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i. Foreword

Directorate General for Research & Innovation, Environment Directorate
European Commission

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.

ii. 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
Anatrack Ltd, UK.

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".

STRUCTURE OF THE WORK

Stages in TESS were planned as Work-Packages (Figure 1). The preparatory stages examined information requirements, processes and other governance used in formal environmental assessments and other decisions that affect biodiversity. This was done for governments at national (WP2) and local levels (WP3), and also for individual stakeholders (farmers, foresters and managers of land for angling, hunting and watching wildlife, first in TESS partners countries, and then through systematic pan-European survey (WP5). Capabilities of local communities to supply information were examined, as was the availability of models to offer decision support from that information (WP4). Analysis of gaps in demand and supply of knowledge, and of best practice in governance, then informed the synthesis of a system design (WP6).

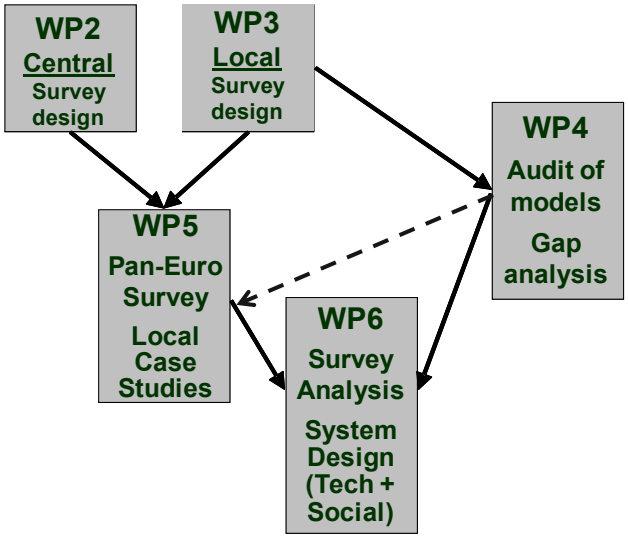

Figure 1. The temporal sequence (from the top) and connections (arrows) between work packages that represent stages in the TESS project and chapters in this book.

In this book, Chapter 2 is about the pilot survey of government officers at national level, to identify information demand and supply (WP2), which was completed in countries with TESS partners (Table 1). Chapter 3 (based on WP3) addresses the equivalent pilot surveys at local level, of stakeholders who make decisions directly affecting use of land and species, including administrators in the two lowest tiers of government, farmers and foresters, and managers of land for fishing, hunting, gathering and

watching wildlife, and for countryside exercise activities. Chapter 4 shows how the information flows from sources to stakeholders can be synthesised.

Table 1. The 14 Partners in 10 countries who started the TESS project in 2008.

Aristotle University of Thessaloniki	Greece
Tero Ltd	Greece
Bournemouth University	United Kingdom
Natural Environment Research Council Centre for Ecology and Hydrology	United Kingdom
Anatrack Ltd	United Kingdom
European Sustainable Use Specialist Group	Belgium
Federation of Associations for Hunting and Conservation of the EU	Belgium
Tallinn University of Technology	Estonia
Szent István University	Hungary
Pro-Biodiversity Service	Poland
Ordenamento e Gestão de Recursos Naturais Ltd	Portugal
Danube Delta National Institute for Research and Development	Romania
Centre for Cartography of Fauna and Flora	Slovenia
WWF Turkey	Turkey

Chapter 5 (based on WP4) presents a survey of models suitable for predictions and decision support when managing land and species at local level, and takes a first look at how well these meet demands for data identified in earlier chapters. Chapters 6 to 8 describe the Pan-European survey (WP5) that was conducted across all EU member states except Cyprus, together with Norway, Switzerland, Turkey and Ukraine. The survey used questions refined from Chapters 2 and 3 to record information demand systematically, for analysis of institutional capacity, other governance factors and environment indicators to suggest best practice that should be built into a decision-support system.

The capacity and willingness of local communities to supply knowledge was then a special feature of Case Studies, involving socio-economic projects and mapping, that are summarised in Chapter 9 and then detailed briefly in Chapters 10-19. Chapter 20 then brings together data on governance and demand for information from the Pan-European survey (from WP5), with findings of excellent local ability to collect data in Case Studies, and with further evidence of gaps in supply of predictive models (WP4), to inform the technical and socio-economic design for a Transactional Environmental Support System.

