1. Executive summary

TESS assists the integration of biodiversity information from the local level into planning and land-use decisions, while at the same time encouraging local people to collect such information in order to maintain and restore biodiversity and ecosystem services. Towards this, TESS has produced:

- Analytical evidence and results from case studies in 8 countries, together with a pan-European survey (29 countries) of information flows between local actors and central planners in relation to biodiversity management decisions.
- A database of models for local ecosystem management.
- Recommendations and guidelines for biodiversity management at local level, based on how biodiversity trends relate to the different management practices across Europe.
- A design for a Transactional Environmental Support System, to support exchange of environmental information between central and local levels, as well as meeting commitments in many areas of the Convention of Biological Diversity.
- A booklet of simple policy guidelines to present all the results for policy makers.
- The organization of two technical workshops and a final conference in the European Parliament in Brussels.

To achieve the above, TESS first analyzed government information requirements at national and intermediate levels and identified local information needs. It created a database of models suitable for bio-socio-economic predictions and compared them with the requirements for information. Case studies of local communities tested how best to meet local decision support needs in exchange for local monitoring that meets central policy requirements. Case studies also examined whether local monitoring (based on schools, NGOs, local community groups or individuals motivated by use of natural resources) can supply the extra environmental data that are needed. A survey of government and local practices in 31 European countries identified factors associated with effective application of formal assessments (EIA+SEA), together with priority areas for internet-based decision support and local monitoring to benefit livelihoods and biodiversity.

14 organizations from 10 European countries participated in TESS (http://www.tess-project.eu), coordinated by the Aristotle University of Thessaloniki. Although much more research about information needs and technical development of decision-support mechanisms is required, we are moving into a practical implementation phase. We developed a knowledge portal (http://www.naturalliance.eu) aiming to deliver decision support in all EU languages for local people, empowering them to reverse the trend of the loss of biodiversity experienced in Europe.

We remain convinced that environmental information needs to be gathered and used by ordinary citizens subject to safeguards about what is sensitive and within a common EU-wide framework. We believe that such an approach will demonstrate that land-managers are not the problem but the solution to conserving and restoring Europe's biodiversity. Towards this, 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 in the longer term.

2. Project context and objectives

2.1 Background

For the past 50 years, subsidies and market forces have encouraged intensive use of a few crop species in Europe. This degraded ecosystem services that sustained Europeans for centuries, and homogenised land-uses from whose previous diversity had bloomed our rich culture, livelihoods and nature. Species with special niches or limited ability to re-colonise have widely disappeared through habitat loss and fragmentation, and biodiversity has declined drastically at local level.

Over the same 50 years, human ability to predict has increased through the use of computers; we can now predict the development of habitats and species populations in space and time. Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA) have been using such predictions to constrain adverse developments (Treweek 1999). Together with regulations at EU level, including protecting 17% of Europe's area in Natura 2000, formal assessment systems may help halting biodiversity loss at continental level.

However, current formal assessment systems are bottlenecked by dependence on experts, which limits application and can also create conflicts (Therivel 2004). Moreover, formal assessment systems do not cover the myriad decisions made by individuals at local level, on what to remove or plant and how and when to manage it. Decisions that are made for farm fields and gardens are small-scale and are left out of formal assessment systems, but do summate to change our environment.

Work across Europe further shows that private spending on biodiversity for wildlife-related activities is at least EUR 40 billion annually in the EU (Kenward et al. 2009). An opportunity therefore exists for this private spending to be combined with public funding for conservation of biodiversity in Europe. This was foreseen in the Convention on Biological Diversity (CBD), in which an emphasis on sustainable use of biodiversity (in 13 of 19 substantive articles) aimed at giving "incentive-based conservation" a strong boost (Hutton & Leader-Williams 2003).

We contend that the internet offers the way to implement commitments of CBD parties towards incentive based conservation. Thus we have designed an internet based decision support system for 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 and ecosystem services.

2.2 Methodological approach

TESS contends that local communities can restore environments if they are enlightened, empowered and aided by policy-makers and society as a whole. This provides scope for a transaction between governments and local communities: in order for governments to conduct complex assessments through EIAs and SEAs for developing policy and high-level plans, they need to consider the results of local decisions; in order for individuals to make small-scale assessments and decisions, they need complex knowledge that government can provide to local level. Thus:

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

The internet is the key both to the collation of local knowledge and the automatic distribution of decision support to communities and individuals. However, a system for knowledge exchange will work only if it meets social requirements, by being not merely user-friendly but also user-attractive and socially integrated both at local and at central levels. To achieve this, in the first phase of TESS we listed and analysed government information requirements at national and intermediate levels and identified practical needs and stakeholder perspectives at the local level. We also developed a database of models suitable for bio-socio-economic predictions and decision making assistance at the local and regional level in order to examine where there are gaps in the supply of models and data, compared with the demand for information.

Case studies of local communities tested how best to meet local decision support needs in exchange for local monitoring that meets central policy requirements. These case studies also examined whether local monitoring (based on schools, NGOs, local community groups or individuals motivated by use of wild resources) can supply the extra environmental data that are needed, and how we can plan projects to benefit biodiversity and livelihoods together with local people who wish to aid their environment because they make use of it.

To identify current best practice for incorporating biodiversity and wider environmental information into decision-making on land-use across the EU, a survey of government and local practices in all 27 EU member states plus some candidate states also took place. This study assessed how the use of biodiversity and environmental information in EIA and SEA has affected ecosystem services and biodiversity in both protected and cultivated areas. The survey also identified priority contexts for internet-based decision support and local monitoring to benefit livelihoods and biodiversity.

The ultimate aim is to aid restoration and maintenance of biodiversity and natural resources by reversing the processes that caused so much degradation. Therefore, although baseline monitoring and continuing assessment of wide areas could solve several problems with EIA, for example enabling 'pay by results' to replace 'pay for process' subsidies (Ferrano & Kiss 2002), TESS is much more ambitious than merely supporting central policy.

3. Results

The fundamental result is the socio-economic and technical design for a Transactional Environmental Support System (TESS) to support exchange of environmental information between central and local levels, as well as meeting commitments in many areas of the Convention of Biological Diversity. The design is being tested in a knowledge portal to continue beyond TESS (http://www.naturalliance.eu) towards the intelligent GIS that could exchange decision support for fine-scale mapping of decision outcomes. This approach will enable integration and delivery of formal environmental assessment systems with local knowledge and practices, through information and communication technologies, including GPS, remote/local sensing, and internet/mobile services. Results also include recommendations and policy guidelines based on how biodiversity trends relate to different practices across Europe, addressed to those involved in the formulation, implementation, monitoring and evaluation of policies - at European, national, regional, and local levels.

However, on the way to this fundamental result we need first to consider:

- TESS reports:

i. Describing information flows in relation to biodiversity management from local and regional actors to central governments;

ii. Assessing local decision making processes for biodiversity management, including the use of participatory approaches;

iii. Bringing these together for SEA, EIA and other environmental decision making at all levels.

- Analytical evidence and results from case studies in 8 countries, together with a pan-European survey (29 countries) of information flows between local actors and central planners in relation to biodiversity management decisions. The case studies also conducted local monitoring exercises with simple mapping tools used by citizens or citizen groups, and examined how projects to benefit biodiversity and livelihoods can be planned together with local people who wish to aid their environment because they make use of it.

- The TESS database of models that formalize knowledge for local ecosystem management, to enhance ecosystem services generating direct benefits to the manager. The models provide scope to improve the health of ecosystems at small scales. More specifically, the models provide knowledge for sustainable farming and timber production as well as maintenance and improvement of leisure objects.

- Recommendations and guidelines for policy makers in relation to biodiversity management at local level, based on how biodiversity trends relate to the different management practices across Europe.

These results are presented in more detail in the following sections.

