde for their support with the stakeholder meetings. In particular, we would like to thank Anders Rademacher Svendsen, Birgitte Norby Jensen, and Morten Lehgaard Madsen for helping to prepare for the meetings. The scenario study can be found on the world wide web at http://www.tress.cc/scenario/scenario.html.

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Australia's Natural Resources
- building a landscape based and integrated approach to natural resources management

Colin Creighton
Executive Director, National Land and Water Resources Audit
GPO Box 2182, CANBERRA ACT, Australia 2601
colin.creighton@nlwra.gov.au

Abstract

Australia is a unique complex of land, water and biodiversity resources. Australia has progressively doubled biological productivity from its landscapes in the 200 years since European settlement. Australia recognises that information is the currency for implementing sustainable development and has embarked on an integrated program of natural resources data collection and assessment through a partnership across Government, industry and community and coordinated by the National Land and Water Resources Audit. The key components of this approach include:

- *assessment, understanding the status and trends in condition of Australia's natural resources;*
- *knowledge brokering, translating information into priorities and actions at scales from local to national;*
- *monitoring, tracking changes in condition and use and encompassing water use, quality and quantity; soil properties and health; nutrient balance and budgets; land use; biodiversity, terrestrial, river and estuary; and management practice, all agricultural industries;*
- *resource accounting, integrating social, economic and biophysical components of natural resource management;*
- *communication, providing reports and access to assessments, including Australia's Natural Resources Atlas – www.environment.gov.au/atlas; and*
- *data management, maximising returns on investment in all natural resources data collection.*

This paper summarises Australia's integrated approach to natural resource management and by way of four applications, demonstrates the role and efficiencies of an integrated, spatial and landscape based approach to monitoring and assessing natural resources.

Australia's approach to natural resource management

Responsibility for natural resource management in Australia is increasingly being delegated to regional and local groups and managers. People are being encouraged and empowered to participate in the design and implementation of innovative solutions based on local knowledge and experience within their own catchments. An all encompassing community-driven approach involving encouragement, partnerships and local commitment is being given much greater emphasis than the externally driven regulatory approach.

The key ingredients for natural resource management in Australia are:

- **multi-faceted approaches** - across disciplines and issues;

- **planning** - based on regions of common or linked management interests;
- **spatial assessment and management frameworks** - considering available data, scale of management responses and the 'total' system for example catchments, bioregions, groundwater flow system, landscape / land system units;
- **partnerships** - wide ranging partnerships, across industries, government, science and community groups;
- **commitment** - facilitation, resources and commitment provided by local, State and Commonwealth governments;
- **shared vision** - a shared vision for the region, recognising trade-offs between competing social, economic and environmental demands;
- **solutions focus** - pragmatic and solution-orientated activities, making best use of, often incomplete, data and scientific understanding;
- **cost-effective** - emphasis on key components where improvement can be achieved, based on an analysis of costs, benefits and likely return on investment of various opportunities; and
- **opportunistic** - identifying key management opportunities, promoting common property resource stewardship and protective management of ecosystems in natural condition

These ingredients apply equally to information provision. Information based on readily accessible data, sound and underpinning science and monitoring and evaluation of programs and their outcomes are all crucial to the success of any natural resource management program. Information needed to support these components establishes the client base for developing and managing Australia's natural resources data collection, and its collation and assessment to provide information. It generates an imperative for strategic investment in these activities. The information must be based on rigorously collected data. It will assist managers to better understand the ecosystems within which they are working, and for which they are responsible. Sound data allows changes in resource condition to be tracked and policy and management initiatives evaluated, an essential basis for continuous improvement and to show with certainty the extent of any benefits from investment in natural resource management programs.

Information is one of four key components identified for natural resource management, the others being partnerships, property rights and incentives (John Anderson, MP Deputy Prime Minister, ABARE Outlook Conference, March 7 2002).

Information - a key ingredient for landscape scale assessment and management in Australia

Information underpins and provides the context for:

- **policy development** - particularly at State and Australia-wide scales, such as the development of the Council of Australian Governments water allocation and management arrangements;
- **understanding -** building an ethos of sustainable natural resource management behaviour and stewardship across all sectors of the Australian community
- **planning** - especially regional planning as a way to engage community, industries and government in natural resource management partnerships;
- **decision-making** - evidence-based and using information collated from data sets at scales from local and specific, such as with water licence approvals, through to regional and national, such as assessment under the Environmental Protection and Biodiversity Conservation Act;
- **investment -** establishing priorities and setting targets;
- **program implementation** - monitoring progress and finetuning delivery of major programs; and
- **making improvements** - in management and practice, developing and implementing through industry, community and agency partnerships activities such as sustainable and productive

farming systems, ecologically appropriate fire regimes and pollution minimising waste treatment systems.

To generate information a structured approach is essential. The Audit has applied a set of key principles for the delivery of information. These are:

Principle 1: Collect data spatially referenced and at as finer scale as feasible within the bounds of client needs, applications and costs of data collection.

Principle 2: Maintain the richness of fine scale data sets and when aggregating with broader scale data sets to provide regional or national coverages, ensure that these collations still preserve and permit user interrogation at the finer scale.

Principle 3: For all data sets, critically evaluate and document their appropriateness and validity, listing constraints to their use and levels of reliability.

Principle 4: In determining attributes on which to collect data, make sure the attributes inform management and as much as possible, relate to cause rather than end impact.

Principle 5: Information, being a collation and aggregation across data sets, is done within those spatial boundaries most appropriate to management responses. These boundaries might describe ecosystems, bioregions, , river reaches, catchments or administrative units as appropriate to client applications.

Principle 6: Information products must meet various and often differing client needs and therefore their provision is often better done electronically within internet Atlas "make a map" environments.

An example of this systems based approach to collecting and analysing data is provided in Figure 1, detailing how terrestrial river and estuary attributes are combined to build a catchment based understanding of resource condition and management opportunities.

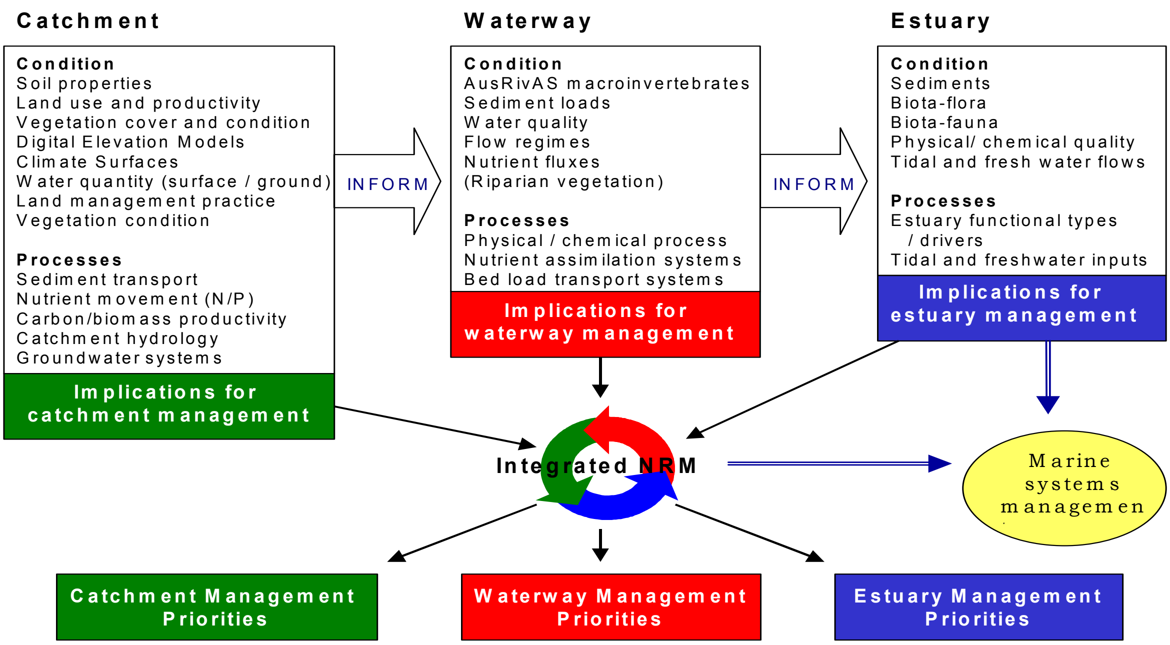

Figure 1: Systems and Process Based Integration of Natural Resources Datasets

A portfolio of natural resources data sets, collation and assessment tools and information packages aligned with policy instruments and refined within the context of public and private benefits, meets this need. The National Land and Water Resources Audit's Final Report [NLWRA, 2002] details 9 enabling recommendations for this to continue in Australia as an underpinning to natural resource management. This paper illustrates the power and strengths of this approach through applications covering terrestrial biodiversity conservation, soil productivity, rivers and estuary health and the economics of agricultural land uses.

Application 1: Determining landscape health from a biodiversity perspective

[PowerPoint group of slides 1 to 6]

Australia has developed a series of standardised approaches to collate data and provide information on its biodiversity resources. The first of these is a standardised approach to mapping native vegetation. Through an Australia-wide partnership a hierarchical classification of Australia's native vegetation has been implemented The National Vegetation Information System presents information as a hierarchy, defining structural and floristic patterns of Australia's vegetation. The hierarchy is made up of six levels presenting information from a broad classification [levels I to III] to a detailed level of vegetation data [levels IV to VI]. This can be summarised by presenting native vegetation in Major Vegetation Groups.

This hierarchy allows multiple and variable scale data sets across Australia to be collated into a common and shared Information System and for a range of products to be developed. Information sets that can be developed from this rigorous data management system include:

- extent of native vegetation,
- comparisons of vegetation type, pre-settlement and current, and
- levels of clearing, different vegetation types.

Because the information is spatial, data sets can be combined and analysed with other data sets to deliver various client products, including:

- carbon sequestration
- fragmentation of habitat
- nature conservation protection status of vegetation types and
- landscape health.

Landscape health involves designating a hierarchical set of ecosystems, subregions and bioregions over the Australian terrestrial landscape and collating information on condition and threatening processes within this hierarchy. To synthesise the results, Australia's 354 subregions were assigned to one of a six-tiered classification of the extent of "stress". This assessment took account of the extent and fragmentation of native vegetation, threatened ecosystems and species, and frequency of salinity, weeds and feral animals.

In summary, the management relevant findings included that nearly half of Australia's subregions are in excellent environmental health, presenting opportunities for protective management with 152 regions in relatively good condition. Protective management activities across all tenures in these subregions are likely to be most cost-effective and will ensure these subregions remain in good condition. About 10% of Australia's subregions have been identified as stressed with 17 subregions appeared in the highest stress category and a further 20 in the second tier. These subregions would require substantial investment to regain key conservation values.

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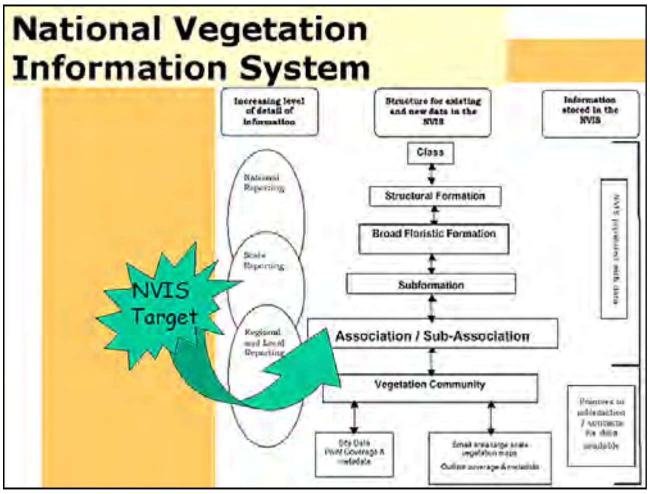

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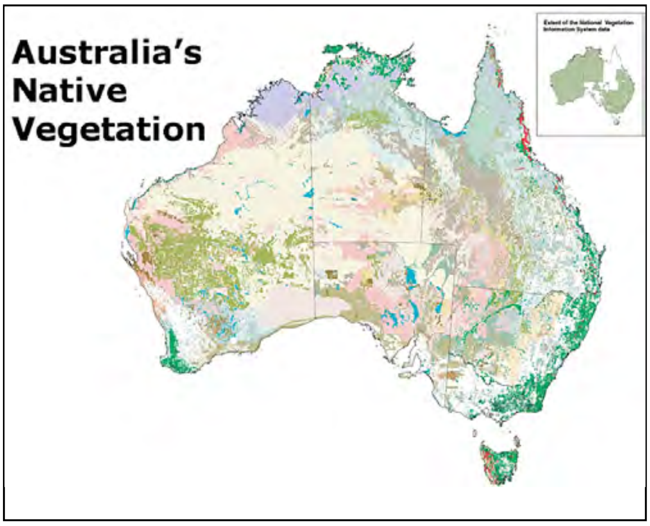

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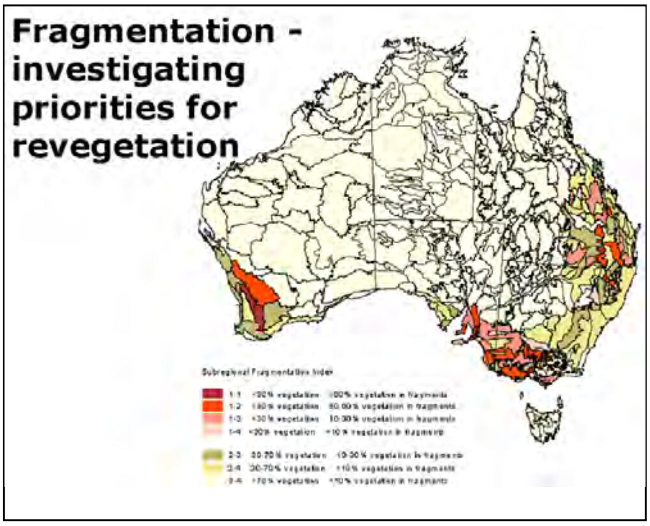

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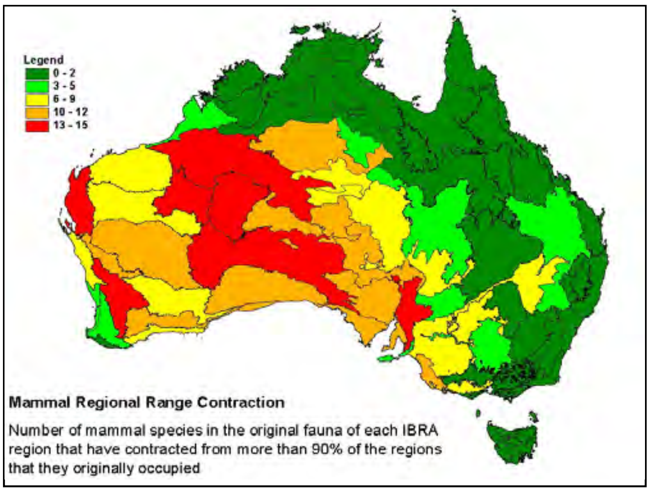

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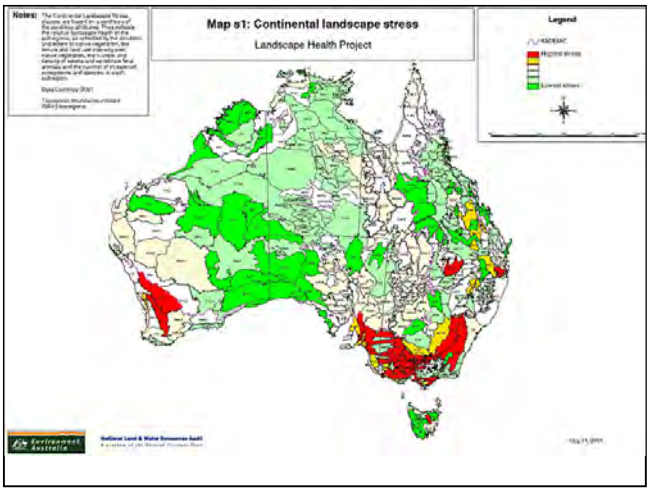

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PowerPoint group of slides: 1 to 6

Application 2: Understanding key factors and management opportunities for soil health

[PowerPoint group of slides 7 to 12]

Australia's agricultural landscapes have doubled in biological productivity since European settlement. Agriculture in the higher rainfall, more fertile areas, primarily in the temperate coastal areas has, through addition of nutrients, use of legumes and irrigation, doubled the biological productivity of agricultural landscapes. The importance of irrigation development, integrated farming systems and nutrient management cannot be underestimated if Australia is to increase its agricultural productivity.

Cropping systems have delivered substantial gains in productivity. Between 1982 and 1997, cereal grain yields per hectare have improved in most regions. Improved nutrient management, especially through the use of nitrogen based fertilisers has contributed significantly. Nitrogen based fertilisers come at a potential cost – acidification of soils.

Australia's soils are variable, but we now have much of the spatial information to inform their management. Through the partnerships developed by the Audit, Australia's soil scientists have worked together to develop the Australian Soil Resource Information System. The compilation includes those soil attributes most commonly required to characterise, model or predict land resource processes that drive plant productivity, measure resource sustainability or control the rate of resource degradation. These management-related attributes are an essential underpinning in developing understanding of soil management opportunities.

Partnerships between science and agribusiness provide the other key component to better nutrient management on-farm – spatially related and fine scale data sets, collected on farm to support production and when interpreted in the context of soil properties provide an insight into soil management issues. The analysis across all key nutrients was based on-farm soil testing linked to an understanding of soil properties and production rates. This analysis demonstrated that Australian agriculture needs to closely examine and fine tune fertiliser use and become more skilled in managing legume regimes to achieve optimum plant productivity. These improved practices could both reduce input costs and minimise negative impacts to rivers and estuaries.

Attention to soil management practices to minimise soil acidity needs to be coupled with nutrient management. In the more intensive agricultural areas the use of nitrogen-fixing legumes and nitrogenous fertilisers has become common. This has improved soil fertility and plant productivity. Excess soil nitrogen can lead to soil acidification. This looms as a significant soil degradation issue, already affecting up to 25 million hectares, with more to come. By working with agribusiness and their on-farm soil testing activities Australia will be able to track progress in addressing this issue.

Australia can now set targets for action on soil acidity. Information on soil properties detailed in the Australian Soil Resources Information System combined with land use mapping and soil testing data sets from agribusiness were used to identify the levels of lime required across agricultural Australia to mitigate against the acidifying effects of current farming systems. These targets will assist agribusiness and farmers in their soil management activities. For example, approximately 12 and 66 million tonnes of lime are required to adjust existing acidic soils to a typical agricultural production pH of 4.8 and 5.5 respectively. Maintaining soil pH values at 4.8 and 5.5 requires ranges of 0.6 – 3.1 million tonnes and 2.4 – 12.3 million tonnes of lime each year respectively.

To complete the analysis, because all this information has been collated spatially, we can superimpose the productivity figures to understand the economic costs of soil acidity. Based on economic analysis, soil acidity is the major on-farm soil management and productivity issue. The economic impact of soil acidity on-farm is five to six times greater than that of dryland salinity. Based on yield gap calculations, a gross benefit of $1.5 billion, equivalent to 24% of profit at full equity, could be secured by addressing acidity. By comparison, salinity results in losses of $200 million on-farm (3% profit at full equity), and is not always treatable. Sodicity, an inherent soil characteristic was included in the Audit assessments to demonstrate the relative biophysical limitations to agricultural productivity (Figure 2).

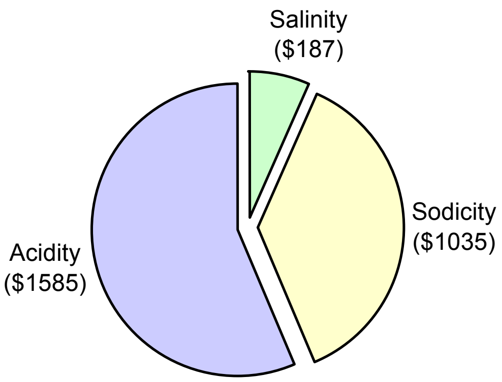

Figure 2: Estimated national gross benefits (additional agricultural profit) attainable from amelioration of productivity constraints due to soil acidity, soil salinity and soil sodicity.
Soils Treatment Gross benefits ($m)

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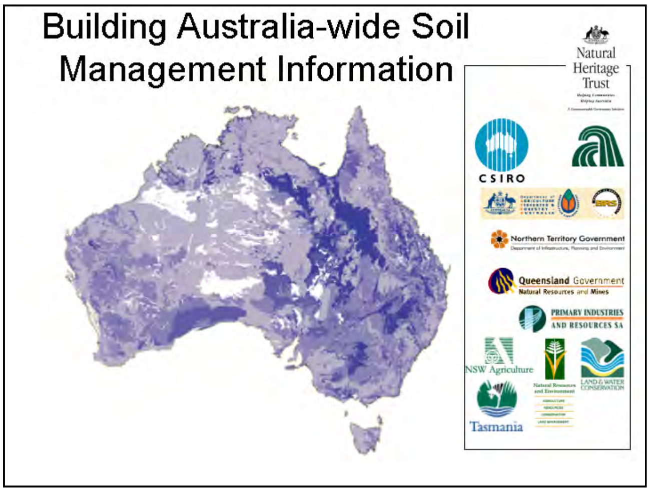

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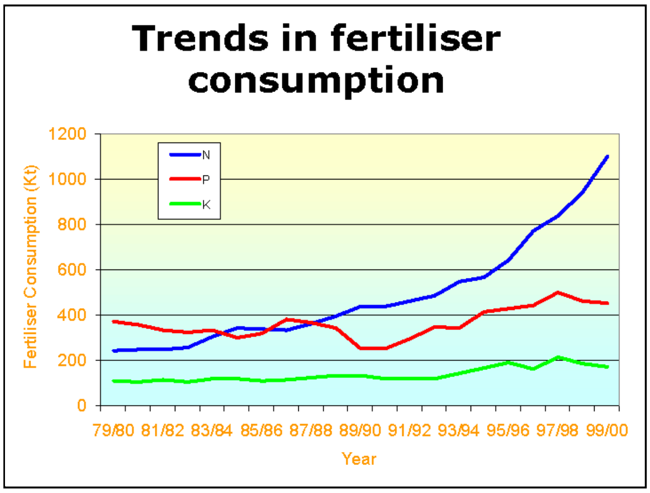

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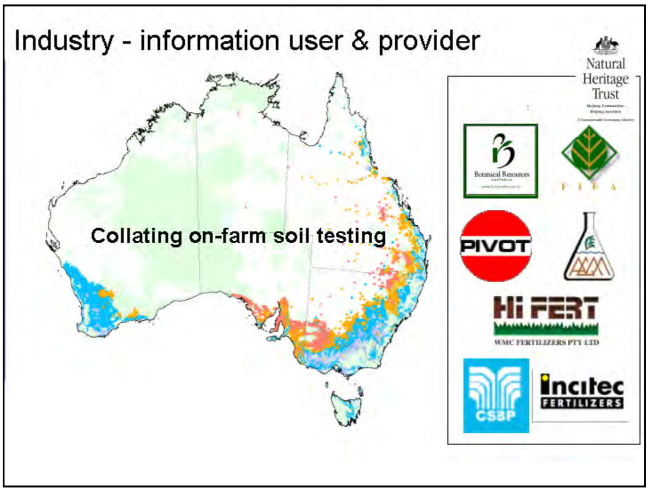

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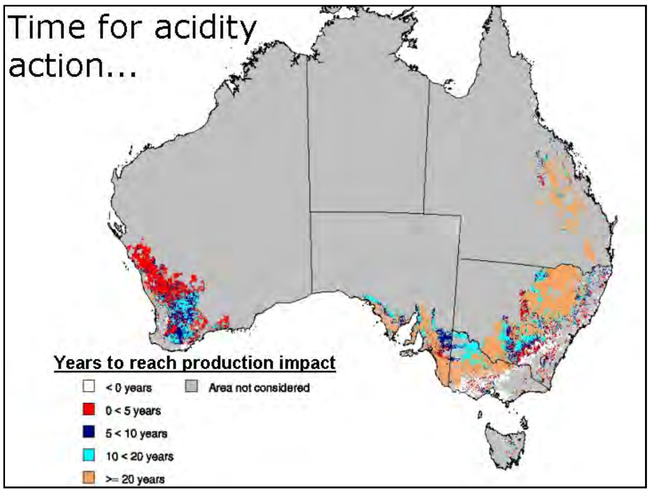

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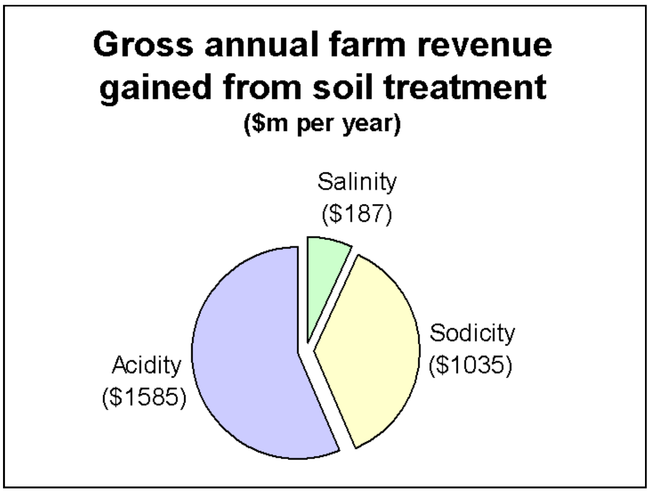

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PowerPoint group of slides: 7 to 12

Application 3: Integrating soil and nutrient budgets across the landscape to determine catchment, river and estuary health and management opportunities

[PowerPoint group of slides 13 to 22]

A key challenge for landscape scale natural resource management is to understand the amounts and sources of diffuse point source pollution, particularly increased loads above natural of sediments and increased enrichment levels from key nutrients – phosphorus and nitrogen. The Audit approach to collating and managing data spatially allows for the integration across data sets and the development of sediment and nutrient budgets for a catchment. All of Australia's agricultural regions have been assessed by a method that accommodates a combination of mapping, modelling and monitoring and integrated across a range of data sets collated for other assessments. This integrated use of data sets well illustrates the power of the Audit's approach as enunciated in the principles for data collection and analysis.

Data sets used included:

- native vegetation pre-settlement – as part of the input to understanding natural loads of sediments and nutrients [ex the National Vegetation Information System];
- current native vegetation – as part of the analysis of changed catchment hydrology and runoff characteristics as well as the intactness of riparian vegetation, to understand the role of river bank erosion [ex the National Vegetation Information System];
- soil properties to understand the spatial variations in erodibility and natural nutrient levels within soils [ex the Australian Soil Resources Information System];
- climate variability, to understand the intensity and transport capacity of rainfall events;
- land use mapping, to understand likely levels of sediment and nutrient export as a result of our agricultural practices;
- point source pollution rates to ensure these are included within budgets for each catchment;
- topographic data within digital elevation models to map the passage of sediments across the landscape – for example, it is estimated that only 5% of hillslope erosion arrives within rivers, the rest resorting down slope;
- stream flow information and digital elevation models to determine stream power and river reaches [over 14,000 reaches for agricultural landscapes of Australia] and therefore the budgets of sediments and nutrients either staying within or moving down to the next river reach; and
- estuary type, as part of understanding the ultimate fate of that proportion of the sediment and nutrient that exits rivers.

The results clearly demonstrate the types of erosion and consequent management opportunities and investment strategies vary in relative importance in differing parts of Australia. A summary of some of the findings below illustrates the importance of this type of analysis as an input to natural resources management.

Soil erosion varies in locality and type within any basin. On average across agricultural Australia 90% of the erosion comes from 20% of the area and varies in relative mix of type within each basin. Hillslope or sheetwash and rill erosion is highest in tropical northern Australia. Grazing is the main land use contributing to hillslope erosion and the key localities for improved management have been determined through the Audit's analysis. The greatest scope for reducing soil loss is through improved pasture and stock management aimed at maintaining adequate ground cover at all times, (including drought planning, off-stream watering, cell grazing and management of pasture species). These issues are of greatest importance in the northern Australian grazing lands where river suspended sediment loads have most increased, often in excess of 20 times natural levels and where sediment delivery to the coast is more likely.

Gully erosion is a significant source of sediment delivered to streams, particularly in southern Australia. Remedial works should be focussed on those gullies that continue to erode and either threaten structures or yield considerable amounts of sediment.

Riverbank erosion is widespread across the agricultural landscape. 65% or about 120 000km of the river length assessed is cleared of riparian vegetation. At a conservative cost of $10,000 per kilometre for fencing and replanting, rehabilitation would cost about $1.2 billion. This high cost of repair demonstrates the imperative for encouraging conservation in those areas where riparian vegetation is relatively intact, for example by encouraging best practice, if necessary backed up by planning controls.

This analysis in itself, because it is spatial across the Australian landscape can be used in conjunction with other data sets to quantify additional key issues for natural resource management such as water quality costs and river and estuary health. Some of the findings are summarised below.

In terms of water quality, turbidity is equally important as salinity in downstream costs. Estimates of costs for making incremental improvements of 10% in water quality are detailed in the pie chart (Figure 3). Soil management to minimise erosion has immediate benefits and is likely to provide a more rapid return on investment than activities to minimise dryland salinity.

Present values of downstream costs associated with increases in water quality parameters over the period 2000 to 2020.

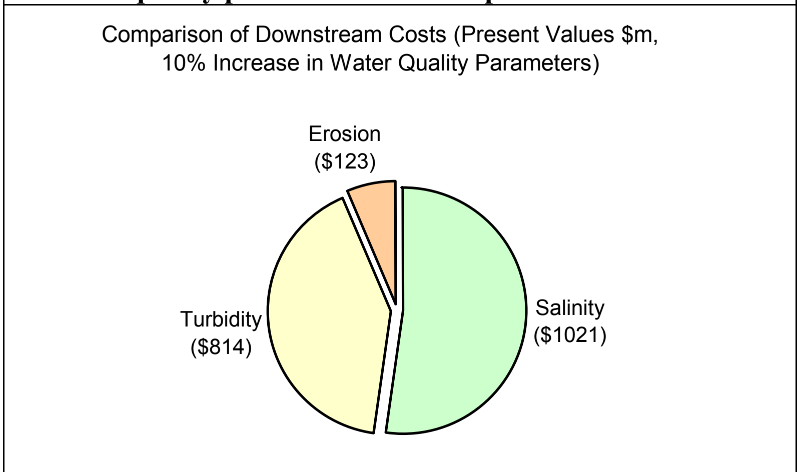

Figure 3: Present values of downstream costs associated with increases in water quality parameters over the period 2000 to 2020.

Aquatic biota, as represented by macro invertebrate indicator species provides a partial measure of river condition that can be combined with some of the data sets listed previously to determine reach by reach the condition and management opportunities for Australia's rivers. Over 85% of river length was classified as having undergone some environmental modification. Environmental features included catchment disturbance, reduced riparian vegetation, hydrological disturbance and increases in the load of suspended sediments and nutrients. New South Wales, South Australia and Western Australia have the greatest amounts of modified river length (97%, 96% and 93% respectively) and the Northern Territory has the smallest amount (34%).

Riparian and instream habitats are key management factors for the health of Australia's rivers. Protection of riparian habitat where still present and re-establishment in most catchments together with improved catchment management to minimize sediment and nutrient inputs is essential. Largely unmodified rivers occur especially in far north Queensland, in eastern Victoria and Tasmania. These require protective management to ensure their condition is maintained. Rivers with the most modified condition are in parts of the Murray Darling Basin, the Western Australian wheatbelt, western Victoria and the South Australian cropping areas. Riparian areas of many of these rivers are dominated by weeds.

The fate of nitrogen and phosphorus entering rivers also varies. With an understanding of sinks, managers can start to understand key differences in processes and management opportunities. For example, in far north Queensland less than 40% of phosphorus and nitrogen ends up on floodplains, with the remainder transported down river to estuary. This is compared to the Burdekin and Fitzroy, further south where in excess of 60% of the phosphorus is captured by floodplains.

An understanding of estuary type allows managers to identify the key sinks for sediments and nutrients. The dominant processes that drive estuary behaviour determine the susceptibility of estuaries and their adjacent nearshore areas to various catchment pressures – including changes in turbidity, circulation and sediment trapping / nutrient enrichment. For example, sedimentation caused by catchment erosion is particularly significant for wave-dominant estuary systems because this type of estuary has a high tendency to trap sediment in the lake environments that characterise these estuaries. Tide-dominant estuaries transport sediments to the near-shore marine zone.

For Australia's 1000 estuaries assessed, these key processes and therefore management opportunities and constraints vary. In much of southern Australia wave-dominated systems are common, with most of the catchment derived sediment and enrichments staying within estuaries. For much of tropical Australia, tide-dominated systems are common, with the estuary acting more as a conduit than a sink. In these systems much of the catchment-derived sediments and enrichments are exported to the nearshore zone, such as to the Great Barrier Reef lagoon.

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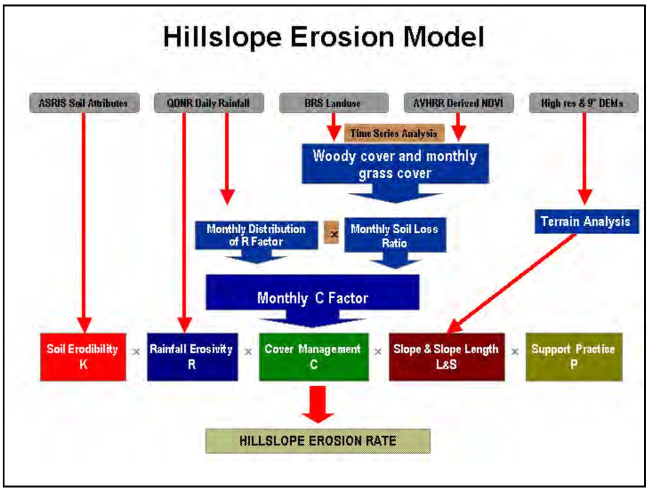

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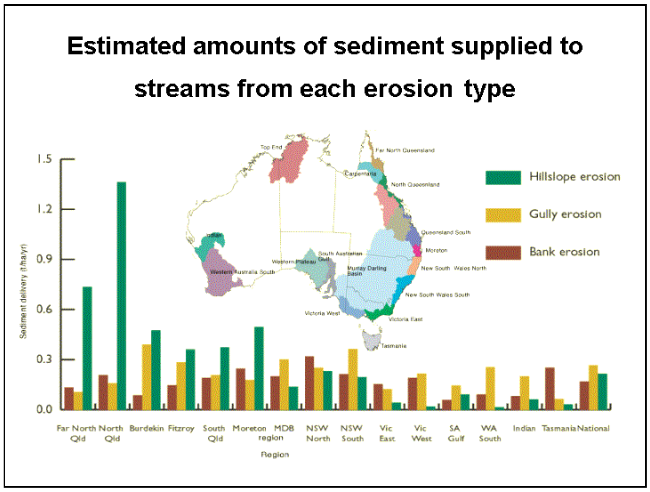

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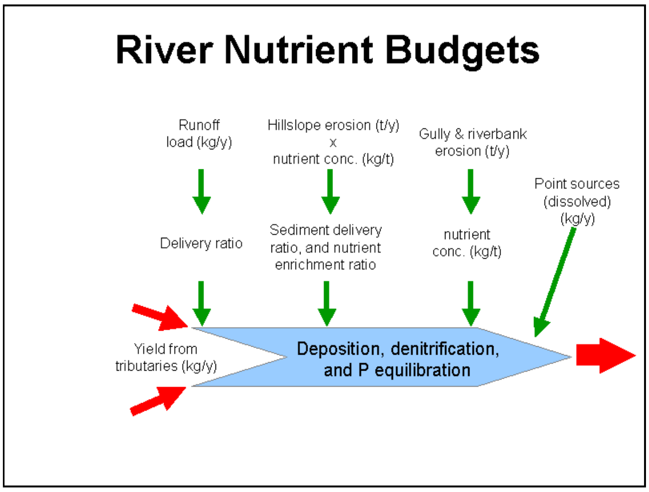

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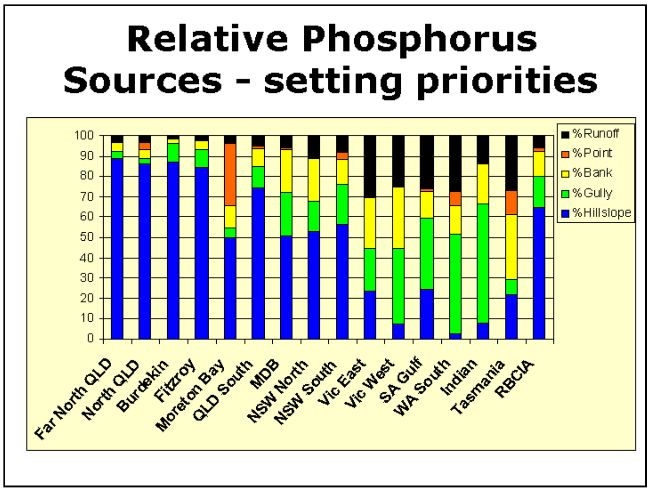

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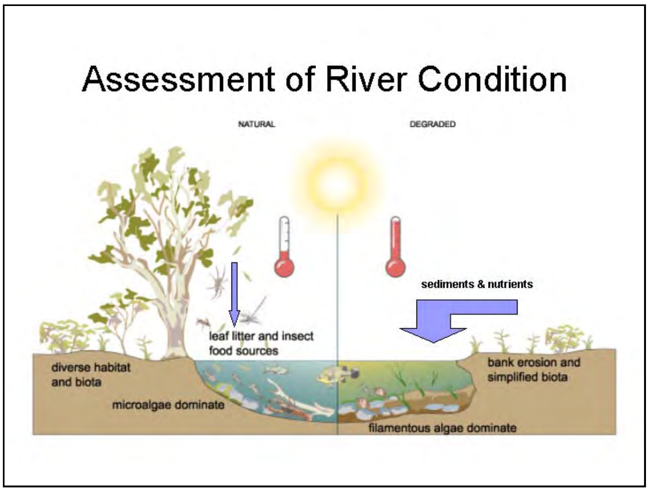

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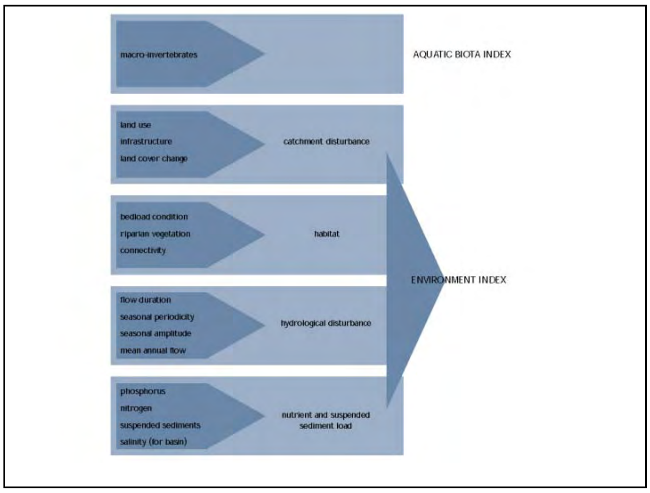

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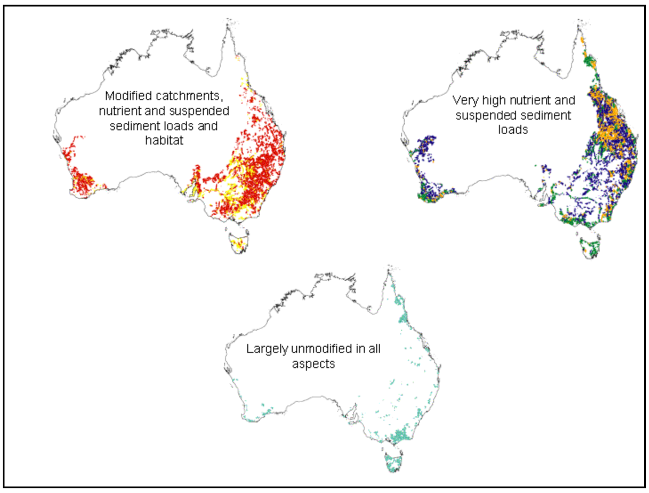

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Type of Coastal Environment	Sediment Trapping Efficiency	Turbidity	Circulation	Habitat Loss due to Sedimentation
Tide-dominated Delta	Low	Naturally High	Well Mixed	Low Risk
Wave-dominated Delta	Low	Naturally Low	Salt Wedge/ Partially Mixed	Low Risk
Tide-dominated Estuary	Moderate	Naturally High	Well Mixed	Some Risk
Wave-dominated Estuary	High	Naturally Low	Salt Wedge/ Partially Mixed	High Risk
Tidal Flats	Low	Naturally High	Well Mixed	Low Risk
Strand Plains	Low	Naturally Low	Negative/ Salt Wedge/ Partially Mixed	Low Risk

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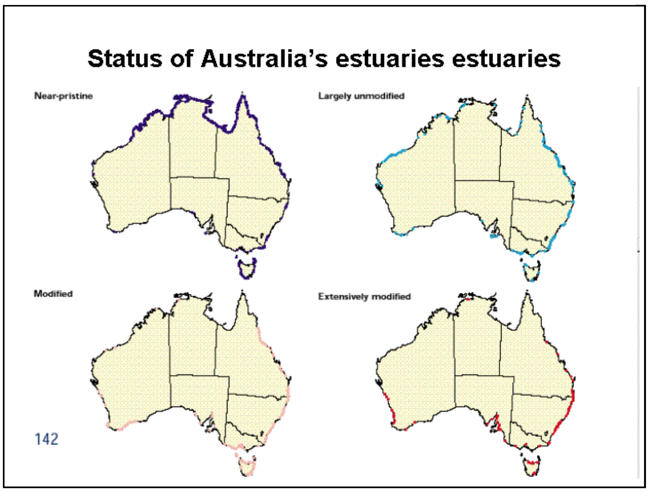

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Application 4: Building economic outcomes into natural resource management

[PowerPoint group of slides 23 to 28]

Many of the data sets and their integrated products described above together with other Australia-wide data sets can be combined to provide an analysis of returns from Australian agriculture. Again the methods are based on the principles for spatial data collection and management and involve:

- spreading spatially the income derived and collated by statistical local areas to the land use patterns thereby providing a spatial understanding of income across the landscape
- likewise assigning costs of production and costs incurred through degradation to this spatial pattern of land use
- analysing these series of data sets to derive products such as profit at full equity, returns / hectare, and returns for key inputs such as water used.

Some of the findings illustrate the power of this approach and its role as an input to program and policy development. Profit at full equity is variable across the agricultural commodities. Over the five years to 1996/97 total profit at full equity from agriculture averaged $7.5billion, with the commodity groups of dairy, cereals and cotton accounting for over 50% of the profit.

Profit at full equity is an indicator worthy of continued analysis. Since 1996/97 wool, sheep meat and beef prices and profits have recovered significantly. Undertaking regular re-analysis of profit at full equity building on Agricultural Census results will assist policy makers in understanding the comparative shifts and positions of all commodity sectors.

Managing lands for maximum Australian agricultural productivity can be concentrated in key areas. Of 454 million hectares used for agriculture and pastoralism, 6% is used for cultivation and intensive farming. A very small proportion of the Australian total agricultural landscape produces most of the net return to land, water, capital and management. 80% of profit at full equity comes from about 4 million hectares, or less than 1% of the area used for agriculture and pastoralism in total.

Productivity can also be analysed in a catchment context, providing insights to catchment management opportunities and needs. 14 river basins out of a total of 246 account for 50% of the total profits from agriculture in Australia. Many of these basins include major irrigation areas, demonstrating the importance of irrigation to Australian agriculture. Irrigation areas, because of their small size, capital intensiveness and close attention to management, provide a unique opportunity to encompass improved natural resource management practices.

Net economic returns provide a further insight into the economics of Australian agriculture. The Organisation for Economic Cooperation and Development has developed a method for converting estimates of the costs of all forms of government assistance to agriculture into a producer subsidy equivalent. If this estimate is deducted from profit at full equity, an estimate of the net economic gain to the resource base and management skill is obtained. While Australia in a global context supports agriculture at comparatively low levels, there are differences between Australian agricultural industries. Applying this method to Australia's regions provides further insight to the economic variations in Australian agriculture.

There are also insights into resource use that can be gained from this analysis. Different irrigation enterprises and intensity of water use in those enterprises leads to a wide range in the economic benefits achieved from irrigation. There is scope for further rationalisation of water use and increases in return as water use moves to higher value products.

Annual returns to water and intensity of water use (Profit at Full Equity 1996-97)[a]

Land use	Water returns	Total water use	Per cent of total water use	Water use
	$/ML	GL	%	ML/ha
Vegetables	1295	392	2.6	3
Fruit	1276	665	4.4	7
Tobacco	985	13	0.1	4
Grapes	600	781	5.2	8
Tree Nuts	507	140	0.9	6
Cotton	452	2 314	15.5	7
Coarse Grains	116	518	3.5	3
Dairy	94	5 902	39.5	7
Peanuts	90	25	0.2	3
Hay	54	20	0.1	4
Rice	31	1 696	11.3	11
Legumes	24	33	0.2	3
Sheep	23	13	0.1	4
Sugar Cane	21	1 195	8.0	7
Beef	14	1080	7.2	4
Oilseeds	10	85	0.6	3
Cereals	-9	87	0.6	3
All irrigated land uses	**193**	**14 959**	**100.0**	**7**

[a] Derived from estimates of mean water use per land use type in each region.

Concluding Comments

These four applications, solve disparate but fundamental and inter-linked problems in understanding the condition of Australia's natural resources and management opportunities. Understanding landscape health in agricultural environments requires such a multi-thematic spread of analysis and products.
Collectively these four applications also demonstrate the role of a strategic approach to data collection, collation, analysis and integration. To deliver these various products it is essential to employ and underpin analysis by the common approach to data as articulated in the principles. We will always have scarce resources for data collection. Tactical combinations of mapping, monitoring and modelling underpinned by good data management are essential and will ensure we maximise return on investment in data collection through its application to a range of problems.

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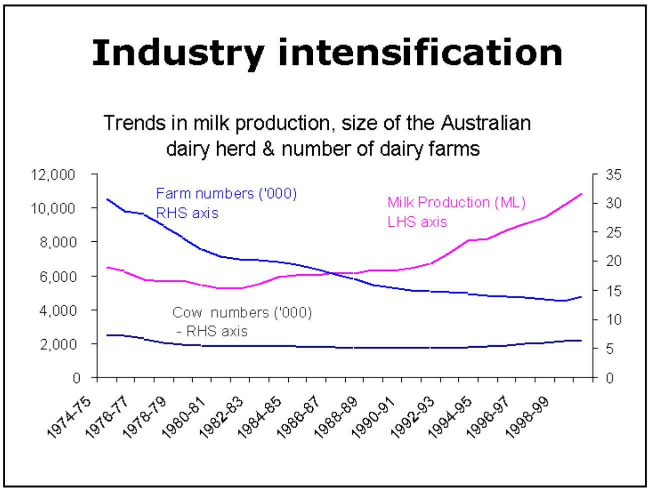

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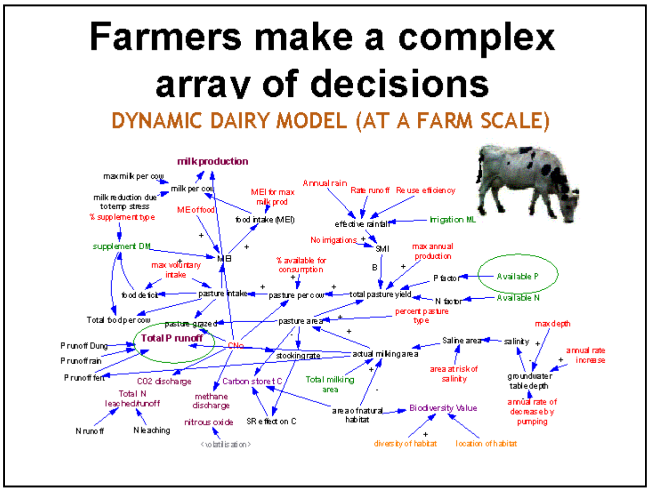

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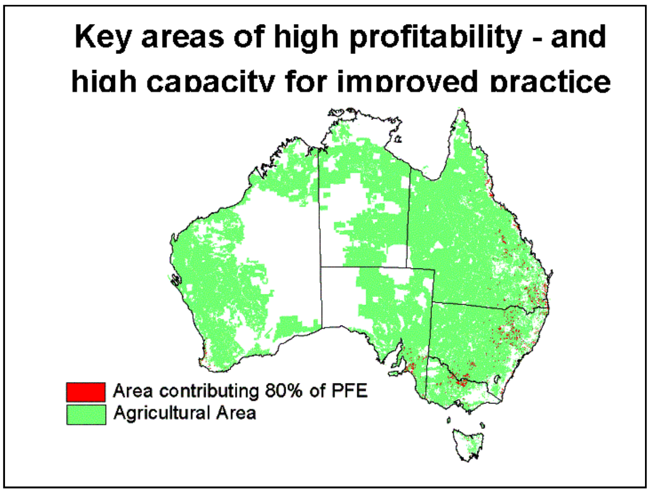

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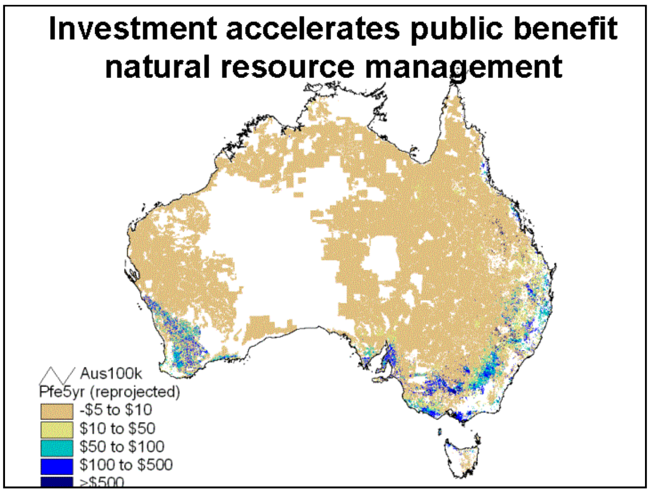

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Following is a listing of the summary Australia-wide assessments prepared by the 5 year National Land and Water Resources Audit. These were coordinated and prepared by a team of 8 facilitating partnership Australia-wide activities with a budget of $A35M.

Australian Water Resource Assessment 2000 - status of Australia's water resources, surface and groundwater, including use, environmental flows and development opportunities

Australian Dryland Salinity Assessment 2000 - assessment of the extent of, and management options for, dryland salinity

Australian Landscape Health 2001 & ***Australian Native Vegetation Assessment 2001 -*** detailing the condition of Australia's sub-bioregions and the extent and type of Australia's native vegetation respectively

Rangelands – Tracking Changes – collating information on Australia's rangelands and detailing the Australian Collaborative Rangelands Information System

Australian Agriculture Assessment 2001 - resource challenges and practice issues on–farm (acidification, nutrient management, soil erosion) and off–farm (sediment, nutrients transported through waterways to estuaries)

Australians and Natural Resource Management 2002 - social and economic dimensions of natural resource management based on natural resource accounting and a social profile of rural Australia.

Australian Catchment, River and Estuary Assessment 2002 - assessment of the ecological impact of the changes to hydrology, habitat, sediment and nutrient regimes within rivers and estuaries

Australian Biodiversity Assessment 2002 – assessing the condition of Australia's terrestrial biodiversity

Australian Natural Resources Information 2002 – setting the directions for natural resources data management and information provision

Australia's Natural Resources 1997-2002 and beyond 2002 – summarising the condition and management opportunities for Australia's natural resources and recommending an information-based approach to natural resource management

The **Australian Natural Resources Atlas** www.environment.gov.au/atlas provides information to aid decision making across all aspects of natural resource management. The Atlas presents information Australia-wide, by State/Territory and regionally, and also by information topic. Users of the Atlas can prepare maps overlaying various information sets – using the "make a map" facility – or search hundreds of reports in a matter of seconds. The Atlas also provides electronic access to all the above Australia-wide theme reports.

The **Australian Natural Resources Data Library** http://adl.brs.gov.au/ADLsearch/ provides a data documentation search and data download facility and supports the Atlas with links to Commonwealth, State and Territory data management systems. The Data Library primarily contains Australia-wide biophysical, social and economic data prepared through the Audit and with links to other Commonwealth, State and Territory data management services. Data are provided under license at cost of transfer.

Results from the Recent Landscape Inventories for Building Landscape Indicators in Belgium

Marc Antrop
Geography Department, Ghent University
Krijgslaan 281, S8, B9000 Gent, Belgium
Tel:+32 9 264 4705, Fax: +32 9 264 4985
Email: marc.antrop@rug.ac.be

Abstract

The development of landscape indicators in Belgium is not a simple task and has many very specific constraints. Between 1970 and 1993 successive institutional reforms made Belgium gradually to become a federal state, composed of three regions (Flanders, the Walloon region and Brussels Capital region) and three communities (flemish, francophone and germanophone). As the regions are responsible for all territorial matters and the communities for all cultural matters, the responsibilities and policy making related to spatial planning, landscape conservation and management and environmental gradually became divided and fragmented also. Legislation, policy and research developed differently and data for a uniform assessment of the Belgian situation became increasingly more difficult to obtain. Since 2001 also the agricultural policy was transferred to the regions. Belgium is highly urbanised (97%). The population density in the northern part is particularly high and exceeds an average of 500 inhabitants/km² and the building pattern is extremely scattered. Transportation infrastructure of different kind is extremely dense. Agriculture occupies less than 3% of the active population but still has an impact upon almost half of the territorial area (approximately 1.4 million ha). Since the 1970s the number of agricultural exploitations has been decreasing and only 37.5% of the farms of 1975 still existed in 1996. Simultaneously, the average size of the farms increased from 8,5 ha to 19 ha, but with important spatial variation between the different natural regions. The natural and cultural landscape diversity is traditionally high and becomes increasingly fragmented. Inventorying and assessing landscapes is difficult and happens differently according to the regions. In Flanders a detailed landscape atlas and evaluation was realised between 1995 and 2001; in the Walloon region similar initiatives are just starting and in Brussels-Capital region landscape is not a political priority. The Flemish landscape atlas is a GIS database and has already been accepted as a official document in the Flemish policy. Combined with other datasets it allows the development of landscape indicators and the first results have been applied successfully already in strategic environmental planning. The methodological expertise obtained here is now also studied and discussed in the Walloon region and the possibilities for a generalisation and integration at the federal level of Belgium is examined.

Keywords: Belgium, Flanders, Wallonie, region, landscape indicators

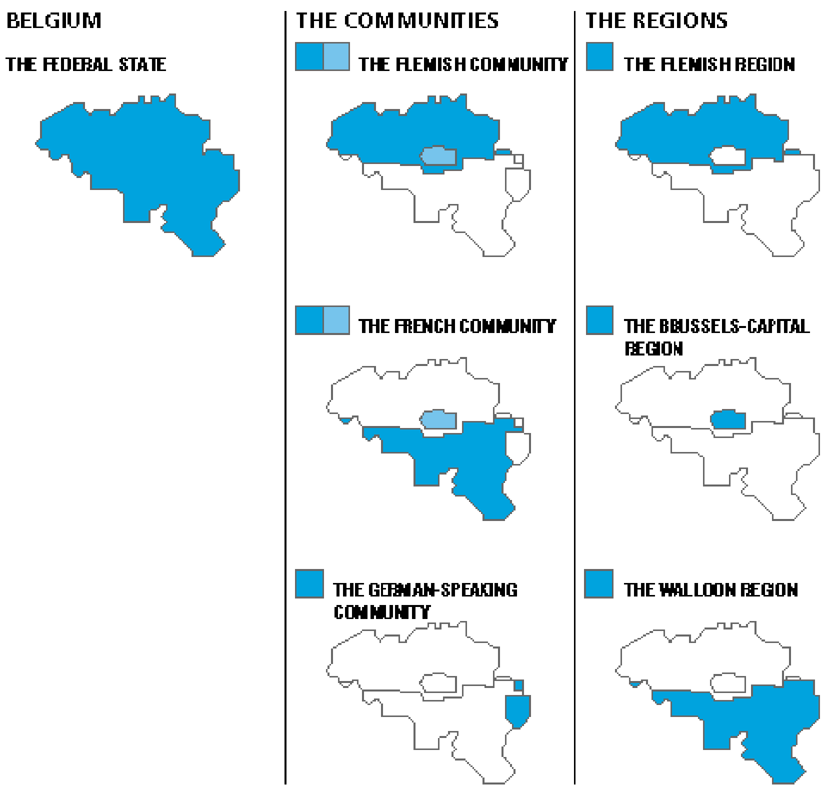
The case Belgium

Belgium is a small country situated in the centre of the European Union. It is highly urbanised (97% urbanised) distributed in 15 urban regions of at least 80,000 inhabitants, grouping about 53% of the total population. The population density in the northern part is particularly high and exceeds an average of 500 inhabitants/km² and the building pattern is extremely scattered, while south of the basin of Samber-Meuse rivers, the population is concentrated in small villages and the population density rarely exceeds

50 inh./km². In addition, Belgium is situated at the cross roads of Europe. Transportation infrastructure of different kind is extremely dense, which is well illustrated by following data: an average road density of almost 55km/1000 km² and railroad density of 110 km/1000km². In Flanders region the transportation infrastructure occupies 7.6% of the total area.

Between 1970 and 1993 successive institutional reforms made Belgium gradually to become a federal state, composed of three regions (the Flemish region (Flanders), the Walloon region (Wallonie) and the Brussels Capital region) and three communities (flemish, francophone and germanophone) (Figure 1). As the regions are responsible for all territorial matters and the communities for all cultural matters, the responsibilities and policy making related to spatial planning, landscape conservation and management and environmental gradually became divided and fragmented also. Legislation, policy and research developed differently and data for a uniform assessment of the Belgian situation became increasingly more difficult to obtain. Existing publications dealing with Belgium as a whole are rare and out-dated (Antrop ,1999, Denis, 1992, Christians, Daels and Verhoeve, 1992, Christians and Daels, 1988). Since 2001 also the agricultural policy was transferred to the regions.

Figure 1: The federal Belgian state (http://www.fgov.be)



In Belgium agriculture occupies less than 3% of the active population but still has an impact upon almost half of the territorial area (approximately 1.4 million ha) (Denis, 1992). Since the 1970s the number of agricultural exploitations has been decreasing and only 37.5% of the farms of 1975 still existed in 1996 (Van Hecke, 1992). Simultaneously, the average size of the farms increased from 8,5 ha to 19 ha, but with important spatial variation between the different natural regions. Agriculture is very varied and highly intensive and specialised as well. In particular in Flanders regions the intensive pig farming results in severe environmental impacts and agricultural and environmental policy are actually important issues.

Landscapes in Belgium

General characteristics

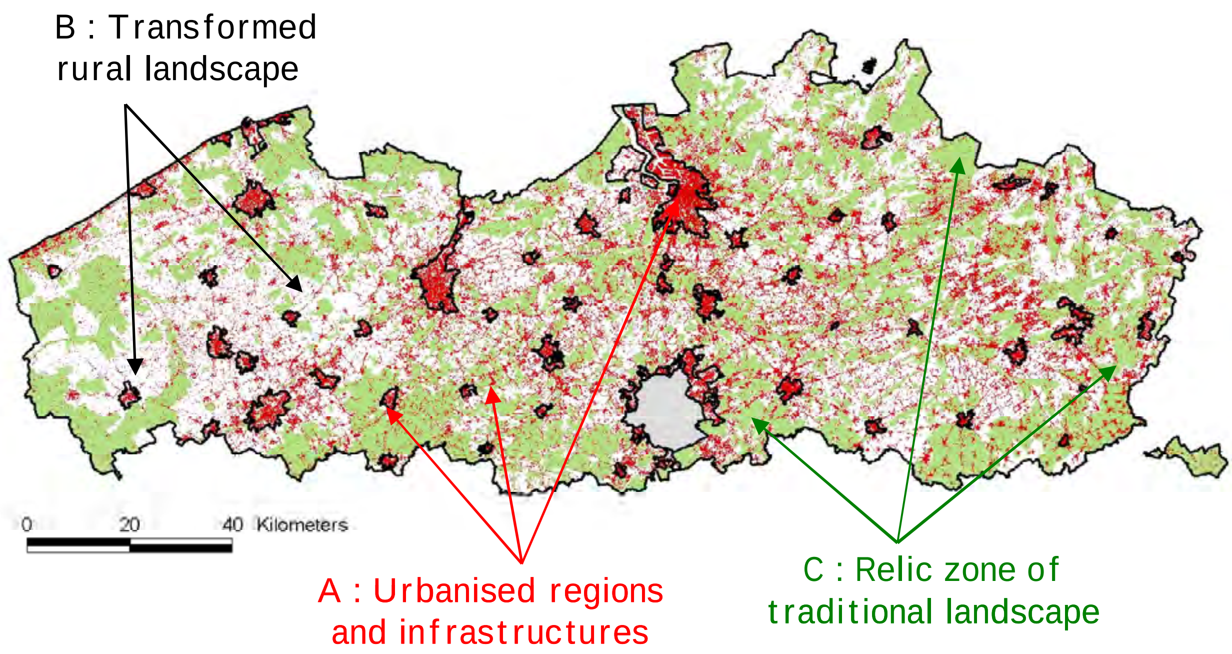
The natural and cultural landscape diversity is traditionally high and becomes increasingly fragmented and dynamic. The origins of the important landscape diversity are the physical geographical composition and the geographical situation in the cultural space of Europe (Antrop, 1999). The geological structure encompasses the Palaeozoic folded bedrocks of the Caledonian and Hercynian orogens, most of the Mesozoic and Neogene sedimentary deposits, as well as Pleistocene formations and Holocene coastal formations which have been transformed into polderland. The lithological diversity is expressed also in many soil types and relief forms, which humans used in a varied way through a long history.

Belgium consists of a narrow corridor of lowlands that starts at the coastal plain along the Strait of Dover and gradually widens to the east forming the Northern European plain. Before the coastal land reclamation during the medieval period, marshy coastland bordered fertile agricultural land of the loss belt. To the South the uplands of the Ardennes formed a hostile and forested area linked to the Hercynian uplands of the Eifel and the Vosges and Black Forest. Thus, the Belgian corridor formed the gate of cultural exchanges between Northern and Southern Europe, and the British Isles and continental Europe. This resulted is long territorial disputes and cultural mixtures that also influences the landscape development. It is the cause of the final division between the Flemish and Walloon region and the formation of the federal state of Belgium.

Flanders region

In Flanders region 128 units of traditional landscapes have been defined, mapped and described (Antrop, 1997). They are grouped into 23 landscape regions. These are used as a framework in other research domains and policy making (Antrop and Van Nuffel, 1997). A brief description of the landscape characteristics is available, as well as indications for appropriate management (http://geoweb.rug.ac.be/services). The Landscape Atlas of Flanders gives an inventory of the relics of the traditional landscapes at a scale 1/50000 (Hofkens and Roossens, 2001) and is integrated in GIS-Flanders for distribution (http://www.gisvlaanderen.be). Relic zones represent areas where characteristic landscape structures still can be recognised dating from the pre-1950s changes (Antrop, 2001). Relic zones occupy 4933 km² (36.3%), non-urbanised rural area is 6243 km² (46%), urbanised rural area is 2037 km² (15%), urbanised relic zones 369 km² (2.7%). Lists of protected landscapes are available at the Monuments and Sites Division of Flemish ministry (http://www.monument.vlaanderen.be/) and maps are available through GIS-Flanders.

Figure 2: Actual condition of landscape heritage conditions in Flanders based upon the Landscape Atlas and CORINE Land Cover (Van Eetvelde and Antrop, 2002)



Walloon region
In the Walloon region the polarisation is very pronounced between intensive used and highly urbanised landscapes and more extensive used and the countryside characterised by reforestation and population loss. Since 1998, the Walloon government created the Permanent Conference for Territorial Development (C.P.D.T. http://cpdt.wallonie.be) to coordinate and stimulate interdisciplinary research on regional development and to build common datasets and maps. Some of the themes include rural development, environment and landscapes. In the Walloon region, monuments, sites and landscapes are managed by other administrations and institutions than landscapes (http://www.wallonie.be). The integration of landscapes with nature conservation and forestry is more distinct, while the cultural heritage has more links to tourism (Atlas de Wallonnie, 1998). A preliminary mapping of landscape units, called 'territoires paysager' has been achieved recently (Feltz, 2002). About 100 landscape units were defined and grouped into 19 regions ('ensembles'). Further subdivision and characterisation is foreseen. Two types of units are recognised: 'classic' territories and an overlay of a-modal territories, which mainly refer to the deep valleys.

Brussels Capital region
The Brussels-Capital region has only a limited area of nature and agriculture to manage. Most important is its part in the Zonien forest that covers the three regions east of the city. No initiatives concerning landscapes are taken and most of the policy effort deals with the architectonic heritage.

The current status of landscape policy

General

The federal government has no direct authority about landscape policy and environment. However, it is still the institutional level where regional decisions have to be integrated to fit into the international framework. The many steps that have to be taken between the different regional authorities is one of the reason why Belgium at the federal level is rather slow in the ratification of international treaties. However, it is important to mention that at the federal level 14 agricultural regions were defined for administrative, financial and statistical purposes. The division was mainly based upon soil qualities and does not correspond to the landscape classification that are used today. Detailed agricultural statistics refer to the agricultural regions and to the municipalities.

Flanders region

Several administrations are involved directly and indirectly with the landscape. Consequently, several ministers are involved. Because of the complex networked structure of the matter and the political network, most decisions have to be taken at the level of the entire Flemish government. Landscape protection, as well as the protection of monuments and sites, is coordinated by one division in the administration of spatial planning, housing, monuments and landscapes (Afdeling Monumenten en Landschappen) under the authority of one minister,. However, spatial planning is under the authority of another minister. Agriculture, environment, forestry, nature conservation are the responsibility of a third minister in a separate administration. However, both administrations belong to the department Environment and Infrastructure. Consequently, the legislation dealing with the landscape is mostly sectorial, interferes and causes conflicts (Van Hoorick, 2000). Most conflicts are situated at the interfaces between policies of agriculture, nature conservation, forestry and cultural heritage. Spatial planning is considered generally as the coordination authority that should solve these conflicts. Consequently; many directives and rules concerning general land use and landscape management are incorporated into the legislation of spatial planning, in particular the spatial structure plan of Flanders (RSV, Ruimtelijk Structuurplan Vlaanderen). The Flemish government made not yet a decision about the legal implementation of the European Landscape Convention, but most policies follow the indications in the convention by taking landscape issues in their policy.

Walloon region

Several directories of the Walloon regional ministry are involved directly or indirectly with landscape issues. The protection and of monuments and sites is done by the Division of Patrimony, which resorts under the directory of spatial planning. Also in the Walloon regions agriculture and environment belong to two other separate directories. Issues concerning landscapes are divided over these. The Division of Patrimony focuses upon the traditional architecture and has less concern with the spatial dimension of landscapes. Landscapes are under direct management of the physical planning and those with high natural values depend largely of the directory of natural resources and the environment. As in Flanders, most of the integration has be achieved by spatial planning and here also the spatial structure plan contains the directives (SDER Schéma de Développement de l'Espace Régional) (Ministère de la Région Wallonne, 2002). The SDER also contains the legal implementation of the European Landscape Convention. The landscape is considered as a common heritage and the approach is strongly visually oriented. The landscape forms the visual framework to integrate the architectural heritage and natural valuable areas with economic development.

Brussels Capital region

Considering landscape management the Brussels Capital region is mainly concerned with architectural city planning and the protection of monuments and the management of a part of Zonien forest.

Possible landscape indicators

The major criterion to define the landscape indicators for the whole of Belgium is the possibility to integrate the data and the specific indicators that are used at the regional level. At the federal level Belgium uses data sets at the European level as well, such as the CORINE Land Cover, which is also used by the OECD (OECD, 2001). However, the regions adapted the Belgian CORINE land cover data to obtain more detailed maps using specific classifications as well. Still some additional indicators can be defined that are specific for the regions, but could be developed in future for the whole of the country. These are summarized in following tables. Table 1 gives an overview of the possible landscape indicators in relation to agriculture with their data sources and significance. Table 2 is a preliminary attempt to defined the indicators using data from different sources. The difference in land cover and land use statistics illustrate the important uncertainty that still exist. The differences are not due to a change in time, but partially also to the small definitions of the categories used and different registration methods.

Table 1: Possible landscape indicators Belgian federal level

Indicator	*Units*	*Data sources*	*Significance*
Land cover	categories	CORINE Land Cover database	Landscape diversity
Land use	categories	National Statistics (NIS)	Landscape diversity and land use intensity
Built-up area	% total area	CORINE Land Cover, National Cadastre	assessment of trend/ population pressure
Agricultural area	% total area	Land use map or CORINE Land Cover	assessment of trend
Forested area	% total area	Forest inventories or CORINE Land Cover and National Statistics	assessment of trend
Water bodies	% total area	Forest inventories or CORINE Land Cover and National Cadastre	assessment of trend
Road density	km/km²	Mobility data bases, National Institute for Statistics	fragmentation
Average farm size	ha	National Statistics (NIS)	Agricultural land use intensity
Protected areas	% territory	regional ministries	implementation of landscape in policy
Protected objects by category	number of objects	regional ministries	implementation of landscape management in policy
Relic landscapes	% area relic zones and anchor places	Landscape Atlas of Flanders	landscape stability
Visual absorption capacity of the landscape	score/km²	Flanders	buffer capacity of the landscape for visual intrusion of constructions

Table 2: Preliminary landscape indicators for the three regions of Belgium

Indicator	*Source/Year*	*Flemish region*	*Brussels Capital*	*Walloon region*
Land cover	CORINE Land Cover			
Agricultural land	1996	64%	3	53
(grassland)		(10%)	(1)	(14)
Forest, uncultivated		8%	11	31
Urbanised or built-up		23%	74	13
Other		5	12	3
Land use	NIS 1980 (Denis 1992)			
Agricultural land		67	11	56
Forest, uncultivated		12	12	32
Urbanised or built-up		14	57	7
Transport infrastructure		7	20	5
Road density	Verbruggen 1994, 1996 (Flanders); Atlas de Wallonie	0.325 km/km² (0.148 km/km² motorways)	-	0.147 km/km² (0.049 km/km² motorways)
Average farm size	Van Hecke in Denis 1992 (data from 1989)	10.2	-	25.3
Protected areas	Van Hoorick 2000			
Landscapes	Institute for Nature	2.7%		
Nature reserve	Conservation (Flanders);	1.56%		
Public	Atlas de Wallonie 1998	0.6%		< 1% (5197 ha)
Private		0.8%		< 1% (985 ha)
Forest reserve		0.1		<1% (245 ha)
Natural park		-		4% (67850 ha
Special protected zones		(20%)		20% (335828 ha)
Number of protected monuments, sites and landscapes	Atlas de Wallonie (data 1996)	M 7086, S 1282, L 666		3208
Relic landscapes	Landscape Atlas of Flanders	39% (16%)	-	-

Possible future developments

The differentiation between the regions of the federal Belgian state will continue to grow on domains of policy, data provision, mapping and applications. Nevertheless, European and international trends of assessing and monitoring the environment are present and allow chances for integration. Special efforts for realising the synthesis are however not self-evident and need to be developed. Additional indicators that are significant both for agriculture and landscape could be defined such as the proportion of sensitive areas, accessibility of places, population dynamics at the local level of settlements.

Conclusions

The political structure of the Belgian federal state causes different development in the policy in many domain related to agriculture and landscape. Data collection varies accordingly and makes comparison and integration a growing problem. An important problem is the continuity of the indicators for assessing trends. Many changes in definitions of descriptive categories and methods of registration induce a lot of uncertainty and demands careful and critical analysis of the data sets available. The Belgian landscapes are very diverse and the fragmented policy regarding the landscape adds to the complexity. Also, many differences exist between the regions in Belgium demanding specific indicators. Nevertheless, several indicators at the federal level and internationally comparable can be constructed.

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Internetsites

Federal
http://www.fgov.be

Flemish region
http://www.vlaanderen.be

http://www.gisvlaanderen.be

http://www.gisvlaanderen/geo-vlaanderen/erfgoed/landschappen.html

http://www.monument.vlaanderen.be/

http://geoweb.rug.ac.be/services

Walloon region
http://www.wallonie.be

http://cpdt.wallonie.be

Brussels Capital region
http://www.brussel.be/

http://www.brussel.irisnet.be/

Landscape Indicators Bridging Nature and Man – Structure, Function and Value of an Agricultural Landscape

Reija Hietala-Koivu
MTT Agrifood Research Finland
FIN-31600 Jokioinen
Tel. +358-3-41881, fax +358-3-4188 3196
Present address: Department of Forest Ecology, University of Helsinki
P.O.Box 27, FIN-00014 Helsinki University,
Tel. +358-9-1911, fax +358-9-1915 8100, email:reija.hietala-koivu@helsinki.fi

Abstract

Rural history and implementing agri-policy are mirrored in an agricultural landscape. No doubt, the basic structure and composition of agricultural landscape depends on local climatic and natural conditions. There is a close connection between agricultural landscape management and biodiversity management at the gene, species and habitat level. The purpose of this paper is to present four ways to measure agricultural landscapes according to OECD landscape work and its definition of agricultural landscape context divided into themes of agricultural landscape structure, function and value. However, the main emphasis has been laid here on the Finnish agricultural landscape scale.

It is proposed here that the structure of agricultural landscape is measured based on ecological value assessment and especially on the edge lengths of ditch boundaries that are located closest fields. Field margins are suggested to be of great importance to maintaining species diversity in the ordinary agricultural landscapes. Secondly, the functionality of agricultural landscape can be assessed considering the amount of open and managed cultivated areas. Maintaining the openness of agricultural landscapes is one of the targets of the Finnish Agri-Environmental Programme and also cultivating according to good local agricultural practices. In addition landscape values are becoming more and more important. Agricultural landscapes are places for food and fibre production but also areas for recreation and gaining rural experiences and other public commodities; amenity values of landscapes. It is proposed that they are measured by analysing the utilisation rate of rural farm tourism accommodation and by numbers of building permits in rural areas.

Keywords: Edges, Landscape indicator, Multifunctionality, Openness, Rural area

1. Background of the Finnish landscape indicator work

This paper is a proposal for landscape indicators to the larger set of indicators prepared for the Ministry of Agriculture and Forestry in Finland. The indicators are to be used in monitoring the implementation of the Ministry's strategy for sustainable use of natural resources (MMM 2001; Yli-Viikari et al. 2002).

The Finnish Ministry of Agriculture and Forestry defines close connection of agricultural landscape management with biodiversity management at different scales (gene, species, habitats) (MMM 1999; MMM 2001). In Finland we have paid more attention to the management of traditional agricultural biotopes than the management of ordinary landscapes. At the same time as the areas of traditional biotopes have decreased, ordinary agricultural landscapes have been homogenized. Large ordinary rural areas have lost a lot of their agrihistorical features as field margins, barn areas and clumps of trees and bushes within fields.

In this work agricultural landscape management has been defined according to clear value judgments (structure, function and value of landscape), which are compatible with OECD landscape work (OECD 2001), although the main emphasis has been laid here on the character of Finnish agricultural landscape. In addition, our intention was to keep a number of indicators as low as possible and we also wanted to keep the data access of indicators easy and cheap.

2. Indicator material

The proposed indicators here are the following:

1. The edge density of field margins (structure)
2. Change in openness of landscape (function)
3. The utilisation rate of rural tourism accommodation (value) and
4. Building permits for houses and farming purposes in rural areas in comparison with cities and densely built-up areas (value).

2.1 The edge density of field margins

Field margins such as other semi-natural habitats (meadows, clumps of trees and bushes within field) lying close to cultivated area play an important ecological role in maintaining many species in agricultural landscapes. One of the most important changes in the Finnish agricultural landscape since the 1950s has been a decline in the number of linear elements (Ruuska and Helenius, 1996; Hietala-Koivu, 1999), with an especially dramatic decrease in the numbers of open field ditches and their margins. Over 420 m/ha of open ditches have been replaced by sub-surface drainage in Finland in the course of time. Ditch boundaries located nearest to fields are suggested to be of great importance in maintaining species diversity in ordinary agricultural landscapes.

The edge density of field margins as an indicator describes easily how field parcels have scattered along the area in relation to the total field area. This index indicates an abundance of the ditch boundaries between field and other forms of land use (forest, constructed area, road, waterways etc.). It also connects structural information of the landscape level to the species diversity level describing edge richness in an agricultural landscape.

The edge density of field margins is calculated in kilometers /100 ha/ administrative agricultural region. Finland is divided into 15 administrative agricultural TE-centre regions (=Employment and Economic Development Centres in Finland). In addition, this paper also presents information concerning the region of Åland's government and administrative board (Fig. 1). Data from Finland is available at the Information Centre of the Ministry of Agriculture and Forestry.

2.2 Change in openness of agricultural landscape

Agricultural landscapes with open and managed fields and rural settlements are an important part of Finnish rural culture. Open, cultivated fields made up only 6.5% of the total area of Finland in 2001 (2.2 million ha, including fallow areas). Therefore maintaining the openness of agricultural landscapes is one of the targets of the Finnish Agri-Environmental Programme; fortunately over 90% of the Finnish active farms (accounting for 96% of the field area) had opted to participate in the programme in 2001 (MTTL 2002).

The openness of the landscape as an indicator measures an option to see a scenery in agricultural areas. However, it is good to note that in addition to openness, the visual diversity of agricultural landscape depends on other multidimensional aspects of scenery including sounds, odours, colours and heights of plants and placing of construction areas in a landscape. It varies spatially a lot in Finland because of different local nature conditions.

Change in the openness of agricultural landscapes is measured by percentage in each TE-centres and Åland. The change is presented by numbers (%) in a thematic map which shows with graduated colours the percentage of total utilised agricultural area / TE-centre. Data from Finland is available at the Information Centre of the Ministry of Agriculture and Forestry.

2.3 The utilisation rate of rural tourism accommodation

Agricultural landscapes are places for food and fibre production but also areas for recreation and gaining rural experiences and the other public commodities. In recent years multifunctionality in agriculture (ecological enterneurship, rural tourism etc.) has proved to be one way for many farmers to get additional income. According to the Agricultural Census about three thousand Finnish farms in 2000 had additional income from tourism, accommodation and recreation services. Furthermore, two thirds of those farms announced this line of business is more important source of income than practising agriculture (The Information Centre of the Ministry of Agriculture and Forestry 2001).

