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Foreword

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Over the last 20 years, European policymakers have adopted the practice of using Environmental Assessment tools to support decision-making. Formal procedures and guidance are well established within the European Commission and in most EU Member States. However, EA procedures alone do not guarantee that the tools used are always the best and most efficient. Therefore the European Commission launched a series of comprehensive research projects to understand decision-making for the environment and to develop science-based EA tools. The project TESS (Transactional Environmental Support System) funded under the EU's Seventh Framework Programme for Research and Technological Development was one such project.

TESS has made three major contributions to understanding Environmental Assessment and decision making for the environment in general. It has provided the first Pan-European analysis of EAs, showing that countries where their density is highest have least urban sprawl, and that EA density in turn reflects positive attitudes of local people to benefits from nature. It has shown that although statutory EAs are important, the prevalence of local informal decisions for managing land and species is many thousand times greater. It has noted that local knowledge gathered for these decisions, and for countryside recreations which generate some €62 billion annually, creates high local ability to provide base data of value for EAs and citizen science. These findings have indicated scope for a system, as designed in the TESS project, to acquire local knowledge that would benefit environmental decision-making at all levels. This is relevant to Europe's 2020 strategy and to meeting the Aichi targets of the Convention of Biological Diversity.

While TESS has now ended, the cooperation it promoted between policymakers and "local decision makers" - such as farmers, gardeners and hunters – continues through a legacy web portal www.naturalliance.eu available in 21 languages. The portal offers best practise examples and support tools, such as free mapping software developed by TESS, for anyone to map areas and species in their local environment. In exchange, users will be asked to record their detailed local data through the portal, on species and habitats in their gardens, fields or forests, in order to help local, regional and national authorities make decisions on land use.

The more local information is available, the easier it becomes for decisions to be taken at EU or national level, for example in the implementation of agricultural and structural fund policies. A project such as this is a good example of how EU-funded research is finding solutions to bring basic scientific research to policy makers. I hope that you will enjoy this publication and make good use of it.

Preface

Robert E. Kenward (Anatrack Ltd, UK)

This project, which was contracted to design a Transactional Environmental Support System (TESS) under the European Commission's Framework Programme 7, is deeply rooted in the Convention on Biological Diversity (CBD). This international convention, which stems from the "Earth Summit" in Rio de Janeiro in 1992, has three pillars: the conservation of biodiversity, its sustainable use, and the equitable sharing of the benefits of its genetic resources. The second pillar, sustainable use, is defined as "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity", in other words as "use that conserves". CBD calls for sustainable use in 12 of its articles (5-8, 10-13, 16-18, 21). CBD calls for conservation by protection in one article (8), yet far more attention has been paid to conservation by protection than to conservation by sustainable use.

The use of biodiversity lies behind the myriad decisions made by individuals at local level, on what to remove or plant, and how and when to manage each species. Decisions that are made for farm fields and gardens are small-scale individually, but they summate to change the environment. Even if 17% of the land surface is protected by 2020, as recommended at the 10th CBD conference in Nagoya in 2012, most land will lie outside protected areas, but influence them through pollution, hydrology and fragmentation.

The International Union for the Conservation of Nature (IUCN), founded in 1948 and now with more than a thousand government and non-government organisations as members, was the initiator of CBD and many subsequent documents. These included the Ecosystem Approach, which stressed that humans too are a part of natural systems and was adopted at CBD's 6th conference in 2002. The previous year (2001), IUCN had also started work on a document which, at CBD's 7th conference in 2004, became the Addis Ababa Principles and Guidelines for Sustainable use of Biodiversity. Both documents stressed the engagement of local people for conservation, through applying local knowledge, monitoring and empowerment, with appropriate governance at all levels for adaptive management of wild resources.

Also in 2001, IUCN's European Sustainable Use Specialist Group delivered to the Council of Europe a paper on agri-environment innovation for the Kiev Inter-Ministerial Conference on the Environment. The paper concluded: "Optimising the enhancement of biodiversity through sustainable use will require integration of ecological, economic and social factors in complex models. Although such models must be developed centrally, the Internet can be used to disseminate knowledge in expert systems, so management decisions can be made locally, and to retrieve local knowledge to improve the models. Thus, modern technology can enable local communities to regain motivation and responsibility for managing their environment."

A third project also beginning in 2001, and which helped plan for TESS, was a survey in the UK Natural Environment Research Council (NERC) of opportunities for technology transfer. The survey revealed 41 software applications among 115 products with commercial potential in NERC's Centre for Ecology and Hydrology, with much software available outside CEH too. Discussion with government officers encouraged a mapping of this supply to the requirements of stakeholders. This led to a review of information needs of local council and landowners in Purbeck, UK, which later informed a similar process across Europe for the TESS project.

In 2005 members of European Sustainable Use Specialist Group won a bid in the EU's Framework Programme 6 for a project on Governance and Ecosystem Management for Conservation of Biodiversity (GEMCONBIO). The GEMCONBIO project gathered data that showed not only the importance of adaptive management, but also that annual private spending in Europe on fishing, hunting and watching wildlife in the EU was at least €40 billion. The evidence that local biodiversity-dependent recreation had so much value, combined with increasing recognition of the CBD concepts developing in IUCN and elsewhere around 2001, gave renewed impetus for the successful 2008 bid to design a TESS.

1. Introduction

Robert E. Kenward, Jason Papathanasiou (University of Macedonia, Greece), **Basil Manos** (Aristotle University of Thessaloniki, Greece) **& Stratos Arampatzis** (Tero Ltd, Greece)

ABSTRACT

Change in land-use and hence biodiversity result from decisions at local level, which are restrained only in part by formal environmental assessments. However, local knowledge and adaptive management for small de-intensification measures could be mediated by the internet to restore biodiversity and ecosystem services at low cost, by providing decision support to local managers of land and species while also collating their knowledge to guide policy-making. We introduce four questions that challenge the development of suitable internet systems and which this project seeks to answer.

BACKGROUND

For 50 years, subsidies at continental and state level have successfully driven the production of a few crop species in Europe. Commercially driven homogenisation of diverse local land-use continues to degrade ecosystem services that sustained Europeans for centuries (Pretty 2002). Species whose dynamics and colonisation operates at small scale have disappeared through habitat loss and fragmentation, so that biodiversity has declined drastically at local level (e.g. Paine & Pienkowski 1997; Thomas *et al*. 2004).

Over the same 50 years, human ability to predict the outcome of manipulations has increased through the use of computers. Forecasts from associative models, which neglect causation, are being replaced by more accurate prediction from individual-based models that incorporate behavioural mechanisms (Goss-Custard 1996, Sutherland 1996). Models can be spatially specific through linkage to habitat and socio-economic data as cells in geographic information systems (GIS). Adverse development can be constrained (under 85/337/EEC) after environmental impact assessment (EIA) at local level (e.g. Treweek 1999) and more recently (under 2001/42/EC) following strategic environmental assessment (SEA) on a broader scale (Wood & Jeddow 1992). However, these high-level directives, and protection of areas (e.g. Habitats Directive, 92/43/EEC), have not had the desired effect of halting the loss of biodiversity by 2010 (Dimas 2009).

USE OF LAND, ECOSYSTEM SERVICES AND BIODIVERSITY

Irrespective of the formal processes for planning strategic programmes (SEA) and large development projects (EIA), the myriad local "me-too" decisions tend to make use of land intensive and monotonous outside protected areas. This creates the risk that the 17% of land which is targeted for protection (CBD 2010) tends either to be remote or "small islands of biodiversity in a sea of agriculture" (Hutton & Leader-Williams 2003). However, recent thinking goes beyond a hands-off approach to conserving the riches of nature.

After the Ecosystem Approach of CBD (2002) stressed that humans too are a part of natural systems, the Millennium Ecosystem Assessment (2005) recognised benefits for humans from ecosystem services, for *regulating* climate, floods and disease, for *provisioning* with food and materials, for *cultural* recreation and aesthetics and for *supporting* those three service categories with soil and clean air and water. Recent interest in valuing those services (e.g. in The Economics of Ecosystems and Biodiversity 2010) has tended to focus on the importance of *provisioning* services, and the need for public spending to conserve *regulating* and *supporting* services from ecosystems as public or common goods. Unfortunately, *provisioning* services tend to become private crops grown intensively at the expense of biodiversity; moreover, high biodiversity is not always essential for *supporting* and *regulating* services, partly because humans can fill the consumptive role of other species (e.g. predators).

However, some *cultural* services that depend on biodiversity generate resources, in terms of finance and voluntarism, which are only just being recognised in Europe. Resources from private recreational

use of biodiversity (e.g. hunting, fishing and watching wildlife) could provide de-intensification measures at local level (Kenward & Garcia Cidad 2005). The importance of de-intensifying was illustrated by Newton (2004), who identified the main factors associated with decline of 30 bird species as: (i) weed control, (ii) early ploughing, (iii) grassland management, (iv) increased livestock levels, (v) hedgerow loss and predation. All can be addressed in ways that produce small reductions in crop yields. Thus, reduced cereal yield when field-edges are left unsprayed, which increases the abundance of game birds and other wild fauna and flora (Boatman & Sotherton 1988), could be offset by income from hunting and watching wildlife.

THE PROBLEM OF COMPLEXITY

Unfortunately, the current system of formal environmental assessment is bottlenecked by a dependence on experts, which limits its application to large or severe cases and can also prejudice repeatability in conflictive ways (Therivel 2004). When socio-economic sustainability factors are included as well as environmental, as recommended at the World Summit on Sustainable Development (WSSD 2002), the complexity of assessment becomes daunting (Jacobs & Sadler 1989; Therivel & Minas 2002): application of assessment to 70 ecosystem services in 34 contexts was listed in the Convention on Biological Diversity (CBD 2002). Moreover, the challenge far beyond the current assessment system is how to influence the daily small-scale decisions made for farming, forestry, gardening and council management of parks and road verges.

Thus, although we now know that annual spending in Europe on biodiversity-dependent recreational activities exceeds €40 billion (Kenward et al. 2009), and have accumulated much information about re-diversifying land and restoring ecosystem services (Rey-Benayas et al. 2010, Bullock et al. 2011), we also know that to re-diversify much land outside protected areas is very complex, both in terms of ecological research and also in terms of economic support for applying that research. So we are still as constrained as when Pimm et al. (2001) noted "Paradoxically we are not limited by lack of knowledge but failure to synthesis and distribute what we know."

TOWARDS A TRANSACTIONAL SYSTEM

To address these issues, the TESS project maintained the view proposed to Council of Europe (Kenward & Garcia Cidad 2005) that the internet offers the best way to implement CBD commitments on local knowledge, monitoring and governance for adaptive management of biodiversity resources. Web services could collate the extensive bio-socio-economic environmental knowledge that is currently fragmented across Europe, to provide background for SEA and EIA. Furthermore, an internet system could also supplement these formal assessments, based on a few individuals, by context-adapted support for the myriad small-scale decisions taken by local stakeholders. Information could be provided to encourage projects at local level (e.g. farm shops) to neutralise wider commercial pressures, and for skilful tuning of small de-intensification measures (e.g. headlands), public works (e.g. road verges) and gardens which could benefit biodiversity at minimal cost. It is challenging to bring together all the information needed for use of land and its wild resources in ways that are environmentally, socially and economically sustainable. However, to give all land-managers across Europe comparable expertise without such a system is impossible.