The process of designing TESS revealed many interesting findings, on central governance relationships and local data demand and supply, which form the basis for broad recommendations and guidelines in Chapter 21. This leads in Chapter 22 to recommendations for European Commission and similar future projects, after which the editors provide a concise summary of the project in Chapter 23.

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?

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KEY TERMS

Keywords

Adaptive Management, Decision Support, De-intensification, Ecosystem Approach, Ecosystem Services, Environmental Governance, Pan-European, Sustainable Development, Sustainable Use

21. Guidelines and Recommendations

Robin J.A. Sharp
European Sustainable Use Specialist Group of IUCN-SSC, UK

Julie A. Ewald
Game and Wildlife Conservation Trust, UK

Robert E. Kenward
Anatrack Ltd, UK.

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.

THE ROLE OF GUIDELINES DERIVED FROM A SCIENTIFIC RESEARCH PROJECT

TESS was a scientific research project. This means that among other things it strove to be objective and rigorous in gathering and analysing information. It benefited from financial resources provided by the organs of the European Union and the cultural richness which comes from collaboration among a range of European research institutions. At the same time the project was constrained by formal requirements to follow programmes of work prepared long in advance, which do not allow for "adaptive management".

When the object of study is not the behaviour of a restricted number of animals or plants in a laboratory but, in effect, the 500 million strong population of Europe, the challenge to achieve rigour and objectivity is all the greater. Much of the work in TESS was about exploring the capacity and willingness of ordinary people using or managing land to record scientific information in a way that will assist their decisions and those of others to be more favourable for conserving wildlife. This encompasses farmers and gardeners, as well as those who hunt or fish, walk in the countryside or enjoy observing nature.

Asking relevant questions either directly or through representatives is subject to a range of limitations such as possible misunderstanding of what is intended on the part of the respondent or their lack of knowledge or reluctance to take seriously "yet another survey" whose relevance is obscure to them. Nevertheless TESS has done its best, within quite modest human and financial resources, to conduct its enquiries on the same basis in over 130 randomly sampled local communities in 27 European countries, as well as carrying out 10 local case studies involving direct socio-economic surveys and experimental mapping by non-experts.

One of the keys to the success of the Pan-European surveys was the network of Country Co-ordinators developed by the European Sustainable Use Specialist Group of IUCN/SSC during the previous GEMCONBIO-UNWIRE study. This network provided a combination of translation skills with

expertise in the subject of the questionnaires and was crucial in persuading local communities and land managers to participate. This relatively inexpensive methodology appears to be fairly unusual or perhaps even pioneering, at least in the general area of science in which we have been operating.

Underlying Philosophy

Having made this claim to objectivity in a sphere of social enquiry where precision is inevitably elusive, we should perhaps indicate the broad approach which lies behind TESS. This is a general conviction that conservation of biodiversity needs to be addressed within a wide context of human activity as recently encapsulated in the Malawi and Addis Ababa Principles adopted by the UN Convention on Biological Diversity (CBD). These principles and guidelines of an ecosystem approach and sustainable use of biodiversity recognise that, to coin a phrase, "we are all in this together".

Thus, without ignoring the importance of protected areas and species, the TESS project has focused on what is referred to as the wider countryside. This is the roughly 80% of land and inland water bodies in Europe that is not subject to special designation, where people have to earn a living or wish to practice a variety of pursuits that do not have conservation as their primary objective. Unless their impact on biodiversity is taken into account and unless their use of it is sustainable then conservation risks being confined to isolated islands of strictly protected land surrounded by a sea of intensive land-use.

Going beyond this we see the potential for such use to provide incentives for conservation, when people recognise the social and economic benefits which derive from it. To put it another way, governance objectives are normally achieved either through carrots or sticks. Regulation, which remains necessary in many contexts, is the stick, whereas incentives are carrots. We have been concerned mainly with carrots, that is to explore the extent to which people can be motivated to integrate conservation goals or environmentally friendly use into their day-to-day activities on land or water, as well as what are the information needs to make this possible.

Another important aspect of the thinking behind TESS is explained in a paper derived from the GEMCONBIO project, prepared by a number of TESS participants and others and published in the Proceedings of the National Academy of Science (PNAS) in 2011. This paper "Identifying governance strategies that effectively support ecosystem services, resource sustainability, and biodiversity" shows the importance for biodiversity conservation and sustainable use of adaptive management and knowledge leadership, as exemplified in the CBD Principles mentioned above. TESS can be said to have designed a system to deliver (automated) knowledge leadership while facilitating adaptive management.