The volume of rural tourism describes how widely recreation services produced by farms have been utilised and furthermore how much multifunctionality of rural areas is considered by public. Good landscape and environmental management in business is important in building an environmentally convincing image. This is essential especially for an enterprise which ’produces’ recreation services based on utilisation surrounding environment. As general in business life it has to be taken into account that advertising and relationships between demand and supply have impacts on the viability of rural tourism enterprises. The utilisation rate of rural tourism accommodation as an indicator measures volume of overnight stays. It is expected that if overnight stays at rural tourism farms increase, experiences relating to agricultural practising and rural landscape also increase.

The Working Group is measuring and keeping statistics on the capacity of rural tourism in Finland by annual questionnaires (Rural Policy Committee / Rural Tourism Working Group 2001a, - 2001b). Limitation of this questionnaire is that the number of answers can vary yearly because they take place on voluntary base.

2.4 Building permits for houses and farming purposes in rural areas in comparison with cities and densely built-up areas

Willingness to invest in building new houses is reflected by national economic trades and aims of regional housing policy and planning. In some EU member states, housing accessibility is the main policy concern both in terms of supply and cost relative to rural incomes. Furthermore, in agricultural production investing in building grain stores, garages for farm machinery, livestock sheds and warehouses is supposed to correlate generally with the willingness and belief of farms on improving profitability of the practising agriculture and agricultural production conditions.

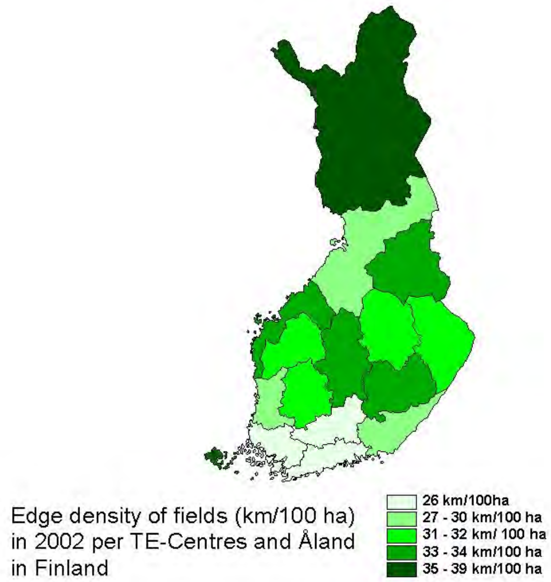
The attractiveness of rural environment for living is measured here by number of building permits granted by local authority. While one building permit for houses can include more than one residence, a number of residences of permits has been taken into account here. Building permits for houses and farming purposes were compared between cities, densely built-up areas and rural areas in Finland by graphs (Statistics Finland 2002).

3. Results

3.1 The edge density of field margins

Figure 1 shows spatial differences between the values of edge densities (km/100 ha) around the TE-centre regions and in the Åland Islands in 2002 (data concerning the previous years was not yet available) in Finland. The results of this indicator from the year 2002 show that the edge densities of fields are lower in the south than in the other parts of Finland, and especially in Lapland and Åland. Probably, the fields in the south are situated more compactly. Moreover, it has to be noted that in Finland crop cultivation has largely limited to the south and west of the country, where subsurface drains have been installed in 70%-80% of the arable land in recent decades (Salaojakeskus, 1999). Milk production and forestry have become the main sources of income in the east and north of the country, where also soil properties generally are poorer because of stony soil and shorter growing period. The values of edge densities vary from minimum 26 km/100 ha (the southern Finland i.e.Uusimaa, Varsinais-Suomi and Häme) to maximum 39 km/100 ha (Åland), it means a difference of 110 m/ha.

Figure 1: The edge density of fields (km/100 ha) in 2002 in Finland.

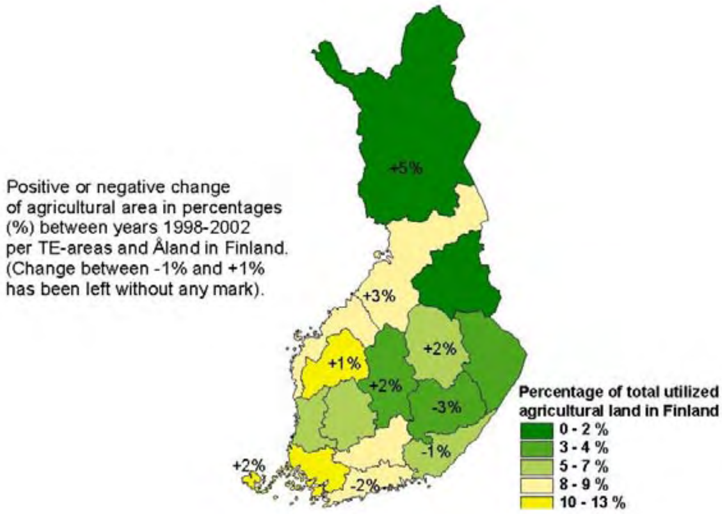


It is important to remember that landscape level changes cannot be explained out of context, without a knowledge of nature conditions, rural history and national or EU agricultural policy programmes that have been implemented.

3.2 Change in the openness of agricultural landscape

The results of this indicator indicate a slightly decreasing trend of cultivated land in the southern Finland i.e. changes –3 and –1% (Fig. 2). Changes between –1 and +1 have not been marked into the map. In hectares changes vary from the decrease of 4060 ha (in the south, in Uusimaa) to the increase of 6080 ha (near Lapland, in Northern Ostrobothnia). Field areas in South Savo (eastern Finland) have decreased by 1960 ha resulting mainly from afforestation. In south region, in Uusimaa, the construction projects of roads and new residential areas near cities and densely built-areas have changed arable land for another form of land use.

Figure 2: Change (%) in the openness of agricultural landscapes by numbers / TE-centres and Åland. The thematic map with graduated colours shows the percentage of total utilised agricultural area / TE-centres and Åland in Finland.



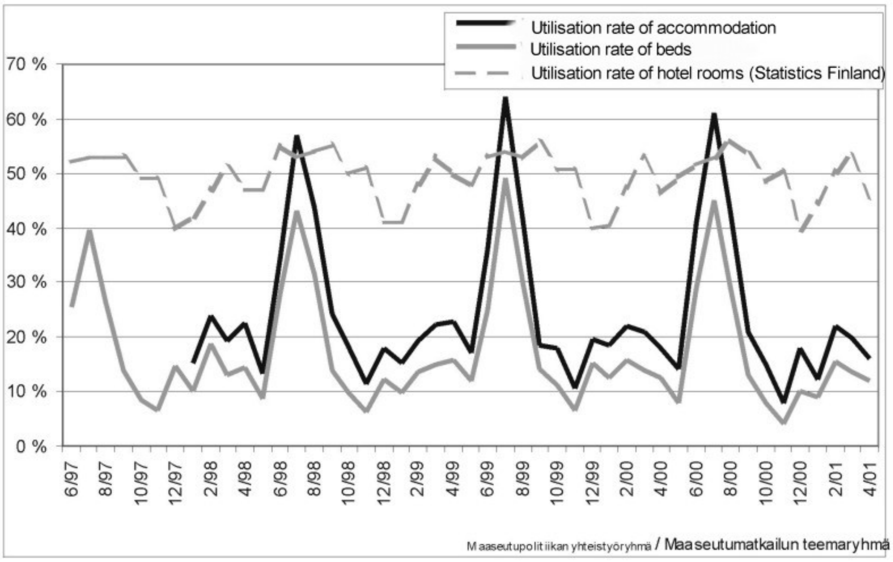
The background information on the percentage of total utilised agricultural area plays here a useful role in presenting regional differences of the openness in agricultural landscapes around the country.

3.3 The utilisation rate of rural tourism accommodation

According to survey of the Rural Policy Committee/Rural Tourism Working Group (2001) the utilisation rate of rural tourism accommodation was at the highest in summer 1999 (Fig. 3). In summer 2000 it was 61% (data concerning a period between April 2001 and April 2002 is not yet available). Farm tourism is seasonally popular in the summertime while outdoor recreation in the wintertime is usually concentrated on ski resorts. Figure 3 shows utilisation rate of bed places and hotel rooms in addition to utilisation rate of accommodation. Utilisation rate of hotel rooms is more constant annually than the rate of accommodation of rural tourism; however, greater rate of rural tourism in the summertime describes people's willingness to enjoy the countryside and to value its significance for recreation.

One limitation for this measure in Finland is that number of answers can vary yearly. It would be recommendable for measuring the connections of public commodities to landscape and rural environment if a rural tourism enterprise had a duty to announce utilisation rate of accommodation or number of visitors at a farm.

Figure 3: The utilisation rate of accommodation 1997- April 2001 in comparison with the utilization rates of bed places and hotel rooms in Finland.



Source: Rural Policy Committee / Rural Tourism Working Group (2001).

3.4 Building permits for houses and farming purposes in rural areas compared with cities and densely built-up areas

In rural areas the trend of granted building permits for houses decreased during the 1990's (Fig. 4). General economic depression in Finland in the beginning of the 1990's had impacts on many lines of business around the country. This can also be seen in the decreased numbers of building permits for farming purposes in the 1990's (Fig. 5).

Figure 4:

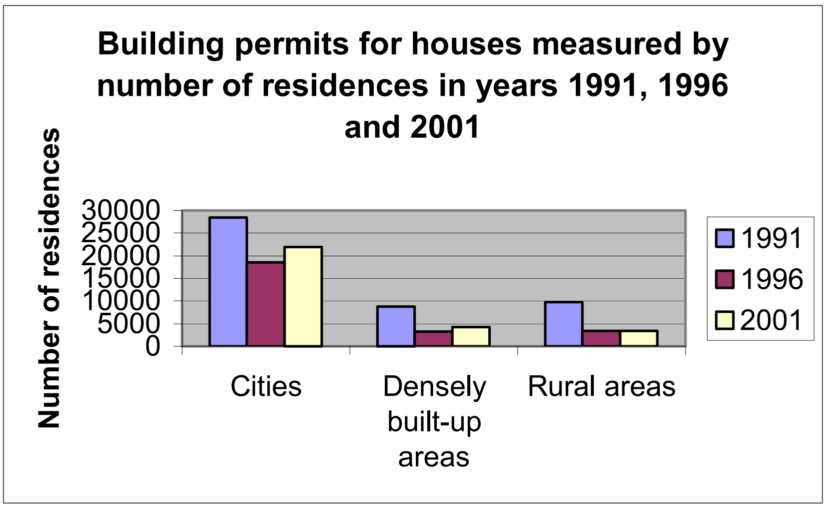
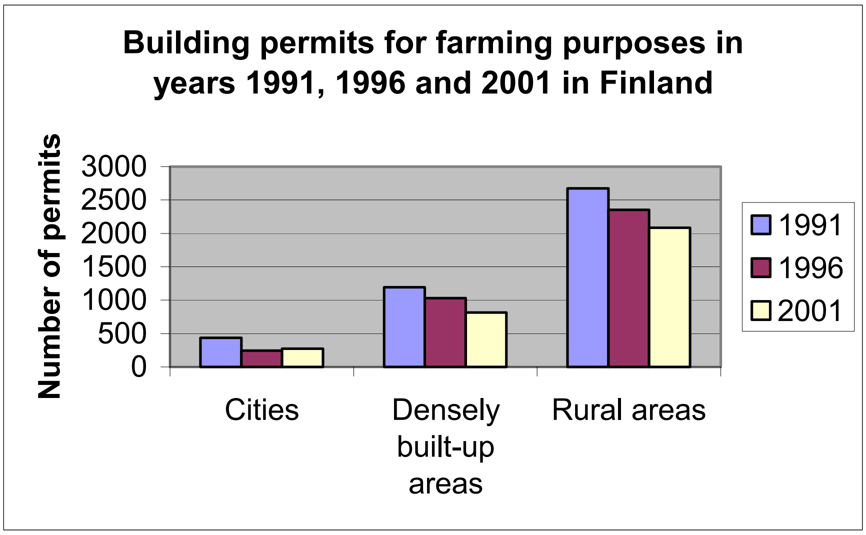


Figure 5:



Rural building activities in Finland during the period 1991-2001 seem to have a overall decreasing trend. Human action is concentrated on other areas as to rural districts. It would be more useful to analyse the number of permits if it were possible to divide rural areas, e.g. to three subareas according to their distance to densely populated areas, to get the more exact picture about development in rural areas itself.

4. Discussion and conclusion

The first indicator, the edge density of field margins (km/100ha) shows regional differences between agricultural production conditions but also between nature conditions. If edge density especially in the southern Finland decreases in future it will forecast weaker living conditions for species depending on agricultural landscape mosaic.

The second indicator, change in the openness (%) of arable land has to be presented at two levels: it needs the background information of total utilised agricultural land showing the reference level to which the change in openness can be compared with. The openness of rural landscape is nationally important feature in Finland because of its rarity comparing to forest land.

The third and fourth indicators describe amenity values of rural landscape based on the assumption that increased interest on recreation at rural tourism farms or on construction in rural areas would show the increased significance of rural environment. The third, utilisation rate of accommodation in rural farm tourism (%) has its weakness on data availability. The fourth, numbers of building permits in rural areas in comparison with cities and densely-built areas would need data concerning spatially more exact information about building activity inside the rural areas.

This proposed set of indicators at national level includes both visual and ecological but also social and economic features. There is still a lot of doing with testing the sensitiveness and validity of the indicators when they can be used in the monitoring of landscape development. However, the minimum number of indicators forms a base for a wider analysis to describe the temporal and spatial development in the Finnish landscapes according to the strategy for sustainable use of natural resources.

Acknowledgement

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Indicators of Landscape Dynamics: On-going Land Cover Changes

Marie-Françoise Slak and Alexandre Lee
Ecole Nationale d'Ingénieurs des Travaux Agricoles de Bordeaux,
1, Cours du Général de Gaulle, BP 201, 33175 GRADIGNAN Cedex, France
tel : (33) 557 35 07 07; Email : slak@enitab.fr, fax : (33) 557 35 07 39

Abstract

France has developed a statistical survey for the estimation of land-cover and land-use which takes into account the entire country. Data is collected annually at checkpoints that are situated on a 2-level grid map. This provides a reliable multi-purpose data source. Annual information makes it possible to design indicators on land-cover description and land-cover changes. Changes can be detected by checking frequency modifications in categories from year to year. It is also possible to obtain results highlighting changes affecting the spatial organization, hence to obtain quantitative indicators strongly linked to landscape changes.

Indicators have been designed on landscape opening, landscape closing, dynamic urban densities, scattering, and agricultural diminution. Using the same methodology, many other indicators could be designed in order to study other dynamics, depending on the target.
The method will be explained and examples of landscape characterization will be developed; such as changes from one category to one another and indicators of trends in landscape changes. Quantifications by region can be obtained (statistical data) and statistical maps produced on the scale of the entire country.

Results and Methods developed in this paper come from a collaboration between the ENITA in Bordeaux and the SCEES (Department of statistics for the French Ministry of Agriculture). They were coordinated by Nicole Bonneviale. A complete paper will be published in the french Agreste publication in late 2002.

Key words: landscape changes, landscape indicators, land cover survey, landscape scattering, landscape closing

1. Landscape indicators: Why?, How?

1.1 Why ?

To describe landscape, it is necessary to design tools such as indicators. But the questions are "what are the purposes of landscape indicators? What is the value of a landscape, of landscape destruction or landscape change?". The aim of this research is to highlight processes affecting landscape. These processes are not just limited to agricultural policy: for instance urban extension impacts agricultural landscape as well as sustainability, in the same way that forest extension impacts agricultural landscape and sustainability.

Research was focused on producing indicators designed to provide information to policy-makers concerning landscape trends. The datasource mobilized is the French land-cover survey called "TERUTI", developed and managed by the French ministry of agriculture.

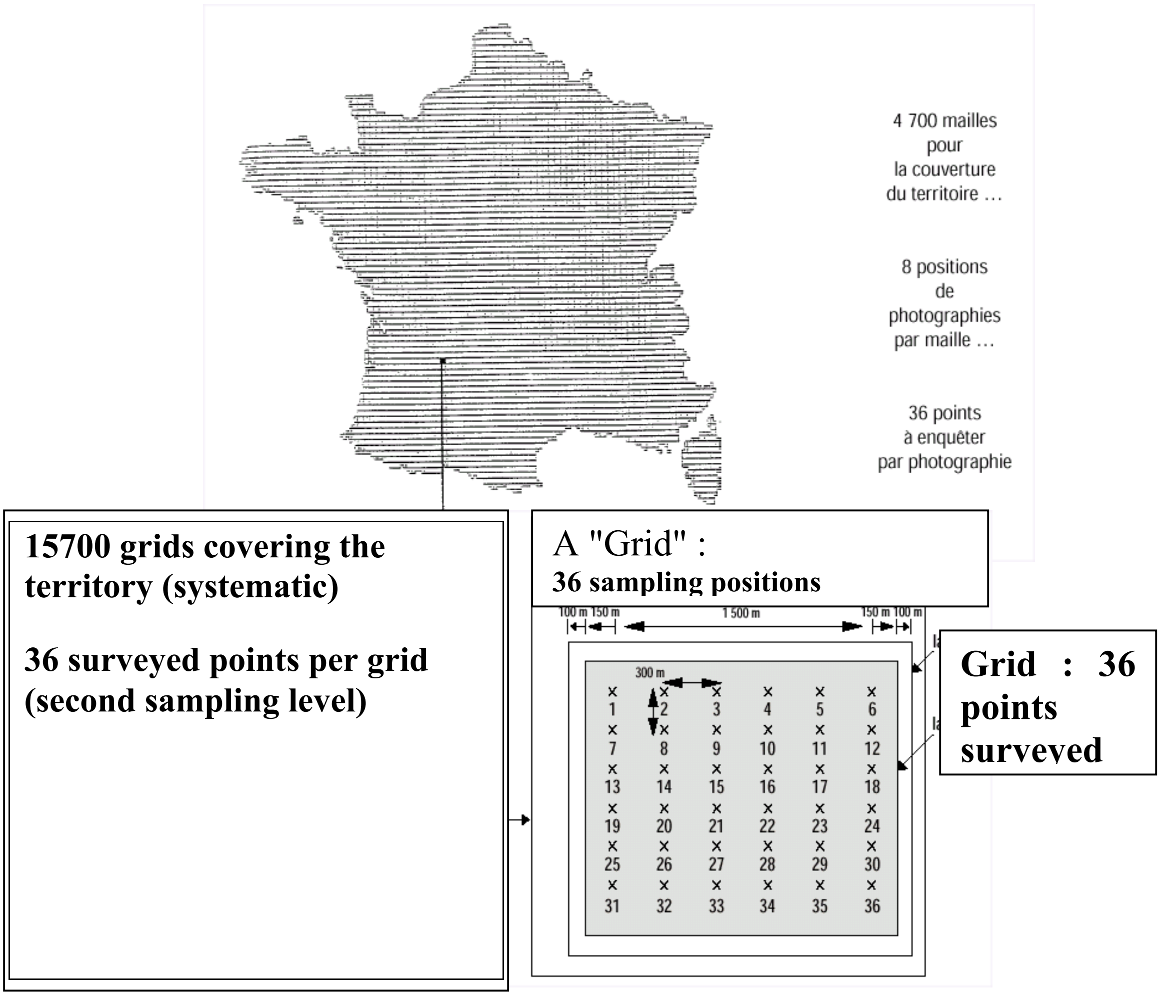
1.2 How ?

Landscape is a complex concept. A first meaning covers physical and biological quantitative descriptors. Such quantification can provide national or regional quantitative indicators. Obviously, a land-cover survey will provide this kind of data. But the special design of the TERUTI survey allows us to obtain information about the spatial arrangement of different types of land-cover, from a sampling grid. Any change in this arrangement means a change in landscapes; that is why we can obtain indicators concerning the visible landscape through statistical data analysis.

2. TERUTI Land-cover survey: a source for obtaining landscape; description and landscape change indicators

France has developed TERUTI, a statistical survey of the Ministry of Agriculture for the estimation of land-cover and land-use, which takes the entire country into account. Data is collected annually at checkpoints that are on a 2-level grid designed as described in Figure 1 (Slak et al., 1995a).

Figure 1: Two level sampling



Each sampled point is observed annually by human eye. Data is collected by the SCEES. Data includes land cover and land use, two different nomenclatures are used. The physical classification has been broken down into 82 categories which are likely to be regrouped according to the objectives of the data process. For example, the regroupings used appear in Table 1.

The collection of information annually makes it possible to design indicators on land-cover description and/or land-cover changes. From the annual TERUTI survey, the ENITA and the SCEES developed together a method of data process on land use which allows the spatial dimension of land use to be identified. The main value of this lies in the possibility of comparing annual frequencies over the 15700 grids, and more generally, to detect and represent changes in spatial arrangements among the 36 surveyed points in each grid.

Standard land-cover data which gives only total areas of cover, e.g. agricultural land, urban areas, etc., can be greatly improved by introducing a spatial dimension showing how the different covers are distributed. This paper explains methods used in France to introduce this spatial dimension. The assessment of trends in land use constitutes one of the components in the assessment of trends in landscapes. The methods have been extended to all the grids and results reported on statistical maps.

3. Three different methods of data processing

This paper presents 3 ways to obtain landscape indicators, and more particularly, identifiable landscape trends when changes occur.

3.1 Frequency indicators

The first method is relatively crude: it consists in the presentation of *frequency results* using the grid as a statistical unit. It provides a way of representing the main categories of a territory through easily understandable statistical maps. Such maps are useful for a first characterization of a territory depending on its main land-covers.

The easiest way to analyse land-cover data per grid is to note whether one of the classes defined in table 1 is dominant. A threshold is set for 50 % of points belonging to the same cover on a grid (covers of the first level classes, or covers of the second level classes). The computation provides results for the entire country: a very high proportion among grids shows a dominant class with a 50% frequency threshold. This makes it possible to produce tables and statistical maps such as Map 1.

The frequency method provides detailed information, but the 50% threshold is sometimes a limit (example: for artificial land-cover, the landscape seems "artificial" long before land-cover reaches the 50% threshold of the "Artificial" class). This method enables us to detect changes of dominant land-cover, but accuracy is limited by the fixed threshold. The advantage is that anybody can very easily interpret maps and tables obtained through this method.

Table 1: TERUTI physical classification regroupings (Slak et al., 1997b)

Physical survey code	sub-category	category secondary	major categories
15, 16 11, 17 12, 13, 14 49 50, 69, 70, 71 18 19, 20, 21	rocks, glaciers, falls dunes, beaches, saline fens fresh waters mountain pastures range land leafy forest resinous forest	rocks and waters range land mountain pastures forests	"nature"
72 22, 23, 26 24, 25 73 53 to 66 43 46, 47, 48, 51 27 to 42, 44, 45, 52 67	hedges scattered trees poplar plantations paths vines, orchards perennial crops meadows annual crops kitchen gardens	hedges scattered trees poplar plantations paths vines, orchards perennial crops meadows annual crops	"agricultural"
68, 84 74, 75, 76, 78 85 to 91, 77, 79 80, 81 82, 83	artificial green artificial altered artificial built up artificial car parks artificial roads		"made artificial"
99			forbidden areas[1]

(1) Not surveyed (military land for example)

3.2 Texture indicators: landscape homogeneity indicators

The second method is based on methods used in image analysis (Haralick et al., 1973): the data process makes it possible to distinguish different structures of organization, even if the overall areas involved are identical. With a method that uses only global data – frequency - it is impossible to distinguish between some types of spatial organization that are very different, and therefore correspond to very different landscapes. For example, if agricultural use is represented by white and woodland by black, data on overall area by use will give the same results in the two following situations (figure 2).

Figure 2: left homogeneous texture, right heterogeneous texture: frequencies are equal.

This method provides *texture* results more closely linked with landscape than the previous one. In this way, it is possible to define homogeneity versus heterogeneity of landscape components. An algorithm allows us to obtain automatic classification of the different grids.

The aim was to obtain indicators describing homogeneity/heterogeneity of land-cover observed through the survey (in a way similar to visual perception). The TERUTI grid is composed of 36 points (6*6). The size alone made it impossible to keep a highly detailed classification for land-covers by point. The decision was therefore made to work with 3 categories – those of the first level classification - for this method. For each grid a matrix was calculated, describing the number of contacts within similar or different land-covers. The matrices are normalized in view to render them easy to compare and interpret (details in Slak et al, 1997a, Slak et al. 2003).

3.2.1 Texture indicators: Cooccurence matrix:

	Naturel	Agricole	Artificiel
Naturel	Contacts nat- nat	Contacts nat-agr	Contacts nat-agr
Agricole	Contacts nat-agr	Contacts agr-agr	Contacts agr-art
Artificiel	Contacts nat-art	Contacts agr-art	Contacts art-art

From this data it is possible to create coefficients describing homogeneity (**INT**=Σ $(Ci,i)^2/\Sigma$ $(Ci,j)^2$) or diversity (**ASM** = Σ $(Ci,j)^2$). These are used as texture indicators. **ASM** is a descriptor designed by Haralick (Haralick et al.,1973), **INT** was designed specifically for landscape indicator purposes (Slak et al., 1997a, Slak et al, 1998). The closer to 1 the indicators are, the more homogeneous the land-cover structure is.

Each grid provides coefficients for each contact within classes, more INT and ASM calculated as mentioned above. Automatic classification is applied, using this data, allowing each grid to be affected to a group, depending on its homogeneity or heterogeneity, described by the design of a threshold applied to the ASM and INT levels (Slak et al., 2001b).

3.2.2 Groups obtained by automatic classification
This method is highly systematic: the hypothesis is that any combination is theoretically possible. Group production is based on successive steps. The first step identifies *highly heterogeneous grids* (INT <0.6*), homogeneous grids* (INT>0.86), and medium ones.

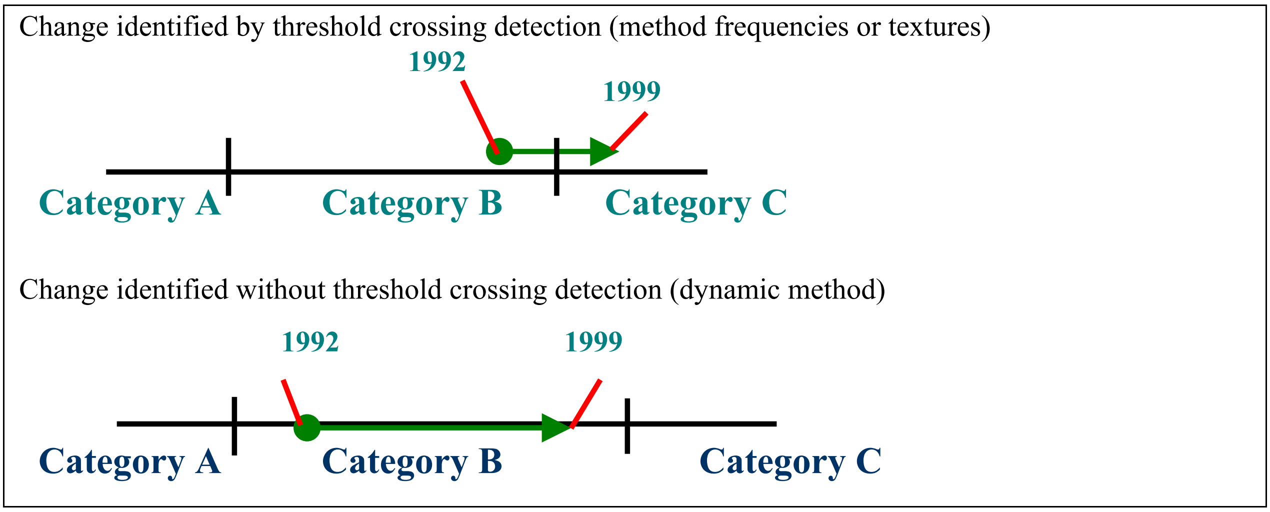
Among homogeneous grids, a distinction is carried out between uniform homogeneity (high ASM) and homogeneity with several covers (low ASM). Among medium heterogeneous grids the main kind of contact is detected if ASM>.25 (Slak et al. 2001b, Slak et al., 2002, Slak et al., 2003).

The algorithm was performed for the entire land-cover dataset concerning all French regions. The classification makes it possible to describe and compare homogeneity levels and their variations between 1992 and 1999.

3.3 Trend indicators
The third method is the one that makes it possible to define, with the highest accuracy, landscape trends over time.

When developments or other changes occur, no distinction can be made between a development which constitutes a continuation or fragmentation of the space through the frequency method. Using the texture method the change is detected only if a threshold is crossed. But very often, changes occur without producing any threshold crossing (see figure 3).

Figure 3: Changes described by threshold crossing or no threshold crossing



3.3.1 Detection of changes
The texture method was developed to allow us to identify the spatial organization of land-covers, providing information about landscape homogeneity or heterogeneity. The dynamics method, was designed specifically for the **detection of changes** in the structure of land-cover over time.

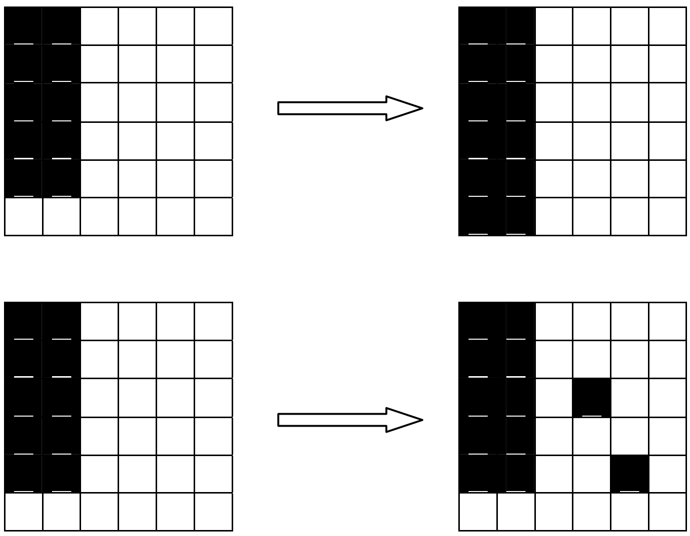
In the two following figures the land-cover frequency changes over time in the same way, starting from 12/36 of land under urban cover to 14/36. For visual perception - that involved in landscape perception - these two situations are very different : for the first case the "border" moves between the two different covers, but landscape change is slight regarding the overall picture. In the second case, a more violent change in landscape occurs. Such changes involve very different simultaneous impacts on landscapes, habitats, soil resources and even agricultural sustainability.

The method needed in order to detect sub-threshold changes had to be sensitive to two types of characteristics: (1) the homogeneity or heterogeneity of the organization of the land-cover, (2) the continuous or discontinuous development of a category (Figure 4 and 4').

Figure 4 and 4': Different trends of landscape change

Top: homogeneous texture at t1, urban extension from t1 to t2 connected to previous urban areas (no agricultural scattering),

Bottom: homogeneous texture at t1, urban extension from t1 to t2 with scattering of the agricultural landscape (from Slak et al, 1999b)



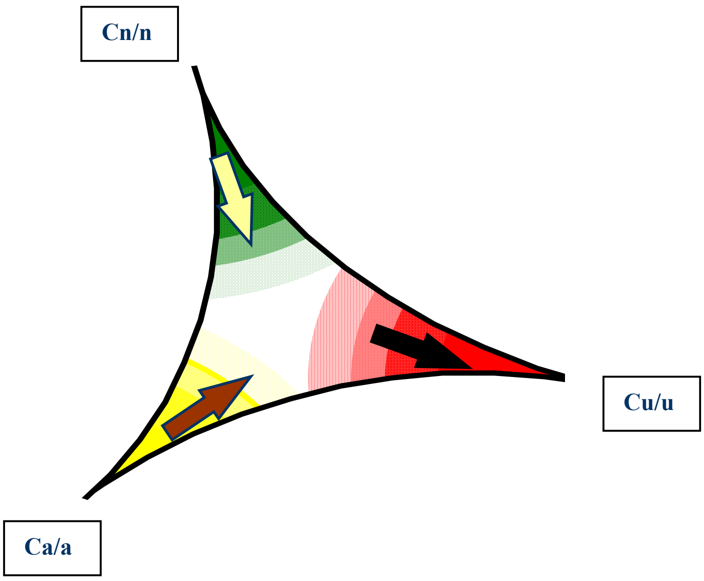
3.3.2 Data used to perform trend indicators

The texture indicators used are the same as for the texture method, except that land-covers are observed through 2/2 matrices (land-cover A/land-cover non-A). That makes very easy interpretation of INT and ASM variations possible. Details of the indicators are described in a paper to be published by SCEES (Slak et al., 2003). From INT, ASM and the number of homogeneous and heterogeneous contacts, it is possible to detect relative homogeneity/heterogeneity and changes over time.

When A land-cover is homogenizing, simultaneously the number of contacts between A and A land-covers increases and INT changes. If the initial situation was mainly agricultural, INT (A) will increase, but if the initial situation was other than agricultural, INT (A) may decrease. Series of conditions were established which, when satisfied, define each of the 7 dynamics. Each dynamic describes trends in landscape changes from data available.

The seven trends can be represented by illustrations, describing the respective proportion among C(X/X) occupation. Here U is used for "Urban" (artificial), A for "Agricultural", N for "Natural".

Figure 5: Main simple trends described by indicators



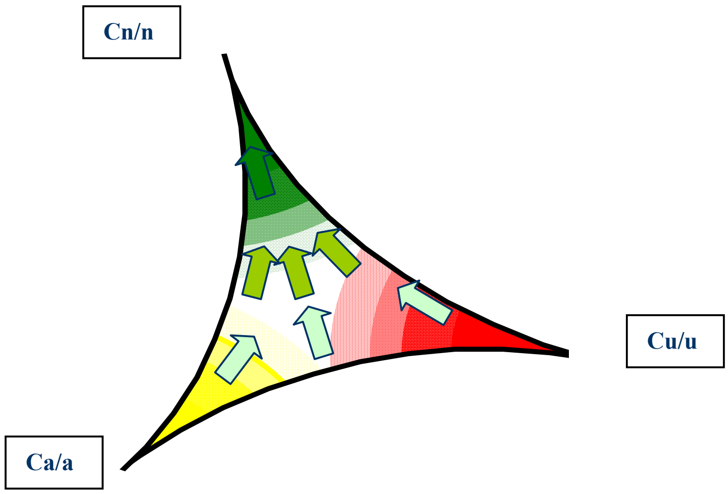
Brown: agricultural scattering

Yellow: forest scattering

Black: urban densification

Other indicators are more complex: examples are landscape closing, landscape opening, artificialization, agricultural decreasing (other than agricultural scattering), stability. The trend "landscape closing" is illustrated with Figure 6.

Figure 6: Landscape closing



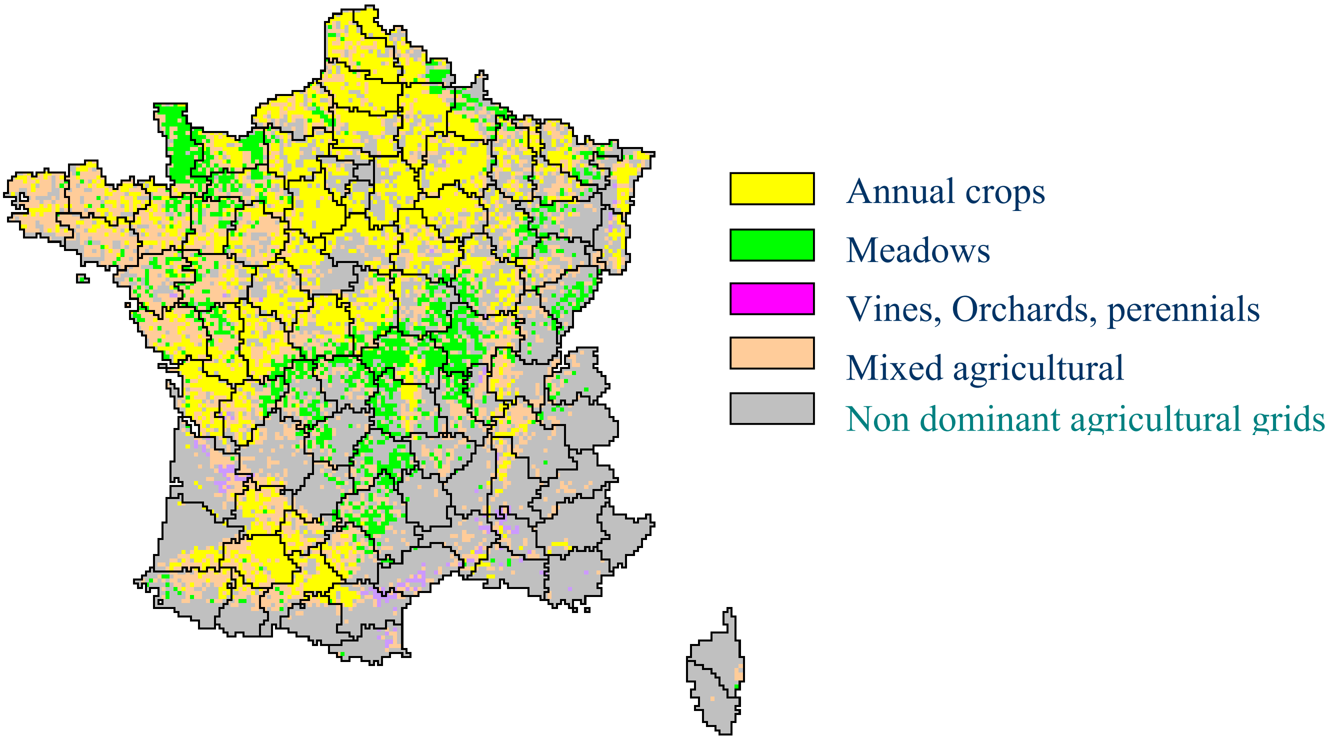
These trends are more or less strong, hence different levels were designed to indicate the intensity of the trend (low intensity or strong). Several trends can occur simultaneously.

4. Results

4.1 Frequencies method: Results in France 1992-1999

Several papers provide results from this method (Slak et al., 1995b, Slak, 1999a, Slak et al., 2001a)

Map 1: Statistical map of mainly agricultural grids 1999



4.2 Texture method Results in France 1992-1999

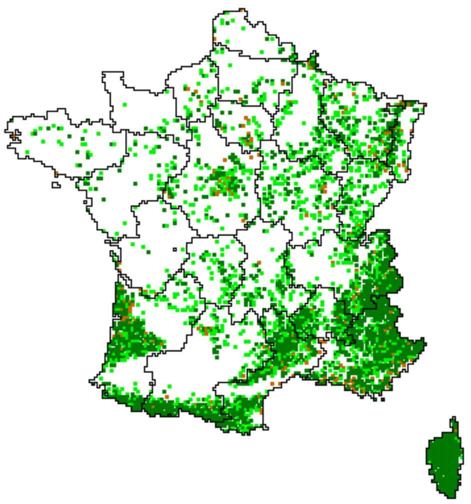
The frequencies method disallowed the detection of spatial organization and describes only a very low level of "mixed" grids (about 7%). The texture method is less detailed regarding land-cover (no distinction is made among "agricultural" classes, for example between arable land or meadows, vineyards…), but conversely, cooccurrence matrices allow us to detect homogeneity/heterogeneity degrees for each grid. Highly homogeneous grids represent almost 35% of all surveyed cases. Their number decreases mainly because homogeneous agricultural grids are decreasing (homogeneous agricultural grids: –9,5%). On the other hand, homogeneity of natural and artificial covers is increasing, and the growth of these categories is high over a 7-year period (+ 16,4% homogeneous artificial grids).

Homogeneous grids with double cover represent 33% of the cases. Such a spatial arrangement increased during the period observed. This is mainly due to grids with agricultural and artificial covers. Heterogeneous grids represent about 30% of the grids (compared to 7% "mixed" observed with the majority frequencies method). The number of heterogeneous grids increased over time.

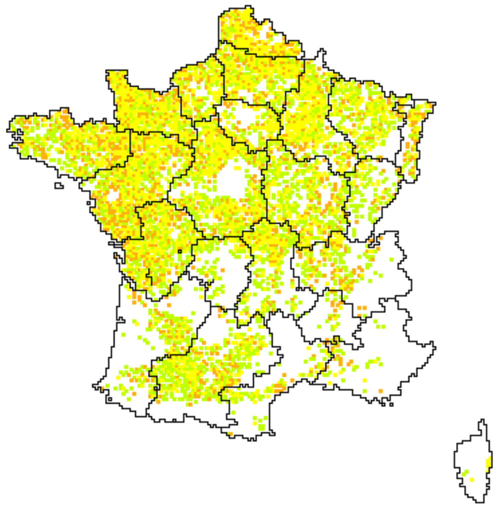
Over the 1992-1999 period, very homogeneous grids decreased and heterogeneous ones increased over the entire French territory.

Map 2: Homogeneous natural landscape

Map 3: Homogeneous agricultural landscape



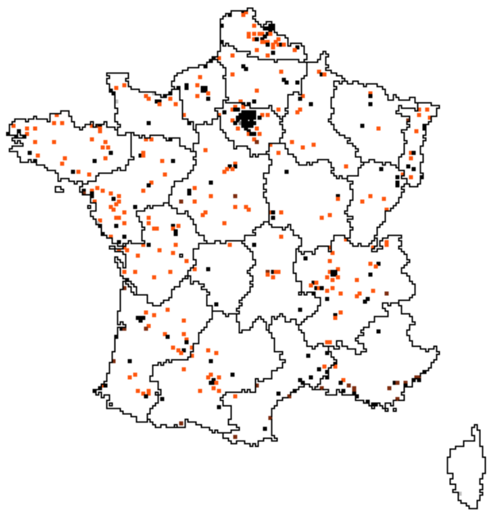
Natural homogeneous
homogeneous Natural > Agricultural
homogeneous Naturel > Artificial



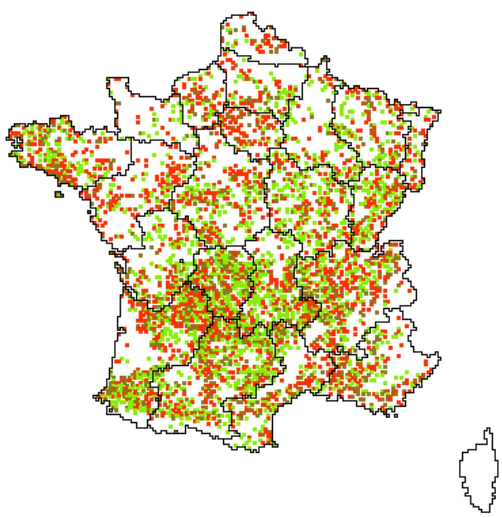
Agricultural homogeneous
homogeneous Agricultural > Natural
homogeneous Agricultural > Artificial

Map 4: Artificial landscapes

Map 5: Heterogeneous landscapes



Artificial homogeneous
heterogeneous Artificial & Agricole
heterogeneous Artificial & Naturel



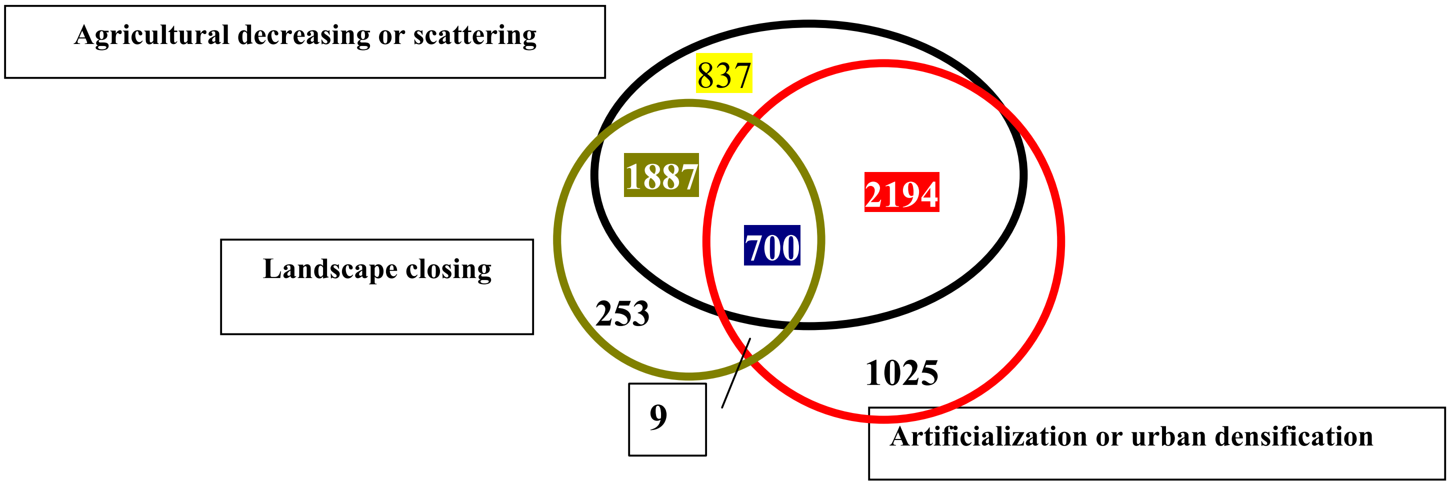
heterogeneous Naturel & Agricole
heterogeneous Naturel & Agricole & Artificiel
Heterogeneous

This method provides information on the land-cover spatial distribution and landscape structures. Comparisons over time have allowed us to obtain some information about changes but this method is limited because changes are detected only when a threshold is crossed. The following method improves the analysis of changes over time.

4.3 Dynamics method Results in France 1992-1999

Several trends can occur simultaneously. In this case the method allows us to detect for example, that agricultural decrease (agricultural scattering + agricultural decrease) is in relationship with urbanization or forestation. For France 1992-1999, the results are represented figure 7: when the number is 1887, it means that over 1887 grids landscape closing occurs simultaneously with agricultural decreasing or scattering, 253: over 253 grids landscape closing occurs solely.

Figure 7: Main trends associated with agricultural landscape modifications

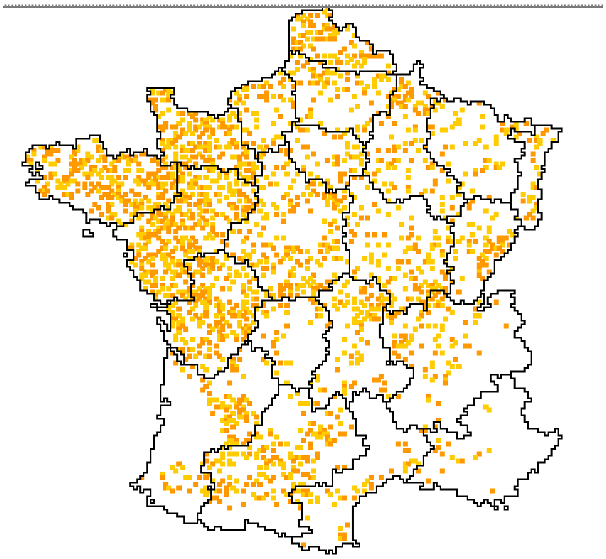


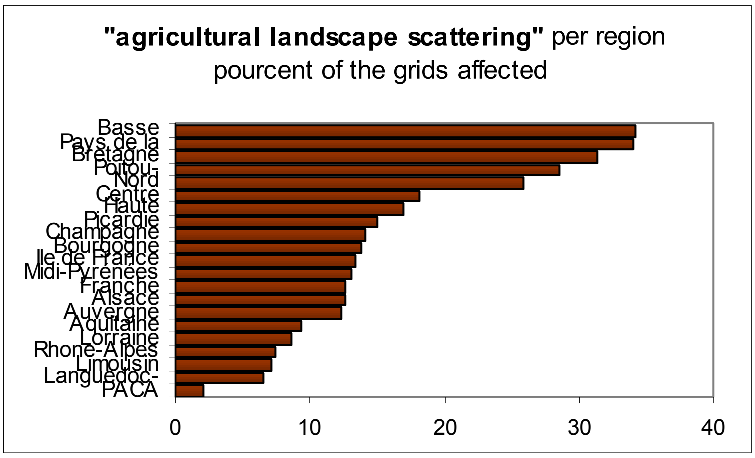
Each dynamic may be quantified by region or represented as a statistical map. The example of landscape scattering is illustrated, in Figure 8 and Map 6.

5. Discussion

Figure 9 presents a comparison of the three different methods of estimating landscape changes per region. The frequencies method is the less sensitive, because of the 50% threshold, the second allows us for landscape texture characterization – but threshold crossing limits the interest to check changes – and the dynamic indicators are the highly sensitive indicators to detect changes over time.

Map 6 and Figure 8: Statistical mapping of agricultural landscape scattering, France 1992-1999

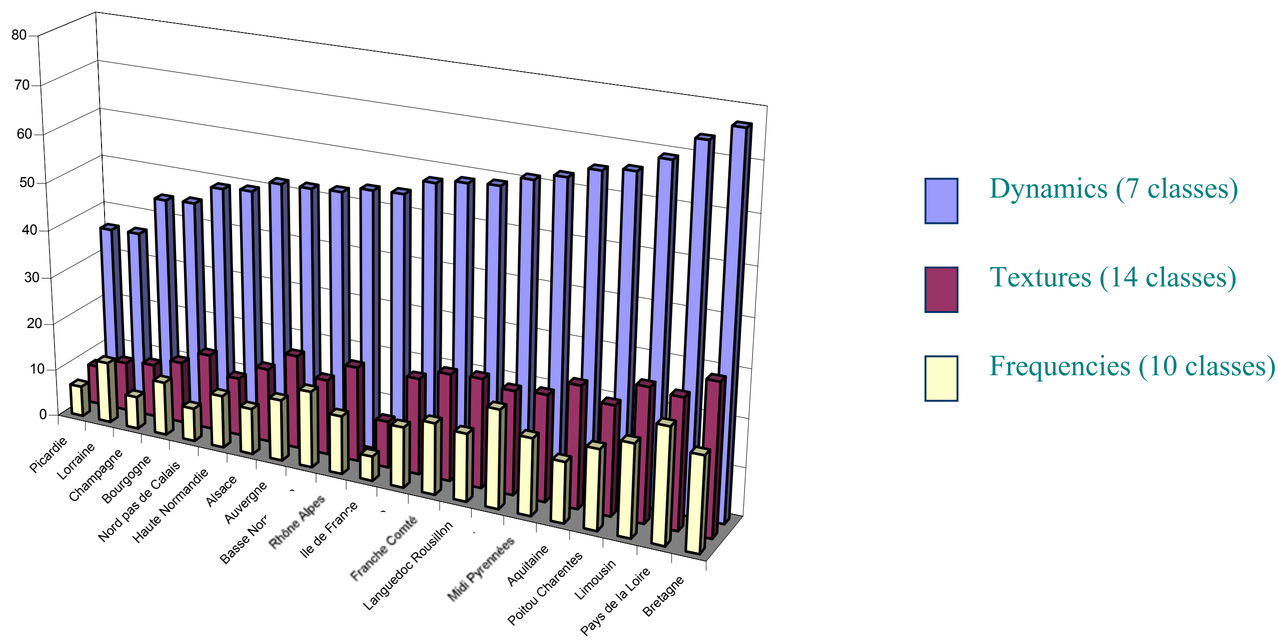




Agricultural scattering

Agricultural scattering (slight)

Figure 9: Results for France, comparison of the three methods presented



6. Conclusion

Three kinds of indicators closely linked to landscape structures, particularly agricultural landscapes are proposed. These indicators are based on the observation of the interface between 2 or 3 principal categories of land-cover. This categorization could be applied to any other breakdown of the classification (meadows/non-meadows for example), or other criteria depending on the use of the indicator.

The observation of very small unit areas and the interpretation, not of an agglomerated form of this information, but of the structure of this information is of considerable value. This can be automated and the sensitivity of the proposed indicator to changes over time is high.

Each of the three methods presented has its own advantage and limits. These three have been presented because they are considered as complementary methods.

The frequency method allows us to produce results which are easily interpreted, but their link to the landscape lacks accuracy. The texture method allows us to characterize a heterogeneous level of landscape components. The dynamic method enables us to check trends affecting landscapes over a wide area.

The dynamic method is highly sensitive. Highlighting trends, it provides useful information for policy makers: it enables them to check on-going processes in ordinary landscapes. The dynamic method is the best suited to detect the beginnings of land-cover change from a land-cover survey such as TERUTI. The advantages of such indicators alert us to changes which are not only dependent on agricultural policies, but also on urban policies or changes. Agricultural landscape depends on agricultural policies but also on the effects of other landscape changes for the sustainability of agricultural activity. These indicators may provide information on trends in habitat changes, landscape trends, as well as the effects of public policy changes over the years.

The main value of the indicators is to enable the detection of static landscape description and a first detection of trends over a major area. Landscape changes are the results of driving forces, but can also become driving forces for environmental or social changes. Hence landscape change indicators should provide a worthwhile contribution to understanding sustainability and to the follow-up of that sustainability.

Other countries are not using the same survey as the French one. The E.U. countries are building the LUCAS survey, which might be extended every 5 or 7 years and provide data used in the same way.

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A System of Agricultural Landscape Indicators for Greece

Theano S. Terkenli and Thanassis Kizos
University Hill, University of the Aegean
Mitiline81100, Lesvos, Greece

Theano S. Terkenli	Thanassis Kizos
Department of Geography	Department of Environmental Studies
Tel: ++3022510-36414	Tel: ++3022510-36229
Fax: ++3022510-36499	
t.terkenli@aegean.gr	akiz@env.aegean.gr

Abstract

The extent of theoretical or applied research on agricultural indicators in Greece is so far minimal and consists mainly of scientific attempts towards the construction of a theoretical framework, with a few notable exceptions of institutional and policy-making attempts targeted towards specific physical landscape features, such as terraces and the protection of ecologically-sensitive natural landscapes. This paper embraces a broader perspective to the agricultural landscape and aims at developing a system of agricultural landscape indicators that combines natural and cultural characteristics and their dynamic relationships as these are substantiated in the specific category of agricultural landscapes, while emphasizing agricultural landscape particularities, such as landscape identity, locality and richness, that are deemed especially crucial to Greek landscape planning, policy and management. Thus, what is proposed here is a system of specific indicators that is structured at various geographical scales; at each scale, landscape indicators are quantitatively or qualitatively measured at more than one level of measurement/ grade of "quality", character/ identity (or any other landscape characteristics and their interrelationships), in order to determine "improvement", "deterioration", or whatever pre-specified landscape policy and management targets.

Keywords: Greece, agricultural landscape, landscape indicators, cultural landscape, rurality, scale

Introduction

The extent of theoretical or applied research on the agricultural landscape in Greece is so far minimal and consists mainly of scientific attempts largely towards the construction of theoretical frameworks, with a few notable exceptions of institutional and policy-making attempts targeted towards specific physical landscape features, such as terraces and the protection of ecologically-sensitive natural landscapes. By contrast, this paper embraces a broader perspective to the agricultural landscape and aims at making some first steps towards developing a framework for designing an agricultural landscape indicator system that combines natural and cultural characteristics and their dynamic relationships. The perspective followed here is a scalar approach to landscape, while the emphasis in this attempt is on distinctive agricultural landscape qualities, such as landscape uniqueness (identity), diversity and richness, that are deemed especially crucial to Greek landscape planning, policy and management.

1. Greek landscape science and practice: an appraisal of the present situation

Processes of establishment of landscape science, research and practice as such have been slowly gaining ground in Greece in very recent years. Specifically, in the 1990's landscape science underwent a shift from the fragmentary, peripheral and haphazard preoccupation of the so-called design sciences (architecture, landscape architecture, urban and regional planning) with practical landscape issues as they developed out of related design and planning initiatives and interventions in space to a more concerted, focused and systematic landscape approach by several more disciplines and practitioners. This has, so far at least, remained mainly a qualitative shift characterized by its very limited extent and impact on actual landscape problems and issues in Greece. In fact, the Greek landscape, taken for granted till the end of the 1970's, was first acknowledged through interconnections emerging at the time between agricultural modernization and the rural landscape as well as between nature and human society. Generally speaking, systematic physical planning interventions have been restricted to the metropolitan and urbanized areas, whereas mobilization in matters pertaining to the agricultural landscape in Greece has only very recently been instigated through European Union legislation and subsidized interventions (C.A.P.) that enforce the protection and preservation of the rural landscape.

The absence of the landscape, not only as an object of research and as a historical resource but also in terms of practical spatial interventions, is almost ubiquitous in all disciplines and fields of practice in any way pertaining to the landscape, including rural sciences in general. With regard to the rural landscape in specific, two conflictual positions prevail in Greece today: that of the landscape as an indispensable part of Greek (agri-)cultural heritage demanding the protection (even if in the form of museums) of its most significant characteristics and that of the landscape as a rural development area, regardless of the type of human intervention. In specific, in rural studies, rural geography, rural sociology and local/ rural development, the landscape is conceptualized as a productive resource, either in primary economic production or in tourism, and as a vital living space for its rural inhabitants. Rural landscape science is here in its infancy, still grappling with issues of landscape conceptualization to which we turn next. In sum, there has so far been no concerted effort in Greece by either academics or professionals to develop a rural landscape science in terms of either primary research or practical intervention in rural space. Academic interest in the rural landscape has produced some very sporadic research on either particular agricultural landscape features (such as island terraces) (Petanidou 2000) or studies at a more general level. Besides older studies of the Greek landscape by French geographers (Sivignon 1975; 1989, Pechoux 1989), there have only been a few more recent studies on innovative action in rural environmental protection, promotion and education, as well as on agricultural landscape modernization (Louloudis 1992, Rackham and Moody 1996, Kassimis and Louloudis 1999, Dimopoulou 2002).

This situation is accordingly reflected in the institutional context for the Greek landscape, in effect non-existent in Greek legislature and state interventions in rural space. The landscape's proper existence is legally acknowledged in the environmental context, where it is defined as "any dynamic entity of biotic and a-biotic environmental factors and elements that either separately or interactively compose a visual experience in a given space" (Issue of Government Gazette 160/16-10-1986, 3258). The landscape concept appears in various environmental laws, master plans and regulatory statutes, in effect in statutes concerning the protection of archeological spaces, as well as in legislature on *traditional* settlements, aesthetic forests and national parks and is implicitly or explicitly dealt with in environmental legislature as "areas of high biological, ecological, aesthetic or geomorphologic value" (Issue of Government Gazette 160/16-10-1986, 3257). Thus, so far both at a research level and in practice, any agricultural landscape measures or interventions in Greece stem from E.U. or state environmental projects, such as regional development projects (i.e. the protection of vineyard landscapes in Santorini) and the implementation of C.A.P. regulations in the context of agro-environmental measures. C.A.P. has been the main driving force behind most change in Greek rural space—change that has proven to be detrimental to the Greek landscape.

2. Definitions of landscape, agricultural landscape and rurality

The landscape has been traditionally and contemporarily conceived as cultural by the discipline of geography which partly owes its academic constitution to the study of landscape during the past eighty years. In the past few years, however, a cultural definition has been gaining ground in all scientific fields pertaining to the landscape, notably landscape ecology, environmental studies and various rural science disciplines and fields of practice (Tress and Tress 2001). On this basis, the landscape may be conceptualized as a visible expression, or better as a literal or metaphorical image, of the humanized environment (Urry 1995; Cosgrove 1994; 1998). "As a portion of land which the eye can comprehend at a glance" (Jackson 1984:3), it is perceived mainly through sensory –particularly visual-- in addition to cognitive processes, and represents both a medium and an outcome of human perception, experience and action. Conversely, cultural landscapes are created by human action and experience inscribed in place through time. Thus, landscape analysis and planning tend to originate in the perceived landscape forms, functions and communicated meanings, aiming at the fulfillment of their multifunctional roles as sustainable milieus of human livelihood (Tress and Tress 2001, Terkenli 2001a). Besides the landscape's visual or iconological qualities (Daniels and Cosgrove 1988) emphasized above, however, another set of critical landscape qualities relate to the landscape's articulation through its *observer*, recently reiterated and upheld by The New Cultural Geography. The latter tradition in geography views the landscape principally as a way of seeing, a cultural image, a pictorial way of representing, structuring or symbolizing surroundings (Daniels and Cosgrove 1988:1), inextricably entwined with symbolic dimensions of landscape production, reproduction and representation. This perspective of landscape as a form of representation and not as an empirical object (Rose 1993:89, Rose 1996) is currently drawing increasing support among geographers and to a smaller extent among landscape scientists, more generally. This landscape perspective will provide the basis for our rural landscape analysis, further below. It argues and demonstrates that landscape is not fixed but in a constant state of transition as a result of continuous, dialectical struggles of power and resistance among and between a diversity of landscape providers, users and mediators.

The term agricultural, with regard to the landscape, however, may indeed raise more practical problems and analytical constrictions than provide useful categorical delimitations in the attempt to create a system of agricultural landscape indicators. Agricultural landscape definitions vary and, at the same time, for reasons displayed above and further elaborated below, are highly contingent upon time, space and social context. For example, functional definitions of agricultural space are dependent on land use (Forman and Gordon 1986) and range accordingly. Moreover, definitions of agricultural landscapes in terms of land used for agricultural production and animal husbandly exclude the natural dimension of the landscape; instead, the agricultural should be viewed as much richer and variable in content and context (Kizos 2002), encompassing the whole countryside.

Rather, then, than an analysis of the agricultural context of self-contained farming activities and, borrowing from political economy, industrial geography and commodity chain perspectives, our discussion is based on and revolves around the rurality of landscape in a globalizing world where urban ways of life increasingly predominate. The rural concept is deemed preferable in lieu of the agricultural for our purposes, as encompassing all that is left out through the usage of the term *agricultural.* By connoting a multiplicity of land uses, it is far richer, though more vague in meaning, thus probably serving our purposes of landscape analysis better as *what is left* after everything else is defined (Gousios 1999). In land-use terms, rural areas are defined as supplementary spaces to urban areas, what is left when urban spaces are defined through indicators such as population density and/or population figures (OECD 1994, CEC 1997, Hoggart et al. 1995, Harrington and O'Donogue 1998). In economic terms, rural areas comprise the hinterland of developed centers from which the benefits of development diffuse (incomes, infrastructure and services) (Spilanis 1996), constituting, in other words, supplementary development spaces. In policy terms, due to agriculture-dominated countryside planning policies, rural spaces have tended to be considered as agricultural economic spaces in uniform agricultural-development models that ignore most if not all local and national particularities (Gousios 1999, Marsden 1999, Gray 2000, Richardson 2000).

Contemporary agricultural landscape planning and policy implementation aim at identifying problems, organizing resources and generating action of various sorts in rural areas, often with the stated aims of diversifying the economic base, seeking a pluralistic and egalitarian social order and maintaining/ conserving a healthy natural environment. For these reasons, in our discussion, the agricultural landscape will carry connotations of rural landscapes, a broader category of non-urban or forest landscapes in which we place our effort towards the construction of an agricultural landscape indicator system/ framework for Greece.

Contemporary approaches in the growing literature on rurality seek to define rural as a singular concept, de-spatialized and independent of the urban (Gray 2000), that is disengaged from geographical locality, associated instead with socio-cultural representations of what is considered rural by its users or agents that shape and consume rural space (Halfacree 1995, Pratt 1996, Gilg 1996). In this way, a whole series of ruralities emerges, each expressed as a landscape of socio-spatial myths and symbols for each of the groups that *do* the rural (Little and Austin 1996, Lawrence 1996). *Doing the rural* here refers to the construction of different ruralities on the basis of local spatial, historical and socio-cultural particularities and their relationships with other ruralities (Philips 1998, Gray 2000). This approach to the agricultural and the rural brings us very close to the established definitions of the landscape as a cultural concept and construct, that is a culturally constructed image of space by the various groups or individuals who produce it, reproduce it, consume it, imagine it and invest it with meaning and value.

A one-sided, monolithic analysis of rural societies, useful as it might be in deriving readily measurable and applicable indicators, would serve to conceal important rural dimensions and mechanisms and eventually result in inappropriate, ineffective, even detrimental policy initiatives and impacts on the landscape. What is suggested here is that different functions of the rural landscape be identified, functions and uses that comprise different ruralities along with the groups or the landscape *observers* that create these ruralities, in order to identify the major transformation forces at play in the specific landscape. These rurality—landscape correspondences (meaning that to each identified rurality corresponds a different landscape) are proposed as powerful tools in deriving suitable indicators in order to monitor agricultural landscape change and evaluate rural and/ or agricultural policy and will be used in developing our framework for designing a system of agricultural landscape indicators for Greece.

3. Greek rural landscape characteristics and particularities

Throughout Greek history, continuous and unchecked human intervention has been irreparably degrading the Greek landscape; indeed the destruction of the Greek natural landscape originates in pre-historic times, around 1,000 B.C. Prehistoric landscapes, however, were physically and geomorphologically established earlier on, with the consolidation of the coastline about 9,000 years ago, when the Aegean Sea, after millennia of sea-level change assumed its present configuration. From this point on begins the development of Greek landscapes as we know them today on the basis of a simple distinction between a) island, b) coastal and c) inland agricultural/ rural and urban landscapes. Both from a physical geographical and from a human geographical perspective, these three broad types of landscapes (island, coastal and inland) represent three different, albeit highly variable and historically changing geographical entities, three distinctive ruralities. Broadly generalizing across time and space, island landscapes have almost always been characterized by external references for their production, reproduction and consumption; coastal landscapes have at all times retained both an external and in internal orientation, whereas inland landscapes have been both dependent on coastal urban poles of development and isolated or cut off from the rest of the country. Similarities, however, may also be drawn among the main characteristics, values, problems and challenges of these three types of Greek rural landscapes and these will be displayed here grouped together as they apply to different scales of landscape analysis.

At present, new social and economic relationships and tensions emerge out of issues revolving around the domestication, organization and management of rural space and formulating new types of rural landscapes that incorporate urban models and ways of life. The Greek rural landscape has been rapidly altering face in the post-war period, in accordance to models, imperatives, trends and forces imported through larger-scale cultural transformations: land use change, rural area desertification, unplanned urban development, widespread environmental degradation and so on. Modernization, tourism and development have brought higher standards of living in Greek rural areas within the time range of one generation (the post-war generation), but have created great external and internal crises and problems within the local societies and the landscapes they inhabit or use.

The main qualities or values of the contemporary Greek agricultural/ rural landscape may be grouped into three categories: uniqueness, diversity and richness (Stathatos 1996, Terkenli 1996, Rackham and Moody 1996, Anagnostopoulos 1998, Mendoni and Margaris 1998, Terkenli 2001a). Landscape uniqueness (identity) refers to the distinctive geographical expression of its ecological, aesthetic, cultural and historical values. The Greek rural landscape's enormous diversity, in terms of the natural environment and agro-ecosystems, is related to its geomorphology, the micro-rural structures of Greek agriculture, the variability of Mediterranean agricultural ecosystems and other factors. It is equally related to the depth of the landscape's cultural heritage as imprinted in the built environment (bridges, fences, terraces, fountains, folk architecture etc), all exhibiting enormous richness in physical and cultural landscape forms, functions and symbolisms. Through the centuries, the rural landscape has been invested with spirituality and other metaphysical and ethical qualities, though its highest value remains that of a rich context of human life. One of its basic values is indeed its depth of historicity, as evidenced from a variety of real, imaginary or mythological data, threatened at present by factors related to multiple contemporary facets of *development*. Moreover, it is a context that carries the potential of being developed for pedagogical purposes, in order to foster a natural besides an ecological conscience. Finally, it represents a very significant asset in tourism promotion and more generally place promotion, aiming at local development through population retention and increased employment opportunities (the cases of the Cyclades and of Northern Crete).

The dangers and problems that the Greek rural landscape faces at present are manifold: land subdivision, land use change and lack of comprehensive rational planning, partial documentation and restoration of historic landscapes, unchecked urban sprawl, landscape homogenization and banalization, intensification of agriculture, loss or degradation of its natural/ aesthetic/ cultural character (i.e. through soil erosion, collapse of old structures, interventions incongruous to local landscape identity etc), desertion of mountain and remote rural landscapes through abandonment of traditional rural activities, unequal development or geographical exclusion/ discrimination, lack of protection measures from illegal interventions, fires, floods, etc. What the contemporary Greek society is presently witnessing is the selling-off of the Greek agricultural/ rural landscape or its overwhelming dependence on state or individual economic or political interests. Local interests and input are normally ignored or essentially non-existent. Finally the Greek rural landscape is plagued by yet another ghost: the precedence of the State Archeological Service in legal matters and decision-making concerning landscape planning, policy and management as well as determining land use for industrial, agricultural, or other general development purposes.

4. Remarks on the organizing principles and variables of a system of agricultural landscape indicators

All physical geographical and human geographical aspects (forms, functions and values/ meanings) of the agricultural landscape are measurable with the aid of a variety of qualitative and quantitative approaches, methodologies and indicators that are scale-appropriate. Spatial differentiation and temporal change may be measured across various spatial units of analysis (landscape, region, locality), controlling for geographical scale, or the reverse. Levels of analysis (indicators and their grades/ levels of measurement) may accordingly vary by geographical location, by landscape type, by landscape dimension (physical or human), by category of landscape forms, functions or symbolisms, or by scale of approach. Current landscape quality and change estimation must necessarily be place-oriented, namely geographically, historically and socio-culturally situated, thus contingent on regional and substantive differentiation, which in turn requires a similarly place-specific analytical scheme, such as the development of the system of agricultural landscape indicators proposed here. This claim, however, does not imply that some more general organizing principles and variables may not emerge out of this task that could potentially be of use in the future construction of such indicator systems of more general application. Such an objective is pursued here with the aid of a scalar approach to landscape use, management, planning and policy developed for the case of the Greek agricultural landscape.

Real, perceived or imaginary landscape emerges from its relationship with its observer, and it is, of course, the extent and nature of that relationship that necessitates and dictates the appropriate scale of landscape analysis. Ontologically and epistemologically, the theoretical concept and geographical construct of landscape are scale-dependent. Landscapes crystallize both theoretically and historically at specific scales. The old definition of landscape as “a portion of land which the eye can comprehend at a glance” points to this inextricability of landscape definition and landscape production, reproduction and consumption from the scale of the human body and the human reach into his/her surroundings, be that landscape as home, landscape as an economic resource or as an object of recreation. It does so by highlighting the two most significant defining characteristics of landscape (the visual and the relational vis-à-vis an observer). As Anne Buttimer emphasizes in her research project and article both entitled *Landscape and Life: Appropriate Scales for Sustainable Development*, where rural landscape analysis is conducted on micro-regional, metropolitan and transnational methodological scales: “For sustainable landscapes and livelihoods it is important that an appropriate scale for action and interaction be identified: a scale at which bottom-up and top-down interests could be negotiated” (1998:3).

Thus, what is proposed here is a system of specific indicators that is structured at various geographical scales; at each scale, landscape indicators are measured at more than one level of measurement (otherwise grade of diversity, character, identity or any other conceptualization) of landscape properties or features and their interrelationships in order to determine their “quality”, “improvement”, “deterioration” or whatever pre-specified landscape policy and management targets are set forth by the major factors at play at this particular scale of landscape approach. In the construction of such an indicator system, questions of indicator applicability, relevance, reliability and/or realisability should be raised at every step with regard to production vs. consumption dimensions and characteristics of the agricultural landscape, while the whole indicator framework/ system thus produced is intended to reflect and measure agricultural landscape identity, diversity and richness, as applied to Greek physical and cultural geographical particularities.

5. Towards a system of indicators for the Greek agricultural landscape

Ruralities may be constructed on an urban-rural or a rural-rural basis. The employment of urban-oriented perspectives in defining the rural (urban-rural ruralities) vs. rural-rural perspectives of the side that *does the rural* for a living is, as we argue, largely a matter of landscape scale and will be treated as such in the development of our indicator system. Indeed, though the development of an agricultural landscape indicator system may be organized on the basis of differences in landscape type (in our case: island, coastal, inland) or on geographical location particularities, it is deemed more appropriate to select a scalar organizing scheme for our purposes. This choice is justified on the basis of a) the multitude (richness) of distinctive features, values, problems and dangers characterizing the Greek rural landscape (uniqueness/ identity), b) most of which, however, tend to be common over the geographical expanse of the Greek territory and c) whose diversity between landscape types as presented above (island, coastal, inland) tends to be less significant than the differences characterizing the different scales at which Greek rural landscapes are constituted, imagined and used. In other words, the problems of Greek agricultural landscapes or their values at stake tend to be better substantiated and thus organized according to scale of analysis and intervention rather than landscape type, not minimizing, of course, landscape type particularities. Landscapes are constructed, perceived or consumed at a wide variety of interlocking, often overlapping and ever transforming scales. Of these, three scales are selected for the purposes of our argumentation, as the most pertinent ones in the case of the Greek landscape: the national, the state (central and regional) and the local. These seem to illustrate best the three main distinctive variables of the Greek agricultural landscape: uniqueness, diversity and richness.

The national scale of the Greek agricultural landscape is the one at which the urban-rural relationship is articulated; thus it refers to landscape ruralities constructed through the perspective of urban Greeks—the highest and fastest-growing percentage of Greek population. This rurality is constructed through the paradox of the definition of a notion by a group or groups of people who do not inhabit it, but all the same shape its meanings and functions and are responsible for the construction of agricultural/ rural symbolism: the idyllic rural, the *paradise lost* (Halfacree 1995, Williams 1985/ 1996). Such symbolisms create artificial, ideal rural landscapes that especially urban dwellers seek as imitations of *authentic* rural life (Hoggart et al. 1995, Marsden 1996). The rise of demand for such landscapes creates an analogous rise of demand for recreation services, high environmental quality and residential space in the countryside and therefore becomes a major force of agricultural landscape change. This scale perspective of the agricultural/ rural landscape largely also coincides with the Greek media perspective of the Greek rural landscape, produced, perceived and consumed as the primordial Greek cultural hearth, the cradle of Greek identity, the cultural landscapes of childhood memory, family roots, the collective old country. This scalar perspective also attributes to the Greek rural landscape qualities such as vacation playgrounds and objects of recreational desire and attraction, shared by the international tourist perspective of these same landscapes. The prevailing goal here is preservation and/ or promotion of landscape uniqueness, diversity and richness.

The state or administrative scale (central, regional and local subscales) at which the Greek agricultural landscape is articulated, analyzed and managed is one that combines or strives to combine several, often contradictory elements and relationships within and between agricultural landscapes. The fragility of remote, border, mountain or arable landscapes plagued by the problems displayed above is explicitly acknowledged. On the one hand, due to their peripherality and marginality, they are viewed as ridden with socio-economic problems and often geo-political threat. On the other, state-scale landscape initiatives struggle to reconcile and manage the tensions and conflicts stemming from widely varying sides and interests that converge in rural landscape construction, maintenance and promotion. The attempt at this scale(s) is overwhelmingly aimed at reconciling and managing all of these sides and interests through planning initiatives, policy and management strategies of sustainable development.

Agricultural/ rural landscape values, dangers and issues, as mentioned above, are, however, very differently perceived at the local scale, constituting different landscape ruralities to those discussed above. These are the people that *do the rural* for a living. Although the differences between local groups and factors in terms of occupations, lifestyles, survival strategies and relationships with the local landscapes vary widely over the Greek territory, rendering such a category practically non-existent, there do seem to exist some common trends that make this particular rurality useful enough as an analytical tool for our purposes. In Greece, perhaps the most significant trend characteristic of this scalar category of rurality is the de-agriculturalization of the country (Papadopoulos 1999, Damianakos 1999). Although this trend is certainly highly connected to urban-rural formulations of rurality, it also encompasses another highly distinctive trend: the diversification of rural households' activities and products. At the same time, rural residents demand similar standards and quality of life as their urban counterparts. They place personal or family economic interests and preservation of place identity higher than any externally induced ideas of sustainable development (Terkenli 2001b). Thus the goal that in essence prevails in this category vis-à-vis the Greek agricultural landscape is short-term satisfaction of economic pursuits, conspicuous consumption as well as raising the household income and standard of living. In some rare occasions it may be accompanied by earnest efforts towards innovation and growth coupled with environmental management.

Our proposed conceptual framework for designing a system of agricultural landscape indicators for Greece appears in its most elementary form in Table 1. According to this framework, appropriate indicators, grouped by a) land cover or landscape forms, b) land use or landscape functions and c) land values or landscape symbolisms, are selected on the basis of relevant existing bibliography and on-going research on agricultural landscape indicators for all landscape features of the two main landscape dimensions, the physical geographical and the human geographical. Landscape, rather than agricultural landscape, has been selected in this case as a broader category to which the system of indicators could be relevant, though in the application of this framework emphasis and weight of precedence will obviously be placed on features and variables pertaining to the rural. In the establishment of the most suitable and feasible indicators for the case of the Greek agricultural landscape, precedence and a higher degree of significance should be assigned to the three most distinctive categories of landscape characteristics: uniqueness (identity), diversity and richness. In other words, for the Greek landscape, these three variables should serve as principal poles in the selection of indicators for each category. In each scalar category, the guiding principles in the selection of the appropriate indicators also vary according to the perspectives, goals and objectives of the groups of landscape users, factors or mediators that use, plan, manage or make decisions about the landscape, as outlined above. Often, these indicators or categories of indicators may overlap; elsewhere there may be gaps due to the small degree of significance of a certain landscape feature or dimension of a landscape feature for the respective group operating at a particular scale. In some cases, certain categorical dimensions of landscape features may hold no meaning or particular significance at the specific landscape scale measured, indicating the irrelevance of establishing indicators for that particular scale. It is assumed that, not only further research is essential but also that, in order for such a framework to approach a more complete form, more detailed and specific knowledge on agricultural landscape indicators needs to be drawn from such already existing bibliographical sources or work and research now in progress.