Environmental knowledge for assessment is a commodity, of value for government decisions but also to individuals constrained by government regulations and motivated by an array of public and private incentives. Potentially, the market for such knowledge is huge. This provides scope for a transaction between governments and local communities. In order for governments to conduct complex SEA and SIA assessments for developing policy and high-level plans, they need a summation of the results of local decisions. In order for individuals to make small-scale assessments and decisions, they need complex knowledge that government can provide automatically to local communities and individuals via the internet, in exchange for the summation of local knowledge and monitoring. In brief:

- Central government can derive complex knowledge by collating local knowledge.
- For sustainability, central government needs to guide local actions and monitor results.
- Communities and individuals have local knowledge & capabilities (skill, cash, time).
- They need complex knowledge to guide their actions for long-term sustainability.

Thus, TESS aimed "to design a decision support system related to environment and land use that will enable policy makers to integrate knowledge from the regional and local level into the decision

making process, while also encouraging local people to maintain and restore biodiversity ecosystem services".

CONCLUSIONS

TESS produced regular reports for European Commission to demonstrate the successful progress of the project. Those of most interest have been simplified to produce the chapters that follow, which include many interesting research findings. However, the most important questions to be answered if the TESS project is to be implemented, and which are considered again in the concluding chapter, are the following:

- Do local people require information that a transactional system can deliver?
- Can local people contribute enough data of use at higher levels?
- Can current technology build such a system?
- Can the building and long-term operation of such a system be supported?

2. Central Information Flows and Decision-Making Requirements

Robin J.A. Sharp (European Sustainable Use Specialist Group of IUCN/SSC),
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ABSTRACT

Information needs of government for SEA, EIA and other aspects of biodiversity conservation and sustainable development were studied. This included needs related to biodiversity for land use planning, for operation of the EU Common Agricultural Policy, for agricultural policy more generally and for Biodiversity Action Plans. Legislation and its implementation were considered at European Union and member state level by direct enquiries and a preliminary questionnaire survey in project partner countries. Preliminary conclusions were drawn and lessons learned for a Pan-European survey which followed.

INTRODUCTION

Work on the "Central Policy Environment" topic, had as its objectives

- To identify information needs of government for SEA, SIA and other aspects of biodiversity conservation and sustainable development.
- To determine how that information is obtained.
- To produce a report detailing the information flows from local and regional to central.

The main Task was for the TESS consortium to gather information on how data for these processes is managed in 4 to 5 states, if possible with different types of environmental governance. After preliminary analysis it was decided (i) to focus on SEA and EIA at high level, since these techniques are embodied in EU law as explained below, (ii) to ignore SIA (sustainability impact assessment) because this is not generally embodied in legislation, and (iii) to include information needs related to biodiversity also for land use planning, for operation of the EU Common Agricultural Policy (CAP), for agricultural policy generally, and for Biodiversity Action Plans (BAPs) under Article 6 of the Convention on Biological Diversity (CBD).

SOME PRELIMINARY CONCLUSIONS

The following are some conclusions relevant to the first part of the TESS project, based mostly on the information from the National Level Enquiry in 8 countries, but to some extent on information in the

Commission's reviews of EIA and SEA and other literature. Later chapters show the extent to which the comprehensive survey of all 27 EU member states and 4 other countries in Europe support these conclusions.

- EIA & SEA Directives from EU level and national LUP laws are generally sound.
- They require input of biodiversity information where relevant.
- They encourage public involvement and transparency.
- But formal processes are often daunting, resulting in dominance by consultancies and NGO "experts".
- The wide variation in numbers of EIA's annually by country has not been explained – it must affect the quality of assessment & monitoring.
- There is no obligation or governments or anyone else to ensure the availability or quality of environmental data need for EIA, SEA or LUP, although the INSPIRE Directive (European Commission, 2007) is a major effort to fill this gap at European Union level.
- Where EIA's and SEA's have assembled data, including biodiversity data, there is no obligation on member states to store and make this available for wider environmental monitoring by organisations such as the European Environment Agency or nationally.
- There is plenty of biodiversity data on the internet but the geographical coverage and quality are generally poor for decision making.
- Main contents are lists of endangered species and habitats.
- There is an absence of policy responsibility for making it fit for use.
- BAP's are useful tools where they exist but the absence of regional or local Plan's in most countries limits their relevance for decision support.
- CAP is only at the beginning of using environmental and biodiversity information at farm level.
- We need a better idea by country of the extent of land still farmed under production subsidies compared with land under single farm payments and more specialised agri-environment schemes.
- Generally there is a lack of integration between biodiversity information providers and the decision making regimes we have been studying.

3. Local Information Flows and Decision-Making Requirements

Kathy H. Hodder, Adrian C. Newton, Loretta Perrella, Jane Butters
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ABSTRACT

This enquiry characterised the use of information on biodiversity and ecosystem services in the environmental decision making process at the local (as opposed to national) level. Data were collected from nine case study areas, in eight countries, to explore local requirements across a range of governance systems and bioregions in EU and accession states. A strong demand for information was noted across all the case studies, with some variation in needs between societal groups. This contrasted with a substantial proportion reporting considerable difficulty in acquiring the necessary information for decision making. This was particularly true for detailed habitat data. Although the internet was commonly used to search for information, much of the data accessed was not stored on computers and not regularly updated or spatially referenced. Notably, the highest perception of these impediments to data access occurred in the stakeholder groups that also indicated the greatest requirements for information.

INTRODUCTION

The work described in this chapter was designed to gather information at the local level, in rural areas, to complement the information collected concerning the national level in described in Chapter 2. This local enquiry gathered data from nine case study areas, in eight countries, to characterise the use of

information on biodiversity and ecosystem services in the environmental decision making process. Conducting the survey across a range of countries allowed the enquiry to consider local requirements across a range of governance systems and bioregions in EU and accession states.

At the local level, the decisions include formal processes like SEA and EIA, as at higher levels of governance, but also local planning applications, and the myriad informal decisions made by communities and individuals that are small-scale individually, but summate to change the environment.

The enquiry at local level therefore considered (i) local administrations involved in formal assessment and planning decisions, including participatory processes, and informal decisions for managing public land or guiding community actions; and (ii) informal decisions by local stakeholders.

The enquiry addresses the following questions relating to the flow of information on biodiversity and ecosystem services at the local level:

- What are the information needs?
- What determines the information needs?
- What information is used?
- What information is needed but currently unobtainable?
- What are the barriers to obtaining information?

Analysis provides insights into the relationships between the utilization of such information, and key differences between the case study areas. Such differences might include their environmental governance, the nature and extent of community participation, land-use, and status in terms of biodiversity conservation.

BACKGROUND

Paradoxically we are not limited by lack of knowledge but failure to synthesis and distribute what we know (Pimm et al. 2001)

CONCLUSIONS AND RECOMMENDATIONS

The aims were condensed into five questions regarding the supply and demand of environmental information to local governments and selected groups of individual stakeholders.

These were:

i. What are the information needs?
ii. What determines the information needs?
iii. What information is used?
iv. What information is needed but currently unobtainable?
v. What are the barriers to obtaining information?

What are the Information Needs?

The survey found that all groups of interviewees spent a substantial proportion of time considering environmental matters when making management decisions although the greatest needs for environmental information were in government, nature-watching/reserve management and forestry. The demand for environmental information varied between the groups of interviewees but almost all categories of information that were surveyed (biodiversity and ecosystem services) were required, to some degree, by all categories of stakeholder. Notably, information on heritage conservation was an exception. Information on physical hazards such as flood and fire risk, biodiversity and tourism capacity were key issues for local governments across the case studies. In particular, Tier 1 tended to put more priority and need more information on ecosystem services and socio-economic considerations generally than Tier 2, which was in turn more focussed on biodiversity issues than Tier 1.

What Determines the Information Needs

All of the possible ‘drivers’ that might determine information needs that were identified in the survey were rated as important factors by the interviewees from all sectors. These included a statutory requirement to inform management decisions, a need for information for local policy formulation and a need to inform management decisions. Despite recognition of the importance of statutory

requirements in driving information needs; local government interviewees tended to report a fairly low level of direct involvement in EIA and, especially SEA processes. This was particularly notable in the most local level of government (Tier 1). Nevertheless, the relatively low requirement reported for specific data types to inform EIA that was reported by Tier 2 as well as Tier 1 is a little surprising.

The number of decisions being made might also drive information needs. When viewed in terms of the area managed, it was evident that the individual stakeholders in the farming and rural business category reported more decisions annually than the other categories. Further work in this area would be required for more robust interpretation that allows comparability between decisions. In other words a decision to trim 50m of hedge by a one farmer is not equivalent to a decision to trim all the hedges in a large estate by another farmer, or indeed, a decision by a local government department to grant planning permission for a major development. If this approach is to be used in future surveys, the 'decisions' need clear and specific definition. For this reason, data on areas affected by decisions were tightened for the Pan-European survey in Chapter 6.

The extent of involvement in the decision making process may also influence perceived needs. The survey indicated a disparity in the perception of the participatory process between local government and individual stakeholders. The stakeholders generally felt that they had little involvement and influence, whereas the local government responses reflected a perception that the mechanisms for engagement with local communities were in place. If individuals do find it difficult to engage with local environmental decision-making processes, this perceived disenfranchisement is likely to reduce their demand for information.

What Information is Used?

A reliance on Internet sources of information was reported across all government & other stakeholder categories and in all of the case studies. In contrast, there was a limited use of local survey data and especially of information derived from scientific survey. This raises the question of the quality and validity of information that may be being used to make decisions affecting environmental management right across the sample of case studies.

It was apparent that much of the information accessed by local governments was not stored on computers; even less was regularly updated or spatially referenced (i.e. mapped). Another point of interest, and importance for design of information systems, was that although most information was needed by government, forestry and nature-watching/reserves, four of the stakeholder groups (especially hunting and nature-watching/reserve-management) were at least as active as Tier 2 governments in generating their own environmental information, as demonstrated by the proportion of their information requirements that were met through their own survey and record keeping.

What Information is needed but Currently Unobtainable?

A substantial proportion of interviewees reported difficulties in obtaining adequate information for their decision-making purposes. This response was found in all government and other stakeholder groups, and across all case studies. Although biodiversity information at the National level (e.g. national figures for biodiversity and habitat) was relatively accessible, species and habitat data collated at the local & regional level appeared to be the most difficult category of information for interviewees to access.

Notably, the highest perception of these impediments to data access occurred in the stakeholder groups (local government & nature watching and reserves) that also indicated that greatest requirements for information, although foresters seemed to have adequate access. Perhaps the motivation of interviewees affected the likely perception of barriers. In other words, stakeholders who expressed little need for information were unlikely to encounter barriers to obtaining data.

What are the Barriers to Obtaining Information?

Many potential barriers to obtaining adequate information were reported in the surveys and this occurred in all of the case study countries and all of the stakeholder groups. The most frequently cited problem was a difficulty in finding & accessing information. Other key issues encountered by the interviewees were the accuracy of the data, availability at an appropriate spatial scale, and the age of data.