These are the principles and findings which have guided TESS as it has sought to draw policy conclusions and guidelines for action out of the scientific work which has been undertaken, with all its acknowledged and unacknowledged shortcomings. If you think that the investigation and reporting of scientific facts about nature is best left to experts whether in universities, government agencies or NGO's or if you consider that preservation of so-called "biodiversity hotspots" or the rapid extension of protected areas should be the priority for conservation effort, then the following guidelines may be of little interest. We might also add that it is not our wish to repeat here the kind of broad principles and guidelines already mentioned, which stand at a higher level. Indeed, these higher-level concepts, rather than the findings of TESS as such, are what have influenced us to conduct TESS in the way we have.

The Recommendations and Guidelines

In framing recommendations and guidelines (in bold type) we considered different audiences such as various levels of government and local users, as well as those who commission and carry out research and monitoring. The order adopted is related to the way in which the project was implemented and should not be seen as having any further significance. We offer summaries of key findings and then propose guidelines or recommendations which arise from them.

In the TESS project we first considered higher echelons of governance at the EU and national or immediately sub-national government levels.

Information for higher-level assessments

The EU Directives on Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), though not integrated into a single instrument as originally intended and as would still be desirable, are based on sound principles which oblige those formulating national strategies or proposing large physical projects to assess their impact on the environment in the short and longer terms.

The Directives have been translated into national laws, using permitted differences in scope and procedures, but are applied with a surprising degree of variation (Chapters 2, 3 and 7). It is not clear what purpose is served by such variation, other than a claim to have met a political demand for a degree of subsidiarity. It would be expected that the annual number of large new projects coming forward for assessment in each country would be loosely related to the size of its economy. However, although there were relationships with country size and population density, there was no sign of a relationship with GDP; the reasons for this remain elusive, though our investigations have revealed some unexpected correlations. Among these were relationships that suggest de-tiering at local level, which makes consultation and the contribution of genuinely local knowledge into higher-level decision-making more difficult, is not environmentally beneficial.

It is, nevertheless, clear that the vast majority of land use planning decisions are made outside any formal impact assessment system as laid down by the Directives (Chapters 2, 3 and 7). In many cases these decisions will involve informal environmental assessment but, since many small cases may have as much impact as a few larger ones, there is an argument for requiring the principles of such assessment to be embedded into national planning law generally.

It should also be noted that those who frame the laws, whether at EU or national level, do not themselves directly require the environmental information set out in the assessments. They require developers or bodies formulating strategic plans to gather the information and the deciding authorities to assess if it is adequate and what role it should play in influencing the outcome of the process (Chapter 2). This has relevance for the "transactional" ambitions of TESS, since it means that there are not simple upward and downward flows of information related to these formal assessments and resulting decisions which affect the environment and biodiversity.

Biodiversity information, which is available in a wide variety of formats on the internet in many cases, is gathered together in ad hoc fashion for these assessments but then dispersed rather than being added to national or EU level databases. In spite of praiseworthy requirements for public involvement in SEA and EIA processes (Chapter 3 and 7), they remain formidable and many local municipalities, much less ordinary land managers, have no experience of them at all.

A requirement for EIA when semi-natural habitats are converted into intensive agriculture could in theory provide a valuable instrument for conservation in the wider countryside. Regrettably this is generally by-passed (Chapter 2). However, there is a gradual movement towards environmental assessment based on mapping as a condition of single farm payments under the CAP. It seems probable that the huge number of management decisions taken by farmers, horticulturalists and gardeners are of more significance for the health of Europe's natural heritage than the large-scale developments currently caught by formal EIA. As long as agricultural support systems continue they may be a more effective tool for assessing and influencing land management changes of environmental significance.

Accordingly the following recommendations are proposed when considering how environmental and sustainability assessment should be carried forward through incentives and regulations.

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.