Table 1: A conceptual framework for designing greek rural landscape indicators

Landscape Dimensions	Categories of Landscape Features	Categorical Dimensions of Landscape Features	Landscape Scales: National - (International)	State - (Administrative)	Local
Physical Geographical	Water regimes	Land Cover – Forms	1,2,3,17,18,26		
		Land Use – Functions	1,2,17,18,26		
		Land Values – Symbolism	17,18,26		
	Geomorphology	Land Cover – Forms	1,2,3,17,18,26		
		Land Use – Functions	1,2,17,18,26		
		Land Values – Symbolism	17,18,26		
	Relief	Land Cover – Forms	3,17,18,26		
		Land Use – Functions	17,18,26		
		Land Values – Symbolism	17,18,26		
	Geology and Soils	Land Cover – Forms	3,17,18,26		
		Land Use – Functions	17,18,26		
		Land Values – Symbolism	17,18,26		
	Exposures and views	Land Cover – Forms	3,17,18,20,22,23		
		Land Use – Functions	17,18,20,22,23		
		Land Values – Symbolism	17,1820,22,23		
	Climate	Land Cover – Forms	1,2,17,18		
		Land Use – Functions	1,2,17,18		
		Land Values – Symbolism	17,18		
	Flora	Land Cover – Forms	1,2,3,4,5,6,17,18,19,20,21,22,23,24,25		
		Land Use – Functions	1,2,17,18,19,20,21,22,23,24,25		
		Land Values – Symbolism	17,18,19,20,21,22,23,24,25		
	Fauna	Land Cover – Forms	1,2,17,18,19,20,21,22,23,24,25		
		Land Use – Functions	1,2,17,18,19,20,21,22,23,24,25		
		Land Values – Symbolism	17,18,19,20,21,22,23,24,25		
Human Geographical	Social	Land Cover – Forms	7,8,17		
		Land Use – Functions	7,8,17		
		Land Values – Symbolism	7,8,17		
	Economic	Land Cover – Forms	7,9,10,17,19,21,22,23		
		Land Use – Functions	10,17,19,21,22,23		
		Land Values – Symbolism	7,10,17,19,21,22,23		
	Cultural	Land Cover – Forms	6,7,10,11,12,17		
		Land Use – Functions	7,10,11,12,17		
		Land Values – Symbolism	7,10,11,17		
	Institutional	Land Cover – Forms	7,10,17,19,21,22,23		
		Land Use – Functions	7,10,17,19,21,22,23		
		Land Values – Symbolism	7,10,17,19,21,22,23		
	Visual/ Perceptual	Land Cover – Forms	7,9,11,12,13,14,15,16,17		
		Land Use – Functions	7,10,11,12,17		
		Land Values – Symbolism	7,10,11,14,17		

Literature cited in Table 1

1. Legakis et al, 1993
2. Naveh and Lieberman 1994
3. Hatzistathis and Ispikoudis 1995
4. Thorn 1997
5. Clay and Marsh 1997
6. Eleftheriadis et al. 1990
7. Daniels and Cosgrove 1988
8. Rackham and Moody 1996
9. Lindsay et al. 1979
10. Jackson 1984
11. Taylor 1994
12. Terkenli 2000
13. Gunn 1979
14. Stefanou 1978
15. Jakle 1987
16. Clay and Marsh 1997
17. Buttimer 1998
18. Klijn et al. 1999
19. Hoffman 2000
20. Wascher 2000
21. Wacsher 1999
22. Wascher Mugica and Gulinck 1999
23. ECNC 1996
24. CEC 2000
25. EEA 2001
26. Higgins and Higgins 1996

6. Discussion and critique of the proposed framework for designing an indicator system

Obviously, this schematic attempt at constructing a system of agricultural landscape indicators for the case of Greece has a suggestive and exploratory character and only sets forth the basic steps towards organizing a conceptual framework for designing such indicators. The indicator system proposed here is characterized by a high degree of generalization and simplification in matters pertaining to the organization of space, time and socio-cultural differentiation. The categorization scheme, categories of landscape features and their dimensions and, generally speaking, the organization of the whole indicator system is obviously at best schematic and indicative and does not represent any *complete* story of the Greek agricultural landscape or rural reality. Rather, it is hoped that it will be of use in developing a more sophisticated and effective system of agricultural landscape indicators for Greece in the future. By beginning to expose here the challenges and contradictions, rather than suggesting a well-developed analytical tool for the Greek agricultural landscape, we only take a small step towards inviting more future research on it.

Traditional patterns of small-scale rural activities in Greece have historically retained observed distributions of human geographical density in landscape mosaics of high cultural and ecological, if not economic, value. These have produced a high degree of ecological, economic and cultural differentiation and diversity in highly heterogeneous but cohesive landscape contexts. Culturally, such rural landscapes in Greece are the outcome of historical processes of land division as imposed by the church or the state but also by individual or community intervention in the function of certain physiographic parameters (i.e. through terracing) and the striving for subsistence in restricted and marginal lands. In these cases, the basic dangers today lie in the changing scales of landscape structure and function, urbanization, agricultural intensification or alternately landscape desertion. As contemporary Greek rural landscapes urbanize at a fast pace, landscape analysis and management are becoming increasingly pressing in Greece through concern for the environment more generally (agro-ecosystem degradation, housing construction and urban expansion). They are also becoming increasingly imperative through the growth of ecotourism and agrotourism, through a re-discovery of the Greek cultural heritage and through tendencies that are just emerging among urbanites of a *return to nature* and to rural and environmental values and cultural roots.

In conclusion, contemporary rural landscapes appear no longer spatially enclosed, bounded and tied to a restricted notion of locality. Both in terms of function and of symbolism, they are increasingly produced, reproduced and consumed through processes involving forms, functions and symbolisms with external, rather than internal, references. Today's Greek rural landscapes may no longer be viewed as segments of the geographical world. Rather, they must be viewed as situated systems or images at the interface of different and rapidly changing scales of contact with an observer(s) or a user(s), thus necessitating an ongoing renegotiation and reorganization of indicators systems and their applications.

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Testing Indicators of Landscape Change in Norway

W. Fjellstad, W. Dramstad and R. Lågbu
Norwegian Institute of Land Inventory (NIJOS)
P.O.Box 115, 1431-Ås, Norway

Abstract

As in most industrialized countries, agricultural landscapes in Norway have undergone large-scale changes during the past 50 years. In general, the trend has been intensification of production in the most suitable agricultural areas, whereas abandonment and reforestation have been the trend in marginal agricultural areas.

Such changes have led to pressures to quantify the type and extent of change through monitoring programmes. These programmes, through extensive efforts in mapping land cover/land use in agricultural landscapes, provide an excellent opportunity to test landscape indicators. While the number of easily available landscape indicators is increasing rapidly, a considerable amount of work still remains when it comes to testing them – especially on real landscapes.

Using these maps of landscape change enables us to assess important indicator characteristics such as sensitivity, interpretability, transparency and their ability to differentiate between types of change. By using statistical packages in a GIS environment, we can test indicators for their ability to detect different types of landscape change. In this paper, we use maps documenting changes in agricultural landscapes during a 30-year period to test a selection of indicators for their ability to detect, quantify and communicate landscape change. We discuss how the results can be used to aid the selection of indicators as tools in policy making and monitoring.

Introduction

The demand for landscape indicators is ever increasing, yet there is still no internationally accepted set of indicators to monitor changes in landscapes. Part of the delay in developing this theme may relate to the different content that people apply to the term 'landscape'. Within the context of OECD work, aspects of land cover and land use change have been removed form the 'landscape' topic and defined as a separate set of 'generic indicators' that are of relevance to many other themes within the OECD set of agri-environmental indicators (AEIs). Aspects of the landscape of relevance to biodiversity and wildlife habitats are also defined as separate themes. The landscape indicators then, are designed to capture human appreciation or valuation of landscapes, incorporating such issues as sense of place, cultural identity and aesthetics.

Indicators are designed to simplify and quantify reality; to provide simple measures that can be compared over time and from place to place. Yet the disciplines incorporated in the landscape theme have little tradition of quantification and will often emphasise the uniqueness of phenomena rather than looking for generalities. Standardised national data are scarce for these themes, if they exist at all, and supplying indicators at a national level thus necessitates methods of data collection that are cost effective and can give fast results that can be updated at reasonable time intervals.

In this paper, we consider indicators designed to capture aspects of the landscape that the literature (e.g. Appleton, 1975; Kaplan and Kaplan, 1989; Bourassa, 1991; Wherrett, 1998; Parsons and Daniel, 2002) suggests are important for aesthetics and sense of place. We make use of data from the Norwegian programme for monitoring agricultural landscapes, a sample based programme that provides a realistic framework for national data collection. Using historical data from old aerial photographs, we test a set of landscape indicators, consider their value for monitoring changes in the agricultural landscape and discuss some of the issues involved in establishing such indicators internationally. The aim of the paper is not to address the actual landscape changes in these case examples, but rather to focus on our experiences of using the different indicators and methods for displaying and communicating results.

Methods

The Norwegian programme for monitoring agricultural landscapes (the “3Q programme”) was begun in 1998 and makes use of a sampling procedure that involves the mapping of about 1475 sample squares of 1 x 1 km in size. The squares are mapped from true colour aerial photographs and indicators of status and change are calculated based on the maps. Around 20 % of the squares are mapped each year such that coverage of the entire national sample takes five years.

In order to test indicators of change on real landscapes, 15 sample squares were selected for a historical study. Using aerial photographs from the 1960s (1963 to 1969, depending on availability of old aerial photographs), the squares were mapped according to the 3Q methodology, i.e. using the same classification system and mapping rules.

The following landscape statistics were calculated from the maps: occurrence of water, area of different land types, numbers of both natural and man-made point and line objects, heterogeneity of land types (Fjellstad *et al.*, 2001), accessibility, and the lability of the landscape.

The occurrence of cultural heritage remains was recorded in the field in 1998 as a part of the 3Q programme and data for the same 15 sample squares are presented as a background to discussion on cultural heritage indicators. Unfortunately, however, data are not available from the 1960s for this topic.

As a general descriptor of landform, Nelleman’s (1997) Terrain Ruggedness Index was calculated, based on data from the topographical maps of the Economic Map Series.

Occurrence of water

The Water Presence Index (Dramstad and Lågbu, 2000) takes into account the area of water surface (WSA) within a landscape in relation to total area of that landscape, and the number of waterbodies (NWB).

$$\text{Water Presence Index (WPI)} = (\text{WSA} \times \text{NWB}) / (\text{WSA} + \text{NWB})$$

where WSA is the percentage value of the total area covered by water surface and the NWB is the total number of waterbodies.

Land cover/land use statistics
The area of different land types is generally recognised as valuable information for monitoring agricultural environments and is included in the OECD indicator set as “generic indicators”. This information is also essential for evaluating changes in the landscape.

In addition to areas, numbers of point objects were registered, including features such as solitary trees, ponds, semi-natural habitat islands surrounded by arable land, and piles of stones cleared from the fields. Line elements included stonewalls, field margins, paths, ditches and streams. These landscape elements may occupy a very small area but are of significance for the appearance and functioning of the landscape.

Heterogeneity of land types
The heterogeneity index (*Hix*) (Fjellstad *et al*., 2001) was developed for the 3Q programme to distinguish between ‘large-scaled landscapes’ with few elements per unit area, and ‘small-scaled landscapes’ with many elements per unit area.

Hix is calculated from land type recorded on a lattice of points spread out across the study area. For the 3Q sample squares, the points are organised as a 10 × 10 lattice. Each point in the lattice has a number of neighbours, usually 8 but fewer along the edges of the study area. The total number of neighbour relationships in a 10 ×10 lattice with no missing data is thus 684.

The heterogeneity index *Hix* is calculated as the proportion of neighbouring points that are on identical land types. *Hix* will equal 1.0 in an extremely heterogeneous area where no two neighbouring points have identical land type and 0.0 in a completely homogeneous area where all points have the same land type. *Hix* represents the probability of finding identical land types when two points separated by a certain distance represented by the mesh of the lattice are compared. It is thus a very simple measurement of autocorrelation at this particular lag distance.

Accessibility
The measure of accessibility used in the Norwegian monitoring programme (Mathiesen *et al*., 1999) takes into account whether land is legally accessible or not and whether it is physically possible to access the land. First, all land types are defined as either legally accessible or not. Thus, arable land is not legally accessible whereas all natural areas such as forest are accessible (according to the Norwegian law of free right of way). A map can then be drawn showing which areas of the landscape are legally accessible and which are not.

The next step involves an analysis to determine which of the legally accessible areas are in contact with a path or road or some legal means of access. Thus an area that is legally accessible but that is surrounded by non-accessible land will not be included in the final measure of accessible land, because it is impossible to reach that area. This measure is highly relevant in agricultural landscapes, where non-arable land that could be used for recreation may occur as islands within arable land. The addition of paths in such a landscape could greatly increase the total area available to people for recreation.

Due to the Norwegian law of free access to uncultivated land, it is generally easy to define different land types as legally accessible or not. Nevertheless, there are some areas that cannot easily be defined. Many built up areas for example may be legally accessible to those who live or work there but not to unauthorised persons. These areas were coded as “indefinable accessibility”.

Lability
The lability indicator (Dramstad and Lågbu, 2000) is a simple measure of the degree to which a landscape would undergo change if human activities in the landscape were to cease. Change in this respect refers to whether an area of land would be classified as a different land type or not in a repeated

mapping after the cessation of human activities. Each mapped land type was classified to one of three categories 1) change of land type within 10 years, 2) no change of land type during the first 10 years but change within 100 years 3) no change in land type even 100 years after the cessation of human activities.

Cultural heritage
Several measures are calculated to express the occurrence of cultural heritage remains: the total number of cultural heritage objects, the area of the land influenced by the presence of cultural remains (defined as all land within 25m of an object), and the clustering of objects (defined as the number of patches of cultural heritage interest within a 1 x 1 km square.

Ruggedness
The unevenness of the terrain was measured using Nelleman's (1997) Terrain Ruggedness Index (TRI), whereby a grid is overlaid on a topographic map and, for each grid cell, four transects with a fixed length are placed across the centre. For each grid cell, the transect that crosses the most contour lines is selected for calculation of TRI.

Terrain Ruggedness Index (TRI) = (TNC x TNF) / (TNC + TNF)

where TNC denotes the total number of intercepted contours along the selected transect, and TNF denotes the total number of changes in aspect along the same transect. The index value thus increases with increasing ruggedness. The contour interval and the size of the grid used will clearly affect the index value and, as with most indicators, constancy in method of calculation is thus essential if geographical or temporal comparisons are to be valid.

Terrain ruggedness was calculated for the sample squares using the terrain information from the Norwegian Economic Map Series and using four grid cells per 1 x 1 km square for the placement of transects.

Results

As others have previously illustrated (e.g. Piorr et al., 1998), kite diagrams display a range of information in a simple form and can be a useful tool for making comparisons over time or from place to place. As an example, Figure 1 shows pairs of kite diagrams for five of the monitoring squares. The shapes of the kites help to highlight similarities and differences between squares and to identify areas undergoing similar trends of change.

In Figure 1, for example, diagrams c) and e) show two monitoring squares that, in the 1960s, had rather similar patterns of indicator values. The patterns are also similar in diagrams of values for 1998 (d and f) indicating the same patterns of change in these two squares. Generally, there was little change in the lower part of the diagrams from the 1960s to 1998, whilst in the upper part we see an increase in the proportion of arable land, and a clear reduction in the number of solitary trees and in the proportion of pastureland.

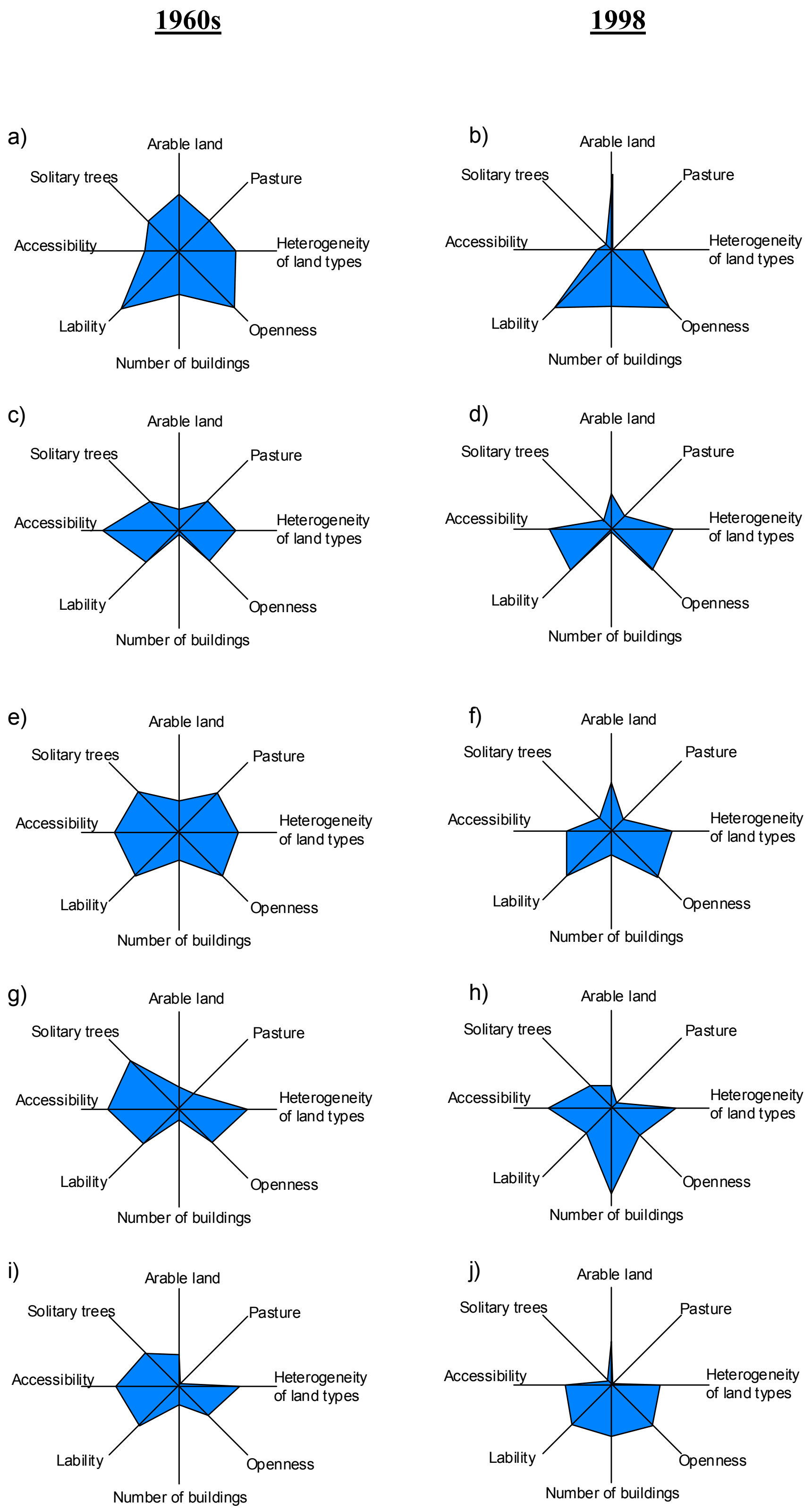

Figure 1:

Pairs of kite diagrams illustrating landscape changes from the 1960s (on the left: a, c, e, g and i) to 1998 (on the right: b, d, f, h, and j) for five monitoring squares in Norway (1 x 1 km squares). The axes are the same in all diagrams and show: the proportion of arable land in the square (maximum value = 100%), the proportion of pasture land (max. value = 50%), the heterogeneity of land types (max. value = 1.0), the openness of the landscape (max. value = 100%), the number of buildings (max. value = 150), the lability of the landscape (max. value = 100%), accessibility (max. value = 100%), and the number of solitary trees (max. value = 50).

The reduction in numbers of solitary trees and proportion of pasture are common trends, resulting in kites that look 'pinched in' along these axes in all of the 1998 diagrams. In the two pairs of diagrams g) to h) and i) to j) we see two monitoring squares influenced by building construction since the 1960s.

Studying the different kite patterns gives an indication of the link between accessibility and the proportion of arable land. The square with the most arable land in the 1960s (a) also has the lowest accessibility. Arable land can be seen to have increased in this square in 1998 (b) and accessibility has declined.

The point here is not the particular landscape changes in these illustrated examples, but rather to show how the kite diagrams can be used to illustrate changes and to identify patterns of change and possible connections between the magnitude or direction of changes of different variables. This type of visualisation makes for easier analysis of patterns of change than studying the same information in the form of tables of numbers.

Obviously, kite diagrams would not be used to analyse changes for each square of the Norwegian monitoring programme, but would be suitable for comparing larger landscape regions when change data becomes available, and for comparing regions in Norway with regions in other countries.

For cultural heritage features, historical data was not available. Table 1 shows a number of variables recorded from the 15 monitoring squares in 1998.

Table 1: Number of cultural heritage features per 3Q monitoring square, divided into point features and linear features (sorted by increasing no. of point objects). The number of patches indicates whether these features are spread over the entire square (many patches) or clustered together(few patches). The last column in the table shows the total area of the square that is within 25m of a cultural heritage feature.

3Q square	No. of point objects	No. of linear features	No. of patches	Area within 25m of cultural heritage features (hectares)
1	0	0	0	0,00
2	3	1	3	1,31
8	6	0	3	1,04
14	8	0	4	1,36
4	9	0	4	1,43
10	11	0	4	1,57
11	13	0	6	1,97
5	16	0	8	2,38
3	20	1	6	4,66
7	25	0	9	3,78
6	27	0	8	3,60
15	28	4	7	9,47
9	38	2	9	5,29
12	50	0	15	6,34
13	69	0	18	8,01

Discussion

Occurrence of water

The presence of water has been shown to be important in human aesthetic appreciation of landscapes (Wherrett, 2000), and is also a resource for recreation and outdoor activities. Water provides important ecological services and is an essential resource for the farmer. In Norway, where water is plentiful and natural irrigation of crops is the norm, most farms without easy access to rivers or lakes would historically at least have had a farm pond to secure water for husbandry and in case of fire. In more intensively cultivated regions of Norway, many of these ponds have been filled in during recent decades (Fjellstad and Dramstad, 1999).

The Water Presence Index attempts to capture two important aspects of water occurrence in a landscape: both the area of water and the number of water bodies. For sample squares that contain a few farm ponds but no other water, the index value is less than 1 % and the loss of a couple of ponds is reflected by changes in the index value of less than 0.5 %. One square, however, where a large river was present, had a WPI of 7.41 % in the 1960s and 1.84 % in 1998, the change being due to a higher water level resulting from natural variation in rainfall. The results from this square thus overshadowed the smaller changes in the other squares, yet the policy significance of the loss of farm ponds was far greater than the natural changes occurring in the river. Natural water bodies can, of course, be excluded from the calculation of the index to make a "farm pond index" that combines information on size and number. However, farm ponds are generally rather small and changes are more likely to affect presence/absence than size. Thus, whilst the WPI may be useful for describing and monitoring the occurrence of water in large regions, e.g. for recreational purposes, for the specific purpose of monitoring the agricultural landscape, simple statistics on numbers of farm ponds are a more transparent, policy relevant indicator.

Land cover/land use statistics

It is widely recognised that land cover/land use statistics are essential in describing the landscape and the way in which it changes over time. Nevertheless, there remain challenges in the use of such data. Importantly, there is no single classification and mapping system that covers all OECD countries and data are therefore often not comparable. When presenting statistics, definitions of land categories must always be included, and care must be taken in interpreting changes. Scale is also an important issue, including the scale at which data are collected (e.g. in the field, from aerial photography, from satellite etc.), the scale of mapping (e.g. minimum mappable size of land units), and the scale at which indicators are calculated and reported (e.g. the degree of differentiation within higher order land use classes such as agricultural land, and the degree to which indicators are aggregated by regions or countries).

For reporting to be meaningful in terms of reflecting real changes in landscapes, some type of landscape typology or landscape regionalisation is necessary. We know that different trends of change occur in different types of landscape and that opposite trends may occur in different parts of the same country (Fjellstad and Dramstad, 1999). Well known examples include the marginalisation of agriculture in mountainous areas and intensification in lowland areas, and the movement of people from rural areas to urban areas. Whilst total areas of different land cover/land use types per country may be relevant for some interests within international monitoring, the landscape perspective requires a better differentiation of this information within countries.

In addition to area statistics, the landscape theme requires reporting of "points and lines", i.e. landscape elements that may occupy very small areas but have a significant impact on the appearance of the landscape, such as solitary trees, farm ponds, clearance cairns, hedgerows, windbreaks, fences, stone walls, transhumance tracks etc. Sample-based monitoring provides a feasible means to record such elements in a cost-effective manner.

Openness

One landscape attribute that has an impact on human landscape experience is the degree of openness in the landscape. Aesthetically, people often tend to prefer fairly open areas with scattered clumps of trees and shrubs. The resemblance of this type of landscape to the savannah environments where humans originated and similarity in preferences between different cultures, lead many to believe that landscape preferences have an evolutionary basis (e.g. Appleton, 1975; Kaplan and Kaplan, 1989). The existence of such generalities makes openness an interesting landscape indicator for international reporting.

Openness can quite easily be derived from land cover/land use data. Since most land classification systems tend to distinguish between low growing vegetation types and forest, openness may be a measure that is comparable between countries and is relevant even when the types of vegetation and land use in different countries are very different from one another.

Recording state and change in the openness of different landscape types may indicate the degree to which people may find a particular landscape more or less aesthetically pleasing. However, human aesthetic preferences are obviously far more complex and diverse than this and are not to be satisfied by one type of landscape. There are numerous reasons for taking aesthetics into account in policy decisions, including the fact that scenic landscapes can positively influence human health, that they have a tourist attraction that brings economic benefits and that the provision of scenic landscapes may play an important role in the development of environmental concern (Parsons and Daniel, 2002). It is nevertheless unlikely that such a simple indicator of aesthetics as ‘openness’ could guide aesthetically based policy decisions. Rather the relevance of openness as an indicator would not be as a measure of aesthetic value but rather as an objective indicator of changing landscape character. Through quantifying changes and the rate and direction of change, policy makers would be made aware of developments. Whether the changes were considered positive or negative and the decision as to whether to act on the information or not, to preserve landscape character or allow it to evolve, would be issues of debate.

As for other land cover statistics, a measure of ‘openness’ for an entire country provides little landscape information since it is the geographical location of the open and closed areas in relation to each other that is of relevance to landscape character. As a minimum requirement a national figure of openness would have to be combined with some measure of spatial distribution (such as the heterogeneity measure *Hix* described in this paper) in order to describe whether open and closed areas are intermingled or clearly separated from one another. As is the case for land cover statistics, opposite trends of change in openness in different landscape types may easily cancel one another out in an indicator calculated for an entire country, making the indicator insensitive to change. To be of use for national policy development and as information to guide management decisions, the indicator should be calculated for landscape regions.

Heterogeneity of land types

Spatial heterogeneity of land types has also been linked to human scenic preferences (Dramstad *et al*., 2001), in addition to its relevance for ecological variables. However, as for openness and other measures of landscape content, there is no single optimal heterogeneity value for which to aim. Some species are favoured by heterogeneous landscapes with many edges, others by homogeneous landscapes. Some landscapes are characterised by high heterogeneity and others by low heterogeneity (at a specified scale of measurement). Again, the value of spatial heterogeneity as a measure for monitoring resides in the fact that it can indicate landscape change. How to respond to the information or the setting of targets will be value judgements that must be made for the area in question.

Accessibility

The measure of accessibility used in the Norwegian monitoring programme is an indicator that works well for Norwegian conditions, where areas can be easily defined as legally accessible or not. In other countries, with other rights of access, this indicator may be more difficult to calculate. Paths may not always be mapped, for example, and private roads and paths may be difficult to separate from public rights of way.

In Norway, the measure of accessibility is subject to strong seasonal variation. In winter, when the ground is frozen, arable land is also accessible to the public. Agricultural fields then become a valued area for recreation, highly suitable for the preparation of cross-country ski-tracks.

Lability

The lability index describes the potential for landscape change if human activities cease and is thus a rather hypothetical index. It avoids some of the difficulties associated with related concepts such as ‘naturalness’ or ‘ecosystem integrity’ that can be challenging to define, for example, for ‘semi-natural’ land types that have been managed extensively for generations. Yet lability can be difficult to interpret. Areas with a large proportion of agricultural land would have a high lability, since the landscape would change quite rapidly if agriculture were abandoned. Low lability on the other hand, may reflect either areas with a high proportion of natural land types that would not change if humans disappeared, or areas so strongly affected by humans, such as built-up areas, that they would take a long time to change to another land type category. The intention behind the lability index was to identify landscapes vulnerable to rapid change if land use ceased, however, in practice these are generally those landscapes that are dominated by agriculture. Thus, in terms of usefulness, lability seems to have very little advantage over general, broad category land use statistics.

Ruggedness

Landscape ruggedness is, to a large extent, a landscape descriptor that we would not expect to change significantly on human timescales, but that describes a characteristic of the landscape that has been shown to be important in human landscape perception (Wherrett, 1998) (and also to ecological processes in the landscape, e.g. Nelleman, 1997).

Of course, ruggedness of the terrain can be changed through grading of the land to improve agricultural conditions. This is a type of change that was previously subsidised in Norway, motivated by a desire to strengthen national food security through increasing the area of arable land. By deriving terrain models from stereo pairs of photographs of the same areas in the 1960s and in 1998, the ruggedness index would enable quantification of the degree of change due to grading. Similarly, this index would be interesting to apply in areas where the landform has been altered by terracing for agriculture.

Deriving terrain models from aerial photographs is, however, a rather costly process and the availability of old aerial photographs is also often limited. Calculating changes in terrain form over time may, therefore, be rather unrealistic for large areas. Most countries, on the other hand, have access to general topographical maps and we see the greatest value of the ruggedness index as a descriptor of the landform in an area. As such it can also indicate the vulnerability of an area to change, since it gives information about the suitability of the land for cultivation, with very rugged areas being more difficult to cultivate than areas with a low index value. Ruggedness is also a very obvious component of landscape character, and may therefore be useful in defining landscape types or regions. Background descriptive information such as terrain ruggedness is likely to play an important role when analysing trends of change to understand their causes.

Cultural heritage

Generally, for the selection of squares examined in this study (Table 1), the more objects present in a square, the greater the number of patches and the greater the area influenced by cultural heritage elements. The average area of influence of each cultural heritage feature, however, declines as the number of features increases. So if area of influence were used as an indicator, loss of cultural heritage objects from an area densely populated with other objects would be given less weight than losses from an area with few other cultural heritage objects. There is logic in this kind of weighting if the aim is to ensure that a certain level of cultural heritage interest is maintained in all landscapes. However, sites with a high density of cultural heritage objects may be considered more important to preserve than scattered objects in every landscape. Thus the choice of indicator involves some value judgements about which aspect of cultural heritage development we need to be informed about. Similarly, linear elements such as historical roads or old stonewalls obviously have a larger area of influence than point elements. Again this is logical in terms of the chances of a person in the landscape finding the cultural heritage feature, but may not reflect the value that a cultural heritage expert might assign to the feature. Until these value issues are resolved, number of point elements and length of linear elements may be the most appropriate indicators to use, being at least transparent and easily interpretable.

International indicators for monitoring cultural heritage must take into account that different countries may have widely different cultural heritage. In addition there are various aspects of the cultural environment to be captured in an indicator. The number of objects is an easily measured quantity and clearly relevant at a national level. In terms of impact on the landscape it is also interesting to know whether these objects are clustered in one area or whether they are scattered about over a larger area. Thus, the number of patches of cultural heritage interest in a landscape and the total area influenced by cultural heritage remains are both interesting quantities.

In addition, there are more qualitative issues to address such as the type and condition of the cultural heritage remains. Are they common elements or treasured rarities? Are they representative of the region or peculiarities? Are they fragments from one period of history or does the complement of remnants in an area tell the story of a landscape through the ages? Are the objects of interest to ordinary people in the landscape or only recognizable to cultural heritage specialists?

Cultural heritage features may be objects, linear elements or areas and can include all traces of man’s activities through the ages and even comprise natural features that are associated with for example special events or religious beliefs. Objects in today’s agricultural landscape such as signposts, telegraph poles, silo towers and storage barns may be of cultural heritage interest in the future. In the face of this overwhelming variety of possible cultural heritage features it is important to define what and how much should be recorded. It is easy to accept that different selections may be appropriate in different countries. It may also be helpful to identify the important elements in defining cultural identity in a region and focus on regional lists of indicators, rather as ecologists may use regional lists of indicator species in assessing the qualities of a particular habitat.

Conclusions

Scientists generally recommend using a range of indicators to report on landscape change, in order to capture different aspects of a complicated reality. Politicians, especially at international level, see the need to keep the total number of indicators to a minimum, so that monitoring and reporting do not become insurmountable tasks and to avoid information overload that may hinder analysis of the data gathered. Thus, whilst monitoring programmes are likely to continue to gather large amounts of data for national analysis, landscape experts must come to agreement on priorities for international reporting. The few indicators that are chosen must be flexible enough to be embraced by all of the OECD countries.

In trying to keep the number of indicators to a minimum it may be tempting to combine multiple information in a single index. Experience suggests, however, that the combination of two or more pieces of information in a single index value often make the index more difficult to interpret than if the information had been given separately. Generally, simple statistics, with transparent methods of data collection and calculation, are to be preferred over complicated indices that try to combine many aspects of interest.

There are many qualities in the landscape that may be poorly reflected in quantitative indicators or that can only be expressed by adding extra indicators (e.g. total number plus proportion of high/medium/low quality). The importance of habitat quality, not just quantity, is a typical example from the biodiversity theme. Water quality in farm ponds is an issue that is relevant both in terms of habitat value for wildlife and experience value for people. For the cultural heritage theme, there are value judgements to be made in deciding which features should be registered, before one even starts to consider the state and conservation value of the features that are selected. Just as different habitats are valuable to different species, cultural heritage features may have different value to different members of society. This means that even when we have chosen indicators to describe the landscape and the changes that occur within it, wide discussion is necessary to decide how that information should be used and how to set targets or thresholds for future developments.

In trying to develop standardised sets of landscape indicators we can recommend general land cover/ land use statistics, with the important addition of point and linear elements (natural and cultural features); landscape openness; spatial heterogeneity of land types; and accessibility. In particular, for indicators to function as *landscape* indicators we recommend the use of a landscape typology or landscape regionalisation as a background for reporting. Such a regionalisation should take account of natural conditions such as climate, topography, and types of natural vegetation as well as identifying central cultural characteristics that are important for regional cultural identity. Landscape regions can then provide a background against which to assess changes and develop meaningful policies.

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Countryside Quality Counts: Tracking Changes in England's Landscape

Carol Somper
Countryside Agency for England

Abstract

The UK 's diverse landscapes are the cornerstone of our cultural and natural heritage. They are vital to local and national socio-economic well-being. The agriculture industry is in recession in the UK, contributing only £6.5 billion to the total economy in 2001. It remains, however, the major instrument for managing over 75% of the UK's land surface. The landscapes that result from agriculture and related industries are vitally important for recreation, tourism and locally distinctive products. In England, rural recreation and tourism alone generates £14 billion per annum for the national economy.

Socio-economic forces are driving fairly rapid change in most of the countryside. To better plan for the future we must be able to track and monitor cumulative change in all aspects of 'landscape' from local to national scale, i.e. bottom-up and top-down. The UK has a spatial framework of landscape 'character areas' and landscape types. In England, these are being tested as a reporting framework for two new national indicators under a government-backed collaborative research project called "Countryside Quality Counts". This aims to:

- *deliver indicators of 'change in' Countryside Character' and Countryside Quality to help complete the UK's suite of indicators for sustainable development;*
- *contribute to the evidence-base for enhancing the development of spatial planning and agri-environment policies and their instruments;*
- *encourage a more informed dialogue between decision-makers and the communities they serve to achieve a better quality of life in rural areas (in terms of both health and wealth) in ways that conserve local landscape character.*

Introduction - new indicators for an unmet need.

There is a gap in the current set of sustainability indicators for landscape for the UK (as published in the government's "Quality of Life Counts" report[1] (1999) in support of the UK's post Rio Sustainable Development Strategy) in that it is not possible to say "how the countryside is doing" in terms of whether its landscapes are changing for the better or for the worse. This is because the existing landscape indicators in use mainly comprise individual landscape elements or 'characteristics' such as:

- length and condition of hedgerows
- length of stone walls and banks
- numbers of ponds
- area of woodland in the UK

[1]For more information see www.sustainable-development.gov.uk

Related indicators such as the extent and management of Sites of Special Scientific Interest, the "extent of land under agri-environment agreements" and "net loss of soils to development" all provide further context. All of these existing indicators deliver useful national data but their limitations become obvious when analysing what the data actually mean in terms of everyday experiences of countryside change . For example, the UK government's Countryside Survey for 2000[2] found that the rate of hedgerow loss occurring in the 1980s had stopped in the 1990s. This has been regarded as a success for government policies. However, the national estimates include the balance between new hedges planted under agri-environment incentives and the loss or decline of long established hedgerows. Neither do the estimates take account of their geographical distribution or their contribution to local landscape character. Thus countryside character could be changing significantly without being reflected in the national indicator. Similar analyses can be made for the extent and quality of grassland pasture and woodland.

An example of a more comprehensive national indicator is the UK headline indicator of wild bird populations. The index has been developed as a proxy measure for the overall 'health' of the countryside environment. The index shows a marked decline since the early 1970's, particularly for arable farmland species. This decline closely mirrors increased agricultural production in the UK facilitated by technological advances, and encouraged through EU and UK policies and related subsidies which combined to result in 'intensification'. It has slowed in recent years due to a combination of environmental factors such as milder winters, but also as a result of the increasing impact of agri-environment measures. However, this indicator also suffers from the difficulty of limited geographical disaggregation and the interaction of trends of increasing and decreasing species included in the index.

The new landscape indicators for England are being designed to be 'integrative' and present information at the landscape scale as:

a. an indicator of 'change in countryside character', to determine *what changes, where and why* and,
b. an indicator of Countryside Quality, to determine *which changes matter and why*.

The first indicator is being developed as a pre-cursor to the second one concerning 'quality' of the countryside. The methodology is still under development but it is taking account of the 'three pillars' of sustainability, namely economic, social and environmental aspects. The intention is that these indicators will capture much more about the state of the wider countryside in aggregate, whilst also being able to comment on changes at a finer, more local level of resolution through the links being developed with Countryside Survey 2000 data on individual landscape characteristics. In this way, they will be capable of relating broad national measures back to local variations in countryside character and changes to it, making it much easier, for example, to examine how sustainable or otherwise local agricultural practices are. The new indicators will be more sophisticated than those already in use because they will reflect the linkage between issues and impacts, both adverse and beneficial, of 'joined-up' policy making. However, it will also be important that the new indicators are transparent and meaningful to the intended audience of policymakers.

The rationale for taking a character-based approach to new landscape indicators

Landscape is about the relationship between people and place: it is the setting for all our lives. Landscape has economic, social, community, scientific, historical and environmental value. It is an integrative concept encompassing both natural and cultural attributes. Take for example an English mixed farming lowland landscape such as that found on the fringes of the North Cotswolds and

[2] *Accounting for Nature* ref - see www.cs2000.org.uk

Oxfordshire. The landscape here is multi-functional in that it:

- produces crops, livestock and woodland products,
- provides for local recreational and visual amenity;
- contains important historic artefacts such as ridge and furrow, ancient Neolithic monuments, historically significant farm buildings and related field enclosure patterns;
- has related and varied levels of biodiversity including nationally important Sites of Special Scientific Interest;
- determines the quality and quantity of water reaching aquifers and thus influencing water supply and flooding events downstream;
- supports a thriving tourism industry.

Furthermore, this one type of landscape has, in its long human past, fulfilled many other types of function, many of which have shaped its present character. Today's landscapes perform many different functions for society at many levels from local to national. This scenario is further reinforced when iconic landscapes of national and international importance are involved, such as the English High Weald, Salisbury Plain with its focus on Stonehenge as a World Heritage Site, the Scottish Highlands or the Pembrokeshire Coast of Wales. The picture is the same across Europe and elsewhere. In fact, all landscapes are multi-functional.

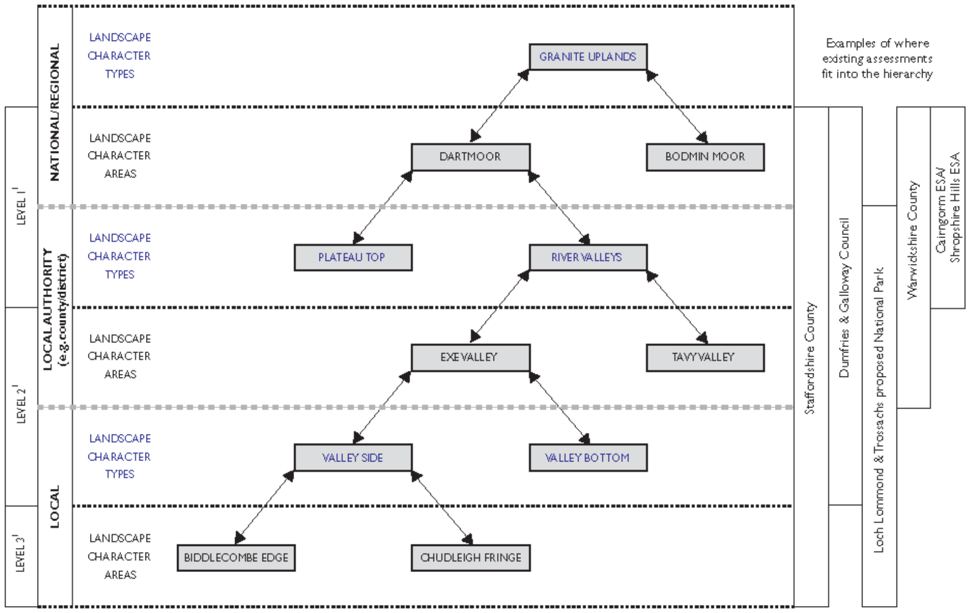
The impacts of the 2001 outbreak of Foot and Mouth Disease (FMD) in parts of the UK forcibly brought home to many policy-makers how closely 'landscape' and agricultural land use, cultural values and the economy are intertwined. Although agricultural systems are the primary means of land management for some 75% of the land area of the UK, agriculture's contribution to GDP is in decline, falling from around 2.2% for the UK a whole in 1982 to only 0.8% or £6.5 billion in 2001. However, the FMD epidemic revealed that England's agricultural landscapes support a thriving tourism industry attracting significant numbers of domestic and overseas visitors. Tourism statistics for the year 2000 estimate that UK residents alone made 33 million overnight trips to the English countryside. Rural tourism supports over 380,000 jobs in the countryside and is worth over £14 billion to the national economy. This includes £9 billion for day trips, the most recent data (1998) show that 1.25 billion day leisure trips were made to the English countryside. FMD had a far greater impact on tourism and related businesses than on agriculture per se. The overall impact on the national economy amounted to some £4.1billion but this was much greater in rural areas of high value landscape important to tourism such as Cumbria where 40% of businesses were affected and up to 15,000-20,000 jobs were at risk (7-9% of total employment). These figures illustrate how the decline in agriculture's direct contribution to the UK economy is being offset by rural economic diversification, and how important the character of the landscape is be for the economy in rural areas.

Furthermore, this evidence strongly reinforces the *cultural* role that agricultural landscapes perform at both a local and national level. There is very little true wilderness in the UK, particularly in England. Archaeological investigations have shown that, at some time or another, virtually every part of the English landscape has been settled and farmed. Technological developments over the millennia have given rise to changes in how the land has been managed and farmed, and most of these changes can to some degree still be discerned within present-day landscape character. Large tracts of landscapes have changed dramatically over time as a result. These changes continue today and will continue into the future. The issue at hand is how to track and manage such change along more sustainable lines than in recent decades. Settlement patterns in the UK evolve and change as part of these processes. In this context, it is highly debatable whether the term `agricultural landscapes' is descriptive enough to cover all of these scenarios and circumstances. Surely the term 'landscape', or better still 'landscape character' on its own is sufficient to encompass any scenario for changing land use?

Landscape as a concept is often used to provide a unifying framework for integrating different policy sectors. This enables a broad range of issues to be considered and dealt with in ways that accord with sustainable development principles. For these reasons it is crucial that we recognise what still survives from the past and that we understand the history and development of the current, existing "character" of the landscape when considering how it might change in the future. This should help to ensure that any changes that are taking place now are guided and managed for the most beneficial outcome for society at the time. In doing so it is vital that both national and local needs are given equal consideration.

Countryside or landscape character is the term used across the UK to describe what makes one place different from another, i.e. what sets one area apart from its neighbours in terms of locally distinctive 'characteristics' and the patterns in the landscape that these give rise to from one area to another. These characteristics are the natural and cultural landscape elements and features that comprise a locality's "sense of place". For example, woodland, shelterbelts, arable fields, pasture and hedgerows are found across the UK, but not always together and occur in different proportions in different places and in different types of landscape. This 'character-based' approach is extremely flexible since it delivers a spatial hierarchy of landscape units that can be navigated from the strategic and national to the very local and specific or vice versa (see figures 1& 2 for how the landscape hierarchy works).

Figure 1: The Landscape Character Assessment spatial hierarchy - an example of the relationship between the different levels [1] of generic landscape types and geographically distinct Character areas.

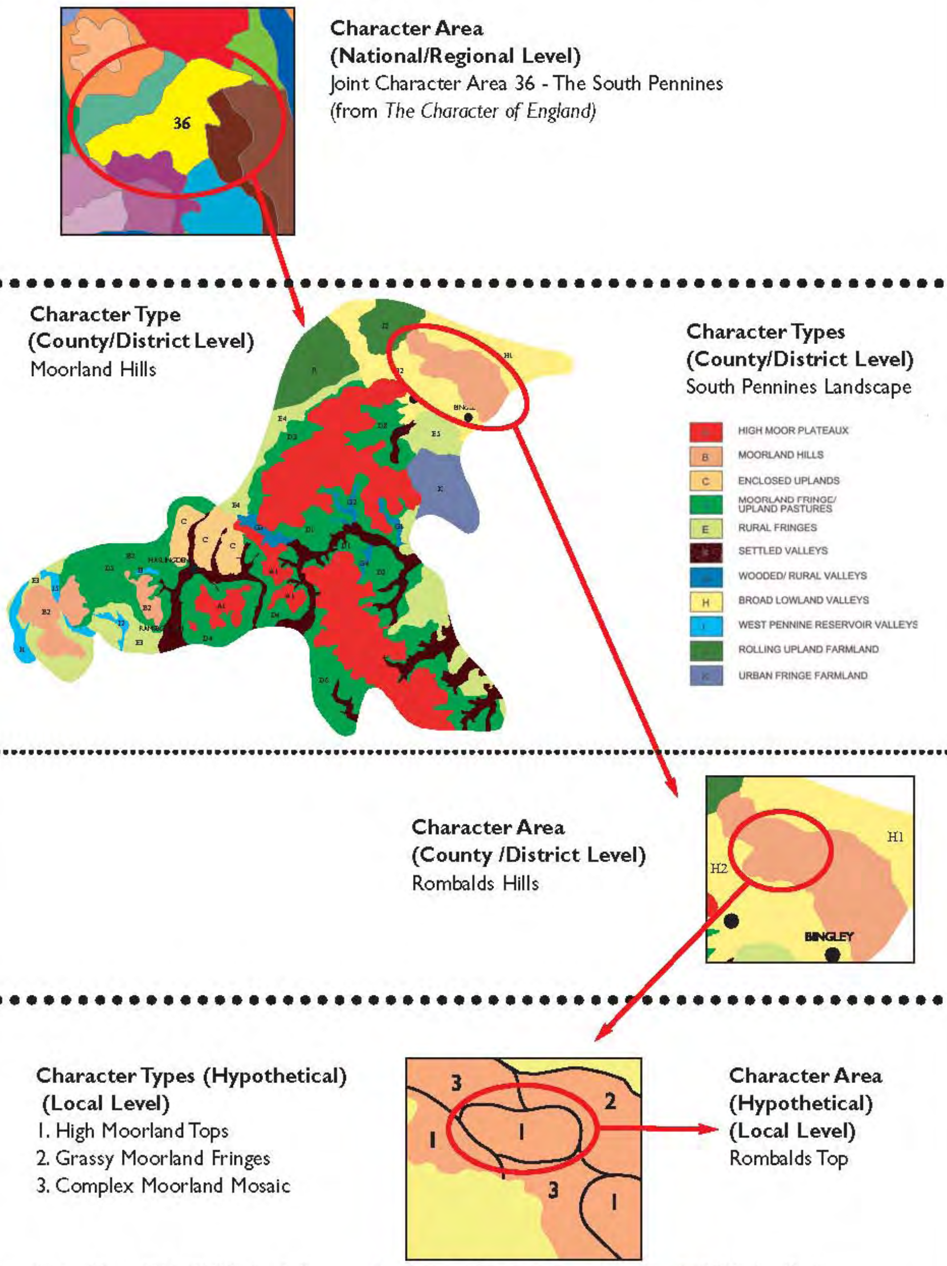


[1]Some practitioners use this parallel system in parts of England but it is not used in Scotland

Source: Landscape Character Assessment: Guidance for England & Scotland (2002)

The major strength of this approach is that it is mainly descriptive, largely objective and policy neutral. For example, countryside character exists everywhere as opposed to highly valued landscapes which do not. Character is not expressed in terms of 'good' or 'bad' but in neutral language to describe the *difference* between landscape units. The landscape units themselves are not bound by areal administrative boundaries. This encourages adjacent planning authorities to work more closely together on landscape types and areas that cross their boundaries.

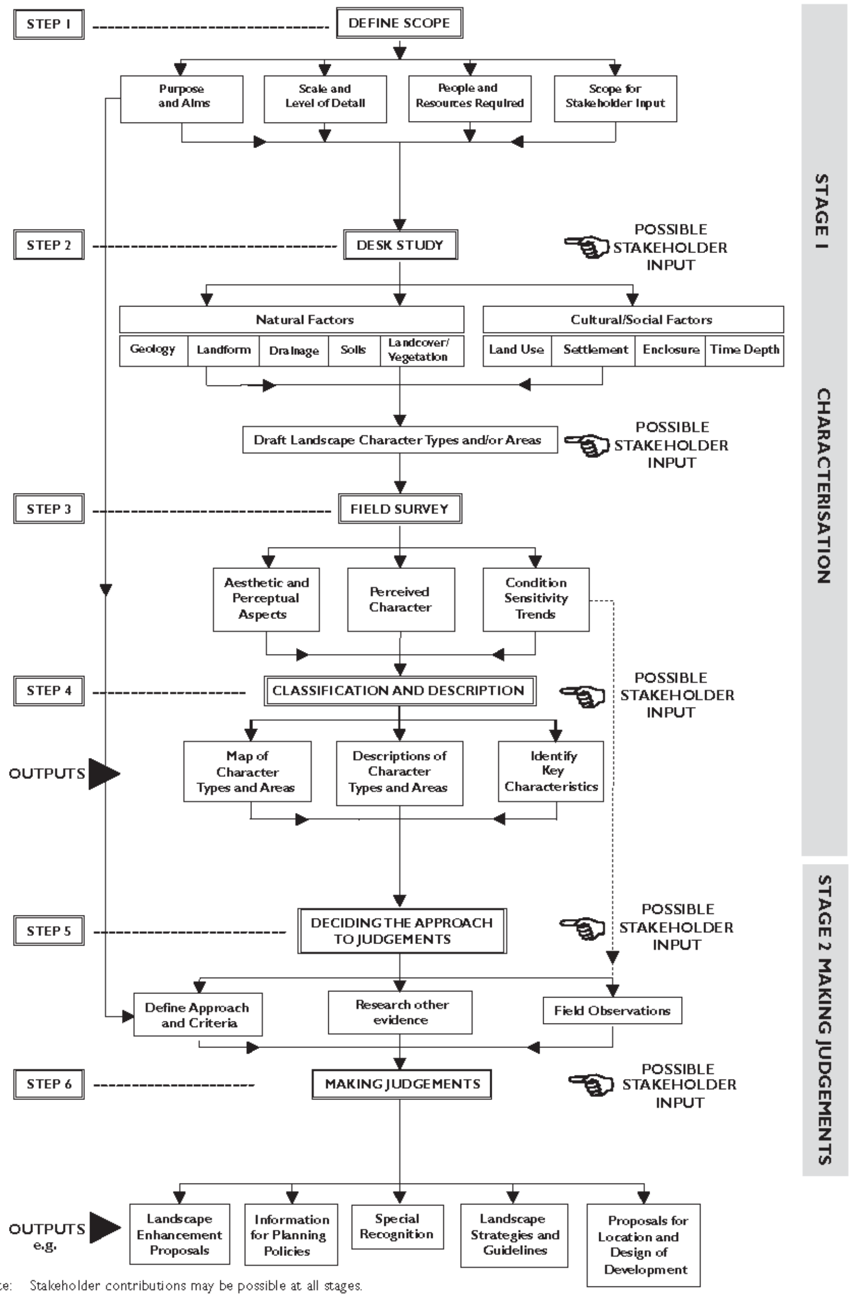
Figure 2: The Landscape Character Assessment spatial hierarchy - an example of the relationship between the different levels [2]



Source: Derived from LUC (1999) South Peninnes Landscape Character Assessment. For SCOSPA, Bradford, for publication in Landscape Character Assessment: Guidance for England & Scotland (2002).

Landscape character assessment (LCA) has evolved over the last decade as a tool to support sustainable development practice across the UK. It is a structured and systematic way of describing what makes 'landscape' and how landscape varies across defined geographical areas (Figure 3 summarises the process).

Figure 3: Flow diagram of Landscape Character Assessment methodology



Footnote: Stakeholder contributions may be possible at all stages.
The whole process may be iterative.

Source: Landscape Character Assessment: Guidance for England & Scotland (2002).

Evaluatory methods can be applied to the results of LCA to help determine what matters and why about existing character as a basis for evaluating emerging and future changes to it. Government agencies and Departments in England, Scotland, Wales and Northern Ireland have all been involved in the development of their own national initiatives to develop some form of landscape character assessment methodology based on interpreting and combining a series of attribute layers (geology, landform, soil types, land use, cultural patterns, settlement patterns, ecological interest). These various landscape initiatives are listed below:

- Wales - LANDMAP and the CADW/CCW register of historic landscapes (www.ccw.gov.uk)
- Scotland - Landscape Character Assessment Programme and RCHMS Historic Landscape Assessment (www.snh.org.uk)
- Northern Ireland - Northern Ireland: Landscape Character Assessment 2000.
- England - Countryside Character initiative (http://www.countryside.gov.uk/cci/) linked to English Nature's Natural Areas and Lifescapes initiatives (http://www.English-Nature.org.uk/science/natural/), complimented by English Heritage's Historic Landscape Characterisation programme[3].

These complementary approaches within the UK arose out of a shared, common need to use some form of landscape classification to help understand and resolve spatial planning and land use issues resulting from a range of socio-economic drivers of landscape change. Expanses of greenspace or countryside between expanding urban areas and settlements are highly valued by society within the UK, and possibly more so in England where population densities and pressure for development is greatest. Many places, particularly in the South East, Midlands and South West of England are coming under intense and increasing pressure for new development; primarily housing, transport infrastructure and minerals extraction (particularly aggregates associated with the construction industry). At the same time, traditional land management industries like agriculture are becoming less important to the UK economy in terms of national income and export values, although their value in landscape maintenance remains as important as ever. These national landscape approaches are being increasingly used at both national and local levels across the UK to help resolve spatial planning issues in more sustainable ways. Earlier this year the Countryside Agency (CA) for England and Scottish National Heritage (SNH) launched a joint publication for practitioners on how to undertake and apply the results of landscape character assessment (LCA) for a range of sectoral policy applications at different scales (http://www.countryside.gov.uk/cci/guidance/index.htm). The Countryside Council for Wales similarly launched its LANDMAP manual earlier in 2002. Each of these guidance manuals stress the importance of stakeholder involvement in both the assessment stages and the subsequent decision-making processes that follow. Without the appropriate involvement of local groups, individuals and organisations in making decisions about an area, less robust decisions will follow. There are now many examples of where local knowledge is being incorporated into character-based schemes and initiatives following on from assessments to ensure more sustainable outcomes are achieved such as the 9 English Land Management Initiatives (LMI).

The High Weald Land Management Initiative (LMI)

This initiative was set up in 2000 to help farms, other rural businesses and rural communities to find sustainable ways of diversifying to maintain the areas' distinctive environment and the local economy and communities dependant on it. Before the initiative was launched, the landscape character of the High Weald was explored in a series of workshops involving local stakeholders, including the farming community. A strong consensus emerged that the key characteristic of the High Weald landscape is its distinctive mosaic of interlocking woodlands, linear wooded features and small fields. This helped the groups to establish and agree environmental (landscape) targets for the area. These targets included ones for hedgerow conservation, new woodland planting, field edges, arable headlands, unimproved permanent pasture, ponds and streams. The targets are now being refined two years on in 2002.

(Source: High Weald Land Management Initiative and the High Weald AONB Unit, 2001).

[3]See ref Fairclough et al (1999)

Character-based approaches are being used throughout the UK to help and devise and implement new agri-environment schemes such as the Agency's Land Management Initiatives, and refine targets for existing schemes such as Environmentally Sensitive Areas (ESAs) and Countryside Stewardship. For example, the management and economic regeneration of undesignated yet important landscapes such as the Culm Measures in the South West of England and the Humber Head Levels towards the north east coast are using agri-environment funds to establish improved management regimes designed to help boost the local economy of each area whilst conserving local landscape character of high nature conservation value and historic interest.

Project background and policy context

Closely linked to the application of LCA, the new national landscape indicators research project is a further development of the Countryside Agency's Countryside Character Initiative. It grew out of the UK government's commitment to develop an indicator of 'countryside quality' as part of its suite of 150 indicators for sustainable development. This same commitment is repeated in greater detail in the Rural White Paper for England (2000) in which government stated that it would:

"publish a measure of change in countryside quality, including issues such as biodiversity, tranquillity, heritage and landscape character using analysis of the results of Countryside Survey 2000 and based on the Agencies' character areas map."

Subsequently, a major research project led by the Countryside Agency for England began in April this year with the overriding aim of developing an approach to tracking change in the English countryside. This work is supported by central government and sister agencies, reflecting the breadth of interest in integrated approaches in England. Details about the project, its sponsorship, and composition of the project team can be viewed at http://countryside-quality-counts.org.uk/.

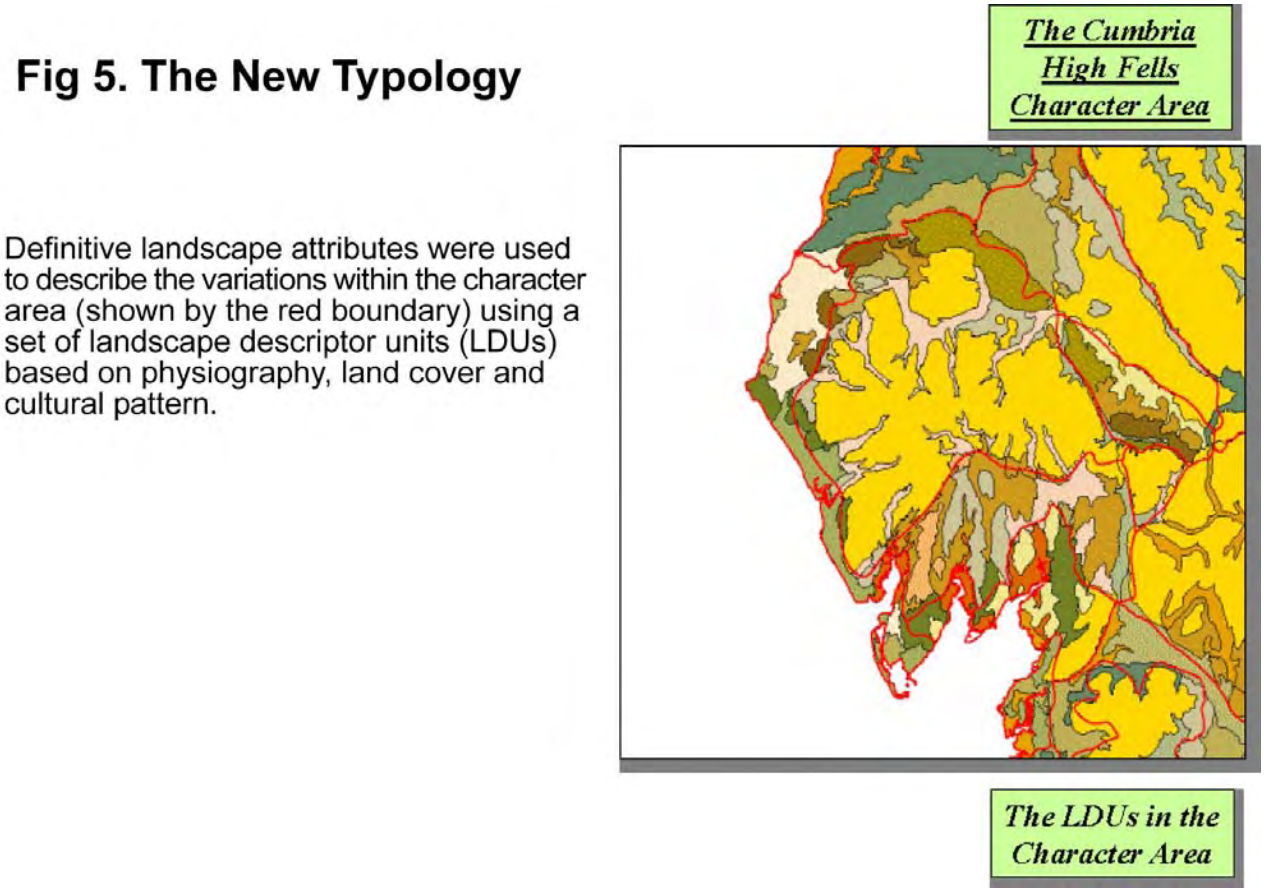
The research brief calls for the development of not one but two new national indicators since it was considered too difficult to construct an indicator of countryside quality without first establishing how and where countryside character is changing. To recap, the project aims to deliver:

a. an indicator of 'change in countryside character' to determine what changes, where and why and,
b. an indicator of Countryside Quality to determine which changes matter and why.

The project builds on recent work begun under the Countryside Character initiative to develop a national landscape classification and typology for England which fits within the national framework of 159 character areas (refer to Figure 4 and Figure 5).

Fig 4. The New Typology

Using the various combinations of physiology, land cover and cultural pattern, generic landscape character types have been mapped for the whole of England.



One of the first key questions currently under investigation is how the typology and national character area framework can be used to construct indicator(s) of change in character. The main advantages of using the typology as a starting point is that it:

- is comprehensive and consistent in its coverage of the whole of England;
- describes how landscape or countryside character is expressed at more local scales across an area, enabling these differences and characteristics to be taken into account in translating national agri-environment measures to the local level;
- links directly with the majority of existing detailed LCA work undertaken by local authorities and groups in 80% of England; and as a result of which it;
- can be directly translated into local area-based plans as part of the statutory planning system.

These indicators are being designed to help improve understanding both within and outside of government as to how the countryside is really changing as opposed to perceptions about countryside change. A critical factor in this will be the ability to link measurements of different types of change to the key socio-economic drivers of change. This includes not only national legislation but also funding streams and policy instruments operating at the European level and above. Ultimately we need to understand where and how policy interventions could make the most cost-effective difference. This will also involve looking at how subsidiarity and modulation measures can best be applied to agricultural systems operating in England and the UK as a whole.

The indicators will also need to be relevant to all those organisations and individuals dealing with land use and landscape planning, and in particular the linkages between them. Ideally, the indicators should enable us to look back at how trends for change have emerged and to ultimately look forward at how trends may develop to result in future landscape change, including the creation of more sustainable landscapes in the future. For example, national and European agri-environmental schemes are increasingly multi-objective, looking beyond agriculture to the wider well-being of rural areas as a whole. This requires that their success must be measured against a wider set of objectives. The proposed indicators of countryside character and quality should help bring together these different elements. In doing so they will help identify the need for different levels of government intervention and help to more closely target resource allocation on a geographical basis.

The project will establish base lines against which trajectories can be considered and the impacts of the driving forces for change will be assessed. Just as importantly, the indicators will need careful presentation in order to fulfil an awareness-raising role, both amongst policy-makers and the general public, urban and rural communities alike (since both are dependant on each other). For example, the indicators are needed to help people understand *what* is happening, *why* and *how fast* certain changes are occurring. This should help us look at what may happen to the landscape in the future. Constructing 'futures' scenarios is an increasingly popular technique for trying to resolve current issues in many policy fields[4]. Examining potential changes to future landscapes may prove to be a productive mechanism for identifying more sustainable socio-economic policies that impact on rural land use and communities.

The project team will further develop the policy context for the project as the work progresses. They will be aided in this by a small 'expert panel' and a wider advisory group comprising representatives from central government, NGOs, local authorities and agencies. For example, the varying impact of new telecommunications and renewable energy infrastructure on the character of the countryside will probably be considered, i.e. at what scale do which impacts matter most, to whom, and what types of landscape will be most affected.

Research objectives and the developing methodology

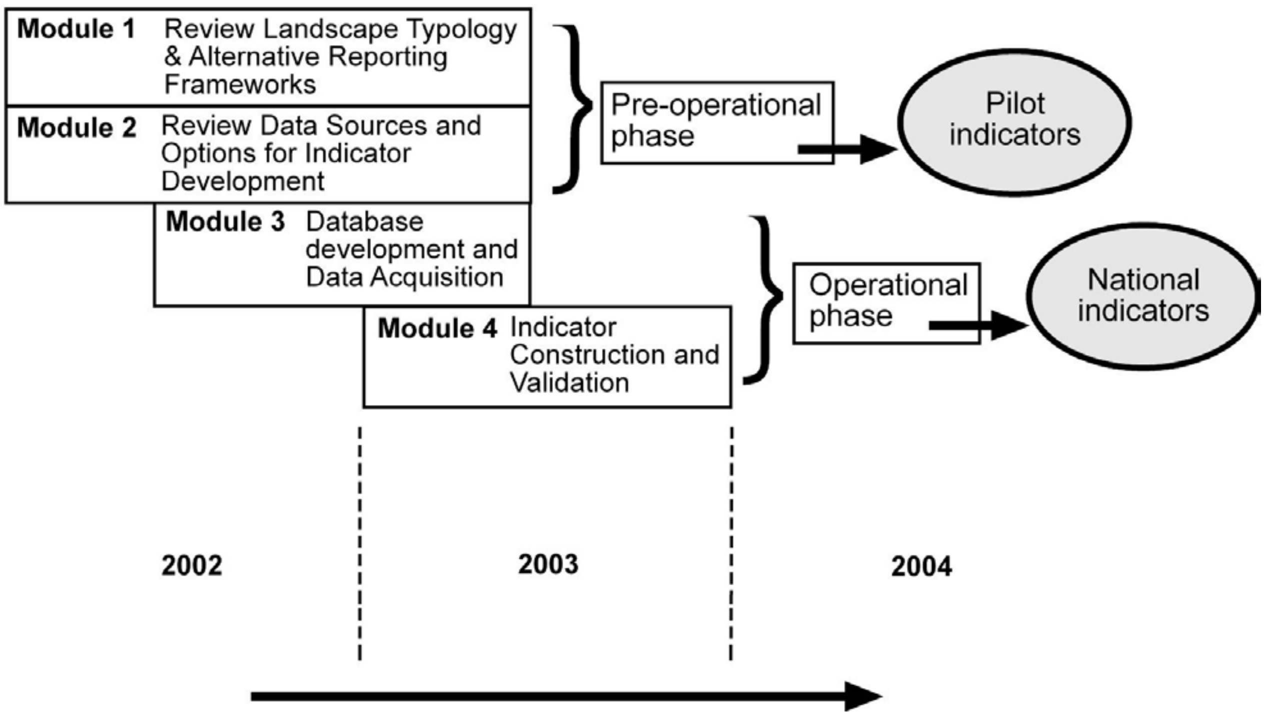
The project began with data review to identify key data sets prior to setting up a process for integrating essential baseline and trend data for the natural, cultural and built heritage as a relational database for data presentation through GIS. At the same time a consultation process began to secure in principle acceptance of the new national landscape typology and project objectives with potential users of the final indicators. The project will also pilot the integration and best use of government's Countryside Survey series habitat change data, for reporting on aggregate change in character at landscape type and character area levels, and separately for both for specific landscape features and ecological trend data. The project will culminate in the delivery of a methodology for aggregating all aspects of character change - natural and cultural - for reporting on overall extent, magnitude and type of change, i.e. what change has occurred at the landscape type and character area levels. A major challenge will be the development of a robust definition of "Countryside Quality" acceptable to central and local government, and the subsequent development and delivery of this second indicator, linked to changes in character. The results will be made freely available from the project partners via the government's MAGIC intra-net system (see **www.magic.gov.uk)**.

To meet these various objectives the programme of work comprises linked and overlapping modules as set out in Figure 6. Modules 1 and 2 are being undertaken in parallel and comprise the pre-operational phase leading to the development of pilot indicators. These modules include a series of eight regional seminars across England. These will be closely followed by a web-based consultation on the most favoured indicator options shaped by the seminars. Potential regional and local users of the final

4 *"Is this the future we want*" (2002) ref CAX 103

indicators are being invited at the earliest stages of the project to influence and help shape the development of national indicators that best relate to local initiatives and needs. This early attention to stakeholder involvement should not only help to produce better products but it will also promote ownership of the final indicators and a deeper understanding of how they can best be used.

Fig 6. Work programme



As well as examining the utility of the new landscape typology, the seminars are being used to explore which data potential users consider to be worthwhile in constructing the indicators so that changes in character can be represented at local and national scales. This exercise relates to Module 2 of the project and includes investigation of perceptual and aesthetic aspect of landscape character such as ‘tranquillity’ and wildness. Feedback from the seminars will be used to inform the geographic analysis of prevailing trends for change arising from the data as perceived at the local level by professionals and NGOs working in those areas. Stakeholders are also being asked to state how such changes relate to their perceptions of countryside quality and which changes present opportunities for shaping future landscapes in their region.

The main national data sets under investigation in Module 2 are:

Data set	**Attribute**
National inventory of Woodlands and Trees	- woodland cover and pattern
Land Use Change Statistics	- changes in (rural) land use
Agricultural Census	- changes in land management regimes
Countryside Survey 2000	- changes in the stock and condition of BAP habitats
Post Address File	- settlement patterns (inc changes in size and function)
Tranquillity	- visual and noise disturbance patterns
Historic and cultural heritage data	- changes in historic or cultural character

The integration of these national datasets poses a number of technical and conceptual problems. Each of the datasets has, for example different spatial and temporal resolutions, making the task of linking them technically complex. The National Inventory of Woodlands and Trees is, for example, a complete census of woodland cover for parcels above 2ha which can be used to describe woodland character at local scales for a single point in time (1998). By contrast, change data from Countryside Survey 2000 is sample-based and can be only be used to make reliable statistical estimates at national and regional scales (i.e. county level and above). Thus the successful linkage of such data within a system of indicators will depend on the development of flexible reporting frameworks, that can accommodate the various technical restrictions associated with each dataset. The agricultural census is particularly problematic, since although it has been made available on a 5km x 5km grid basis at national scales, these data have been generalised in some localities to preserve confidentiality.

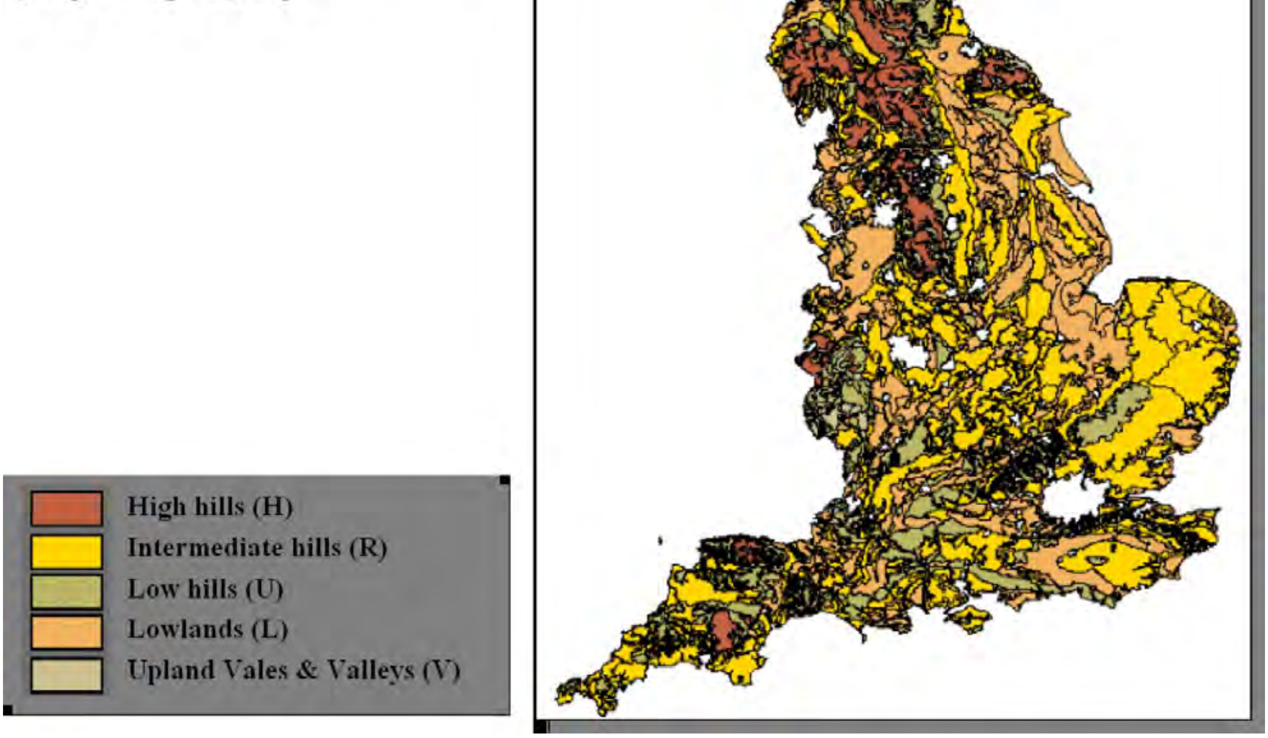
The integration of these national datasets also poses considerable conceptual challenges, for it is unlikely that these sources of information can be used to describe changes in character across the range of attributes used at local scales to describe what is distinctive and unique to each character area. One approach being explored by the project team is to use these changes to characterise some of the key driving forces shaping all landscapes, and to combine these data with the existing character area descriptions to highlight what sorts of landscape might be sensitive to particular sorts of change. In this way the outputs of the project could be used to highlight not only what general sorts of changes are occurring, but also *where they are likely to matter most*. The goal is to develop indicators that are robust at regional and national scales, but which can also be disaggregated to refine our detailed understanding of the nature and consequences of change at the local level, by combining the information with more detailed local knowledge. Conceptually, therefore the indicators could be used as part of a framework that will help shape and contextualise local action as well as perform at a more strategic level for national purposes. The new landscape typology for England will be a key part of this framework.

In taking the conceptual development of the indicators forward, data source at the Lands Use Change Statistics, the Agricultural Census and CS2000 are likely to play fundamental roles. It seems likely that key forces for change in the countryside, such as the conversion of rural land to more developed uses, with the consequent loss of 'rurality', coupled with the impacts of changes in farming systems on land cover at regional changes, can be represented using existing data resources, for 5 to 8 year periods, using 1990 as a base-line. Current work involves constructing a series of pilot studies using these data, with a programme of wide consultation to test the robustness of the outputs from the work.

Work recently began on Module 3, as part of the operational phase of the project, on the development of the database and data acquisition, including the specification for data capture. Two major challenges to be overcome are firstly, how to reconcile the use of different data at different scales and secondly, at what time periods can the data be refreshed to provide meaningful updates for the change in character indicator(s) since some data are revised annually whilst others can take between 5-10 years to be renewed, depending on the method and complexities of data collection. The historic data is possibly the least well-marshalled at present, with a considerable amount of information in existence but much of which is inaccessible due to variations in standards, protocols and consistency of coverage at a national scale. The key deliverable from Module 4 will be a fully structured relational GIS (ARCInfo) character database using MS Access software, with a summary version suitable for limited interrogation on ARCView.

Indicator construction and validation will begin under Module 4 early in 2003 and complete in early 2004 to result in the publication of the finalised indicators. The results of the early seminars and consultation process will guide work under this module by providing insights as to what sorts of landscape change matter at what scales and by helping to refine definitions of ‘quality’, for example, should change in quality be viewed simply as change in the condition of functional elements and characteristic in the landscape? Or should it describe the way changes impact on the quality of life for the people who live in or visit the countryside? Such changes could be the result of increasing telecommunications infrastructure causing changes in recreational and visual amenity, or the changes resulting from agri-environment measures and woodland planting in a range of landscape types grouped according to definitive attributes such as physiography as shown in Figure 7.

Fig 7 Landscape types grouped according to physiography



The project team will advise on, and help the project partners to set up an annual validation and appraisal exercise based on the statutory agencies "Quality of Life Capital" evaluatory methodology (for more information see http://www.qualityoflifecapital.org.uk/). This will involve the circulation of hard copy and digital versions of the completed characterisation section of the matrices to the various agencies regional teams and to each regional fora for a `professional evaluation' of the significance in the magnitude and extent of changes in each region as suggested by the various trend data. These assessments, once agreed, will be incorporated into the database as having been validated. These data will then be used to help compile the second indicator of Countryside Quality.

It will be critical to identify potential members for each of the regional groups required to validate the change data and agree the analysis of changes to the region's landscape so that this validation process can best be set up and run over time to report the Countryside Character and Countryside Quality indicators at appropriate intervals, e.g. this will probably be every 5-6 years. This is possibly the most challenging component of the project and this approach may well undergo adjustment as the project progresses and the indicators are tested during the pilot stage in Module 3.

Conclusions to date

The primary aim of the "Countryside Quality Counts" project is to develop national indicators for England that will make a major contribution to the development of evidence-based policy development at the national level. In view of the hierarchical nature of the developing reporting framework of landscape units, it will also be possible to 'drill down' to the local level or even aggregate certain local landscape character data to form a bottom-up approach to policy development. The ability to travel either way through the data and present different levels of detail at different scales will give the final database an important utility. It could emerge to become a powerful planning tool for government and others to use. The results of landscape character assessment are already used to inform a range of spatial planning and land management policies, including those found in area-based plans covering the location and design of new development and changes in land use. Thus is may well be possible to build on this by designing national level strategies for new housing, minerals extraction and the development of national transport and renewable energy infrastructure that meet national objectives whilst taking proper account of local landscape diversity and the value that local communities place on this.

It is arguable that the indicators under development are not in themselves measures of sustainable development. They can however be used to help measure progress towards the environmental aspects of sustainable development. For example, they might help us look at the effects of landscape designation and to ask if the right types of change are occurring in the right places. They will also link with the development of indicators for sustainable agriculture. This is something the existing indicators either cannot do or can only do so in a very limited way.

At present, the second indicator of countryside quality is being approached as more of an umbrella concept, covering both character and value, where the latter includes more perceptual elements such as 'landscape tranquillity'. The new CA/SNH guidance handbook defines landscape quality as " the functional condition of characteristic components of the landscape and its overall state of repair or 'intactness'. Thus the research focus here will be on the distinction between *quality* and *character.* The success of the project may well hinge on how well this difference is put across.

The success of this project will determine whether or not similar indicators are developed for other countries within the UK. There is clearly merit in considering how this approach could be transferred to other countries outside of the UK that have national landscape typologies in place.