4. Models of the Information Flows and Decision Making Process

Loretta Perrella, Kathy H. Hodder, Julie A. Ewald & Robert E. Kenward

ABSTRACT

During pilot surveys at local level individual stakeholders and officials in local government were asked to list the main environmental issues for which they needed to make decisions, and then to select sources of information they used in each case. Overall, habitats were in the most important information topic for decisions, followed by socio-economics, species and hazards. However, models of information flows showed great variation in the priorities and the main sources across the stakeholder categories and tiers of local government.

INTRODUCTION

The ultimate objective of TESS is to design a transactional environmental decision support system, linking central policy planning to local livelihoods. The project aims to assist policy makers to integrate knowledge from the EU, national, regional and local level into the decision making process. There are several aspects of decision making that need to be considered in the design of a support system: information needs and flow; the processes that are to be influenced by the decision and the decision making process itself (Wierzbicki et al. 2000).

A survey of local governments and other stakeholders across the partner countries characterised the use of information on biodiversity and ecosystem services in the environmental decision making process in Chapters 2 and 3. A variety of information flows, analysis approaches and decision processes used for environmental assessment and sustainability assessment for biodiversity were identified by discussions with government departments (Chapter 2) and local case-study sites (Chapter 3) across a limited range of countries, in which partners were based and in which governance approaches were likely to differ. Combining their results revealed complex interactions and patterns of information flows between local, regional and national decision makers.

Conceptual models serve as a key planning and evaluation tools in conservation projects and are useful tools for expressing interactions in complex systems (Margoluis et al. 2009). They are used in information systems development to represent static or dynamic phenomena and to articulate user requirements (Wand & Weber 2002). In this case, conceptual models are used to illustrate the flow of information between local and central governments and local stakeholders. The conceptual modelling format is then used with information from survey across all European states (Chapter 6) to illustrate these flows clearly in Chapter 7.

CONCLUSIONS

The conceptual models of information flow were designed to illustrate the flow of environmental information between local and central governments and local stakeholders in the decision making process. The models show that decision-making within the environmental sector is a highly complex process that relies on highly variable patterns of data exchange between stakeholders and local, regional and central levels of government. Understanding and quantifying these relationships is key to designing an effective decision support system to enable informed decisions.

Information types and their sources

The largest number of environmental issues overall involved habitat issues, on average 36% of issues identified by stakeholder groups and 49% of issues identified by local government. Although information was supplied for these decisions from all sources, for local governments these tended to be skewed towards central sources. Foresters and nature watcher stakeholders both made use of their own

internal management plans or records for these decisions (26% and 28%, respectively), but also relied on government agencies, scientific studies and consultants for information for these decisions.

Socio-economic issues were more important for the various stakeholder groups (32% of issues) compared to the local government levels (23%). In particular nature watchers, farmers and recreational access stakeholder groups identified relatively more issues (an average of 42%). They used a variety of information sources for these decisions with particularly consultants (24%), scientific studies (19%) and the internet (14%) important for nature watchers, while farmers relied more on government sources (55% in total) instead of scientific studies and the internet, with consultants still quite important (27%). Recreational access stakeholders used all of the information sources for socio-economic decisions fairly evenly, as did the two levels of government.

Decisions involving species were more important overall for stakeholder groups (average of 19% versus 6% for local government) and figured highly for hunters and fisheries stakeholders (average of 29% of decisions). These two stakeholder groups used a variety of information sources to make their decisions, with consultants (17% for hunters and 18% for fisheries) and government agencies (19% for hunters, fisheries 27%) figuring highly. Interestingly farmers were the group that made the most use of scientific surveys for these types of decisions (29%).

Hazard issues were relatively more important for the local government levels than for the stakeholder groups, with an average of 22% of issues by local government involving hazards, whilst the average was 13% for stakeholders. Fisheries stakeholders were the outlier amongst the stakeholders, with 29% of their issues involving hazards. For local government, fisheries and farmers, the government figured highly as an information source for hazards (average of 71% of information sourcing), particularly government agencies for fisheries and farmers (33% on average).

Comparing sources

Government figured highly as an information source for all decisions, with stakeholders using them for an average of 41% of information sourcing, and local government for an average of 51%. Amongst the three types of government information source, government agencies were the most consulted, with an average of 20% of information sourcing by stakeholders and 19% by local government. Stakeholders and local government both used scientific studies and the internet for roughly 18% of their information sourcing on average, with stakeholders relying more on internet searches, 7% versus 4% for local government, while local government relied more on scientific surveys, 14% versus 11%. Local knowledge and NGOs did not figure highly as sources of information, with only 5% and 8% of stakeholder and local government information sourcing on average. Consultants/advisors were more important for stakeholder groups, with 15% of information sourcing provided by them versus 10% at the local government level. Nature watchers, hunters and foresters were noticeable in the relatively high use of consultants 19, 18 and 18% of information sourcing respectively. However, some stakeholders relied nearly as much on their own records on average (14%) as they did on consultants; this was true for especially foresters (20%) and nature watchers (20%), as well as hunters (13%) and fisheries (13%) stakeholders.

The most notable effects can be summarised as:

- Habitats were in the most important information topic overall but came second to socio-economics for access managers and to species for hunters.
- Socio-economics had the lowest priority for hunters but was second highest for all other groups.
- Natural hazards generally had the least priority, except for governments and fisheries.
- Farming and fishery interests used government agencies for information relatively more than any other stakeholder category or tier of local government.
- Managers for nature watching and reserves and for forestry relied most upon their own records, which were also important in hunting and fisheries.
- Local knowledge was used relatively little as an information source overall, but most by access interests and the lowest level of local government (but not the level above).

The models illustrate the complexity of information exchange and participation in local decision making. Most decision variables require information held at all levels; local, regional and central and the majority of decisions use a variety of different information sources. The differences between stakeholder categories may reflect the nature of their activities and the complexity and number of

decisions taken in these categories. However, the models incorporate data from only eight case study areas. Therefore care should be taken in drawing general conclusions before considering the more representative study in Chapters 6-8.

5. Database of Environmental Decision Support Tools

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ABSTRACT

This chapter investigates modeling and data sources for environmental decision support for local authorities and private managers. A metadatabase of 198 computerized environmental decision tools was collected using a questionnaire with two sequential web-pages of 4+16 questions (http://tess.ttu.ee/). Half of the software applications are freely downloadable and well described online. The database contains 42 references reported as 'forestry' tools, 50 as 'agriculture or apiculture' tools, and 15 targeting to either 'amenity areas' or 'tourism and access-based recreation'.

The most domain-general toolbox, InVEST, integrates models which support management of natural capital, including pollination of crops and production of timber, but is limited in types of natural capital and management situations. Agricultural toolboxes DSSAT and MicroLEIS cover soil quality issues well but ignore management of agricultural landscapes where natural and semi-natural habitats provide wild crop pollination, biocontrol of pests and other services. The most prominent sustainable forestry toolboxes are UBC-FM and NED-2. The latter contains simulation models and qualitative knowledge bases, but complex forest management conditions require more flexible metamodeling approaches. For the management of recreational sites, no integrated toolkit exists. As most of the existing environmental tools support option assessment, future development should address also earlier decision-making steps.

INTRODUCTION

Among several concepts of environmental management, the concept of natural capital (e.g. Hawken et al., 1999) sees the world's economy as being within the larger economy of natural resources and ecosystem services that sustain us. Only through recognizing this essential relationship with the earth's basic resources can businesses, and the people they support, be sustained in the long term.

In practical implementation of natural capitalism, one possible constraint is the question of ownership and hence responsibilities for management. Most natural capital in the biosphere and its services remains a common good, so that market forces fail to regulate its sustainable management effectively.

Scale of Environmental Management Problems

In a simplified scheme, private and common issues project as local and widespread issues, respectively. Market failure can be explained as the failure of local investments to generate local benefits. For instance, a company which invests in producing atmospheric oxygen will never benefit from ordinary market forces. At the same time, market forces usually fail to hinder a company in the introduction of alien species. However, widespread drivers create also local consequences (Figure 1).

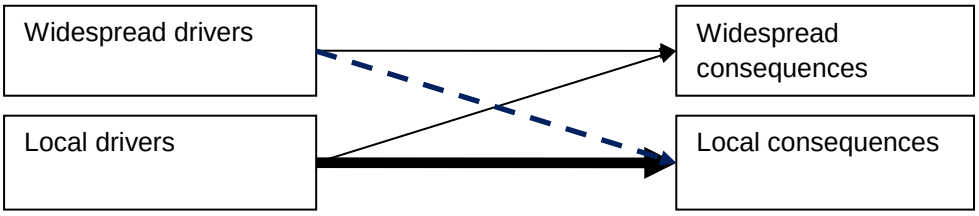

Figure 1. Interactions with widespread issues limit the efficiency of local actions (dashed arrow)

Nevertheless, many field-scale investments to natural capital still give significant field-scale benefits. For instance, fertilization of soil is a typical investment to natural capital which gives returns to the field manager. To facilitate environmental management, we created a database of decision support tools which was targeted on activities where local ecosystem management decisions bring direct benefits to the manager via improved ecosystem services. Some ecosystem services, such as genetic resources and primary production, are essentially global. However, services such as provision of materials and pollination have great local significance (Figure 2). To promote health of ecosystems, the database was targeted on the management of ecosystem services which generate local benefits.