While the requirements for formal assessment are a top-down flow from international and national implementation levels, there is no corresponding flow of information from participants to these levels about the relevant impacts and the effectiveness of the processes (Chapters 2, 3 and 7). Just as participants often have difficulty in finding the information they need, which is available in a variety of forms and from a range of sources, so authorities setting the rules or enforcing them are in effect discarding the information gathered at considerable expense for each individual assessment. While there has been effort in some countries to harmonise and digitise biodiversity records (Chapters 3, 7 and 20) this has been mostly to assist conservation projects rather than to facilitate decision making by land users. So far there has been little evidence that national level governments appreciate the contribution that information from non-experts or "citizen science" could make to policy or policy outputs in biodiversity related fields. This is probably due to the widespread mindset that information about wildlife is only reliable if provided by experts.

The need for local, regional, national and European frameworks to integrate data and make it easy to use by non-experts is evident. The work of the European Environment Agency (EAA) in this endeavour is of critical importance at European level. In the national context Biodiversity Action Plans (BAP) have brought together government departments and agencies, local government, business interests, land managers and NGO's to assess the state of biodiversity and to devise and implement plans to restore it, a process which is impossible without data gathering and monitoring over time. In a few countries this collaboration and the necessary structures have been adopted voluntarily at regional and local levels (Chapters 2 and 7), each with their own targets for habitat and species restoration and thus the need and indeed motivation for appropriate information gathering. If local BAP consortia could be put in place more widely, they could provide the ideal frameworks for harmonizing biodiversity data and making it genuinely accessible to non-experts. Equally data provided by citizens could be integrated into the various formal environmental assessments, thus promoting a genuine two-way transactional approach.

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.

Understanding information needs and making information available

Although TESS examined national level requirements for environmental assessment and information, its special focus was on local decision-making and the need for information to support these decisions. It looked at the various categories of local users of environmental information, such as local governments at the "lowest" level (parishes/municipalities: LAU2 in Eurostat classification), and in some countries at the second "lowest" level (districts: LAU1), foresters, farmers, nature-watchers, anglers, hunters and recreational access groups. The categories of information identified related to habitats, species, socio-economic issues, hazards and tourism/income generation potential.

Sources of information were extremely varied, with local government, national government and government agencies making the most significant contribution, along with their own records being important for local stakeholders, especially foresters and nature watchers (Chapters 3, 4, and 7). Scientific studies, consultants, local knowledge and NGO's played a lesser part. Although there is plenty of environmental information of varying quality available on the internet, local land managers do not yet use it strongly. On the other hand local authorities in about half of EU countries carry out an appreciable amount of systematic recording of biodiversity and/or use geographic information systems. Overall the picture is complex and apparently little studied.

The different categories of users of information had greater or lesser requirements for some types of information but all needed data on species and ecosystem services. The most local governments were more concerned than others with hazard issues, while "district" or second level-up councils were more focused on biodiversity issues than parishes and municipalities, almost certainly because formal responsibilities were allocated at the higher level.

In seeking to identify local authorities at the lowest level in different countries to meet our survey criteria, we were struck by an increasing tendency over the last thirty years or so for the lowest tier of authorities, parishes or municipalities, to be abolished, made optional or merged for all serious functions into *ad hoc* consortia. So-called efficiency, derived from McKinsey type analysis, is being promoted at the expense of genuine localism, citizen involvement and listening carefully to what an increasingly educated and curious population has to say about what is going on around it. This trend is directly counter to what TESS identified in Chapter 8 as valuable for biodiversity conservation and doubtless for other public goods of the non-monetary type.

The drivers of information needs were fulfilment of statutory duties, local policy formulation and the need to guide management decisions. Local stakeholders tended to get most of their information on socio-economics, species and hazards from government and consultants, but to generate most of the information on habitats themselves; yet this local knowledge was relatively little used at national government level (Chapters 4 and 20).

As already noted, SEA+EIA assessments were not very significant for those surveyed at local level in many countries, which is perhaps not surprising when in many countries there are fewer than 200 formal SEA+EIA's annually. When informal decisions were also considered, individual private local stakeholders took many more decisions than local authorities, doubtless mainly of a management character, but it was not feasible to distinguish between the importance of various decisions. Apparent needs for information may be influenced by the type of decision and the extent to which stakeholders consider that their participation in formal processes conducted by local governments is genuine. Difficulties in obtaining adequate information for decision-making were widely reported by user groups, especially at regional and local levels. Where data existed, accuracy, spatial scale and age of data were noted issues (Chapters 3 and 20).

Local authorities were also asked about the information that was needed on biodiversity and ecosystem services and what was actually available. There was great variation in both the need and availability of necessary information.