3.1 Information requirements for environmental decision making

The TESS process involved planning and trial questionnaires at national level for 9 countries and at local level for 8 countries (Sharp et al. 2009, Hodder et al. 2009), leading to a quantification of information flows (Perella et al. 2009). The survey protocols were then refined and applied at the same levels for national administrations (30 countries), local administrations (28 countries) and local stakeholder categories. Surveys covered not only the environmental issues that respondents needed to address, but also the information they currently used to address the issues and, for administrations, other aspects of governance concerned with formal and informal environmental decision making. The surveys were restricted to rural LAU2s, defined as those where resident density did not exceed 150/km2 (except on Malta and Greek islands, where resident density was routinely at least this great).

Information is needed for environmental decision making, which inevitably becomes denser at lower levels. Policy decisions at EU level that result in Directives and hence national laws are much rarer than the number of environmental assessments created by those laws. Surveys showed that the number of those environmental assessments (SEA+EIA) is variable across countries but averages about 2.5 per thousand km2. That is an average of less than one per year at the lowest level of government administration (LAU2), which averages closer to 100 km2, although at any point in time an LAU2 may be handling more than one of these protracted processes.

However, surveys showed that LAUs typically take about 3-20 environmental decisions annually, although again with great variation, because they also take land use planning decisions for developments usually covered by strategy but not qualifying for EIA, and they also have responsibility for areas of council land for amenity, along roads etc. Private managers each make a similar average number of local decisions. However, then it was also taken into account that average areas of local council decisions covered smaller areas than those of private land managers, and that there tended to be many such private managers in the area of each LAU2, all private managers except those of fisheries had a decision density 4-5 orders of magnitude greater than for local authorities.

The section below:

1. Outlines the main actors in decision-making
2. Explains the way conceptual models are used to assess information flows
3. Considers the information flows which occur for the high-level decisions
4. Draws conclusions for the development of TESS

3.1.1 The Decision-Makers

Environmental decisions may be broadly divided into two types. Formal decisions are based on statutory processes and reflect adopted policy. Some of the policy originates in the governance machinery of the European Union as Directives (e.g. on EIA and SEA) which are then implemented through national legislation which transposes their provisions into national law. Other policy originates nationally in addition to those Directives, in some cases through adoption of wider international conventions such as the CBD and in some cases through Land Use Planning legislation that is not specifically regulated at EU level. The latter policy in particular may be varied in its implementation through special rules made at various levels of government.

The initiative for a land-use strategy or strategic planning framework requiring SEA will normally come from national or regional government and will involve consultation with those living in the area, inviting participation from individuals, businesses, civic groups, groups with specific interests and other non-government organisations (NGOS), as well as government agencies with relevant responsibilities. Similar consultations will arise for impact assessment of specific projects and other land-use planning decisions (EIA, LUP), which in these cases will have been initiated by a person or group intending to carry out a particular development project. These formal, statutory decisions are subject to a variety of governance processes and involve many parties who need environmental information on the right scale and in accessible form, making scientists and information suppliers, including the interested public, a part of the process.

Users of land and species for other purposes may be regulated, or subject to funding conditions, more directly as a result of governmental policy, for example through regulations under the Water Framework Directive or subsidies provided by Common Agricultural Policy (CAP). However, the decisions about what to grow in field or forests, how to manage that growth, or what species to encourage (and harvest) or discourage, are based on many other factors including topography, weather, markets and cultural interests, as well as characteristics of the cultivated, domesticated or wild species concerned. A wide variety of information is needed for these informal decisions, which is obtained in different ways by different stakeholder groups.

There is accordingly a plethora of people involved in making decisions that affect the environment, including policy-makers, those designing strategy and approving projects based on that policy, and those making less formal decisions informed by policy but also many other factors. To whom is it most important for TESS to supply information, and how should this be supplied, in order to guide those decisions?

3.1.2 The Analytic Approach

How can TESS decide where it is most important to supply information? A major consideration must be the impact of the decisions, in terms of effect, area involved and frequency. That should involve not just decisions to prevent detrimental actions, but also aiding decisions to encourage beneficial action such as restoration work. Another consideration for the viability of a system that encourages people to transact information, is where do governments, organisations and individuals have most need for information, and what are the economic factors that are likely to support its delivery. Such economic considerations involve both public and private funding, because governments need information for policy and strategy just as individuals do for livelihoods.

Thus, information is needed on decision impacts and on information flows. A start on assessing decision impacts was made in the initial TESS work-packages, and then continued through an EU-wide survey and local case studies. While defining the routes by which information flows, there is a need also to consider their impact, which may be greatest where demand and supply are most poorly aligned, and where information generation will have the greatest benefit for policy making.

A variety of information flows, analysis approaches and decision processes used for environmental assessment and sustainability assessment for biodiversity were identified by enquiry on government practices nationally and by structured interviews in local case-study sites, across a range of 9 countries (Estonia, Greece, Hungary, Poland, Portugal, Romania, Slovenia, Turkey and the United Kingdom), where approaches were likely to differ. Standardised questionnaires provided comparability in both cases, between levels of government and across stakeholder groups at local level.

The strength of flows is illustrated by the width of arrows, which represent the proportion of records for that type of flow across the nine countries. Of particular interest in this analysis is the variation in widths shown across countries at different levels of government. This is important for planning collection of data later in the project. A thick arrow now only indicates where there is little variation to analyse when seeking to identify best practice, but also where information delivery from local level may be useful for informing policy and other formal decision making.

3.1.3 The Information Flow Models

The most fundamental flows of information are directions for framing regulations. Data from TESS research are combined to show this in Figure 1. EIA, SEA and CAP legislation is proposed by the European Commission and adopted by the Council of Ministers and the Parliament, whereas Biodiversity Action Plans are a soft law requirement of the CBD and Land Use Planning laws are framed mostly at national level.

Figure 1. Except for Land Use Planning, instructions for framing environmental laws and procedures now come primarily from international level.

The low level of variation in these procedures gives little scope for analysis of best practice, but indicates that informing European Union policymakers about the effects of their policies on EIA, SEA and CAP at a local level is very important. Likewise, informing national governments about impacts of Land Use Planning is very important, partly due to their ability to make regulations on matters that are not subject to EU legislation and partly because they are able through the Council of Ministers to influence EU policy.

Figure 2 shows where approvals are given for EIA, SEA, CAP and LUP. It indicates much more variation than shown by Figure 1 in the level at which the instructions are implemented within each state.

Figure 2 The variation between states in the lowest level at which approval is given for EIA, SEA, LUP and CAP subsidies. Data are available for 9 countries on the first three aspects but for only 8 on CAP which does not apply in Turkey.

The format of Figure 1 is used to combine all the information in Figure 2, and also on BAP processes to display information flows in Figure 3. These information flows reporting on completion of statutory decisions are in themselves relatively uninteresting for TESS. However, they indicate where the reporting process originates, and hence where the decisions are made. In the countries surveyed, this was entirely at local levels for LUP, substantially at local levels for EIA, but only at regional level and above for SEA, and predominantly at national level for CAP and BAP processes (Figure 3).

In view of the fact that land-use planning is typically about conversion to built-up areas, like EIA and SEA but more frequent than these formal environmental assessments, decisions at local level on land-use planning are at least as important as formal EAs. Moreover, although the myriad daily decisions of land managers, from forester to gardener, may mostly be less extreme than creating buildings and roads, they are denser and over larger areas. Simply "tidying"the uncultivated areas widely, by removing field headlands or because trimmers make it easy to remove rough vegetation in gardens, may have a devastating effects on plant diversity, hence invertebrates and whole food webs on which these depend.

Figure 3. The reporting on EIA, SEA, BAP, CAP and LUP, to higher authorities.

The levels at which decisions are made is indicated even better by the levels where consultation occurs, shown in Figure 4. Formal decisions on EIA and Land Use Planning were mostly by Local Authority Units 1 &2 , within SEA frameworks (and BAP and CAP processes) decided at higher level.