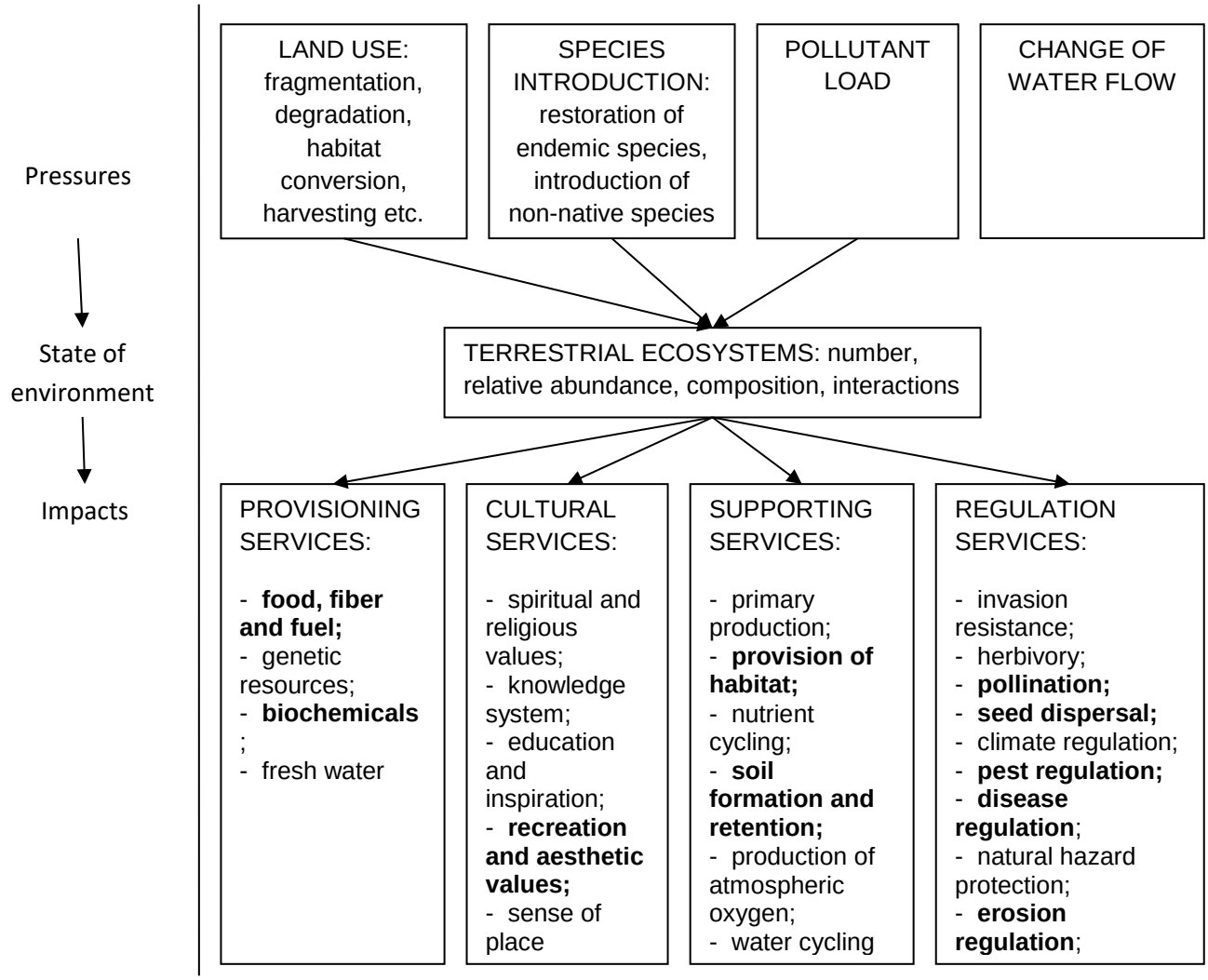

Figure 2. A representation of ecosystem services in the DPSIR framework. Bold font indicates services which generate mostly local effects and therefore where local management applies.

Beyond the "tragedy of the commons', several other obstacles hinder sustainable management of ecosystem services. Short-term (tactical) interests often compromise long-term (strategic) interests. Ecosystem health is usually a long-term issue, requiring strategic planning. Due to natural buffers, the consequences for ecosystem health of different management scenarios tend to lag. Managers therefore need tools to assess ecosystem health issues strategically. We identified three economic areas where sustainable local ecosystem management might bring immediate benefits: farm-scale agriculture, estate-scale timber production, and on-site management of recreational objects (Table 1). The aim of the database was to identify information tools for these management challenges across the entire EU.

Table 1. Areas of interest represented in the TESS database

Economic area	Scale	Target groups	Output	Major factors
Agriculture	Farm	Farmers	Sustainable crop and fodder production issues: **soil maintenance, fertility, health**. Field factors limiting pests.	Erosion. Drainage. Irrigation. Pollinators. Chemicals. Cultivation structure. Buffer strips. GMOs. Pollination. Biocontrol. Weather and climate.
Forestry: timber production	Estate	Private forest owners and managers	Sustainable timber production. **Forest health**	Tree disease factors. Biocontrol agents. Drainage. Irrigation. Harvesting options. Storm and fire resistance. Climate change
Nature recreation: hunting, fishing, birdwatching, hiking, walking, picking, riding	Recreational site	On-site tourism operators, local land-owners	**Maintenance and improvement of the leisure area**: production of forest game, production of fish in a small lake, number of birds valuable for watching, attractiveness of the area, availability of forest fruits	Habitat requirements, Effects of pollutants, Hunting and fishing rate, tramping, garbage, number of people, behaviour of people. Climate change from travel.

CONCLUSIONS

The InVEST project has provided a good integrated framework for the development of a comprehensive ecosystem management toolbox. However, the first version of the toolbox provides little practical decision support. This gap has partly been bridged by some more specialised toolkits.

The existing crop management toolkits cover soil health issues well but remain very limited in wider field health issues such as ecosystems around the fields (grassy field margin etc.) providing biodiversity, biocontrol agents, pollinators and other services. A Sustainable Forest Management Toolkit addresses forest health issues well. However, it has been applied mostly in Canada. Hence, adaption to the European conditions might appear challenging. There is no comprehensive recreational site management toolkit (Figure 11). Core models for such a toolkit might be RBSIM and SODA.

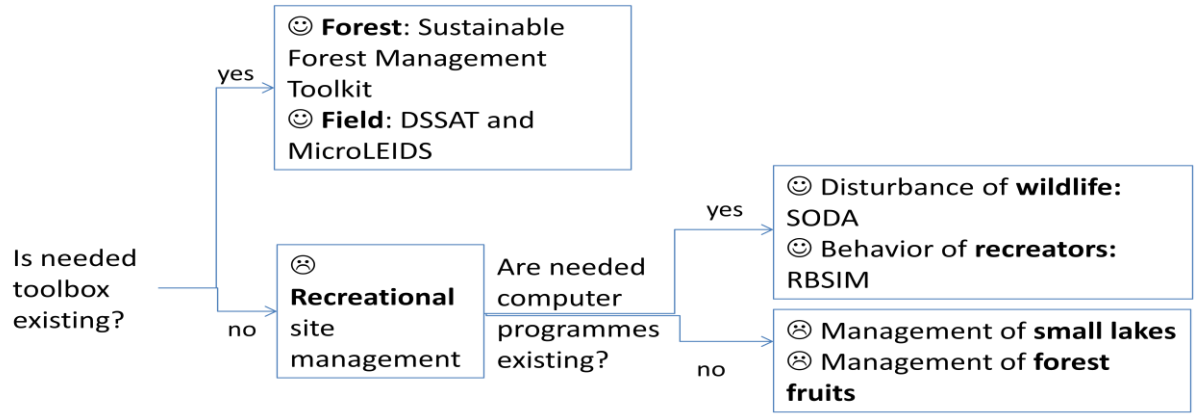

Figure 11. Results of vertical gap search

Considering the need for information for the management of various types of ecosystem services (Chapters 3 and 7), the database provides models about provisioning and supporting services (Table 6). Gaps have been identified in biodiversity, regulating and cultural services.

Table 6. Results of an analysis for thematic gaps.

Ecosystem service type	Information demand	Information supply	Conclusion
Biodiversity	high	low	thematic gap!
Provisioning	low	high	ok
Regulating	medium	low	thematic gap!
Supporting	medium	high	ok
Cultural	medium	low	thematic gap!

Chapter 4 indicates that local land-managers use the internet weakly while local authorities use GIS well, and that local authorities in many Western European countries have high digital enablement (see also Figure 11 in Chapter 7). However, there is a question of whether the digital decision support should be focused to these countries or rather to countries with good biodiversity status. The project therefore did not focus any particular group of member states.

Chapters 3 and 4 also noted that local governments were especially interested in socio-environmental issues. Hence, while compiling the database, conceptually broad environmental models, containing economic terms and socio-cultural dimension, were given special attention.

6. Pan-European Survey & Database of Environmental Assessment Factors

Julie A. Ewald, Robin J.A. Sharp,
Pedro Beja (CIBIO at Universidade do Porto, Portugal) **& Robert E. Kenward**

ABSTRACT

In order to design TESS, it was necessary to determine how and what information is utilized across Europe when decisions affecting the environment are made at present, and which systems now in place appear to be working in terms of environmental protection and conservation. We used a Pan-European survey to determine not only which systems are currently in place but also what further information is needed by national and local governments as well as stakeholders. Results from this survey, together with published information from previous projects, the European Union and the United Nations, were collated into a database for further analysis. Here we describe both the Pan-European survey methodology and also the database.

INTRODUCTION

The purpose of the TESS project was to develop innovative methodologies for scaling down, from the EU or national level to the regional and local level, the analysis of policy impacts on multifunctional land uses and economic activity, with special emphasis on new Member States as well as on Accession and Candidate Countries. It was to include a participatory approach and to take into account stakeholder perspectives. These improved methodologies should enhance the scope of Strategic Environmental Assessment (SEA) and Environmental Impact Assessments (EIA). It is expected that this will augment the analysis of possible policy impacts (in particular those related to rural development and to Cohesion Policy and Pre-Accession Aid) on sustainable development by the different Commission services.

In order to help develop these methodologies, we needed to determine what was in place now concerning how information for planning, policy and environmental decision making is fed from the national level down to the local government level and to stakeholders (and how it is fed back up through

the system). A pilot survey was used to test questions in the countries represented by the Project Partners, with surveys of both national and local governments, as well as land management stakeholders (see Chapters 2 and 3). The results of this pilot survey were used to develop a standard survey of how environmental assessment functions at national and local levels (including stakeholders) across all EU member states (plus 4 potential members), and to seek associations with indicators of biodiversity and related environmental quality across these states that may indicate best practise. This pan-European survey led to a database of factors relevant to SEA and EIA. Here we describe the methods used for the pan-European survey and the database created from it. This database was then used in Chapter 7 to investigate the pattern of these governance factors across Europe, and in Chapter 8 to analyse the relationship of policies on land uses and economic activity to trends in ecosystem services and biodiversity in cultivated areas as well as in protected areas.

The Pan-European Survey

In Chapter 2, it was noted that as well as formal assessments (SEA and EIA), formal environmental decision by government at various levels includes Biodiversity Action Plans (BAPs, NBSAPs) under Article 6 of the Convention on Biological Diversity and planning for payments under the Common Agricultural Policy (CAP). Land Use Planning (LUP) for all developments is also a formal process, whether or not EIA or SEA are also involved.

Questions from the pilot survey on national governance of all these formal decision processes (Chapter 2) became part of Pan-European survey. So too did questions from the local municipality and stakeholder pilot survey (Chapter 3), on decision-making and related information requirements of local administrations, as well as on attitudes of local authorities towards managers of land and species and the extent of their participation in the formal decision processes. The pilot survey defined six main categories of stakeholder, apart from local government, who make decisions affecting the use of land and species. These categories are (i) farmers and horticulturalists (including gardeners) with their short-rotation crops, (ii) foresters and managers of other trees with their longer rotation, (iii) managers of inland fisheries and angling for aquatic species, (iv) those managing hunting areas, (v) nature and wildlife watching reserve managers and (vi) managers of access land for many other activities, including gathering wild fungi and plant products, keeping and exercising recreational animals, rambling, boating, climbing, camping etc. There were indications in the pilot survey that these six groups of stakeholders were taking many more informal decisions than the formal (and informal) decisions made by local authorities. This was explored systematically across countries in this survey, with questionnaires again refined carefully from the pilot surveys in partner countries.

The following sections of this chapter describe the methodology applied in the Pan-European survey. It also describes indicators derived from the governance processes that were combined, with data from the Governance and Ecosystem Management for Conservation of Biodiversity project (GEMCONBIO, Manos & Papathansiou 2008) and indicators on environmental impact (e.g. the Streamlined European Biodiversity Indicators, EEA 2010), to analyse of which of these indicators are related to biodiversity outcomes throughout the EU member states and Accession and Candidate Countries.