At local level decisions were also assessed in terms of the areas estimated to be affected per decision. Informal decisions, probably mostly affecting council amenity land, related to much smaller areas than did statutory assessments, so that on average council decisions affected smaller areas than other stakeholders. Taking into account the greater average area affected by decisions of private managers and the greater number of them than of councils, all except managers of fisheries had a decision density 4-5 orders of magnitude greater than that of local authorities (Chapter 7).

Information requirement on ecosystems for provisioning (crops, medical, biofuels), regulating (flood/fire/disease hazards) and supporting (water/air/ soil quality) services was also highly variable, whereas information on cultural services (amenity, recreation, tourism) was generally in high demand (except in a country where local authorities were most interested in natural hazards). Information on biodiversity (protected and harmful species and habitat maps) was also generally in high demand (Chapters 3 and 7).

We may conclude from these considerations that decision making within the environmental sector is a complex process that relies on dense patterns of data exchange between stakeholders and local, regional and central levels of government**.** Accordingly the following guidelines are suggested:

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.

Participation in and attitudes towards wildlife-related activities

The local authorities also produced estimates of the prevalence in their communities of households involved in land-use activities. There was very considerable variation between countries in the estimates for every activity. However, the averaged estimates across countries in Pan-European surveys were that 44% of rural households engaged in gardening, 20% in farming, 15% in gathering wild fruits, fungi and invertebrates, 18% in fishing, 8% in hunting and 6% in forestry. Although on average only 6% were thought to go on excursions to watch wildlife, 11% were thought to feed birds at home. The smallest proportion of households (4%) was thought to have members riding horses, but 23% were estimated to use the countryside for other exercise activities (Chapter 7).

When compared to the non-randomly selected rural areas in the local case studies , where households were directly interviewed by surveyors, these participation rate estimates appear to be very low (Chapter 20). Direct interviews revealed 70% of households engaged in gardening, 53% in gathering, 35% in fishing, 18% in hunting, 13% in horse-riding, 32% in wildlife watching, 47% in attracting wildlife with food and 70% in taking exercise in the countryside (Chapter 9). This underlines the importance of direct interviewing of individuals by random sampling across EU countries, rather than relying, as TESS perforce had to, on local government estimates of their activities. It also reinforces the findings of the UNWIRE study that many millions of EU citizens benefit from wildlife-related activities and spend their own money on them.

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. Accordingly 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.

As already mentioned the socio-economic surveys carried out in the local case study areas demonstrated much higher participation rates in wildlife-related activities (feeding birds, gathering fungi, angling, hunting etc) than did the Pan-European surveys which relied on local administrations for their best assessment of such participation (Figure 1 in Chapter 20). What is also interesting is that rural people took a balanced view of the benefits and disadvantages of wildlife, though with a clear inclination to seeing it positively. Clear majorities valued biodiversity for use as food and for recreational activities associated with it (Chapters 7-9). Thus their attitudes appeared to be pragmatic rather than sentimental, in contrast to what is sometimes seen at national level where well-organised groups with a non-pragmatic approach may have an undue influence on conservation policy. Engagement in countryside activities was minimally affected by educational level (Chapter 9).

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.

Citizen capability for biodiversity mapping

As well as surveying local attitudes to the importance of wildlife, the local case studies encouraged local volunteers to test the use of specially purchased digital tablets suitable for use in sunlight in order to map biodiversity and land use information at local level (Chapter 9). This experiment was constrained by the development of the technology available at the time when planning took place (late 2009) and the resources of country partners to engage local people in the experiment. Even though only 46 people in 8 countries eventually took part the results were both interesting and encouraging. The majority of helpers had no previous experience with mapping equipment, which makes their comments especially interesting.

Summaries in Chapter 9 show that 76% rated the mapping hardware favourably and 67% the software. Suggestions for improving the mapping facilities from the users included a need for better GPS capabilities (20%), improved maps (20%), more sensitive touch screens (9%), more visible screens (7%), less weight (7%) and longer battery life (4%). Some 80% of helpers considered they had gained significantly in knowledge from their participation in the project and a similar proportion would be likely or very likely to participate in such projects in the future. No less than 97% of participants considered that their governments should support mapping projects of this kind. It was notable that the rural case studies showed high interest and competence in citizen-science mapping of habitats and species, together with a high level of engagement in wildlife-based recreational activities which could inform and motivate mapping. Accordingly we make the following recommendation:

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.