Recommendations

The JWP are asked to consider the following recommendations at their December 2002 meeting:

- That the concept of 'landscape character' and character-based methodologies should be adopted by the OECD as a means of taking into account differing patterns of national and regional distinctiveness whilst promoting a common approach to the development and use of landscape indicators;
- that an internationally acceptable form of landscape classification be promoted by the OECD for adoption by a range of international organisations (e.g. the Council of Europe, Eurostat and the WTO) and national governments to enable the development of a hierarchy of landscape units from local to global for linking strategic policy-making to national, regional and local policy implementation and vice versa, i.e. a seamless two-way process.
- the OECD should more strongly promote the concept of 'cultural landscapes' in recognition of the fact that agricultural land use and, in particular, that development of agricultural systems and changes to them over time, are an integral component of the historic development of rural areas; their diverse landscapes and varied communities.

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Landscape Indicators of Agri-environmental Condition in the United States

Stephen J. Brady
Natural Resources Inventory and Analysis Institute
US Department of Agriculture, Natural Resources Conservation Service
and Forest Service Inventory and Monitoring Institute
Suite 300, Bldg. A, 2150 Centre Ave., Ft. Collins, Colorado 80526-1891
Telephone: 970.295.5721, Fax: 970.295.5885
e-mail: sjbrady@fs.fed.us

Abstract

The fundamental agri-environmental questions of immediate interest to U.S. policy makers have to do with sustainability of the resource base and pollution abatement. Indicators of resource condition are evaluated to identify the area of land under conservation treatment and the area of land that may still need treatment. Many types of indicators provide useful information to characterize the effects of land treatment. While "landscape" per se does not receive agricultural policy consideration in the U.S., indicators related to landscape structure and function do. Indicators addressing environmental features, land use patterns, and cultural features fall within the OECD category of "landscape indicators." Indicators of land capability, highly erodible land, and soil erosion have been used extensively in U.S. agricultural policy in recent decades. Examples of landscape structural indicators for conservation treatment are described in terms of what environmental attributes they indicate and how they are determined from the National Resources Inventory. While effective agri-environmental indicators must be clearly defined in terms of what it is they indicate, some indicators serve crosscutting objectives by providing information about multiple attributes of ecosystem sustainability.

Keywords: Agri-environmental indicators, Landscape, National Resources Inventory, United States.

Introduction

Agricultural policy in the United States includes provisions for both commodity and conservation programs. Agricultural conservation programs address many of the OECD agri-environmental indicators. The fundamental agri-environmental questions of interest to U.S. policy makers have to do with sustainability of the resource base and pollution abatement. The resource base is broadly defined to include soil, water, plants, animals, and air. Indicators of resource condition are evaluated to identify the area of land under conservation treatment and the area of land that may still need treatment. Many types of indicators provide useful information to characterize the effects of land treatment. While "landscape" per se does not receive agricultural policy consideration in the U.S., indicators related to landscape structure and function do. In the following pages I briefly describe land use patterns, U.S. Department of Agriculture (USDA) conservation programs, monitoring of conservation progress, and the use made of agri-environmental indicators.

The National Resources Inventory

Much of the data in the succeeding pages is the result of analyses of the 1997 National Resources Inventory (NRI, Natural Resources Conservation Service, NRCS, 2000). The NRI is a stratified random sample of over 800,000 points that has been repeated at 5-year intervals since 1982. It is an inventory of soil, water, land cover/uses and related resources on the nonfederal lands of the U.S. Each sample point is associated with a specific soil map unit component. Extensive data on the physical and chemical properties of each soil are stored in relational data bases linked to the NRI which allow complex analyses of soil properties by land uses or regional patterns. The purpose of the NRI is to obtain statistically reliable estimates of the conservation treatment of the nonfederal lands. Estimates are used by the U.S. Department of Agriculture (USDA), Congress, policy makers, and others in evaluating national programs and policies pertaining to agriculture, land use, and natural resources occurring on nonfederal lands. In the following pages, NRI data are displayed by Farm Resource Regions (FRR) for convenience. The FRRs reflect geographic specialization in the production of farm commodities defined by the USDA Economics Research Service.

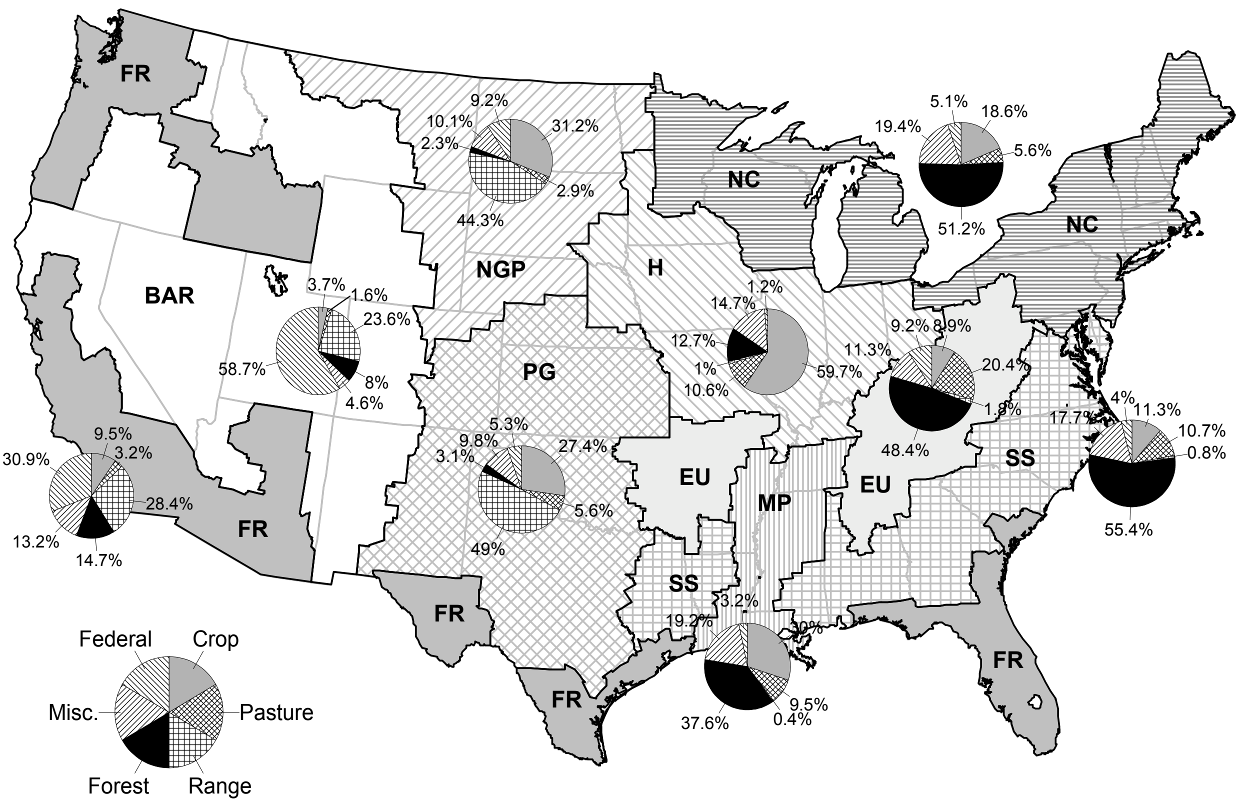
Land Use in the United States

Seventy-nine percent of the land in the United States is in nonfederal ownership. Land under federal administration consists primarily of forests, rangelands, and parks. Most of the nonfederal land is in private ownership and therefore is protected from public trespass. Most agricultural production occurs on nonfederal land although some federal rangeland is used by individuals for livestock grazing on an annual fee basis. Major land uses in the United States for 1997 (NRCS, 2000) are rangeland (20.9%), forest (20.9%), federal (20.7%), cropland (19.4%), pasture (6.2%), developed (urban, industrial, built-up, and roads, 5.0%), Conservation Reserve Program (CRP, 1.7%), and miscellaneous (water bodies and streams, mined land, barren, etc., 5.2%). The distribution of land uses is primarily determined by physiographic characteristics including geomorphology, topography, soil, water, and climate. While cropland occurs nearly throughout the United States, it is most abundant in the Heartland (29.2%), Prairie Gateway (19.3%), Northern Great Plains (15.6%), and Northern Crescent (10.5%, Figure 1, Table 1). Rangeland occurs primarily in the arid west-central regions of the Prairie Gateway (32.2%), Basin and Range (23.7%), Fruitful Rim (22.1%), and Northern Great Plains (20.5%). Cropland, pasture, rangeland, and other agricultural fields occur in mosaic patterns intermixed with other land uses across the landscape.

Agricultural Conservation Policies

Agriculture policies regarding the environment were initially focused on soil and water conservation, but have broadened to include the resource base. Formal efforts by USDA to conserve soil, water, and other natural resources date back to the 1930s when the Soil Conservation Service (name was later changed to the Natural Resources Conservation Service, NRCS, in 1994) was established to combat the "Dust Bowl." Technical and financial assistance was provided on a voluntary basis to farmers for conservation treatment. USDA also offered commodity adjustment, disaster, and insurance programs to producers of agricultural commodities that were motivated exclusively by economic factors. Prior to 1985 the emphasis of USDA conservation programs had been on providing technical and financial assistance for the voluntary application of soil and water conservation practices. The Food Security Act of 1985 brought significant change in the way the federal government addressed agricultural conservation issues. While participation in U.S. Department of Agriculture (USDA) programs has always been voluntary, the changes brought about by the 1985 Food Security Act linked some conservation standards to all USDA farm program benefits. Since about 85% of agricultural producers participated in one or more USDA farm programs, these changes were significant. The report by Zinn (2001) provides an excellent description of this legislation for those desiring more information.

Figure 1. Geographic distribution of land uses by Farm Resource Region[1] in 1997.



[1] Farm Resource Region (FRR) names are: H - Heartland, NC - Northern Crescent, NGP - Northern Great Plains, PG - Prairie Gateway, EU - Eastern Uplands, SS - Southern Seaboard, FR - Fruitful Rim, BAR – Basin and Range, and MP - Mississippi Portal.

Source: NRCS, 2000.

The Food Security Act of 1985 created three substantial new conservation provisions: Highly Erodible Land (HEL), Wetland Conservation, and the Conservation Reserve Program (CRP). The HEL and Swampbuster provisions represented a new approach by denying access to USDA farm program benefits to land users who did not meet program requirements for soil erosion levels and wetland conservation (Zinn 2001). The CRP provided an opportunity to take eroding or environmentally sensitive cropland out of production in return for 10-year rental payments. All three of these provisions have been retained in amended form in subsequent farm legislation passed in 1990, 1996, and 2002. These provisions collectively set an environmental standard for agricultural crop production. HEL is defined by USDA as land that has a soil erodibility index (EI) ≥ 8. The EI is defined by factors from the Universal Soil Loss Equation (USLE; Wischmeier and Smith 1978) or Wind Erosion Equation (WEQ, USDA Soil Conservation Service 1978), whichever is applicable. The EI is computed using the soil, climate, and topographic variables from the USLE and WEQ in the numerator and the T-value (i.e., the tolerable limit required to maintain productivity) in the denominator. The EI calculated using this procedure represents an index of potential erosion based upon natural conditions since it does not include the effect of management practices such as contour farming, crop rotations, or conservation tillage. It is possible to farm highly erodible cropland in a sustainable manner if conservation practices are applied and proper management techniques are followed, but costs of conservation practices and inputs are often higher on highly erodible cropland. Likewise it is possible to farm non-highly erodible cropland in an unsustainable manner if conservation management is neglected. Program rules generally define fields as highly erodible if more than a third of the area of the field, or 20.2 ha, consists of soil map unit components that are highly erodible. The HEL provision can be subdivided into Conservation Compliance and Sodbuster.

Table 1. Broad land cover/use categories by Farm Resource Region[1].

hectares X 1,000

FRR[1]	Cropland	CRP[2]	Pasture	Range	Forest	Misc.[3]	Dev.[4]	Federal
H	44,510.2 (251.4)[5]	2,491.8 (19.9)	7,888.6 (167.7)	745.5 (62.9)	9,496.5 (164.4)	1,906.6 (57.6)	5,251.7 (104.5)	873.3 (6.4)
NC	16,022.4 (215.4)	553.5 (6.8)	4,845.3 (132.9)	0.0 (0.0)	43,985.1 (348.8)	3,533.3 (125.4)	8,666.9 (125.4)	4,402.8 (4.6)
NGP	23,744.0 (403.9)	3,327.6 (16.7)	2,235.8 (173.7)	33,659.3 (671.5)	1,762.7 (139.4)	1,868.0 (141.0)	1,258.0 (64.0)	6,992.4 (10.7)
PG	29,371.9 (341.3)	4,104.1 (21.7)	6,004.3 (162.2)	52,667.6 (656.7)	3,322.6 (271.5)	1,385.3 (137.9)	3,920.3 (113.2)	5,725.1 (10.8)
EU	4,763.1 (128.7)	100.6 (9.1)	10,844.6 (177.2)	959.2 (73.5)	25,733.1 (220.6)	895.8 (45.0)	3,869.6 (102.3)	4,880.6 (11.1)
SS	7,636.9 (154.9)	652.3 (10.1)	7,227.9 (167.0)	568.8 (57.8)	37,375.8 (251.1)	1,354.6 (58.3)	6,018.9 (123.2)	2,717.3 (9.8)
FR	12,078.6 (369.2)	864.8 (4.5)	4,123.4 (168.1)	36,237.4 (815.1)	18,696.4 (457.7)	5,120.8 (344.0)	7,199.4 (214.2)	39,414.4 (10.3)
BAR	5,990.7 (269.6)	581.0 (8.9)	2,591.1 (221.2)	38,880.0 (1,204.6)	13,127.8 (543.7)	2,952.2 (301.6)	1,966.5 (100.8)	96,674.8 (12.7)
MP	8,202.6 (138.8)	556.1 (8.4)	2,605.1 (94.9)	112.2 (17.5)	10,271.7 (144.1)	1,395.2 (62.2)	1,332.8 (49.6)	879.4 (6.3)
48 States	152,320.2 (811.1)	13,231.9 (31.8)	48,366.1 (497.8)	163,829.9 (1,735.1)	163,771.7 (937.8)	20,411.8 (525.9)	39,484.1 (357.4)	162,560.0 (14.2)

[1] Farm Resource Region (FRR) names are listed in Figure 1, above.
[2] CRP represents land in the Conservation Reserve Program where environmentally sensitive croplands have been converted to perennial vegetation.
[3] Misc. represents miscellaneous and all other land cover/uses.
[4] Dev. represents land developed for urban, suburban, industrial, or transportation uses.
[5] Margins of error are in parentheses ( ). The 95% confidence interval is defined as the estimate ± margin of error.

Source: NRCS, 2000.

The HEL Conservation Compliance provision essentially requires land users who produce agricultural commodities on highly erodible cropland to follow a management plan that will contain soil erosion rates within specified limits or risk losing eligibility for most farm support programs on all the land they farm. Nearly 30% of the cropland and CRP land in the U.S. qualifies as HEL (Table 2). The HEL

Sodbuster provision applies to HEL that is converted to agricultural production from permanent cover such as pasture, rangeland, or forest. The provision requires producers who convert HEL to agricultural production to follow an approved conservation plan or they will loose eligibility for most farm support programs. About 40% of the rural land not in cropland use (e.g., pasture, range, forest, etc.) occurs on soil map unit components that qualify as highly erodible. The Wetland Conservation provision denies USDA farm program benefits to producers who convert (or drain) a wetland for the purpose of producing agricultural commodities.

Table 2. Highly erodible land (HEL) on cultivated cropland (CultCrop), noncultivated cropland (NonCult), and Conservation Reserve Program (CRP) land by Farm Resource Region[1].

hectares X 1,000

FRR[1]	CultCrop	NonCult	CRP	%HEL	HEL
H	7,927.2	1,478.3	1,506.3	23.2%	10,911.8
	(147.8)	(66.1)	(51.1)		(164.6)
NC	2,628.5	1,325.9	225.3	25.2%	4,179.6
	(88.0)	(62.9)	(9.0)		(108.7)
NGP	6,177.3	1,303.6	1,816.6	34.3%	9,297.4
	(292.5)	(102.1)	(13.6)		(308.4)
PG	10,118.1	676.3	2,739.9	40.4%	13,534.4
	(238.5)	(55.3)	(19.9)		(241.0)
EU	903.7	1,433.3	56.3	49.2%	2,393.2
	(46.0)	(62.8)	(7.8)		(75.9)
SS	948.5	521.2	235.7	20.6%	1,705.5
	(55.0)	(39.5)	(11.4)		(67.1)
FR	2,452.2	505.1	354.3	25.6%	3,311.6
	(150.9)	(60.6)	(9.1)		(165.2)
BAR	1,855.8	789.1	345.6	45.5%	2,990.4
	(173.8)	(83.1)	(19.6)		(193.9)
MP	735.2	201.2	271.6	13.8%	1,208.0
	(47.6)	(25.5)	(20.5)		(59.1)
48 States	33,746.5	8,234.0	7,551.5	29.9%	49,532.0
	(482.1)	(196.3)	(59.7)		(519.6)

[1] Farm Resource Region (FRR) names are listed in Figure 1, above.
[2] Margins of error are in parentheses ( ). The 95% confidence interval is defined as the estimate ± margin of error.

Source: NRCS, 2000.

Conservation plans approved by local Soil and Water Conservation Districts are required under the HEL provisions. The farm operator agrees to manage the HEL fields according to the plan. Those plans, prepared with NRCS assistance, result from an evaluation of soil and site conditions, landowner objectives, and soil and water conservation treatment needs. Conservation plans include management specifications to reduce soil erosion. Examples of such practices include: contour farming, terraces, conservation tillage (often including minimum amounts of crop residue left on the surface after planting), grassed waterways, cropping system specifications (i.e., crop rotation), and other practices. While the HEL provisions do not specifically address other resource concerns, there may be significant improvements to landscape, habitat, biodiversity, and other environmental amenities in agricultural ecosystems from the application of practices for soil and water conservation. These environmental benefits increase as individual conservation practices are applied as part of an integrated resource management system.

As noted above, agricultural land uses are primarily determined by attributes of natural features, then to a lesser extent by policy. Economic conditions and analysis of the 1982 NRI data prompted federal agricultural policy makers to evaluate cropland use in relation to soil erosion and land capability factors. This analysis resulted in shifts to agricultural policy that discouraged producing annually cultivated crops on lands where the risks of increased soil erosion were greater. As a result of these policy shifts (implemented by programs discussed above such as HEL and CRP), cropland soil erosion rates declined from an average of 9.0 metric tons/hectare in 1982 to 6.3 metric tons/hectare in 1997 (NRCS, 2000). Much of this improvement resulted from the conversion of about 13.2 million hectares of cropland with excessive soil erosion rates to perennial cover through the CRP. In similar fashion, 80.8% of cultivated cropland now has estimated soil erosion rates less than the “tolerable” soil loss level, while in 1982 only 73.4% of cultivated cropland had soil erosion rates that were below the “tolerable” soil loss level (NRCS, 2000). The term tolerable here refers to the rate of soil erosion that does not jeopardize the long-term sustainability of the soil resource and represents a specific value for each soil map unit component. These examples illustrate some of the environmental benefits of those policy shifts:

1. The productive capacity of the soil is conserved.
2. Marginal soils with greater environmental risk, higher input costs, and lower natural productivity are farmed less intensively or are removed from cultivation.
3. Wildlife and aquatic habitats associated with downstream receiving waters and wetlands receive much less sediment and associated pollutants than they did in 1982.

Concomitantly the National Research Council (NRC, 1993:4) analyzed agricultural practices and impacts to identify opportunities that held the most promise for “improving the environmental performance of farming systems while maintaining profitability.” They made the following broad recommendations:

1. Conserve and enhance soil quality as a fundamental first step to environmental improvement.
2. Increase nutrient, pesticide, and irrigation efficiencies in farming systems.
3. Increase the resistance of farming systems to soil erosion and runoff.
4. Make greater use of field and landscape buffer zones.

They also noted that these four approaches are interrelated. Emphasis on one objective to the exclusion of the others may exacerbate one environmental problem while solving another.

It is in our best interests to encourage cultivation of the best soils and discourage cultivation of soils that have one or more drawbacks to intensive uses. The better soils exhibit reduced environmental risk, reduced input costs, and greater inherent productivity; therefore it is easier to use them in sustainable ways. We can classify soils using a system of land capability classes (Hockensmith and Steele, 1949) that assigns all soil map unit components to one of eight classes. These eight classes indicate progressively greater limitations and narrower choices for agriculture. Using this concept 7% of cropland soils are class I, 46% are class II, 31% are class III, 11% are class IV, while about 5% are in classes V-VII. Subclasses are also assigned to these soils to identify specific limitations such as erosion problems, wetness problems, root zone limitations, and climatic limitations. From the subclass assignments one observes that 52% of cropland soils have erosion problems, 27% have wetness problems, 9% have root zone limitations, and 5% have climatic limitations. Many of the identified problems and limitations can be overcome with management, although costs and complexity of management increase as the land capability classes depart further from class I. Other classification criteria also exist. Soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops are classified as prime farmland soils. Just over half of the cropland and CRP land qualifies as prime farmland soils (Table 3).

The attributes of soils and the benefits of careful use as described above are generally not obvious to the casual observer, but are best quantified through scientific inventory (i.e., the National Resources Inventory) or other research endeavors. While many of these characteristics may not fall neatly within the realm of proposed OECD indicator criteria, they certainly contribute to improved environmental quality and enhance the long-term sustainability of agriculture. It is important to recognize and receive credit for national policies resulting in these not so obvious, but extensive, improvements to maintaining the sustainable capacity of the resource base for future generations. The approach to landscape (and other agri-environmental) indicators should be integrated across all agricultural land and not just the most valued agro-ecosystems.

Table 3. Prime farmland by Farm Resource Region[1] for some important land cover/uses.

hectares X 1,000

FRR[1]	CultCrop[2]	NonCult[2]	CRP[2]	%Prime[3]	PrimeLd[3]
H	30,950.5	1,108.4	929.2	70.2%	38,189.8
	(247.6)[4]	(60.8)	(22.6)		(260.0)
NC	7,195.9	1,613.0	207.6	54.4%	14,836.3
	(158.5)	(78.8)	(28.8)		(256.7)
NGP	6,725.2	404.1	358.9	27.7%	8,444.6
	(155.6)	(61.1)	(13.9)		(169.8)
PG	16,208.6	769.3	1,324.4	54.7%	27,481.9
	(264.7)	(58.0)	(43.7)		(310.9)
EU	1,655.7	827.4	58.0	52.2%	7,818.8
	(88.4)	(50.5)	(10.9)		(163.1)
SS	3,983.2	494.5	364.8	58.4%	15,360.3
	(122.7)	(40.5)	(15.3)		(223.8)
FR	4,549.3	1,321.0	125.9	46.3%	8,573.2
	(194.6)	(128.4)	(8.3)		(260.6)
BAR	768.6	687.4	67.2	23.2%	1,955.4
	(81.5)	(105.0)	(9.1)		(139.9)
MP	6,330.0	223.3	318.6	78.5%	11,463.5
	(130.3)	(26.5)	(19.3)		(162.6)
48 States	78,367.1	7,448.3	3,754.5	54.1%	134,123.8
	(514.9)	(222.3)	(68.2)		(670.9)

[1] Farm Resource Region (FRR) names are listed in Figure 1, above.
[2] CultCrop and NonCult represent cultivated and noncultivated cropland, respectively, while CRP represents land enrolled in the Conservation Reserve Program.
[3] %Prime represents just the cropland and CRP land totals, while PrimeLd includes all land cover/uses (i.e., pasture, range, forest, etc.) occurring on soils that qualify as prime farmland.
[4] Margins of error are in parentheses ( ). The 95% confidence interval is defined as the estimate ± margin of error.

Source: NRCS, 2000.

Agricultural Conservation Programs

The policies described above generally have to do with sustainability of the natural resource base and pollution abatement. The return on investment of installing many conservation practices is often very long and may extend to future generations. Landowners may not live long enough to recoup their investment. Likewise many of the benefits of conservation application accrue offsite to neighbors and communities downstream. Since the benefits are often greater to the public than to the private landowner it has become commonplace for the public to help pay the costs of installing the practices to the land or other costs of program participation. While many landowners have a strong conservation ethic and some have the financial resources to pay for conservation treatment of their lands, there are many who cannot afford to go it alone. Consequently many of the agricultural conservation programs offer cost-sharing arrangements where the landowner's share may be as low as 10-25% of the total cost. The most recent suite of conservation programs available to landowners is briefly summarized in Table 4.

Table 4. A summary of important conservation provisions of the Farm Security and Rural Investment Act of 2002.

Program	Provision
Environmental Quality Incentives	Financial and technical assistance is provided to help install or implement structural and management conservation practices on eligible agricultural land.
Conservation Security	A new national incentive payment program to reward stewardship and provide an incentive for addressing additional resource concerns on agricultural working lands.
Conservation Reserve	Financial incentives are paid to retire environmentally sensitive cropland by converting it to perennial vegetation for contracts of 10 or, in certain cases, 15-year duration.
Wetlands Reserve	Financial and technical assistance is provided to restore and protect wetland functions and values, especially by retiring marginal land from agriculture.
Farmland Protection	Purchases 30-year or perpetual conservation easements to help farmers and ranchers keep their land in agricultural uses.
Wildlife Habitat Incentives	Financial and technical assistance is provided to develop wildlife habitat on private land.
Small Watershed Rehabilitation	Provides essential funding for the rehabilitation of aging small watershed impoundments that have been constructed over the past 50 years.
Grasslands Reserve	Enroll up to 809,389 ha of restored, improved, or natural grassland, rangeland, and pastureland for 10-30 year agreements or 30-year or permanent easements.
Desert Terminal Lakes	Provides funding to help conserve desert terminal lakes.
Forestry	New cost-share program to assist private, non-industrial forest landowners in adopting sustainable forest management practices.
Conservation of Private Grazing Land	Technical assistance is provided to landowners and managers to voluntarily conserve or enhance their resources to meet ecological, economic, and social demands.
National Natural Resources Conservation Foundation	Is a private, nonprofit corporation established by Congress to provide the means to research and promote innovations for the conservation of natural resources on private land to prevent excessive soil erosion; enhance soil and water quality; and protect wetlands, wildlife habitat, and strategically important farmland subject to urban conversion and fragmentation.

Source: http://www.nrcs.usda.gov/programs/farmbill/2002/

The Environmental Quality Incentives Program (Table 4) is well funded and has the potential to affect thousands of hectares of working agricultural lands through the application of conservation practices such as terraces, grassed waterways, irrigation water management, wildlife habitat management, manure storage structures, and comprehensive nutrient management plans. The Conservation Security Program is a new program that will provide incentive payments to producers who historically have practiced good stewardship and incentives for those who want to do more. Program guidelines are incomplete at this time but graduated incentives will be based on addressing one or more resource concerns on part or all of a farm. The other programs in Table 4 involve cropland retirement options or conservation treatment for specific resource concerns.

These voluntary programs are designed to encourage sustainable uses of agricultural lands by rewarding good conservation management. Under most of these programs the participants must comply with the HEL and Wetland Conservation provisions in order to maintain their eligibility for program participation. However all USDA programs are voluntary. They have been successful because many farmers would like to maintain or improve the sustainable capacity of their land for future generations and because the economic incentives to participate are great. Land users do have the option of forgoing all USDA farm program benefits and then generally having the freedom to manage the land in their own way. There are some exceptions to this statement but attention to soil and water conservation issues is voluntary unless the land user does participate in USDA programs.

Landscape Indicators

Aldo Leopold (1966, pp. 177-178) captured the essence of landscape quality:

> "There is much confusion between land and country. Land is the place where corn, gullies, and mortgages grow. Country is the personality of the land, the collective harmony of its soil, life, and weather. . . . Poor land may be rich country and vice versa. Only economists mistake physical opulence for riches. Country may be rich despite a conspicuous poverty of physical endowment, and its quality may not be obvious at first glance, nor at all times."

How then do we indicate its value? Leopold (1966) did suggest two criteria for evaluation:
Is soil fertility maintained? Is a diverse flora and fauna sustained?

Recently the National Research Council was charged with making recommendations for ecological indicators for the nation. Based on a comprehensive set of criteria the committee recommended the following indicators within three broad categories (NRC, 2000, pp. 7-8):

1. As indicators of the extent and status of the nation's ecosystems: *land cover and land use*.
2. As indicators of the nation's ecological capital: *total species diversity, native species diversity, nutrient runoff, and soil organic matter*.
3. As indicators of ecological functioning or performance: *carbon storage, production capacity, net primary production, lake trophic status, stream oxygen*, and for agricultural ecosystems, *nutrient-use efficiency and nutrient balance*.

While some of the terminology is different, one will note the strong similarity of this list to the list of agri-environmental indicators proposed by OECD. Landscape does not explicitly appear on this list but several indicators related to landscapes do.

As per the OECD work on this subject (OECD, 2001, pp. 365-398): Landscapes can be considered as composed of three key elements: *landscape structures* or appearance, including environmental features (e.g. habitats), land use types (e.g., crops), and artificial objects or cultural features (e.g. hedges); *landscape functions*, such as a place to live, work, visit, and provide various environmental services; and *landscape values*, concerning the costs to farmers of maintaining landscape and the value society places on agricultural landscape, such as recreational and cultural values. Examples of indicators potentially useful in describing each of the three key landscape elements are summarized below.

Landscape structure:

- Land cover and land use
- Wetland area and change in abundance
- Proportion of the agricultural landscape –
    - Supporting natural (e.g., residual) vegetation (i.e., riparian areas, odd areas or inclusions).
    - Exhibiting specific conservation practices (i.e., contouring, strip-cropping, terraces, etc. Figures 2 and 3).

These indicators of landscape structure have been discussed by several of the OECD agri-environmental expert groups and are generally well accepted. See the report and discussion documents (i.e., Brady and Flather, 2001) from the OECD Expert Meeting on Agri-Biodiversity Indicators for more information (http://www1.oecd.org/agr/biodiversity/index.htm).

Landscape function:

- Proportion of the agricultural landscape –
    - Land Capability Class I, II-IV, and >IV.
    - Land Capability Class II-IV with erosion problems (subclass **e**).
    - Land Capability Class II-IV with wetness problems (subclass **w**).
    - Land Capability Class II-IV with root zone limitations (subclass **s**).
    - Land Capability Class II-IV with climatic problems (subclass **c**).
    - Prime farmland.
    - Highly erodible land (HEL as discussed above).
    - Cropland soil erosion rates (estimated using standard protocols).

These indicators pertain to environmental services such as net primary productivity or crop yields and were discussed in a preceding section. While most of these are the result of geomorphologic, physiographic, topographic, and climatic factors, they also provide very useful information regarding landscape functions. Better soil and site conditions require lower inputs, have greater productivity, and have reduced environmental risks. Agricultural policies may provide incentives to encourage the use of better soil and site conditions for intensive production and discourage the use of those that are only marginally suited for cropping.

Landscape values:

- Public and private costs to apply and maintain conservation practices.
- Proportion of individual land users who apply complete conservation treatment to their farms.
- Number of participants in specific federal conservation programs.

Landscape values represent to a large extent the socio-economic and cultural values of landscape. The economic values are probably best described from ancillary data unless techniques are available to estimate the values and costs on-site.

Use of Indicators

The essence of this policy challenge concerning landscape and other amenity values associated with agriculture, is that there is no “right” or “correct” level for the supply of these amenities (Bromley, 1997). How much is optimal, precisely which landscape features does society value, and to what extent do changes in policies and policy mixes affect landscape? (Sinner, 1997). While landscape per se does not receive agricultural policy consideration in the United States, the related issues of sustainability and pollution abatement do. The structure and function of landscape components are of value in providing many ecological functions and services (Daily, 1997). Indicators of sustainability are important in agricultural landscapes to communicate with policy makers and to assure society that we are using the resources within their long-term capacity to perform.

Impacts to the agricultural landscape often occur on a site-specific basis. If we try to mitigate environmental impacts on a site-specific basis, it is difficult to account for the cumulative effects that result. While site-specific problems can be identified, it is difficult to identify the full extent of those problems without an objective, large-scale strategy in place. The examples described above regarding highly erodible cropland, prime farmland, and cropland uses by land capability class could only be detected and quantified because a statistically designed natural resources inventory (e.g., the National Resources Inventory) was in place. That inventory provided the basic data from which useful indicators could be derived and evaluated. The problems at any one site were generally minor, but when viewed in the context of cumulative effect it became clear that the issues required resolution. Consequently USDA was able to address those issues through policy adjustments (Highly Erodible Lands provision) that provided incentives for desired agricultural land uses and disincentives for undesirable uses of the resource base. The resulting shift in policy resulted in a much faster resolution across an extensive agricultural base than could have been achieved through site-specific problem solving. Indicators are very important to monitoring and maintaining sustainable use of the agricultural resource base.

When indicators of sustainability reveal scores outside of the acceptable range, management decisions are required. The previous discussion pertained to large-scale databases and policy decisions. Likewise management decisions are needed on site that require an evaluation of alternatives from which to choose the best course of action. From the previous examples there are many different ways to control soil erosion on agricultural lands. Changing the crop rotation from intensive row cropping to a longer term rotation including small grains and hay or meadow is often the least expensive, but may result in reduced income or excess hay to dispose of. Conservation tillage practices have advanced in recent decades to provide dependable results. Typically they consist of reduced tillage practices that leave residue from the previous crop on the soil surface. The straw or stalks are sometimes shredded or disked, but not plowed under. The crop residue on the soil surface absorbs much of the kinetic energy from rainfall, permitting the water to soak gently into the soil rather than dislodge soil particles creating erosion. Some conservation practices result in strikingly beautiful landscape views such as the examples in Figures 2 and 3 below. They are presented to illustrate that taking corrective actions to mitigate concerns about sustainability (i.e., addressing elements of ecological function or structure) do result in significant changes to the landscape. The judicious selection of conservation practices results in benefits to multiple ecosystem components. Benefits accrue to both the private landowner and to the public; often the public benefits are greater than those to the private landowner. In those cases it seems reasonable that the public would subsidize their benefits.

Figure 2. Contour strip cropping, alternating bands of corn (maize) and alfalfa in a field on the Iowa-Minnesota border are visually appealing as well as functional in controlling soil erosion (1999 NRCS photo by Tim McCabe). The perennial vegetation and trees in the valley bottoms help to filter sediment and pollutants from the runoff before it leaves the site.

Figure 3. Terraces and no-till farming work to control erosion and runoff on a farm in Montgomery County, Iowa (1999 NRCS photo by Tim McCabe).

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Evaluation of the Agricultural Landscape in Austria – Examples

Klaus Wagner
Federal Institute of Agricultural Economics
Schweizertalstr. 36, 1133 Vienna, Austria
Tel.: +43 +1 8773651 64
klaus.wagner@awi.bmlf.gv.at

Abstract

Some of the recent research projects in Austria concern questions about the appearance of the landscape under cultivation. One example is an INTERREG IIC project (finished in 2001), which developed a sectoral and transnational coordinated system for the evaluation of landscape functions and created a planning method for an efficient land use. The results show the effects of agriculture on different landscape functions like the resource protection, the hazard damage protection, the function of recreation, the spatial structuring function and the habitat function, including the landscape appearance. These functions were evaluated in a region of intensive agricultural land use with a very low share of wood. The original aim was the identification of areas suitable for forestation without risking a decrease of the different landscape functions. Another ongoing process in Austria is the midterm evaluation of the rural development program and connected research programs for creating and evaluating indicators on behalf of the EU-regulations. The questions of coherence between farmland and natural or biophysical characteristics, of the homogeneity or diversity of farmland and the cultural identity of farmland as well as other social values should be answered in three differently structured test-regions in Austria.

Keywords: Agricultural functions, Agricultural landscape indicators, landscape evaluation

1. INTERREG IIC project: Evaluation of agricultural landscape functions

Experts who are into regional planning complain about the lack of consciousness for an economic use of agricultural land. Calls for a better protection of agricultural land were raised on national and international, political and scientific level (Austrian Conference on Regional Planning, OECD). The subproject of an INTERREG IIC project of the Federal Institute of Agricultural Economics contributes to a more sustainable and economic use of agricultural land, which is often seen just as residual area, after all other social demands on space have been satisfied (Ministry for Agriculture, Forestry, Water Management and Environment, 2001). There is a trend towards segregation into regions with intensive production and extensively used regions. The consequence is a reduction of agricultural functions to only one purpose (production) on the one hand, and the expiration of agricultural land use at all on the other hand. It shows the need for a careful planning scheme especially in regions that are under high pressure because of the many competing land uses. But the agricultural landscape and the other green structure elements have various other functions besides the production of food and raw materials.

Theses circumstances should be made clear to the public: e.g. the effects of agricultural land use:

- on water and soil are expressed in the Resource Protection Function;
- on the protection of objects like settlements are expressed in the Hazard Damage Protection function;
- on the diversity of species and landscapes are expressed in the Agricultural Habitat Function;,
- on the amenity of the landscape and the suitability for recreation are expressed in the Recreation Function;
- to separate different, each other disturbing uses or exploitations, like industrial plants near settlements, are expressed in the Spatial Structuring Function.

1.1 Evaluation model

The evaluation of agricultural landscape functions shows the effects of agriculture on the above mentioned functions The model integrates different sectors (forestry, water management, agriculture) and is adapted to different national needs (Germany, Austria, Hungary and Greece participated in the project). For the purpose of the evaluation of agricultural areas it has been applied in the reference region of Marchfeld, which is located in the eastern part of Austria, in the surroundings of Vienna. Because of different competing land users the conflicts are increasing there (intensive agricultural production with partial irrigation, ground water overloaded with nitrate, small shares of woodland and risk of wind erosion, expansion of built-up areas near the capital Vienna, increasing traffic volume, mining of gravel, oil, gas). So called “agro-functional land units” are the evaluation units, which are homogenous in type of landscape, in natural conditions, in land use and in administrative belongings, with an average size of ~500 ha. Because of their complexity the different functions have been divided into sub-functions, which have been evaluated by different criteria and indicators. For each agro-functional unit the six agricultural functions have been evaluated in an ordinal scale of values from 0 to 5, whereby 0 stands for the function not being relevant and 5 indicates that the function is of significant importance (Fig.1). The evaluation does not express money terms.

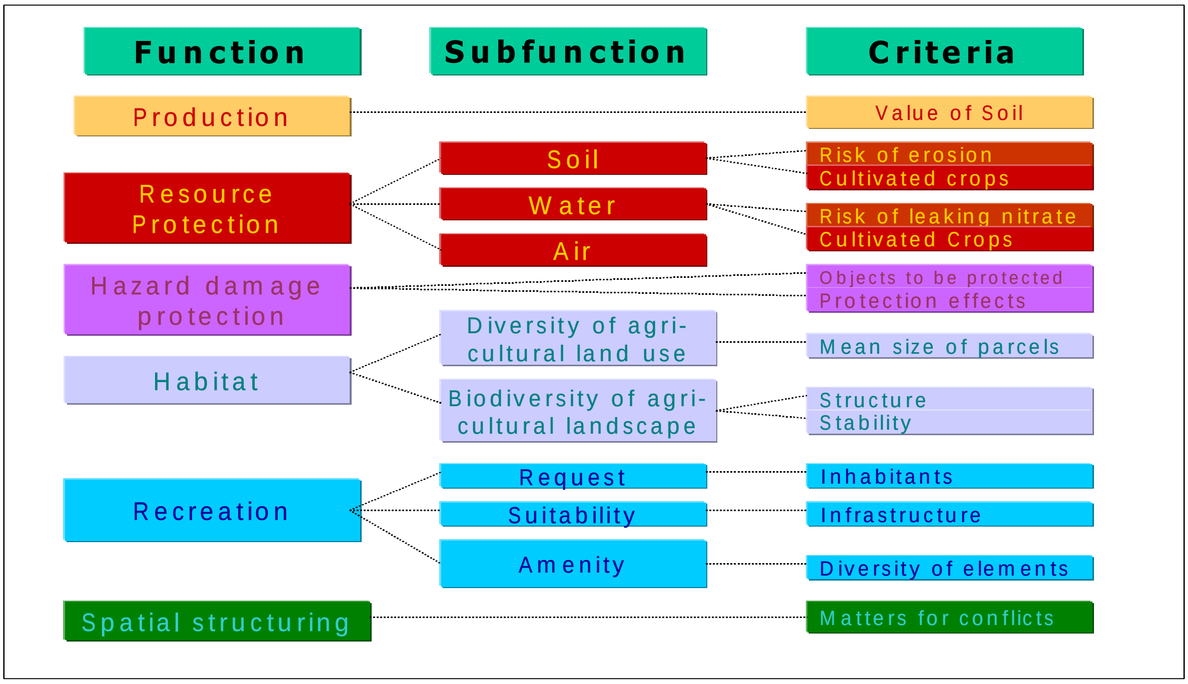

Figure 1: Scheme of evaluation of agricultural areas.

1.2 Special landscape indicators in the evaluation model

The evaluation of the habitat function has been divided into the criteria of diversity of the agricultural land use and the diversity of the agricultural landscape. As an indicator for the first one the average size of different fields in the land-units has been chosen and classified according to a scale from 0 to 5. It was recorded directly on site, but could also be derived from aerial or satellite pictures depending on the scale. On the other hand, also the biodiversity of the agricultural influenced landscape (outside the actual agricultural area) has been evaluated. It has a structural component (percentage of the area of natural landscape elements in the units) and a component of stability (age of the landscape as a weighing factor). The aggregation of these indicators indicates the influence of agricultural land use on the diversity of the cultural landscape; it is expressed in a scale from 0 to 5.

The landscape is an important component also in the framework of the function of recreation. The function of recreation has been evaluated due to the demand of areas for recreation (dependent on the number of inhabitants in the surroundings of the land units) and due to the suitability or attraction of the land units for recreation. The suitability depends on the infrastructure (paths, streets per unit), as well as on the number and the length of boundaries between landscape elements, which are directly connected to the agricultural land use.

1.3 Results

Figure 2 shows a compilation of the agricultural evaluation results for the 24 agro-functional land units in the reference area including 7 communities of Marchfeld. The height of the bar graphs indicates the values of the functions from 0 to 5. Of great importance is the common scale as a basis for the different functions to make the values more or less comparable. Even in this small region big differences in the importance and the intensity of the functions occur, although it is a quite homogeneous region with regards to land use and landscape compared to other Austrian regions:

- In the northwestern part (hilly area) the different functions are linked to a high degree. The functions of production, habitat, recreation and the function of space structure obtain relatively high values and therefore this part has only a low priority for measures.
- In contrast, in the eastern and flat part only the function of production reaches high values. In this case the agricultural and regional policy is asked to decide, if measures for increasing the other functions should be implemented.
- In the surroundings of settlements the functions of habitat, recreation and of space structure are dominating. In some cases the function of production is evaluated very low but the high values of the other functions are showing the need for such open areas among built-up areas and woodland. In order not to loose the different functions of the area, the development planning and the political decisions have to protect the open space, although if the agricultural use shows no high productivity.

The result of this uniform and integrated evaluation process of agriculture, forestry and water management is compiled in a common map in a comparable form. It is a contribution to keep up the different functions of landscape and to avoid conflicts between the different land use categories. A comparison of the functions between different moments, regions and nations could be elaborated. The evaluation system can also serve as a basis for the discussion of development processes, for the harmonization of sectored policies and for the simulation of the effects of different land use scenarios like reforestations. The social value of green structures including agricultural areas could be made visible and comparable, beyond the mere production of food and raw materials. More information about the international project "Natural Resources" on the web: http://www.naturalresources.de/.

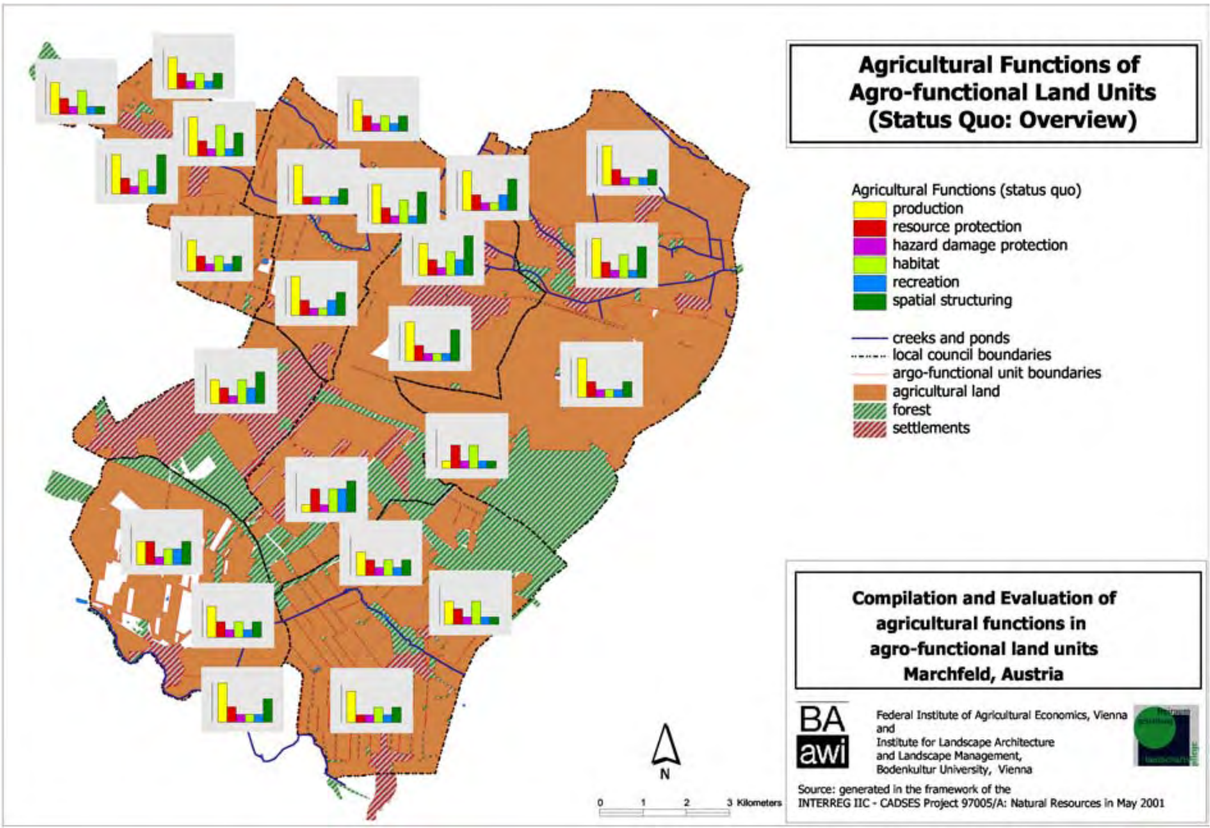

Figure. 2: Evaluation results of agro-functional units.

2. Landscape indicators in the midterm evaluation of the environmental program for agriculture

In accordance with different EU directives the process of the midterm evaluation of the rural development program in Austria has been started this year. Especially in the framework of the Environmental Program for Agriculture the EU wants to know the effects of the measures on the visible landscape (EU, 2000). The question VI.3 is concerned with the coherence of the agricultural areas and natural characteristics, the homogeneity and diversity of the agricultural areas and the cultural identity of the areas. A research project was suggested from the Ministry for Agriculture, Forestry, water management and environment to find manageable indicators for these specific criteria of the evaluation (Bartl, K, Bogner, D., 2002). The indicators will be tested in some reference areas. The work on this project ill be finished in the year 2003. Up to now the following indicators will be derived with GIS support in a comparison of the situation before starting the environmental program and now.

2.1 Coherence

As an indicator for the coherence of the agricultural area with the natural and biophysical characteristics of a zone the percentage of an area with an adjusted agricultural land use will be calculated.. Every type of agricultural land use will be assigned to different location parameters like sea level, climate, slope, soil, water levels. The share of adjusted and not adjusted land use areas can be calculated.

2.2 Differentiation

The differentiation of the agricultural land use can be expressed in the number of different agricultural land use types, which have very different features over the year in colour, height, structure, time of harvesting etc. These attributes are visible and concern the appearance of a landscape. For each of the land use types an area balance can be calculated and compared to different years. A second indicator for the differentiation can be the relation between the length of visible borderlines between different land use types (taken from Orthophotos) and the size of an area. A comparison of this indicator over different years gives hints to the development of the differentiation of the landscape.

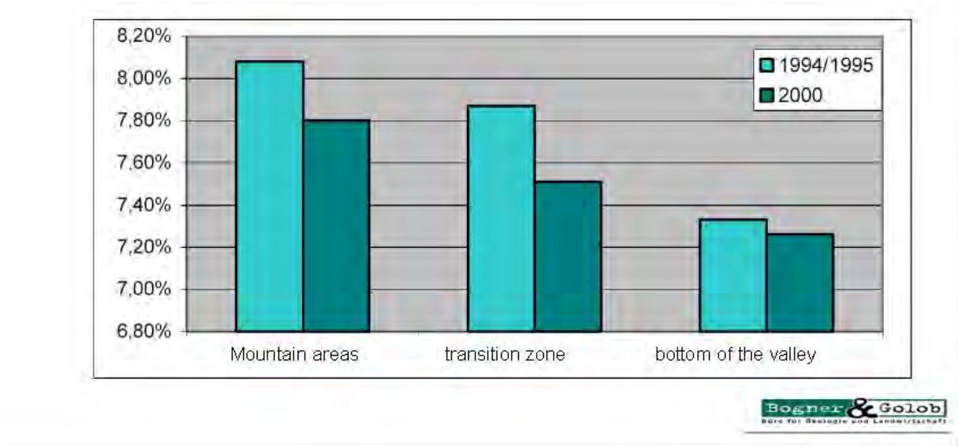

Figure. 3: Differentiation in an Austrian alpine reference area.

2.3 Cultural Identity

The evaluation of the cultural identity is the most difficult criteria to quantify. It could be measured by the share of typical kinds of land use or by a typical pattern of landscape elements. The problem is the definition of "typical" with respect to the historical time horizon. One approach is that this status of a landscape is seen as typical land use, which lies back 2 generations (Hoisl et al., 2000). But there is no common meaning about this. A second indicator is the share and the distribution of typical landscape elements that again have to be defined carefully. For this a specific regional model or "Leitbild" would be necessary.

3. Other EU-projects

Other ongoing research programs on the European level with Austrian participation concerned with landscape evaluation are the LUCAS project (Land Use and Cover Areas and Changes, see EUROSTAT (2002)) and the SPIN project (Spatial Indicators for European Nature Conservation, http://spin.space.noa.gr/about/welcome.html). They are not particularly linked to agriculture but the evaluation methods for the landscape have similar approaches and should be taken into consideration too. The LUCAS project (EUROSTAT) aims at a statistical EU-wide overview of the development of the land use, land cover and landscape elements in a specific grid system (18x18km) with a two-stage survey (2500 reference points in Austria). The SPIN project is focussed on the development and testing of a coherent spatial indicator system based on multisensor satellite data and GIS to accomplish monitoring and management tasks in the context of NATURA 2000. Indicators will assess fragmentation, spatial distribution and neighbourhood relations of key habitats. One of the 7 test areas is an alpine region in Austria.

4. Conclusions

In the light of the discussions at the OECD workshop in Oslo, October 2002, some conclusions in respect to agri-environmental landscape indicators can be drawn, besides common statistical requirements:

- Clear definitions are needed.
- Comparability in scale and time has to be taken into account.
- Indicators have to be transparent and repeatable, easy to calculate and understand. Complex models can show better results but the translation into public policy often is very difficult.
- The size of the observed landscape units is crucial and influences the results very much. Only units referring to the natural and cultural conditions can show exact results and prevent from blurred averages.
- Important is an integration of different functions of the landscape but the aggregation with a weighing of the indicators is not of real use, better seems to be to show the results of different indicators side by side (e.g. bar graph, net graph).
- An integration of the surrounding of the areas of interest is also of great importance because the areas directly are a carrier of functions but have also the function of scenery for functions on other areas – maybe some kilometres away.
- The interpretation of the results of a measurement of an indicator depends very much on regional or local concerns and priorities - it can differ completely. But for this reason clear objectives for the landscape have to be set. Inhabitants of the region have to be involved as well as scientific approaches; top down and bottom up processes have to meet to create a regional “Leitbild” for the landscape.
- The scale of the observation determines the degree of details not only in the kind indicators but also in the objectives, the functions and the structure. On a national level and for reasons of OECD comparisons indicators only can describe the situation regarding to the aims and show if there are problems or not (e.g. how many regions in a nation meet the targets for the landscape, while the targets for the landscape can differ …). It makes no sense to compare nationwide the kilometres of landscape borderlines or similar values, see above.

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Assessment of the Contribution of Land Use Pattern and Management of Farming Systems to Landscape Quality: a Landscape Indicator

Ph. GIRARDIN and J. WEINSTOERFFER
UMR INPL-INRA Agronomie et Environnement Nancy-Colmar
BP 507 68021 Colmar Cedex - France
Tel: 33 3 89 22 49 20 Fax: 33 3 89 22 49 33
girardin@colmar.inra.fr

Abstract

The objective of this research work is the evaluation of the impact of land use pattern and intensity on landscape by means of an indicator. The method used to calculate a "landscape indicator" (I_{LAND}) allows to take into account the objective as well as the subjective approach of landscape. I_{LAND} corresponds to the degree of agreement between landscape supply by farmers and landscape demand by the social groups. The supply and the demand are evaluated through four criteria : "Diversity", "Upkeep", "Openness" and "Heritage". The landscape supply is calculated from data of landscape objects (punctual, linear and spatial) for each criterion recorded at the field level. The values of the four criteria for the landscape demand are allocated by the user(s) of the indicator (decision makers, regional council, social groups...) into five classes (0 to 4). The value of the landscape indicator is the least favourable difference between supply and demand for the four criteria. An example of calculation of the "landscape indicator" for an arable farm is given. The collection of data needs two hours with the farmer and two hours for a survey of the farm land.

Keywords: Assessment, environment, indicator, farming systems, landscape

Introduction

More and more people nowadays believe that our landscapes are deteriorating. Our politicians, especially at the local and regional level, would like to take action but do not have the tools to respond to the people's wishes. Agriculture, by exploiting much of the rural space, plays a dominant role in the evolution of our landscape. Hence the development of a tool which could be used to estimate the influence of land use pattern and intensity on the landscape could prove to be a valuable aid within the context of any land management project.

Evaluation of landscape

Landscape evaluation has been a recurring theme in research since the beginning of the 19th century. As Beroutchachvili and Rougerie (1991) and Le Floch (1996) showed, landscape was at first regarded primarily as a descriptive science. After these naturalistic approaches, some others encompassing the whole geosystem including, as well as the vegetation, relief, soil, geology and climate, reappear in the context of exploring and managing new lands in countries such as Australia (the so-called CSIRO[1] method), Russia (Dokoutchaev's "Landschaftovedenie") and Canada, with the agro-ecological approach

[1] Commonwealth Scientific and Industrial Research Organisation

of Dansereau (1973) and Philips (1985) cited by Beroutchachvili and Rougerie (1991). However, these methods adopt a simplistic approach about the very notion of landscape, leaving out man and all the emotional relationships which relate him to his surroundings. The landscape is, in fact, fundamentally binary, consisting of an "objective pole" and a "subjective pole".

The landscape - from an objective point of view- is its material substance, made up of forms and actual objects present within a particular physical area. The landscape - from a subjective point of view - has to do with the way these concrete forms are seen, looked at, appreciated, interpreted. The appearance of the various objects in space and the way they are arranged is neutral. It only becomes "landscape" when the observer decides what he could make of it. This subject/object duality is to be found in the most recent studies. But very often, an unequal weighting is attributed to the both components entering into the landscape evaluation.

Thus, some approaches taking into account the objective component of the landscape suggest that criteria depending only on concrete shapes of landscape should be used to evaluate it. It is the case for disciplines which attempt to measure the scenic value of landscapes, based on the analysis of photographs taken obliquely ("scenic beauty" - Shafer and Mietz, 1970), of view cones ("Besançon school" - Brossard and Wieber, 1984), or of particular sites ("Sitology" - Fischesser, 1985). Other approaches at the subjective end of the spectrum emphasise the social description without really considering the role played by the spatial data in the perception of a landscape. It is the case, in example, of the methods adopted by sociologists, pragmatically use the questionnaire technique (Kalaora, 1993). The approaches which take into account the objective-subjective duality in landscape evaluation correspond fully to the accepted definition of landscape. The assessment measurements used always strive to link a given object to a precise type of representation. Geographers also use this method, using complex analytical codes to demonstrate the main landscape units present within a given geographical entity ("Quebec school" - Bailly, 1986 and "French school" - Avocat, 1984). The ethno-sociological approaches (Cloarec and De La Soudière, 1992; Brun-Chaize,1976) are based on carrying out interviews - either structured or unstructured - of samples of the population living in a particular area. They often use photography as an aid to reconstruct the mental images which individuals have of their surroundings. Economists (Facchini, 1994), using the "hedonistic value" method, compare land values and salaries in different areas, working on the principle that these figures include a contribution representing environmental benefit which is largely dependent on the environment.

Assessment of agricultural landscape

Despite the sound foundation for many methods for assessing landscape, it seems that it brings into play much more information than can be assimilated. The agricultural landscape, on the other hand, is formed only from elements arising directly from land use pattern and intensity, which is bound to facilitate its evaluation. The introduction of a reliable tool for assessing agricultural landscape could thus open up new perspectives for land management, considering that most of the rural area is given over to agricultural use.

Like landscape, agricultural landscape has been the subject of description and complete studies as to its underlying generative processes ("MAP" project - Landais et al., 1996). There is also interest in the intrinsic value of features created by agriculture ("the agro-ecological approach" Baudry, 1986) or the mere perception of the agricultural landscape which the rural population may have (Cadiou, 1991). Apart from a method specifically devoted to bocage landscapes (Colson and Senger, 1995) no approach which takes into account the objective-subjective duality in the evolution of agricultural landscape has yet been investigated. The idea grew, however, since the early nineties when there was talk of asking the agriculture to become a "landscape service provider" (Permanent Assembly of the Chambers of Agriculture, 1991). And in this context, numerous authors in their respective disciplines, such as Luginbühl (1996) (geography), Fischesser (1990) (landscape architecture) and Deffontaines (1996) (agronomy), implicitly assumed that to evaluate the agricultural landscape with consistency it is necessary to address three basic questions: 1. What shapes are available? 2. What shapes are desired? 3. How does one reconcile these two?

Presentation of agro-ecological indicators
Some agronomists have been trying, since 1994, to estimate the sustainability of farms using indicators which reflect the impact of agricultural practices on the environment. These agro-environmental indicators (Girardin and Bockstaller, 1997; Girardin et al. , 2000)) represent a compromise between scientific results and the need for concise information. Hence, although they are presented in index form, they must be sufficiently representative of reality in that they satisfy various tests of sensitivity, probability, and usage value. Several agro-environmental indicators have already been developed, notably for the influence of inputs (nitrogen, phosphorus, pesticides, organic matter or water), crop rotation and crop cover, on the environment. In view of the large number of questions about the effect of land use pattern and intensity on the landscape, it is proposed to adapt the three basic ideas suggested by the literature concerning evaluation of agricultural landscape to the philosophy of agro-environmental indicators in order to create a Landscape Indicator.

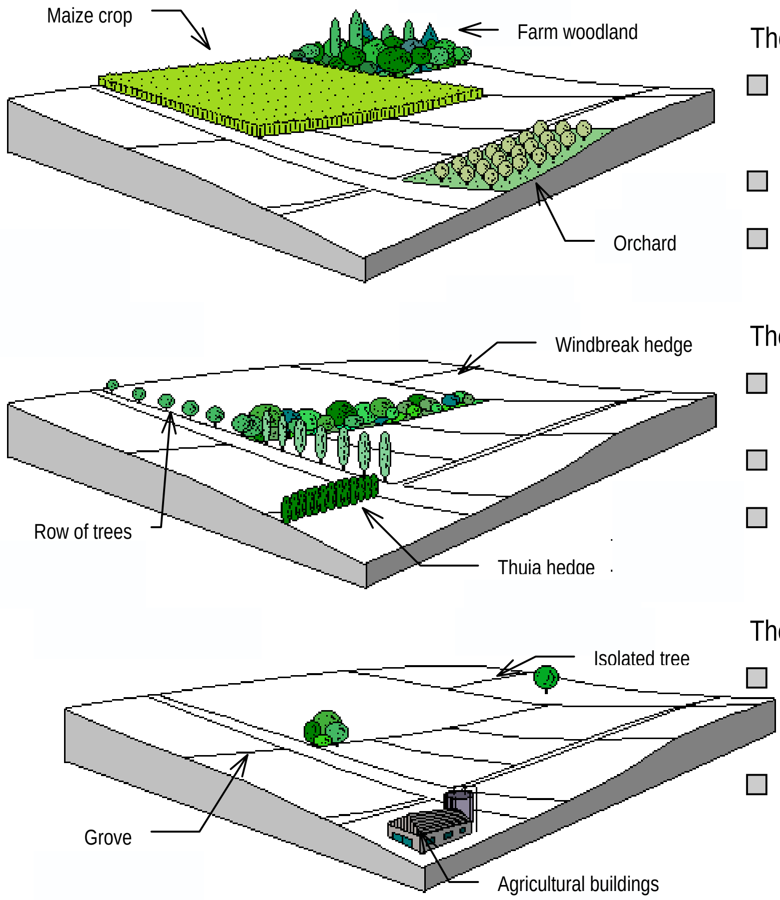
The development of such a tool for evaluating the landscape requires the adoption of several hypotheses which we will attempt to justify in the next section. This will be followed by a concrete example of a calculation for a particular farm. The last section will be devoted to discussion of the results and the limitations and possibilities of the method adopted.

Description of the indicator

Procedure for developing an indicator
The development of an indicator reflecting the influence of the practices of each farmer on the landscape might seem very restrictive. But it responds to a genuine desire on the part of its would-be users - local or public authorities which care about the evolution of the landscape such as regions, counties, rural communities, national or regional parks - which need quick and simple ways to respond to landscape problems which might be presented to them. If it is to be really useful, the indicator must however faithfully reflect reality whilst being easily accessible to its potential users. Its elaboration therefore imposes the use of evaluation criteria which are able to respond to these two requirements. One example of calculation will be presented.

Scale: landuse pattern and intensity responsible for shapes present within a field
The management of rural land by the farmer depends on his agricultural practices. The notion of an agricultural practice denotes "the way of applying a technique, which is peculiar to each farmer" (Deffontaines, 1991). This "way of doing something" is not neutral and is governed by various factors, both natural (soil, slope, water, exposure, climate) and human (regulations, market forces, family and ownership history of the farm, labour availability, or simply the farmer's objectives). The area scale for which the farmer's practices are meaningful is the field. The field is a "complex spatial structure" always made up of a single crop and associated with a logical sequence of agricultural techniques (Deffontaines, 1991). It is possible to distinguish within it three main types of shape (figure 1). The spatial shapes, mainly constituted by the crops, the permanent grass and the wood land, represents the basic structure of the landscape. The linear shapes, situated around the edges of the crops, play an important role in structuring the agricultural landscape and serve to emphasise the relief. Finally, the isolated shapes such as single trees, copses, agricultural equipment and buildings, all add variety to the landscape.

Figure 1: The three main types of shape within a field



The **spatial forms** can be described according to ...

- their farm yard, crops, meadow, grazed pasture, spontaneous or cultivated set aside, follow land, intensive orchard, wooded orchard or farm woodland,
- their volume : surface, shape and height,
- their upkeep : weeding, tillage, cutting, grazing or prunning.

The **linear forms** can be described according to ...

- their hedge, row of trees, grassland margins, wall, enclosing wall, muret, terrasse, trench, bank,
- their volume : length, width and height,
- Their upkeep : prunning of hedgerow or upkeep of fence.

The **puctual forms** can be described according to ...

- their Isolated tree, grove, storage buildings, livestock buildings, slurry tank, irrigation system, ponds, pools, fountains, stone heap ...
- their upkeep : prunning or maintenance.

Supply and demand in relation to landscape

As many authors have suggested in the context of a rigorous evaluation of agricultural landscape, it is necessary to link all the shapes produced by agriculture to two basic ideas, those of supply and demand in landscape. By retaining the objective-subjective duality - a principle which constitutes its very essence - these represent a new concept of landscape, more pragmatic and more in tune with the problems currently arising in agriculture and calling for quick and simple responses.

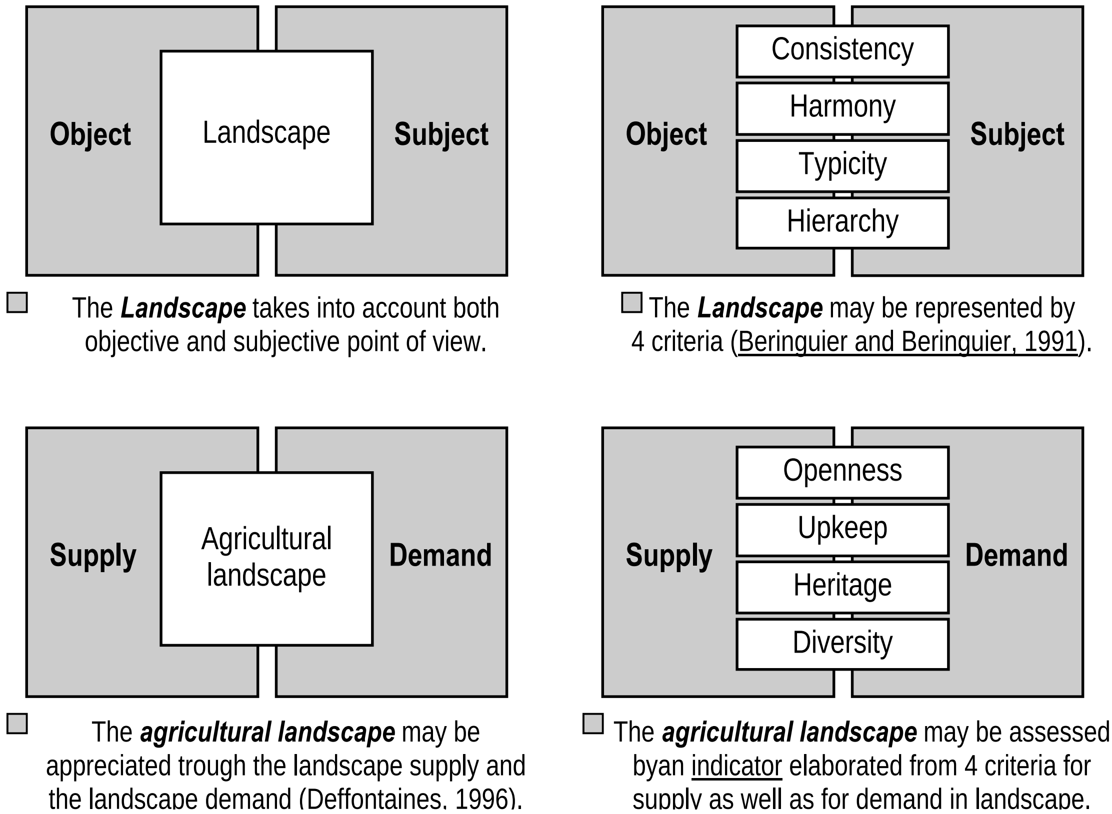
By his actions, the farmer can only introduce new elements into a pre-existing and much vaster reality. The objective aspects of the landscape can thus be linked to a landscape "supply" which is the contribution of shapes introduced into the landscape by the farmer. As for the demand, it roughly corresponds to the subjective aspects of the landscape, in that it only considers the landscape by singling out its usage value. Cadiou (1991) showed in fact that there exists "a clear correlation between the useful landscape elements and those considered to be aesthetically valuable". The demand thus corresponds to the requests of social groups most affected by the evolution of the agricultural landscape, such as associations for nature conservation or leisure activities, tourist offices or residents' associations.

Evaluation criteria for reconciling supply and demand in landscape

Reconciliation of the objective and subjective aspects of landscape constitutes an essential stage in its assessment. The simplest way to do that, is to limit the notion of landscape to its main components which can be thought of objectively as well as subjectively. In this context, Beringuier and Beringuier

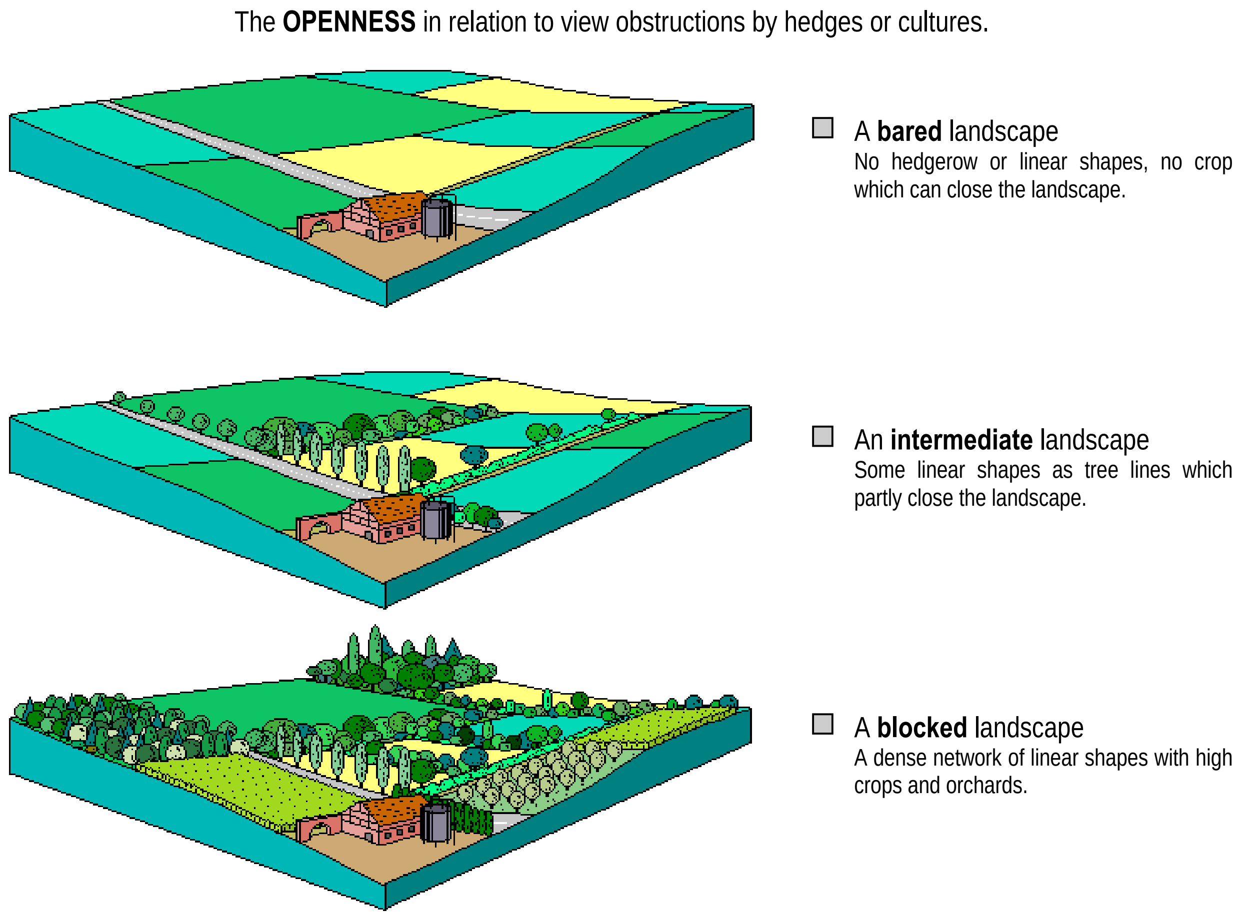
(1991) distinguished four "landscape criteria" which allow landscape evaluation to be undertaken as objectively as possible: consistency, harmony, character and hierarchy. This modelling of landscape is in full agreement with the philosophy of indicators, as it leads to a simplification of the very notion of landscape and thereby simplifies the calculations. It is nevertheless necessary to adapt it to the definition which has been adopted within the context of our study: the evaluation measurements should not connect landscape as an object and landscape as a subject but supply and demand in the matter of landscape. Four main evaluation criteria can be proposed: openness, upkeep, heritage and diversity. These evaluation criteria are close enough to the agricultural landscape to be representative of the main forms introduced by agricultural activity whilst being the subject of most of the demands expressed by society (figure 2).

Figure 2: Synthesis of the justification for the method of evaluation adopted



Thus "openness", in the context of the landscape indicator, is defined in terms of the ease with which a given observer situated within a farm can obtain an extensive view over the surrounding country (figure 3). It is considered that the landscape shapes of major importance in the supply of openness in rural spaces are, first and foremost, the spatial objects such as crops, or linear ones, such as hedges. It can be assumed that the potential angle of vision presented to an observer situated within a farm will be the greater when this vegetation is scarce. The requests of social groups regarding the openness or otherwise of the landscape are clear, and are manifested in a different way depending on whether the landscape in a mountain or in an open field area is considered.

Figure 3: The " openness" criterion



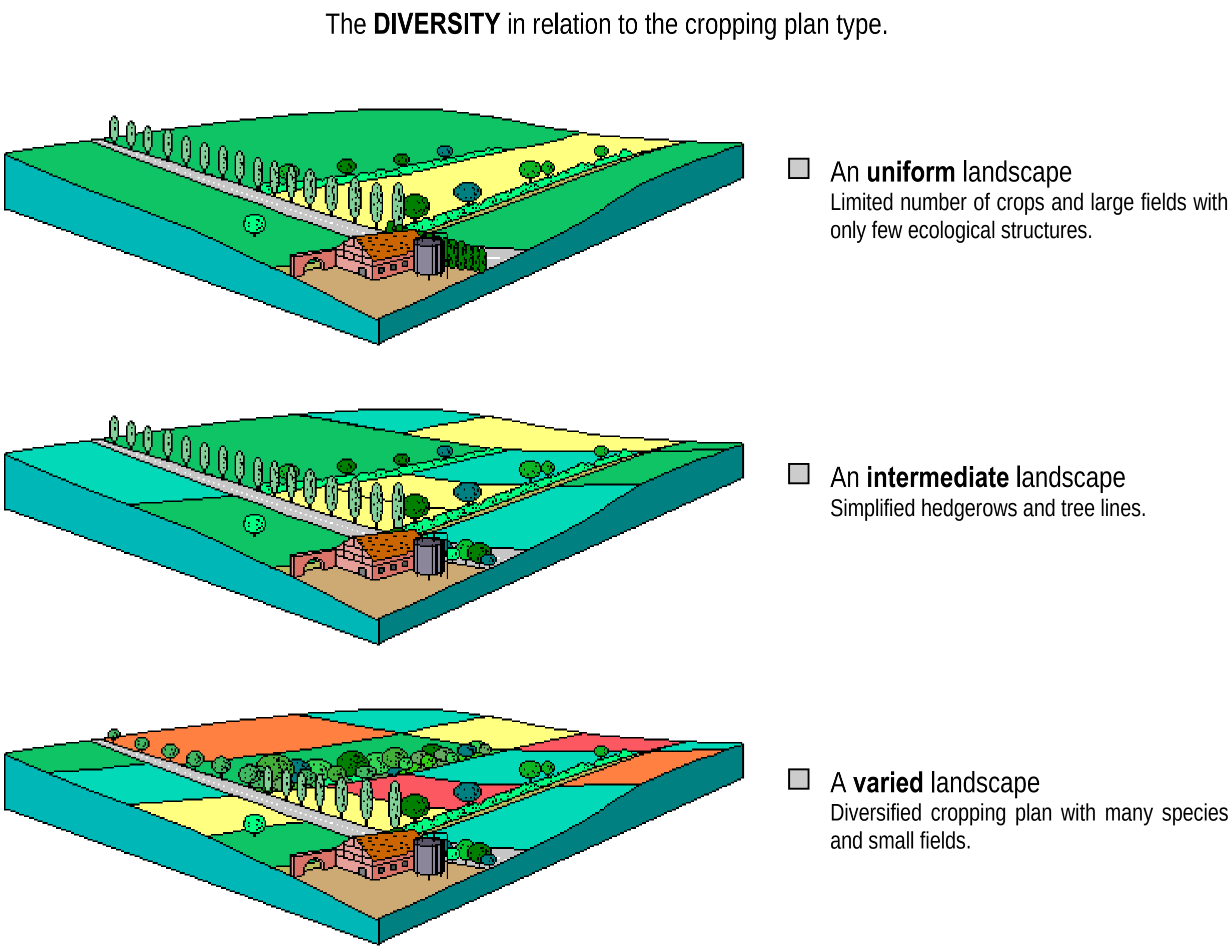
The worries in mountainous areas are well known and are mainly concerned with the risk of the landscape closing up, due to the expansion of fallow lands or forests following on from the phenomenon of dereliction of agricultural land. In the plain, the question of openness appears in a different way: it is often a case, in the context of agricultural products of high added value, of making profitable use of every inch of space. Crops are therefore favoured at the expense of any other non-productive activity.

“Upkeep” of the agricultural landscape can be defined by the practices which work best in submitting nature to the yoke of agricultural activities in order to obtain land forms which are as uniform and well organised as possible. Upkeep imposes a crop management system which is fixed for a year, valid in the context of the management of the field and for its surroundings. The supply of upkeep therefore depends on the frequency of the farmer's operations on the fields and the farm buildings. As for the demand for upkeep, it is possible, according to Luginbühl et al. (1991), to discern two main trends in the sensitive relationship between man and landscape. One trend, mostly shared by the rural community and linked to current modernity and its relationship with aesthetics and life, is a "tamed" nature. The other is the deserted landscape which is often compared with the return to the wild state, a symbol of purity and freedom where nature is not corrupted by man.

Patrimony may be defined as a heritage yet to be revealed. We assume in fact that it is possible to give patrimony to a landscape by providing evidence of numerous "traces" of ancient practices which remain in the landscape. Assessing the amount of heritage on a farm comes down simply to estimating how far practices adopted by one generation are transmitted to the following generation. Since the "most patrimonial" practices are those which are most closely connected with past habits and customs, we assume implicitly that all the shapes in a field can be part of the "heritage supply" in the agricultural landscape. As for the demand for heritage, authenticity is fashionable: today there is a genuine desire, which is catered for by the development of a new kind of tourism: cultural tourism. Faced with the deep changes which have overcome agricultural activity in the last 50 years, man today no longer recognises himself in the landscape and feels the need to explore his identity. This request for heritage, whether it be historic, social, economic or technical, comes mainly from those who are seeking their roots, i.e. mainly citizens with rural origins.