CONCLUSIONS

Using surveys piloted in Chapters 2 and 3, surveys of national administrations, local administrations and individual stakeholders were used to construct a database of 65 variables across 30 European countries, to enable analyses of patterns of governance across Europe in Capacity, Priority and Process variables used in environmental decision-making at all levels in Chapter 7, and of relationships between these variables and ecological or socio-economic impacts in Chapter 8.

7. Pan-European Analysis of Environmental Assessment Processes

Robert E. Kenward, Julie A. Ewald & Robin J.A. Sharp

ABSTRACT

This chapter presents data on variation between national and local levels for information requirements, and on the pattern of data within these levels across Europe. It notes high decision-making, use and generation of information at local level, with high variability between countries in some factors relevant to governance of environmental decisions.

INTRODUCTION

The strategic objective of TESS is "to design a decision support system related to environment and land use that will enable policy makers to integrate knowledge from the regional and local level into the decision making process, while also encouraging local people to maintain and restore biodiversity ecosystem services". To design such a system, three requirements are to:

- Identify the information needs of policy makers and how this information is obtained;
- Identify information needs for decision making at more local levels; and
- Identify governance that aids biodiversity and thus that such a system should support.

These requirements were the basis for the Pan-European survey.

The pilot studies of governance in Chapters 2 and 3 tested questions to be used for the Pan-European survey, while Chapter 4 showed how information flows could be visualised to examine differing requirements between stakeholders and levels of government. Chapter 5 started a process of assessing forecasting capabilities available in models. Chapter 6 set the scene for more detailed analysis of how governance may impact the environment, and hence be guided through a TESS, by describing the Pan-European survey and resulting database of 65 variables across 31 countries.

The variation in cultural history and governance processes across Europe provides a rich field for analysis of associations between social institutions and impacts on the environment. Some of these associations are likely to be causal, and thus indicate governance mechanisms which, if identified, can be used to minimise adverse impacts or even promote beneficial ones. Thus, if governance mechanism A causes impact B, modifying A may provide useful adaptive governance. Alternatively, if environmental impact B affects people and thus relates strongly and causally to a socio-economic impact C, and C is more easily measured than B, then C may be a useful indicator of B.

Chapter 6 included recognition that robust analyses of associations need statistically representative information. However, robust analyses also need to take into account the patterning of information across countries. The patterns across countries are of interest because they show differences between countries; however, patterns also need to be smoothed (and if possible normalised) before use in the parametric multivariate analyses in Chapter 8. Thus, looking back to Figure 4 in Chapter 6, a majority of 12 countries had 3 Ministries at national level making decisions affecting the environment, with 9 having just one or two such Ministries and then a tail of 1-2 countries each having 4,5,6,7 or 8 Ministries involved, again totalling 9 countries. This skewed pattern gave 3 categories (of 9, 12 and 9 countries with 1-2, 3 and 4-8 Ministries respectively, for analyses in Chapter 8 to see whether environmental outcomes related to having more Ministries involved.

CONCLUSIONS

Was the survey effective?

Internet tools (e.g. www.surveymonkey.com) now exist for answering up to 10 simple survey questions and, being automated, can accommodate very many respondents. However, the survey had many more questions, which needed careful translation at local level. For this sophisticated survey,

the use of Microsoft Excel workbooks and Access database provided a powerful tool, simplifying translation (although cells for translated text must be large enough for all languages) and enabling automated data extraction.

The network of Country Coordinator system pioneered by the European Sustainable Use Specialist Group of IUCN/SSC in the UNWIRE survey (www.gemconbio.eu) again proved its worth for expert translation and extraction of necessary information, both at national level and also in linking with local communities and managers of wild resources on land and in water.

High quality data with strong variability gives good opportunities to detect relationships between governance variables and environmental impacts. With precise questions that sought objective responses (e.g. on whether or not particular practises occurred), a comparison of range bars and average values in Figures 11 and 13 showed relatively little variation between local authorities within countries compared with differences between countries. European Environment Agency and Eurostats share Environmental Topic Centres with responsibility for using information as surveyed in this study. EEA advice and their collated data were especially helpful (Chapter 6). However, estimates of participation in stakeholder activities (Figure 14) were subjective and varied much within countries. Will the Eurostat topic centre on Natural Resources note the prevalence of environmental decision-taking by managers of land and species (Figure 4), and choose to help improve data on these stakeholders?

Which decisions needs informing and how?

The number of decisions made at EU level as Directives, and as regulations by policymakers at national and sub-national levels, are necessarily relatively few compared to the decisions made by local stakeholders in the use of land, water and species, simply because local stakeholders are far more abundant. However, the very wide influence at high level, in setting constraints and incentives for those at local level who affect the land and species, makes it crucially important that those policymakers are well informed. This is recognised by the many projects and initiatives aimed at assisting policy-makers, including the new International Panel on Biodiversity and Ecosystem Services (IPBES).

The number of those environmental assessments (SEA+EIA) is variable across countries but averages about 2.5 per thousand km^2. That is an average of less than one per year at the lowest level of government administration (LAU2), although at any point in time an LAU2 may be handling more than one of these protracted processes. Local authorities also take some 3-20 informal decisions annually. However, larger numbers of decisions affecting biodiversity across larger areas are also made annually by private managers. Moreover, in making decisions about what to cultivate and how to manage crops of wildlife, decisions by private managers have 10,000-100,000 times the density of those made by local councils (Figure 4). Even though a decision by a council to develop an area may appear to have more long-term effect than a change in use of a field, that field may gradually have become the last local habitat patch for a particular species that will then take decades to re-colonise the area naturally. The monitoring of land-use, to guide conservation of habitat linkages and replace species opportunistically where linkages are broken, therefore seems at least as important as formal processes of environmental assessment and land-use planning.

These managers often have good knowledge of how crops and domesticated species respond to weather and hence changing climate, how to maintain soil quality and avoid hazards, with use of local knowledge declining as one moves up through government (Figure 5 and Chapter 4). Local stakeholders especially record information on habitats (Figure 7). However they require as much information as local authorities on wild species and habitats, and more on statutory requirements and benefits, for instance affecting the control of species for economic or social benefit (Figures 6-7 and Chapter 3).

The internet is not yet being used strongly across Europe as a source of information for environmental decision making, especially by local land-managers (Figures 5-7). At local level it is government agencies and private consultancies which provide much of the information required, other than local knowledge. Thus, it is important for the TESS design to aim to deliver information to government agencies and consultancies at local level, as well as to local authorities and stakeholders. As farmers

and hunters affect land with the highest density of decisions (Figure 4), it is encouraging that farmers are stakeholders who most frequently use the internet and hunters are prolific sources of local data.

It is encouraging that about half the countries in the European Union showed appreciable systematic recording and/or use of GIS by local authorities (Figure 11). Moreover, two thirds of countries could use maps in digital format for agri-environment payments. Thus, there is much evidence of good practice and conditions exist to expand good practice across countries across Europe using an appropriate TESS design.

8. Biodiversity Trends Associated with SEA and EIA Practices

Pedro Beja, Julie A. Ewald & Robert E. Kenward

ABSTRACT

This chapter compares trends in policies on land uses and economic activity to trends in ecosystem services and biodiversity in cultivated areas as well as in protected areas, using a database defined in Chapter 6. The analysis revealed associations between capacity, priority and process variables on one hand, and impact variables on the other.

For the TESS project, the most important analyses involved the number of EIAs and SEAs. There were relatively more of these in countries where local administrations consulted most with NGOs, were responsible for relatively small populations and perceived nature most positively. Except for consultation, the processes used when conducting assessments and monitoring their results did not positively affect the number of assessments, the environmental and social impacts investigated, or the numbers of those using the resources. Additional analysis indicated interesting relationships with conversion to artificial land-cover, positivity to nature indices, knowing the term "biodiversity", species conservation status, consultation at local level with NGOs and the proportion of a country's population that was hunters or anglers.

INTRODUCTION

The analysis reported here is important both for examining the operation of the statutory EIA and SEA assessments across Europe and for the design of a TESS, the ultimate goal of this project. This is because although the legislative framework for EIA and SEA is created at high level in national governments, the actual conduct of the assessments is mostly at the lowest levels Chapters 2 and 7, especially for EIA. Therefore data on the attitudes and consultative processes behind these assessments needed to be collected at the local level. This is also the level at which a TESS must operate in order to guide the decisions made by individual managers of land and species.

Managers and other beneficiaries of wild resources are important because their management has both positive and negative impacts on biodiversity outside the formal assessment process. Their economic significance alone may be considerable, as European anglers, hunters and wildlife watchers spend in excess of €40 billion annually (Kenward *et al*. 2009), with anglers and hunters also having appreciable positive impact on habitats (Oldfield *et al*. 2003; Sharp 2010). Beneficiaries and managers of wild resources could also be important when involved in consultations for formal assessments, depending on the attitudes of the local government administrations. Here we pay particular attention to these local considerations, which have been overlooked in previous studies.

It was apparent at the start of data-collection that indicators of trends in biodiversity, in terms of changes in specific taxa, were still inadequate for analysis of relationships across countries. Therefore, analyses in this report focussed more on the status of species and habitats (for example as registered annually in reporting for Article 17 of the Habitats Directive), on the status of rural recreations that depend on the

abundance of particular species, and on trends in remote-sensed land-cover that are a proxy for the habitat changes which impact biodiversity.

Summary

1. Population growth rate was the strongest associate of the rate of change of land-cover to artificial surfaces (e.g. buildings, roads). This 'artificialisation' was most strongly related to growth and to the relative rarity of EIAs and SEAs nationally in areas outside Natura 2000; semi-natural habitat increased most rapidly where environmental data were considered poor but where guidance texts were most available.
2. The rate of growth of artificial land-cover has increased since 2000 to a similar extent both within and beyond areas designated for Natura 2000; since 2000 the relationships between population growth, economics and conversion to artificial land-cover have tended to decouple within Natura 2000.
3. Numbers of EIAs and SEAs were highest where local administrations perceived nature most positively (and where fewest people understood the term biodiversity). This positivity was associated with population density, political stability, more consultation at the local level with NGOs and an administrative priority on the environment (rather than economics) when managing land and species.
4. The government assessment of the adequacy of the proportion of land designated within Natura2000 was highest in countries with the highest World Bank governance scores. However, habitat conservation status was not linked to socio-economic or environmental variables to an appreciable extent.
5. Species conservation status was best in countries with the most wetland, and generally where GDP was high and hunters and anglers more common in the populations.
6. Hunters were a higher proportion of populations of countries with low human population density and abundant semi-natural habitat; anglers were more common where there was more water and a lower area of Special Conservation Interest designated. The conservation status of species was highest, as was the influence at local level of NGOs, in countries with more anglers.
7. Except for consultation, the processes used during EIA and SEA assessments and monitoring of their results did not positively affect the number of assessments, the environmental and social impacts we investigated or the numbers of those using natural resources.

CONCLUSIONS

1. Conversion to artificial land-cover is probably caused by population growth but this can be decoupled through conservation designation.
2. Frequent EIAs and SEAs were associated with low rates of artificialisation.
3. Frequent EIAs and SEAs, but not the processes within assessments, were associated with positive attitudes to nature and consultation of NGOs by administrations at local level.
4. Numbers of hunters and anglers were linked positively to species conservation status, to knowledge of conservation status and to influence during local consultation.
5. The Nature Positivity index estimated in this study was a better indicator of beneficial environmental attitudes than being aware of the word biodiversity or of biodiversity loss.