Figure 4. Levels at which consultation occurred for EIA, SEA, LUP, CAP & BAP

It is important to understand that, in terms of information sourcing for all local management decisions, as opposed to the consultation for statutory decisions (Figure 4), the information flows between stakeholders and government are more complex. These flows, together with other information sources used by stakeholders are shown in Figure 5.

Figure 5. The sources of information cited for addressing environmental decision-making (above) by national governments and private local stakeholders, also (below) including local authorities and, among stakeholders, hunters.

All groups got ca. 30% of guidance from government or agencies and ca. 10% from publications, with similar use of the internet. However, whereas national governments also made quite extensive use of NGOs and consultants, local knowledge (including personal records) were used much more at local level, with hunters most extreme in this respect (Figure 5). The use of local knowledge by national governments tended to be more on hazards (e.g. fire, flood, disease) than habitats, while habitat information dominated the needs of managers. In the context of scope for information transaction, the stakeholders also generate their own information, from keeping records as a form of local knowledge and in some cases by conducting systematic monitoring guided by scientists. Regulatory information affects stakeholders from central government (e.g. on nationally designated species and habitats), from local government (e.g. on EIA and LUP requirements) and from government agencies; agencies are also part of the processing of information between all levels of government.

3.1.4 Conclusions from modelling information flows for central policy

A conclusion from Figures 1 and 3 is that much of the policy designed to ensure that the environmental impacts of formal decision-making (EIA, SEA, CAP, BAP) are assessed and acted upon is now adopted in the form of international rules and transposed into domestic legislation at national level. Thus it is policy makers at European level who have most need of information on the effectiveness of these various instruments. This underlines the importance of integration of data at European level, which is promoted through the EIONET run by European Environment Agency (EEA) as part of plans to create a Single Environment Information Space (SEIS), including a Biodiversity Information System for Europe (BISE). It is EEA that will provide information to decision makers at the European Union level and to ministries at national level, using data that are collected and maintained at national level.

However, predictive modelling for the environment requires spatially specific data, which can only be gathered at a sufficiently small scale at local level. Although remote sensing is increasingly able to supply some of this, it will be many decades before it can provide adequate data for all locations, at least in biodiversity contexts: neither satellites nor DNA sensing techniques can map flora and fauna distributions widely at the flower and insect scale. For economies of scale and as a single gateway for European level, it makes sense to integrate locally-collected environmental data at national level. Indeed, of 27 broad-based databases cited in TESS D3.3, there were 21 at national level. The UK was one of the first to have a National Biodiversity Network (NBN) and a Multi Agency Geographic Information Consortium (MAGIC) for environmental data. However, the role of regional and national government, as shown in Figure 3, is mainly a responsible for reporting completion of statutory processes to higher levels, rather than a flow of detailed local information to central government.

The focus for LUP decisions and most projects requiring EIA is at local level, which is also where the informal decisions made by stakeholders are much more numerous than statutory decisions, although individually perhaps of less impact. What seems to be changing rapidly is for much policy-making to move to European level, albeit with data integrated at national level. However, the data from local level for integration nationally is only just starting to be organised for EEA through EIONET, although remote sensing is further forward. In both cases the main player centrally is EEA, in partnership with national governments, so these should be high-level anchors for TESS. For local level, TESS needs to service the government levels that interact most with local individual stakeholders and their representative groups, which will often be at the lowest hierarchical level of local government (LAU2 in the Eurostat classification: NUTS 2009) but sometimes (especially where there is no effective LAU2 level or the lowest level authorities have few powers or responsibilities) at LAU1.

Information is of course used at other levels, notably for SEA processes relating to land use, which often inform LUP at regional level within countries, and for BAPs. CAP too may increasingly involve SEA at national and regional level. However, these planning processes at intermediate levels involve personnel capable of tapping and interpreting relatively raw data if integrated nationally. The challenge is (i) to deliver complex information in a simple way that motivates monitoring by communities and individuals, and (ii) to integrate data from the monitoring for high level. These are the two priorities for the development of TESS, although tapping information at all levels of government between central and local levels will be encouraged.

3.2 Case studies

3.2.1 Local case studies

TESS partners were asked to develop local case studies in the local communities with which they had already conducted pilot work on decisions and information flows (Section 3.1). The studies consisted of two projects: a) the socioeconomic project and b) the mapping project. The aims of the case study projects were to test (by simulation) 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.

3.2.1.1 Municipality of Kerkini (Greece)

The Greek Case Study focused on the Municipality of Kerkini. The Municipality of Kerkini is in northern Greece, in the Region of Central Macedonia, Prefecture of Serres and is adjacent to Lake Kerkini, which is a designated Nature Reserve.

The area covered by the municipality of Kerkini is well known for rare species of birds, either resident or passing through during the migration period. Bird watching and hunting are increasingly becoming sources of income for the locals along with the exploitation of other rare species like the water buffalos. The population of the water buffalos in Greece as a whole decreased in recent decades, while their numbers flourished especially in the Kerkini area and helped the initialization and continuation of ecotourism and recreational activities. Since they do not exist in many other habitats in Greece, they helped to keep the local population in the area without emigration. Also, the Womens' Association of Ano Poroia (a village in the Kerkini municipality) is using locally collected herbs and fruits like chamomile, oregano or wild blackberries to produce traditional dishes and beverages. The project aimed to help local people identify new sources of income related to tourism activities while protecting the area's biodiversity.

The mapping project used the informal hotel owners' cluster and the local riding horses' owners to map the routes followed by riding horses, one of the main recreational activities of the area. In addition walking and climbing paths used for recreation have also being mapped. Finally, the association for hunters, who have deep knowledge of the various paths around the coastal part and the forests that surround the municipality, helped to map paths of wild boar, one of the main game species of the area. Wild boar hunting is allowed for certain periods of time every year. The spatial information acquired will contribute to the conservation of the number of wild boar, as this species has become extinct in other nearby areas.

3.2.1.2 Participatory development of recreational plan on Laulasmaa Landscape Protection area (Estonia)

In the northern part of Estonia, ~30 km west from the Estonian capital Tallinn in the Keila Rural Municipality, is the Laulasmaa Landscape Protection Area. The area was established in 2005 to protect sandy coast with permanent vegetation, forested dunes and limestone cliff. Its total area is 42 hectares and it has become a popular recreational area among local inhabitants and visitors, although no special conditions had not been created for recreational activities (paths, ball fields, beach infrastructure etc). The project activities consisted of mapping suitable paths for recreational use with an objective to combine them with relevant protection regimes and carry out a survey among local inhabitants. The main objectives of the project were:

- To find out inhabitants;
- Current uses of the area;
- Awareness on conservation values;
- Needs for information types and sources concerning the study area;
- To introduce mapping results to inhabitants;
- To gather feedback and input for choosing between different alternatives.

3.2.1.3 Cycle route and flooded area in Bozsva (Hungary)

Bozsva is a small village in the county of Borsod-Abaúj-Zemplén in Hegykoz region in north-eastern Hungary ("Northern Hungary") on the border with Slovakia. Bozsva originally was two different villages, Kisbozsva and Nagybozsva, but in 1977 the two villages were unified. The two parts of Bozsva have not reached each other; the distance between them is 650 m. The municipality has an area of approximately 16.39 km2. The 2009 census shows there were 205 people and 103 occupied houses in Bozsva. The average household size was 2,15 people/km2. The local government is directed by five elected representatives and a mayor. Tasks of policy administration are managed by the office of district notary in Füzéskomlos.

This year was an especially difficult year for the people of Bozsva. Heavy rains caused problems in many villages and towns in Hungary and in Bozsva there were floods too. Houses and bridges collapsed and cultivated products rotted. The flood caused problems not only in the life of the local people , but in the building of the cycling route too. The roadbed was taken away by water, so excavations had to be started to rebuild it.