Finally the 4th criterion, "diversity", simply describes differences in nature, quality or aspect (figure 4). It is considered that the supply of diversity comes mainly from cropping pattern, i.e. the way the crops are distributed over the farm (size of fields and number of different crops). The demand of diversity corresponds to a diversity of views which appeals above all to the "hedonistic" aspect of landscape (Sautter, 1990). There exists for everybody a natural attraction for diversity which is a source of pleasure, satisfaction or happiness. The monotony of present-day agricultural landscapes is often denounced, notably because of the preponderance of certain crops.

Figure 4: The " diversity" criterion

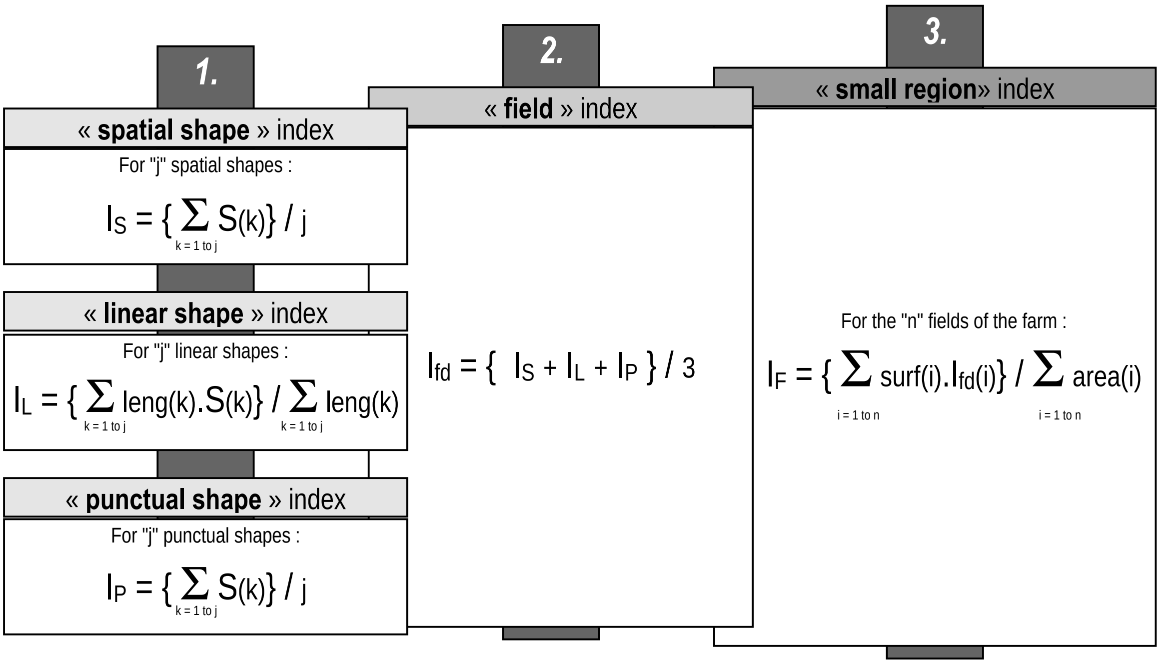


Testing landscape criteria

Four evaluation landscape criteria have been defined which can be used both in terms of supply and demand. In order to establish a landscape indicator which will describe the degree of agreement between supply and demand, it is necessary to calculate the supply and the demand alternately for each of these four criteria. For each of these two estimates, there need to be similar measurement scales. The choice of a methodology based on the development of indicators requiring quick and easy calculation means a limited number of levels must be used: only five levels in each criterion has been kept.

The estimate of the landscape supply is quantitative. It is expressed (figure 5), for each of the three basic shapes (punctual, linear, spatial), by a score from 0 to 4 which is not a scale of values but characterises the state of the basic shapes and constitutes the "shape indices" (I_P, I_L and I_S). A score of 0 is given to the shape contributing the least to the criterion. That of 4 is used for one which contributes the most. The values of I_P, I_L and I_S are given by expert judgements.

Figure 5: The three aggregation levels of "basic shape" indicators



The calculation is done from the agricultural data for the four criteria (diversity, upkeep, openness and heritage). For the "landscape diversity" criterion, which only takes into account the nature and relative size of the fields within the farm, the supply of diversity of a farm is integrated into the calculation of the "cropping plan index" , already in use (Bockstaller and Girardin, 1996). For the three other landscape evaluation criteria, the values of the three basic shapes present within a field (spatial, linear or punctual) are calculated from the data available on the farm. In the particular case of the "landscape upkeep" criterion, it is considered that the scores for maintenance of basic landscape shapes depend primarily on the frequency with which the farmer operates on them (table 1). For the "landscape openness" criterion, it is assumed that only the basic linear shapes and the crops (spatial shapes) are important in obstructing views (table 2). As for the "landscape heritage" criterion, it is found out to what extent each basic shape present has been maintained, or, conversely, is the result of new practices (table 3).

In order to get a "farm index" (I_F) representing the contribution of the whole farm in respect of each of the assessment criteria, it is necessary to go through three distinct stages of aggregation (figure 5). In the first phase, the "basic shape" indices are combined according to which of three groups of basic shapes present in a field they belong, i.e. groups with "spatial", "linear" or "point" shapes. For this first stage, the aggregation is done by simple averaging of the indices allocated to each shape. A weighted mean is used in the particular case of linear shapes because their length is an essential parameter in their particular contribution to the landscape supply.

Table 1: Allocation of indices to basic shapes contributing to landscape upkeep

Contribution of the *spatial shapes* to the *upkeep supply*

Crops	Tillage and weeding				
	No intervention	Mechanical weeding		Chemical weeding	
		no tillage	tillage	no tillage	tillage
Winter cereals, rape seed	0	1	2	3	4
Spring cereals, peas		0	1	2	4
Other spring crops		0	0,5	1,5	3,5
Green manure		2	3	2	3

Set aside	Spontaneous set aside		Cultivated set aside
	after sunflower, maize, soybean, sugar beet or potatoes	after cereals, rape seed or peas	
	0	1	2

Follow land	0

Permanent crops				
	meadow	Cutting frequency / year		
		≥ x 3	x 2	x 1
		4	2	0
	cut grazed pasture	Cutting or grazing frequency / year		
		≥ x 3	x 2	x 1
		4	2	0
	grazed pasture	Intensive pasture		extensive pasture
		with refusals cutting	without refusals cutting	
		4	2	0

Arboriculture - Forestry	Woody plant pruning		
	Regular upkeep	Occasional upkeep	without upkeep
	4	2	0

Farm Yard	Aspect		
	upkept	occasional	untidy
	4	2	0

Contribution of the *linear shapes* to the *upkeep supply*

Upkeep of each linear shape	regular	occasional	without upkeep
	4	2	0

Contribution of the *punctual shapes* to the *upkeep supply*

Upkeep of each punctual shape	regular	occasional	without upkeep
	4	2	0

Table 2: Allocation of indices to basic shapes contributing to landscape openness

Contribution of the ***spatial shapes*** to the ***openness supply***			
Forest	***0***	Wooded orchard	***3***
Intensive orchard, hops	***1***		
« Closed » crops (1)	***2***	« Open » crops (2)	***4***

Contribution of the ***linear shapes*** to the ***openness supply***			
Linear wooded margin	***0***	New hedge, ,line of tree (3)	***3***
Windbreak hedge	***1***		
Hedge fence	***2***	Grassland field margin	***4***

(1) *"Closed" crops* = maize, sorghum, sunflower which close the landscape because of the height of the plants.
(2) *"Open" crops* which have no influence on the openness of landscape.
(3) Less than 2 years.

Table 3: Allocation of indices to basic forms contributing to landscape heritage

Contribution of the ***spatial shapes*** to the ***heritage supply***				
The crops	Species	Usual	New	
		4	***0***	
	Area	Stable	transformed	changed
		4	***2***	***0***
	Shape	Stable	transformed	new
		4	***2***	***0***
The farm	Site	Identical	new	
		4	***2***	
	Arrangement	Identical	transformed	new
		4	***2***	***0***
	Farm yard	Identical	transformed	new
		4	***2***	***0***

Contribution of the ***linear shapes*** to the ***heritage supply***		
Linear shapes	Stable	transformed
	4	***0***

Contribution of the ***punctual shapes*** to the ***heritage supply***						
Punctual shapes	buildings	Maintained customs	Died out customs	Rebuilt according to the traditional style	Deeply reshaped	Newly built or destroyed
		4	***3***	***2***	***1***	***0***
	vegetation	Identical		new		
		4		***0***		

Thus "shape indices" are obtained: I_S (spatial shape), I_L (linear shape) and I_P (point shape) representing the contribution of each shape group present within a field to the landscape criterion considered. The second stage is to combine the three "shape indices" at the field scale to obtain a "field index" ,I_{fd}, assuming that, at this level, each shape group has an equal influence in the contribution to the landscape supply. Finally, the "farm index", I_F, is obtained by combining all the field indices. This is done in proportion to the total area of the farm, assuming intuitively that the supply contribution to the landscape of each field is proportional to its area.

The assessment of the landscape demand is qualitative: it is done using "qualifiers" with the help of social groups judged as being representative and known to be actively interested in the landscapes . For each measurement of landscape evaluation, they will be allowed to choose between several qualitative measures the one which, in their opinion, best describes the kind of landscape which they would wish see in the area or region in which a given farm exists. The assessment of the demand is summed up in a brief questionnaire on which are listed all the terms currently used to describe agricultural landscapes. It is assumed that the choice of the median score in the qualitative assessment of a landscape criterion represents an indifference on the part of the observer.

Comparison of the quantifiers, for the supply, with the qualifiers for the demand, is done, for each criterion, by recording the absolute value of the difference between the value of the supply and that of the demand (table 4).

Table 4: Comparison between supply and demand for a pilot farm

	Evaluation **criteria**							
	Openness		***Heritage***		***Upkeep***		***Diversity***	
Supply *Quantitative* landscape evaluation	*Calculated according to* ▪ ponctual ▪ linear ▪ spatial shapes	I_F	*Calculated according to* ▪ ponctual ▪ linear ▪ spatial shapes	I_F	*Calculated according to* ▪ ponctual ▪ linear ▪ spatial shapes	I_F	*Calculated according to* ▪ fields delimitation ▪ fields utilisation	I_{cp}
Demand	Bared	4	Preserved	4	Meticulous	4	Varied	4
	Stripped	3	Protected	3	Well kept	3	Heterogeneo	3
Qualitative landscape evaluation	=	2	=	2	=	2	=	2
	Obstructed	1	Modified	1	Badly kept	1	Homogeneou	1
	Blocked	0	Transformed	0	Disused	0	Uniform	0
Difference	Supply-Demand		Supply-Demand		Supply-Demand		Supply-Demand	

The landscape quality is assumed to be function of the range between landscape supply and landscape demand, and, of the four criteria (openness, heritage, upkeep and diversity). But, it was assumed that one of these criteria cannot compensate for another in the final result. It is the reason why it was decided to use the least favourable difference between supply and demand (D_{MAX}) to represent the Landscape Indicator. The maximum difference obtained can be scaled to a maximum of 10 by using a mathematical conversion to obtain the Landscape Indicator (I_{LAND}):

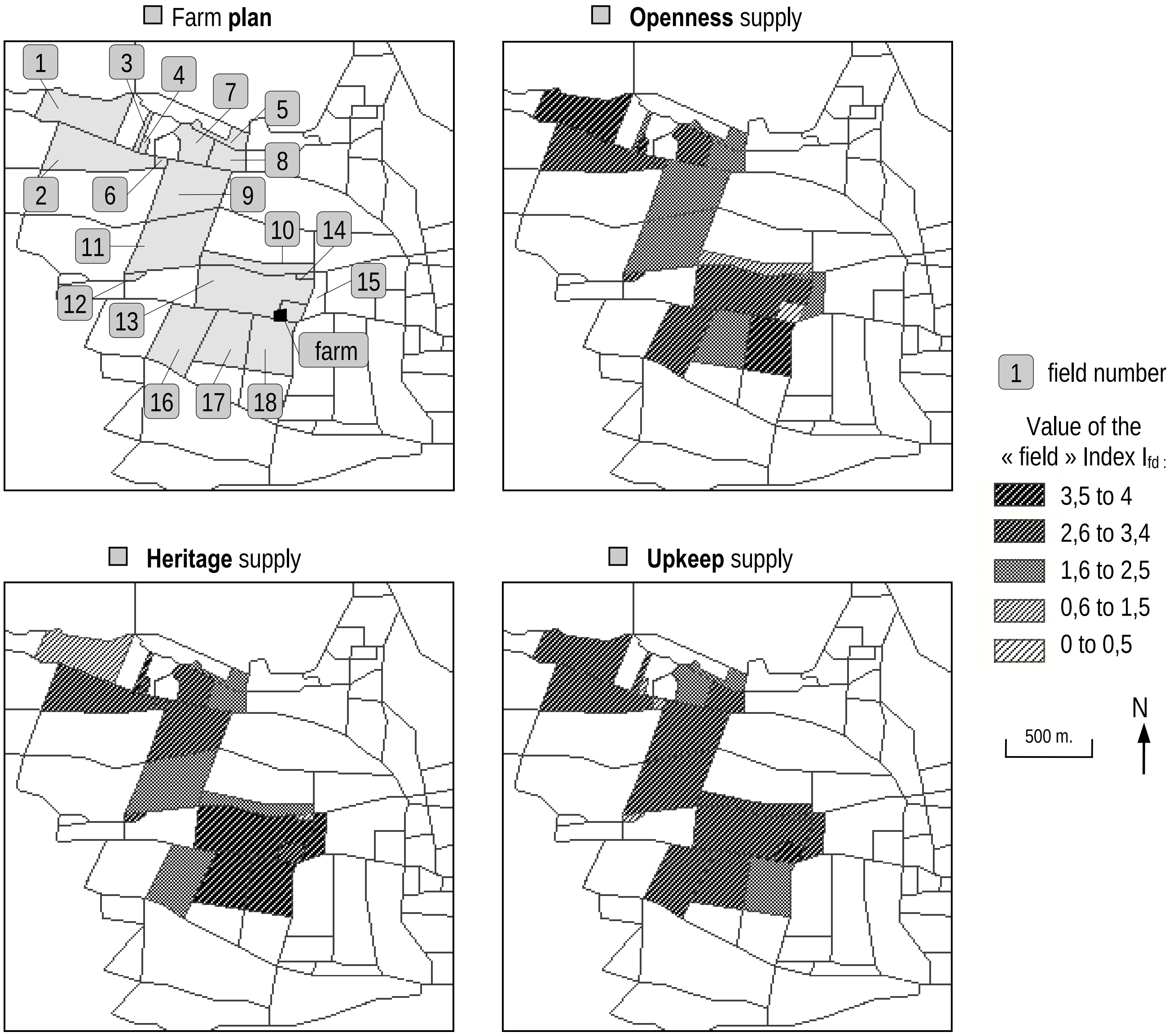
$$I_{LAND} = 10 - (D_{MAX} .2.5)$$

The values of the ranges between landscape supply and landscape demand were used to calculate an indicator, but, they could be used in multicriteria analysis to sort, rank or classify different landscapes according to the degree of fitting between supply and demand (Roy and Bouyssou, 1993). This method avoids the compensation between criteria.

Example of a calculation

The principles of assessing an agricultural landscape described above were applied to an arable farm. A 99 ha farm situated in southern Alsace (France) was chosen, with 18 contiguous fields.

Figure 6: Representation of the landscape supply for a agricultural land



Estimation of landscape supply and demand was done in two main phases. The first involved collection of data. It consisted in making a precise inventory of all the basic shapes present within the farm. It was done in company with the farmer who was the only person able of providing us with the data needed to estimate the landscape supply. The next phase was to use the data to combine the values obtained on the farm in a simple way to arrive quickly at a calculation of the "field indices", and then of the "farm index" I_F for each of the four landscape criteria considered. The indices obtained were mapped (figure 6).

Estimation of the demand has been simulated from the Departmental Landscape Plan (Tacquart and Sgard, 1993) which has set out the overall landscape strategy for the *department*. For the region of southern Alsace (France), the openness does not match any particular demand. Heritage and upkeep should be taken into account in regard to the touristic tradition of the region and its culture, traditionally German, for its distinctive, well-kept appearance. Finally diversity should be encouraged so as to cherish the great variety of miniature landscapes already present.

Comparison of these two estimates shows, in this case, a good correlation between landscape supply and demand (table 5). For the landscape indicator, calculated at the farm level, a value of 7/10 is obtained. This indicates that most landuse pattern and intensity satisfy the demands of the community, apart from those relating to crop diversification. Bearing in mind the reasons for having developed this Landscape Indicator, one might therefore expect that the departmental Council would be prepared to give, for example, financial support to the investigated farm if, in this case, the farmer agreed to diversify his crops.

Table 5: Assessment of landscape criteria

	Evaluation **criteria** ***Openness***		***Heritage***		***Upkeep***		***Diversity***	
Supply *Quantitative* landscape evaluation	■ predominance of lower crops ■ hedgerows not much developed.	2.6	■ The main structures of the field pattern are preserved, ■ only a crop diversification has been led.	3	■ Frequent interventions on the crops, ■ well kept farm buildings.	2.9	■ Predominance of cereals and maize fields, ■ other cultures on small surface areas.	1.8
Demand	Bared	4	Preserved	4	Meticulous	4	Varied	4
	Stripped	3	Protected	3	Well kept	3	Heterogeneou.	3
Qualitative landscape evaluation	=	2	=	2	=	2	=	2
	Obstructed	1	Modified	1	Badly kept	1	Homogeneous	1
	Blocked	0	Transformed	0	Disused	0	Uniform	0
Difference		0.6	min.	0		0.1	max..	1.2

$$I_{LAND} = \text{Max}\{(\text{"Supply"} - \text{"Demand"})_i\} = 1{,}2$$

Discussion

A four step process was followed to elaborate the landscape indicator. The first step was to define the people or the social groups involved. The farmers gave the data used for the calculation of the landscape supply, other social groups defined the landscape demand. The second step was the assumptions used to build the indicator. In this case, the indicator was defined as the range between supply and demand of landscape, taking into account the objective and the subjective approaches. The third step corresponds to the way of calculation of the indicator, through four aggregation levels: basic information into three shape indices, shape indices into field indices, field indices into four farm indices, and, farm indices into the final landscape indicator. At the first three levels we use the additive process because the compensation between criteria can be acceptable. For the last level of aggregation, the minimum value of the farm indices for the four criteria (openness, diversity, heritage and upkeep) gave the value of the final indicator, because there is no compensation effect at this level. The fourth step was the implementation of landscape indicator calculation from the field data, to evaluate the availability of the information, and the easiness of calculation. The validation was not discussed here. The landscape indicator is a decision aid tool and it must be validated by means of an usefulness test which can only be implemented after the users of the indicator have tested it, and, have evaluated its efficiency as a decision aid tool.

Conclusions

This landscape indicator was elaborated as a decision aid tool for policy makers to evaluate the impact of land use pattern and intensity on the rural landscape. To be efficient, this tool must be easy to use, readable and understandable, and, reflecting the field reality. These constraints oblige to use only the easily available data to simplify the information, but, this indicator must be scientifically based yet. The first originality of the landscape indicator is the way to calculate by comparison between landscape supply by farmers and landscape demand by some local or public authorities, instead of an absolute value compared to a reference threshold. By this way, the objective and subjective points of view about the landscape are taken into account. The second originality of this study is to evaluate both supply and demand with the same four criteria (openness, upkeep, heritage and diversity) which cover the main aspects of the landscape evaluation. This global indicator could be improved by taking into account two social criteria: accessibility and tranquillity. We recommend those four criteria to OECD policy makers, they are easy to collect. The calculation can be done at the farm level, with data collected at the field level. But this landscape indicator could equally well be used for an assessment at the level of a catchment area or a small region.

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Indicators of Landscape Functions Related to Modifications and Patterns of Agricultural Landscapes

U. Stachow, J. Hufnagel, M. Glemnitz, G. Berger, J. Bachinger, P. Zander and C. Sattler
Centre for Agricultural Landscape and Land Use Research (ZALF) e.V.
Eberswalder Str. 84, D-15374 Müncheberg, Germany (www.zalf.de)
Corresponding author: Ulrich Stachow (ustachow@zalf.de)

Abstract

This paper discusses some relations between agricultural land use and landscape functions. The focus is on functions which are scale dependent, for example the habitat function of arable fields, which is related to biodiversity. Statements about the occurrence of species depend on the spatial scale in focus. Typical scales of observation in agricultural environments are individual fields, farms or landscapes, for which different objects are appropriate. We propose a unifying approach to link the scales and develop a model for agricultural environments which includes individual cropping systems, farms, and landscapes.

On the basis of individual agricultural measurements, the impact of production systems on ecological functions are assessed. The assessments can be integrated for individual crops, farms and landscapes. On all levels comparisons can be made, which, for example, allows to identify favourable crops, farming types or landscapes for specific ecological functions.

In order to be able to analyse the relation between agricultural production and environmental functions it seems essential to develop a method to describe agricultural land use in detail for large areas, to evaluate agricultural measurements in relation to the impact on the landscape function and to assess land use options.

Introduction

Agricultural ecosystems, like arable fields and grasslands, are important for the ecology of landscapes not only due to their large extent in many European areas. These ecosystems are of crucial importance for basic functions of rural landscapes such as vegetation dynamics, soil protection, nutrient balance, and providing habitat for wildlife. Land use changes are typical for agricultural landscapes, which means continuously changing conditions for ecological functions, and hence, the need to develop concepts of sustainability and indicators for dynamic systems. Obviously, many land use changes originate from changing economical conditions, new technologies and other driving forces.

In the last decades, the degree and frequency of changes in agricultural land use has been increasing in Europe. At the same time, the level at which political instruments induce or effect the land use changes has also been shifting to larger scales (Poppe, 1999). Because of possible significant ecological impact of land use changes, detailed models which relate land use and landscape functions are needed. However, in order to evaluate the importance of the land use for individual landscape functions, not only the impact of land use practices on landscape functions is important to identify, but of other driving forces as well. For example, biodiversity of any agricultural landscape depends on the specific land use, and land use changes will effect biodiversity. However, the history and development of land use, landscape structure (e.g. the abundance and distribution of semi natural areas) and other factors can be also very important for the biodiversity of rural areas. In order to assess the importance of the current agricultural practice for biodiversity, understanding of the relative importance of agriculture seems to be essential. Obviously, this varies between landscapes or regions.

More over, ex ante assessments of ecological effects of possible land use changes are urgently needed. Especially the globalisation of the agricultural markets is a new challenge for assessing and maintaining the sustainability of agrarian landscapes. The same applies to the CAP reform. Consequently, research and application of knowledge focusing on the effects of new environmental policies and expenditures is highly recommended for supporting political decisions (UNEP, 2000).

In order to sustain or enhance ecological functions of rural landscapes, appropriate indicator systems are to be developed. Here, we explore some properties of ecological functions of agricultural land use, relate those properties to temporal and spatial scales and discuss possible indicators. We illustrate our procedure with examples of a specific function, the habitat function. We conclude that detailed knowledge of agricultural production is indispensable for developing a framework for the assessment of relations between agricultural land use and ecological qualities of agricultural landscapes.

In this paper we focus on environmental functions of agriculture which operate on different scales. Especially, we ask:

- How can agriculture be described to relate adequately to landscape functions?
- What are “land use changes” and how do they affect environmental functions?
- Which scales are important to identify important properties of environmental functions and appropriate indicators?

Ecological functions of agricultural landscapes

There are many environmental functions of landscapes which are affected by the current land use. Different land uses, like agriculture, urbanized areas, or industrial land use, may affect different sets of landscape functions. Of course, the actual relations vary also with the region and the spatial configuration of land use types within a given landscape.

Agricultural land use has substantial impact on many essential landscape functions. However, an exhaustive analysis seems necessary to assess the impact. For example, soil conservation can be high or low through agriculture, depending on the grown crops, the adaptation of soil conservation measures etc. Obviously, in many cases a type of agricultural land use can be found, which meets the desired performance of each given landscape function. This seems especially true for “production” and “regulation” functions.

Structure of environmental functions

Environmental functions of agricultural landscapes are organized in different ways. While some functions can be described irrespective of scale, others are scale dependent. For example, biomass production of an agricultural landscape is composed by the properties of the different vegetation units, which might be adequately characterised by soil and land use. Any upscaling of this environmental function seems possible by the aggregation of the identified spatial units. Consequently, it seems sufficient if indicators of this function are restricted to one scale.

In contrast, other environmental functions are more like a complex system, e.g. habitat or biodiversity. These functions are not appropriately describable at one scale, because different scales exhibit different emergent properties of these functions. For example, the biodiversity at the spatial level of single arable fields exhibits properties like weed diversity, microbial diversity etc. However, biodiversity of larger areas, e.g. farms or landscapes, includes not only the biodiversity of habitats like arable fields, but also the diversity of species with larger home ranges which encompass a diversity of "habitats". Also, the diversity and spatial configuration of habitats are components of larger scale biodiversity. Ecologist have named these levels α, β, and γ diversity. Indicators of biodiversity and other complex landscape functions should relate to this scale dependency and encompass different scales.

However, the real world is the outcome of complicated interactions between different scale aspects, scale related processes, scale interacting processes and multi-scale processes. Because of these interrelations, there often will be a multitude of ecological effects of a single cause. In order to guide the development of agriculture into and within environmentally sound paths, it seems important to model agricultural production, including significant driving forces of changes and the referring interrelations with the environment. For example, because many EU agricultural policies have environmental impact, it would be very valuable if this could be assessed before they are put into practice. This holds for future developments of European agriculture like the introduction of genetically modified organisms (GMO), crops for biomass and energy use, innovative technologies like precision farming and also for agrienvironmental schemes etc. Obviously, management related changes in agriculture can be modelled and predicted. A major challenge is to translate the very detailed knowledge about agricultural management practices and the driving forces behind the changes into environmentally meaningful assessments and indicator systems.

Agriculture and landscape functions

Obviously, changes are basic characteristics of human dominated landscapes. Land use changes include changes of different scales. On single fields, for example, farming technologies can change, like machinery and chemicals. On farm scale, the selection of crops and the crop acreages may change, also the introduction of new crop species, changes between conventional and organic farming practices, or between animal husbandry and cash crop production. Partly, these changes are due to progress made in science, technology and plant breeding. However, the market conditions, available subsidies and other means to further or limit the growing of specific crops play a major role in the decision processes of farmers of what to grow and how. Thus, a multitude of forces can drive "land use changes". Because these driving forces themselves may change, e.g. prices for goods or agricultural products, continuous land use changes take place. Therefore, the question to ask to evaluate environmental impacts of land use changes is not if there are altered environmental impacts due to land use change, but how do the changes modify the functionality of landscape components. This calls for integrated evaluation schemes instead of disciplinary views, because the environmental functions are related to each other, although of different importance dependent on the situation.

Not only the main functions should be covered, more importantly, an integrated multifunctional scheme needs to be developed. This need is related to efforts to implement a more complete image of the services by agriculture into the public debate. There is increasing awareness that agriculture produces not only food or raw material, but that important landscape functions (ecosystem services) are driven by farming. Equally important is the understanding that many environmental landscape functions will not be sufficiently fulfilled without appropriate land use.

Hierarchical systems to relate agriculture with environmental functions

Landscapes are complex systems, which are structured spatially and temporally in multiple ways. In agricultural landscapes, the agricultural land use is part of this system and related to the environmental functions of the landscape in multiple ways. In order to develop indicators for landscape functions it seems necessary to analyse important relations between functions and agriculture. At least. there should be an answer to the question: what is important to know about the agricultural land use of a landscape in relation to the landscape functions?

Three spatial scales are important in agriculture and these may form a useful base for an integrated scheme of monitoring, modelling and evaluation of the environmental performance of agriculture:

- Field level: On this level agricultural management measures are conducted, for example the application of fertilizers and soil tillage by ploughing. These activities are crucial for many environmental functions, like biodiversity and soil conservation. It is important to note that some detailed information is required on the field level. For example, the relation between fertilization and some environmental functions depends on the type, amount and time of application. The same holds also for pesticide use, soil tillage and other activities. Land use changes of this level include changes of the crop rotation, tillage regimes, pesticide and fertilizer use etc.

- Farm level: On farm level, the type of farming is determined. Some types are animal husbandry, cash crops, and organic farming. The farm type determines important characteristics, like the crop rotation, the use of fertilizers and pesticides. Land use changes on the farm level include the introduction of new technologies, the decision to change the crop rotation, the shift from conventional to organic farming.

- Landscape level: that is the level, where the accordance of the land use types with the natural, geomorphologic background will mainly influence the functions. The size of the farms and fields, the abundance and distribution of farming types and non agricultural habitats determine the landscape characteristics. Land use changes on the landscape level include larger scale activities like marginalisation, intensivication etc.

For each scale a specific set of driving force, state, pressure and reaction indicators, limited to that spatial scale can be identified. For instance, the diversity of species within a specific habitat type, like arable fields, can be very different from the biological diversity of habitats or the diversity of land use types on the landscape scale. Through this it is evident that a suitable set of indicators for landscape functions in relation to land use changes should encompass all relevant scales. A multiscale approach is also essential to identify the relevant scale for appropriate actions to change insufficient situations.

Habitat function of arable fields as an example for an hierarchical assessment

Arable fields are the habitat for many species. In agriculturally dominated landscapes and regions, the flora and fauna of fields contributes significantly to the overall biodiversity. Moreover, agriculture has been identified as a major factor of biodiversity changes in Germany, especially the decline of species diversity (Haber and Salzwedel 1992). Hence, strategies to analyse and protect biodiversity in rural landscapes call for careful consideration of the agricultural situation. While many field studies have been conducted about species abundances in different agricultural systems, a “top down” approach is still missing which integrates regional agricultural variability and habitat suitability in relation to selected species or species assemblages. For example, in the coming years, winter-rye cultivation is likely to decrease dramatically, at least in Germany, because rye cannot be culivated economically any more on many sites. What consequences can be expected for wildlife in agricultural landscapes due to this change? Rye fields are abundant in some regions and serve as habitat for many species. Results of existing field studies on rye fields may give an overview of species that can be effected. However, it is very difficult to assess the possible effects without comparing rye fields to other crops and without including landscape specific land use systems. This is because the importance of rye differs in agricultural landscapes, and the management practices for rye cropping can be different as well with different effects on species. Therefore, a "top down" approach to assess consequences of land use changes should encompass all important agricultural crops, be specific to regions and include the agricultural variability to apply measurements which effect the habitat quality for selected species. Our efforts to identify and forecast important trends of ecological effects of land use changes on a regional basis, not a field specific assessment. We integrate information of three spatial scales: field specific management systems, farm types and landscape. Figure 1 outlines the modelling approach.

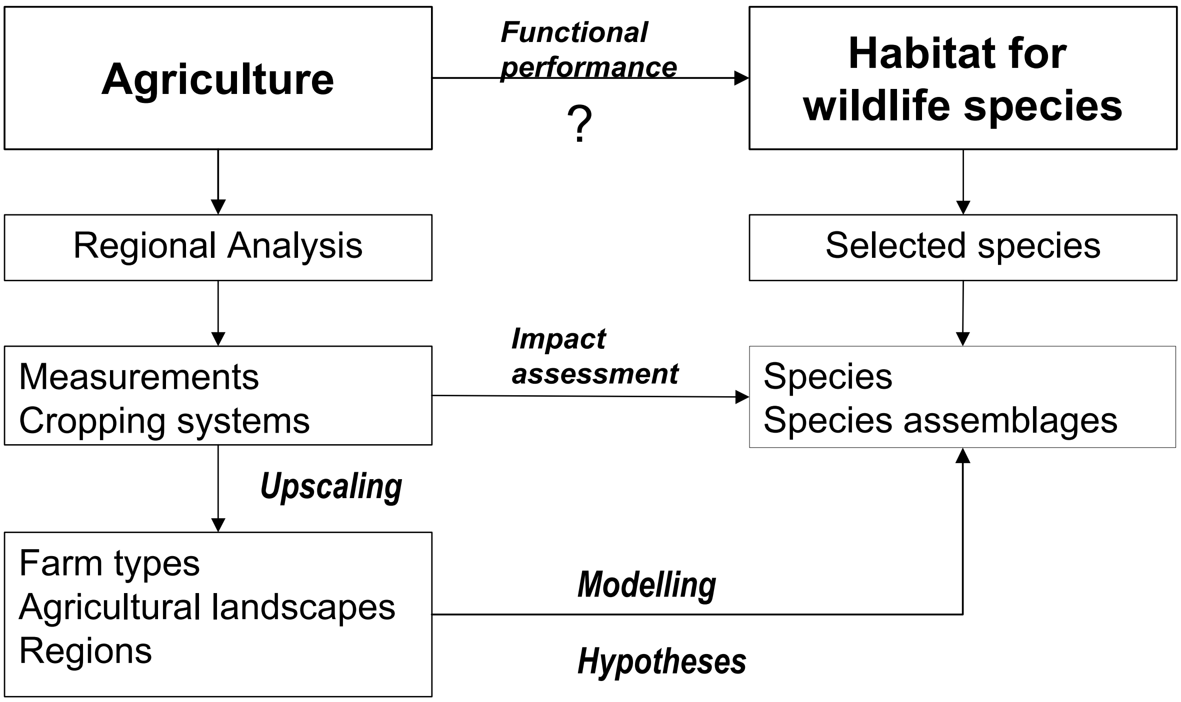

Figure 1: Modelling approach for a multiscale assessment of agricultural habitats.

In order to cover landscapes and regions, agricultural cropping systems are modelled based on sequences of individual measurements (e.g. ploughing). The cropping systems are specific to regions, soil quality, farming system etc. Each measurement is evaluated with regard to the impact onto the habitat requirements of selected field dwelling species. This allows the assessment of cropping systems, farms and landscapes in terms of habitat quality of arable land.

Regional assessment of the effects of agricultural land use changes onto wildlife species and species assemblages : Steps of the model

We designed a model to integrate information on agricultural land use, regional characteristics, and wildlife species to generate large scale habitat assessments of arable fields, which can be used to describe the current situation and also the effects of anticipated land use changes. The aim is to assign qualitative values to arable fields as habitats, e.g. the field is probably very suitable for selected species, or probably unsuitable. We chose a quality measure of five classes: 1) very suitable, 2) suitable, 3) medium, 4) unsuitable, 5) unsuitable. The modelling approach consists of the following steps (see Figure 2):

- Step 1: Characterize those species or species assemblages, for which the effects of land use changes should be assessed.
- Step 2: Assess the effects of the crop stands (e.g. crop density, architecture, length of vegetation period) and the agricultural measurements onto the habitat suitability for each species or species assemblage.
- Step 3: Delineate regions or landscapes, which should be assessed separately (landscape classification)
- Step 4: Analyse and describe agricultural land use in such a way that the typical management practices are identified for the grown crops in each region or landscape.
- Step 5: Combine the assessments of every single agricultural measurement to overall assessments of the production systems for the crops
- Step 6: Apply the assessments for the cropping measurements in each region to the species and species assemblages to generate habitat suitability estimates.

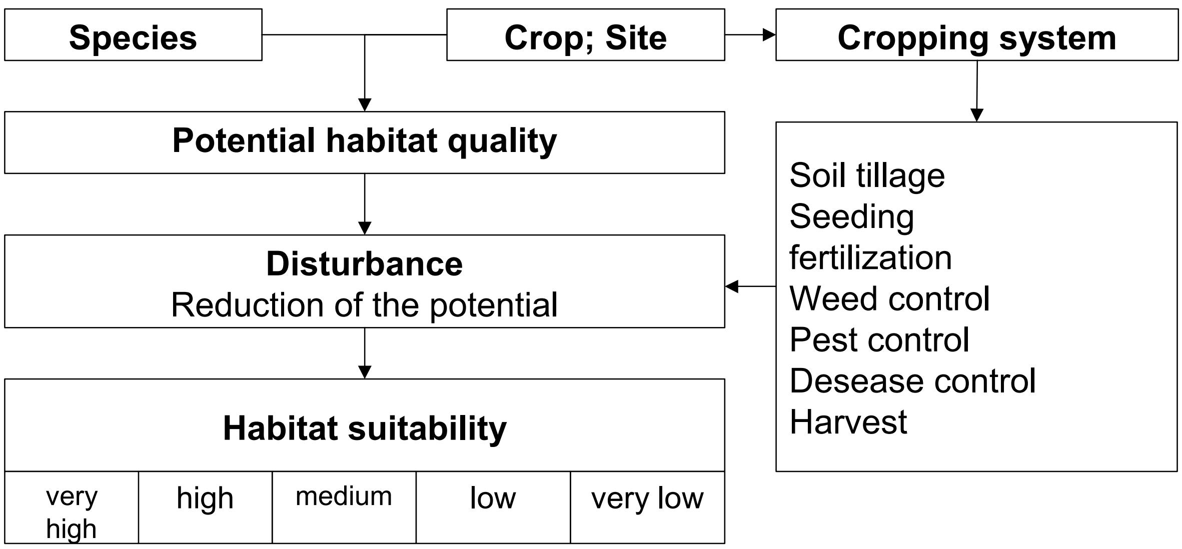

Figure 2: Schematic overview of the assessment process: The habitat quality of an arable crop field for a selected wildlife species (or species assemblage) is the result of the “potential habitat quality”, which is determined by the crop (through the length of the growing season, architecture of the vegetation etc.) and the site (density of the crop, yield expectation etc.). This potential is reduced by the cropping system (through individual measurements). Habitat quality is expressed in five “Suitability classes” for the species.

In the following, an outline for each step is given.

Species and species assemblages

Wildlife species and species assemblages of arable fields were chosen if they have the following attributes:
- Arable fields are essential habitats in the life cycles;
- The biology and ecology is well known and habitat requirements can be described
- Are susceptible against some agricultural measurements;

Examples of species and species assemblages are:
- Single species: skylark, hare
- Species assemblages: Field nesting bird species; fall germinating weeds; spring germinating weeds; ground beetles and spiders; hoverflies.

Species assemblages should not consist of species which are too different to handle within a single assemblage. If this is the case, the assemblage should be split into groups with more similar species.

Assessment of effects on species and species assemblages

Essential for the habitat suitability for a species of an arable field are: the length of the growing season of the crop; the architecture of the crop stand (density, microclimate etc.), and the agricultural cropping practices during the year. Because the length of the growing season is crop specific, and the architecture of the crop stand can partly be deduced from soil quality information and yield expectation, we constructed for each species or species assemblage "habitat potentials" for each crop on three soil quality classes. This represents the maximum values for the habitat suitability, which is then reduced by agricultural practices like soil tillage, pesticide application, mechanical weed control etc. The effect of each measurement was assessed, whereupon the time of the application was also respected. Figure 3 gives examples: some cropping systems for oat as sequences of measurements, adapted to the region "Lueneburger Heide", and the impact of the measurement on the habitat quality for the skylark.

Delineation of regions and landscapes

Climate and soil conditions determine largely the agricultural production of a region. For Gemany is very diverse in this respect, we combined area wide information on climate and soil for a landscape classification. We used the classification of the DWD (German meteorological service), which discriminates 87 regions (DWD 1962), in combination with a soil map, "BÜK 1 : 1 000 000" (BGR 2000), in which the dominating soil types are described. Three site quality classes were distinguished, characterized by low, medium and high agricultural yield expectation. For each region the abundance of these site classes was determined. Figure 4 gives the landscape typology of the DWD.

Four regions were selected for closer analysis (Figure 4), which differ significantly in climate, soil qualities and cropping patterns. For example, region 55: ('Niederrheinische Tieflandsbucht') has the most fertile soils and no portion of poor soils, whereas region 55 ('Lüneburger Heide') is dominated by very poor soils.

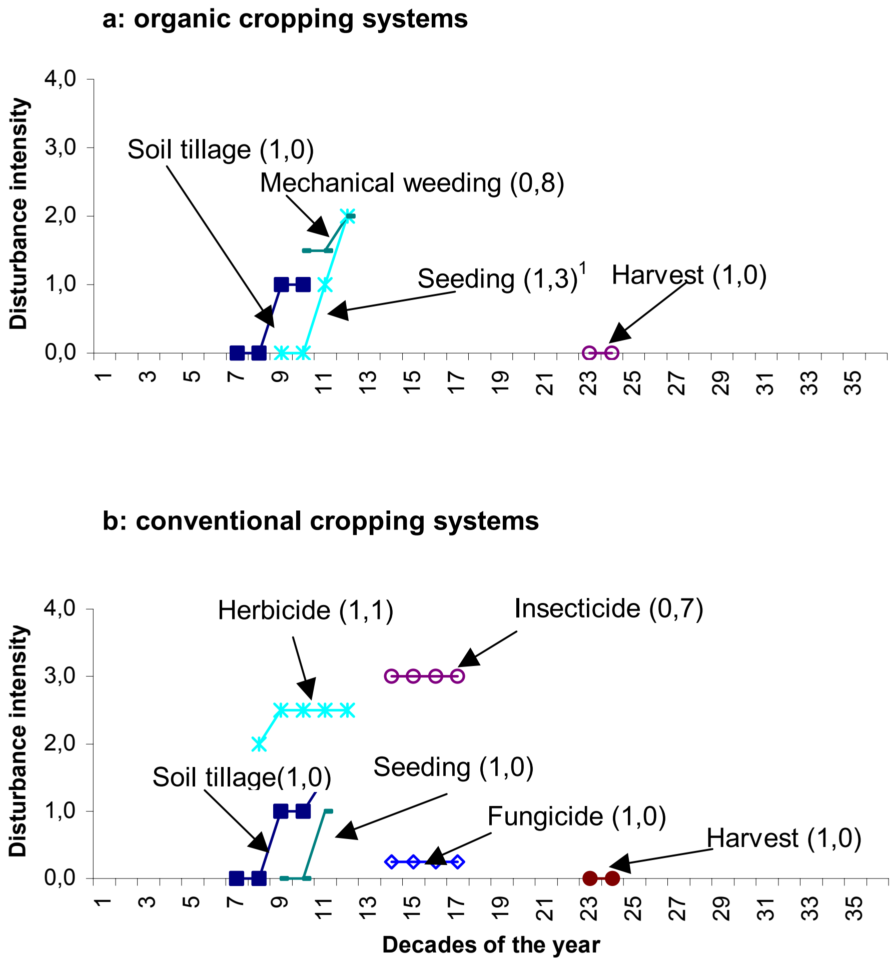

Figure 3: Organic and conventional cropping systems for oat and impact of each measurement on the habitat quality for the Skylark. For each measurement the time and frequency is given (e.g. "Soil tillage" is conducted in decade 7 to 10, beginning of March to beginning of April, on 100% of the oat fields). The impact of the measure is described as "disturbance intensity", which is assessed in five classes: no impact (0,0) to total elimination of the population (4,0). Note that the disturbance intensity of a agricultural measure may change in time, due to the biology and ecology of the species during the year, which results in time dependent sensitivity against disturbances.

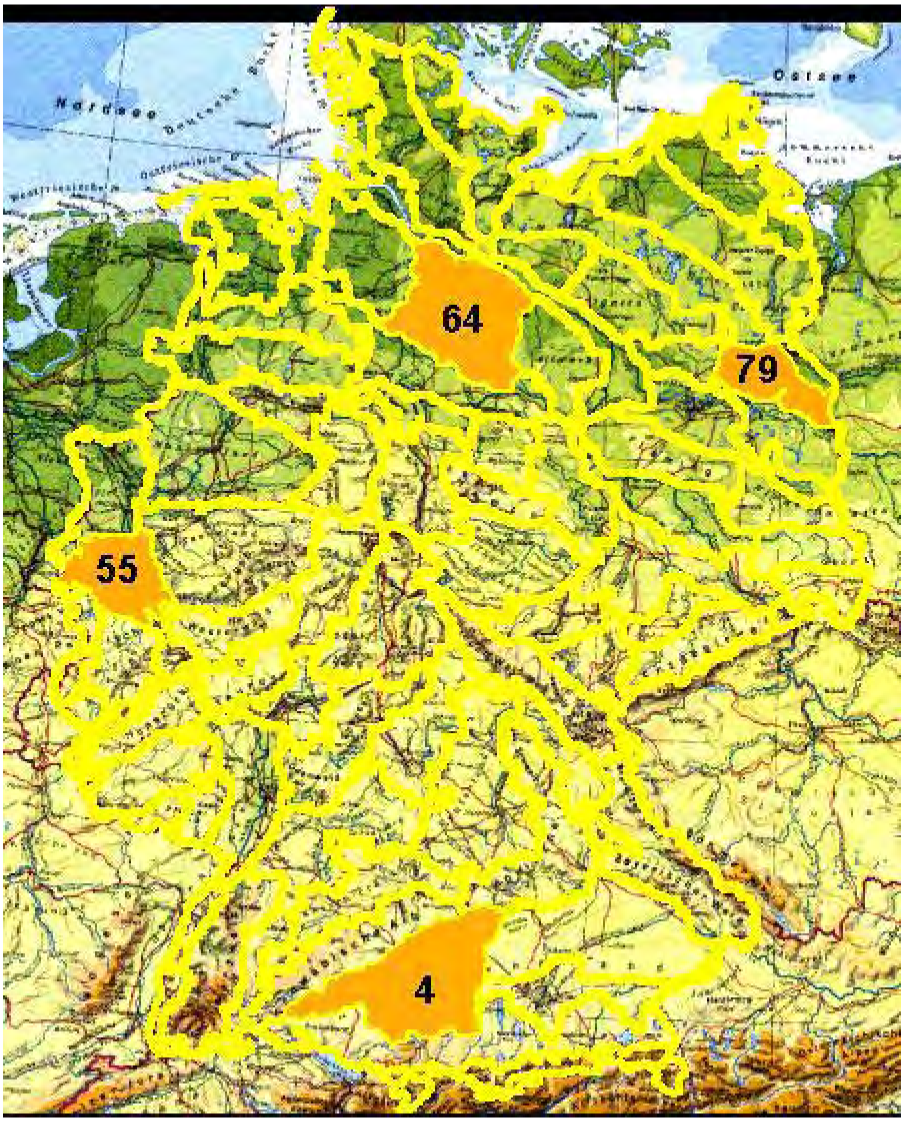

Figure 4: Delineation of regions in Germany by the DWD (German meteorological service). This typology serves as a basis for regional modelling of agricultural cropping systems. Four regions were selected for analysis: 4: (Donau-Iller-Lech Platten); 55: (Niederrheinische Tieflandsbucht); 64: (Lüneburger Heide); and 79 (Ostbrandenburger Platte). These regions differ significantly in climate, soil qualities and cropping patterns.

Description of the agricultural cropping practices in each region

Based on the crop growing statistics for each region, specific cropping systems were generated for each crop, which are in accordance with the BMP (best management practice) principles, and cover a typical variety of agricultural options, depending on the site, the type of farming (with or without animal husbandry), or conventional and biological farming. The regional specific sets of cropping systems consist of sequences of agricultural activities, typically from the preparation of the seed bed to the harvest of the crop. Note that for each crop on each site class a "potential habitat value" for each selected wildlife species was assessed, and also the effect of each single agricultural activity in every decade (each month is divided into three "decades").

Combination of the assessments

Because for each agricultural situation (region, site class, crop, cropping system) a single habitat suitability value for each species or species assemblage was targeted, the individual values for the individual activities which compose a specific cropping system were combined. The basis is the “habitat potential”, as the maximum suitability for a given crop and site, which is then reduced by the impact of the cropping system. This reduction is determined by the activity with the most detrimental effect for the species (e.g. herbicide applications were often seen as the most detrimental agricultural activity for hoverflies). As a result, for each region a set of cropping systems is generated, each of which represents a value for the habitat suitability for the wildlife species and species assemblages.

Regional specific habitat suitability assessments of arable fields

Because an agricultural region typically consists of more than one site quality, and also, there are often several alternative cropping systems for a specific crop, the habitat suitability of a crop grown in a region is not one single value, but a range of values. Thus, each crop represents a window of suitability values between “very suitable” and “very unsuitable”. Each region is characterized by the “suitability windows” of the crops grown in respect to the selected wildlife species and species assemblages. As an example, the habitat suitability windows for a group of field nesting bird species is shown for the four regions. Furthermore, different farming systems, organic and conventional are modelled and assessed in respect to this group of species (Figure 5).

Figure 5 shows for 13 arable crops the suitability as habitat for bird species like Quail, Partridge, and Corn Bunting, in four regions and for different production systems, conventional and organic. This allows comparing some important scale related issues of agricultural production for the habitat function. For example, the value of individual crops for the selected species in the same region can be compared, or the performance of different production systems in respect to the habitat function. The regions themselves also exhibit significant differences, e.g. the width of the suitability windows and their distribution in regard to the suitability classes. For example, in regions 4 and 55, no crop stand is a ‘suitable’ or ‘very suitable’ habitat for field nesting birds. On the other hand, in the regions 64 and 79 large differences can occur between different fields of the same crop, especially in organic production systems. For example, in region 64, organically grown winter rye has a suitability window which covers ‘very suitable’ to ‘unsuitable’ habitats.

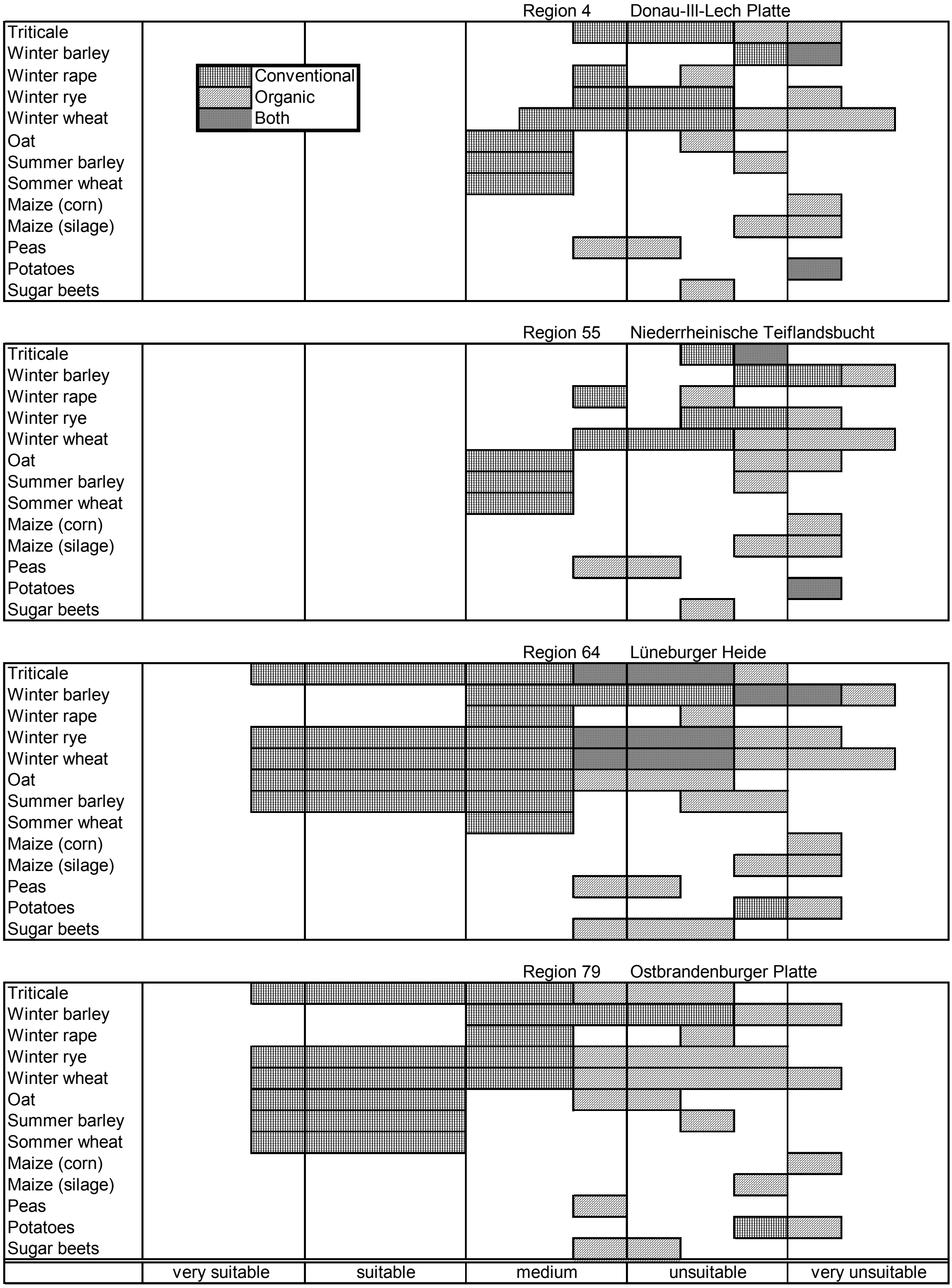

Figure 5: Habitat suitability windows of 13 crops for field nesting bird species in four German regions. Conventional and organic production systems are separated (no organic production of maize, peas, and sugar beets is assumed). The production systems are modelled and based on principles of BMP (Best management practice) and organic farming.

Results: assessments and uncertainty

The results can clarify the understanding of agricultural impact on wildlife species abundances in agricultural landscapes. A rule based assessment system generates suitability values for crop fields as habitat for selected species. This is not an estimation of the current situation for the species, because the existence and abundance of wildlife species depend not only on agricultural activities, but also on factors like landscape structure and biotic interactions. However, the contribution of agricultural cropping systems, specified to regions, farm types and sites, to the habitat quality of landscapes and regions for selected wildlife species is being assessed through this approach. Focussing on the current agricultural situation, the habitat suitability of arable fields can be compared between regions, important crops, sites, and cropping systems. Even individual agricultural measurements can be identified that seem to be especially important for specific species, for example if some measurements limit significantly the habitat quality. Moreover, some ecological effects of alternative land use scenarios can be assessed. For example, if the acreage of crops shift, the resulting distribution of "suitability windows" for species can be compared. Also, effects of introducing novel cropping systems and of specific measurements is assessable. In figure 5 some effects in the habitat function of arable fields due to shifts between conventional and organic production can be seen.

The assessments are difficult to verify. One problem is that the results do not give estimations about the current existence and abundance of the species, but about the contribution of the cropping systems. Empirical data of species abundance encompass all factors which determine the abundance, which means that individual factors are difficult to isolate. Furthermore, the effects of agricultural measurements on species often are "best guesses", not based on experiments. Anyway, guesses seem not to be avoidable, because many of the experiments needed have not been conducted. However, guesses can be attributed with a degree of certainty: In some cases, the effects of agricultural measures can be assessed with a high degree of uncertainty, while others are more difficult and bear more uncertainty. This uncertainty can be expressed with a "certainty class", which helps to interpret the results and also hints to open research questions.

Conclusions: Assessing land use changes

Agricultural landscapes fulfil several ecological functions. Changes of agricultural land use will also change the functional performance. As shown in the examples, "changes" of agricultural land use can take place on different scales. Individual measurements, cropping systems, farming systems, abundance and distribution of different farm types are examples of scales. It seems not possible to attribute specific scales with more importance than others in respect to landscape functions like habitat quality, because on each scale changes can take place which fundamentally effects the functions, e.g. introduction of new technologies; support of specific crops; support of specific farming systems; development of farm types in regions. All of this can have large impact on functions.

Therefore, a model which includes the agricultural production in detail seems to be promising when related to environmental functions. In our model, single agricultural measurements, conducted in a specific time period are the "smallest unit" of agricultural activities, often without effect on the function. However, they combine to all other scales, where other effects on the functions may emerge. In this way agricultural systems are modelled, beginning at single activities which are rationally related to each other to form cropping systems. Cropping systems of a farm also are related to each other in respect to the farm type, e.g. farms with animal husbandry vs. without animals.

Obviously, there is no scale of agricultural activities which is independent of the others. If changes occur on one scale, this may affect other scales as well. Hence, indicators of functional changes in agricultural landscape should include all scales of agricultural activities.

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Agricultural Land Management and Agricultural Landscape

Yasuhiko KURASHIGE
Japanese Ministry of Agriculture, Forestry and Fisheries

Abstract

Due to natural and historical conditions, Japanese people tend to appreciate well-managed agricultural land where agricultural production is carried out in a sustainable way. In this sense, agricultural land management can be regarded as an important factor that affects the quality of agricultural landscape. The paper proposes to see the changes in the ratio of a share of well-managed agricultural land area and that of agricultural land area with declined agricultural stock, as an indicator for analysing agricultural landscape. There are certainly some limits to the proposed indicator because of its simplification, for example. However, if the objective of establishing the agricultural landscape indicator is to compare the changes in the agricultural landscape situation across the country with harmonised methods, a sophisticated indicator would be pointless because it would be too complicated. The future challenge could be to make efforts to elaborate common criteria across countries to gauge the degree of land management or that of agricultural stock.

Introduction

The purpose of this paper is to propose an example of internationally comparable indicators for analysing agricultural landscape, with a focus on relationships between agricultural land management and agricultural landscape. The basic idea is to try to find common points between various agricultural landscapes rather than to identify their differences or originalities.

1. Characteristics of agricultural landscape in Japan

Japan is situated in a temperate monsoon belt, with an average temperature of 15℃ and annual rainfall of over 1,500 mm. The typology of the Japanese archipelago is very complex. Long mountain ranges varying in altitude from 1,000-3,000 meters form a backbone. There are hundreds of volcanoes; thousands of short, steer rivers flow from these mountains. Plains and basins are small and narrow. Of the total land area of 38 million hectares, approximately 70 per cent of Japan is hilly and mountainous with only 13 per cent, or 5 million hectares, suitable for agriculture, whereas forestry accounts for 67 per cent[1]. The average farming scale is only 1.6 hectares.

Paddy rice farming is well adapted to such conditions. In a paddy, which occupies more than half of total farmland area (Figure 1), rice is cultivated under a shallow covering of water. In order to utilise irrigation water effectively, the paddy field has to be levelled and each field surrounded by bunds. On gently sloping hillsides, paddy fields are built as terraces, while in low and wet areas, paddy fields have been created through a carefully calculated combination of drainage and levelling. Farmland area has,

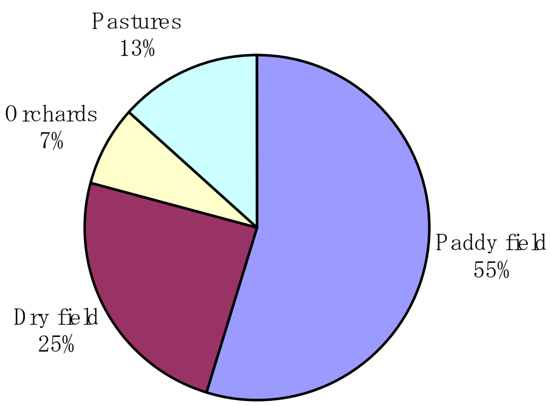
[1] OECD (1987), p.12, OECD(1998), p.214.

however, declined due to conversion to residential area and, especially in recent years, suspension of land management (Table 1).

A European professor once pointed out, when he visited Japan, that there was no agricultural land in Japan but "garden". In fact, it is not the "nature" but highly artificial or managed nature which composes agricultural landscape. This is especially relevant in Japan under the Asian monsoon climate with a lot of annual precipitation, where agricultural land is soon occupied by weeds without permanent management of land[2]. Generally speaking, existence of weeds in agricultural land could be positively evaluated if, for example, biodiversity increased. However, Japanese people tend to appreciate well-managed agricultural land where agricultural production is carried out in a sustainable way. This tendency could be partly explained by the natural and historical conditions of agriculture in Japan.

In this sense, the degree of agricultural land management can be regarded as an important factor that affects the quality of agricultural landscape. If it is possible to measure the degree of land management, the figure could be regarded as an alternative indicator to analyse agricultural landscape.

Figure 1 Share of agricultural land use (1999)



Source: Japanese MAFF

Table 1 Changes in farmland area in Japan (1960 – 2000, thousand ha)

Year	1960	1970	1980	1990	2000
Farmland area	6,070	5,796	5,461	5,243	4,830
Expanded (per year)	29	50	32	12	4
Reduced (per year)	34	103	45	47	40

Source: Japanese MAFF.

[2] Shinji (1994), p.24.

2. Proposal of an indicator

How to measure the degree of agricultural land management?

It is not easy to measure the degree of agricultural land management. The most difficult point is probably the definition of "management" of agricultural land that is influenced by the subjectivity of producers. One solution would be to see changes in the level of agricultural stock, resulting from investment in land. Agricultural stock will deteriorate without permanent re-investment and the appearance of agricultural land will change. In this sense, agricultural land management could be defined as "permanent investment in land by its owner or cultivator, which retains agricultural stock and enables agricultural production".

If we had exact data that allowed us to follow all the changes in agricultural stock of all agricultural land, we would have an excellent indicator representing the degree of agricultural land management. As this is not the case, this paper focuses on two different levels of agricultural land management and assesses their share in total area;

a) share of well-managed agricultural land area (supposed to provide high quality agricultural landscape)
b) share of agricultural land area with declined agricultural stock (supposed to provide low quality agricultural landscape)

Share of well-managed agricultural land area

There could be alternatives to measure well-managed agricultural land area. If there is no data category, one solution could be to assess the share of agricultural land under public schemes committed to agricultural land management, including landscape maintenance and enhancement because the probability that the land is well-managed is high in the land under public schemes.

In Japan, the Law concerning the consolidation of agricultural promotion areas was enacted in 1969 in order to confine the areas where agriculture should be promoted from the viewpoint of a better use of national land resources and to take the necessary measures for the development of regions. Under the law, agricultural promotion areas are designated by prefectural governments and plans for the consolidation of agricultural promotion areas are made for each designated area by municipal governments. These plans lay down future agricultural land use by setting up "agricultural land areas (noyochi kuiki)" where land usage is determined. If the owner or cultivator does not use the land as determined, the local government has the right to take legal or administrative action against the owner or cultivator of the land to use the land appropriately.

In the "agricultural land areas", the so-called land development activities (construction of houses or other artificial objects, etc.) are also restricted and are subject to the control of the respective local governments. Agricultural public works can be carried out only in designated parts of agricultural land areas.

In this regard, "agricultural land area" could be described as well-managed agricultural land, at least institutionally. The "agricultural land area" was about 4.3 million ha in 2000 and its share of total agricultural land 88.9 per cent. Table 2 shows its evolution for the period 1985-2000.

Table 2 Changes in "agricultural land area" and its share of total agricultural land.

	1985	1990	1995	2000
Area (1000ha)	4,515	4,526	4,432	4,296
Share (%)	**83.9%**	**86.3%**	**88.0%**	**88.9%**

Source: Japanese MAFF.

Share of agricultural land area with declined agricultural stock

The Census of Agriculture contains statistics for different types of land, including a type of "land which has not been cultivated for more than one year and the owner or the cultivator of the land does not have the intention to recultivate that land within a couple of years". Although the definition in the Census includes the intention of the owner or cultivator of the land, the area of this type empirically coincides well with the objective condition of the land. Therefore, this type of land in the Census can be regarded as agricultural land with declined agricultural stock. The area was 0.21 million ha in 2000 and its share of the sum of that land and cultivated land 5.1 %. Table 3 shows its evolution for the period 1985-2000.

Table 3 Changes in the area of "land which has not been cultivated for more than one year and the owner or the cultivator of the land does not have the intention to recultivate that land within a couple of years" and its share of the sum of that land and cultivated land.

	1985	1990	1995	2000
Area (1000ha)	93	151	162	210
Share (%)	**2.0%**	**3.3%**	**3.8%**	**5.1%**

Source: Japanese MAFF(a)

How can these indicators be made internationally comparable?

The absolute values of the above-mentioned shares are not internationally comparable, due to the fact that it is almost impossible to have the same data across countries. The changes in the shares can, however, be compared. The alternative would be to assess the ratio of the shares as follows:

$$ALI = S_1 / S_2$$

Where,

ALI = proposed agricultural landscape indicator
S_1 = share of well-managed agricultural land area
S_2 = share of agricultural land area with declined agricultural stock

The advantage of this indicator is that it could provide more balanced information concerning land management. As S2 is, in general, smaller than S1, the indicator is influenced by changes in the land area with declined agricultural stock.

Table 4 shows a trial calculation of the proposed indicator for the Japanese case. If the value of the indicator increases, agricultural landscape in the country is supposed to improve and vice versa. As the indicator is influenced by positive and negative changes affecting agricultural landscape, policy makers could analyse the situation in a balanced manner.

Table 4 Trial calculation of the proposed indicator for the Japanese case.

	1985	1990	1995	2000
S_1	83.9%	86.3%	88.0%	88.9%
S_2	2.0%	3.3%	3.8%	5.1%
ALI (S_1/S_2)	**42.1**	**25.8**	**23.3**	**17.3**

Advantages and Limits of the proposed indicator
The proposed indicator has some advantages according to the criteria that agri-environmental indicators need to meet[3]:

- The indicator addresses the degree of agricultural land management that is one of the key issues for agri-environment policies *(policy relevant)*.
- Although the indicator needs elaboration, the proposed methodology is simple and falsifiable *(analytically sound, easy to interpret)*.
- The indicator uses existing public data. Countries which do not have the same data can use other data representing well-managed agricultural land, for example, the share of agricultural land under environment payment, area of agricultural land with hedge, etc.*(measurable)*.

The proposed indicator has, however, certain limitations. For example;

- The indicator is based on data relating to agricultural land management, instead of that relating to landscape management. Although there is supposed to be a relationship between the degree of land management and the quality of agricultural landscape, it is not possible to accurately prove the relationship.
- As certain ambiguity remains in the definition of agricultural land management, it may be necessary to give a more precise definition to select data representing the share of managed agricultural land and agricultural land with declined agricultural stock more effectively.

[3] OECD (2001), p.22.

3. Conclusion

Landscape and agricultural landscape seem to have significant differences; the latter is "the visible outcomes resulting from the interaction between agricultural commodity production, natural resources and the environment"[4]. Because of the importance of the "production" aspect, agricultural landscape is inevitably linked to farmers' practices. This is why the paper attaches much importance to the management of the land and proposes to see the relationship between the degree of land management measured by the agricultural stock level and the quality of agricultural landscape. It is also because of the priority given to comparability across countries, rather than the detailed analysis or evaluation of the agricultural landscape of each region or country.

There are certainly some limits to the proposed indicator, as mentioned above, due to its simplification, for example. However, if the objective of establishing the agricultural landscape indicator is to compare changes in agricultural landscape situations across countries using harmonised methods, a sophisticated indicator would be pointless because it would be too complicated. The future challenge may be to make efforts to elaborate common criteria across countries to gauge the degree of land management or that of agricultural stock.

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[4] OECD (2001), p.368.

Indicators for Agricultural Landscapes and Policy Implications: A Korean Perspective

Song-Soo Lim
Korea Rural Economic Institute, Korea
340 Hoigi-dong, Dongdaemun-ku, Seoul 130-710, Korea
Tel. 82-2-3299-4382; Fax No. 82-2-968-7340; e-mail: songsoo@krei.re.kr

Abstract

Agricultural landscapes in Korea have rather unique characteristics compared with those of other OECD countries. Most distinguishable landscape features rest upon differences in land-use patterns. Influenced by Monsoon climate conditions and mountainous topography, agricultural landscapes are largely associated with terraced paddy fields. In addition, this study suggests a few potential indicators for agricultural landscapes including the levees of paddy fields, stonewalls on Jeju Island, changes in agricultural land-use patterns and land-use diversification. Estimated indicators show mixed results. While an increase in environment-friendly farming areas has strengthened landscape features, the progress of contraction, intensification and concentration in land-use patterns as well as a decrease in diversified land-use appears to threaten the preservation of agricultural landscapes. It is thus suggested that policy measures specific to agricultural landscapes should be introduced under the general criteria and guiding principles.

Keywords: agricultural landscape, indicator, agricultural land-use, policy measures

Introduction

Agricultural landscapes encompass diverse interactions between agricultural activities and the natural environment. In OECD (2001a), agricultural landscape is defined as "*the visible outcomes resulting from the interaction between agricultural commodity production, natural resources and the environment, and encompass amenity, heritage, cultural, aesthetic and other societal values.*" It further indicates that agricultural landscapes are "*man-made or cultural landscapes*".

This definition of agricultural landscapes raises two implications. First, agricultural landscapes are not necessarily homogeneous across regions or countries. Being attached to man-made or cultural landscapes they convey unique features and a diversity of locality. The diverse nature of agricultural activities adds complexity, too. It is because agricultural production relies upon location-specific natural conditions including climate, soils, water, and labour. As a consequence, different types of agricultural production and activities create heterogeneous agricultural landscapes.

Second, agricultural landscapes are to a great extent linked to environment-friendly farming practices. Since agricultural landscapes are largely associated with ecosystems of biological diversity, including species and habitats, the farming practices that improve environmental quality are of great importance. In a static view, certain agricultural activities contribute to the creation or maintenance of landscapes, regardless of their impact on the environment. However, if such agricultural activities are based upon environment-friendly farming practices, agricultural landscapes will be further improved in most cases.

In this regard, agricultural production in tandem with environment-friendly farming practices must be properly considered in any discussion of agricultural landscapes.

Regarding the above definition, it is also important to understand that agricultural landscapes are not limited to literally "*the visible outcomes*". The fact that agricultural landscapes reflect the social and cultural activities of human beings enables one to substitute "*the visible and recognised outcomes*" for "*the visible outcomes*". Only when agricultural landscapes are recognised by people and the society, do they start to account for societal values and preferences. By internalising "*who*" in the evaluation of agricultural landscapes this approach further justifies the claim that agricultural landscapes are not identical across regions or countries. Since societal values and preferences depend upon culture, tradition, economic well-being and many other things, the recognised agricultural landscapes appear to be different and diverse.

The objectives of this paper are three-fold. First, it aims to identify the features of agricultural landscapes in Korea. Second, it suggests several indicators that measure the states of and changes in agricultural landscapes in the country. Finally, it raises a few policy issues addressing the maintenance and improvement of agricultural landscapes.

A Comparable Review of Agricultural Landscapes

Up to this stage, a limited number of studies have dealt with agricultural landscapes in Korea. A common approach by most studies is under landscape control planning (Suh and Lee 1996). Some address visual preferences and perceptions of rural streams, rural residence and rural landscapes (Sung and Im 1992; Kim, Cho and Im 1999; Suh, Choi, Byoun and Na 2000; Lee and Shim 2000) and another explore land-use and landscape patterns in rural areas (Kim and Lee 1997).

Two studies analyse indicators of agricultural landscapes directly. Park, Lim and Lee (1998) introduce characteristics of agricultural landscapes and provide indicators of cultivated areas and vegetation cover rates by agricultural commodity, distribution of landscape objects and perceptions of green fields. Kim (2002) suggests various indicators of agricultural landscapes including changes in cultivated areas by agricultural commodity and length of stonewalls and windbreak forests around mandarin fields.

A key element of agricultural landscapes that has not been identified in the previous studies includes paddy fields. Rice production in Korea has a thousand years' history. As a staple food, rice still occupies a majority of arable land and plays a vital role in shaping rural communities. Besides, the sentiment of hometowns and rural areas rests greatly upon paddy fields, especially to urban residents. The fact that a large share of the urban population today is made of migrants from rural areas makes this observation more persuasive.

Compared with other countries' features of cultural landscape on agricultural land, the proposed paddy field related features in Korea are quite distinguishable (OECD 2001a). Only Japan identified terraced paddy fields as one of cultural landscape. The differences in landscape features are mainly due to differences in agricultural land. Many OECD countries rely heavily on upland farming whereas Korea and Japan, like many other Asian countries subject to Monsoon climate farm in paddy fields. In this regard, one may compare hedgerows in upland fields with the levees of paddy fields. Both of the features are known to bring environmental and scenic advantages.

As for farm buildings in Korea, there remain only limited features. First, most common materials used for farm buildings were easily perishable. For example, it was common to use rice straw for house roofs and blocks of dried mud for walls in rural areas that had to be replenished periodically. Second, increased demand and policy initiatives for better living conditions in rural areas gradually replaced straw-thatched houses with slate- and tile-roofed houses and old walls with cement blocks. Despite its inevitable nature, the intensive drive for rural modernization programs in the country in practice resulted in the degradation of cultural landscapes and loss of historic features in rural areas.

Stonewalls and windbreak trees around agricultural land are other characteristics of agricultural landscapes in Korea. Among others, stonewalls found on Jeju Island provide a unique example. Jeju Island is located in the southern part of the country. Its unique geographical characteristics shaped by volcanic activities resulted in a climatic environment and vegetation structure differing from the mainland of Korea. The natural environment peculiar to the island also contributed to the maintenance and development of inherent and local-specific landscapes (KLEA 2001).

An abundance of basalt and enormous human effort to overcome natural disadvantages made it possible to create a beautiful landscape. As upland boundaries along with windbreak trees, stonewalls help prevent soil and wind erosion, and provide habitats for wildlife. Inside villages, stonewalls also work to support houses and provide protection against driving rainstorms. With holes between stones, stonewalls are resistant enough to bear strong wind pressure.

Further research may identify and analyse many different features of agricultural landscapes in Korea. They will be comprised of other environmental features and land-use patterns, cultural landscape elements in relation to agricultural land, and landscape management. Once the elements of agricultural landscape are clearly identified, their policy implications can be assessed by economic analysis. Policy makers can take advantage of economic analysis measuring the costs and benefits of landscape provision in determining optimal levels of remuneration. When the society values agricultural landscapes and landscape provision goes beyond reference levels it will require public intervention to correct market failure and stimulate sustainable agriculture.

Indicators for Agricultural Landscapes

There is only limited research that addresses indicators for agricultural landscapes in Korea. Lack of raw data and methodological limitations have hindered serious studies on this issue. Given these circumstances, this section is intended to identify some features of agricultural landscapes in the country and analyse them as indicators. Despite being incomplete, an attempt will be made to interpret the indicators associated with policy context.

Terraced paddy fields

Definition
The areas of paddy fields located in valleys or comprising more than 7% of slopes.

Background
It is well known that paddy fields in valleys provide a unique landscape. A famous example is the rice terraces of the Philippine Cordilleras, which appeared on UNESCO's List of World Heritage in Danger in 2001. It was recognised as *"a landscape of great beauty that expresses conquered and conserved harmony between humankind and the environment"* (http://whc.unesco.org/sites/722.htm).

Paddy fields generally provide a number of non-commodity outputs or public goods. A number of studies deal with multifunctional aspects of paddy fields in Korea. For example, Eom and Yoon (2000) and Oh (1995) estimated the value of non-commodity provision by paddy fields, including flood control, water resource replenish, air and water purification, prevention of soil erosion and landslides, and so on. Lee and Rhim (1999) and Han et al. (2000) investigated the relationships between biodiversity and paddy fields.

In particular, terraced paddy fields have attracted increasing concern for several reasons. First, terraced paddy fields have a unique landscape and cultural sentiment. They provide people with peaceful feelings and self-admiration of cultural heritage. They also serve the public as educational and cultural places and recreational sites. Second, terraced paddy fields have greater environmental value than paddy fields in a plain. Located in valleys or slopes, terraced paddy fields play a critical role in preventing soil erosion, landslides and floods. Reflecting complex land-use patterns harmonised with mountains and waterways, terraced paddy fields have a superior function in biodiversity preservation.

Method of calculation

In Japan, terraced paddy fields are defined in various ways (Jeong 2002). One definition indicates paddy fields that have greater than 1/20 or 5% in slopes. Another defines terraced paddy fields when an ear of rice in a lower field is not taller than the levee of the next upper field. On the contrary, no definition has been formulated for terraced paddy fields in Korea. Neither has consistent data for the status of terraced paddy fields been filed over time, nor have policy measures targeted them directly. It is thus assumed that paddy fields having greater than 7% of slopes qualify as terraced paddy fields. This threshold is made only for convenience and is to be compatible with existing statistical categories. Statistical data for terraced paddy fields can be founded only in RDA (1992). From the mid-1980s to the early 1990s, the RDA implemented comprehensive research on soil landscapes in the country and published a series of reports. RDA (1992) categorised all paddy fields by slope and province. So far, this is the only source providing statistical data for the areas of terraced paddy fields.

Result and interpretation

Table 1 shows the areas of paddy fields by slopes in Korea. As of 1992, the area of terraced paddy fields is estimated as 260,240 hectares or about 20% of the total area covered by paddy fields. The fact that about 70% of Korean territory is mountainous partly accounts for why the area of terraced paddy fields is relatively large. This figure turns out to be larger than that of Japan. For instance, OECD (2001a) shows that the area of paddy fields (terraced and in valleys) in Japan was 220,000 hectares in 1985. Jeong (2002) quoted that the area of terraced paddy fields in Japan amounted to about 13% of the total paddy fields in 1993. Since rice is a staple food and was the most important source of rural income, farmers' efforts to secure rice production are manifested in the form of terraced paddy fields in less favourable areas.

Table 1. Areas of paddy fields by slopes

	0 ~ 2%	*2 ~ 7%*	*7~15%*	*15~30%*	*30~60%*	*60~100%*	**Total**
Areas of paddy fields	550,332	477,677	215,479	44,761	34	1	**1,288,24**
Share of total area (%)	43	37	17	3	0	0	**100**

Source: RDA (1992)

However, as competitiveness and efficiency are becoming a determining factor in modern agriculture, farming in terraced paddy fields is no longer viable in economic terms. Its costly management and lack of farm labour have forced a large proportion of terraced paddy fields to be transformed into other uses or abandoned. Loss of rice production in the fields amounts to the sacrificing of the associated ecological and landscape values because they are jointly produced outcomes.

Levees of paddy fields

Definition
The length of the levees of paddy fields where environment-friendly farming practices are adopted.

Background
The levees of paddy fields are essential structures for paddy fields to function as a provider of above-mentioned environmental service. Maintenance of the levees is a requirement for receiving direct payments in Korea. With an average height of 27 cm the levees prevent soil erosion, and provide flood control and foster water resources. Their scenic value is comparable with those of hedgerows. In addition, the levees offer habitats for various species and become access routes for people. The levees remind people of a symbol of rural life.

Since pesticide use is a decisive factor affecting the prevalence of fauna and flora on the levees so that environment-friendly farming including no-pesticide and organic production should be a precondition. It is noted that according to Han et al. (2000), the number of freshwater invertebrate and macro invertebrate in surface water of experiment paddy fields without insecticide application was double that of cases with insecticide. An Internet search of over 700 web sites containing the Korean term of 'the levees of paddy fields' indicates that many people apparently attach great sentiment of rural areas to fauna and flora on the levees. Most commonly referred animal and plant are respectively frogs and beans. Beans are planted on the levees of paddy fields help mitigate insect or disease damage to rice. Other animals that can be found on the levees include snake, firefly, crane, water cock, butterfly, yellow wagtail, red-throated pipit, little curlew, white stork, pheasant, white-fronted goose, tufted duck, ruddy shelduck, plover, narrow-mouth frog and so on. Other plants encompass mugwort, Mexican ageratum, shelfheal, shortawn, evening primrose, wild camomile, majusaka, white grass, pursalne, thistle, wild walnut, dandelion, knotgrass, conevolvulus, China pink, Indian strawberry, and so on.