9. An Overview of the Case Studies

Dimitra Manou & Jason Papathanasiou (Aristotle University of Thessaloniki, Greece)

ABSTRACT

TESS partners were asked to develop local level case studies for Estonia, Germany, Greece, Hungary, Poland, Portugal, Romania, Turkey and the UK. All studies consisted of a socioeconomic project and a mapping project, except that there was mapping alone in Germany. The aims of the case study projects were to test how best to meet local decision support needs in exchange for local monitoring that meets

central policy requirements and whether local monitoring (based on schools, local community groups or individuals motivated by use of wild resources) can meet government requirements. Such information requires mapping of ecological information, for combination with socio-economic information; the case studies also aimed at assessing local attitudes and capabilities. This chapter presents an overview of results from the studies, which are described individually in the following nine chapters.

INTRODUCTION

The Aristotle University of Thessaloniki was the leader of this Work Package, with responsibility for the analysis and synthesis of the results collected by the following partners:

1. Tartu College, Tallinn University of Technology (IST) Estonia;
2. Aristotle University of Thessaloniki (AUTH) Greece;
3. Szent Istvan University, Institute for Wildlife Conservation (SZIU) Hungary;
4. Pro-Biodiversity Service (PBS) Poland;
5. ERENA, Ordenamento e Gestao de Recursos Naturais Ltd. (ERENA) Portugal;
6. Danube Delta National Institute for R&D (DDNI) Romania;
7. WWF-Turkey;
8. Bournemouth University (BU) United Kingdom;
9. Anatrack Ltd. (Anatrack) United Kingdom;
10. Federation of Associations for Hunting and Conservation of the EU (FACE).

AUTH, SZIU, PBS, ERENA, IST and DDNI prepared one case study each while WWF-Turkey prepared two case studies; FACE reported on two mapping projects in Germany. BU conducted socio-economic study in the Frome Catchment whereas Anatrack arranged mapping and survey of Arne Parish, within the catchment, with the participation of 335 local residents (in contrast to the smaller sample in other projects).

21. Design of a Transactional Environmental Support System

Robert E. Kenward, Nick M. Casey, Sean S. Walls (Anatrack Ltd), **Janet M. Dick, Rognald Smith, Sarah L. Turner, & Alan D. Watt** (Natural Environment Research Council - Center for Ecology and Hydrology, UK), **Jason Papathanasiou, Zacharoula Andreopoulou** (Aristotle University of Thessaloniki), **Stratos Arampatzis, Olympia Papadopoulou** (Tero Ltd), **Gabor von Bethlenfalvy** (Federation of Associations for Hunting and Conservation of the EU, Belgium), **Carlos Rio Carvalho, Rui Morgado** (ERENA: Ordenamento e Gestão de Recursos Naturais SA, Portugal), **Robin J A. Sharp** (European Sustainable Use Specialist Group of IUCN), **Zenon Tederko** (Pro Biodiversity Service, Poland), **László Szemethy, Judit Gallo, Daniel Székely** (Szent Istvan University, Hungary), **Mari Ivask, Kristjan Piirimäe, Eve Aruvee** (Tallinn Institute of Sustainable Technology, Estonia), **Ion Navodaru** (Danube Delta National Institute, Romania), **Basak Avcioglu, & Engin Gem** (WWF-Turkey), **Julie A. Ewald, Nick Sotherton** (Game and Wildlife Conservation Trust), **Adrian C. Newton, Kathy H. Hodder** (Bournemouth University)

ABSTRACT

This chapter draws on results from previous chapters, in some cases creating new syntheses by combining information across chapters and including findings of previous projects. Its specific objective is to consolidate all these findings in the design of a system to support transaction of information for environmental assessments and decision support at central and local levels, by local

managers of land and species as well as by policymakers. It recognises the need not merely to provide a technological tool, but also to consider demand and supply for information in that tool, the ease of use of the tool, motivation to use the tool and cost of maintaining the tool long-term: a tool that is not desirable, practical and durable will not last. The chapter therefore first addresses who makes the most decisions, finding not only that local managers of land and species have high need of support, but also that their demand is least met by model-based decision support despite their high capacity to generate data. For this reason a system was designed primarily to accommodate needs of knowledge transfer at local level. Consideration of data quality, ownership and confidentiality was important, together with scale, uncertainty (and resulting liability) of resulting decision support. All these considerations can be addressed by developing trust in operation of such a system, for which a basis in the civic sector (rather than in private business or government) was recommended. A portal was launched to continue informing all interests of the scope for building and opportunities from use of such a system.

INTRODUCTION

The strategic objective of TESS was "to design a decision support system related to environment and land use that will enable policy makers to integrate knowledge from the regional and local level into the decision making process, while also encouraging local people to maintain and restore biodiversity ecosystem services". Specifically TESS aimed "to design an internet-based system capable of:

(i) delivering environmental decision support locally, to help local land-users make micro-assessment decisions that benefit incomes and biodiversity, in exchange for

(ii) a supply of monitoring data that will summate effectively for use centrally, in order to enhance information for government assessments".

However, in order to provide monitoring data that covers the whole landscape systematically enough to summate for effective government planning, the system will need to be very useful for managers of farms, forests, fishing and hunting areas, gardens and council land, as well as for communities and their volunteers. Above all, a system must be intuitive to use in the context of other necessary tasks. The red, green and blue lines that denote potential spelling, grammar and other mistakes in Microsoft Word are good examples of such context adaptation, based on very extensive computing. In a TESS context, submission of a farm-plan might elicit a response "income will increase to X" but also colour a stream red to indicate likely excessive nitrate run off and flash field areas, such that if the cursor was moved over them a comment would read "Nitrate risk can be offset by increasing buffer strips to 10 m" or "90% risk of halving partridge population can be reduced to 10% by…." A system capable of providing baseline data for SEA and EIA, but also and especially of providing decision support locally for the simplest daily tasks would need to support operation at a variety of scales (Table 1).

Scale	Context/Question	Operation Mode
Field Individual	! BEEP ! HARRIER NEST AHEAD	*Satnav seeks to divert harvester for 20 meters*
Garden Individual	Is it too early for the Nymphalid butterfly larvae if I cut the nettles?	*Intelligent GIS on GPRS-enabled tablet or smart-phone.*
Farm Individual	If I use my land like this in future, what happens to my income, game bags and nitrate run-offs?	*Guidance on electronic farm plan through colour codes, with comment-bubbles for proposed mitigations.*
Parish Community	How do we route this path to optimise views while minimising erosion and wildlife disturbance?	*GIS-based modelling with 2D/3D views on desk-top PC by councillors in local community centre.*
Region	If trends in land-use continue for 20 years, how can we still meet planned biodiversity targets?	*Scenario models of minimal subsidies for leveraging restoration through sustainable use activities.*

Table 1. Operation modes of an internet-based Environmental Support System.

Apart from the need to scale for delivering data and decision support at different levels, many other aspects need consideration. These include (1) confidentiality, (2) payments for data where necessary and (3) input in many formats. Delivery of decision support must also address requirements for (4) civil liability for advice given, (5) audit of processes, (6) output in multiple formats and a variety of geographic languages and (7) incorporation of models of many types. Development of such a system

is of necessity a very long-term exercise, and must therefore (8) be based on durable yet replaceable software for expansion to handle huge information loads, (9) have ability to interface with proprietary software yet avoidance of reliance on it, and (10) involve appropriate governance and funding agencies. Although public funding is important for initiation, this must not preclude a subsequent balance of public, private and voluntary resources, to ensure funding in the long-term and that the system remains responsive to the needs of users. A system that transacts locally-based monitoring for centrally-provided decision support will self-fund, for long-term development, only if it effectively meets user requirements at all levels.
In order to deliver support required by central and local levels, TESS needed to understand what information is required at the different levels, what is available and where there are gaps. The next section of this chapter is an overview of the requirements and gaps in knowledge indicated in previous chapters, followed by a consideration of the needs for maintaining data quality, ownership and confidentiality, and for handling uncertainty in a decision support system. The consideration of technical design for the system precedes a section on social design, in the form of market surveys that involved launching an information portal to continue after TESS.

CONCLUSIONS

A Transactional Environment Support System is seen as a way of improving information flows between policy-makers and stakeholders in order to benefit management of the environment at local level, and policy-making at high level to help that management. Knowledge leadership for adaptive management at local level benefits biodiversity and ecosystem services, so the system is designed for local adaptive management with knowledge leadership, as well as for adaptive governance and planning at European and national levels.

It is important for two other reasons to have a system for local managers of land and species, and not just for formal government environmental assessments (EAs, i.e. SEA+EIA). On one hand, local managers of land and species take decisions (which summate to change the environment) at a density >5 orders of magnitude greater than EAs. On the other hand, ca 100 million Europeans use wild biodiversity for recreation and spend >€60 Billion annually.

Surveys showed that local stakeholders want detailed information about species and habitats, but also revealed gaps in use of detailed map coverage, both for strategic assessments at high level and for biodiversity modelling to enable management at local level. Other serious gaps were the targeting of most EU projects at policymakers, while governments also underestimate numbers of people involved in biodiversity-based activities and have a lower requirement than local people for information on habitats. Yet the case studies showed that local people are capable and enthusiastic about mapping species and habitats.

Moreover, although more than 2000 models to assist decisions on biodiversity and ecosystem services had been built during the last two decades, they had not been made simple enough for use by those who actually manage land, water and biota nor generally been made available in languages other than English. Nevertheless, the wealth of models in databases shows a very considerable volume of knowledge in the scientific community that was considered sound enough for modelling; the few models usable at local level show that technology transfer to local stakeholders is practical, albeit perhaps initially through consultants and other advice services.

The necessary technology transfer, further modelling to fill gaps, and many other aspects of this would need engagement with many scientists, so they too (with government and local managers) are stakeholders in such a system. It must suit them too, as well as providing local knowledge for planners and central policymakers, and information that local people want in ways they can use.

The integration of information on biodiversity and related environmental matters from the local level into planning and land-use decisions generally uses maps and, in digital format, GIS. This applies for scientists and for land-use planning by government, but often also to the myriad daily decisions made informally by those who manage land and species. This, GIS is a lingua franca across all these groups, and even easy to provide across languages with translation of short words where symbols and intuition alone do not suffice. To enable local knowledge from individuals to be exchanged for decision support that is enabled by their mapping, the TESS proposal is for the decision support to be delivered in an intelligent multi-lingual GIS.

However, the success of building adequate coverage through information exchange will depend not only on good enough decision-support technology to make the exchange attractive but also on trust in handling private data and trust between different interests that need to work together to make best use of a support system across multi-owned and multi-use landscapes.

Technical considerations must be adequately addressed to ensure support of the environmental science community, which in turn can influence trust of government and private stakeholders. Features within the system must be transparent and auditable. Data tagging for accreditation, confidentiality and quality control are important, as are practical aspects, such as spatial scaling thresholds (e.g. 1 m through ground-based vector mapping for detail in heavily managed habitats, 5-10 m for vegetation blocks in large areas of semi-natural habitat). Uncertainty must be addressed throughout (e.g. with Bayesian networks). Finally, a system will only become effective for application at a broad geographic level, in GEOSS and GMES, if it becomes comprehensive in scope; this requires standardisation in cooperation with European authorities.