Two different tasks were carried out in the case study. The first one was the assessment of the area of flood. Bozsva has been flooded this year because of the large amount of rain. Since one of the main income sources of Bozsva is tourism, an assessment of the flood and its effects has natural and economic importance. The aims were to map the flooded places and the position of structures, as well as to assess endangered natural resources and natural values in order to be able to forecast the effect of future floods.

The second task was the mapping of the cycle route and its environment. Cycling is very important in terms of ecotourism. The socio-economic project was to plan the implementation of the cycle route. The importance of a cycling road is unquestionable in terms of ecotourism. The problem is a rubbish-heap located near the cycling road. Clarification of property rights made progress difficult, so the main task became one of mapping the bureaucratic labyrinth of Hungary for the necessary planning.

3.2.1.4 Zator (Poland)

The Carp Valley region, including the Zator District, is characterized by very high nature value and a local economy based on using natural resources. Fishponds and water bodies left after gravel extraction cover over 22 % of the Zator District and aquaculture has been a major sector of the study area economy for hundreds of years. The natural values linked to fishponds and water bodies within the region are the major component to a local sustainable development strategy. Therefore, the Polish TESS team intended to demonstrate the importance of accessing information about livelihoods for sustainable management of natural resources, in a way which benefits both nature and people.

In practical terms the case study intended to demonstrate the potential for setting up a voluntary system of mapping environmental and biodiversity aspects with a use of modern GPS techniques, as well as to develop a socio-economic project proposal related to better and sustainable use of natural resources based on fishponds, such as bird watching, angling (fishing), recreational tourism and extensive aquaculture (perhaps organic), allowing for protection of biodiversity on one hand and economic survival of fishpond production on the other. This co-existence is the indispensable condition for both long-terms survival of natural values and fishponds, and livelihoods of various professions linked to these.

The second consideration was lack of proper and transparent information on nature resources, their spatial distribution and business opportunities which could be based on these resources. This was a reason for developing habitat and species maps, which would facilitate proposals aimed at economic revitalization of the fishponds, at the same time as providing active protection measures for their biodiversity. Beyond ensuring implementation of Natura 2000, the plan was to look at multifunctionality of the fishpond complex as a way of diversifying incomes of people living in that area.

The case study was to address the above problems, by designing a project proposal to promote development of pro-biodiversity businesses based on compromises in resource management among all the stakeholders. This was to create conditions for improved management of the fishponds as nature resources and for local livelihoods.

Achieving this goal required mapping of information on the spatial distribution of biodiversity, and of existing and potential risks and threats. Therefore, the two projects planned in the framework of the case study involved development of a socio-economic project closely linked and integrated with the mapping project. Apart from testing possibilities for setting up volunteer-based work, the mapping also provided information on vegetation overgrowth on fishponds in the Przyreb complex, which was needed for the socio-economic study and was otherwise not available.

3.2.1.5 Iberian lynx (Lynx pardinus) conservation in Holm oak montados in Southeastern Alentejo (Portugal)

The project area comprised the territory of the Portuguese municipality of Barrancos, located in SE Portugal. The municipality is economically depressed but includes areas of high natural value. The municipality of Barrancos, the central government environment administration and the more decisive stakeholders in the region are aware that conserving and increasing natural value is a key question for the future of this community. The region's socio-economic equation can be described as follows: Since the beginning of the last decade of the XXth century there was a considerable decline of the traditional systems of agriculture based on labor, that were not replaced by globally more productive systems. This was associated with a decline in population, production and employment. During this period cereal production diminished to irrelevant levels and, at the same time, cattle and iberian pig production increased. High quality, origin-certified ham and other pig products are produced in Barrancos, but agriculture based on animal production and the ham industry is not enough to generate sufficient jobs for the local population.

The specific objectives of the socio-economic project were to identify:

a) a socio-economic framework in the project region to shift the local production towards activities linked with biodiversity conservation;

b) a baseline of current local participation in biodiversity related activities;

c) the stakeholders and the possible evolution of biodiversity management governance models; and

d) the new activities emerging in the region associated with biodiversity management and their capacity to generate employment.

The general aim of the mapping project was to evaluate the ability of local non-specialist and untrained people to collect biological data. In the scope of the mapping project we also evaluated the adequacy of the hardware and software equipment used in relation to its cost, operational conditions and positioning errors. The specific objectives of the mapping project were to:

a) Compare trained professional with untrained non-professional observers in a for wild-rabbit monitoring in the study area.

b) Map the results of the test.

c) Evaluate the adequacy of the equipment used in the test.

3.2.1.6 Sfantu Gheorghe commune (Romania)

Sfantu Gheorghe is a fishing community, based mainly on andromous migratory fish stocks, Pontic shad (Alosa imaculata) and sturgeons as well as marine costal fishing for small species as sprat, (Sprattus sprattus) and anchovy (Engraulis encrasicolus). Due to the collapse of fish stocks in April 2006, Romania banned sturgeon catching for ten years and costal fishing with giant trap nets was abandoned, thus affecting community livelihoods. The fishermen are still catching other fish species, but the ban on sturgeon and abandoning costal fishing have affected their income. The alternative to this negative impact is their involvement in tourism by providing tourist services like boat trips, guiding, accommodation or local cuisine and products.

The project intended to stimulate the local community to promote use of alternative natural resources to improve community livelihoods. The goal of the project was both to help local people to identify the exploitable natural resources within their area and to develop local products for visiting tourists or open market. This required the collection of the information on the main locations of the resources, species and habitats, on their abundance and on the risks of exploitation. These data could also be used when designing tourist trails to avoid a negative impact on valuable biodiversity resources. The data collected by the local people and stakeholders will be further used in local planning and development, i.e. the development of a community-based tourism highlighting the local natural products and resources, or in designing tourist packages for tour-operators.

The objective of this project was to bring together the local community, stakeholders with interests within the region and outside experts, with the aim of creating community-based socio-economic activity in the Danube delta. The plan was to use Sea-buckthorn (Hippophae rhamnoides) to provide sustainable alternatives to sturgeon fishing and costal fishing.

Specific objectives are:

a. to enhance knowledge and understanding of the biology of the Sea-buckthorn (Hippophae rhamnoides) to maximize the economic potential, respectively tourism potential of this species

b. to build competence and improve practice of local product-based tourism in the Tulcea region of the Lower Danube

c. to provide a model for the development of sustainable, environmental tourism in Romania as an alternative to widely developed mass tourism.

3.2.1.7 Firtina Valley, Rize (Turkey)

Due to semi-tropical rainy weather conditions, the main economic activity in the lower plains and hills of Firtina Valley is tea cultivation. It is a traditional agricultural activity carried out on areas gained by clear cutting forest in the past. Cattle breeding is the second important economic activity in the alpine zone, especially seasonal hay cutting. Although tourism is gaining importance in the region each year, traditional income still has the higher importance.

Although the agriculture is small scale, its main impact on natural resources is pollution in freshwaters (especially rivers) due to pesticides used in tea and hay cultivation. The rivers of the Firtina basin supply water for households and tourism, besides being important habitat for endemic sea trout (Salmon trutta labrax). Local authorities, NGOs and universities give high importance for the conservation of this species. However, not much attention is given for prevention of pollution created from agriculture and waste disposal. In last few years, governmental organizations and research institutes have conducted research on cultivation of sea trout in local fishing farms which can be an alternative income for local people.

This study focused on reducing pollution created by agriculture, through raising awareness and developing a system for monitoring water pollution and habitat degradation.

3.2.1.8 Egirdir lake, Isparta (Turkey)

Lake Egirdir provides Isparta and Egirdir with drinking and agricultural irrigation water. Fruit cultivation, especially apple, is a common practice around the lake. With around 500,000 tons per year, 20 % of the apple production of Turkey (which equals to 1% of the worldwide apple production) is done in the Egirdir Lake Basin.