Method of calculation
A practical difficulty in measuring the exact length of the levees calls for alternative methods. One of the easiest methods would be setting up an estimation formula using a land register. According to Kim (2002), the length of a regular square field can be estimated by:

$$L = 4\sqrt{S} + 2\sqrt{S}(\sqrt{N} - 1), \qquad (1)$$

where L is the length of the levees of paddy fields in km, S is areas in hectares, and N is the number of plots per S.

Since neither paddy fields nor plots are necessarily regular square forms, equation (1) should be adjusted accordingly. After comparing the estimated length with actual length obtained by a cadastral map, Kim (2002) suggested an adjusting factor value (f) of 1.57. So, the final equation (L*) for estimating the length of the levees becomes:

$$L^* = \{4\sqrt{S} + 2\sqrt{S}(\sqrt{N} - 1)\} \times f\ . \qquad (2)$$

Result and interpretation
Table 2 shows the estimated length of the levees of paddy fields over the period of 1999 to 2002. The estimated length of the levees expanded from 1,417 km in 1999 to 8,280 km in 2002, resulting in an increase of almost 500% over the period. This gain is attributable to a drastic increase in the areas of paddy fields under environment-friendly farming practices. A strong demand for food safety and environmental protection among consumers is a driving force behind the increasing adoption of

environment-friendly farming in agriculture. The share of the paddy field area under environment-friendly farming in the total paddy field area grew from about 0.16% to 1.03% between 1999 and 2002.

Table 2. Estimated length of the levees of paddy fields

	Area of paddy fields under environment-friendly farming (ha)	Number of plots	Estimated length of the levees (km)
1999	1,714	11,647	1,417
2000	2,171	15,821	1,856
2001	4,782	34,124	4,035
2002	11,077	62,213	8,280

Source: Data for area of paddy fields under environment-friendly farming and number of plots are obtained from the Ministry of Agriculture and Forestry (MAF, http://www.maf.go.kr) and the Land Information Centre (http://lic.mogaha.go.kr/main.html) respectively.

The increasing response to market signals by farmers is another factor behind the growth. To secure higher farm incomes, farmers are increasingly adopting environment-friendly farming practices and technology. As of today, the average price of rice produced by environment-friendly farming practices is greater than that of conventional rice by 20% to 30%. Direct marketing and green tourism associated with rice production could pave another opportunity to secure higher farm incomes. Despite downsizing pressure upon overall rice production, environment-friendly rice production is likely to expand in the future. And then it will further reinforce the landscape values associated with the levees of paddy fields.

Stonewalls

Definition
The length of stonewalls in uplands and orchards on Jeju Island,

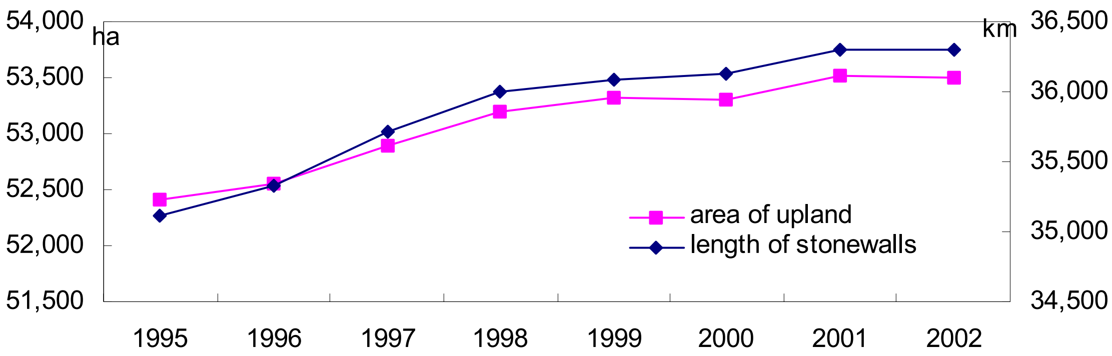
Background
As indicated in the previous section, stonewalls in uplands and orchards on Jeju Island create unique agricultural landscapes. They are known to protect plants from animals, prevent soil and wind erosion, provide wildlife habitats, define boundaries and reflect socio-cultural values as national heritage and tourism resources (Kim 2002). Although visitors and travellers recognise these stonewalls as one of the important cultural landscape features on the island, no research on them has apparently conducted. In particular, the ecological and economic value of stonewalls is at most vague at this stage.

Method of calculation
The length of stonewalls is estimated by using the same method as was used for the levees of paddy fields.

Result and interpretation
According to Figure 1, the estimated length of stonewalls in uplands and orchards showed an increase from 35,116 km to 36,293 km over the period of 1995 to 2002. Gains in the length of stonewalls are due to an increase of about 18% in orchard areas that were mostly designated for mandarin production in the same period. Areas of uplands in fact shrunk by 5%. It is thus evident that a robust increase in orchard land has significantly extended the length of stonewalls. But, worsened farm profitability and over-production problems faced by mandarin production could result in a negative impact on stonewall

maintenance. The nature of joint production between mandarin and stonewalls highlights this probability. Lack of policy concerns as well as structural arrangements to increase farm scales is another impediment to nurturing this valuable landscape. Limited opportunities for market creation and insufficient economic incentives for farmers to maintain stonewalls make it necessary to adopt specific policy measures.

Figure 1. Estimated length of stonewalls on Jeju Island



Source: Data comes from the Land Information Centre (http://lic.mogaha.go.kr/main.html).

Agricultural land-use patterns

Definition
Proportion of arable land as a share of total land, proportion of arable land with intensive input use as a share of total arable land, and proportion of farms with greater than 3 hectares of arable land as a share of total farms.

Background
From the structure of landscape perspective, agricultural land-use patterns are important as they affect the total stock of agricultural landscapes (OECD 2001a). As an element of landscapes, changes in agricultural land and its components could create different landscapes. Different cropping patterns may result in different interactions between agriculture and wildlife habitats. Intensive farming and structural adjustment may damage biodiversity and wildlife habitats by causing greater input use and increasing homogenisation, respectively.

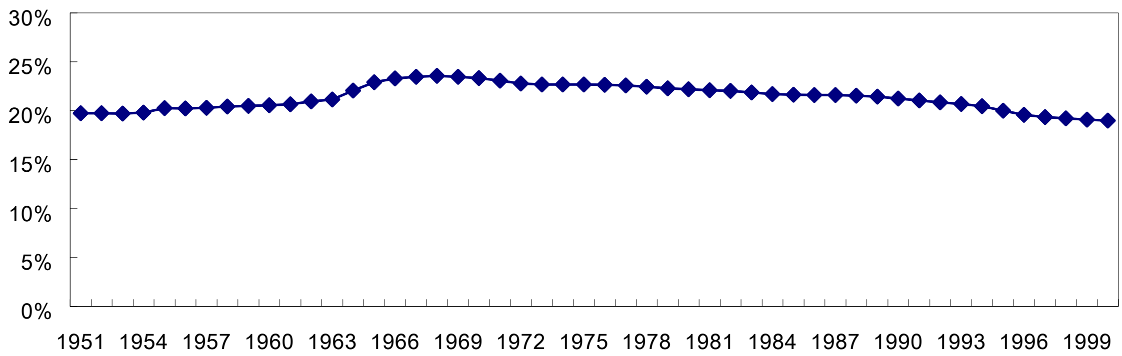
Method of calculation
To identify changes in agricultural land-use patterns, three indicators are established. These are based upon the Swedish approach with some modifications (OECD 2001a). First, there is the expansion-contraction indicator. The indicator refers to the proportion of arable land as a share of total land.

Second, there are the intensification-extensification indicators. One indicator is estimated as a proportion of arable land with intensive input use as a share of total arable land. Input covered here is only chemical fertilisers and their application levels in terms of active ingredients are taken into account. The threshold levels for nitrogen, phosphoric acid, and potassium are established as 10-10-10 kg per 10 are, respectively. Under these criteria, 4 out of 9 commodity groups turn out to be intensive land-use, including coarse grains, greenhouse plants, vegetables and fruit trees. The other indicator is the proportion of greenhouse area as a share of total arable land. Greenhouses are shown separately to reflect changes in scenic views too.

Third, it is a concentration-marginalisation indicator. This indicator is expressed by proportion of farms with greater than 3 hectares of arable land as a share of total farms. As of 2000, average farm size in Korea is only 1.3 hectare, so that the threshold level, 3 hectares of arable land could be large enough to represent large farms.

Result and interpretation
Figure 2 shows the estimated expansion-contraction indicator. Since the late 1960s, the share of arable land in total land area has gradually decreased to below 20%. A shift of agricultural land into non-farm use seems a leading cause of arable land contraction. In the period from 1990 to 2000, more than 13,000 hectares of arable land was converted into non-agricultural land-use every year. It can be thus said that contracted arable land has reduced the physical stock of agricultural landscapes.

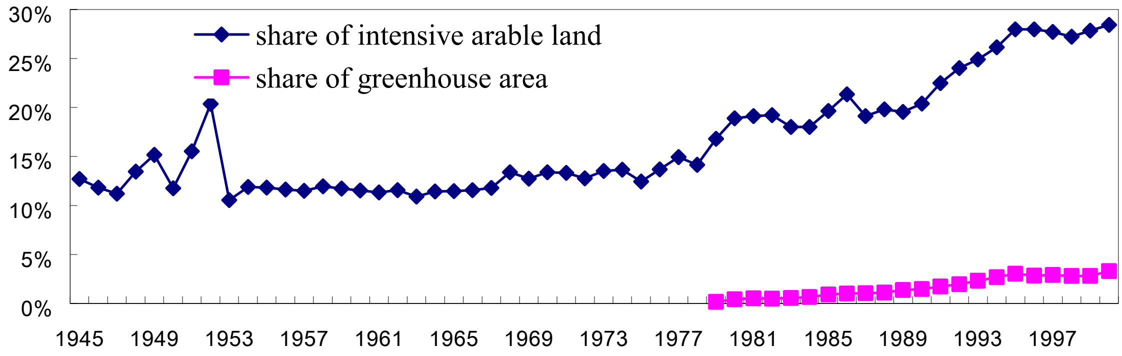
Figure 2. The expansion-contraction indicator



Source: Data is based on the MAF (http://www.maf.go.kr).

Figure 3 shows two intensification-extensification indicators. Since the early 1970s, the share of intensive arable land has steadily increased up to almost 30%. Increases in commercial commodity production including fruits and vegetables expedited higher fertilisation rates and thus intensive farming management. The appearance of large-scale farms seemed to contribute to agricultural intensification. The share of greenhouse area has also shown an upward trend since 1979. The overall intensification that is occurring in agricultural land-use implies more homogeneous agricultural landscapes and potential threats to biodiversity and wildlife habitats.

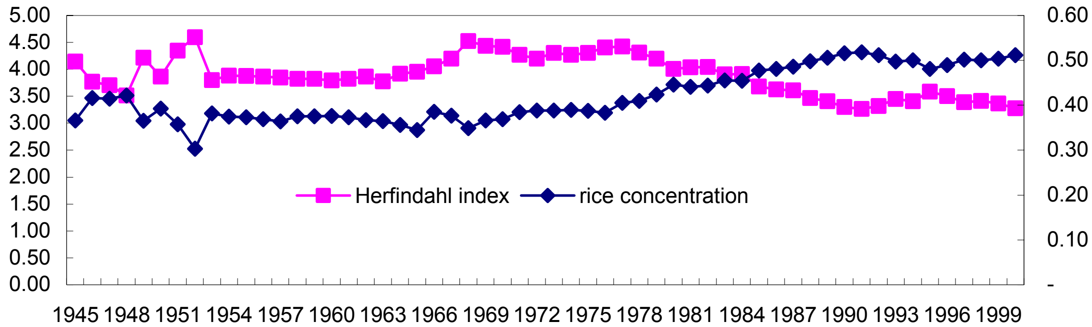
Figure 3. The intensification-extensification indicators



Source: Data is based on the MAF (http://www.maf.go.kr).

Figure 4 shows the concentration-marginalisation indictor. In 2000, large farms accounted for more than 5% of total farms, which indicates an on-going process of concentration. A steady growth in farm sizes is all thanks to market development and government programs. The more open and free market structure in the today's world requiring more competitive and efficient producers makes farmers concentrate and specialise their production and management systems. The government agricultural programs are also targeted at boosting farm competitiveness internally and externally. In response to the freer trade environment, it is inevitable for farmers to have to compete with one another and with foreign suppliers.

Figure 4. The concentration-marginalisation indicator



Source: Data is based on the MAF (http://www.maf.go.kr).

Such a progress toward concentration may pose heavier burdens on the environment. Like previous cases, farm concentration could result in homogeneous structure of agricultural landscapes and thus is likely to impede biodiversity and wildlife habitats. In addition, growing concentration may be accompanied by intensive farming practices that cause environmental stress.

Overall, the revealed phenomena of contraction-intensification-concentration in agricultural land-use patterns indicate that agricultural development over the past 50 years in Korea has not been favourable from a landscape perspective. Conversion of agricultural land into other uses appears to deplete the physical stock of agricultural landscapes and homogenisation through intensive farming and farm concentration tends to degrade ecological conditions.

On one hand, the on-going process of structural adjustments and deteriorating rural labour structure will continue to expedite agricultural land contraction and concentration. The over production problem in rice coupled with ever-increasing demand for other land-use will add to the difficulties in securing desirable agricultural landscape structure. On the other hand, growing concerns for food safety and environment-friendly agricultural production by consumers associated with newly introduced agri-environmental measures by the government will promote extensive agricultural structure to a certain extent.

Diversification in land-use

Definition
Diversification index of arable land by commodity.

Background
It is deemed that the more diversified the land-use pattern the more intricate are the features in landscape. The rationale behind this claim is that diversification in general is likely to add complexity, heterogeneity and seasonality to landscape features. By providing diverse environment of wildlife habitats, diversification in land-use could enhance biodiversity. Diversification could also improve landscape values by creating heterogeneous features by different vegetation cover and by season.

It is however noted that diversification alone does not automatically guarantee superior landscape features. Locality and harmonisation are equally important elements that comprise landscapes. Diversified land-use must be in harmony with specific localised environmental conditions. It is likewise important to note that a homogeneous element of landscapes could be desirable in certain areas. For example, pasture fields on Jeju Island located in hilly areas create open and beautiful landscapes despite their homogeneous nature.

Method of calculation
Diversification in land-use patterns is assessed at a national level. A national approach is adopted to get rid of the above-mentioned locality and harmonisation concerns. According to Tauer and Seleka (1994), a general form of measuring diversification is as follows:

$$(3) \qquad I_\Phi = (\Sigma\, S_i^{\Phi})^{1/(1-\Phi)},$$

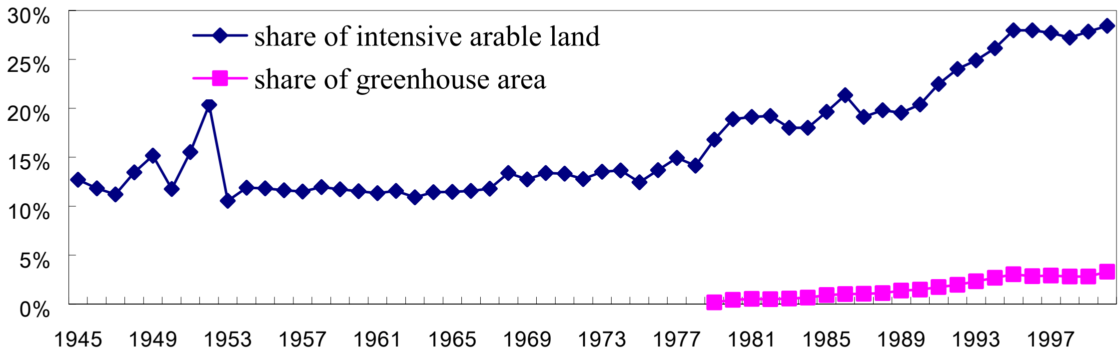
where i=1…n, S_i is the share of the i[th] item and Φ is a parameter, $\Phi \geq 0$ and $\Phi \neq 1$. With $\Phi = 2$, the index becomes the inverse of the Herfindahl index or $I = 1/(\Sigma\, S_i^2)$. The parameter Φ determines the weight between the number of items and the evenness. The higher the value of Φ is, the greater the emphasis on evenness is. For $\Phi = 0$, this index only counts the number of items. As unevenness grows, the index value becomes smaller at any Φ. Here the Herfindahl index is calculated from the area data being comprised of 10 commodity groups.

Another indicator adopted in this study is the concentration rate. The concentration rate refers to the degree of concentration in land-use for specific crops. Since rice is a staple food and its area accounts for the largest share in arable land in the country, a rice concentration rate is established as proportion of rice area as a share of total arable land.

Result and interpretation
Figure 5 shows the estimated diversification index and rice concentration rate over the period of 1945 to 2000. A downward trend of the index since 1968 indicates that agricultural land-use is becoming less diversified. In other words, the index highlights an increasing trend of concentration in agricultural land-use. An increasing trend of the rice concentration rate since the same year appears to prove an on-going process of concentration. Since total arable land shrunk over the period, the stable level of rice area turned out to be concentrated. As for other commodities, areas for vegetable, fruits and greenhouse increased their share of total arable land.

Less diversified or more concentrated agricultural land-use is largely due to market development and the government's agricultural policies. Cheaper imports from abroad have substituted for domestically grown coarse grains, wheat and pulses. Weakened market demands for barley, roots and tubers and mulberry leaves have reduced their share of agricultural land-use. The government policies targeting agricultural competitiveness and modernisation induced the expansion of commercial crop production and structural adjustments.

Figure 5. Diversification index and the rice concentration rate



Source: Data is based on the MAF (http://www.maf.go.kr).

The increased concentration in agricultural land-use may imply deteriorating landscapes at the national level. Monotonic area arrangements with fewer crops may fail to contribute to the complex nature of landscapes. For example, when double cropping systems of rice and barley in paddy fields vanish, a valuable landscape element in winter and the next spring seasons goes away, too.

A macro- and national approach may deliver inadequate implications regarding landscapes. From regional perspectives, concentration on harmony with local conditions may imply de facto landscape improvement. Another concern is the way of grouping crops. If the 10 commodity groups were divided into individual crop levels, it would have shown an opposite outcome.

Policy Implications for Agricultural Landscapes

As of today, no specific policy measures have been adopted to address agricultural landscapes in Korea. The fact that most policy measures are in fact tailored to protect the environment by reducing input use and livestock wastes implies that the country is in an early stage of environmental policy development (Lim 2002). Although direct payments for paddy fields introduced in 2001 require cross compliance of maintaining the levees, they are principally meant to preserve the roles of paddy fields, including flood control.

In order to determine if any policy action specific to agricultural landscapes is desirable, step-by-step general criteria must be established and examined accordingly. Similar to OECD (2001a), this study sets out the following criteria. First, it is about justification of public intervention. Policy measures appear to be valid only when market failure occurs and no market-oriented alternative exists. As public goods, most agricultural landscapes could be both site-specific and general landscapes, which invite government intervention (OECD 2001b). The fact that many OECD countries are implementing specific policy measures to preserve various agricultural landscape features and quality signifies the government efforts to internalise public good nature of agricultural landscapes.

Second, policy measures must be based upon social demand for landscape. Specific policy action could be valid if the society asks for better landscapes than a current level without any policy intervention. But, when markets are already distorted by the existence of unpriced but valuable outputs such as landscape, public intervention could be seen as correcting market failure. Studies show that people in Korea recognising landscape as one of the leading values attached to agriculture (Oh et al. 1995; Lee 1996; Kim 2000).

Third, policy requirements must be technically feasible and economically efficient. It is necessary to set up operational targets for agricultural landscapes and encourage farmers to enhance them. The associated costs and benefits must be appropriately identified and distributed. So far, no study is known to have dealt with economic costs and benefits for the features of agricultural landscapes.

Finally, environmental service provided by agricultural landscapes must go beyond good farming practices or environmental reference levels. Regulation (EC) No 1257/1999 defines *'usual good farming practice'* as *'the standard of farming which a reasonable farmer would follow in the region concerned'* (http://www.defra.gov.uk/erdp/pdfs/regulations/445-2002.pdf). On the other hand, reference levels are defined as *'mark the borderline between the activities farmers can carry out with the associated environmental effects according to their own interests, and the activities for which they are obliged to mitigate the associated environmental effects at their own expense (property rights)'* (http://www1.oecd.org/publications/e-book/5101171E.PDF). Farmers who provide agricultural landscapes beyond good farming practices must be compensated under a provider-gets-principle while farmers who fall short of good farming practices are obliged to satisfy them under a polluter-pays-principle. As indicated, these guiding principles have not been applied to agricultural landscapes at least in Korea.

Features of agricultural landscapes in Korea appear to meet the general criteria as public goods. But, the above-suggested features of agricultural landscapes must go through formal tests, encompassing socially desirable targets, reference levels and feasibility. It also needs to take lessons from other OECD countries that have already adopted various policy measures for agricultural landscapes.

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Mexican Landscape: A New Challenge of Environmental and Natural Resources Policy

Martha Niño Sulkowska
Urban Sustainability Director
Ministry of Environment and Natural Resources
mnino@semarnat.gob.mx
Blvd. A. Ruiz Cortinez, 4209-5º, Col. Jardines en la Montaña
Tlalpan, 14210 DF México
Phone: (52 55) 5490-0994

Abstract

This paper offers an overview of the guidelines and challenges used to build a landscape national policy and the role agricultural landscape indicators play in this process.

Keywords: landscape policy, indicators

Foreword

For the last 30 years, environmental policy in Mexico has gone through a complex process of evolution in it's goals as well as in it's strategies and instruments designed to contain, prevent and revert the multiple and complex manifestations of environment decay.

In it's wide action field the present administration has consider the need to meet new challenges, that in spite they had been evident from the first stages of the environmental policy, other problems, such as, pollution, decay and exhaustion of air, water, soil and wild life took precedence. So landscape in the 70's was recognized as essential to human environment because it is a unity of integration of multiple environment elements, presently it is an ambiguous item which is taken as synonymous of some elements of environment, that has been seriously and irreversibly changed by urban and economic expansion.

The revaluation of landscape as a common good which must be protected, used and recovered, creates a new scope of environmental political action that required concepts precision and systemic approach that reflect an integral attitude towards the relationship between culture and the environment.

The Mexican landscape takes us to consider the relevant features or characteristic of our environment and the role that agricultural landscape plays in it. From these elements I'm going to make some considerations about the limits and goodness of the different measures presently in practice in order to have possibilities to advance in the use of new instruments, such as indicators.

Mexican Landscape Heritage

To describe Mexican biological diversity is a complex task. Mexican multiple landscapes, the different species that live in them and the genetic richness of domestic plants make this wide meaning of diversity. The presence of two big oceans, its location between two large biogeographical regions, the neartic and the neotropical, as well as the complexity and variety of it's topography give to Mexican territory an extraordinary biological and ecosystem diversity.

Landscape understood as a synthetic expression of all the environmental factors has developed in Mexico under all the possible fashions. In Mexico you can find almost all the environments known on earth, this characteristic that only India and Peru can match. There are 19 provinces and 51 ecological regions, where the preservation of 14 are world wide priority.

In this vast mosaic we have from the perennifolias tropical rain forest to desserts as well as temperate forests and aquatic habitats, complex as well as fragile. With only 1.4% of the world's surface, it has almost 10% of all the species known in the world and is the third country in the world in number of animal and plant species. According to specific groups, Mexico is the country with the largest variety of reptilians and is among the first in moss, marine grass, flowers and mammalian animals.

This diversity is also found in society. Mexico is a multiethnic and pluricultural country where more than 50 native languages are still spoken. The native farmers, which have a profound knowledge of their heritage, use very efficiently their surroundings. For instance, the Huaves from San Mateo del Mar, Oaxaca, can identify 18 different agricultural habitats. It is also surprising that throughout the chinampa system it has been possible to farm for more than 400 years.

The ecological and cultural richness of the country offers vital functions that can be identified as a flow of environmental goods and services, one of them is landscape and scenic values.

The concept of landscape

The word **landscape** has been used throughout history with wider and narrower different meanings.

The classics use to see the landscape under a wide and integrating perspective, emphasizing the purely esthetic aspects within the notion of space referring it to "facies" or "species" and to the place as "sitius" or "locus".

It's ethimological meaning associated to country or rural is lost in the modern meaning of the word in Spanish, which sees it as landscape in a painting or drawing, which depicts a certain amount of land where the meaning of space is reduced to art.

Landscape has been considered in different ways. For some authors, landscape is born from human contemplation, and is different for according to different eyes. For others, landscape is an historic moment, a synthetic manifestation of geologic and physiographic conditions and circumstances that happen in a place, a mixture of all the features interacting in a certain time and place. A third party thinks that landscape includes besides the physical aspects, the human and their mutual interactions with each other. In all the definitions there is a common item, which is a space, a peace of land and the perception of this land.

A global and general definition of landscape must reflect a systematic and interdisciplinary view towards the existing relationships between our culture and place where they interact. The degree of variation and subjectivity has a series of appraisals of the elements and factors that are not landscape by themselves but that take part in it. That is why it is necessary to delimit the concept, without loosing the integrity.

Landscape is not only made of trees and vegetation, landscape is not reforestation. Certain landscape components such as color and texture are basic elements of dessert landscape. Landscape not only includes natural items it also includes human things such as buildings, cars, people which together make each place peculiar.

Because of the devaluation of the everyday life, of the spontaneous, it has not been paid attention to establish landscape criteria for the sustainable use and preservation of this heritage.

Landscape is not a far away contemplative concept, it involves an interactive condition with observer. The handling of landscape must answer it's own needs, acknowledging the heterogeneity and diversity of the countries landscapes.

Within the preservation of nature, landscape is identified with natural landscape, which besides of not being renewal, is a factor of land appraisal and support of economical and social activities from there the importance of it's preservation.

Based on nature criteria, we can recognize five different types of landscape:

I. Places where there has not been human presence.
II. Seminatural places as in agricultural landscape.
III. Places where natural environment has been altered specifically, not generically: some parts have been changed but not the original use. For example some forests have been substituted by eucalyptus and pines.
IV. Places physically altered by large works such as ports and highways.
V. Places made artificially natural, like urban and suburban green areas with many variables.

Actually near of 31'104,451 ha are under agricultural use and more than 60% of total land surface exhibit heavy erosion process. In the specific case of agricultural landscape indicators, we must differentiate between intense agricultural activity with high environmental impact and where local identity is lost, from those other practices where traditional agriculture takes place in harmony with local conditions, which have great cultural and natural value.

Landscape considerations in territorial planning.

From an ecological regionalization perspective landscape on land is one of the five hierarchical categories of regional units.

Landscapes are homogeneous units easily distinguished on the field, because they make valleys, hills, plateaus, mountain ranges, because his scale ranges and from 1:250,000 to 1:50,000. For the definition of precise limits topographical charts will be used as a back up to edaphological charts, aerial photographs and field trips.

Landscape scales are variable and have to do with micro and macro. Landscape is defined by large views and land, but it also has to do with composition spiritual references and sensitivity, and it goes from miniature gardens to public parks. For the purpose of landscape protection, we need advance in a identify property units of landscape perceived at human scale.

The indicators to which landscape is subject to are related to potential land use, agricultural capacity, quality of air and water, forest deterioration and air and water erosion.

Basic data for landscape description usually consider:

- Places and areas of mayor visual value, urban and rural.
- Natural and architectural places with visual beauty.
- Communication and service infrastructure linked to recreational and tourist use of relevant landscape.

- Preservation degree by landscape alteration and its characteristics.

Frequently used criteria for the evaluation of landscape quality, consider:

- Convex landforms such as mountain ranges, hills peaks esthetically reinforced by isolation predominance, definition or distinction, variation on the vegetation and geological superficial cover.
- Concave elements such as valleys, cannons, depressions, aesthetically modified proportion between depth and sides, materials, slopes, continuity, simple or complex configuration of relative scale or size and relief.
- Weather variations referred to light and color and to the irregular influence of climate.
- Visual transparency defined by vegetation density or topographic obstacles of the land.
- Visual complexity defined by the amount of visual information that the observer must evaluate and order.

Not withstanding the determination of territorial policies in ecological planning process, landscape is not a part of the ecological quality of natural resources not of the natural frailty of the territory.

Conservation of landscape heritage

Agree with definitions established by Convention Concerning the Protection of the World Cultural and Natural Heritage (UNESCO, 1972), the world heritage includes a wide range of possibilities between natural and cultural borders, that in practice usually was divorce or nor integrated. Also, distinguish several dimensions, from small scales like monuments to large places, understanding that the places must be formally delimited. The landscape integration is criteria applied to all monument or set to be considered like a cultural heritage, but the rate of urbanization and agriculture expansion difficult do it. In this way, landscape can be understand like a place or zone distinguish for his unique characteristics of integrations of human and natural objects or activities.

The ecological and cultural richness of the country offers vital functions that can be identified as a flow of environmental goods and function, one of them is landscape and scenic values.

Within the preservation of nature, landscape is identified with natural landscape, which besides of not being renewal, is a factor of land appraisal and support of economical and social activities from there the importance of it's preservation. The landscape is an opportunity to give economic value to ecological functions of ecosystems. In urban ecosystems the landscape represent value for land cost. In costal ecosystems landscape is the resource that support tourism activity and in some natural protected areas recently to tourists must pay for the enjoy landscapes and the money in applied to financial conservation activities.

During last 125 years the nature conservation in Mexico has evolved through different stages as a product of its own cultural and socioeconomic dynamics and also because of the influence of international tendencies and conceptions. In Mexico there are two main categories, which have been considered for preservations the agricultural landscapes: our cultural heritage and our natural heritage. In the case of natural protected areas, we have 127 of them which cover 17'056,400 ha that represent the 8.5% whole national territory.

The federal protected areas include five main categories: biosphere reserves, national parks, natural monuments, protection of natural resources areas and wildlife protection areas. Only two of them make mention of landscape aesthetic and recreational uses, and in all are specific zones to preservation traditional agricultural processes. The most important responsibility for protected landscape is in local level in which landscape is an important resource valuated for the people.

The protection of cultural heritage put attention in monuments more that in his environment in with this are included.

In addiction, recently with regard to attend poverty problems in 24 main region that covers 728000 ha, we promote programs for sustainable management of natural resources in more than 250 natural communities in many agroecological zones.

Conclusions

From the environmental and natural resources policy perspective, the landscape is an integrated indicator of several biophysical and socioeconomics processes, which should acquire a relevance in itself.

Because of the extension and diversity of local conditions we should develop indicators related to the typology of landscape that reflect the different landscape types.

The management of landscape as an indicator of sustainability in agricultural activities results irrelevant given that there are other processes which have a bigger impact in the environment as for example, deforestation, pollution, water depletion, soil erosion or salinization.

When agricultural practices are based in ecological principles that ensure sustainability, the landscape becomes a consequence of human intervention. In this case the agroecological landscapes are protected like an important kind of our heritage

The main challenge to advance in the development on these indicators consist in the need to define a clear conceptual framework in order to analyse the expression of territorial integrity

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Agricultural Landscape Indicators
A Suggested Approach for the Scenic Value

Calliope Pachaki
Centre of Planning and Economic Research
22, Hippokratous St. GR-10680 Athens, Greece
Tel.: 0030-210-3627321
Fax: 0030-210-010-3630122

Abstract

The scenic value of the agricultural landscape has generally been considered as a granted externality of the productive activity. The preponderance of the economic considerations, however, make that this externality is no longer automatically positive. So it is now under scrutiny, as co-produced public good, in order to secure its adequate quality

As the aesthetic-scenic value is highly subjective, this paper suggests that it should be broken down into "qualities", on which it is easier to agree that they are desirable. Factors or events that enhance or diminish these qualities can then justifiably be used as indicators of upgrading or degradation of the landscape. The impact of these factors will be signed as negative or positive on each quality and graded according to the relative size of the changes they inflict. Positive changes should be encouraged and negative discouraged. Each society can choose its own set of desired qualities according to its perceptions. One such set of 7 desired qualities is analysed and corresponding indicators suggested. It comprises: variety, richness, integration, ecological soundness, smoothness, accessibility, special effects.

This approach is conceptually simple and transparent and avoids subjective evaluations of what is beautiful or not. Technically, it can gradually be made more complete, refined and accurate.

Keywords: Agriculture, landscape, indicators, scenic value.

Introduction

The agricultural landscape has until recently been regarded simply as a positive externality of the productive activity, taken for granted and not further examined. Now, however, it is being realized that the economic function of the use of the soil has assumed such a preponderance and acquired such a momentum that the other functions (among which the environmental/ecological, the cultural/heritage and the amenity/scenic ones – see OECD, 2001, p. 369) are not automatically performed in a satisfactory way. The more so as the underlying activity, agriculture, is in the midst of a change of conditions, internationally, which may cause it to change dramatically and in unforeseeable yet directions – OECD 1998a, Potter 1998. So these other functions are coming now under close scrutiny, as producing separate goods of increased value to society as they become scarcer, and for which suitable mechanisms should be set up to secure their adequate supply. These "goods" are now examined either as joined products, co-produced during the agricultural activity, or as externalities influencing public goods whose value should be made to play a role in the decision making of the farmers.

Whatever the starting point, a crucial step in the procedure of bringing these other functions into attention is the effort to design a coherent monitoring system and a system of assessing the ongoing changes, so as to be able to base policies on them.

1. The relevant efforts in Greece

As in most countries, little has been done yet in Greece in this precise direction. So far, the efforts concern the whole environmental aspect of agriculture, or the landscape in general. Thus:

- The Ministry of Agriculture is participating in the OECD efforts to develop a conceptual framework for the environmental impact of agriculture (OECD meetings of Helsinki 1997 and York 1999 – see Tikof 1996, 1998).
- The National Statistical Service is hosting a Eurostat conference on environmental indicators for agriculture (in Crete). One of the items will be the landscape.
- At least one major empirical project has been undertaken which shows the cultural, environmental and ecological value of the characteristic agricultural landscape of terraces in 23 islands of the Aegean (Interreg project sponsored by the Ministry of the Aegean – see Petanidou, 2000). The terraces have been proposed as a relevant landscape indicator by Greece, in the framework of the OECD work (OECD, 2001, p. 387).

On the general landscape front:

- Landscape is taught as a separate subject in several Universities and under different perspectives (ecological, cultural, environmental, scenic). There are lots of research projects going on, concerning mostly mixed landscapes, some of which touch on subjects examined in this meeting.
- The UNESCO in collaboration with Greece has set up a bi-annual prize named "Melina Mercouri" for the safeguard and enhancement of the cultural landscapes. The prize was awarded for the first time in 1999 and Greece won a "Special Mention".
- Greece has just signed (3rd Dec. 2001) the European Landscape Convention under the auspices of the Council of Europe. The ratification is still pending (Norway is the first country to have "approved" it).

As we see the effort is still at the beginning, which justifies the submission of some ideas for discussion by someone who is not an expert on landscape or indicators but is interested in the valuation of public goods produced by agriculture, given its multifunctional character.

2. The proposed system in a nutshell

Given that the amenity value, and more particularly the scenic/aesthetic one, is highly subjective, it is suggested that it should be broken down into constituent qualities, on which it is easier to agree that they are desirable. We can then locate factors or events that enhance or diminish these qualities and use them as indicators of upgrading or degradation of the landscape. The impact of these factors will be characterized as positive or negative on each of the qualities they influence, and graded according to the relative size of the change they inflict or they themselves undergo. The assessment of the changes will depend also on the present state of the landscape.

Each national or even local society can propose its own set of desired qualities according to its perceptions and values, and even change it when the values change – for tastes are not independent of these two factors. The set of qualities can tentatively be formed through consultations between experts in various fields and administrators and then tested for acceptance in political settings or against the public opinion. (One of the methods to be used could be the visualisation of alternative scenarios, as suggested by Tress and Tress at this Expert Meeting). Before the tests however, diffusion of the relevant information and argumentation should take place, so that the public become more aware and confident about their attitudes and choices.

This approach has the advantage of being conceptually simple and transparent, avoiding the subjective valuations of what is beautiful or not, while providing a basis for justifying most of the elements that have already been proposed as indicators. Technically, it can start very simply, with gross qualitative characterizations, and develop gradually to become more complete, refined and accurate. As such, it is proposed for countries which have not already gone very far in developing their own system. The set of desired qualities that is proposed here, corresponds, I believe, to the nature and values of the greek landscape and to the perceptions, so far, of the people acquainted with it.

3. Preliminary remarks

There are some basic assumptions on which the analysis rests, which are best stated at the beginning:

1. There is an environmental/ecological function of the landscape as a whole, which should be of predominant significance in any evaluation system. This is more technical and more objective to evaluate, so I will not deal with it. The same holds for the cultural-historical-heritage value, which is also more objective to document and evaluate. These values, however, generally move in the same direction as the scenic one. So very many of the indicators developed for the first can serve also for the latter, and conversely: what serves the scenic value today becomes a cultural value in the future. But if there is a conflict, one should be clear about which function is served and for what purpose.
2. The natural landscapes, unless degraded by violent human interventions, are both environmentally functional and aesthetically satisfying. So the agricultural landscapes that are closer to the natural satisfy also these conditions. This is a basic assumption on which much of what follows rests.
3. Landscape includes not only the visual effect from a panoramic view-point, but the holistic impression on all senses: sounds, scents, close views, particular atmospheres are all part of the landscape concept and should be monitored. Otherwise, the largest part of the countryside-experience is lost.
4. Any landscape can have an “identity value” for those associated with it, or a novelty value for those not familiar, and be liked; thus any violent or very fast changes may have negative emotional impacts for the people concerned and should be assessed with caution (See also Luginbühl, 2001).
5. All landscapes, including the agricultural ones, are affected by extraneous elements that do not integrate. Modern life and technology make for more and more of such elements to have a disrupting effect (large public or private works). If monitoring has to be effective, it has to monitor these elements too.
6. Agricultural landscape should encompass also the family orchards, gardens and courtyards, as well as the farm and village trees, all cultivated for amenity purposes in the older times and very often now neglected. These produce the most exquisite effects and deserve attention.

4. The desired qualities

Given the above premises, it is easy I think to agree, that the following qualities add to the scenic value of the landscape:

1. ***Merging into the natural landscape*** (which includes the exisence of natural patches amid the cultivated areas): This gives a natural framework, variety, richness, ecological robustness. It is referred to, sometimes, as “naturalness”. If this quality exists, many of the others are automatically satisfied. However in many of the flat areas no natural environment is left or visible. So other qualities must be looked for.
2. ***Variety***: Although uniform landscapes can be very impressive, in general a varied landscape is more easily satisfying than a monotonous one. Variety includes shapes, forms, colours etc. A special form of variety is the changeability over the seasons, which gives the feeling of renewal and rhythm. This quality refers mainly to the effects produced by the agricultural activity itself. It is sometimes referred to as “non-homogeneity”.
3. ***Richness***: It takes into account the number of elements constituting a landscape (fields, trees, waters, flowers, birds) including the cultural ones (villages, churches, mills, farm buildings). But, in addition, there is a sense of luxuriance and fertility in the meaning of richness: whatever gives the impression of poorness and aridity, or too much order and sterilization, reduces this quality.
4. ***Smoothness or non-disruption***: This concerns man-made elements. They can be internal to agriculture (buildings, installations) or external (public works, urban sprawl). They could all add to the richness of the landscape, but very often they have a disrupting and degrading effect, depending on the care it is taken to integrate them. This quality can easily encompass what is often referred to as “tranquility” or “non-disturbance” which includes visual as well as acoustic disturbances. It can also include “neatness”, which refers to the care with which the agricultural operations are performed and the agricultural space managed.
5. ***Special effects*:** Some cultivations or the ecosystems associated with them produce at times effects that are very impressive, or generally appreciated and recognized as part of the physiognomy of an area. Examples are the almond-tree blossom in the winter, the wild flowers in all open spaces in the spring, etc. Naturally, it can encompass the “peculiarity” or “character” or “uniqueness” of a landscape (Somper, Terkenli and Kizos at this Expert Meeting).
6. ***Accessibility***: In order for the landscape to have its full effect (and so to have “use-value” in addition to the “existence-option-bequest value”) it is necessary for it to be accessible and in more than one ways, i.e. not just visible from far away. Thus, arrangements that permit accessibility, like country roads, paths, farm and country houses open to visitors, country museums, should be monitored, as permitting the full impression of the countryside to be experienced. One particular form of accessibility is “open-ness”, which is meant to signify not just “expansive news” but a degree of tameness, of not being lost in a solitary, no see-through environment.
7. ***Environmental soundness***: this quality monitors factors or events that have a detrimental effect on the landscape because they undermine the sanity of the underlying ecosystem[1]. Such are the water or air pollution (acid rain), the soil deterioration (erosion, salinity, chronic drought), the fires, the extended use of herbicides and pesticides. All these not only reduce the richness of the landscape, but give a distinctly miserable appearance. Of course, positive factors of sanity can also be monitored. The need for this quality is sometimes expressed as a quest for “cleanliness” of the countryside (as in Schupbach at this Expert Meeting).

The above qualities overlap to some extent but not entirely: they are essentially complementary. For example, ecological soundness contributes to the richness, but does not cover the cultural elements, nor does it preclude the monotony of monocultures. Between them they cover most aspects we appreciate in a landscape (not withstanding the “identity” value which can make any landscape precious), as has been revealed in fieldwork using the perceptional approach (see OECD, 2001, Ch. 7). Most of them are

1 “As the Convention itself recognizes, it is essential to care not only for areas of outstanding beauty but also for the ordinary, everyday and degraded areas”. Council of Europe (2001), appendix 2, welcoming speech by the Director of DG IV.

synergic, i.e. the enhancement of one enhances the other (ex: richness and variety), but not all the way: some may become antagonistic after a certain point (too much richness may make accessibility difficult, or too much accessibility may be disruptive; or, strong visual effects may be associated with extended cultures, which is against variety). Also, the effect of each quality on the value of the landscape may not be positive ad infinitum: after some time it may become too much (ex: richness perceived as congestion); the aesthetic effect is mostly one of balance. In practice, however, problems of “too little” rather than of “too much” are likely to arise.

These relations could be formulated in a formal way for clarity and consistence. However we should be cautious with formal approaches, as many of these interrelationships are qualitative and not quantitative (ex: smoothness or integration of extraneous elements depends on how well designed they are). In any case the marginal effect of any change must be considered on each of the desired qualities, and characterized as positive or negative depending also on the level of satisfaction of each quality at any point of time.

5. The building up of a monitoring system

For each of the desired qualities characteristic events can be enumerated which indicate positive or negative changes. The size of the impact can be approximated by the absolute or percentage change of the indicator itself or of the affected area – whatever makes more sense. It can then be characterized as marginal, small, considerable, large, alarming, depending on the range of changes normally observed over a past period considered as normal. Depending on whether these changes are inflicted upon a situation that is already problematic or not, they can give an indication as to whether measures are called for and how strong. Measures can be taken also if negative trends can be ascertained over the past period, and the situation should not be left to deteriorate.

Thus at the beginning of the exercise we should attempt to characterize the present situation of each quality on a simple scale, with “acceptable” as the starting point and then satisfactory, good, very good, enough, on the positive axis, and deficient, poor, alarming, bad, on the negative axis. The characterization would be more or less tentative, based on some standards or some past image of the same area. It would however give an idea as to how strongly positive changes should be encouraged and negative ones discouraged. In cases of doubts or controversies the present situation can be denoted as “acceptable” and deteriorations prevented.[2]

The scope of the exercise depends of course on the use we intend for it. If the purpose is to introduce landscape considerations into the actions of farmers, we concentrate first on the elements which depend immediately on their activity and can be easily internalized with incentives or regulations. If the purpose is really to monitor the entire rural landscape as an important element of the quality of life for all, then the extraneous elements should be monitored and managed.

The geographical unit for monitoring can be either visual (views from a network of observatories) or geographic (valleys, basins or other landscape units) or administrative (communities or prefectures). I suggest that the administrative units are more practical to operate and, if not too big, they often coincide with a geographical unit. In Greece, the prefectures very often coincide with a valley and its surrounding mountains; it is not too big as to allow unacceptable balancing of good and bad changes, and has the necessary administrative mechanisms (directorates of agriculture or/and environment). It is clear that for

2 The idea of “visual landscape assessment at county and district level” has already been applied in the U.K. See Statement of the U.K. to the Council of Europe conference, Council of Europe (2001), appendix 9. Possibly suitable methods are also suggested by Dramstad et al. and Puschman and Dramstad at this Expert Meeting.

the scenic value the lowest practicable level of observation is required: the scenic value cannot be perceived from very far away.

Some events or factors give indications about several qualities at the same time, so they could make more powerful indicators. For example the presence of some birds add to richness, special effects (nests and chicks of storks) and are indicators of a rich and sound underlying ecosystem.

Some affect all qualities in the same direction, so they are more unambiguous and thus more useful. Ex: signs of erosion, air pollution, fires, concentrations of garbage. Such phenomena are harmful unambiguously. The ambiguous ones are more difficult to handle. For example, buildings and installations (silos, mills, irrigation systems) could add to the landscape or be very disruptive depending on how carefully they are designed.

Some are easier to monitor, quantify and interpret, so they are first candidates. Ex: area covered by natural patches, borders, hedges, big trees, streams and canals; also, the number and index of concentration of cultivations, as an indicator of variety.

Finally, some events depend on individual actions in the area or in the agricultural activity, and so are easier to influence with regulations or incentives. Others have more of a public good character, originate from more diffuse sources and are very difficult to influence in the short run (like those affecting ecological soundness or variety).

In a progressively building up monitoring system one should start from the easiest (most readily available), most unambiguous, most powerful and most easy to influence indicators in order to have quick results, but gradually proceed to more specific, complicated and general ones, i.e. not directly connected with the agricultural activity; because these will trace factors and events which influence indirectly but in a very powerful way the agricultural and all rural landscape, (ex.: air quality around industrial areas or motorways).

It is debatable if the impact on every one of the above qualities should be combined into an overall effect, especially if the impacts are in opposite directions. This would entail weighing of the different qualities and quantifying the effects on each, which would increase arbitrariness and decrease transparency. Given the radical changes that the agricultural landscape has been undergoing, the loss of many elements of richness and the intrusion of many disrupting elements, it is probably better to avoid counterbalancing the negative changes with some positive ones (perhaps in accessibility and some special effects). Instead we should try to discourage negative changes and encourage positive ones in each of the desired qualities. Compromises will have to be done anyway.

If however a ranking of the desired qualities should be made, I would suggest the following, with the criterion of securing the fundamentals, avoiding the worst and letting nature do its work: Ecological soundness, merging into the natural landscape (or allowing for natural elements), smoothness (or integration of extraneous elements), richness, variety, accessibility, special effects.

It is clear that environmental/ecological indicators that are already available and which can give indications about the perceptional aspect of the landscape as well, should be freely and immediately used. Such are indicators on air, water, soil pollution, erosion and desertification, loss of macro-biodiversity and others. The same holds for indicators on cultural characteristics that are available from relevant databases or studies (Petanidou, 2000, Hughes and Mackey, at this Expert Meeting).

6. Suggested indicators for each desired quality

On the basis of the above rationale one can suggest a series of possible indicators for each of the qualities, from which sets can be chosen and worked out in successive layers.

1. Merging into the natural environment

- Percentage of cultivated land
- Area/percentage of natural and semi-natural patches in the cultivated area (borders, hedges, forest patches, drainage canals, natural irregularities)
- Number of scattered trees, especially big trees, including old trees in family orchards, courtyards and village squares.

2. Variety

- Number of practised cultivations, average or typical size of plots, index of concentration of crops.
- Number and area of cultivations which present high seasonal variability (arable crops, spring blossom, winter falling leaves etc).

All these indicators rest on available or easily obtainable data.

3. Richness

- All previous indicators of variety and merging.
- All local indicators of macro-biodiversity, especially those concerning wild trees, birds, wild flowers, small animals like bats, frogs, lizards, insects like butterflies, bees, crickets, cicadas.
- Traditional elements connected with agriculture (old farm houses and barns, wells, stone walls, terraces, mills).
- Monuments like churches, old houses, stone bridges, and traditional villages.
- Ponds, streams, canals, forest patches etc.

4. Smoothness (or non-disturbance)

Here we look for elements which have a disruptive effect due to their size, incongruous style, lack of care to integrate. Unavoidably, many of them will be ambiguous or controversial. However it is better to be watchful and bear pressure on all agents to take care to integrate. Besides, it is not uncommon to see organized reactions against large public or private works that are deemed to spoil the environment. Recently, there was such a demonstration in one of the greek islands (Naxos), on the grounds that a big silo installation on a private estate spoiled the whole landscape of the area. So, there are indications about the positive or negative effects of such elements.

Starting with the most unambiguous we suggest that the following should be monitored:

- Scattered or concentrated garbage from discarded materials of the agricultural activity itself (plastic sheets, tins, sacs, etc).
- Modern farm buildings and installations which show no care for integration and are not camouflaged with vegetation either (cheap “provisory” constructions).

These give indications about “neatness” in performing the agricultural activities.

- Polluted or degraded areas (withdrawal fields, abandoned fields) with no efforts at management or rehabilitation.
- Public works which show no preoccupation for aesthetic and environmental integration (roads, bridges, fly-overs, energy or communications pillars, dams, etc).
- Large private buildings (factories, storage houses) with no care for integration and for managing the surrounding space.

Local authorities and NGOs are the most suited to set up a kind of landscape-watch to prevent degradation of the local landscape.

5. Special effects

Here we list all cultivations or practices that produce impressive effects or are characteristic of the area. These may be visual effects, or sounds, smells, micro-environments (ex. small orchard with rare butterflies in Paros). We can also list cultivations or vistas, which may not be impressive at first sight, but are associated with the tradition or the image of the area. Examples of such impressive or characteristic environments are: the very old semi-natural olive groves on Corfu island, the fruit-tree groves on mount Pelion, the "terraces" in places where flat land is very scarce, the bursting of wild flowers in the spring everywhere in Greece, but also in the cultivated areas.

6. Accessibility

- Paths, narrow roads, old bridges, pic-nic areas, panoramic view-points, hiking trajectories and guidance facilities.
- Traditional inns, taverns, cafes, mountain chalets, bird-watching facilities, natural-history museums.

The existence and maintenance of such arrangements show a high degree of awareness about the natural beauty of the area and its use for recreation. Small local museums contribute to the intellectual accessibility by giving information about the natural and cultural landscape.

7. Ecological soundness

- Relevant indicators of air, water, soil pollution (i.e. which have visible effects on the vegetation and the wildlife).
- Signs of erosion, drought, salinization, desertification (areas affected).
- Areas affected by fire or tree illnesses.
- Waste management practices (responsible also for many fires).
- Excessive or improper use of herbicides and pesticides (effects on wild flora, birds, insects and appearance).
- Indicators of biodiversity.
- Re-afforestation, rehabilitation schemes.
- All indicators of natural richness and variety.

This system is suggested specifically for Greece whose landscape is characterised by variety, richness, merging into the natural landscape; but also, by ecological fragility, increasing loss of traditional elements, and disruption by uncarefully designed and ill-finished public and private works. It could be used for checking further unfavourable changes and for acknowledging and rewarding agriculture, which possesses the desired qualities and thus contributes to the beauty of the overall Greek landscape. However, it could be adjusted to suit other types of landscapes as well.

7. Indicators and agriculture

The above presented system is of course linked to agriculture, since it focuses on the characteristics of the agricultural landscape, but it is independent of any particular cultivation or product mix, as it concentrates on desired qualities rather than on specific elements. In this sense it is decoupled from specific products, emphasising the points where care should be taken, so as to allow nature and culture to produce their aesthetic effects.

But, of course, the agricultural landscape as a whole is not decoupled from agriculture. It is agriculture as an activity which produces the specific open, tame, accessible and at the same time rich and varied landscape, with its special types of ecosystems. If agriculture is abandoned, land abandonment, erosion and aridity or urban sprawl are likely to occur, rather than afforestation and reversion to a natural kind of landscape (such has been the case in some of the greek islands). (See also Tikof 1998).

Concerning the specific indicators proposed, from those enumerated above, it seems that the following can be influenced by individual actions of the producers and could be easily incorporated into the agro-environmental policies.

- Natural and semi-natural zones in the cultivated areas.
- Scattered trees and family orchards and courtyards (number of species maintained).
- Traditional elements connected with agriculture.
- Modern buildings and installations (compliance to certain rules).
- Management of farm wastes with a view also to preventing fires (good practices).
- Macro-biodiversity indices related to rational use of pesticides and herbicides (birds, insects, wild flowers).
- Accessibility arrangements.
- Rehabilitation schemes for degraded land (de-salinization etc).
- Conservation of crops that are listed as producing special effects (among which variety) or having an identity value for the area.

8. Indicators and rural development

One of the main assets of the rural space is landscape, which encompasses natural, agricultural and urban elements. The system presented above, by focusing on qualities and by including contemporary man-made elements, gives the opportunity to keep an eye on all the elements that make up the landscape, including modern settlements and constructions. This will help monitor the changes and put pressure on all activities to consider their impact upon the public good they all shape, and try to integrate.

The adoption of such a monitoring system by local authorities, where focusing would be mainly on environmental soundness (prevention of fires, waste management), richness (allowing nature and culture to have their effects), non-disruption (seeing that modern constructions are carefully designed and well finished), accessibility (inducing people to discover and enjoy the landscape) would help raise consciousness about the landscape as an important factor of the quality of life (consumer good and civil right[3]) but also as an asset that can contribute to local development. From the first point of view the effort would be to develop mechanisms for allocating the costs of maintaining or enhancing it among all those benefiting (non-degradation being an obligation, while enhancement is a service to be remunerated). From the second point of view, the “production” of a pleasant landscape could develop into a pole of local development financed partly by public funds, as a public good of general interest, and partly by those actually enjoying it (inhabitants and visitors).

In such a landscape producing activity, which should encompass also the urban areas by preserving what natural elements exist (trees, ravines, parks) and by developing programs of the type “the countryside in town”, local farmers could take part by, among other things, co-operating in specific projects and developing the necessary nursery plantations.

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3 “The landscape is a key element of individual and social well-being: its protection, management and planning entail rights and responsibilities for everyone”. Preamble to the (draft) European Landscape Convention, Council of Europe (2001), appendix 6.

In all these endeavours, a monitoring system with relevant indicators can be an invaluable tool for applying policies.

9. Conclusions – Recommendations

This paper has presented a rationale for justifying indicators on the basis of their contribution to, specifically, the scenic value of the landscape. The same indicators will certainly be contributing to the environmental and the cultural values, and vice-versa. And most of the time the effects will be in the same direction (Although some cases of antagonism can be thought of: some very clean and orderly fields producing special effects appreciated by some, result in poor and fragile ecosystems. Conversely, some rich, flamboyant ecosystems may be conceived as giving messy and congested landscapes - see OECD, 2001, p. 382-383). So the set of indicators chosen for their environmental and cultural significance can be justified also for their scenic contribution, according to the preceding analysis. Thus, the aesthetic considerations come to reinforce the other two. But it is important to be clear about why we choose what.

Also, it is important that the aesthetic view-point comes to the foreground and is recognized as a valid concern affecting our quality of life. And not only as a consumer good, but also as a productive infrastructure affecting our state of mind and creativity.

So that an inspiring environment is accepted as a legitimate social demand, and its provision accredited partly to agriculture and internalised in its decision making. And also, that it is required from all other activities, which affect the rural space and very often determine the aesthetic end-effect by creating the focal points.

As for practical recommendations the following can be suggested:

- Policy makers should collaborate with experts in developing practical and transparent monitoring systems, and try to gain public acceptance and understanding for them.

- Farmers should collaborate and even be at the head of the efforts to conserve a rich and sound rural landscape, and ask that their contribution be recognised, accepted and supported. It is in their best long-term interests to assume more functions and responsibilities than less.

- Local authorities and organizations should keep track of whatever monitoring systems are developed and set up their own landscape-watch, so that they can join in the pressure groups against degradation of their landscape.

- Local differences in the landscapes may make for different elements to serve as indicators. However, wider agreements can be sought on what qualities contribute to the upgrading or the degradation of a landscape, so as to form wider alliances among regions.

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Documenting Landscape Change Through Fixed Angle Photography

O. Puschmann and W. Dramstad
Norwegian Institute of Land Inventory, NIJOS

Abstract

Remote sensing, whether through satellite imagery or aerial photography, is a commonly used basis for data collection in land use / land cover monitoring. The Norwegian monitoring system for agricultural landscapes (3Q) is one sample-based monitoring programme that applies this methodology. In addition, a landscape reference system has been developed for the whole of Norway that aims to provide an overview of the landscape resource as seen from the ground perspective. The resulting 45 regions in the Norwegian landscape reference system share features related e.g. to major landforms, vegetation and agriculture. There is, however, a need to bridge the gap between land cover data, commonly available in many countries, and the way people experience the same landscapes. As an aid in this process, NIJOS has linked a module of fixed angle landscape photography to the Norwegian monitoring programme. The process of comparing data from the different perspectives for the same areas has just begun. Still, it is immediately apparent that significant changes can be documented through ground-based photographs. In some cases these are also changes that will not appear as significant from the maps or the map based indicators. We therefore suspect that ground-based photography in many cases may provide an early warning of different types of landscape changes. In this paper, we document the methods employed and some preliminary results. Further, we discuss similarities and differences between the two approaches related to their potential in the assessment of landscape change.

Introduction

Recently there has been an increased focus on landscapes in general (Wascher, 2000) and landscape multifunctionality (Brandt et al., 2000) in particular. Following the temporal and spatial scale of landscape changes seen e.g. in agricultural landscapes during previous decades, landscape monitoring has moved up on the political agenda. To an increasing extent politicians require information that is more than mere snapshots in time. From simply descriptions of state, focus of interest is shifting towards change. This tendency is further strengthened by the increased focus on international reporting, e.g. within the OECD framework. Numerous countries now have established, or are about to initiate monitoring programmes. Although these programmes differ in a range of aspects, many of them use remote sensing information as a basis for data collection.

Remote sensing is perhaps the most time and cost effective way of gathering data for large areas, especially when the topic of interest is land use and land cover, and spatial structure of landscapes or features correlated with spatial structure (Dunn et al., 1991). Following the construction of digital maps, a large number of indicators can be calculated rather easily through GIS. In combination with the pressure to suggest good indicators for international reporting, the task of developing and testing indicators has become increasingly important within many academic environments. In this process of indicator development and testing, it is important to keep in mind the overall aims behind the indicators; they shall ease communication of important but complex matters as an aid in landscape policy development, decision-making and management. Further, landscape indicators should provide information about landscape issues that are relevant to the people living in the landscapes we monitor, and not merely represent scientific interest. As each step in the process of mapping and indicator calculation tends to move us further away from the raw data and real world landscapes, it is important to ensure that these requirements are fulfilled.

The Norwegian monitoring programme for agricultural landscapes, the 3Q-programme, is one example of a monitoring programme in which remote sensing data constitutes the major data source and results are reported through a wide array of indicators (Dramstad et al., 2002). The 3Q programme was initiated in 1998, and is a sample-based programme to record present state and monitor changes in Norwegian agricultural landscapes. The main aims are to:

- give feedback to shape policy development
- control that environmental goals are met
- provide an empirical basis for setting new environmental targets
- enable comparison of development trends in Norway with those in other countries.

As outlined e.g. through recent discussion on the multifunctionality of agricultural landscapes and the ongoing work in the WTO, there may be a wide array of interests represented in a landscape. While the interest previously in focus in agricultural landscapes was production, attention today is shifting towards amenity-related interests such as recreation, aesthetics and management of cultural heritage. Therefore, landscape managers and planners need to take these interests more fully into consideration. In the 3Q programme, this is reflected in the four issues of major interest to be reported from the programme; i) spatial structure, ii) biodiversity, iii) cultural heritage and iv) accessibility.

However, the 3Q programme and other landscape scale monitoring that is based on remote sensing, views the landscape from a birds-eye perspective as opposed to the human perspective from the ground. In Norway, the ground perspective is captured within a landscape reference system, developed as a tool for landscape policy and management (Puschmann, 1998). By linking the 3Q sample squares to this landscape reference system, indicators can be calculated for subsets of sample squares and developments can be compared between different landscape regions. What remains an important question, though, is whether the landscape indicators capture, measure and report those aspects of the landscape that are important to the people living in the landscape. Are there for example differences related to the different perspectives from which the landscape is viewed? To learn whether a gap exists between indicators based on remote sensing and the way people experience the same landscapes, NIJOS has developed a module of fixed angle ground-based photography and linked it to the Norwegian monitoring programme for agricultural landscapes.

To test the suitability of fixed angle ground-based photography for documenting landscape change, several landscapes originally photographed using the same methodology some 10 years ago were revisited and re-photographed during the summer of 2002. In this paper we present the methodology and discuss the role of ground-based photography in landscape monitoring and in indicator development and analysis work.

Method

To establish the sample of squares to be included in the 3Q monitoring programme, a systematic grid of points was made to cover the entire country, with 3 km between points. A 1 x 1 km square was drawn up around every point that fell upon agricultural land. The total sample comprises about 1475 squares with agricultural land at their centre. True colour aerial photographs (scale 1: 12 500) are obtained for each square during a five-year inventory cycle, i.e. around 20% of the squares are photographed annually. The aerial photographs are interpreted according to a hierarchical land use / and cover classification system developed for this particular purpose (Engan, 1999), and digital maps are produced of all squares.

To assess the accuracy of the interpretation of aerial photographs, the 3Q maps are compared to a field control from a random sample of 10 % of the 1km^2 squares. The fixed-angle ground-based photography was carried out at 130 of these same "control squares". The photographed control squares have a geographical range from 58º south at Lista to 70º north by Vadsø and thereby represent a large proportion of the variation present in Norwegian agricultural landscapes.

Defining the fixed angle positions and what to include on the photographs

The 3Q ground-based photography project uses a qualitative approach when defining and establishing the fixed-angle photo-positions. This means that a skilled landscape-photographer is responsible for picking out both objects and positions from where the first photographs are taken. Every 3Q-square is documented with between 25 and 40 photographs, intended to capture the landscape character of the square. The number of photographs differs because the 3Q-squares vary in both landscape complexity and the share of agricultural land. More photographs are needed to document landscape character in a 3Q-square with high landscape complexity and dominated by agricultural land use, than in a square with low landscape complexity and a small proportion of cultivated land.

In the field, the photographer records on a map (scale 1: 5000) the position at which each photograph is taken, the view-direction (i.e. the fixed-angle), the number of the photograph and the focal length used (Figure 1). The latter is useful information when *exactly* the same landscape view is photographed again after five, ten or 50 years. In 2002 we began to use a global positioning system (GPS) to document the fixed-angle positions more exactly. The use of GPS eases the transmission of the fixed-angle information from the field map to the NIJOS 3Q photo-information database

Equipment, fieldwork and selection of motives

The photo equipment consists of different small format Nikon cameras and various zoom lenses with a total focal width from 20 mm to 400 mm. Most of the approximately 4 200 photographs in the photo database are taken with a focal range from 28 - 60 mm. A tripod is always used, which allows all photographs to be taken with f. 22/32 to maximise the field of depth. Most of the photographs are taken with a foreground framing to add depth to the scene. This can be signs, stones, a road, fence, brook etc., in the foreground. The reason is not only to lead the viewer's eye into the photo, but also to establish some elements in the foreground that make it easier to recognise/identify the same motive, five, ten or fifty years later. A few examples of photos are shown in figure 2.

Filters are normally not used, because it is the physical landscape, not special light effects, that we focus on. For these photographs, being the first in the time series, NIJOS used only high quality slide films, because we want the opportunity to print *every* photo with a maximum quality if needed. This is also the main reason why the project has not yet begun to use a digital camera. As the development of digital cameras has accelerated enormously during the last five years, it seems likely that the second round of photographs will be digitally photographed. This will also ease the job of both updating the photo-databases and distributing the time-series. Today we scan all the slides ourselves.

Weather conditions, time of day and seasonal effects

It is apparent that light conditions have an impact on the photographic result. Time of day and cloud cover influences the warmth of colourings. Overcast skies have a softening effect, while bright sun produces a hard light. At the middle of the day the light is normally very flat, and for most professional photographers rather uninteresting. Due to the travelling distances between the 3Q-squares and the costs involved, however, we have to photograph under the existing weather and light conditions when we arrive at the location. It is not possible to wait for optimal conditions.

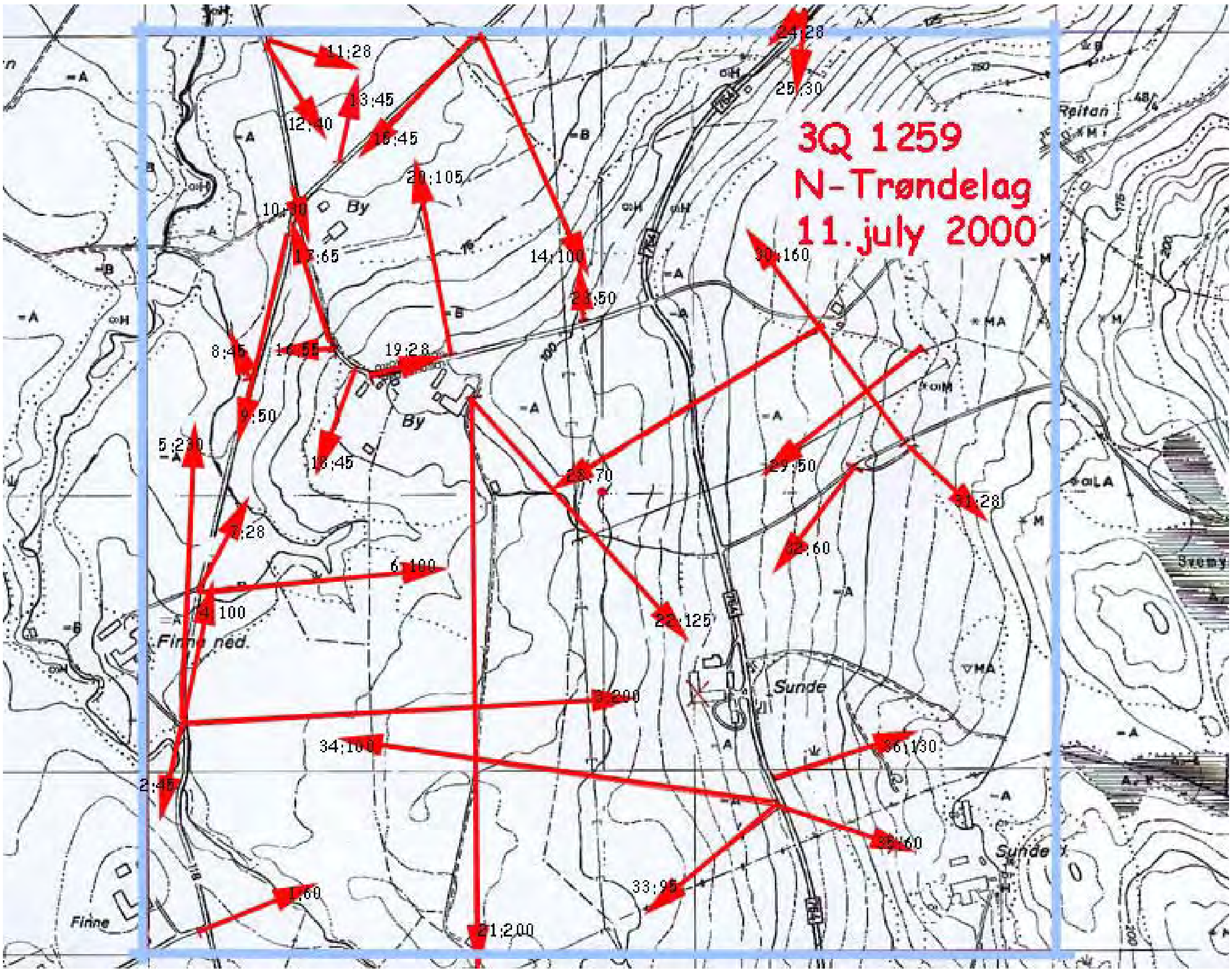


Figure 1. Information recorded when photographing a 3Q-square. Determining the location of the first photographs in the time series involves a qualitative approach, with the intent to capture the different objects, land-uses and variations, that together forms the landscape character. In the second round of photography, exactly the same landscape-frames will be photographed from the same position and with the same settings. In this 3Q-square 36 photographs were taken. On the map, the first number (ex.21:) refers to the photo number; the second (21:200) shows that the photo is taken using a 200 mm focal length.

Also time of year has a great impact on the final result, mostly because of the colour- and species changes in the vegetation. Most of the 130 3Q-squares were photographed in the period June-August, but a few also in September and October. For the second round of photography NIJOS has yet to decide whether the 3Q-squares should be photographed at exactly the same time of year or not. The question is subject to discussion.

Figure 2. Example of photographs from six different 3Q squares. While some photographs are overviews of the landscape, smaller landscape sections or of farms, other focus on particular elements present within the landscape such as old buildings or the transition zone between water and agricultural land. The figure also illustrates the information linked to each photograph.

Results

Several different trends of development previously documented (Fjellstad & Dramstad, 1999, Johansson & Norderhaug, 1993) to be ongoing in Norwegian agricultural landscapes were captured through the ground-based photographs. The disappearance of old buildings and building environments is one example (Figure 3a & b). Reforestation through natural succession of areas that were formerly grazed is a development reported from many European countries (Figure 3c & d). In addition, there were photographs showing that hardly any change had taken place during the 10-year period (Figure 3e & f).

1992 2002

Figure 3a & b. Certain landscape changes were rather pronounced. Photo b) also illustrates the use of GPS to ease the process of exact positioning on the map.

Figure 3c & d. Reforestation accompanied by a change in land use was apparent in other areas**.**

Figure 3e & f. In contrast, there were photos were hardly any landscape change could be detected.

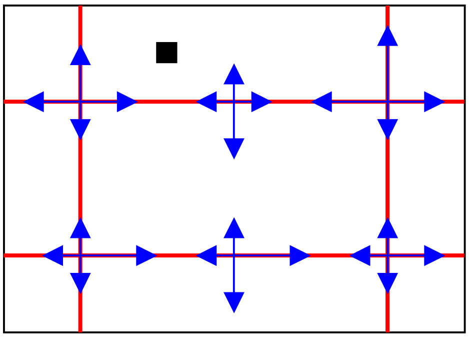
Discussion

To photograph landscapes within the framework of a fixed angle approach, with the purpose of documenting changes through time, is very different from traditional scenic landscape photography. Where photographers normally try to avoid the parking lots, signposts, telephone wires, roads etc., we consider them as elements of great importance in our "every-day" landscapes. This means that we try to take photographs that show landscapes with "all" their elements, without making judgements about whether these features are of neutral value, good or bad. We believe this total content of different elements to be important for the landscape experience of the viewer, and we further consider it to be important because telephone wires, signposts and roads actually do change with time.

NIJOS aims in this project to produce realistic photographs that communicate what we can see in a distinct landscape *now*, and at the same time produce a framework that will have an interest in the future. This is where composition, light, foreground framing, and human interest can make all the difference, but still the same photograph must be able to tell a story in the future. Simultaneously, an aim of the project was to support the process of indicator testing and development as the photographs could be considered the "ground truth" of what the indicators optimally should capture. And last but not least, we wanted to examine the degree to which supplemental information from ground-based landscape photographs could contribute to our understanding and communication of changes in the landscape.

The choice of fixed-angle positions; a quantitative or a qualitative approach?
In assessing possible methods for ground-photographing 3Q-landscapes, two different approaches were apparent (Figure 4). We could aim for as quantitative an approach as possible with a method e.g. based on transects and fixed photo-directions similar to that being used in the LUCAS-programme (Bertin et al., 2001). The alternative was to allow for a more qualitative approach where the photographer in the first round of photography subjectively would choose the points later to determine the fixed angles. To evaluate these two alternatives, we conducted a simple experiment.

Initially we constructed a grid with 100 metres between every fixed point from where we photographed in four different directions. We soon realised that this would not give us the photographs we wanted. Our strongest objection was that we felt we lost too many important landscape elements such as small buildings, solitary trees, fences etc. In addition, we felt we could not fully focus on the different and often few objects, patterns or variations that furnish a landscape and make it common, different, special or rare, i.e. the elements that provide a landscape with its unique character. Thirdly, and equally important, *the photographs did not look good*. Too often the photographs did not manage to tell a story on their own, something we intended to be an important difference between the ground photographs and aerial photographs or maps. It was apparently necessary to clarify the aims and objectives of the fixed-angle photo-project. For whom, now and in the future, would we like the photographs to have an interest?



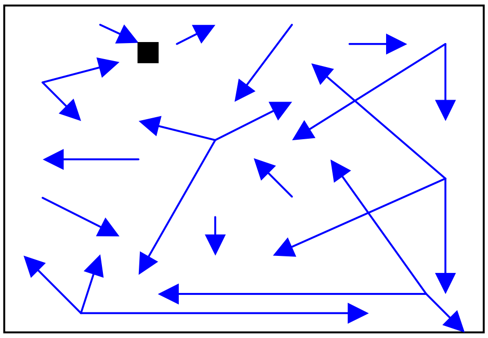
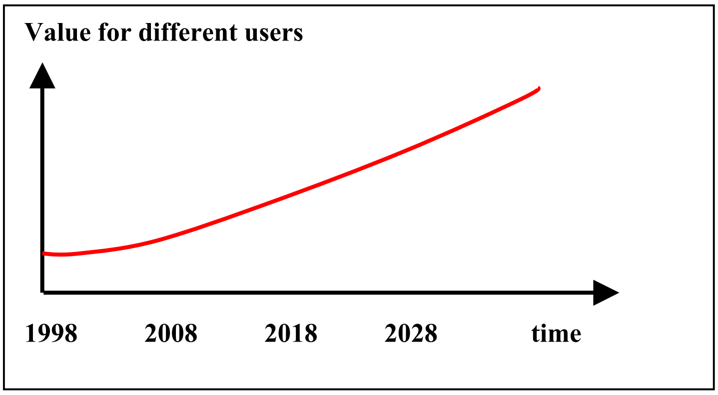


Figure 4. Different methods for determining the fixed angle photo-spots.
To the left; a quantitative approach where the location and direction of photographs are pre-defined, and where all the photographs are taken with the same focal width. To the right; a qualitative approach where the photograph locations are more subjectively chosen, and where the photographs are taken with different focal width. The first approach is strictly quantitative, repeatable and objective. The last approach is clearly qualitative and with a purpose and desire to "catch" the motives/landscapes in a more story-telling and picturesque way. The black dot illustrates a landscape object that has a particular impact on landscape character (e.g. a small house, a solitary tree, a little creek), which might not be at all visible on the photographs taken using the first approach.

Photography is commonly regarded as a subjective way of expressing how individuals experience their surroundings. Taking that into consideration, we decided to have a purely qualitative approach when it came to picking out the fixed angle points in the first round of photography. Unlike the rest of the 3Q data, we wanted to present every ground-photographed 3Q-square as something individual and unique, and also to try to combine the desire of uncovering these individual landscapes with the best possible photographs. We wanted the time-series photographs of the future to increase in value for as many different professions and uses as possible (Figure 5). Further, we wanted the photographs to have a certain picturesque quality and value now, because the photographs also are intended to be used as illustrations today, e.g. in papers, reports and presentations. This is, after all, an important economic aspect of the project. Photographing with fixed angle in transects did not fulfil these more "commercial" wishes. We do not believe that our initial choice of letting the photographer decide on points from which to take the photographs has lessened the quality of the project. The points from where the photographs are taken are now established. In the second round of photography the photographer will have to take the photographs of the same landscape views, using identical focal width. This pushes the method towards a more quantitative approach.

Figure 5. Increased value over time. One of the main challenges in the fixed-angle photography project was to establish a concept that made the time-series photographs increase in value for different kinds of professions and users.



Supplemental information

Ground-based photographs capture the content and composition of landscapes from a different angle compared to airborne sources of monitoring information and can thus provide information on aspects of the landscape that are hidden from the air. Forest edges are an example of a landscape feature important to a wide array of landscape interests (Fry & Sarlöv-Herlin, 1997), but that are problematic to record from remote sensing information due to tree crown cover and shadows. From a series of ground photographs, however, the importance of edges in a landscape will be clearly apparent. Small-scale topographic features are another example. Everything that occurs under trees is problematic with remote sensing data, where expanding tree cover may hide objects that were previously visible, such that real changes may be difficult to distinguish from changes in visibility.

In addition, remote sensing information tends to direct attention towards area, whereby elements or changes that affect large areas will be clearly documented whilst changes of limited spatial extent are more difficult to record accurately. Two examples of relevance in many Norwegian agricultural landscapes are the disappearance of farm ponds, and the disappearance of the grassy bank network formerly dividing independent fields. These are examples of landscape elements of importance to several landscape interests, but whose importance are more difficult to capture through remote sensing and indicators as they cover so small proportions of the total area. If relevant, they can easily be given attention through ground-based photographs.

Perhaps the most obvious advantage of ground-based photography is its ability to record the specific qualities and characteristics of any particular landscape or landscape element, whilst airborne data must be categorised and generalised. Thus whilst airborne data capture may record the presence of a building at a particular location at two time intervals, ground photography may show that an old traditional farmhouse has been replaced with a modern style bungalow or a summerhouse. This is a type of landscape change that may have clear implications for the experience or perception of the landscape, but which is difficult to record through remote sensing. It is, however, easily captured through ground-based photographs. The same may apply to e.g. traditional style wooden fences being replaced with more modern types. Similar more qualitative changes may be recorded for a wide range of elements, e.g. cultural heritage elements, farm buildings and remnants.

Conclusion

While we consider remote sensing a highly valuable tool in monitoring and in providing cost-effective data from which to obtain indicators of change, we need to be realistic when it comes to the limitations in monitoring landscapes from above. Thankfully, at least some of these limitations can to a certain extent be dealt with through an added module of ground-based photographs. Examples of issues where ground-based photographs may provide a valuable supplement are related to the limitations in detail and depth in remote sensing data and for issues less well correlated with spatial structure and amount of area. In particular, ground-based photographs illustrate the fact that there are landscape features of importance from a ground perspective that appear far less significant when the landscape is studied from above.

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Recommendations

We strongly recommend that the link between landscape features - remote sensing information - maps - landscape politicians/planners/managers occasionally be further extended to include also the people actually experiencing the landscapes we monitor. Only then can we make sure that the numbers we report fulfil the requirements we want them to; To ease communication of important but complex matters as an aid in landscape policy development, decision-making and management. And only then can we feel confident when we report our success in reaching the environmental targets outlined that the numbers holds the meaning we intended them to.