Biodiversity trends associated with high-level assessment practices

At the opposite end of the spectrum to these surveys of attitudes and activities at local level, an attempt was made to relate perceived trends in biodiversity, conservation and human development indicators at European level with information derived from the TESS and GEMCONBIO projects in order to see whether any potentially significant correlations occurred (Chapter 8). This was no easy task but it is important not just to accumulate information but to see where it may be leading and to take corrective action where feasible. Surprising or seemingly implausible correlations Europe-wide indicators give particular cause for reflection.

This need for reflection applies particularly to recently available CORINE data relating to land cover change across the Continent. Protection status does not yet appear to have any positive effect in reducing the mean rates of conversion from other land-cover categories to artificial surfaces across countries. Artificialisation increased significantly between the periods 1990-2000 and 2000-2006, with no significant differences between areas inside and outside Natura 2000.

In view of the very strict constraints which the Directives impose on development in protected areas, this information suggests the need for investigation. It also calls into question what assessment processes may have been followed in the cases concerned. It is not surprising that growth of artificial surfaces is linked both to population and economic growth, but one of the main purposes of the Directives is to shield the most precious elements of Europe's natural heritage from the adverse impacts of economic growth. Another unexpected CORINE finding is that the area of semi-natural habitats increased between 2000 and 2006, possibly at the expense of intensive agriculture.

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.

Correlations also showed that the proportion of hunters in the population was generally highest in countries with low human density and an abundance of semi-natural habitat (Chapter 8). These were also countries with more positive species conservation status. Since separate studies have established that habitats which are modified for shooting pheasant, partridge and grouse are good for a whole range of non-target species, this is a useful piece of corroboration. While it may not be clear why a prevalence of anglers is linked with knowledge of species' conservation status and strong influence of NGO's, it may be reassuring that these phenomena can successfully co-exist.

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.

The Pan-European survey (Chapters 6-8) asked local administrations to score how strongly residents perceived benefit from biodiversity (in terms of food, materials, recreation, tourism, etc), and also how strongly their perceived costs (in terms of pests or risks from disease or wildlife, etc). The scores for perception of benefit and cost were used to derive a 'nature positivity' index.

This index, which was available for 28 countries, proved to be strongly related to different capacity, priority and process variables which were in turn associated with SEBI 2010 indicators. The strongest relationship was with the World Bank governance capacity variable 'Political Stability'. Fifty percent of the variation in nature-positivity (controlling for population density) was explained by the 'Political Stability' variable. This was an improvement on a recent Gallup survey where knowledge of the word "biodiversity" was used as a proxy for nature positivity; recognition of the word "biodiversity" provided no significant positive correlations with any impact variables used in the TESS analyses.

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.

Working towards an environmental decision-support system

TESS trawled widely for decision support models already in existence that might be useful for local land managers, and could perhaps be made easily available in exchange for mapping (Chapter 5). Of 198 models volunteered or selected as suitable for TESS from about 2,400 in databases, 72% were still traceable on line, 49% were suitable for consultation at a local level and 39% were accessible as downloads or web-services. However, only 5% were considered usable by ordinary people for local level (a proportion which fell below 3% in a larger sample). Only 2 of the 205 traceable used large external databases (both of these were based on data in the USA). The conclusion was that the only substantial decision support available was for agricultural and forestry production. There was little on wild biodiversity and almost none for non-experts to use (Chapter 20). The technology transfer gap in this area is large.

There is also a major language gap. Only one of the models for decision support at local level by ordinary people operated in a language other than English, although there may be models not yet found which do so (Chapter 20). To support management decisions to the same standard across Europe requires a system operating in many languages, and bringing together the best models and practice in many languages.

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.

While a sophisticated technological tool would be at the heart of a fully-fledged Pan-European environmental decision support system, it would also be essential to consider demand and supply for the information in that tool, the ease of its use for field-based practitioners, what would motivate users to use and possibly pay for it and the costs of building and maintaining it long term. TESS considers that to re-diversify land-use and hence support biodiversity we need a tool that is attractive to a full range of partners: government at different levels, local communities, voluntary associations and individuals. All have contributions to make to assembling information which can lead to knowledge-based decisions, with scientists guiding and helping to organise the process. Maps are increasingly used by all these groups for data collection and are a convenient *lingua franca* between people in different countries. Ultimately, an intelligent web-GIS could link knowledge to maps in ways that are analogous to those by which spelling and grammar are built into word-processors (Chapter 20).