Apple production is the most significant source of income in the region. The downside of this production, on the other hand, is the pollution caused by it. Indications of deterioration in the water quality in Lake Egirdir, resulting from especially from agricultural pollution, have been increasing in number and intensity. Besides the increase in biomass (pointing to euthrophication), decrease in clarity and in the amount of plankton and fish, various scientific research has shown that there has also been an increase in concentration of pesticides and heavy metals.

Our work followed the increasing trend in projects aimed at decreasing agricultural pollution while maintaining and improving the quantity of production. These projects include transforming the irrigation systems from surface irrigation to drip irrigation, while employing 'early-warning systems' in the fight against pests.

3.2.1.9 Biodiversity and ecosystem services in the Frome Catchment (UK)

The case study project carried out had a strong socio-economic focus and involved the mapping and public perception of the values derived from ecosystem services in the Frome River basin, Dorset, UK. The key objective of this project was to examine the linkages between human well-being and the benefits derived from ecosystem services as perceived by the local community and other stakeholders. Participatory rural appraisal (PRA) techniques were used to elicit the relative importance of the benefits identified to the different societal sectors and to develop suitable indices to measure recreation and aesthetic value of landscapes from the community perspective.

One study involved assessment of the provision of selected ecosystem services as identified by local stakeholders, a stakeholders' workshop and an online survey designed to engage the wider community. Outputs include an assessment of the spatial variation in provision of ecosystem services and their associated values, both under the current situation ('business as usual', BAU), and under a scenario of potential land cover change, focusing on ecological restoration at the landscape scale.

More specifically the objectives were to:

1. 1 Provide a measure of the value of the environment to local people, and how this varies across the landscape.
2. 2 Identify synergies and trade-offs between different ecosystem services, and between ecosystem services and biodiversity.
3. 3 Illustrate the impacts of potential land-use decisions on biodiversity and benefits derived from ecosystem services.

A second project involved mapping native roe deer (Capreolus capreolus) as well as introduced sika deer and their habitats. The area mapped was primarily the western 4.6 km2 of the 29.6 km2 total in Arne Parish, including the two main settlement areas of Stoborough and Ridge that contain more than

90% of the population. In the study, there was cooperation of farmers, foresters, reserve managers, hunters and the local community in general.

Key objectives were for:

i. local people to map where they see deer (in their usual daily activities (strolling, driving, dog walking, riding, in the garden);
ii. a skilled deer counter to assess where deer are;
iii. local people to map the local habitats and where they go in their usual routines (i.e. the transect area they cover, to compare to where they see deer).

A crucial factor in this second project was the support of the local council. This support was motivated by TESS agreeing to conduct, at the same time as this work, the survey and reporting for the periodic Parish Plan which informs SEA at higher level of citizen preferences (an Agenda 21 process in UK). So an Arne Parish Survey, conducted by TESS, included questions on deer and other activities needed for TESS.

3.2.1.10 Mapping of the European Brown Hare

This case study concerned a mapping project carried out by local hunters within Germany and how it integrates into the national level. The aim of the mapping project was to demonstrate which type of information is being generated at local level by a resource beneficiary group, and how this information can meet central policy requirements at local to national level.

The local mapping project was carried out in the German Bundesland of Lower Saxony (Niedersachsen), in the municipality of Gehrden, within the borders a village called Leveste. The subject of the mapping was the assessment of the local European brown hare (Lepus europaeus) population on a hunting area of 792.8 ha. The mapping was carried out by local hunters and the hunting area manager.

The monitoring of the brown hare is part of a wider program within Lower Saxony (Wildtiererfassung in Niedersachsen - WTE), which was initiated by the hunters collective of Lower Saxony in 1991 and is scientifically accompanied by the Institute for Wildlife Research (Institut für Wildtierforschung - IWFo). It is funded by hunting licenses allocated by the Bundesland of Lower Saxony, Ministry for Agriculture. The aim of the monitoring is to evaluate estimations made by hunting area managers through out all of Lower Saxony in a standardised way, and in the long term to evaluate the trends of hare populations.

The local mapping project feeds through the WTE into a German nation-wide monitoring programme, called the Wildtier-Informationssystem der Lander Deutschlands (WILD). WILD is a programme which collects data on the sightings, frequency and populations of wild animals. It is initiated by the Deutscher Jagdschutz-Verband (DJV - German Hunting Association) and its' regional hunting associations and, since 2001, has been a permanent ecological environment study. The most important goal is to develop strategies for conservation and sustainable use of wild animals.

3.2.2 Conclusions

As well as surveying local populations about education levels, digital capabilities, participation and spending in countryside activities, and attitudes to nature and conservation, those engaged in these very varied mapping and socio-economic studies were surveyed about their prior knowledge and post-project conclusions (Manou & Papathanasiou 2011). From the survey reports it was evident that local residents' motivations to participate in both the socio-economic and mapping project vary from desire to acquire new skills and knowledge to love for their community and interest in nature-related issues. Also, there was a common desire for locals across case studies to have more data regarding biodiversity (species etc.) as well as information on possible economic benefits from conserving their natural resources. More robust, continually updated and easily and freely accessed databases would be very much welcomed for the local level.

In return, local people across all case studies appeared to be in position to provide a) data regarding mostly previous mapping and other relevant projects, if any, b) some data on species/habitats and c) on main occupations and economic activities (i.e. ecotourism activities, farming etc.). In fact, there was a general high capability for careful mapping, based partly on a high level of use of maps, including digital versions (e.g.on satnavs) by rural residents. It was also notable that the case studies implementation teams recorded a genuine interest and willingness of the local populations' to participate voluntarily in such projects. Indeed, more than 90% gave the maximum score of five for the importance of governments supporting such work.

On the other hand, local participants encountered problems during the socioeconomic project planning. Main reasons for this were lack of IT education and training, mistrust between the locals as well as towards authorities, lack of necessary data, complicated decision making processes and the fact that local people are not fully aware of the opportunities for activities related to biodiversity.

A very strong proportion of the local residents across case studies had a rather positive and pragmatic attitude towards biodiversity, as indicated by their perceptions of benefits and costs from biodiversity and their responses to a statement that conservation should engage all interests and not be based purely on protection. Their engagement in particular activities (feeding birds and/or other wildlife, collecting wild snails, fungi, fruits, flowers or other plant materials, doing outdoor pursuits, going horse-riding, making excursions to watch wildlife, fishing and hunting) related minimally across case studies either to education levels or conservation attitudes.

Estimates of participation in the activities at LAU1 and LAU2 in the case studies generally underestimated the actual participation of individuals quite strongly (see next section). This indicated a considerable lack of information among local officials about the interest in countryside activities of the local populations they represented.

In conclusion, knowledge and data shared by local residents could certainly be integrated from the regional and local level into environmental decision making to support sound elaboration of EIAs and SEAs. However, comprehensive local contributions could depend on local needs for accessible information also being met.

3.3 Pan-European Survey

3.3.1 Methods and results

The areas that partners selected for local case studies might have been unusual in respects such as attitudes to biodiversity conservation, either through prior contact with partner institutes or having less intensively-used habitats. So although these areas were important for intensive case studies and piloting questions on information flows, decisions, governance and attitudes, they were study sites for obtaining qualitative rather than quantitative findings. The local areas piloted questionnaires that were then revised to remove redundancies and ambiguities, and applied to 30 national governments and 28 local governments across Europe (Kenward et al. 2010).

To ensure the local areas were as representative as possible, countries were each divided into five geographic regions; five local authorities at lowest level (LAU2) were then selected at random from the list of all such authorities with rural population densities in each region. Country Coordinators attempted to survey the first on each list and typically succeeded, although in six cases there was adequate cooperation in only 3-4 regions. Incompletion in these cases, plus the absence of one country coordinator and failure of two at local level is unlikely to have biased the analysis.