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World Network of Biosphere Reserves: Landscapes for People and Nature

Lucilla Spini and Salvatore Aricó
UNESCO
Division of Ecological Sciences
Man and the Biosphere Programme

Abstract

Within UNESCO's Man and Biosphere (MAB) programme, the World Network of Biosphere Reserves has remarkable high natural values (high ecological integrity, high biodiversity, limited human use, rather unstressed systems, resource management being not extraction-oriented, etc.) and high cultural values. It comprises ecosystems and people, thus reflecting the human dimension in the environment, and is a network founded upon principles of maintaining biodiversity while sustaining ecosystem functions and livelihood systems.

Biosphere reserves (408 in 94 countries, hundreds of which in OECD countries), serve as laboratories for research and demonstration of ways in progressing towards sustainability of human environment interactions including wise-use and economic development. Research and monitoring in biosphere reserves encompass environmental and socioeconomic aspects and procedures (methodologies, indicators and protocols).

The wise management of agricultural systems in biosphere reserves is being investigated at two main levels:

- *assessing and monitoring the threats/pressures on the ecological services and values maintained by agroecosystems in key sites that provide good case studies; and*
- *evaluating and cataloguing local biodiversity in relation to agricultural practices through surveys throughout the whole World Network, assessing whether their state is improving or declining.*

Our work focuses also on the testing of the provisions under the Convention on Biological Diversity that relate to agrobiodiversity, in collaboration with the International Plant Genetic Resources Institute (IPGRI).

The main challenge being to integrate findings emerging from both natural and social scientific monitoring programmes and initiatives in order to better understand the links between agriculture, traditional knowledge, culture and society, it is a priority to the MAB constituency and of the MAB secretariat to identify methodologies and indicators that well measure these key interlinkages.

This will constitute the core of the presentation, which will also tackle the importance of using monitoring for educating and raising awareness on environmental and sustainable development issues among policymakers.

Keywords: MAB, World Network of Biosphere Reserves, Landscape, Monitoring, Sustainable Agriculture

Text

UNESCO' Programme on Man and the Biosphere (MAB) develops the basis, within the natural and the social sciences, for the sustainable use and conservation of biological diversity, and for the improvement of the relationship between the people and their environment globally. It encourages interdisciplinary research and information gathering, training in natural resource management, as well as linking with traditional knowledge about resource use.

Biosphere Reserves are the tool to implement such vision. They are areas of terrestrial and coastal ecosystems – areas which are structured in three interrelated zones, known as the core area, the buffer zone and the transition area.

The core area needs to be legally established and give long-term protection to the landscapes, ecosystems and species it contains. It should be sufficiently large to meet these conservation objectives. As nature is rarely uniform and as historical land-use constraints exist in many parts of the world, there may be several core areas in a single biosphere reserve to ensure a representative coverage of the mosaic of ecological systems. Normally, the core area is not subject to human activity, except research and monitoring and, as the case may be, to traditional extractive uses by local communities.

A buffer zone (or zones) which is clearly delineated and which surrounds or is contiguous to the core area. Activities are organized here so that they do not hinder the conservation objectives of the core area but rather help to protect it, hence the idea of "buffering". It can be an area for experimental research, for example to discover ways to manage natural vegetation, croplands, forests, fisheries, to enhance high quality production while conserving natural processes and biodiversity, including soil resources, to the maximum extent possible. In a similar manner, experiments can be carried out in the buffer zone to explore how to rehabilitate degraded areas. It may accommodate education, training, tourism and recreation facilities.

An outer transition area, or area of co-operation extending outwards, which may contain a variety of agricultural activities, human settlements and other uses. It is here that the local communities, conservation agencies, scientists, civil associations, cultural groups, private enterprises and other stakeholders must agree to work together to manage and sustainably develop the area's resources for the benefit of the people who live there. Given the role that biosphere reserves should play in promoting the sustainable management of the natural resources of the region in which they lie, the transition area is of great economic and social significance for regional development.

This outer transition area is extremely important, as it merges in the surrounding environment. In fact it should be underlined that this area have no fixed boundaries – there are no fences between the nominated area of terrestrial and coastal ecosystems and the surrounding bio-regional landscape. It is whole part of a continuum. Experience has underscored the importance of avoiding the conversion of reserves into sharply defined island in a landscape. Rather, the reserve needs to be attuned to what is occurring in its broader setting and seek to modify negative influences. Each biosphere reserve is a part of a regional landscape and is exposed to many of the same disturbances, pressures and variable management affecting the landscape.

However, the nominations of a Biosphere Reserve guarantees that a part of this bio-regional landscape serve as a “living laboratory” for testing out and demonstrating integrated management of land, water and biodiversity. In fact, each of these sites during the nominations (and beyond the nomination process, of course) has demonstrated that it can fulfil the following basic functions:

- **a conservation function**: to contribute to the conservation of landscapes, ecosystems, species and genetic variation;
- **a development function**: to foster economic and human development which is socio-culturally and ecologically sustainable;
- **a logistic function:** to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

These functions are complementary and mutually reinforcing – allowing therefore the daily running of this “living laboratory” in the context of a bioregional landscape.

At the time of printing (August 2002) there are 408 Biosphere Reserve in 94 countries and new nominations are reviewed each year. The ensemble of all these sites is united through regional and thematic networks, but more importantly, through a world network: The World Network of Biosphere Reserves.

In addition, it is important to underline that some (or part of) these areas are recognized under other national (such as national parks, regional parks) or international (such as World Heritage Convention, Ramsar Convention) programmes.

This is a global exercise that is based on the so-called pillars of sustainability – economic, environment and society – as remarked in the “Seville Strategy” – a strategy paper providing a social contract that seeks to reconcile social and economic progress with ecological integrity. In addition it is important to remark that this global exercise is characterized by diversity, both natural/biological and cultural, and its remarkable high value.

The natural values of biosphere reserves can be easily identified by the presence of high ecological integrity, high biodiversity, sustainable use of natural resources, and their integrated management. The cultural values are much more difficult to identify due to the fact that issues related to culture are more subjective and arbitrary. It is beyond the scope of this paper to define culture: however it is important to understand the parts of biosphere reserves which exhibiting cultural values.

There are a wide variety of ways in which a cultural value of biosphere reserves can be interpreted, such as the presence of indigenous groups, the presence of sacred sites or ethno-ecological interactions in biosphere reserves.

First of all, it is important to remark that even the Biosphere Reserve can have a cultural value *per se* as – according to Ronald Engel – gives a “sense of place” and can be considered as the emergent sacred spaces of an environmentally sustainable way of life. However, many “more concrete” features in the biosphere reserves can be attributed a cultural value, such as in the case of the sacred site Uluru-Kata Tjuta in central Australia. Sacred sites are areas deserving special treatment by the local populations, as well as other products of ethno-ecological interactions.

Human societies in different parts of the world have developed a wide variety of relationships and linkages with their environments, in such domains as traditional agriculture, cultivation and exploitation of traditional crops, and characteristic features of local architecture, land use and landscape management – as it has been highlighted during the “Ethno-Ecological Interactions in Biosphere Reserve” held in Luhacovice (Czech Republic) in May 1999. The conference addressed issue such as the ways in which the natural environment is reflected in traditional culture; and the impact of socio-economic development on land use and land cover. In addition, research and methodological issues, such as in the case of the role of ethnography in finding sustainable uses of natural resources, were also discussed in this conference as well as in "The Cultural Mediation in Ethno-Ecology" Conference held in March 2000 in the Cévennes Biosphere Reserve.

The complexity and functions of the biosphere reserve emphasize the relevance of research activities. Research is an important component in the understanding the status of many component of biosphere reserves: it is carried out in a wide variety of field: ecology, economics, anthropology – just to name a few. Research is conducted in biosphere reserves and, given the different areas of a biosphere reserve, it may be conducted on the structure and dynamics of the minimally disturbed natural systems of the core areas, and compared with the functioning of human-affected landscapes in the buffer and transition areas. Such studies, when carried out over the long term, show how these systems may be changing over time. Setting up similar long-term monitoring plots, and harmonizing methods and measurements allows comparison of results regionally and worldwide. The information thus obtained allows us to better understand global environmental changes.

In addition, a monitoring programme has been officially established within the MAB Programme Officially in the early 1990s, with the first Biosphere Reserve Integrated Monitoring (BRIM) Programme workshop organized in 1991. The importance of such a programme was then underlined in 1995 in the "Seville Strategy" and in the "Statutory Framework of the World Network of Biosphere Reserves" - a document setting out the conditions for the functioning of the World Network of Biosphere Reserves. Both documents were subsequently adopted under 28 C/Resolution 2.4 of the UNESCO General Conference, in which the General Conference agreed that "biosphere reserves constitute ideal sites for research, long-term monitoring, training (...) while enabling local communities to become fully involved in the conservation and sustainable use of resources."

Since then, the importance of the implementation of such a programme has been emphasized and underlined by Member States, and the Secretariat has therefore taken further actions (e.g. Special Meeting, Regional Workshops, metadatabase on research and monitoring activities in biosphere reserves etc.) on developing monitoring initiatives.

The ultimate goal of the BRIM Programme is to provide a platform for the integration of the resulting information/data, thus contributing to a better understanding of the changes that take place in the areas being studied and of the factors triggering these changes, while also suggesting options for planning and management. BRIM focuses on different types of monitoring – reflecting the complexity of the biosphere reserve – which can be grouped into these three main categories:

- Abiotic monitoring;
- Biotic monitoring;
- Social monitoring.

The Secretariat along with a pool of experts is currently working on identification and selection of monitoring methodologies and indicators that can be widely used by the World Network of Biosphere Reserves. Agriculture is one of the most common human economic activities in biosphere reserves and surrounding areas. Therefore agroecosystems are one of the targets of the targets of the monitoring programme in order to pursue wise management of agricultural practices. In particular, concerning the identification and selection of indicators of agrobiodiversity, and of biodiversity in general, BRIM is referring to CBD criteria – expressed in the Oslo 1999 CBD meeting on assessment, monitoring and indicators – for a universal core set of indicators, as well as to the criteria identified in the Zurich 2001

OECD Expert Meeting on Agri-Biodiversity Indicators:

- *Quantify information so that its significance is apparent*
- *Be user driven*
- *Be scientifically credible*
- *Be responsive to changes in time and/or space*
- *Be simple and easily understandable by the target audience and exhibit policy relevance*
- *Be based on information that can be collected within realistic capacity and time limits*
- *Be linkable to socio-economic developments and indicators of sustainable use and response*

In order to focus on identifying *ad hoc* methodologies/indicators for assessing and monitoring the threats and pressures on the ecological services ad values maintained by agroecosystems in key sites, collaborative efforts have been sought with the International Plant Genetic Resources Institute (IPGRI). In particular in conserving and/or rehabilitating the genetic pool of wild and/or domestic species. Monitoring activities should be reinforced in this respect with the establishments of appropriate monitoring plots and with evaluation of size and/or zonation of the biosphere reserve (i.e. if it meet special conservation needs). In the long-term, the cooperative effort aims: i) to demonstrate the value of diversity (resistance/resilience, mitigation of vulnerability, recovery, etc.) in production (crop and forestry) systems and the role of people (and their associated knowledge, practices and cultures) in maintaining /enhancing that diversity; ii) to identify a set of options to tackle situations in which that diversity is being threatened, eroded, or lost and to mitigate those adverse situations; and iii) to assist in the making of appropriate policies to enable the implementation of the most appropriate solutions. The core of collaborative operations might be the development of a network of demonstration sites that should focus, whenever possible, on existing biosphere reserves and MAB networks and IPGRI centers and regional offices. The network should aim to be representative of a whole set of ecological (including human ecological) and socio-economic realities (ideally sites should be distributed along a poverty-sustainable livelihood-economic development gradient).

Examples of *in situ* conservation of plant genetic resources related to agricultural practices are found in the Sierra de Manantlán Biosphere Reserve in Mexico. There *Zea diploperrennis*, (known as the *milpilla* or as wild maize) has been extensively studied in order to pursue its *in situ* conservation. As wild relatives of many crops tend not to occupy "wild" and "pristine" environment but they occupy human-maintained and disturbed, their *in situ* conservation involves the conservation of the whole agroecosystem thus including spontaneous and traditional crops. Thus, research and monitoring was conducted on a long-term scale in order to see the dynamics of the *Zea diploperrennis* and the surrounding of the cultivated plots. It was found that plots 15 year post-cultivation revealed the first incursion of young woody trees that could eventually replace *Zea diploperrennis* and other plants. In conclusion, these finding suggests that the long-term persistence of this wild maize will depend upon regular small scale forest openings like those produced by shifting agriculture (Tuxill and Nabhan, 1998).

This example illustrates the complexity and the interactions between agricultural practices and local biodiversity. The scientific community in and outside biosphere reserves is currently more and more focusing on evaluating and cataloguing the status of local biodiversity in relation to agricultural practices. As example we can mention a recent published paper by Benton *et al*. (2002) on linking changes of agricultural practices to insect and bird populations in terms of food quality and/or quantity.

Therefore, biodiversity monitoring *per se*, as conducted in almost all biosphere reserves, further our understanding of the impact that agricultural practices have on the environment and biodiversity. This understanding is essential for the achievement of sustainable agricultural practices, i.e. those "practice that meet current and future societal needs for food and fibre, for ecosystem services, and for healthy lives, and by doing so by maximizing the net benefit to society when all costs and benefits of the practices are considered" (Tilman *et al*., 2002: 671).

Biosphere Reserves and the World Network of Bisophere Reserves as a whole is promoting sustainable agricultural practices whih can avoid socio-economic, cultural and environmental crises. In short, as recently remarked by Trewavas the aim is to promote practices allowing "maximal yields with minimal damages" (2002: 669). An example is found in the Calakmul Biosphere Reserve in Mexico where an agroforestry project has allowed coordinating reforestation along with reinforcing "return for labour", while conserving the local tradition agricultural intercropping system, known as the *milpa* (Shook and Zapata, 1998).

Such example leads us to the important perspective of the land cover type and the concept of landscape. Agricultural landscapes clearly exemplify the interactions of human populations with nature. However, it is important to remark that, especially in biosphere reserve, these landscapes are part of a continuum made of pristine areas and urban/peri-urban ecosystems. Therefore, it is important to implement landscape-scale management – a key-issue in biosphere reserve structure and in general as also underlined by Tilman *et al.* (2002) – and most of all to monitor changes at the landscape level.

In the World Network of Biosphere Reserve, an excellent example of this is proposed by the Biosphere Reserve Landscape Change Project held in six Canadian Biosphere Reserves. A range of methods was employed in this project – such a historical survey records, aerial photos and satellite imagery – and a range of observation was recorded, such as the present day regeneration of abandoned agricultural lands to forests. Apart from the contribution to the scientific knowledge of landscape and land-cover changes, these studies have contributed to the "sense of place" of communities living in and near each biosphere reserve – a growing awareness of the local environment and a shared history of the area, as well reinforcing individual values and feelings towards the land.

As briefly introduced by the above-mentioned project, the social (by "social" is meant social, economic and cultural) components of agricultural landscape – and of landscape in general – should not be forgotten. Therefore, in order to achieve a complete full picture of the situations and ongoing changes in agricultural landscapes, it is extremely important to integrate biodiversity/agri-biodiversity indicators with those related to socio-cultural and economic component of the landscape.

This issue has been recognized by the BRIM Programme's 2002-2003 work plan acceleration has placed strong emphasis on the importance of socio-economic monitoring and indicators within the integrated monitoring systems. Workshops and pilot projects have been foreseen and carried out for the identification of methodologies and indicators, which can monitor changes in the socio-cultural and economic aspects of biosphere reserves.

Given the broad diversity of the human population under study, the methodologies are aimed to be tailored both at the global level and at the site level. The kinds of data collection which can be applied in biosphere reserves, by taking into consideration previous studies. Among these data-collection technique, there are: statistical and demographic data; social surveys; interviews; case studies; rapid rural appraisal; country reports and briefings and non-reactive methods (Lass and Reusswig, in press). There will then be different sets of indicators, following Lass and Reusswig (in press):

1. Core indicators: fixed for all biosphere reserves – obligatory
2. Optional indicators: fixed for all biosphere reserves –selection possible
3. Open space for site-specific proposals.

In particular, the identification of such "social" indicators should be based on the dimensions of the monitoring to be implemented and on the characteristics of all the stakeholders concerned with such landscape.

Among the dimensions, it is important to recall, following Lass and Reusswig (in press): i) basic demographics and well-being of people; ii) ecosystem use; iii) socio-economic dynamism; iv) management, participation and governance; v) values and attitudes; and vi) information, education and research.

Among the primary stakeholders, it is important to recall: i) the farmers (as individuals and as associations); ii) the local/regional/national governments; and iii) the local historian/experts. The farmers' community is – of course – particularly important as they can contribute to compile the knowledge of the situation of the local reality, especially concerning those problems related to the protection of the agricultural and surrounding landscape. In addition, they have an active role in the safeguarding of policies (in the shape of recommendations, objectives and incentives).

However, it should not be forgotten the importance of the local people repository of the traditional knowledge concerning the landscape. The role of the concerned stakeholders of an agricultural landscape is very well exemplified in the Cévennes Biosphere Reserve in France.

This biosphere reserve exhibits a landscape characterized by terraced fields, which are the product of the labour of many generations to cultivate steep slopes and poor soil under difficult climatic conditions. These agricultural terraces, as well as many settlements in this area, are the tangible product of know-how of dry-stone masonry. However, the interest and value of the terracing and dry-stone masonry have undergone a decline due to an exodus at the end of the 19th century / beginning of the 20th century. It is only recently that there has been an effective revival in the interest for this heritage.

The Cévennes Biosphere Reserve project focuses on the utilization of stone for shaping the landscape from many different perspectives:

1. Local architecture and landscape;
2. Protection and safeguarding of cultural heritage;
3. Creation of training and employment for young people to preserve traditions and to combat unemployment in the area.

The interest in this matter has been triggered by the fact that, as H. Bouvier (Cévennes Biosphere Reserve) underlined: the charm of this landscape is due to what people did to this area. The values – both economic and aesthetic – of these landscape features have risen again in the Cévennes Biosphere Reserve. The project, in fact, has been built around the idea of fitting in the present day economy of France and Europe by revitalizing the dry-stone walls to improve cultivation-revenues (e.g. raspberry cultivations, fruit-trees plantations), given the agronomic characteristics of the stone-walled terraced concerning irrigation and heating.

In addition, the historic, cultural and aesthetic values of these landscape features have been greatly revitalized: by training young people in dry-stone masonry and attracting tourists and visitors to the area. This example confirms that the landscape is not just a bio-physical element, but as remarked by Bridgewater and Bridgewater: "essentially all landscape are cultural, and subject to cultural influence" (1998: 38): Agricultural landscapes' values are therefore built into the cultural sphere of the populations inhabiting and visiting such places. It is very important for the well being and wise management of such landscape, to monitor these values within a "values and attitude" dimension of monitoring, by investigating the attitudes towards the biosphere reserve, nature conservation, environmental issues and agricultural practices, as well as towards economic revenues activities. But most of all by their "sense of place" and sense of ownership of traditional knowledge.

There may also be very different perceptions by the various stakeholder groups on the landscapes, such as in the case of the likely costs and benefits of the introduction of a new landscape feature, such as a mine or a road. However, the biosphere reserve can be a tool to allow these different perceptions to coexist in harmony. Education and public awareness campaigns are tools for promoting dialogue on perception of landscapes and human activities taking place and shaping such landscapes – such as exemplified by the Environmental Education Kit on Desertification.

Moreover, exchange of information, experience and personnel also facilitates such process through the regional and thematic networks and the World Network of Biosphere Reserves. A web site also plays an important role in these exchanges, in particular it is important to recall the web pages developed for BRIM (**http://www.unesco.org/mab/brim/index.htm**) where more information can be found on the different types of monitoring methodologies can be found. As a pilot phase, these web pages provide links to different sources of data, and information on currently available methodologies and case studies. In the future, it is envisaged that other sources of information be added and that this part be developed to serve as an Information Facility for Biosphere Reserves, by emphasizing the importance of integrating the biotic, abiotic and social monitoring initiatives.

In particular concerning the agricultural landscape indicators, the main challenge of the MAB and BRIM Programmes is to integrate findings emerging from both natural and social scientific monitoring initiatives in order to better understand the links between agriculture, traditional knowledge, culture and society. It is a priority for the MAB Programme, in particular within the context of the BRIM, to identify methodologies and sets of indicators that well measure these key interlinkages, along with coordinating these efforts with other institutions focusing on monitoring and indicators.

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Methods for Indicators to Assess Landscape Aesthetic

Beatrice Schüpbach
Swiss Federal Research Station for Agro ecology and Agriculture
Reckenholzstrasse 191, Postfach, CH-8046 Zürich,Switzerland
Phone: +41 1 377 73 28, Fax: +41 1 377 72 01
e-mail: beatrice.schuepbach@fal.admin.ch

Abstract

Swiss people and tourist from abroad are interested in a beautiful landscape for recreation. Since the surroundings of urban areas and the mountains are typical regions for recreation and agriculture is a driving factor to shape landscape in these regions, it is logical to develop an indicator for man made changes affecting landscape aesthetic. Even though many people support the idea from landscape aesthetic to be both arbitrary and difficult to describe, there are several landscape aesthetic concepts as well as many methods to assess landscape aesthetic. Therefore it is recommended to derive individual indicators measuring anthropogenous changes affecting landscape aesthetic from an existing sound method, relying on landscape aesthetic concepts as well as landscape perception. Moreover such a method has to have both a successful application and a proven sensitivity to detect even small changes in landscape scenery. In addition a context to explain the outcomes is required. This paper shows that such a method exists in theory but in practise it is far too expensive for an extensive monitoring scheme. Eventually a context for a meaningful interpretation of the results is still lacking in Switzerland. Therefore there is a need for future research stressing both the development of a Swiss landscape typology and a reduction of methodological complexity.

Introduction

An investigation about landscape and biodiversity among Swiss people revealed that the beauty of a landscape is an important or even a very important reason for 90 % of the interviewed persons to choose the destination for a day trip (UNIVOX 2002). For most people 'naturalness', or a landscape that is not affected too much by human activities was the first asset to make up the beauty of a landscape. 'Cleanliness' e.g. clean air and clean water figured on rank two, whereas the third rank was given to the aspect of a neat and tidy scenery. Therefore a beautiful landscape consists of both 'naturalness' and 'neatness'. An additional issue of landscape aesthetic is the fact that objections against projects affecting scenery are increasingly based on reasons dealing with landscape aesthetic. The different approaches to landscape aesthetic of both, the tourist industry and the landscape protection organisations are reflected by various internet sites (http://www.scuol.ch, http://www.grindelwald.ch/galerie, http://www.gstaad.ch/gallery, http://www.graechen.ch/d/galerie, http://www.sos-arvel.ch).

Agriculture is a driving force to shape landscape. A sustainable and multifunctional agriculture is needed to maintain a diverse and attractive landscape, especially in the surroundings of urban areas as well as in mountainous regions. This meets also the interests of recreation and tourism. The 165 km^2 catchment of lake Greifensee, for instance, is for the nearby 1.2 Mio population of the greater Zurich area an attractive place to recreate. Nevertheless, the Greifensee area is also the habitat and resource of income for 5000 farmers and their families, which have to cope not only with a continuous reduction of farming areas but also with the drop-off in prices for their products. However, there is a challenge to conduct the inevitable changes to come in agricultural structures in a way that considers the role of landscape scenery for recreation. Therefore, the development of an indicator for man made changes affecting landscape aesthetic is a vital issue.

Is there a way to quantify landscape aesthetic?

Landscape aesthetic is known to be difficult both to define and to record. Therefore resulting data are assumed to be arbitrary and person dependent. This would be a bad base for an indicator measuring changes in landscape scenery. Nevertheless there are different definitions of landscape and several concepts of landscape aesthetic as well as landscape perception. A neutral definition of landscape, based on a holistic geographical approach, is given by Schmithüsen (1963): Landscape comprises the total of all natural and man made phenomena in a geographically relevant area. Men are perceiving landscape with all their senses (Wöbse 1984). The different ways of perception (sense of eye, ear, smell and touch) are selective, depending on the observers' experience and knowledge (Loidl 1981). Therefore individual groups of observers perceive a certain landscape in a different way according to their socio-cultural background.

There are several conceptual approaches to identify those elements and structures which contribute to the aesthetic of a landscape. Bourassa (1991) distinguishes three groups of concepts:

1. A group based on biological rules
2. A group based on social rules
3. A group based on the ontology of the individual

Concepts belonging to the first group, the so called 'habitat theories' suggest a landscape type, having enabled the successful development of mankind, would also find favour with modern man. According to Hunziker (2000) the 'information processing theory' by Kaplan & Kaplan (1989) is among the 'habitat theories' the soundest. The 'information processing theory' postulates that men are in favour with landscapes bearing an ideal combination of landmarks an landscape elements hence providing both an easy survival and a challenging environment for exploration. All these 'habitat theories' rely on inborn preferences which are genetically inherited from generation to generation.

Concepts of the second group rely on social rules. These are dealing with culture and tradition handed over from generation to generation by symbols and myths. Singular landscape elements can have the particular significance of a symbol creating a strong identity of people with their landscape.

The concepts of the third group deal with the specific preference of individuals for a certain landscape, based on personal experience. However, literature is almost lacking because there is no easy scientific approach to this sort of questions.

A combination of both the biological and the social concepts of landscape aesthetic is the 'epistemological model' of Nohl (Noh1 1980, Nohl 1988, Hunziker 2000). The 'epistemological model' comprises three levels of awareness. On the first level (perceptive level) the various landscape elements are perceived. On the second level (symptomatic level) the perceived landscape elements are interpreted according to their context, whereas on the third level (symbolic level) symbolic values are attributed to the individual landscape elements. In the context of emotions and desires certain landscape elements gain a particular significance far beyond their real identity. Landscape elements perceived on both the perceptive and the symptomatic level supply the demand on orientation in space and stimulation. Landscape elements perceived on the symbolic level supplies the demand for identity or freedom. Hunziker (2000) proposes that the perceptive and the symptomatic level are comparable with the biological concepts of landscape aesthetic, while the symbolic level is more comparable with the social concepts of landscape aesthetic.

Conditions for a successful development of indicators

In order to develop indicators evaluating landscape aesthetic we need a method which allows to derive several indicators measuring different aspects of landscape quality. Such a method must fulfil three conditions: First it must reliably measure the aesthetic quality of a landscape. Therefore it must rely on one of the three groups of concepts described above or on a combination of several groups. So we can make sure, we are really measuring landscape aesthetic. Second, the method should have been applied earlier in order to know its advantages and disadvantages. Third, the method should be as sensitive as to detect even small changes in landscape. Furthermore, after measuring we need a context to explain the outcomes, what should be the fourth condition for a successful application of an indicator measuring landscape aesthetic.

As to the first condition, there are many methods to evaluate landscape aesthetic. Several of them have a evidence of the criteria selected to assess landscape aesthetic (e.g. Perpeet (1992), Riccabona (1992), Hoisl et al. (1989), Feller (1981)). Only the method of Hoisl et al. (1989) is based on the 'epistemological model' by Nohl (Nohl 1980, Nohl 1988) described above and was verified by interviews. Deriving from the three levels of awareness Nohl postulated three factors of perception: The first factor, 'variety', describes how landscape is seen on the perceptive and on the symptomatic level. A landscape rich in 'variety', e. g. a landscape with trees and hedgerows stimulates the observer and helps him to orientate oneself in space. The two other factors of perception, 'naturalness' (linked with the intensity of land use) and 'character' (linked with the 'history' of the landscape) describe how landscape is perceived on the symbolic level. A landscape rich in 'naturalness' gives the observer a feeling of freedom, while a landscape rich in 'character' gives the observer a feeling of identity or of being at home.

The second condition fulfils at least in the German-speaking area only the method of Hoisl et al. (1989). It is one of the rare methods based on a founded concept of landscape aesthetic. Therefore, it was used several times by the author (Schüpbach 2000, Schüpbach 2001) but also in other projects, e.g. Nohl (1993).

What concerning condition three and four, we need to apply a method in order to discriminate different states of a landscape. By this means, we can verify the sensitivity of the applied method for detecting small landscape changes. If we apply the method in different regions, we can verify if the outcomes are differing between regions. In this case a context to explain the results is required. That would be a fourth condition which should be fulfilled.

Testing the method for its suitability to derive indicators

Material and methods

A study evaluating the efficiency of ecological compensation area (eca) (Schüpbach 2001) is suitable to verify whether the method by Hoisl et al. (1989) is as sensitive as to detect small changes in landscape scenery and to decide if a context to explain the outcomes is needed. In this study the method of Hoisl et al. (1989) was applied in three regions, where the effect of ecological compensation areas (eca) is evaluated (Bigler et al. 1998). The three regions are: Rafzerfeld, a flat region with intensive crop production, Combremont / Nuvilly, a slightly hilly region with mixed agriculture and Ruswil / Buttisholz, a hilly region with grassland (Schüpbach et al. 2000). This application is a good test for the sensitivity of a method for assessing landscape aesthetic, since eca are small surfaces (extensively or low intensively used meadows, wild flower strips and hedgerows) in the agricultural used area and make up only 7 % of agricultural used area (Landwirtschaftliche Beratungszentrale 1999). Botanic releves show that the extensively used and the low intensively used meadows, which are the most used type of eca, often do not differ much from the other agricultural used meadows (Hofer et al. 2001). Furthermore the results of three regions show whether the results of the landscapes of the three different regions discriminate. This would mean we need a context to explain the results.

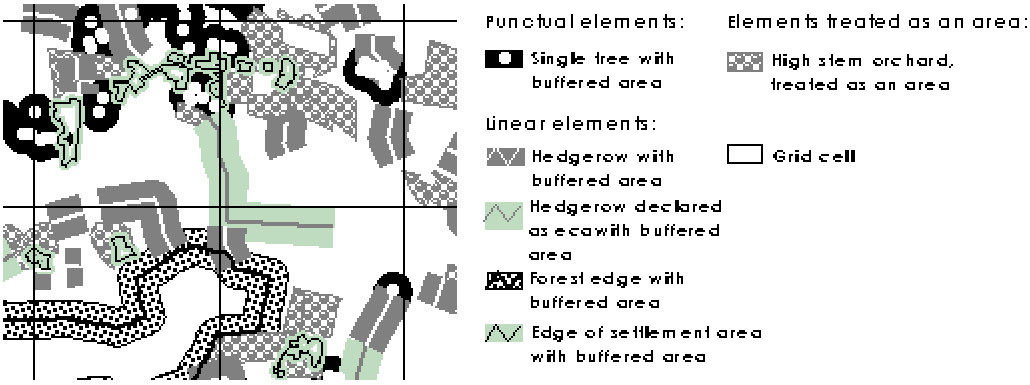
The objective of the study to evaluate the efficiency of eca was to show whether eca have a (positive) influence on landscape aesthetic or not. For this reason digital land using data of the three regions described above were used to calculate the two factors of perception, the 'variety' and the 'naturalness' of the method by Hoisl et al. (1989). According to the concept by Mack (2001) these factors of perception were calculated in two different ways: On the one hand with all landscape elements including the eca and on the other hand as if eca would not exist. For the calculation of the two factors of perception the landscapes of the three regions were overlayed with a grid of 25 ha cell size. The value of each of the factors of perception was calculated for each grid cell.

In order to calculate the 'variety' of a landscape, all elements that contribute to landscape 'variety' are divided in punctual elements (e.g. trees), in linear elements (e.g. hedgerows) and in area elements (e.g. high stem orchards). Punctual and linear elements were buffered by a distance depending on their effect on landscape scenery. All resulting areas were divided by a factor. The result was summarised by each grid cell divided by the area of the grid cell and standardised (Hoisl et al. 1989, Schüpbach 2000). Figure 1 contains both the formula and an illustration for calculating 'variety'. Table 1 shows for each landscape element in the three regions contributing to landscape 'variety' whether it is an eca or not. In the second calculation, all landscape elements contributing to 'variety' that are eca, or only one type of eca were not considered.

Table 1: Landscape elements contributing to 'variety' in the three regions and differentiation in Ecological comensation area (eca) and not-eca.

Landscape element	*ECA*	*Not-eca*
Single tree	CN[2], RB[3]	Ra[1]
Hedgerow	Ra[1], CN[2], RB[3]	Ra[1], CN[2], RB[3]
High stem orchard	CN[2], RB[3]	
Forest edge		Ra[1], CN[2], RB[3]
Edge of settlement area		Ra[1], CN[2], RB[3]

1Region Rafzerfeld
2 Region Combremont / Nuvilly
3 Region Ruswil / Buttisholz



Landscape element	Buffer distance [m]	Divisions factor (D): Area for one point [m2]
Single tree	50	2500
Hedgerow	50	1000
High stem orchard	treated as an area	1000
Forest edge	50	2500
Edge of settlement area	10	2500

Minimum value: 1
Maximum value: 50

Formula for calculating the value of the factor of perceiving 'variety'

$$\left(\frac{\Sigma \ ((\text{area punctual elements} / D) + (\text{area linear elements} / D) + (\text{area elements treated as an ara} / D))}{\text{area of the grid cell}} \right) * 2.5$$

Figure 1: Calculating of the factor of perception ‘variety’ according to Hoisl et al. 1989 and Schüpbach 2000.

For calculating ‘naturalness’ the area of each land use type per grid cell is weighted by the intensity of influence by man. Land use types with no or only a slight influence by man, such as wet lands, have a high value and land use types with a high influence by man, such as fields with intensive crop production have a low value. First ‘naturalness’ of the three regions was calculated including eca. In a second step, an alternative land use according to the concept of Mack 2001 was assumed for eca and the ‘naturalness’ was calculated again. Table 2 shows the definition and the value of the six different land use types. Table 3 shows the different eca influencing naturalness, the assumed alternative land use and their occurrence in the three regions. Figure 2 illustrates the calculation of the ‘naturalness’.

The third factor of perception, the ‘character’ of the landscape was not calculated. This factor evaluates all changes in a landscape during the last 30 or 40 years. The more a landscape changed during the last 30 or 40 years the more the character of this landscape decreases. Such changes e.g. consist in the loss of high stem orchards or hedgerows, reforestation on big areas, the transformation of grassland to crop fields, new roads or new settlement areas. It is an arduous and time consuming process to reproduce all changes of a landscape objectively, therefore it is was not possible within the scope of this study. But it would be important to think about how it could be considered.

Table 2: Land use types, their description and values for the factor of perceiving 'naturalness'

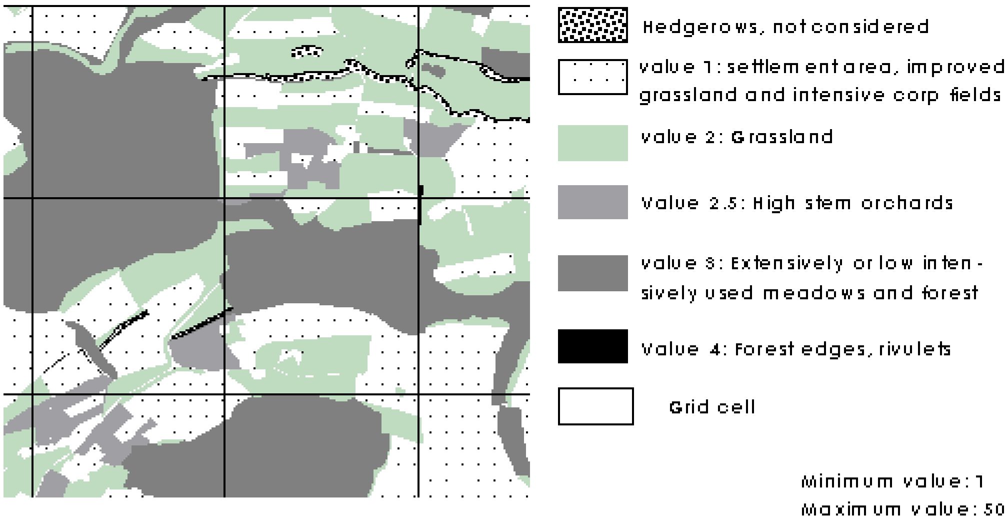
Definitions of land use types by Hoisl et al. 1989	*value*	*Land use types in the three regions*
Areas very intensively used by man such as intensive crop production and settlement areas	1	Settlement area, gravel pit /industry, roads intensive crop fields, improved grassland, sports facilities, tree nursery
Areas with intensive agricultural land use such as grassland with no trees	2	Grassland
	2.5	High stem orchards with improved grassland
Low intensively used agricultural surfaces with grove such as extensively used wetlands with scrub or low intensively used grassland, forests with wood yield.	3	Extensively or low intensively used meadows, extensively used pastures (eca), forest, afforestation
Extensively used agricultural surfaces with no scrub such as extensively used wetlands or dry grassland, water surfaces	4	Wild flower strips (eca) forest edges, escarpment, rivulets, reeds
Surfaces with slight or no agricultural use and scattered scrub such as wetlands or extensively used high stem orchards	5	
Surfaces with slight or no agricultural use and scrub	6	

Table 3: Eca-types, their value for naturalness, their assumed alternative land use according to Mack 2000 and occurrence in the three regions

ECA		*Assumed*	*alternative landuse*	*Occurrance in the three regions*
Description	*value*	*value*	*description*	
Extensively used meadows	3	2	Grassland	Ra[1], CN[2], RB[3]
Low intensively used meadow	3	2	Grassland	Ra[1], CN[2], RB[3]
Extensively used pasture	3	2	Grassland	Ra[1], CN[2]
Wild flower strip	4	1	Intensive crop production	Ra[1]
High stem Orchard.	2.5	2	grassland	CN[2], RB[3]

1Region Rafzerfeld
2 Region Combremont / Nuvilly
3 Region Ruswil / Buttisholz

The results were analysed statistically. On this purpose the U-Test by Mann-Whitney and the Wilcoxon-test for paired samples were applied. Both are nonparametric tests that verify differences between two groups. The U-test by Mann-Whitney compares the means of the ranks of the two independent groups while the Wilcoxon-test for paired samples compares the differences between different assessments of the same object. It is obvious that the Wilcoxon-test for paired samples detects slighter differences between two assessments of one object than the U-test by Mann-Whitney. Since the U-test by Mann-Whitney detected differences between different landscapes (Schüpbach 2000) it was used too. The use of the two methods is suitable to estimate the dimension of the influence of eca on landscape aesthetic.



Formula for calculating the value of the factor of perceiving 'naturalness'

$$\text{Value of naturalness} = 10 * (z - 1) \qquad z = \frac{\sum (\text{area of land use type} * \text{value})}{\text{area of grid cell}}$$

Figure 2: Calculating of the factor of perception ‘naturalness’ according to Hoisl et al. 1989 and Schüpbach 2000.

Results

The statistical analysis with the Wilcoxon-test of paired samples showed that in all regions almost all considered combination of eca has an influence on the value of both of the calculated factors of perceiving. The only exception are the high stem orchards in the region of Combremont / Nuvilly. In this case ‘naturalness’ does not differ statistically significant whether high stem orchards are existing or not. On the other hand the U-test by Mann-Whitney shows only differences in the region of Ruswil / Buttisholz. Hedgerwos declared as eca, single trees and high stem orchards together have a statistically significant influence on the ‘variety’ of the landscape. But hedgerows not declared as eca as well as forest edges that are not eca at all (see table 1) have a statistically significant influence on the ‘variety’ of the landscape too (tables 4, 5 and 6).

Table 4: p-value of the statistical analysis for the region 'Rafzerfeld'

Factor of preceiving and excluded eca type(s)	Wilcoxon-test for paired samples	U-Test by Mann-Whitney
Variety without hedgerows declared as eca	0.043 [1]	0.519
Naturalness without meadows declared as eca	0.001[3]	0.506
Naturalness without wild folwer strips	0.007[2]	0.573
Naturalness withouf medows declared as eca and without wild folwer strips	0.0003[3]	0.255

1 Level of significance: 5%
2 Level of significance: 1%
3 Level of significance: 0,1%.

Table 5: p-value of the statistical analysis for the regeion 'Combremont / Nuvilly'

Factor of perceiving and excluded eca type(s)	*Wilcoxon-test for paired samples*	*U-Test by Mann-Whitney*
Variety without hedgerows declared as eca	0.0006 [2]	0.745
Variety without high stem orchards	0.011[1]	0.167
Variety without hedgerows declared as eca and without high stem orchards	0.00006 [3]	0.102
Naturalness without meadows declared as eca	0.0005[3]	0.902
Naturalness without high stem Orchards	0.524	0.387
Naturalness without meadows declared as eca and without high stem orchards	0.0001[3]	0.431

1 Level of significance: 5%
2 Level of significance: 1%
3 Level of significance: 0,1%.

Table 6: p-value of the statistical analysis for the regeion 'Ruswil / Buttisholz

Factor of perceiving and excluded eca type(s)	Wilcoxon-Test für gepaarte Stichproben	U-Test nach Mann-Whitney
Variety without hedgerows declared as eca	0.00147[2]	0.2866
Variety without single trees declared as eca	0.000002[2]	0.1424
Variety without high stem orchards	0.000001[2]	0.2128
Variety without hedgerows	0.000001[2]	0.000001[2]
Variety without forest edges	0.000001[2]	0.0059[2]
Variety without hedgerows, single trees and high stem orchards declared as eca	0.0000001[2]	0.000521[2]
Naturalness without meadows declared as eca	0.0000001[2]	0.550
Naturalness without high stem orchards	0.000003[2]	0.571
Naturalness without high stem orchards and without meadows declared as eca	0.00000005[2]	0.2866

1 Level of significance: 1%
2 Level of significance: 0.1%

Discussion

The study was described for two reasons: First it should show, whether the method is as sensitive as to detect even small differences between landscapes (condition number three) and second to clarify whether there is a difference in resultants between landscapes of different regions. The results of the study show that the method by Hoisl et al. is as sensitive as to detect seven mall changes in landscape aesthetic. A landscape with eca compared with a landscape without eca is as if a slight change in landscape occurred. The changes between the two landscapes are slight, since the differences in the values of the two factors of perceiving are statistically significant with the Wilcoxon-test for paired samples but in most cases not with the U-test by Mann-Whitney.

The fourth postulated condition, the need of a context to explain the results is necessary to: Hedgerows and high stem orchards show this clearly, that a single landscape element do not have the same importance in all landscapes. While in the region of Combremont / Nuvilly the absence of high stem orchards dos not make a statistically significant difference in the value of naturalness, in the region of Ruswil / Buttisholz the absence of high stem orchards reduces the value of 'naturalness' statistically significant (Wilcoxon-test for paired samples). The absence of hedgerows not declared as eca in the region of Ruswil / Buttisholz cause such a reduction of the value of 'variety' that the difference between the two values is detected even by the U-test by Mann-Whitney. Apparently the loss of the same landscape element has not the same effect in each landscape. The reason of this discrepancy is the different occurrence of hedgerows and high stem orchards in the two regions. As the number of hedgerows and the area of high stem orchards in the region of Combremont / Nuvilly is smaller than in the region of Ruswil / Buttisholz, a complete remove there causes a smaller effect than in the region of Ruswil / Buttisholz. Therefore it can be assumed that the value a landscape element has within a landscape is depending on its area or number it occurs. In order to explain the significance of the loss of a certain landscape element in a certain landscape, we need to know, in which landscape (in which region) which landscape elements are typical. We also need to know which time is the starting base, because the small number of a certain landscape element could be characteristic for a specific landscape type or it could be a cause of a continuous loss of this element. In other words, we need a context to explain changes in evaluation, the fourth condition. The first step to have this context for explanation is to divide Switzerland, or any country we would monitor, in landscape types. Those landscape types should be homogeneous regarding the occurring landscape elements and their frequency. In Switzerland such a typology of landscapes that would allow to denominate the typical landscape elements and to explain changes dos not yet exist. But there are several studies about the future of the Swiss landscape which were launched by Swiss Agency of Environment, Forests and Landscape (SAEFL / BUWAL) (Iselin 2001, BUWAL 2000, BUWAL 1999). A typology of Swiss landscapes would be an element that should not be neglected in the process of developing indicators for assessing landscape aesthetic.

Conclusion

For recreation purposes Swiss people have a demand for a neat landscape containing a certain amount of ‘naturalness’. Agriculture is a driving force shaping the landscape and providing amenities, especially in the surroundings of urban areas as well as in mountains. Therefore a beautiful landscape ideal for recreation is an asset of a multifunctional agriculture. Activities taking care of landscape aesthetic or enhancing landscape aesthetic should be recompensed. From this perspective, there is a need to measure the effects of agricultural activities on landscape aesthetic, to detect both negative changes and positive effects. There is sufficient knowledge about landscape assessment: Based on a mix of landscape aesthetic concepts there is at least one method which was applied successfully. It turned out to be as sensitive as to detect even small changes in landscape scenery. In addition, Swiss Agency for the Environment, Forests and Landscape (SAEFL / BUWAL) launched several studies dealing with the landscape development in Switzerland (Iselin 2001, BUWAL 2000, SAEFL 1999). These studies provide a precious base to establish a typology of Swiss landscapes and to define indicators that measure landscape aesthetic reliably. Our impetus is to collect all those considerations made about landscape and landscape aesthetic in order to establish a typology of Swiss landscapes. Second, we must admit that the method by Hoisl et al. (1989) is rather extensive due to the fact that a very large database on land use and landscape elements is compulsory. However, the existence of such a database, even for only a small but representative part of Switzerland, is far beyond reality. Therefore we should come into a position to evaluate only those landscape elements whose loss would change fundamentally landscape scenery. To simplify the method in favour we have 1) to delineate homogenous landscape patches, 2) to designate individual landscape types, 3) to identify their distribution and frequency.

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Developing Cultural Landscape Indicators for Agricultural Settings in Scotland

Rebecca Hughes and Edward Mackey
Scottish Natural Heritage, UK

Abstract

1. *A requirement for indicators of cultural agricultural landscapes has been identified in Scotland.*
2. *Past, present and future perspectives suggest how information from the Scottish Landscape Character Assessment (LCA) might be utilised in conjunction with the Historic Landuse Assessment (HLA).*
3. *A study of the cumulative impacts of development on tranquillity in the countryside is described.*
4. *Change variables in agriculture tend to be slow acting but some are fast and external events can trigger very rapid and profound changes in rural environments. Future scenarios of change are considered.*
5. *A candidate suite of potential environmental indicators for agriculture has been identified for Scotland, some of which might relate to OECD categories for agricultural cultural landscapes.*
6. *The challenge is to develop landscape-scale indicators, directed towards safeguarding biogeographical and cultural distinctiveness within an evolving landscape that remains functional, robust and attractive.*

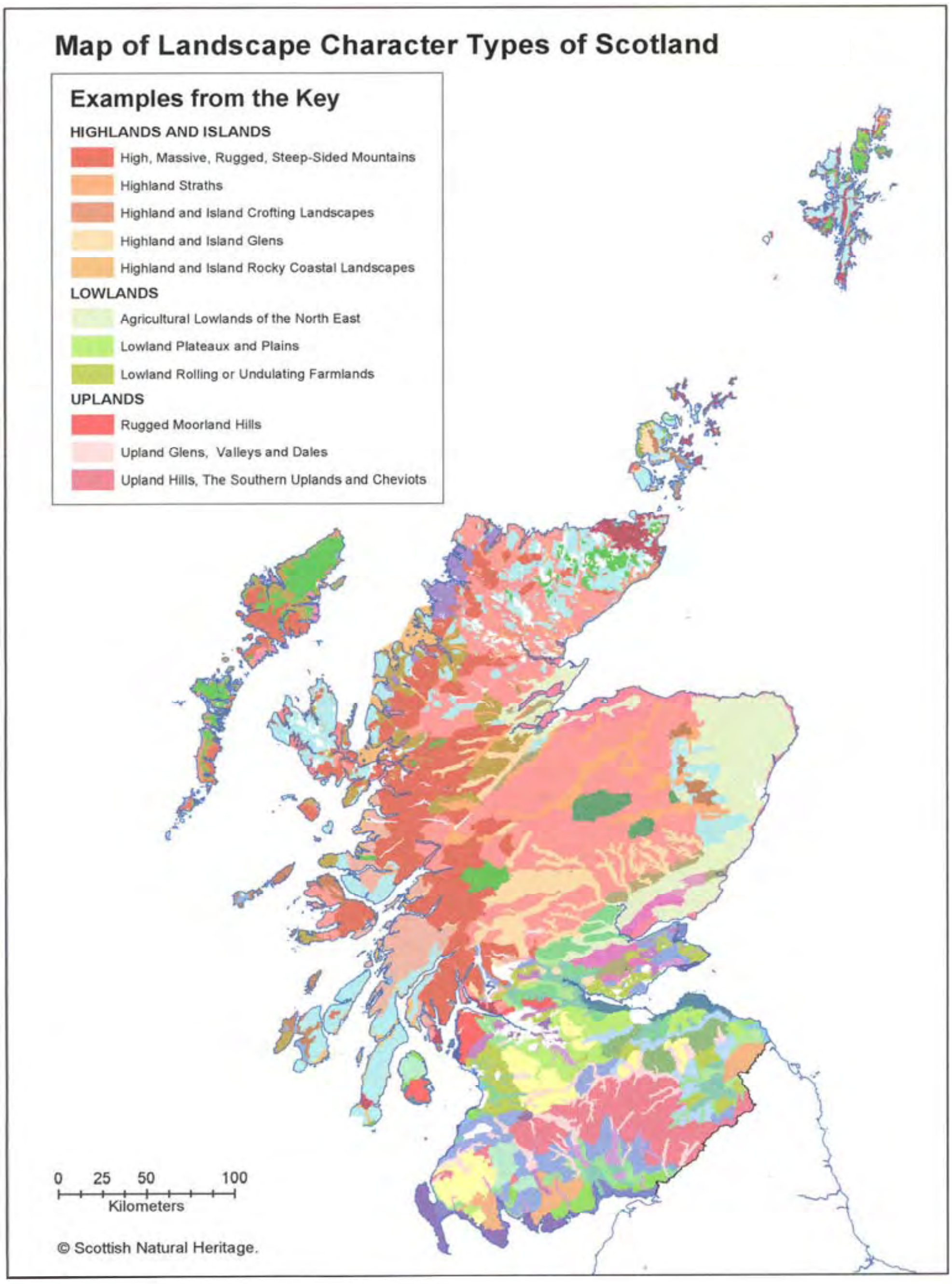
The landscape character of Scotland

The landscape of Scotland is among the most evocative aspects of the natural heritage. It comprises physical, natural and cultural attributes which people see and experience. Aesthetic qualities which people enjoy are also influenced by people's values and preferences. Between 1994 and 1998 a systematic 'Landscape Character Assessment' was undertaken in Scotland (Hughes & Buchan, 1999). This identified more than 3,900 different units of landscape character, which could be grouped into over 360 distinct landscape character types (Figure 1).

Agricultural landscapes are regionally distinct. By cataloguing the diversity and geographical distribution of landscape character, the LCA has been an aid to, for example,

- helping to identify what is distinctive and worth protecting in Scotland's landscape
- informing an assessment of the capacity of different landscapes to accommodate change, and
- helping to guide development to appropriate landscape settings.

Figure 1: The Landscape Character of Scotland
Over 360 distinct landscape character types are summarised into 11 broad classes



Source: SNH

Looking at the past - a history of change

Scotland's glacial history has had a marked effect on landform, soils and the pattern and character of settlement. Low temperatures and high precipitation in the uplands have always limited agricultural potential there, but responses to historical changes in climate are evident from shifting limits of cultivation at the margins. A climatic optimum for woodland around 8000 to 5000 BP was followed by cooler, wetter conditions that contributed to the expansion of peat bogs. The arrival of Celtic people and the technology of the Iron Age, some 2,500 BP, accelerated forest clearance for agriculture. The northern limit of the Roman Empire in Britain, 55 BC to 450 AD, and its enduring influence on settlement, transport and trade, is marked by the Antonine Wall between the Firths of Forth and Clyde. Cold and snowy conditions during the 'little ice age', from around 1300 to 1800 AD, would have imposed severe constraints on farming but milder conditions thereafter, from the late-18th century onwards, coincided with new technologies which transformed agriculture. Commercial sheep rearing, introduced at that time, came to dominate the upland landscape. Intensified cropping through crop rotation, land drainage and field enclosure similarly defined the present-day physical framework for lowland agriculture. Fuelling change, the industrial revolution demanded energy, water, labour, raw materials, access to markets, urban expansion and the development of transport networks.

Hedgerows, so vital to the character of Scotland's lowland farmland landscapes, date generally from the late-eighteenth and early-nineteenth centuries (Whyte & Whyte, 1991). In the uplands, glacial tills provided an abundance of construction material for 'drystone dykes'; walls built of local stone without mortar. Agricultural improvement through 'enclosure' by walls and hedges allowed fragmented and intermixed strips and blocks of land to be amalgamated, and crops and livestock to be segregated. Yet it was not long before the intricate networks of hedgerows and ditches in the lowlands became an obstacle to progress. Fields needed to be amalgamated for mechanisation, unimpeded by hedges, which were removed, and ditches, which were replaced and extended by sub-surface drains. Further technological advances meant that mixed farming, with its associated stock barriers, was no longer required in order to sustain soil fertility or to control pests. By 1988, the length of hedgerow in Scotland was half of what it had been in 1947 (Mackey *et al.*, 1998), with further signs of reduced hedgerow management between 1990 and 1998 (McGowan et al., 2001).

Historic Landuse Assessment

For the most part, archaeological remains have been leveled by ploughing in the lowlands, but standing stones remain in places, cropmarks can on occasion reveal underlying features, and prehistoric structures and artifacts are sometimes unearthed (RCAHMS, 1990). The continuous history of land use removes, obscures and buries earlier components (RCAHMS, 1994). Archaeological features can survive in the less-disturbed rough pastures and heather moorlands of the uplands, where in the past settlement and farming were more widespread. Medieval 'ridge and furrow' cultivation patterns, in which ridged-up cultivation strips were separated by furrows for access and drainage, may be evident on sloping grasslands. Yet in the uplands, plantation forest has often obliterated the historical record (RCAHMS, 1997).

Nevertheless, some 6,000-or-so ancient monuments in Scotland, from prehistoric to industrial, have been scheduled for their national importance (Historic Scotland, 1999). In a celebrated case, the Lowland canals of Scotland, which are of historical, cultural and natural heritage importance, have been restored to use (Lassière, 2002). Improved forest design and restructuring since the late-1980s are nowadays more likely to conserve and, in places, to reveal again such features.

A former Roman fort may appear less dominant in the landscape than the visual impact of a forestry plantation, but the location of a Roman camp may have been of much greater historical significance in shaping the landscape. Although only remnants of the earliest periods of settlement survive as archaeological remains, they can in themselves form distinctive features in the landscape, with a historical resonance that contributes to a sense of place far beyond their immediate physical impact on the ground: the Brochs of Shetland, Neolithic remains of Orkney, Pictish standing stones of Easter Ross, or the stone circles and monuments of Argyll and the Hebridean islands. Historically more recent, hill forts, castles and tower houses often occupy prominent sites.

Cultural elements in the landscape, relating to pattern, scale and form, are incorporated within the Landscape Character Assessment. By identifying the origins of present land use, and surviving elements of past landscapes, the historic character of landscape is being mapped by Historic Scotland and the Royal Commission on the Ancient and Historic Monuments of Scotland (Dyson Bruce, *et al.* 1999). Where past land use can be identified from aerial photographs and maps, and other sources of knowledge, it and contemporary land use are being mapped (at a minimum mapping scale of 1 hectare).

The Historic Landuse Assessment provides a broad overview of the historical origins of present land use, together with scattered evidence of relict land use. It is composed of several GIS layers:

- 'Historic Landuse Periods' describe the time at which an identified land use was current, from Medieval to more recent centuries.
- 14 'Historic Landuse Categories' define national patterns of historic land use, each composed of one of more historic land use type.
- 45 'Historic Landuse Types' describe period of origin, form and function.
- 'Relict Periods' date back to the Mesolithic.
- 15 'Relict Categories' define national patterns of earlier land use, each composed of one or more relict land use type.
- 17 'Relict Types' are abandoned forms of land use which still leave some trace in the landscape.
- 27 'Relict Archaeological Types' refer to archaeological features which are no longer used for their original function.

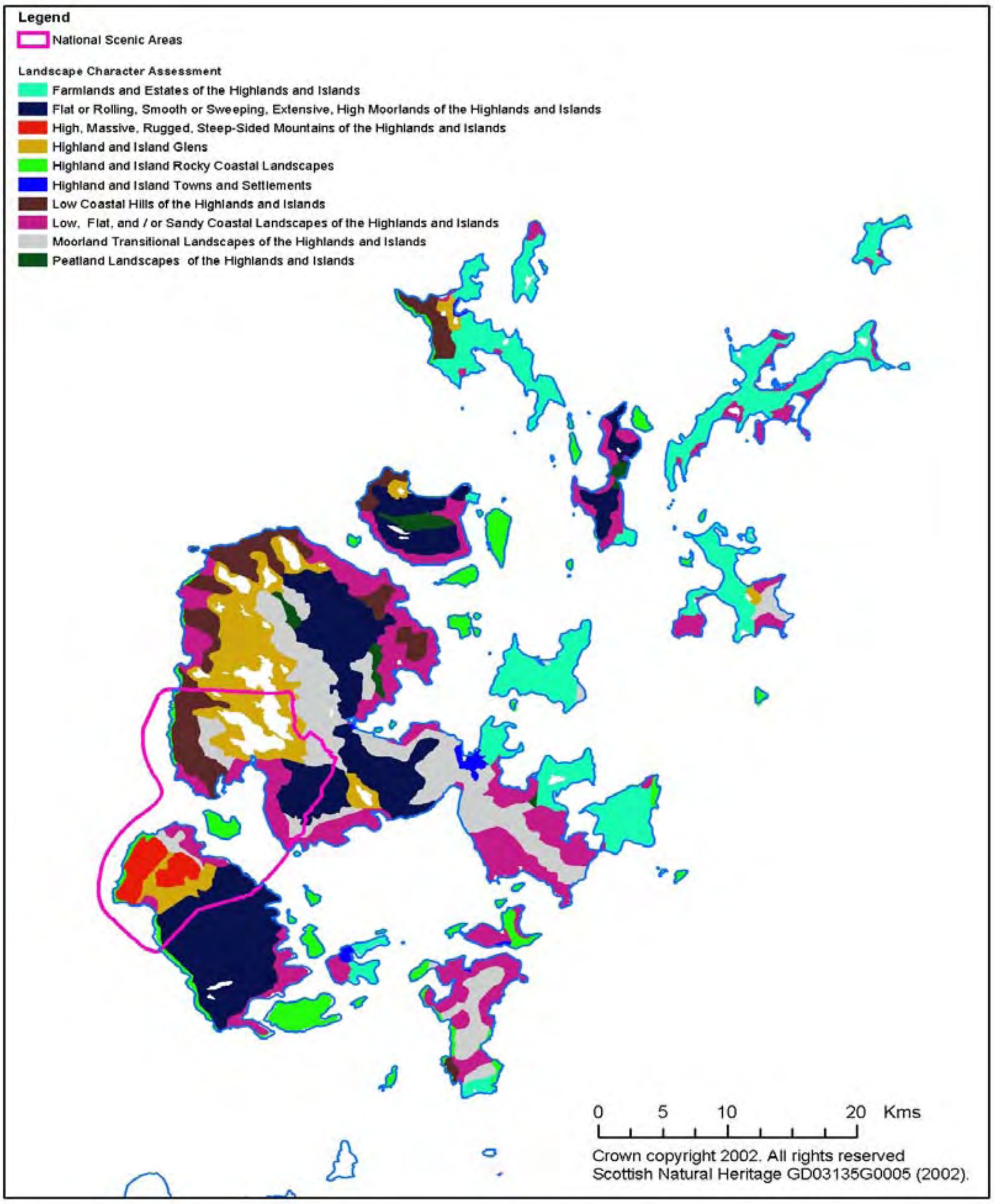
Landscape specialists in Scottish Natural Heritage and Historic Scotland are exploring the use of the complementary tools of Landscape Character Assessment and Historic Landuse Assessment, informed by two case studies of the 'Neolithic Heart of Orkney' (Case Study 1 and Figure 2) and the 'Loch Lomond and The Trossachs National Park' (Case Study 2 and Figure 3).

CASE STUDY 1

NEOLITHIC HEART OF ORKNEY WORLD HERITAGE SITE

The 'Neolithic Heart of Orkney' was designated as a UNESCO World Heritage Site (WHS) in 2000. Located on West Mainland, it includes the internationally important archaeological features of Skara Brae, Maes Howe, the Stones of Stenness and the Ring of Brogar, together with adjacent standing stones and burial mounds. The WHS lies in one of the most sensitive landscapes in Scotland, being a large, open loch basin partly within the Orkney Islands National Scenic Area (NSA). However, considerable development pressure exists for housing, wind turbine generators, improved roads and visitor facilities for tourism. A project to analyse the landscape character of the WHS was therefore commissioned by Historic Scotland and Scottish Natural Heritage to define the setting of the WHS, inform the management strategy and advise on development. Importantly, it examined the relationship between landscape character assessment (LCA) and historic landuse assessment and the possibility of integrating the techniques in order to provide improved indicators of landscape change. It concluded that, although there are important differences between LCA and HLA, in terms of their purpose, methods and products, the HLA could play a more influential role in the LCA process by identifying valued cultural landscapes with a time-depth component that should be taken into account in land use and management decisions.

Figure 2: The Landscape Character of Orkney



Source: SNH

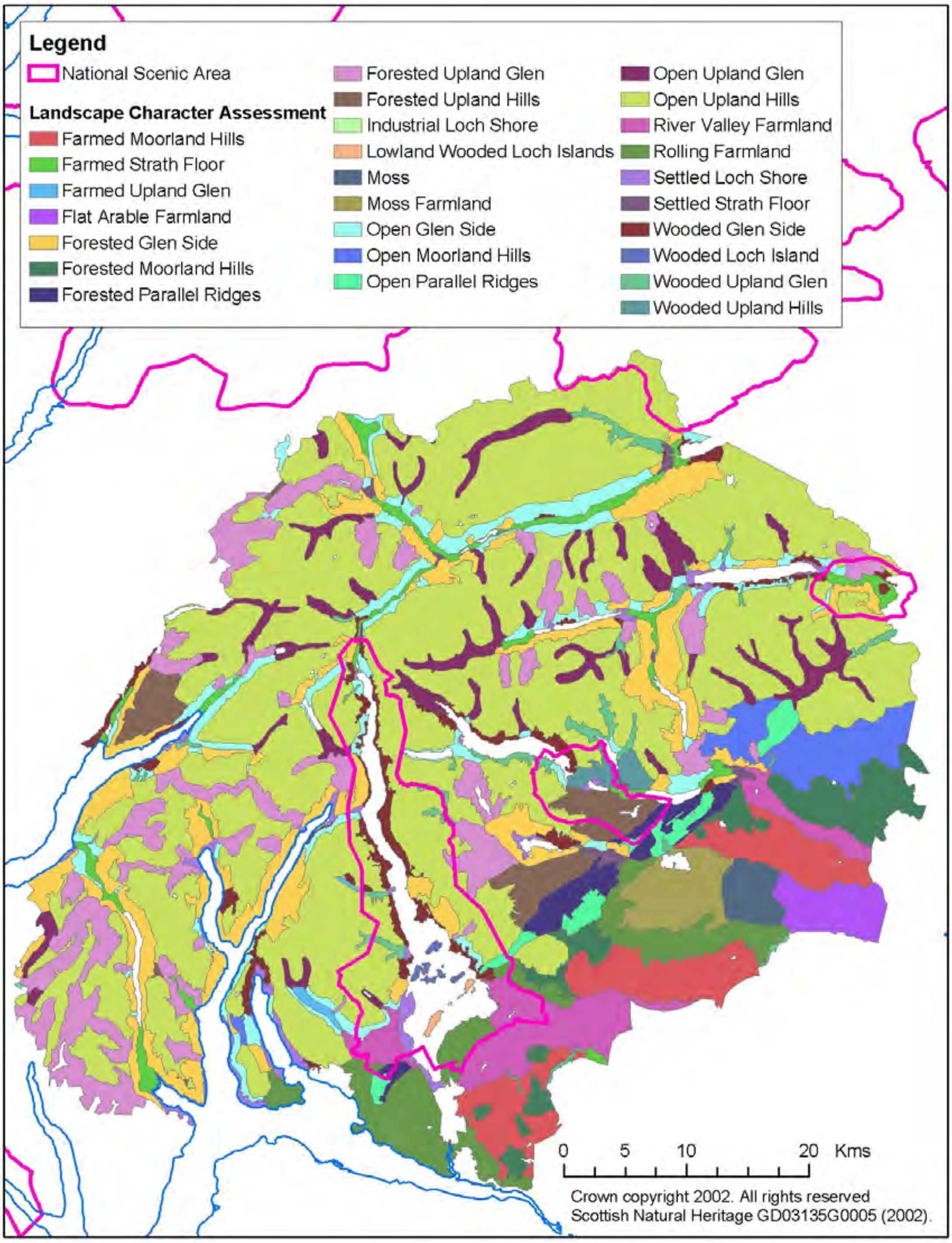
CASE STUDY 2

LOCH LOMOND AND THE TROSSACHS NATIONAL PARK

Loch Lomond and the Trossachs was designated as Scotland's first National Park in 2002. Located to the north-west of Glasgow, the Park embraces the Loch Lomond National Scenic Area. The Highland Boundary fault straddles the National Park, giving rise to the remarkable juxtaposition of mountain and loch, moorland, woodland and lowland plain, including Scotland's largest lowland raised bog, Flanders Moss. Deep sea and freshwater lochs, including Loch Lomond, have historically provided route-ways through otherwise difficult terrain. Natural corridors, such as Glen Falloch, became strategically important for military purposes and trade. The farmland identity is of lowland cropping and livestock rearing, with hill sheep grazing. A popular setting for recreation, the area experiences considerable pressures from tourism and development.

In 2001, a project was commissioned by Scottish Natural Heritage to refine the LCA for the Park area. The coincidence between the Loch Lomond LCA and a Loch Lomond and Trossachs HLA that has been completed for the south-east part of the Park area (RCAHMS and Historic Scotland, 2000) was examined in order to identify cultural influences on the evolution of landscape character, and to ascertain the usefulness of the HLA as an aid to landscape management. As assessment was made of how the two datasets might be harmonised or integrated, for use by, for example, planning authorities.

Figure 3: The Landscape Character of Loch Lomond and the Trossachs



Source: SNH

Looking at the present – continuing change

Enclosed farmland, consisting mainly of arable cropping and improved pasture, extends across 21% of Scotland's land area. However, many of the European landscapes and habitats which have come to be most valued in social, cultural and environmental terms, have evolved through lower intensity farming activities (Beaufoy *et al*., 1994). Examples for Scotland are crofting and extensive sheep rearing. When hill farming is taken into account, agricultural settings extend across 75% of Scotland (Table 1).

Table 1: Estimated habitat extent in agricultural settings in 1998

Broad Habitat	Lowland		Marginal upland		Upland		Scotland	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
a) mainly enclosed farmland								
Arable & horticultural	5360	24	1000	4	40	< 0.5	6390	8
Improved grassland	6600	29	2990	11	920	3	10510	13
b) mainly unenclosed farmland								
Neutral grassland	1190	5	380	1	110	< 0.5	1680	2
Calcareous grassland[i]	0	0	270	1			270	<0.5
Acid grassland	840	4	1590	6	5060	16	7480	9
Fen, marsh & swamp	710	3	1770	7	890	3	3370	4
Bracken	440	2	670	2	550	2	1660	2
Bog	1170	5	8840	33	10370	32	20380	25
Dwarf shrub heath	910	4	2200	8	6910	22	10020	12
c) total agricultural habitats	**17220**	21	**19710**	24	**24850**	30	**61780**	75
d) total area of Scotland[ii]	**22380**	27	**27160**	33	**32030**	39	**81570**	100

Note: Estimates are rounded to the nearest 10km² and so may not sum exactly to the totals

Source: McGowan et al., 2001

Concern has been raised about the running-down and disappearance of low-intensity farming systems throughout Europe, a dwindling rural labour force and out-migration (EEA, 1999). Agricultural intensification has taken place in areas of competitive advantage. Extensification, amalgamation, abandonment and conversion to alternative uses such as commercial forestry, have occurred where farming incomes have been poorest and where it has been most difficult to find successors within an ageing farming population. The fertile lowlands are highly productive but at a European scale, Scotland

[i] Insufficient data to estimate extent in Upland
[ii] Excludes 370km² unsurveyed urban core

has been classed within a typology of five broad types as a predominantly extensive farming region which is said to be particularly susceptible to land marginalisation (Baldock, *et al*., 1996).

Mixed farming in Scotland has declined in recent decades, with the west becoming more dominantly pastoral and the east more dominantly arable. The mixed farm area decreased by 23 per cent between 1987 and 1999 (FPD Savilles, 2001). The number of crofters, as managers of small-scale mixed farms in the north-west of Scotland, fell by 23 per cent between 1960 and 1985, accompanied by reduced tillage and the replacement of their traditional cattle grazing by sheep (RSPB and SCU,1992). Many of the changes over the past decade have been especially evident in the marginal uplands (Haines-Young et al., 2000).

Within the more intensively farmed areas, concern was expressed in the 1970s that the steady elimination of non-productive land and increased efficiency of production posed threats to nature conservation in Britain (Ratcliffe, 1977). For example, the frequency of occurrence of wild plants associated with arable fields declined in Scotland between 1930 to1960 and 1987 to1988 (Rich and Woodruff, 1996). A 34 per cent reduction in hay production and an 8 per cent increase in silage production reflect intensified grassland management between 1991 and 2000 (FPD Savilles, 2001). Declines in farmland birds in Scotland from the early 1970s to the late 1990s have been linked to agricultural intensification (SNH, 2001a), as across Europe (Delbaere, 1998). Conversely, wintering wildfowl and waders have benefited from intensively managed grasslands in the west of Scotland (SNH, 2001b).

Overall, changes in agriculture over the past 50 years have resulted in a reduction in the variety of Scotland's farm landscapes (SNH 2002).

Assessing landscape change

The Landscape Character Assessment is a baseline for Scotland's landscape in the mid-1990s. However, signs of landscape alteration within recent decades, or 'forces for change', were also documented. Those that were recorded as being frequent/ widespread/ increasing in agricultural settings were as follows (David Tyldesley and Associates, 1999).

a) Within enclosed lowland farmland settings

- semi-natural grasslands were replaced by more intensive farming and forestry
- grassland was converted to arable cropping
- field boundaries were neglected or removed, and fields were enlarged
- new, industrial-scale, agricultural buildings appeared in the landscape
- farm steadings fell into dereliction or were converted to residential use
- crofting, as a small-scale mixed farming system, appeared to be in decline
- 'set-aside' became a new component of arable farmland.

b) Within unenclosed mountain and moorland settings

- changes in grazing and muirburn (the management of heather moorland by controlled burning) practices were evident, with evidence of overgrazing by deer in woodlands and reduced heather cover on moorlands
- localised erosion of vegetation in areas of recreational pressure.

Some visual aspects of change can be tracked and quantified by periodic surveys of land cover. Habitat accounts may be constructed (Stott, 2001). The annual agricultural census provides further insights into structural change. However, the cumulative impacts of disturbance on visual and sensory attributes of landscape are more difficult to assess. Nevertheless, the mapping of 'tranquillity', referring to qualities of quietness and visual calm, has been piloted around the A96 road corridor between Aberdeen and Inverness (Ash Consulting Group, 1998). The study area extended along the northern margin of the Grampian and Cairngorm mountains and incorporates elements of urban development, lowland farmland, marginal upland and coast. From photographic and on-site evidence, disturbance increased throughout 45 per cent of the study area between the mid-1960s and the mid-1990s (Figure 4). This was attributed mainly to the expansion of settlements, road traffic, skyglow, electrical infrastructure, rail traffic, airport noise, windfarms, quarry working and telecommunications masts.

Looking to the future – predicting change

Retrospective studies can corroborate and quantify the effects of past and current policies. Vital as this is to reporting on the state of the environment, natural and cultural heritage, they are limited in one important respect: an inability to anticipate where we appear to be heading. So, is it possible to incorporate an element of forecasting?

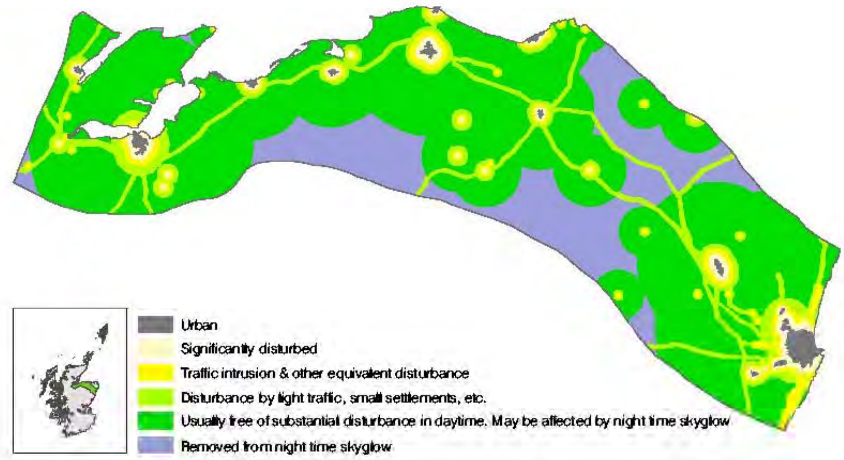
At least one study has attempted to do so, by way of a review of trends over the past decade and a consideration of prospects for the next 25 years (Birnie *et al*., 2002). Underlying causes of change in the agricultural sector, together with constraints on choice, were identified. Change variables could be slow acting or fast-acting, such as demography or technology, but 'trigger events', such as the 2001 foot and mouth outbreak, could have very rapid and profound consequences. Scottish agriculture, it was concluded, is increasingly exposed to rapid changes as a result of external shocks, which may be financial, legislative or environmental. Furthermore, the consequences may vary geographically, influenced by an array of factors among which production advantage, accessibility, amenity potential, and relative dependence on agricultural employment were considered especially important. A range of socio-economic variables are relevant to characterising rural areas at a local scale (Copus, *et al*., 1998) and change at any given location will be influenced by local characteristics, individual circumstances and managerial decisions. Nevertheless, three broad zones of potential change were identified (Figure 5).

Production advantage
Agricultural intensification was thought likely to continue in areas with production advantages. Legislation, such as the European Nitrates Directive, and new forms of delivering agri-environmental support, possibly through Land Management Contracts, would be crucial to mitigating environmental consequences, such as a continued loss of landscape and habitat diversity and structure, increased risk of soil erosion and nutrient enrichment.

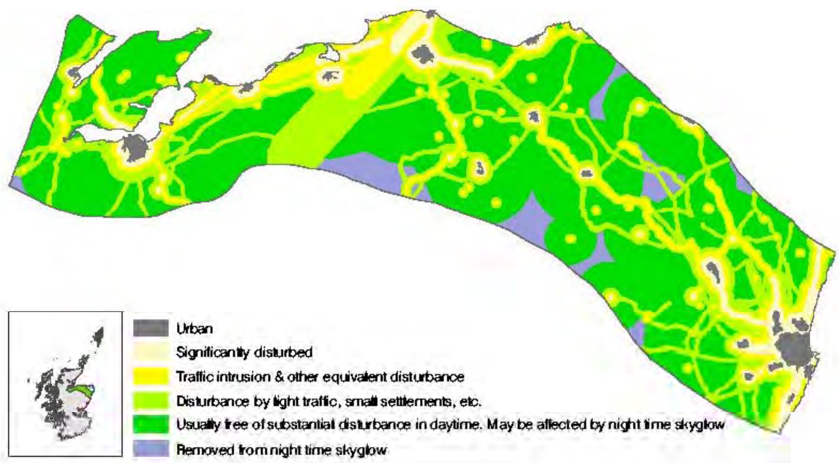
Environment and amenity advantage
Relatively accessible areas with environmental advantages, or areas with high scenic amenity and good access to services, could encounter less pressure for structural change. A more strategic focus on agri-environment support and conservation importance would reinforce the existing trend towards sustaining valued environmental and natural heritage characteristics.

Figure 4: Tranquillity in the north-east of Scotland

a) mid-1960s

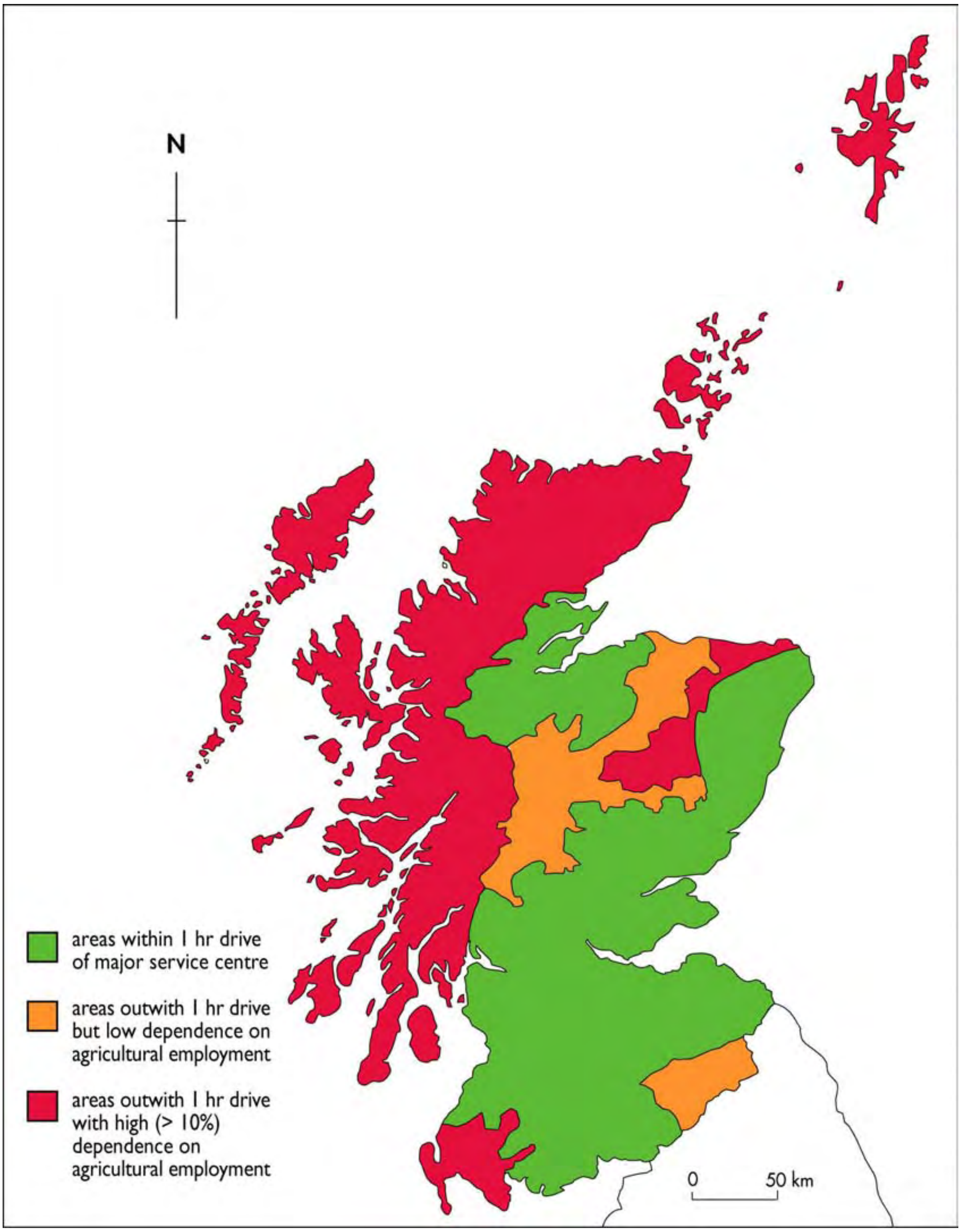


b) 1996



Source: Ash Consulting Group (1998)

Figure 5: Influences on potential patterns of change



Source: Birnie, et al. (2002). Reproduced with permission.