Becoming comprehensive will depend on adoption by the vast majority of stakeholders, which is also most likely if there is trust in the system operating equitably. For this reason, construction and operation should be a non-profit operation, in which all funding is used to improve the system. For durability, system ownership should be constituted in a way that precludes transfer into commercial hands at a later stage in development. The system should be able to handle commerce, including data and services as appropriate to ensure that it is effective, but should remain in charitable ownership as a trust or foundation, albeit with enough input from government and commercial sectors to encourage reputable and efficient operation.

In view of all these considerations, the socio-economic support-base for the system is proposed to be based in the civic (non-profit) sector, with guidance and support where practical from state and private sectors. Thus in the Naturalliance portal, the IUCN's Sustainable Use and Livelihood Specialist Group provides a network which is indispensable for expert translation and linking with local communities and managers of wild resources on land and in water, aided by SME Tero Ltd, while Game and Wildlife Conservation Trust controls finances and software, aided by SME Anatrack Ltd. From the state sector, European Environment Agency is giving support and is the potential link via EIONET to the Biodiversity Information System for Europe, as a basis for providing information to support policy decision-making at high level, and via Eye-on-Earth to provide seamless access for users to data collated at national and European level.

In theory, the very large numbers of local stakeholders across Europe mean that funding an internet-based system could be possible by summing small individual contributions. However, portal tests of willingness to pay suggest that crowd-funding is not practical until the system has enough decision support and other capabilities to be useful for individual stakeholders. Will governments or philanthropists appreciate that providing information to benefit local recreation and livelihoods, in exchange for data required at higher levels for environmental assessments, could also encourage local people to maintain and restore biodiversity and ecosystem services?

21. Guidelines & Recommendations

Robin J.A. Sharp, Julie A. Ewald, Robert E. Kenward

ABSTRACT

Policy Guidelines and Recommendations were derived from direct and indirect sample surveys of stakeholders in most European Union countries and some others and from related analytical work. They call for rationalisation of the high level environmental assessment systems in Europe, greater sharing of data derived from them, more research into the information needs of stakeholders, especially local stakeholders, who take key decisions about the environment, recognition of the value of participation in biodiversity-related activities by ordinary users of the countryside, promotion of citizen capability to

use electronic mapping tools for biodiversity monitoring and management, analysis of the links between land-use changes and success in biodiversity conservation and support for progress towards a comprehensive decision-support system via an internet portal providing a one-stop site for ideas and knowledge.

1. The SEA and EIA Directives should be reconsidered with a view to their integration and formal application at comparable levels across member states.

2. Member States should be required to give regular accounts of how their planning and other decision-making systems incorporate the principles of environmental and sustainability impact assessment in cases which lie outside the scope of formal SEA and EIA.

3. The Commission and Member States should develop environmental cross-compliance requirements to include assessments of significant changes in agricultural and forestry land use and management, which are currently covered by the EIA Directive, while promoting the integration of biodiversity and other environmental information into single farm payment regimes.

4. Member States should increase co-operation with the European Environment Agency by ensuring that information gathered for formal assessments is shared with them and the wider public and by supporting efforts under the INSPIRE Directive and other initiatives to improve the quality and compatibility of environmental data generally.

5. The Commission and Member States should consider encouraging the Biodiversity Action Plan model of collaboration between stakeholders for biodiversity restoration to provide regional and local frameworks for information gathering and monitoring.

6. Steps should be taken to integrate knowledge and data provided by individual land-users into formal environmental decision making to support SEA's, EIA's and assessments for land-use planning decisions.

7. The design of an effective environmental information system needs to standardise and centrally collate a wide variety of ecological and socio-economic data that can be scaled for delivery at all levels. However, the precise data requirements need to be understood and, as far as possible, quantified in more detail.

8. In order to refine information needs for different statutory authorities and stakeholder groups further Pan-European survey work will be needed. This would be enormously facilitated if Eurostat were able to establish rigorous sampling frames across Europe for the groups of land users identified by TESS and for local governments with specific functions.

9. Pending the creation of any widely available interactive decision support system, simple guides to what information is available at local level and what purposes it is suitable for would be of value for many users and would save both time and the expense of hiring consultants to extract routine information. Central coordination would assist the production of such guides.

10. The relevance of participation in wildlife-related activities by millions of EU citizens and the direct and indirect spending associated with these activities should be appreciated by policy-makers.

11. Eurostat should be invited to carry out assessments of these activities across EU Member States by appropriate sampling methods, as has been practised for a number of decades in the United States.

12. Biodiversity conservation policies need to take full account of the perceptions and attitudes of the people who live closest to wildlife and the countryside if their support for and active

participation in conservation is to be secured. These attitudes should be regularly surveyed by the Commission, using the highly developed tools available to Eurostat.

13. Noting the rapid progress made in the development of digital tablets, the fall in prices and their dramatic uptake by the public over the last two years, European institutions, national governments and agencies should promote further experiments and training for local people in mapping for the monitoring and conservation of biodiversity and related socio-economic purposes.

14. Land-use changes are of fundamental importance for conservation policy. Those recorded by recent CORINE data merit urgent investigation. A locally-based recording and mapping system such as is being developed by TESS could rapidly feed information to higher governmental levels, enabling policy adjustments to be made as appropriate.

15. Conservation policy and practice should recognise the legitimate interests and, indeed, positive contribution of such users of land and water as recreational shooters and anglers. Stakeholder partnerships using monitoring and adaptive management will maximise the input of human and financial resources.

16. Further examination of the nature-positivity index is needed. This should cover both the elements that make it up and the external factors that may influence it.

17. The case for a comprehensive decision support system for local land users to integrate environmental, social and economic goals is very strong. However, it will take substantial resources and time to achieve such a system in practice. There are some decision support tools available to use in the short-term but they are limited in application, coverage and the availability of languages other than English, with the consequence that much development work is needed to improve technology transfer in this area.

18. In developing internet-based advice and support for land managers using simple mapping tools, attention should be given to what works and is practical for them, using feedback and market testing and bringing together best practice guidance from a wide variety of sources.

19. Support should be given to the portal for ideas and knowledge exchange via
(a) publicity aimed at land-users from governments and national associations,
(b) data and best practice case study material from researchers and environmental institutions; and,
(c) where feasible, appropriate finance from any quarter.

CONCLUSIONS

Overall TESS has been a thoroughly Pan-European collaboration with all 27 EU Member States and four non-EU states involved and within them many officials in central and local governments and stakeholder organisations and private individuals for whose time and interest we are extremely grateful. Although much more research about information needs and technical development of decision-support mechanisms is required, we are moving into a practical implementation phase.

In this we look forward to strengthening partnerships with existing colleagues and entering into new ones. In particular we are deeply appreciative of the offer of the Executive Director of the European Environment Agency at our final conference in Brussels on 25th May 2011 to provide a home for TESS after the project period has ended. We will be exploring the implications of this in due course, but we remain convinced that environmental information needs to be gathered and used by ordinary citizens, subject to safeguards about what is sensitive at an individual level and within a common EU-wide framework. We believe that such an approach will demonstrate that those who manage and benefit from land and species are not the problem but the solution to conserving and restoring Europe's biodiversity.

22. Assessment Report

Zenon Tederko & Stratos Arampatzis

ABSTRACT

This chapter describes the evaluation processes required by European Commission and added internally, including the strengths and weaknesses identified. Recommendations are made for removal of such weaknesses, and for building on strengths, in future projects.

INTRODUCTION

TESS was evaluated according to the following broad parameters: relevance, effectiveness, efficiency, impact and utility, in accordance with deliverables D 8.1 (Quality Assurance Manual) and D 8.2 (Risk Management Plan) that were developed at the start of the project. The Quality Assurance Manual specified a number of assessment questionnaires for the partners and the manager of the project. The questionnaires were intended to produce a systematic and verifiable process and facilitate the evaluation procedure carried out by the partners every six months

The objectives of the assessment were:

- To measure and evaluate the TESS results using pre-defined parameters;
- To assure that all partners worked in line with the agreed framework;
- To ensure that the assessment results were fed back for immediate or future improvements

During the course of the project there were two internal reviews. Project Management Committee (PCM) Meetings 4 and 6 were specifically dedicated to evaluation. The PCM meeting at month 18 reviewed and discussed the first data of the case studies, ensured they met the project's requirements, and agreed on an interim report. The PCM meeting during month 30 assessed the whole project and agreed on a strategy for further actions. The final internal evaluation (Form C) assessed the overall progress of TESS and its follow-up potential as well as the major lessons learnt, in order to facilitate further actions and plans for future projects.

CONCLUSIONS AND RECOMMENDATIONS

TESS can be seen as an ambitious, challenging and relevant project. Drawbacks are mainly related to the difficulties confronted in the development of some of the more high-end components, minor problems with individual partners and the weak evidence base of impact on practitioners and end users. It should be mentioned however that the present judgement is based on a short third party observation relying only on certain sources. It should not be understood as a fully fledged assessment but rather as a reflection of internal opinions.

A very important and yet intangible impact of TESS can be identified in the mobilisation of stakeholder groups from localities across Europe to work together. Such a task is neither trivial not straightforward, especially in the topics addressed by TESS. In particular the interaction with groups such as farmers, hunters, foresters, national conservation agencies, engineers etc. is an important contribution to much sought but seldom achieved inclusivity.

Last but not least the geographic scope of TESS is commendable, since outputs have been disseminated in all EU languages (plus Russian, Turkish and Ukrainian) and a network of Country Coordinators in all EU Member States ensured that feedback was received from across all Europe.

Table 2 attempts to summarise the findings in the form of conclusions and recommendations.

Table 2. Conclusions and recommendations.

Finding	Conclusion	Recommendation
F1 TESS obtained remarkable local data from case studies but found few models with which to deliver decision support in return.	C1 Ambitious and complex IT-related components are difficult to assess, but such poor technology transfer was very unexpected.	R1a Simplify plans for delivery of envisaged models and systems; R1b This risk could have been assessed earlier in the project.

F2 Findings on Environmental Assessment and Indicators are excellent but uptake of these project outcomes is slow.	C2 Uptake of the project outcomes is dependent on external factors e.g. high level capacity and vision for local democratic engagement.	R2a Introduce or align capacity building curricula in Commission. R2b Prioritise early publication of results in high-impact media.
F3 Some impact was not captured, since only internal views were evaluated. Registering change in behaviour of local people was impractical.	C3 The integrated identification of the impacts needed better concept of incentives and data collation, and greater time-lag before explicit surveys among target groups.	R3a Introduce feedback collection by partners at earlier stages. R3b Better adaptation of concepts to local conditions and capacities. R3c Improved database updating.
F4 It is not clear to what extent the knowledge of local abilities from TESS will be integrated usefully by TESS peer networks.	C4 Evidence for integration of local knowledge is dependent on the individual capacities and engagement of peers.	R4 Develop standardised tools and guidelines in Commission for 2-way communication across peer project networks.
F5 TESS innovated new approaches in its final stages but lacked ability for more timely adjustment to unexpected findings.	Procedures for updating the Description of Work were too onerous for adequate flexibility of innovative and ambitious research.	R5a Simplify Commission process for updating to improve DoWs. R5b Encourage planning of longer timeframes for ambitious projects.
F6 TESS managed to mobilise and interact with stakeholder groups at both EU and local level.	C6 In the context of sustainability the broad involvement of stakeholders has been achieved and is in the position to carry on.	R6 Introduce follow-up finance mechanisms for projects in which expertise and networks (e.g. of stakeholders) provides scope to implement sustainable measures.
F7 TESS pioneered citizen science and disseminated on a broad geographic base in languages for local communities.	C7 EU-wide relevance of TESS themes (EIA, SEA, NATURA, No Net Loss etc.) should allow for broad uptake.	R7 Embed TESS outputs in the dissemination & science promotion mechanisms of all science and other stakeholder organisations.