Results on numbers and areas of decisions by local authorities and local stakeholders in 28 countries did not differ from those in initial pilots, nor did the results shown in Figures 1-4 in Section 3.1, with information flows in Figure 5 actually based on pan-European data). However, there was very considerable variation between countries in attitudes and governance practices (Ewald et al. 2010), so that Beja et al. 2011 could examine how these variables related to Streamlined European Biodiversity Indicators (SEBI 2010) from EEA. Relationships were found for habitat types and human demography, activities, attitudes and governance with habitat conversion, species conservation status and alien species (e.g. Figure 6).

Figure 6. Conversion to developed land relates to population growth & lack of EAs

Figure 6 shows that conversion of habitats to artificial surfaces, which characterize developed land, occurred most where human populations were growing and density of formal Environmental Assessments (SEA+EIA) was low. In turn, the density of EAs related to a number of other variables, of which the strongest was the attitude of local authorities to nature (Figure 7). This attitude was based on the balance of scores given by local authorities to questions about benefits from nature for food, tourism, flood prevention, etc, and their scores for costs from nature in terms of pests, disease and wildfire. There was a highest density of formal Environmental Assessments in countries where local authorities had the most positive attitudes to nature.

Figure 7. EA density was high where local authorities were positive to nature

Biodiversity indicators or proxies (e.g. habitat conversion) were related to variables reflecting capacity of habitats and human populations. However, these indicators and EA density did not relate significantly to other regulatory process variables, such as mitigation, monitoring, and ways of paying for EAs and agri-environment measures.

3.3.2 Comparison with case study data

To investigate abundance of human resources, in terms of numbers who might help monitor and restore biodiversity or pay for biodiversity related activities, questions were asked about participation in countryside activities. Authorities were asked to estimate, during pilot case studies and Pan-European survey, what proportion of their local populations they considered to engage in each activity. In local case studies, individual citizens were asked whether they engaged in the activities and, if so, what the spending on the activities was in their household.

The local authority estimates in the case study areas were on average about half the proportions recorded among their local residents, even though the authorities also tended to estimate higher numbers than for 3-5 local authorities that were selected at random for Pan-European survey (Figure 8) The most accurate estimates were for hunters, perhaps because this group has most connection with council for licences or for management of ungulate populations. Councils might also not be aware of resident participation when individuals engage rarely in an activity such as horseriding, but there was an indication in the data that residents of case study areas may have been more likely to fish, watch wildlife and go riding than in other areas, which could be explained by above average conservation interest and natural habitat in the areas.

Figure 8. The proportion of residents participating in countryside activities (green) was under-estimated by their local councils (red).

The spending data from study areas, which averaged about EUR 850 on all rural recreation (not counting farming and forestry as recreation) may therefore have been an over-estimate. However, among the activities that depended on wild biodiversity, there was no reason why the ratio of average spending per household, of EUR 145 on hunting and fishing to EUR 114 gathering wild foods and feeding or watching wildlife, should be atypical. If it is typical, then the independent estimate of EUR 35 billion total annual spend on hunting and fishing in the EU from previous work (omitting EUR 6 billion from watching and feeding as a probable underestimate) grosses up to a total private biodiversity-dependent spending of EUR 62 billion. This sum is greater than the annual CAP budget of EUR 57 billion, which accounts for half of EU spending. It therefore seems appropriate for the European Commission to take this human resource more seriously as an indicator of sustainable use for assessing the implementation of CBD.

3.4 Database of models for local ecosystem management

TESS is an RTD project which, among other expected results, collected and analysed the existing modelling and data sources to enable generation of a conceptual platform for decision support software solutions. We found that 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. Their report showed high importance of local authorities and private managers or users affecting biodiversity. Hence, the database of models was designed for such local stakeholders.

3.4.1 Conceptual approach

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 valuable resources can businesses, and the people they support, continue to exist.

In practical implementation of natural capitalism, the hardest constraint seems the question of ownerships and hence responsibilities in the management of natural capital. As far as the bulk of natural capital - biosphere and its services - where ownership remains common, market forces fail to effectively regulate its sustainable management.

In a simplified scheme, private and common issues project to small-scale and large-scale issues. Market failure can be explained as the failure of local investments to generate local benefits. For instance, a company which invests (e.g. through forestry) in the production of atmospheric oxygen does not benefit for that service from ordinary market forces. At the same time, market forces usually fail to hinder a company in the introduction of alien species. However, large-scale drivers create also a myriad small-scale consequences that summate to change environments (Figure 9).

Figure 9. Interactions between large-scale and small-scale have strong local effects (red arrows)

However, 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. Thus, this database was targeted on such activities where local ecosystem management decisions bring via improved ecosystem services direct benefits to the manager.

3.4.2 Analysing needs and possibilities of decision support for local ecosystem management

A literature study was conducted, resulting in a research paper (Piirimae 2011). The study concluded that conventional types of environmental decision support system (EDSS), which work as simulation or optimization models, continue to have great potential. However, arithmetic and data processing addresses only a small fraction of the challenges in decision-making. Firstly, assessment of management options requires also qualitative reasoning. Secondly, decision-making consists of several consequent steps which require different mental processes and have design implications for a comprehensive ecosystem management EDSS. Fortunately, in recent years, decision support approaches have greatly diversified. In parallel, new findings in human behaviour and psychology as well as informatics enable more systematic mapping of future needs for design and application of EDSSs.

A review of recent knowledge drew the following major conclusions:

1. As most management models ignore social factors (e.g. impact on reputation), EDSSs might mistakenly recommend environmentally harmful behaviour. Therefore, a totally comprehensive EDDS should include reputation-related consequences in its economic module.

2. In case of long-term or large-scale problems, forecasting capabilities may be insufficient for decisions to result in sustainability. Thus, only local and short-term environmental problems serve as promising subjects to be solved currently by informational tools such as EDSSs. It is particularly important to adapt EDSSs with local social contracts.

3. Whereas the human mind possesses powerful capacities to make decisions independently, the potential of a computer is limited to data processing and analysis, sequential arithmetic and deductive reasoning.

4. As humans do not decide consciously, EDSS can influence decision-making only by stimulating intuitive reasoning and creativity.

3.4.3 Creation of the structure of the database of models

No single model can address the needs of all local ecosystem management situations, and attempts to build such models will likely suffer from over-generality, scale mismatch issues, or endless additions to address new data and questions (Derry 1998). We thus omitted an illusory idea of creating a general global computation algorithm for ecosystem health management. Managers, instead, need a general and flexible framework that answers the questions being asked at the right scale and in a timely and cost-efficient fashion, while still integrating the three dimensions (social, economic, and ecological) that shape managed ecosystems. We therefore designed a metamodel, consisting of a framework of toolkits which build on existing and readily adaptable modelling tools that have been developed and applied to previous research and planning initiatives.

The highest level of hierarchical structure in the metamodel tops is Local Ecosystem Health Management Decision Support Framework (LEDS, Figure 10). This framework could be internal and not obvious functionally to target groups, but could organize a set of toolkits, each of which is a separate product for a distinct target group, distinct economic area and corresponding type of managed ecosystem. Although communicated independently, the toolkits in the framework would interrelate strongly due to many overlapping features. Moreover, although no generic algorithm could compute all outcomes, many algorithms could inform each cell in geospatial arrays.

Similarly with the general framework, none of the toolkits would aim to propose a universal computational model to work everywhere in the EU. Instead, the main purpose of each toolkit could be to outline the process of identifying questions, finding the tools and information to answer them, and then ensuring that the interacting suite of domain specific tools informs the global objectives of the planning process. Instead of answering questions, the toolkits could tend to raise questions, highlight problems, and propose tools for the supply of information. The toolkits could also where appropriate stress the need for collaborative analysis involving the right people for modelling social effects.