Funding issues are likely to inhibit the building of a comprehensive super-model to deliver decision support across all European countries, land-uses and socio-economic variables. Even more pertinent is the constraint that current technological development cautions against this approach, since there has been little technology transfer of extensive scientific modelling (Chapter 5). While higher level processes such as EIA or Natura 2000 designations can afford to assemble site-specific data and the EEA is able to present comparable country information for some biodiversity indicators, the big gap in mapping biodiversity information for monitoring and decision support is at the local level. This is because the current Pan-European maps of land-cover, in the CORINE system, are developed from satellite images to represent habitats in 250m quadrats. However, for population modelling of the smaller animal and plant species, local mapping at scales of 5m and less is needed (Chapter 20).

The building of detailed GIS coverage for field and garden scale at local level would have great advantages for forecasting biodiversity at all levels. However, like the development of decision support to motivate such mapping, it would be a gradual process. The challenge is to start that process. A practical first step could be to provide a one-stop site for ideas and knowledge that can attract individuals and communities, to which existing and new toolkits and decision support systems can be linked in a user-friendly way.

To investigate how such a site might be made attractive as it develops capabilities, national and sub-national organisations representing land users across Europe were asked to complete a questionnaire via Survey Monkey about their and their members' requirements for web-based advice and information (Chapter 20). There were 50 usable responses from 22 countries: 48% were from hunting bodies, 18% from agricultural and water management organisations, 18% from nature watching associations, 8% from anglers' groups, 6% from dog-training bodies and 4% from gatherers of wild resources. Together the bodies concerned had some 1.7m members.

Two consecutive questions asked (i) "Which of the following services are on your web-site?" and, for the same list of 15 services, (ii) "How would you prioritise services for your members on an ideal site?" The resulting scores for presence and priorities were ranked, with the difference indicating the strength of aspiration for the service. Thus, although news-feeds on conservation, discussion boards and e-shopping facilities were widely present, they were not strongly prioritised and thus rank as low aspirations for a portal. Opinion-polling was quite widely available and also popular. On the other hand, examples of best practice, links for decision support (since few organisations used these directly) and monitoring systems were quite widely present and strongly prioritised, while advice on production and wild resources was highly desired but relatively unavailable; services for conservation mapping were also highly required relative to their availability.

Although these samples were small and not statistically representative at a European level, the responses support the thesis of TESS that internet-based decision support on land management related to biodiversity and livelihood interests, with provision of mapping advice and decision support on resources, would find a substantial take-up across Europe. It is also clear that any portal needs to be developed with a responsive attitude to the needs and wishes of a variety of users. Accordingly the first stages of the portal www.naturalliance.eu have been developed within TESS and will be taken forward by some partners after the conclusion of the project. The approach to this initiative can be characterised by the following guideline:

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.

A survey of organisations is relatively easy to arrange on SurveyMonkey, but may not indicate the same information requirements as a survey of individuals. Nor can a survey of organisations reveal what individuals might subscribe to in order to help develop a portal for mapping and decision support.

The final TESS survey therefore used the portal to find out what information and support individuals want and to provide mapping tools. Resource users and others were also given the opportunity to contribute to further development of the decision support, best practice examples and mapping tool that will initially be provided. The portal is now operating in 21 of an intended 25 European languages, building on the network of Country Co-ordinators who provided translations of questionnaires and linked with national and local governments in the TESS Pan-European surveys. The portal also presents links for information on how to benefit from the riches of nature, and how to avoid costs, in order to help develop positive perceptions of biodiversity.

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.

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KEY TERMS

Keywords

Biodiversity Action Plans, Biodiversity Conservation, Convention on Biological Diversity, Environmental Assessments, Environmental Decision Support, Environmental Governance, INSPIRE Directive, Nature Positivity.

23. Overall Conclusions

Robert E. Kenward
Anatrack Ltd, UK.

Jason Papathanasiou
University of Macedonia, Greece

Basil Manos
Aristotle University of Thessaloniki, Greece

Stratos Arampatzis
Tero Ltd, Greece

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.

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KEY TERMS

Keywords

Convention on Biological Diversity, Data Standards, Environmental Assessment, Environmental Decision Support, Geographic Information Systems, Land Managers, Local Government, Recreational Spending, Technology Transfer