23. Overall Conclusions

Robert E. Kenward, Jason Papathanasiou, Basil Manos, Stratos Arampatzis

ABSTRACT

This chapter summarises the intentions, processes and findings of the project, funded by the Commission of the European Union, to design a Transactional Environmental Support System (TESS). It provides an executive summary for the book we have edited.

INTRODUCTION

Chapter 1 introduced the thinking behind this project, to design a Transactional Environmental Support System (TESS). It noted that decisions affecting the environment include not only high level policy and formal assessments, but also informal decisions by local stakeholders. These stakeholder decisions, for instance on what to remove or plant and how and when to manage it, are mostly made without expert advice yet summate to change the environment. After trial surveys in Chapters 2-3, data from 30 countries showed in Chapters 6-8 that the density of informal decisions by stakeholders averaged about 5 orders of magnitude greater than for statutory assessments. Chapter 1 also indicated that biodiversity-dependent recreation could be a cultural ecosystem service with high value for conservation, after which Chapter 9 estimated an annual private spend in Europe on fishing, hunting, gathering and watching wildlife of €62 billion, comparable with state spending of €57 billion (half of the EC budget) annually on the Common Agricultural Policy (CAP). Chapter 1 also noted the complexity of local decision making informed by wildlife ecology, state agri-environment spending and large biodiversity-dependant private spending. . Few socio-ecological models for case studies (Chapters 10-19) were identified in Chapter 3, and very little technology transfer using expert models and toolkits to provide the decision support needed by local managers of land and species were found in Chapter 20.

Local decision support also needs guidance from strategic planning at higher levels. Chapter 20 notes that modelling to predict populations of small species across wide areas, for planning biodiversity restoration, needs habitat mapping at much higher resolution than is currently available and should be complemented by *in situ* data. There are indications that effective high level biodiversity governance needs local people to be well informed about how to get the best from biodiversity: in Chapter 8 the intensity of formal environmental assessments was related to positivity to nature at local government level and other variables acting at local level. Moreover, data from a previous project showed that status and sustainability of biodiversity and ecosystem services depend strongly both on local adaptive management and on knowledge leadership from higher level. The concept in Chapter 1 of an internet system for better information flows between policy-makers and stakeholders, in order to benefit management of the environment at local level and policy-making at high level to help that management, gains support from the findings of this research project. A system could be a designed providing both adaptive management with knowledge leadership at local level, and adaptive governance at European and national levels.

FOUR FINAL QUESTIONS

Chapter 1 concluded by presenting, for consideration in Chapters 2-22, four final questions:

- Do local people require information that a transactional system can deliver?
- Can local people contribute enough data of use at higher levels?
- Can current technology build such a system?
- Can the building and long-term operation of such a system be supported?

It is time to answer those questions.

Local Information Needs and Capabilities

Local government and private land managers handle many decisions on local issues, with support from central government and agencies (Chapters 4 & 7) but have difficulty in finding & accessing recent information on habitats and species at fine scale (Chapter 3). A lack of simple information on socio-environmental issues (Chapters 5, 9 & 20) was especially unfortunate because factors most associated with frequency of statutory environmental assessments (Strategic Environmental Assessment and Environmental Impact Assessment) included the awareness of benefits of biodiversity and other ecosystem services (Chapter 8).

Nevertheless, there is wide use of digital mapping for CAP requirements (Chapter 7), much ability and enthusiasm of citizens for *in situ* mapping and more participation in recreational biodiversity-dependent activities than realised by administrations (Chapter 9). The success of citizen-science initiatives such as the Eye-on-Earth initiative from European Environment Agency (EEA) and Microsoft, and the UK's Open Air Laboratory (OPAL) give confirmation of interest and enthusiasm from outside TESS. Conditions are ripe to exchange decision support for the fine-scale local mapping that is needed to restore biodiversity.

TESS design focussed on local stakeholders also because other EC projects involved TESS partners in decision support for policy (FP7-SPIRAL and SCALES) and environmental assessment (FP7-LIASE). Moreover, both previous substantial British attempts to build socio-ecological decision support systems concluded that their outputs were too high-level and should be accessible for individual citizens.

GIS and Data Standards for Meeting Needs at All Levels

The integration of information on biodiversity and related environmental matters for planning and land-use decisions generally uses maps and, in digital format, Geographic Information Systems (GIS). This applies to statutory Environmental Assessments for strategy or of impacts (SEA, EIA) and other formal land-use planning processes, but often also to the myriad daily decisions made less formally by stakeholders who manage land or species. We found that about half the countries in Europe already had local authorities using GIS (Chapter 7). Indeed, GIS is a lingua franca accessible to all ; the mapping software for TESS was usable down to 6 years of age and even easy to provide across languages with translation of short words where symbols and intuition alone do not suffice (Chapters

9 and 20). GIS is inherently scalable: maps (of species, habitats and geo-referenced socio-economic data) at fine scale aggregate to cover all scales.

Local information in the form of maps will only integrate to give adequate coverage for predicting general trends in species, habitats and socio-economic factors if coverage is both extensive and yet detailed enough to predict the effects of management. A system that meets the challenge of good data coverage at local level can use the Infrastructure for Spatial Information in Europe (INSPIRE) standards of the European Commission (EC), possibly via the Environmental Information Observation Network (EIONET) of EEA, to link with the Biodiversity Information System for Europe (BISE) and Global Earth Observation System of Systems (GEOSS) to deliver relevant information for high level governance (Chapter 20).

Unfortunately there remain serious information gaps in the provision of this type of data across Europe. Excellent pan-European integration like CORINE (Coordination of Information on the Environment) Land Cover maps have little use at local level and there is no software to make its use really easy at any level (Chapters 5 and 20). Predictive modelling, incorporating habitat mapping and management, is used mostly by experts, by some consultants at the local level but not by individual stakeholders. Although local fine-scale mapping is done by stakeholders for CAP reporting (Chapter 7), and for planning on site and by consultants, privacy issues hinder its use by local authorities and there is no integration for use at high level.

Practicalities of Building a TESS

If government needs GIS data on land-use and species for policy planning and environmental assessments, and local managers need GIS-based decision support, there is scope for mutual benefit. Local knowledge from individuals could be exchanged for decision support from government. Moreover, a process that provides information which benefits local recreation and livelihoods (in exchange for data required by government at different levels for environmental assessments) is likely to encourage local people to maintain and restore biodiversity ecosystem services. This is the basis for proposing a Transactional Environment Support System (TESS).

In the long run, a TESS must be practical for communities and individuals needing knowledge, as well as for scientists who guide the knowledge process, and for government policy-makers. The technical design proposes intelligent web-GIS, linking knowledge to maps like word-processors link spelling and grammar checks in documents. The design novelty is not in creating the necessary code, but in combining components not found in previous designs for environmental support, including intelligent web-GIS, with modules for handling ownership, quality and uncertainty of data in models, for language translation and for automated scenario analysis to help solve environmental problems unanticipated by the user.

However, the design of a TESS cannot merely consider the technology for the tool, but also needs socio-economic assessment of the demand and supply of the information in that tool, its ease of use, motivation to use it and cost of maintaining it long-term. In order to obtain adequate local knowledge at a finely-mapped coverage for central policymakers in the long term, the design must provide information that local people want in ways they want, and therefore must consult them (as well as policymakers) during development (Chapter 20). A tool that is not desirable, as well as practical and durable, will not last.

Usefulness and Trust to Gain Coverage and Funding

In order to be desirable, software needs to be provided in a convenient context and be fun to use. Market research for a desirable socio-economic setting, with stakeholders at several meetings, identified the concept of a web-portal serving as a one-stop-site for ideas and knowledge which would be attractive to individuals and communities. Existing toolkits and decision support systems could be linked to such a portal, and later complemented by user-friendly and intelligent web-GIS. Two surveys found similar priorities between stakeholder organisations and individual stakeholders for desirable web-portal content: for information on best-practice in conservation through use of biodiversity, on protected species and habitat maps, and web-services for monitoring species, mapping and conservation news (Chapter 20).

Local information will only integrate adequately for policy and government assessments if coverage is excellent (as noted above) and for wide local private use if there is open access. Wide use and open access require trust. Sensitive handling is needed for system inputs (data and models) to include transparency (e.g. avoiding black-box effects), privacy (e.g. avoiding neighbourly prying), accreditation (e.g. for career or commercial benefit) and uncertainty (e.g. with Bayesian Logic). There must also be trust between stakeholders at all levels. Scientists are crucial stakeholders, for analysis and experiments that build decision support models, and for audit and quality assurance of volunteer data that provides confidence to government and local stakeholders. Social trust from governments and local information stakeholders is more likely if the system is perceived to operate equitably. For this reason, construction and operation should be a non-profit operation, in which all funding is used to improve the system. A base in the voluntary sector also reduces risk of politically-motivated shut down or commercial sell-off.

For the survey of individuals, commitments by non-profit organisations in agreement with commercial firms secured the build and operation of a portal (www.naturalliance.eu), with translation and content contributions from TESS partners. Steering involves a wide spectrum of organisations, without whom the trust of all countryside interests would be unlikely. Establishing the Naturalliance portal has also generated ideas for both rapid and gradual development through government contracts at all levels. Although it also found little scope for development by crowd-funding, the support of a visionary philanthropist would be an alternative to government support for providing the user-friendly and intelligent web-GIS needed to encourage widespread use of the system.

CONCLUSIONS ON TESS AS A TOOL FOR CBD AT ALL LEVELS OF SOCIETY

The TESS approach fits well with recommendations of the Convention on Biological Diversity. CBD objectives are conservation of biological diversity, sustainable use of its components and equitable sharing of its genetic resources. The 18th of 20 targets in the 2010 Nagoya-Aichi strategic plan, is that "By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels." The portal, built in conjunction with the TESS survey of individuals, addresses that target. It also addresses others. These include raising awareness of the values of biodiversity (target 1), integrating such values into development (2), keeping biodiversity-use sustainable (4, 6, 7), safeguarding essential ecosystem services (14) and not merely halving rates of loss of natural habitats (5) but restoring degraded ecosystems (15), not to mention transferring and applying the knowledge and science base relating to biodiversity functioning and trends (19). The TESS concept addresses half the "Aichi Targets", thus potentially making a substantial contribution to the EU's commitment to CBD implementation, provided it receives enough support to be useful for local people.