It was proposed, among other things, to structure the models according to decision steps. However, considering the project scope, more decisive structural criteria emerged from the analysis. First, architecture of the database was solved as a metamodel, organizing the application of various software tools (Figure 10). Second, these software tools were grouped to three toolkits: Field Health Toolkit, Forest Health Toolkit, and Recreational Site Management Toolkit. Various tools in these toolkits could be linked by pipelining with special software platforms such as OpenMI (Moore & Tindall, 2005) and LIANA (Hofman, 2005), while incommensurable tools could be linked holistically, at least partly in a user-mediated way.

Figure 10. Structure of TESS metamodel. Red outline indicates borders used in TESS.

Hence, the fundamental architecture of the database considered the need to organize and integrate various decision support tools into three toolkits. At the same time, functional there was consideration of how each type of each tool would aid a particular decision step. In this context, pre-simulation steps in a decision-making sequence appear relatively domain-general, hence, rather unsuitable for our domain-specific environmental management database. We concluded that pre-simulative tools should be integrated to each final toolkit but largely excluded from the metadatabase.

3.4.4 Creation of the database of models

A MySql database was created with a web-based administration system written in PHP and working on an Apache2 server. The database enables queries, searches and various arrangements to analyse the models (Figure 11).

Figure 11. Interface of TESS database of models

3.4.5 Models in the database

Stage 1. Scanning. The project team and other contributors submitted models to the TESS metadatabase using a web-based submission system (http://tess.ttu.ee). The models were collected mostly from the Internet. Of the existing databases, the most significant sources for this database were ECOBAS (http://ecobas.org), EPA Exposure Assessment Models (http://www.epa.gov/ceampubl), SSG Sources For Environmental Software (http://www.scisoftware.com/html/products.html), NASA Global Change Master Directory (http://gcmd.nasa.gov) and many other environmental management databases. Google search engine (http://www.google.com) and a network of experts around TESS project partners was used to find additional models. This revealed more than 2400 environmental management software tools.

Stage 2. Selection. Among the 2400 scanned models, those suitable for this database were selected according to the following criteria:

(1) Scope and needs of a database focusing on field health, forest health and recreational site management at local scale;

(2) Quality of models, including update frequency, user-friendliness etc.;

(3) Availability of models, including on-line availability of metadata.

Stage 3. Delivery. Metadata for each model were filed using the questionnaire and were collected mostly from web-sites. Fewer data were submitted by external users.

Stage 4. Analysis. The TESS database initially contained 198 models deemed suitable for decision support at local level. However, questions were raised about whether the selection of models for Farm, Forest and Recreation toolkits would really have discovered all the models that could be used at local level. To check this, two people from different partners started from A and from M in the ECOBAS database, and took for comparison, respectively, the first 100 and 95 models that had not been included in the TESS database. Further questions remained about whether the selected models could be used merely to obtain algorithms, and thus as a representation of adequate knowledge to define a useful predictive relationship, or whether the models could with rather little work be used for actual decision support by stakeholders. Therefore, both sets of models were reviewed by a partner that had not created the database, to assess what proportion were usable and local, in the sense of being available for download, suitable for local use and user-friendly enough for stakeholders to use without training beyond normal computer skills (Figure 12).

Figure 12. The proportion usable by local stakeholders among 198 models in the TESS database (left), compared with others selected sequentially from ECOBAS (right).

The conclusion was while all 198 models in the TESS database represented useful predictive knowledge, 50% were no longer available or not for local use, with only 6% deemed usable locally by non-experts. The TESS selection process had been effective, because there were no models suitable for local use by stakeholders in the 195 other ECOBAS models, where 84% were no longer available or not for local use.

The most striking finding of TESS may be the shocking lack of transfer of predictive environmental science from the realm of scientists to local practitioners who, ultimately, make the decisions that change the environment. It goes beyond the lack of locally user-friendly models when one realises that almost all the support for the models is in English; just three usable models were in one or two other languages.

TESS did not ask about languages in case studies (Section 3.2) and local Pan-European surveys (Section 3.3). It was just natural to translate the mapping software and questionnaires in order to facilitate provision of standardised information. Perhaps that was why local participants in case studies and surveys were on the whole enthusiastic and responsive.

3.5 Socio-economic and technical design for a Transactional Environmental Support System (TESS)

3.5.1 Context

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.

A question addressed early in the design was whether the system should be prioritized for local decision-makers or high-level policy makers (Kenward et al. 2011). It was noted (i) that many EC science projects address policymakers, but few seek to interact with local communities, (ii) those constructing previous environmental decision support stressed the local benefits, (iii) a previous survey of local case studies found conservation and ecosystem services to benefit most from knowledge leadership, (iv) local people make the land-use decisions that change environments, (v) local people are enthusiastic and capable, but (vi) scientists don't bother to help them, and (vii) governments underestimate their importance as a resource.

Clearly, the unmet need for knowledge transaction is at local level. Moreover, at high level European Environment Agency is doing a good job of consolidating information for expert decision makers in science and government, through SEIS/EIONET, SEBI, CORINE and the planned BISE. Integration of data to provide indices for policy, and as used in TESS, has proceeded well at European level, partly through encouraging consolidation of data at national levels. However, consolidation to national level is no good for local decisions. The mapped landcover data in CORINE is available at a scale of 250m, and volunteers are now mapping bird species to 5km resolution, but even that is too coarse for work in local farms and gardens. So mapping even to 10m accuracy, as done in TESS case studies, would be a huge advance.

Maps are used by all local stakeholder groups for assessing land-use data (and are a convenient lingua franca between countries). Therefore our main technical design conceives an intelligent web-GIS, for linking knowledge to maps in ways analogous to those by which spelling and grammar are computed for work-processors. An intelligent web-GIS tool is inherently scalable, in the sense that mapping (for species, habitats and geo-referenced socio-economic data) at fine scale aggregates to coverage at all scales. However, universal use of data requires open access and trust. Sensitive handling is needed for system inputs (both data and models) to include transparency where necessary (e.g. to avoid black-box effects), privacy (e.g. to avoid neighbourly prying) and accreditation (e.g. for career or commercial benefit). Outputs need to handle uncertainty, for which Bayesian Logic was recommended and tested on a mock example of a farmer deciding whether, and how, it is economically feasible to enhance shelter while also benefiting biodiversity on an exposed farm.

However, maps will only integrate to give adequate coverage for predicting general trends in species, habitats and socio-economic factors if coverage is excellent. The proposed software tool therefore needs to be not only trustworthy but also to provide a very attractive setting (to be a "must have" tool). For that reason, design was considered both in terms of Technology and in terms of the Socio-Economic setting.

3.5.2 Technology

The TESS project team held workshops in Edinburgh and Brussels to specify technical design of the system. These workshops resulted in a list of high level requirements, a domain model to organize these requirements, a system deployment model and a set of Use Cases essentially reflecting components in the domain model. The Use Cases were then defined by appropriate partners for illustrative purposes, as a guide to the major issues regarding the system capabilities but not intended to be specified at a level that could be implemented by a developer.

3.5.2.1 High Level Requirements

1. The system shall be web based initially, but its architecture must be flexible enough that alternative frontends may be developed (applets, cloud, etc).
2. The system must be able to contain socio-environmental data (spatial and non-spatial data, map images) and models in various formats, for various locations and with varying degrees of confidentiality.
3. All data and models used in the system will be tagged by origin, as public or private and with other appropriate meta-data and will be held secure from unauthorized access.
4. The system shall also support standardized data-bases on private computers, on which the user can change data, mark it public or private, and use it with appropriate models in personal computers or on the system.

5. Public data will be acquired by the system, but may be changed by system or originator [with keeping of a transaction history and version control].

6. There must an appropriate backup and restoration system.

7. Models may be acquired by the system for its use on a public or commercial basis, after appropriate validation.

8. The user and the system must be able to make requests for data and models of third-party databases, providing payment for access where necessary.

9. The user must be able to compare data and models from different sources and otherwise check for validity.

10. The system must be able to verify and check data and models for integrity; format conversions will be treated similarly.