> ***The 'middle-countryside'***
> It was the 'middle-countryside', i.e. outside metropolitan travel-to-work areas, with poorer access to services and a high dependency on agricultural employment, that was considered to be most fragile and especially exposed to, for example, land transfer from agriculture to forestry.

A review of changes in, and prospects for, the natural heritage (SNH 2002) has concluded that current trends appear to be heading towards a situation where, unless co-ordinated action is taken, farming will become polarised between relatively few large highly productive farms capable of surviving without production subsidies and a larger number of smaller farms incapable of deriving sufficient income from the production of food. This could result in a segregated countryside where natural heritage is restricted to protected sites or to the remotes areas of north and west Scotland, and where the intensively farmed areas of the south and east are more or less devoid of biodiversity and landscape interest.

Landscape indicators in agricultural settings

Agricultural landscapes have been described as the visible outcomes of an interaction between agriculture, natural resources and the environment; encompassing amenity, cultural and other societal values. As such, cultural landscapes in agricultural settings may be considered in terms of the structure and appearance of farmland, landscape functions for livelihood and enjoyment, and values that society ascribes to agricultural landscapes (OECD, 2001).

A commonly-held criterion for an indicator is that it should be policy relevant. The 'Forward Strategy for Scottish Agriculture' states that policies will be based on evidence, facts and experience (Agriculture Strategy Steering Group, 2001). For this, environmental concerns, relating to "the natural (air, soil, water, species and habitats) and cultural heritage (contemporary, historical and archaeological features) and their collective contribution to the landscape and countryside", were examined in detail (Agriculture and Environment Working Group, 2002). A working group of representatives from Scottish Natural Heritage (SNH), the Scottish Environment Protection Agency (SEPA) and the Royal Society for the Protection of Birds (RSPB) has been asked to consider the development of environmental indicators for the Forward Strategy. Four themes, based on priorities for action identified by the Agriculture and Environment Working Group, were identified:

1. Pollution to land and water
2. Biodiversity and habitat protection
3. Landscape change
4. Soil processes.

Within the DPSIR indicators framework (Driving forces, Pressures, State, Impacts, Responses), the emphasis is on observed environmental change, or environmental 'outcomes' (i.e. measures of 'state'). Nevertheless, process or response measures (e.g. implementation of actions or activities underpinning environmental outcomes) may also be required. An inevitable mismatch between existing survey data and the requirements of the Forward Strategy calls for pragmatism in making best use of available data, while pointing to requirements for improved data collection.

Taking account of the environmental issues identified by the Agriculture Strategy Steering Group (Table 2) and the Agriculture and Environment Working Group (Table 3), together with indicators put forward at the UK and European scale, a candidate list of environmental indicators for the Forward Strategy has been identified for consideration (Table 4). Although they may appear to correspond broadly with the list of OECD agri-environmental indicators (OECD, 2001), they may differ in important detail.

Table 2: Environmental issues identified in the 'Forward Strategy for Scottish Agriculture'

- Prosperous farming industry which will be a leading player in the protection and enhancement of the Scottish environment
- Joined-up approach to policy, harnessing the expertise of farmers and environment interests
- Land management contracts designed to pay farm businesses for the full mix of economic, social and environmental benefits
- Implementation of the new Rural Development Regulation
- Integrated, whole farm approaches to improving the environment
- Compliance with established good environmental practice
- Environmental protection and enhancement which provide economic returns to farmers
- Waste minimisation
- Watercourse and wetland management
- Implement EC Directives
- Prevention of Pollution from Agricultural Activities Code
- Agricultural schemes should deliver best possible levels of biodiversity
- Increasing funding share for agri-environment schemes
- Environmental Management for Agriculture
- Projects in National Parks
- Pollution prevention and waste management
- Local quality produce
- Agricultural waste regulation under the Water Framework Directive
- Biofuels
- Reduce greenhouse gas emissions
- Land management in flood risk areas

Source: ASSG, 2001

Table 3: Environmental issues identified in 'Custodians of Change'

Implementing Action 41 of the Forward Strategy, the Agriculture and Environment Working Group examined environmental issues which will impact on farming and food processing businesses over the next 5-10 years. It's report, Custodians of Change', considered environmental concerns in more detail.

- Priority environmental issues are diffuse pollution to water, biodiversity and habitat protection, and landscape change
- Most important regulatory driver for agriculture in the near term is the Water Framework Directive
- Impending Pollution Prevention and Control legislation
- Bathing Waters Directive, Birds Directive, Environment Impact Assessment Directive
- Habitats Directive
- Integrated Pollution Prevention and Control Directive, National Emissions Ceilings Directive, Nitrates Directive, Wastes Directive
- Impacts on soil, water and air from fertiliser run-off, organic waste, veterinary medicines (inc. pyrethroid sheep dip), faecal pathogens, pesticides

- Impacts on the natural heritage from fragmentation and degradation of habitats, reduced species diversity, abandonment of land, landscape change, deleterious changes to soil management and seasonal cropping, introduction of alien species
- Mediate the effects of diffuse pollution (nutrients, pesticides, herbicides, pharmaceuticals, slurry)
- Implement Local Biodiversity Action Plans
- Planning policies and guidance for proactive local agricultural landscape design
- Reduce nutrient capital in the system
- Intercept nutrients along their transport pathway
- Soil conservation techniques
- Reed beds / wetland areas, management of sediment 'hot spots'
- Impacts on biodiversity from drainage of wetland, removal of woodland remnants, removal of hedges and walls, upland grassland & moorland (drainage, ploughing, reseeding), intensification of arable and pastoral land with loss of mixed and rotational farming systems, pesticide effects on non-target plants and invertebrates, nutrient enrichment, pesticide toxicity, removal of plant and insect food supply of farmland birds and mammals
- Improvements through creation of wetlands and marshes, river bank vegetation, flood attenuation, ecological networks, reduced soil erosion (and promotion of access)
- Riparian margins, hedgerow borders, linking set-aside strips to create corridors across and between farms
- Decline in habitat quality in upland grasslands, heaths, machair
- Reduce grazing pressure, replace sheep with cattle
- Creation of ecological networks at a bio-regional or catchment scale
- Lack of experience and commitment to landscape design in agriculture
- Carbon sources, carbon sinks
- TIBRE
- Re-design Rural Stewardship Scheme to include access improvements, woodland management, pollution mitigation, hydrological management, protection of natural and cultural features
- Evaluation of agri-environment schemes across the EU has been lacking – regional monitoring of environmental trends is recommended
- Organic Aid Scheme
- Crofting being replaced by reduced sheep ranching – return to cattle and crops
- Water quality downgrading due to consented discharges from food processing effluent
- Serious water pollution incidents from poor practice in spreading non-organic, exempt organic wastes to land

Source: AEWG, 2002

Table: 4 Candidate environmental indicators for agriculture

#	Topic
	Theme 1: Pollution to land and water
1	Diffuse pollution from agriculture to water
2	Pollution events from agriculture to land or water
3	Good farming practice
4	Impacts of pesticides and veterinary medicines
	Theme 2: Biodiversity and habitat protection
5	BAP outcomes
6	Habitat networks
7	Land cover
8	Condition of notified features within designated areas
9	Response to environmental threats
10	Farming systems change
11	Farmland birds
12	Plant diversity
13	Terrestrial invertebrates
14	Upland habitats (grass/heath)
	Theme 3: Landscape change
15	Landscape components
16	Landscape change
17	Flood attenuation
18	Access / accessibility
	Theme 4: Soil processes (inc. climate change, waste minimisation issues)
19	Exceedances in soil
20	Soil C balance (source & sinks) and greenhouse gas emissions
21	Soil impacts
22	Biofuels

Source: Indicators Working Group (SNH, SEPA, RSPB)

Habitat networks (#6) and land cover change (#7) within theme 2, together with landscape components (#15) within theme 3, could be indicators of *structure* in the OECD terminology.

Farming systems change (#10) within theme 2, and access (#18) in theme 3, could be indicators of *function*.

The indicator of landscape change (#16) within theme 3 is likely to contain structural elements but also to incorporate additional knowledge and perception information which correspond with the OECD category of *value*. This is the most difficult type of indicator to define, because it incorporates interpretation and value attributes. Environmental justice demands that we give no less importance to restoring degraded landscapes than we do to protecting the pristine. Given that change is inevitable, we need to be as systematic and as consistent as possible in striving for the best possible outcome for any given location.

Practical difficulties for the specification of indicators are that several of the relevant components, such as habitat networks, are not supported by existing data. Furthermore, change tends to be detected only infrequently through periodic surveys of land cover, and they provide an incomplete view of landscape change.

Developing new viewpoints

To-date, environmental indicators have tended to be based on discrete structural characteristics. New approaches to environmental protection and sustainable development, as expressed by the European Water Framework Directive for example, emphasise the importance of landscape-scale approaches to preserving and restoring ecosystem functions. Ecological networks which incorporate core areas, corridors, restoration areas and buffer zones, together with co-ordinated action, are essential for conserving ecosystems, habitats, species, landscapes and other natural features of European importance (Delbaere, 1998). The recognition that landscape, nature, amenity and productivity can not be managed effectively in isolation, as they have in the past, poses a major challenge for the future.

An appreciation of natural and historical characteristics is not intended to freeze landscapes in time, or to somehow recreate a romantic vision of the past. Instead, it can inform land management decisions which are directed towards safeguarding biogeographical and cultural distinctiveness, within an evolving landscape that is functional, robust and attractive. The challenge that lies ahead is to develop such landscape-scale approaches to land and water management, and to identify indicators that can inform planners, practitioners, policy-makers and others of the intrinsic value and changing state of the environment, natural and cultural heritage.

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Landscape Units in Portugal and the Development and Application of Landscape Indicators

Pinto-Correia T., Cancela d'Abreu A. and Oliveira R.
Department of Landscape and Biophysical Planning
University of Évora, 7000 Évora – Portugal
Tel.+351.266 745 300 Fax.+351.266 744 968
E-mail: mtpc@uevora.pt

Abstract

Keywords: Landscape, landscape unit, landscape character, change, indicator

Introduction

Landscapes have in recent years increasingly been recognised as a fundamental part of the European natural, cultural and scientific heritage, basis of territorial identification. UNESCO and IUCN have previously stressed the need to protect specially valuable cultural or natural landscapes. The need to manage landscapes for conservation was presented in 1996 in the Pan-European Biological and Landscape Diversity Strategy. The advantages of using methods of landscape planning for integrating different social and environmental components have been defended in Agenda XXI. In the Dobris Assessment, from 1995, the landscape is considered in an holistic perspective. In different documents, landscape, seen as the expression of the numerous relations along time between natural and human factors in a given territory, combining thus both aspects, has been seen as an adequate basis for the integrated and balanced management of the European space (Green, 2000; Washer, 2000; Washer and , 2000; Vos and Klijn, 2000).

At national level, already the Portuguese Constitution, from 1976, states clearly that it is a public task to classify and protect landscapes and to promote their management in order to assure the balance of the territory. The Environmental Act, from 1987, and the Land Use Planning Act, from 1998, both contain several references to the landscape. The first defines the concept of landscape and refer the need to create instruments for landscape management. The second introduces the definition of landscape units within the regional plans.

With the European Landscape Convention (Council of Europe, 2000), the landscape has been more clearly introduced in the agenda. This document defends landscape protection, management and planning, both through the recognition of landscapes as a natural and cultural heritage and part of people's identity, and also through the definition of specific policies and implementation of instruments, the integration of landscape in sectoral policies and the involvement of the populations in its management. In the recent "Guiding Principles for Sustainable Spatial Development of the European Continent" (2000), also from the Council of Europe, cultural landscapes are seen as the expression of the diversity of the European space, and therefore closely linked to integrative role of the spatial development policy, which should organise various sectoral policies in regard to their territorial impacts. Both the Landscape Convention and the Guiding Principles stress the need to identify landscapes, define their boundaries, their character, trends and threats and to evaluate their qualities. Only this assessment will make it possible to define strategies and instruments in a subsidiary way, both integrated in a larger framework but also respecting the local specificity and maintaining its identity.

Following this growing concern for the landscape and particularly the demands within the Landscape Convention, the General Directorate for Spatial Planning and Urban Development, from the Ministry of the Environment, has asked the University of Évora, in 1999, to undertake the study "Landscape Identification and Characterisation in Portugal". In a first phase the continental part of Portugal was considered, later on also the Açores arquipelago, following a demand by the Regional Government. The project was supported by INTERREG IIC, which also financed at the same time an equivalent study for Spain.

The main objective has been to consider with an homogeneous approach the whole Portuguese territory, at a broad scale, and to identify large landscape units, each with their own specific character. The identified units should be carefully characterised, as a contribution to support future decision-making in spatial planning and management, both at national and at regional level. The concern in this study was to get a first picture of the landscape in the whole country, as it is in the present situation, and to understand its characteristics, its contrasts, its diversity, its common features, trends and problems. There was no explicit idea of creating a basis for further landscape monitoring. But it has been implicitly expected that this first approach will make it possible to follow up trends and future changes in the landscape – for which the choice and application of indicators has to be discussed.

The Landscape

The concept of landscape can be considered differently from the many different disciplines and approaches who deal with it. Landscape ecology, as an integrated approach, considers landscape as a complex system, permanently dynamic, where different natural and cultural factors influence each other and change over time, determining and being determined by the global structure (Forman and Godron, 1986; Naveh and Lieberman, 1994; Zonneveld, 1990). But besides the more material, or objective characteristics, the landscape has also a subjective component, more connected with the observer and his impressions (Froment 1987; Saraiva 1999). The landscape combines both natural and cultural aspects, expressing and at the same time supporting the spatial and temporal interaction of Man with the Environment, in all its diversity and creativity (Green, 2000; Wolters, 2000).

Aiming at the total understanding of the landscape, this study has adopted an holistic vision, integrating its various components: the **ecological**, which includes both the physical and the biological parts of the ecosystems; the **cultural**, where both the historical factors, the identity role and the narrative qualities of the landscape are considered; the **socio-economic**, referring to the social factors and the economic activities determining the human action permanently constructing and changing the landscape, and also to the regulations and instruments which affect these activities; and finally the **sensorial**, connected with the sensations caused by landscapes, their appreciation by different people or groups of people.

Combining all these components, the landscape units identified are areas with a characteristic landscape pattern, a clear internal coherence and a specific character. These areas can be homogeneous, or also heterogeneous, but then combining in a specific way different patterns. The determining factors for the individualisation of one unit are not always the same: they may be of different types, as well the morphology as the geology, the land use, the historical role, the identity acknowledgement, the specific dynamics, etc. This understanding of a landscape unit is adapted to a national approach, where the whole country is considered. To wok at other scales, the definition should be adapted.

Methodology

In order to secure the combination of perspectives and approaches mentioned above, the first step in this study has been the composition of an interdisciplinary team, integrating mainly landscape architects and geographers, with various experiences and fields of work. The team has also been supported by a diversified group of advisers.

Due to the diversity of the Portuguese landscape, the strong and various contrasts within a relatively small territory, and also due to the objective of understanding and recognising the character of different landscape units, it was decided not to create a typology, but to consider each landscape unit on its own. This approach to landscape unit corresponds in some way to the concept of landscape character area identified in the UK and in Scotland (Countryside Commission, 1998; Usher, 1999).

In order to understand the specific character and features in each landscape unit, and to decide where a new unit should be identified and separated from its surroundings, an important part of the work was based on expert judgement. This expert judgement was supported by a combination of complementary approaches, including cartographic analysis, bibliographic research, interviews, field work, etc.

In a first phase, a comprehensive bibliographic research has been developed, both concerning equivalent projects in other countries of Europe and landscape assessment research generally, and also concerning the characterisation of the Portuguese territory and different visions of its geographic division.

In the second phase, the first identification of landscape units and definition of their boundaries has been worked out. The maps corresponding to the various variables selected have been worked together, leading to the identification of areas with relatively homogeneous characteristics and different from their surroundings. The work scale selected was 1:250 000. The existing cartographic information has been collected and often adapted, in order to produce digital basis with a homogeneous detail and quality of information for the whole territory. The variables explicitly considered were: geology, morphology, altitude, soil, land use, property structure, settlement pattern. Other fundamental variables as climate and the proximity of the ocean, have been introduced in the expert assessment of the previous results. The limits defined in this first phase have also been adjusted with the help of the satellite images and in some cases air photos, and finally decided through expert assessment, within the team.

In a third phase, the first definition of areas and their transition boundaries has been confirmed and adjusted through comprehensive field visits and registers, national and regional bibliography, and consultation of regional experts.

A second period of deskwork, the fourth phase of the work, combining the whole information and the experience and sensitivity within the team, resulted in the final design of the landscape units. This phase has consisted of many hours of debate and common reflection, with all cartographic and photographic documents open on a table, and in many cases also various types of open documents.

This approach allows a large degree of flexibility to the work, since different parameters, or combinations of parameters, can be considered as determinant for the identification of each unit – and the team is aware of the role of these parameters in each case. It is a complex and long process, who requires different types of work, the combination of various sources, and a deep knowledge of all the country by the expert team. But, at the same time, it allows the combination of the objective data with a sensitive assessment of the landscape, and thus an integrated understanding of the landscape.

In the units identified, there is generally a core area with well defined characteristics and character. But between two or more core areas there is a transition zone, with less defined characteristics. The boundary is thus in most cases not an absolute boundary, but more an indication of the existence of this transition between two different landscape units. Exceptionally the boundary may correspond to a clear line in the landscape, as a geological interruption, or radical change in land use pattern.

Besides landscape units, sub-units have also been identified, when a small part of the area considered has special characteristics which deserve being mentioned, or when the unit is divided in two or three parts of equal importance, belonging to the same character unit but with slightly different landscape patterns. In some cases, singular elements have also been identified, when a local feature, due to its form, position, specific degradation, or other factor, stands out from the surroundings, or has a special symbolic value.

The areas defined have been organised in large regional groups, according mainly to similar bio-physical characteristics, following the main geographical classifications of the country defined previously, mainly by Orlando Ribeiro (1993).

The fifth phase of work has been the characterisation of all landscape areas, based on the information used for their identification, but also on the analysis of statistical data and other figures showing trends in the landscape. For each area, a characterisation document has been produced, including both text, photos and detailed cartography.

The sixth phase has been the downscaling of the study into a more detailed scale. It has been done in selected case-study areas, in order to test the methodology, to verify the possible combination with other methodologies, and to try the possibilities of a more detailed landscape analysis, eventually more oriented towards management proposals.

Results

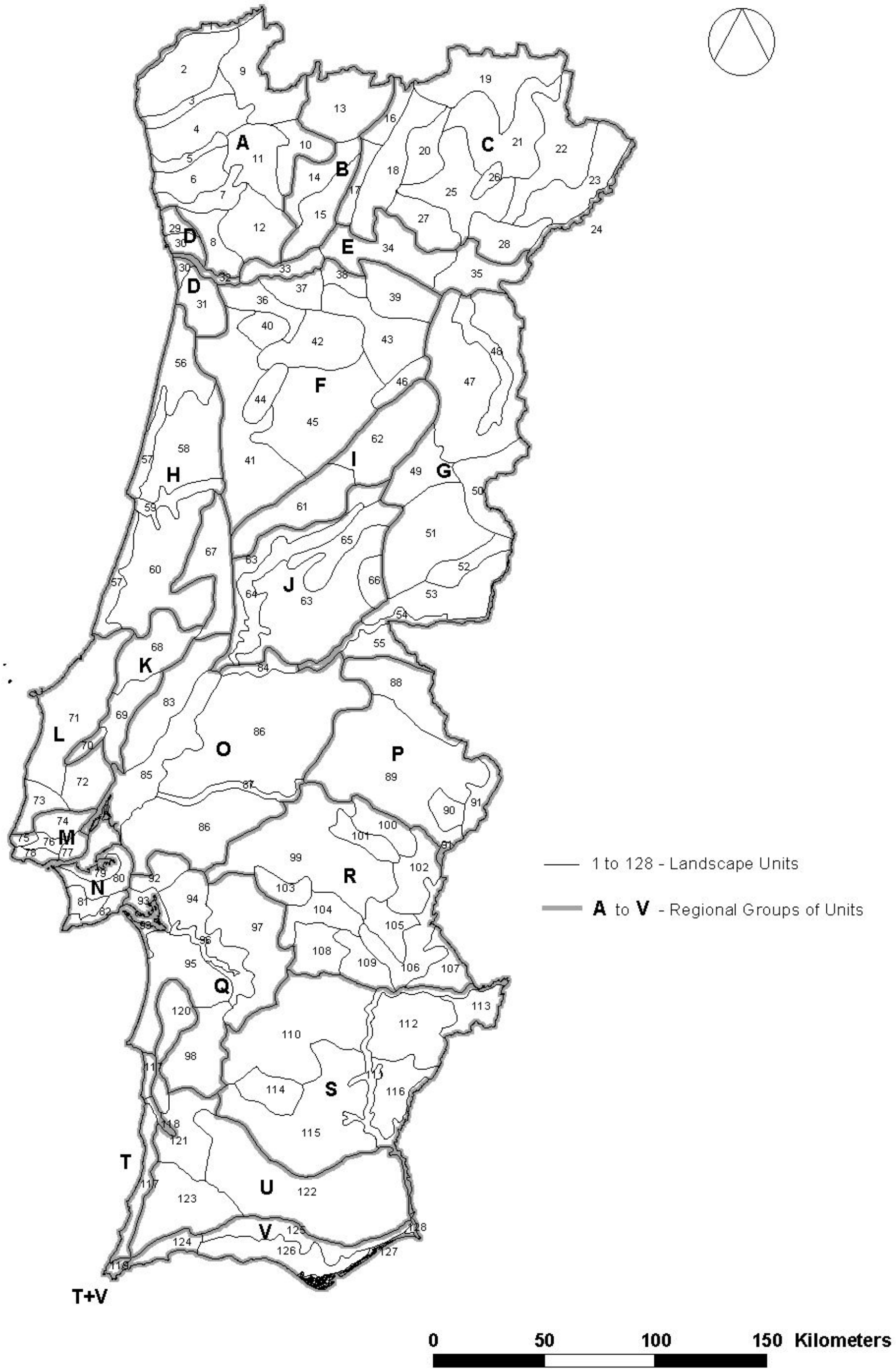
The work developed resulted in the identification of 128 landscape units for the whole continental part of Portugal, organised in 22 regional groups, as it can be seen in Figure 1. Some units include sub-units or singular elements.

The identification of the character of a landscape unit has in most cases not been difficult, but the decision whether it should be considered a separated unit or could be integrated with another with some similar characteristics has often been more complex. It happens that two different solutions can both be coherent, according to different parameters. Furthermore, the decisions on the location of the boundary line have rarely been simple. In general, there is a core area with well defined characteristics. But between two or more core areas there is a transition zone, less well defined. The boundary is thus in most cases not an absolute boundary, but more an indication of the existence of this transition between two different landscape units.

The approach followed, based on the combination of thematic information but also on the knowledge of the experts in the team and on their synthesis capacity, is complex but has the main strength of being integrated and flexible. It allows different parameters to be considered and to be determinant in different cases, and it can be adapted to more or less detail according to the scale of work.

Furthermore, the methodology developed is based on the acceptance that the objective factors, reflecting the material landscape, must be combined with the more sensorial, subjective, understanding of the landscape. This implies a certain degree of subjectivity within the choices made, but the team assumes this subjectivity as a positive and necessary requirement. This means that the units defined are in some way also a reflection of the main sensibilities of the team. Another team would have made in some cases other choices. But the units now defined have an internal coherence and a clearly defined character.

Fig. 1
Portugal - Landscape Units and Regional Groups of Units



For the study, an extensive quantity of information has been collected, adopted, produced and discussed, and this information can also be useful as a basis for much deeper analysis and debate in the future. The landscape assessment now undertaken results in an identification of the Portuguese landscape today, and can help decision making in planning, as it contains information on the diversity of landscapes and the main trends and threats affecting them. Specific measures and objectives for management were not defined at this phase, but orientations have been formulated. The present landscape identification and characterisation is seen by the team as a starting point for further work on knowing and understanding the Portuguese landscapes.

Landscape indicators

Landscape indicators should be useful instruments to detect changing trends in the landscape, and they should allow comparisons as well in space and in time; but at the same time, indicators should be able to illustrate and demonstrate these trends. Communication may even be the most relevant role of indicators, who are thus asked to simplify the complexity of reality (Smeets and Weterings, 1999). According to OECD own report (OECD, 2001), good indicators should be relevant in terms of policy, they should give a good picture of reality, and they should easely measured and interpreted. The same report states that indicators should refer to landscape **structure**, its pattern, its elements, to landscape **management**, and the values connected with its **functions**.

Even if these three types of indicators are equally important, it is clearly more difficult to defined adequate indicators of the landscape function. Concerning both pattern and management, there are several examples from previous studies, which could also be adapted and applied to Portugal.

For the pattern, there could be: a) the rate of agricultural area in relation to the whole area, as the increase or reduction is this rate lead to different trends in landscape change; b) intensification or extensification of agricultural systems, which can be measured through various parameters (livestock density, labour input, land use structure, etc.); c) concentration or disappearance of farm units, as these trends are reflected in the simplification of the landscape and in its scale of organization; d) density of man built elements of cultural value; e) and measures of landscape pattern, measured through air photographs or similar documents, like density and diversity of patches, or density of linear and punctual elements, or also relation between open areas (cultivated fields, pastures, vineyards) and forest.

For the management, some possible indicators could be: a) rate of farm land under any type of management contract related with landscape preservation in some way, or rate of land under a specific type contract; b) regional or local distribution of number of instruments and measures applied; c) dimension of funds applied, also at national, regional or local level.

Concerning function, the type of indicators is much rarely found in literature, even if the need to find them is acknowledged. They are more difficult to define, as information on function does not really exist in the available information, neither on statistics nor on cartographic information, and the upscalling of the possibly existing information at local scale is not really evident.

How many indicators are requested is another open question. If the aim is to evaluate changes in the landscape along time, for different types of landscapes different indicators have to be considered, as the characteristics to be measured may be quite different. The selection of indicators could correspond to a typology of landscapes, been specific indicators selected for specific types of landscapes. To evaluate variations in space, between different landscapes, a common type of indicator may be defined, but that will always be for more general issues and would not cover all relevant aspects, or components.

Conclusion - applying indicators to the Portuguese landscapes

The selection of landscape indicators to be applied in Portugal is still to be discussed, but it is most probable that the future monitoring of landscape changes here will need to be based on some type of indicators – as studies as the one described in this paper are too heavy and complex to be done regularly, aiming at comparisons. For evaluating changes in time, what is required is not to create indicators that support landscape understanding, but that measure these changes according to an initially known condition.

If the idea of defining different indicators for different landscapes is accepted, than the landscape units now defined can be an adequate basis, as they are based on this understanding and represent the landscape as it is actually. And the whole country has been considered, with homogeneous data sources and a common approach, so the whole territory is covered and all landscape types. The acknowledgement of the specific characteristics and trends of these units will make it possible to apply indicators in a more selective way – not the same indicators for the whole country, but specific indicators for specific areas.

To adapt the information sources for the indicators to the shape of the landscape units should not really be a problem. The landscape areas do not follow administrative limits. That could made the use of statistical data easier, but any landscape assessment would hardly respect those type of limits. The statistical data can anyway be adapted to other spatial boundaries. And part of the information to be considered is cartographic information, which better can be adapted to the boundaries of landscape areas.

The study here presented has not been designed and developed with the help of indicators, not with the concern of applying indicators for future monitoring. Nevertheless, the evaluation of future changes is a logical and required extension of the work now done. A combination of selected indicators, adapted to each landscape area and its specific characteristics, but also relevant in a broader context, seems a realistic solution – if it keeps the flexibility and sensitivity needed for the fully understanding and assessment of landscapes and their changes.

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Landscape Types as the Optimal Spatial Domain for Developing Landscape Indicators

Gebhard BANKO[1], Gerhard ZETHNER[1], Thomas WRBKA[2], Ingrid SCHMITZBERGER[2]

1) Austrian Federal Environment Agency, Spittelauer Lände 5, A-1090 Vienna, AUSTRIA
2) Institut for Ecology and Conservation Biology, Althanstraße 14, A-1090 Vienna, AUSTRIA

Correspondence address: Gebhard Banko, Department of Ecology, Austrian Federal Environment Agency, Spittelauer Lände 5, A-1090 Vienna, e-post: banko@ubavie.gv.at, phone: +43-1-31304-3330, fax: +43-1-31304-5700

Abstract

A generic model for the evaluation of agricultural landscapes is presented. The starting point of the model is the stratification of the reporting unit into so called landscape types. For each of these types a guiding vision – a commonly agreed desirable status of the respective landscape type - has to be developed, based on which a limited set of indicators can be used to evaluate the present state of a landscape and the changes over time. The applicability of the indicator set for the evaluation of landscapes and cross cutting issues like various landscape functions (e.g. biodiversity, intensity of land use) could be demonstrated for examples in Austria. The scientific background for this approach is the proposed relationship between structural features of a landscape and its functions and processes. For the in depth analysis automated procedures for the segmentation and classification of earth observation data in combination with GIS utilities are – due to the amount of data do be handled – form a major part of this approach. For the whole territory of Austria 42 different landscape types could be identified and delineated by means of satellite image interpretation. The developed indicator system is used to point out the relationship between the current structure of a landscape as documented by satellite data and the information on processes linked to this structure.

Keywords

Landscape types, landscape structure, landscape function, landscape value, remote sensing, GIS

Introduction

Different approaches concerning landscape indicators have been developed within the last decade. As in most European countries the agricultural practices are predominant factors in shaping the landscape, they got special attention for the development of indicators as well. The indicator development for landscapes is characterized by two main features. On the one side the large extent of landscapes requires the integration of earth observation data in combination with GIS technologies. On the other side the question of the spatial domain and the spatial reference for indicator calculation is a very critical one. Administrative units do not reflect natural borders and are therefore not appropriate to analyse landscapes in a meaningful reference unit. Moving window approaches show a high degree of freedom in the choice of important parameters like window size and spacing and are therefore not appropriate for standardised and harmonised assessment methods. The amount, conditions and trends in habitats and landscapes are one way to valuing land (UKBG, 2001). Landscape units however are regarded as the optimal frame for the analysis of nature conservation related topics, like biodiversity (DG-Agriculture et al. 2000).

Although a number of approaches handled landscape indicators using statistical data, a spatial explicit approach is mandatory due to the characteristics of this complex issues. The calculation of indicators is a tool for serving environmental impact assessments. As no objective evaluation exist yet, the evaluation using indicators has to be at least a comprehensible one. Earth observation and geographical information systems are an essential tool for the derivation of indicators.

In Austria a classification of landscapes was carried out following not only static parameters like geomorphology and climatic characteristic, but taking into consideration the dynamic nature of the phenomenon by integrating land use and land cover information the stratification of the country into a limited number of landscape types enables to formulate paragons, guidelines and evaluation criteria for each of these types. The landscapes – delineated from satellite images – represent the spatial domain for the indicator development and enables the orientation of the indicator calculation according to natural borders and not on administrative borders anymore. One of the main input parameters into the designing, evaluation and indicator system is a detailed land use and land cover classification from satellite imagery. The standard CORINE-classification system has to be enhanced and extended according to country specific needs. A product scale of 1:50.000 is intended and will be developed.

As a previous paper on biodiversity and landscape presented at OECD-Workshop in Zürich (Aubrecht et al. 2001) already integrated the ideas of stratifying the country into regions according to landscape types, this paper extends this ideas to come up with a first suggestion on indicator development in agricultural landscapes as a base for a regional approach in agricultural policy.

An integrated system: landscape types and indicators

Agricultural landscapes are the visible outcome from the interactions between agriculture, natural resources and the environment. Although hardly any common agreement on the exact definition of a landscape between different approaches (cultural, socio-economical, ecological) exits, it is generally accepted that landscapes are composed of the three key elements: landscape value, landscape structure and landscape function (OECD, 2001).

Within the methodology described in this paper the three key elements form a generic system integrating political and/or public value decisions (landscape value), a sound scientific concept (landscape structure) and establishing the link to cross cutting issues like the landscape functions for e.g. biodiversity (figure 1). The scientific background for this approach is the proposed relationship between structural features of a landscape and its functions and processes.

Before agricultural landscapes are analysed and evaluated the following questions have to be answered:

- Landscape value: What is the most desirable status of a landscape?
- Landscape structure: How can this status be measured
- Landscape function: Which amenity values are optimised?

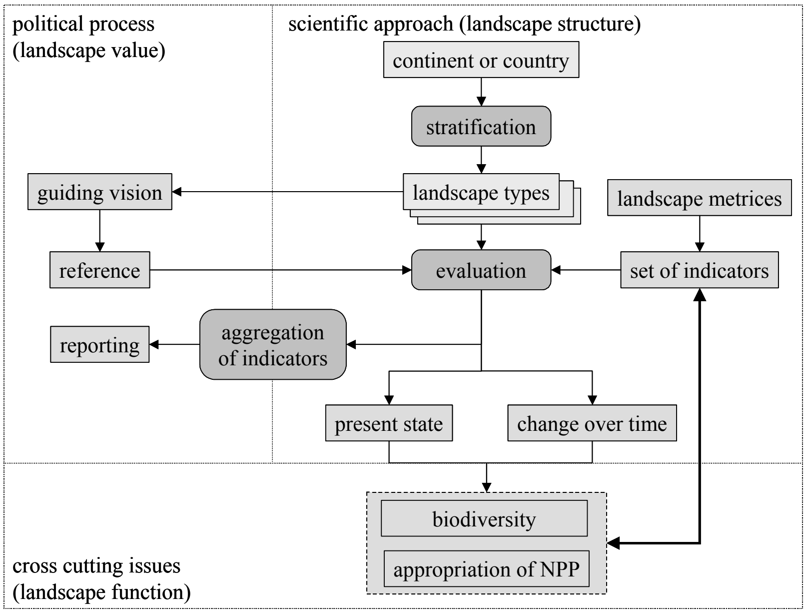

Figure 1: Generic model for the evaluation of landscapes based on spatially explicit indicators

Landscape structure

Landscapes can be characterized by a unique combination of basic attributes like geology, geomorphology, land use and land use history, socio-economic development etc (Bunce et al. 1996). These varying attributes can be grouped together to form landscape types, in order to stratify the total area under consideration into more or less homogeneous regions. Therefore the question of the desirable status of a landscape can not be answered in a general way, but has to take into consideration the regional differences between the landscapes. Earth observation plays a crucial part in the derivation of landscape types, though it enables the geometrically explicit delineation based on an synoptic view of the underlying landscape structure and texture.

An indicator system describing the present state of a specific landscape has to evaluate both the landscape structure and the landscape texture using a limited set of landscape metrics (McGarigal and B. Marks, 1995), derived from digital land use and land cover datasets (mainly using earth observation techniques). Landscape metrics measure the amount and density of specific landscape features and determine how these features change over time. But the measurement for itself does not provide the information needed in the decision making process. Only the combination of the specific measurement and the knowledge of the range and limits of this value enables the sound interpretation of the landscape metrics. To establish a close link between the technical oriented measurement of landscape metrics and the evaluation of an indicator a guiding vision is needed, to define the reference and the desired landscape status. For each landscape type the weight and the positive or negative meaning of each indicator can be defined.

Indicators enable the comparison of landscapes of the same type and enable the analysis of changes over time within an area.

Landscape value

Once the area under consideration is stratified according to landscape types, a guiding vision has to be formulated for each of these types. This guiding vision has to be formulated on a political level and might vary according to what is considered as the most desirable structure and texture of a landscape. For some functions of the landscape, like for biodiversity, this desirable status can be formulated according to the expert knowledge of the desirable conservation status. Such a favourable conservation status can be expressed using the concept of umbrella species, an approach taken for example in the establishment of the Natura 2000 network in the EU.

For purposes of reporting on a higher level the indicators used on landscape level might to be aggregated. Whereas the ecological meaning of the basic indicators on landscape level can be interpreted by experts, the aggregated indicators often lead to misleading interpretations, because the aggregation process decouples the underlying correlation between the indicator and bio-ecological functions (Banko et al. 2001).

Landscape function

The agricultural landscape as outcome of agricultural activities provides public goods and services. The definition of the desirable status of a landscape often tries to optimise some of these amenity goods, which are mostly no-monetary values. Therefore the correlation between the indicator system describing landscape structure and landscape composition is very important when it comes to the point of evaluating the usefulness of the indicator-system. Recent publications have shown the usefulness for landscape indicators for cross cutting issues. In Moser et al. 2002 the usefulness for biodiversity issues were demonstrated using the correlation between landscape indicators (shape complexity) and plant species richness. But also for more general issues, like the intensity of land use, measured as the "human appropriation of net primary production" (Haberl et al. 2002), a series of landscape structure parameters showed strong correlations.

The methodology tested in Banko et al. 2000 is set upon an integrated landscape ecology approach to biodiversity assessment that is built upon the relationship between the landscape composition and structure and the floristic and faunistic species diversity. The approach encompasses the analysis of Earth observation (EO) data and additional GIS datasets in combination with a rule system based on ecological expert knowledge (Turner, Gardener 1991). The following indices were used: area proportion, mean patch size, variation of patch size, compactness, elongation, isolation and patch density (Dramstadt et al. 1998).

Landscape typology: methods and concepts

According to the opinion of Zonneveld (1992), one of the pioneers in landscape ecology, "The landscape ecologist cannot work efficiently without using (landscape) classification." In his textbook "Land Ecology" he also points out, that "Landscape ecologists may use existing classification systems for the various land attributes, but for land units he may have to develop special ad hoc or more durable classification systems". This describes very well the approach, which was chosen within the classification of agricultural landscapes in Austria.

The classification approach aimed at:

1. the identification of spatial units with an "ecological significance" at different scales (local, regional, national, European);
2. a compilation of a geographical database of landscape attributes, which can be associated with those spatial units;

3. the description of landscape types, which can also be used for practical purposes, especially in nature conservation areas and land use planning.

The difficulties, which such an approach has to face, are obvious, since the variability of landscapes throughout the biogeographic regions is extremely large.

The following guiding principals can be mentioned:

- The object of delineation and classification is called "**landscape**". An individual landscape is identified and delineated by means of visual interpretation of satellite images using diagnostic properties.
- The individual landscapes or polygons are grouped into landscape types, using the concept of "**Convergence of Evidence**" (Zonneveld 1995). This means, that in one group of objects (individual landscapes) different kinds of properties converge or coincide in contrast with other groups of objects.
- The **diagnostic properties** which are grouping the landscapes into landscape types have to deal with: landform, geology, climate, exposition, altitude, actual vegetation and land cover. Most of them find evidence in the satellite imagery using information from the spectral signals of various band combinations and the structure of the visual appearance in the image. In addition to this spatially explicit data also spatially non-explicite data is used. The expert knowledge about the long term history of man's influence and additional social-economic information has been used.
- **Diagnostic characteristics** may be selected from those converging properties. This can be done by statistical means. In the case of the ENVIP Nature project it was done with the help of expert knowledge. This knowledge was fed into the classification system by the local experts for the chosen test areas.
- The diagnostic characteristics which are selected to determine a system of landscape types should be preferably a **set of converging diagnostic properties** and not just a single property of the composing parts. This means that we always chose combinations of diagnostic properties (land cover mosaic, geomorphology, land use…) and not just a single isolated parameter.

It has to be mentioned that classification of concrete ecosystems or landscapes is not a goal in itself. It is mainly a tool for environmental policy analysis. In this respect De Haes and Klijn (1994) distinguish between two main families of classification approaches for environmental policy, namely those of a static nature, assembling more or less the physical land evaluation and secondly those of a more dynamic nature mainly associated with environmental impact assessment. Both approaches have to meet the criteria of being related to causes of ecological change and the appraisal of ecosystem quality by society. Consequently ecosystem and landscape classification should preferably be related to environmental hazards and the environmental policy targets at the same time. In the case of Austria these requirements are met because the identified landscapes and landscape types are used as spatial reference units for any further step of land evaluation with respect to nature conservation.

Classification of agricultural landscapes in Austria

For the Austrian territory WRBKA et al. (2002) recently finalised a detailed delineation and classification of agricultural landscapes in two steps:

1. definition of landscape types
2. delineation of individual landscapes

In the **first step**, a sketch map was produced in the scale of 1:500,000 based on a visual interpretation of Landsat TM satellite images. For over 200 sample points, which were statistically distributed all over Austria, field data on landscape structure, land use and biodiversity were recorded. Although this was done for a different purpose, namely the development of landscape indicators, the data could be used to back up the landscape typology as well. In the first analysis it turned out, that there was a strong correlation between geo-ecological land units and land use and landscape structure. This relationship was used to predefine a hierarchy of cultural landscape types. In total 12 cultural landscape type series were classified, which were subdivided into 42 cultural landscape type groups.

The **second step** was to elaborate a delineation manual containing detailed instruction for the delineation of polygons on Landsat TM images. Main criteria for the manual delineation procedure was homogeneity in colour and texture. As colour corresponds with land cover, texture does represent the spatial arrangement of landscape elements, the so called landscape structure. Textural homogeneity appears as repetitive pattern of different coloured patches. For the whole of Austria, more than 13,500 individual landscapes were finally delineated. Table 1 presents the typology.

Table 1: Cultural landscape type series and cultural landscape type groups of Austria

Cultural landscape type series		Cultural landscape type groups	
No.	Nomenclature	No.	Nomenclature
A	Alpine fells and areas of ice	101	Rocks and glaciers of the alpine region
B	Alpine and sub-alpine grassland landscapes	102	Semi-natural and natural grassland of alpine highlands.
		103	Sub-alpine intensive range land.
C		201	Forested mountain slopes.
		203	Bands of riparian woodland along big rivers
		204	Forested gorges and narrow valleys
D	Island type forested landscapes	202	Large extra-alpine forest islands
		205	Forested midlands
E	Upland dairy arming landscapes with high proportion of permanent grassland	301	Grassland dominated inner-alpine clearings
		302	Grassland dominated, narrow, alpine valleys.
		303	Grassland dominated clearings on the fringes of the Alps
		308	Grassland landscapes of extra-alpine mountains
F	Dairy farming landscapes of glacial valleys and basins with high proportion of permanent grassland	304	Grassland dominated alpine lake basins and glacial moraine
		305	Grassland dominated inner-alpine basins and valley floors.
		310	Grassland dominated extra-alpine hill land
G	Lowland mixed farming landscapes with high proportion of permanent grassland	306	Grassland dominated extra-alpine lake basins and rift valleys
		307	Grassland dominated extra-alpine basins and valleys
		311	Extended extra-alpine xeric grassland and pasture landscapes
		312	Illyric grassland - fruit and foddercrop growing complexes.
		313	Grassland dominated extra- alpine narrow valleys
		309	Extended fallowlands (and successional areas)
H	Mixed agriculture landscapes with dominant foddercropping	401	Inner-alpine basins and valley floors with mixed arable-grassland agriculture

		402	Extra-alpine hilllands with mixed arable-grassland agriculture and pronounced foddercrop production.
		406	Pre-alpine clearings with mixed arable-grassland agriculture and pronounced foddercropping
		407	Clearings on the fringes of the Alps with mixed arable-grassland agriculture
		409	Lake basins with foddercrops.
		410	Inner-alpine basins and valley floors with foddercrops
		411	Extra-alpine basins and valley floor with foddercrops.
I	Arable landscapes of extra-alpine lowlands and uplands	403	Extra-alpine hilllands with dominant cereal growing
		404	Extra-alpine basins and valley floors with dominant cereal growing
		405	Extra-alpine clearings with arable agriculture
		408	Extra-alpine mountains with arable agriculture
J	Mixed agriculture landscapes with high proportion of vineyards or orchards.	601	Flatlands and soft slopes with dominant wine production/vine growing.
		602	Steeper slopes with dominant wine growing
K	Viniculture landscapes with high amount of cropland	603	Pannonian arable-viniculture complexes
		604	Illyric fruit-viniculture-foddercrop complexes
L	Settlement- urban and industrial landscapes	701	Urban areas
		702	Densely built up areas along traffic arteries
		703	Historically grown industrial and settlement landscape
		704	Young industrial and settlement landscape
		705	Small towns and suburban settlements
		706	Large excavation and landfill sites

Within a statistical cluster analysis the differentiation of the derived landscape types were analysed based on several digital attribute layers, such as elevation range, slope range, hemerobiotic value of forest ecosystems, geological land units etc. (Schmitzberger et al. 2001).

Application of agricultural landscape types in environmental planning and nature conservation

Ecological meaningful landscape types, the outcome of the classification, serve as reference units for land evaluation and environmental studies on a regional and national scale. The digital data set was recently used in a series of studies, like the ex-ante evaluation of the Austrian Programme for Rural Development (Lughofer et al. 2000), the identification of landscapes with high significance for the maintenance of biodiversity (Aubrecht et al. 2001, Wrbka et al. in print), the calculation of remoteness and fragmentation due to the road network in Austria (Wrbka et al. 2001), and finally the elaboration of a map of sustainable land use based on attributes of landscape structure (Wrbka et al. 1999a, Wrbka et al. in prep.). The new landscape classification of the Austrian territory is used as the most important data layer for the stratification of Austria into environmentally homogeneous regions for the purpose of optimal sampling design for biodiversity and landscape monitoring (Wrbka et al. 1999b).

Although these studies served a wide range of purposes, the methodological approach and the scientific background were quite similar in all cases. The scientific background for this approach is the proposed relationship between structural features of a landscape and its functions and processes. E.g. it could be used in an accounting system for loss and gain of landscape areas (Stott & Haines-Young, 1998).

A common denominator of all the mentioned studies was, that a set of rules was applied to all the polygons to visualise either hidden ecological variables, like biodiversity values or human impact, or to produce a prognostic map of the future state of the investigated landscapes. As an example figure 2 illustrates this procedure. Figure 2a shows a map of Austria with the visualisation of human impact on agricultural landscapes measured by a so called hemerobiotic state (Wrbka et al. in prep.).

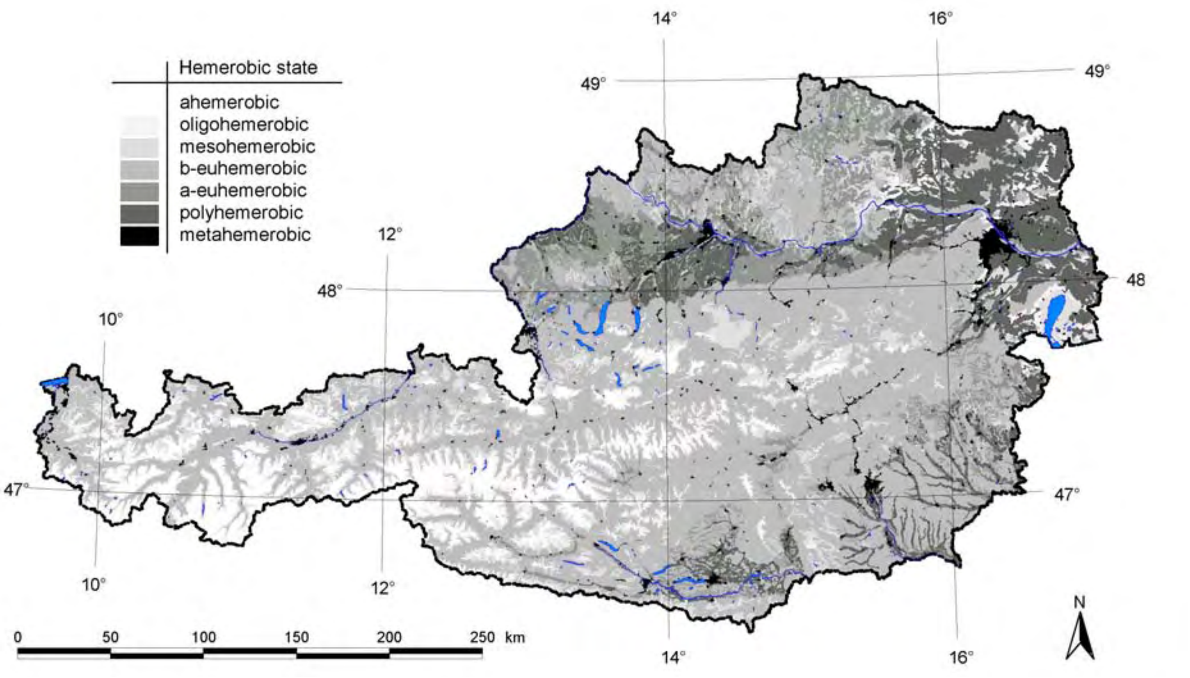

Figure 2a: Human impact on agricultural landscapes (in terms of hemerobic state). The classification of the hemerobic state of a respective landscape type was done by expert judgement and based on the experience of a nation wide cultural landscape mapping survey.

As the first map was simply produced by expert judgement assigning certain values to the polygons, the second map, figure 2b, is the result of a regression model. This model was derived by multiple regression of the landscape structure indicators resulting from the field survey and an automatic segmentation and classification of satellite images.

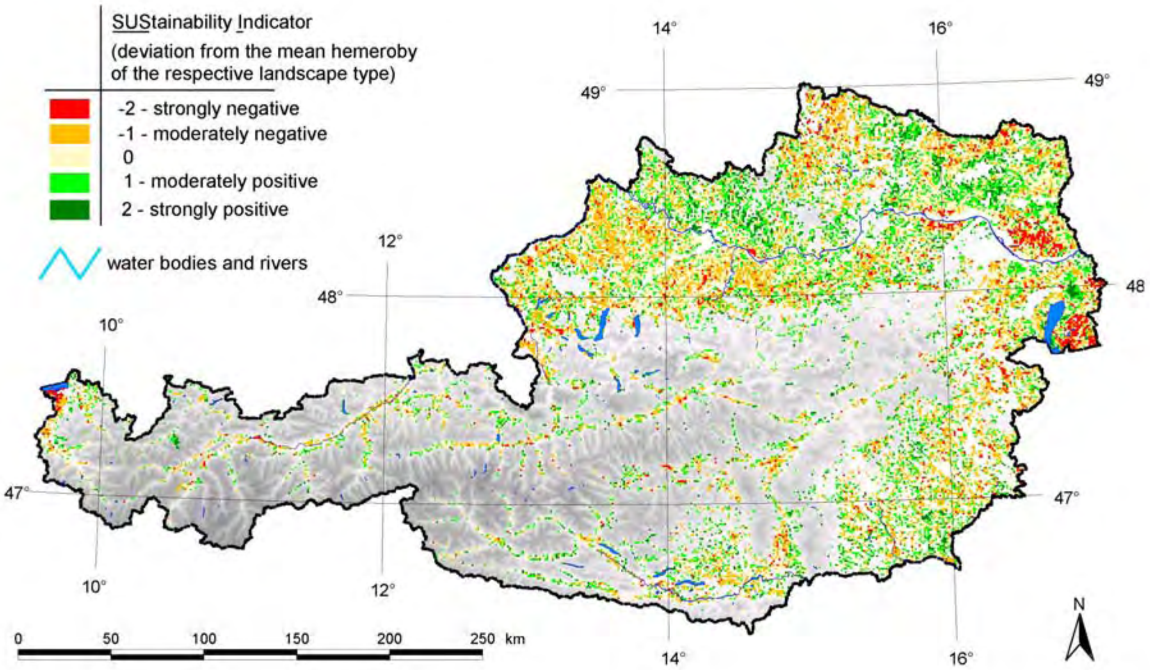

Figure 2b: SUStainability Indicator (SUSI): Sustainability Indicator calculated as mean difference in hemerobiotic state from a specific landscape to the respective landscape type. The difference was calculated from the modelled hemerobic state (ordinal regression model with landscape structure variables derived from a satellite based landcover classification, r^2=0.511, p>0.001). The indicator provides an overview whether the respective part of the agricultural landscape is managed more intensively or less according to the average management practice in a certain landscape type (cultural landscape type group).

Land use intensity

Haberl (1997) could show the relationship between landscape features and processes for the correlation of land use intensity as measured by the so called "human appropriation of net primary production" and a series of variables, which are used to describe landscape structure. The result was, that indicators like landscape diversity or shape complexity were very low in landscapes, which had a high human appropriation of net primary production, indicating a very high human impact.

Biodiversity

Even when it comes to biodiversity issues, landscape structure can be used as a shortcut for this very complex and controversial matter. Moser et al. (in print) demonstrated in some context that the shape complexity as measured by the so called "Landscape shape complexity index", is strongly correlated with not only species richness but also with the hemerobiotic state. In other words, we can postulate, that modern, highly mechanised and very intensive agriculture produces species poor landscapes, which are composed by landscape elements of a very simple geometry. These findings and theory should be further investigated.

Guiding Vision

It has to be said, that all these calculations and indicator operations are useless in land use policy, if they are not backed up by a guiding vision of a satisfactory state of the landscape. If the goal for landscape development is not well defined, indices can be misleading, because they simply describe the actual state not giving any information about how far this actual state is away from a desirable condition. In conservation planning the concept of target or umbrella species is often used to define such a favourable state of a landscape or a region. A similar approach has been chosen for the Natura 2000 programme, in which the favourable conservation status, as measured by the quality and quantity of target habitats in a designated area, is defined. In Austria the discussion of goals and guiding visions for agricultural landscapes has just begun and can be supported by the results of this research. We strongly advocate a procedure in which the elaboration of such guiding visions is done on a broad basis of expert knowledge reflecting also stakeholders interests. This procedure has to differentiate between the different agricultural landscapes, because of the fact, that conservation goals or the framework for sustainable agriculture can be quite different e. g. between an intensively used lowland area and a marginalized upland region.

Conclusions

A methodology has been presented to monitor changes on landscape level with the main emphasis on biodiversity . The methodology follows an integrated approach using earth observation data and GIS-data. Landscape metrics were used to provide a standardised tool for evaluating landscapes according to predefined visions of the optimal conservation status of various landscapes. Although the indices may not show meaningful absolute values their relative values can be used to compare landscapes of the same type at a certain moment in time and the development of landscapes between two moments in time. Landscape metrics are therefore an essential tool to reduce the complexity of natural processes and are a first approach to translate them into numbers that can be communicated more easily to decision makers.

To be able to evaluate landscapes using landscape metrics an approach has been presented to link the generic guiding vision as reference for the favourable conservation status with the numerical dynamic of the metrics under consideration. Only a small number of metrics were used in order to avoid correlation between similar metrics and to concentrate the efforts to understand their ecological meaning.

Further research is needed to improve the comprehensibility of both the establishment of the landscape typology and the delineation of the landscape individuals. Again earth observation techniques provide the best methods therefore.

As landscape structure has to be analysed on different spatial levels - and there are a lot of methodological problems to solve when it comes to the integration of these spatial scales – the problem of process oriented indicators describing human activities in the landscape is much more related to the spatial domain of the relevant census data, which are commonly used in agricultural land use statistics. There is a mismatch between the administrative land units, which were used in agricultural and land use statistics, and the landscape type or segments on a satellite image, which would be much more meaningful in ecological terms. On the other hand the concept of landscape types can not be neglected, because of the strong relationship between pattern and process, which is given only in land units having similar biophysical conditions and comparable land use systems and history.

To conclude it can be said, that the concept of landscape types was not only successfully developed and applied in a series of environmental studies, but can also be extended by the incorporation of socio-economic key variables, such as the farming styles. Using farming styles the group of farmers can be broken down to subgroups according to their needs and reactions in the frame of incentives and direct payment. This is of special important if the future development of agricultural landscapes under certain socio-economic conditions have to be predicted.

A successful combination of these two concepts is able to overcome the obvious constraints of a mere biophysical understanding of landscapes, which is inadequate when dealing in particular with agricultural landscapes.

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OECD EXPERT MEETING ON:
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Oslo, Norway

LIST OF PARTICIPANTS

AUSTRALIA	Colin CREIGHTON, Water Resources Land & Water Australia GPO Box 2182,, Canberra ACT 2601	Tel: (61) 2 62573024 Fax: (61) 2 62579518 Email: colin.creighton@lwa.gov.au Mobile: 0418 225894
AUSTRIA	Klaus WAGNER, Federal Institute of Agricultural Economics Schweizertalstrasse 36 A-1130 Vienna	Tel.: (43) 1 877 36 51 64 Fax: (43) 1 877 36 51 59 Email: klaus.wagner@awi.bmlfuw.gv.at
	Gebhard BANKO Austrian Federal Environment Agency Ecology and Nature Conservation Spittelauer Lände 5, A-1090 Vienna	Tel.: (43) 1 31304-3330 Fax: (43) 1 31304-3700 Email: banko@ubavie.gv.at
	Thomas WRBKA Department of Conservation Biology, Vegetation and Landscape Ecology University of Vienna, Althanstrasse 14 A-1091 Vienna	Tel.: (43) 1 4277-54374 Fax: (43) 1 4277- 9542 Email: wrbka@pflaphy.pph.univie.ac.at
BELGIUM	Marc ANTROP, Geography Department, Ghent University, Krijgslaan 281, S8 B9000 Ghent	Tel.: (32) 9 264 4705 Fax.: (32) 9 264 4985 Email: Marc.antrop@rug.ac.be
FINLAND	Reija HIETALA-KOIVU Department of Forest Ecology University of Helsinki PO.Box 27 FIN-00014 University of Helsinki	Tel.: (358) 40 828 3098 Fax.: (358) reija.hietala-koivu@helsinki.fi
FRANCE	Philippe GIRARDIN **,** Equipe "Agriculture durable", UMR INPL(ENSAIA), INRA Agronomie et Environnement Nancy-Colmar, BP 507 68021 Colmar Cedex	Tel.: (33) 3 89 22 49 20 Fax.: (33) 3 89 22 49 33 Email: girardin@colmar.inra.fr Website: http://www.inra.fr/indigo
	Viviane ANDRE, Chargée de mission Agriculture, Direction des Etudes Economiques et de l'Evaluation Environnementale (D4E-B2), Ministère de l'Ecologie et du Développement Durable, 20 rue de Ségur	Tel.: (33) (0)1 42 19 25 05 Fax.: (33) (0) 1 42 19 17 54 Email:Viviane.ANDRE@environneme nt.gouv.fr

	75302 Paris 07 SP	
	Marie-Françoise SLAK, Laboratorie Analyse de Risques et Gestion des Espaces ENITA de Bordeaux, 1 crs général de Gaulle BP 201 33175 Gradignan cedex	Tel.: (33) 5 57 35 07 07 Fax.: (33) 5 57 35 07 39 Email: slak@enitab.fr Mobile: (33) 6 86 89 82 46
	Jean-Marie DEVILLARD Ministère de l'agriculture et de la pêche DPEI / BOEEE 3, rue Barbet de Jouy 75007 Paris	Tel.: (33) 01 49 55 46 81 Fax.: (33) 01 49 55 49 77 Email:jean-marie.devillard @agriculture.gouv.fr
GERMANY	Annette SELIGER, Federal Ministry of Consumer Protection, Food and Agriculture Section 226 - Koordination der Umweltangelegenheiten Rochusstraße 1 53123 Bonn	Tel.: (49) 1888 529 3774 Fax: (49) 1888 529 4332 Email: annette.seliger@bmvel.bund.de
	Ulrich STACHOW, Centre for Agricultural Landscape and Land Use Research (ZALF-LS), Eberswalder Str. 84, D-15374 Muencheberg	Tel: (49) (0)33432 82267 Fax: (49) 0)33432 82387 Email: ustachow@zalf.de Web-site: http://www.zalf.de
	Dietrich SCHULZ Federal Environmental Agency P.O. Box 33 00 22 D-14191 Berlin	Tel: (49) 30-8903-2885 Fax: (49) 30-8903-2890 Email: dietrich.schulz@uba.de
	Astrid THYSSEN, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety Division N II 5 Godesberger Allee 90 53175 Bonn	Tel: (49) 228-305-2654 Fax: (49) 228-305-2696 Email: Astrid.Thyssen@bmu.bund.de
	Hans-Peter PIORR, Department of Agricultural Land Use, Faculty of Landscape Use and Nature Conservation, University of Applied Sciences, Friedrich-Ebert Straße 28 D-16225 Eberswalde	Tel: (49) 3334 - 657 307 Fax: (49) 3334 - 236 316 Email: ppiorr@fh-eberswalde.de Website: http://www.fh-eberswalde.de
GREECE	Calliope PACHAKI,	Tel.: (0030) 210-3627321 or 3676430

	Researcher, Agriculture, Rural and Local Development, Centre of Planning and Economic Research (KEPE) , 22, Hippokratous Street, GR-106 80 Athens	Fax.: (0030) 210-3630122 or 3611136 Email: ptonikid@kepe.gr or vkapon@kepe.gr
	Theano S. TERKENLI Department of Geography University of the Aegean University Hill Mitiline 81100 Lesvos , Greece	Tel.: (0030) 22510-36414 Fax.: (0030) 22510-36499 Email: t.terkenli@aegean.gr
HUNGARY	József SURJÁN Senior Advisor Ministry of Agriculture and Regional Development Agri-Environmental Management Department 1055 Budapest Kossuth tér 11	Tel: (36-1) 301 4476 Fax: (36-1) 301 4644 / 302 0408 Email: jozsef.surjan@fvm.hu
ITALY	Paola DORIA, Istituto Nazionale di Economia Agraria, Via Barberini 36, 00197 Rome	Tel: (39) 0039 06 47856545 Fax: (39) Email: doria@inea.it
JAPAN	Yasuhiko KURASHIGE Deputy Director, Office of Environment Policy Coordination Minister's Secretariat, Ministry of Agriculture, Forestry & Fisheries, 1-2-1 Kasumigaseki Chiyoda-ku, Tokyo 100-8950, Japan	Tel: (81) 3 3591 5793 Fax: (81) 3 3508 4080 Email: yasuhiko_kurashige@nm.maff.go.jp
	David S. SPRAGUE Chief, Ecological Management Unit, Ecosystems Group, Department of Global Resources National Institute for Agro-Environmental Sciences 3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604, Japan	Tel: (81) 298-38-8226 Fax: (81) 298-38-8226 Email: sprague@niaes.affrc.go.jp
KOREA	Song-Soo LIM, Korea Rural Economic Institute (KREI) 340 Hoigi-dong, Dongdaemun-ku Seoul 130-710, Korea	Tel: (82) 2 3299 4382 Fax: (82) 2 968 7340 E-mail: songsoo@krei.re.kr

LUXEMBOURG	Gérard CONTER, Service d'économie rurale, Ministère de l'Agriculture, 115, rue de Hollerich, L-1741 Luxembourg	Tel: (352) 478 25 76 Fax: (352) 49 16 19 Email: Gerard.Conter@ser.etat.lu
MEXICO	Martha Niño SUKOWSKA, Director of Urban Sustainability, Ministry of Environment and Natural Resources of Mexico Blvd.A. Ruiz Cortinez, 4209-5°, Col.Jardines en la Montaña Tlalpan, 14210 DF Mexico	Tel: (52)(55) 5490-0994 Fax: ( ) Email: mnino@semarnat.gob.mx
NETHERLANDS	A.M. BREURE National Institute of Public Health and the Environment Laboratory for Ecotoxicology PO box 1 NL 3720 BA Bilthoven	Tel.: (31) 30 274 3068 Fax: (31) 30 274 4413 Email: ton.breure@rivm.nl
	Rob MEIJERS, Minstry of Agriculture, Nature and Fisheries, Expertisecentrum LNV postbus 30 6700 AA Wageningen	Tel.: (31) 0317-474849 Fax: (31) 0317-474930 Email: r.meijers@eclnv.agro.nl
NORWAY	Arne BARDALEN Norwegian Institute of Land Inventory P.O.Box 115,1431 Ås	Tel.: (47) 64 94 97 55 Fax: (47) 64 94 97 86 Email: arne.bardalen@nijos.no
	Alvhild HEDSTEIN, Political Adviser, Ministry of Agriculture, P.O Box 8007 Dep, 0030 Oslo	Tel.: (47) 22 24 91 04 Fax: (47) 22 24 91 04 Email: alvhild.hedstein@ld.dep.no
	Wenche DRAMSTAD, Norwegian Institute of Land Inventory P.O.Box 115,1431 Ås	Tel.: (47) 64 94 96 84 Fax: (47) 64 94 97 86 Email: wenche.dramstad@nijos.no
	Wendy FJELLSTAD Norwegian Institute of Land Inventory P.O.Box 115, 1431 Ås	Tel.: (47) 64 94 97 04 Fax: (47) 64 94 97 86 Email: wendy.fjellstad@nijos.no
	Oskar PUSCHMANN Norwegian Institute of Land Inventory P.O.Box 115, 1431 Ås	Tel.: (47) 64 94 97 60 Fax: (47) 64 94 97 86 Email: oskar.puschmann@nijos.no
	Frode LYSSANDTRAE,	Tel.: (47) 22 24 92 37

Advisor,
Norwegian Ministry of Agriculture
P.O.Box 8007 Dep., 0030 Oslo
Fax: (47) 22 24 95 56
Email: Frode.Lyssandtra@ld.dep.no

Anette SØRAAS,
Advisor,
Norwegian Ministry of Agriculture
P.O.Box 8007 Dep., 0030 Oslo
Tel.: (47) 22 24 93 50
Fax: (47) 22 24 27 53
Email: Anette.Soraas@ld.dep.no

Inger-Turid JAHR
The Norwegian agricultural extension service
Frederik A. Dahls vei 20, 14312 Ås
Tel.: (47) 64 97 21 06
Fax: (47) 64 97 21 10
Email: inger-turid.jahr@lfr.no

Ståle NAVRUD
Dept. of economics and social sciences
Agricultural University of Norway
P.O.Box 5033 NLH, 1432 Ås
Tel.: (47) 64 94 89 27
Fax: (47) 64 94 30 12
Email: stale.navrud@ios.nlh.no

Anke LOSKA,
Adviser,
The Directorate for Cultural Heritage,
P.O.Box 8116 Dep, 0034 Oslo
Tel.: (47) 22 94 03 80
Fax: (47) 22 94 04 05
Email: alo@ra.no

Ragnhild HOEL
Adviser,
The Directorate for Cultural Heritage,
P.O.Box 8116 Dep, 0034 Oslo
Tel: (47) 22 94 04 00
Fax: (47) 22 94 04 04
Email: ragnhild.hoel@ra.no

Christian Anton SMEDSHAUG,
Adviser,
Ministry of Agriculture,
P.O Box 8007 Dep, 0030 Oslo
Tel.: (47) 22 24 92 59
Fax: (47) 22 24 95 56
E-mail: anton.smedshaug@ld.dep.no

Steinar SØRLI,
County Agricultural Officer
County Govenor of Hordaland
Dep. of Agriculture
P.O.Box 7315, 5020 Bergen
Tel.: (47) 55 57 21 54
Fax: (47) 55 57 21 41
Email: steinar.sorli@fm-ho.stat.no

Ole Osvald MOSS
Head of Devision
Statistics Norway
Division for Primary Industry Statistics
Oterveien 23
2225 Kongsvinger
Tel.: (47) 62 88 52 32
Fax: (47) 62 88 50 30
Email: ole.osvald.moss@ssb.no

Gary FRY,
Department of Land Use & Landscape Planning
Agricultural University of Norway
Tel.: (47) 64 94 84 01
Fax: (47) 64 94 83 90
Email: gary.fry@ilp.nlh.no

	PO Box 5029, N-1432 Aas	
	Odd EILERTSEN, Norwegian Institute of Land Inventory P.O.BOx 115, N-1432 Ås	Tel.: (47) 64 94 97 72 Fax: (47) 64 94 97 86 Email: odd.eilertsen@nijos.no
	Erik FRAMSTAD, NINA - Norwegian Institute for Nature Research PO Box 736 Sentrum, N-0105 Oslo	Tel.: (47) 2335 5110 Fax: (47) 2335 5101 Email: erik.framstad@nina.no
	Akse ØSTEBRØT Adviser Directorate for Nature Management Tungasletta 2 7485 Trondheim	Tel/Fax: (47) 73 58 05 00 / 01 Email: akse.ostebrot@dirnat.no
	Christina SOGGE Norwegian Institute of Land Inventory P.O.Box 115, 1430 Ås	Tel: (47) 64 94 97 61 Fax: (47) 64 94 97 86 Email: c.sogge@nijos.no
POLAND	Anna LIRO, Head of the Division Ministry of Agriculture and Rural Development, 30, Wspolna Str. , 00-930 Warsaw	Tel.: (48) 22 623 17 54 Fax.: (48) 22 623 20 51 Email: anna.liro@minrol.gov.pl
PORTUGAL	Teresa AVELAR, Environment Audithor Minstry of Agriculture, Praça do Comércio 1149-010 Lisbon	Tel: (351) 213234868 Fax: (351) 213234612 Email: aa@min-agricultura.pt
	Maria José FESTAS, General Direction of Spatial Planning and Urban Development Ministry of towns, spatial Planning and Environment, Campo Grande,50 1749-014 Lisbon	Tel: (351) 217933908 Fax: (351) 217825003 Email: gabdg@dgodu.pt
	Teresa PINTO-CORREIA, Department of Landscape and Biophysical Planning, University of Evora, Colégio Luis Verney, 7000 Evora	Tel: (351) 266 745 334 Fax: (351) 266 744 968 Email: mtpc@uevora.pt
SLOVAK REPUBLIC	Zuzana OHRÁDKOVÁ Ministry of Environment of the Slovak Republic Nature and Landscape Protection Dept. Nam. Ludovita Stura 1	Tel: (421) 2 5956 2223 Fax: (421) 2 5956 2533 Email: ohradkova.zuzana@lifeenv.gov.sk

	812 35 Bratislava	
SPAIN	Francisco MARTÍNEZ ARROYO Head of Section Directorate General of Rural Development, Ministry of Agriculture, Paseo de la Castellana 112 28071 Madrid	Tel: (34) 91 347 17 96 Fax: (34) 91 347 15 54 Email: fmartinez@mapya.es
	Silvia CALVO IGLESIAS University of Santiago de Compostela Laboratorio do Territorio, E.P.S. Campus de Lugo s/n 27002 Lugo	Tel: (34) 982252303 ext. 23292 Fax: (34) Email: scalvo@lugo.usc.es
SWEDEN	Amanda HÖGELIN, Statistics Sweden, Box 24300, SE - 104 51 Stockholm	Tel.: (46) 8 50694515 Fax: (46) Email: Amanda.Hoegelin@scb.se
	Jan SKALOS, Vildandsvagen 26 A, r.329, 227 34 Lund, Swedish University of Agricultural Sciences Department of Landscape Planning Alnarp P.O. Box 58, SE - 230 53 Alnarp	Tel.: (46) Fax: (46) Email: janskalos@yahoo.ca
SWITZERLAND	Beatrice SCHÜPBACH, Landscape Ecology and Biodiversity, Swiss Federal Research Station for Agroecology and Agriculture, Reckenholzstrasse 191, Postfach 8046 Zürich	Tel.: (41) 1 377 73 28 Fax: (41) 1 377 72 01 Email: beatrice.schuepbach@fal.admin.ch
UNITED KINGDOM	Carol SOMPER, Research, Data and Information Branch, Countryside Agency for England John Dower House Crescent Place Cheltenham Glos. GL50 3RA	Tel.: 44 (0) 1242 533410 Fax.: 44 (0) Mobile: 07900608363 Email: Carol.Somper@countryside.gov.uk
	Andrew STOTT, Wildlife and Countryside Science Unit, Department for Environment Food and Rural Affairs, 1/09 Temple Quay House, Temple Quay, Bristol, BS1 6EB, UK	Tel.: 44 (0) 117 372 8445 Fax.: 44 (0) 117 372 8182 Email: andrew.stott@defra.gsi.gov.uk
	Rebecca HUGHES,	From 10.10.02 – 10.04.03

	Scottish Natural Heritage 2 Anderson Place Edinburgh EH6 SNP UK	Tel.: 44 (0) 131 446 2400 Fax.: 44 (0) 131 446 2405 Email: Wintonlea@aol.com
	Roy HAINES YOUNG, University of Nottingham School of Geography Nottingham NG7 2RD	Tel.: 44 (0) 115-9515498 Fax.: 44 (0) 115-9515249 Email: roy.haines-young@nottingham.ac.uk
	Marion POTSCHIN School of Geography, University of Nottingham Nottingham NG7 2RD	Tel.: 44 (0) 115-9515498 Fax.: 44 (0) 115-9515249 Email: Marion.Potschin@unibas.ch
UNITED STATES	Stephen J. BRADY, Natural Resources Inventory & Analysis Institute and FS Inventory & Monitoring Institute, Natural Resource Conservation Service (NRCS), US Department of Agriculture, Suite 300, NRRC, 2150-A Centre Ave., Ft. Collins, CO 80526-1891	Tel.: (1) 970-295-5721 Fax: (1) 970-295-5885 E mail: sjbrady@fs.fed.us
	Joan NASSAUER Professor of Landscape Architecture School of Natural Resources and Environment University of Michigan 430 E. University Avenue, Ann Arbor, Michigan 48109-1115	Tel: (1) 734-763-9893 Fax: (1) 734-936-2195 Email: nassauer@umich.edu
COMMISSION OF THE EUROPEAN COMMUNITIES	Rüdiger ALTPETER Principal Administrator, Agri DG H2, Affaires Internationales Agriculture European Commission Loi 130 6/58, 200 rue de la Loi 1049 Bruxelles, Belgium	Tel: 32 2 295 33 98 Fax: 32 2 295 24 16 Email: ruediger.altpeter@cec.eu.int
	Eric WILLEMS Quantitative analysis, forecasts, statistics and studies unit EC/DG AGRI DG Agriculture, European Commission, B-1049 Brussels	Tel: 32 2 296 00 25 Fax: 32 2 295 84 53 Email: Eric.Willems@cec.eu.int
	Claude VIDAL European Commission – EUROSTAT Directorate F Jean Monnet Building, BECH C2/608 2920 Luxembourg	Tel: 352 4301 37182 Fax: 352 4301 37317 Email: claude.vidal@cec.eu.int

EEA (EUROPEAN ENVIRONMENT AGENCY)	Ybele HOOGEVEEN, Project Manager Agriculture and Biodiversity, European Environment Agency Kongens Nytorv 6, DK-1050 Copenhagen K	Tel.: (45 33) 36 7178 Fax: (45 33) 36 7151 Email: Ybele.Hoogeveen@eea.eu.int Web site: www.eea.eu.int

NON-MEMBER OECD COUNTRIES

SLOVENIA	Danijela SABIC, Head of the Statistical Geomatics and GIS Department, Statistical Office of the Republic of Slovenia, Vozarski pot 12, 1000 Ljubljana	Tel.: (386) 1 2340 712 Fax.: (386) 1 2340 860 Email: danijela.sabic@gov.si

INTERNATIONAL GOVERNMENTAL ORGANISATIONS

UNESCO	Lucilla SPINI, Division of Ecological Sciences, Man and the Biosphere Programme, UNESCO, 1 rue Miollis 75732 Paris Cedex 15 - France	Tel: (33) 1 4568 3736 Fax: (33) 1 4568 5804 Email: l.spini@unesco.org Website: www.unesco.org/mab/

INTERNATIONAL NON-GOVERNMENTAL ORGANISATIONS

Landscape Europe (Int. Network of Expertise)	Dirk M WASCHER, Alterra - Green World Research, Department of Landscape Ecology, Droevendaalsesteeg 3 (100) 6700 AA Wageningen, The Netherlands	Tel.: (31) 317-477932 Fax: (31) 317-424988 E-mail: D.M.Wascher@Alterra.wag-ur.nl
ALTERRA Green World Research	Bärbel TRESS, Alterra - Green World Research Landscape and Spatial Planning Dept. P.O. Box 47, NL- 6700 AA Wageningen, The Netherlands	Tel.: (31) 317-474616 Fax: (31) 317-419000 E-mail: baerbel@tress.cc Website: http://www.tress.cc
	Gunther TRESS, Alterra - Green World Research Landscape and Spatial Planning Dept. P.O. Box 47, NL- 6700 AA Wageningen, The Netherlands	Tel.: (+31) 317-474616 Fax: (+31) 317-419000 E-mail: gunther@tress.cc Website: http://www.tress.cc
BIRDLIFE IINTERNATIONAL	Anna SHIEL, Economist RSPB	Tel.: 44 (0) 01767 680551 Fax: 44 (0) 01767 692365 E-mail: Anna.Shiel@rspb.org.uk

	The Lodge Sandy Bedfordshire, SG19 2DL, United KIngdom	Website: www.rspb.org.uk or www.birdlife.org
ECNC (European Centre for Nature Conservation)	Ben DELBAERE Senior Programme Coordinator Biodiversity and Landscapes ECNC — European Centre for Nature Conservation PO Box 1352, 5004 BJ Tilburg The Netherlands	Tel.: (31 13) 4663240 Fax: (31-13) 4663250 E-mail: delbaere@ecnc.nl, www: http://www.ecnc.nl

OECD SECRETARIAT

DIRECTORATE FOR FOOD, AGRICULTURE AND FISHERIES

Wilfrid LEGG, Head of Division, Policies and Environment Division, Agriculture Directorate OECD 2 rue André Pascal 75016 Paris, France	Tel.: (33 1) 45 24 95 36 Fax : (33 1) 44 30 61 02 Email: Wilfrid.Legg@oecd.org
Kevin PARRIS Senior Analyst, Policies and Environment Division, Agriculture Directorate OECD 2 rue André-Pascal, 75016 Paris CEDEX 16 France	Tel.: +33 (0) 1 45 24 95 68 Fax : +33 (0) 1 44 30 61 02 Email: kevin.parris@oecd.org Website: http://www.oecd.org/agr/env/indicators.htm