11. The system must be able to accept donations, subscriptions and payments on account for models and data.

12. The system must be able to present itself and interact with the user in many languages.

13. The user must be able to create a user account so that the system remembers the user's details (name, address, subscription and account details) at login; the system shall maintain a list of accounts in its central database.

14. The user must be able to search for data by various search methods - location, type, keyword, date and so on - and then view the results.

15. The user and system must be able to apply appropriate data conversions, models and uncertainty analysis in data and produce scenarios.

16. It must be possible for the user to provide feedback on the data and models and there must be a complaints mechanism.

17. There must be scope for documentation, Help and tutorials.

18. The system must be able to interact with large external databases (e.g. CORINE).

19. The system shall be scalable for increasing number of users.

3.5.2.2 Domain Model

A software domain model can be considered as a conceptual model of a domain of interest which describes the various entities, their attributes and interrelationships, plus the constraints that govern the integrity of the model elements comprising that specific problem domain. Derived from the higher level requirements, the domain model produced by the TESS team is pictured in Figure 13.

Figure 13. TESS system domain model

3.5.2.3 Use Cases

The use case view of a system is used to capture its behavior, as it appears to an outside user; it is a partition of the system functionalities into transactions meaningful to actors, as idealized user of the system. Use cases affect every facet of the system design; they capture what is required by the domain model and then show how these requirements are met. Figure 14 shows the relationships among them; see Kenward et al. (2011) for analytic descriptions of each.

Figure 14. TESS system Use Cases

3.5.3 Socio-economic setting

However, the design must not merely provide a technological tool, but must consider demand and supply for the 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 be used. In the long run, a system must be practical both for communities and individuals needing knowledge, and for scientists who guide the knowledge process, as well as for government policy-makers.

Developing a socio-economic setting required market research, and consideration with stakeholders at several meetings gave the concept of a web-portal serving as a one-stop-site for ideas and knowledge attractive to individuals and communities. Existing toolkits and decision support systems could be linked to such a portal and then complemented by a user-friendly and intelligent web-GIS.

To design the socio-economic setting, we found that priorities of stakeholder organisations from such a portal were for decision support on production and other topics, with mapping, species monitoring, opinion survey, and best-practice examples of conserving through use of biodiversity and ecosystem services.

To discover stakeholder interest in a portal for conservation through use of land, water and biota, we used TESS design (inc UseCases 8-12 and 15) to build a 'Naturalliance' portal (http://www.naturalliance.eu), with translation to 15-languages [now 20 languages] and content contributions from TESS partners, to ask individuals with many appropriate interests what they would like from such a portal in future. First findings indicate similar priorities to the survey of organizations: for web-services (for best-practice in conservation through use of biodiversity, monitoring species, conservation news and mapping) and information (on protected species and habitat maps).

The system needs to attract private funding in order to be durable, as state funding cannot be relied on long term. However, if a service on the internet can be made attractive enough for wide enough mapping to be useful, it could also be practical to collect large numbers of small financial contributions electronically. Construction based on small contributions is likely to be gradual.

Naturalliance has not only researched what information is most required by local communities and individual managers of land, water and species, and found it to conform to the original TESS concept of exchanging decision support for local knowledge, but also started to deliver it in a way that could help fulfill recent EU commitments to the Convention on Biological Diversity.

3.6 Recommendations and policy guidelines

In framing recommendations and guidelines we have tried to consider 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.

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 the same level in all 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 co-ordination 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. Accordingly Eurostat should be invited to carry out assessments of these activities across EU Member States by appropriate sampling methods, as has been practiced 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. 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.

17. 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.

18. 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;

c. Where feasible, appropriate finance from any quarter.

4 Impact

The objectives of the dissemination activities are listed below:

- Creation of awareness about the project's results, encouraging trial and involvement;
- Participation in events of high publicity and added value that reach the scientific community and ensure thorough peer review;
- Production of documentation and dissemination material oriented to potential up-takers and users of the project results.
- Encouragement of involvement in the project;
- Change in opinions and attitudes;
- Attraction of additional funding;
- Aid mainstreaming and achieve sustainability for the project;
- Embedding project results into the practices of participants;

- Ensure that the project's methods and outputs are adopted by stakeholders;
- Further developing project results in different contexts and situations.

To achieve these objectives, dissemination activities in TESS concentrated in two levels: The first level was to create awareness about the project results at European level. The second level was to facilitate the collaboration and exchange of information between the partners and other interested parties. The dissemination activities were not only informative, but were also used to receive feedback from interested parties concerning the project's results.

Dissemination tools

The consortium developed the following tools for the dissemination of the project:

- A project logo was developed and templates for presentations and reports were produced;
- A project brochure was prepared including the main points of the TESS project, as well as two project posters. The brochure has been translated in all partner languages to disseminate information on project objectives and process;
- A factsheet of the project was prepared for the needs of the final TESS conference that took place in Brussels, on 25th of May 2011;
- After the end of the project, a leaflet was prepared in English to present the final project results in the general public;
- A "Policy Recommendations and Guidelines" booklet has been prepared and printed in English oriented to reach policy makers even after the project completion;
- The TESS Knowledge Portal (http://www.tess-project.eu, in all project language) has been a focal point for the project's dissemination activities as all intermediate and final results are maintained there, suitable for public access and dissemination. The knowledge portal has and will continue to serve (for at least two years) as an online forum to present the results and receive the feedback of both conservationists and policy makers. An online promotion strategy was developed and implemented. The site attracted 7768 visits from 5179 visitors from 115 countries in the period from 1 January 2009 (launch of the TESS website) until 20 July 2011;
- A mailing list was established including approximately 450 e-mail addresses from relevant stakeholder's from all participating countries. All partners contributed to the development (and regular update) of the mailing list; emails were collected through the TESS dissemination events, and through the contacts of the consortium partners;
- Throughout the project's duration, 3 newsletters have been prepared and distributed in all stakeholders included in the mailing list;

- The 1st Newsletter was distributed on November 2009 introducing TESS project, presenting the outcomes of the 1st TESS project workshop etc;
- The 2nd Newsletter was distributed on November 2010 presenting the outcomes of the 2nd TESS project workshop, informing on recent and upcoming project results and the concluding TESS conference;
- The 3rd Newsletter was distributed on April 2011 informing on recent and upcoming project results and the concluding TESS conference in the European Parliament in Brussels;
- A database with information on European and International conferences, workshops and events relevant to the TESS project was kept and updated on a regular basis and distributed to the project partners via e-mail (every one to two months).

TESS partners participated in 76 events where they presented papers and made announcements, and also submitted articles in scientific publications, journals as well as to the participants' national press. Project dissemination has been also carried out through personal contacts with other researchers, environmental consultants and technicians from central and local government environment departments/positions as well as non-governmental organizations. Particularly important was also approaching officials from central and local administration and stakeholders dealing with EIA and SEA, investigated through the structured interviews, were informed about the project aim and objectives. Reports on TESS were also produced in the newsletters of FACE and IUCN / SSC.

To create a community of interest, TESS also organised two technical workshops and a final conference in the European Parliament in Brussels with participation of high-level speakers, such as the head of the EEA, MEPs, etc.

The 1st TESS Environmental Information Workshop was held on 15-16 September 2009 in London, UK. The workshop presented the results of the first phase of the TESS project to guide the formulation of its succeeding stages. These results were set in the context of international perspectives on Environmental Impact Assessment and the use of environmental information for decision making at national to local levels. Among the 60 participants were experts from the 14 TESS partner institutions, survey coordinators from the European Union 27 and neighboring countries, presenters and invited representatives from national and local government and wild resource beneficiaries. Keynote speakers included Prof Jacqueline McGlade, Executive Director, European Environment Agency, Prof Maria do Rosário Partidário, IST, Lisbon, former President of International Association for Impact Assessment, and Prof. Nigel Leader-Williams, Cambridge Conservation Forum.

The 2nd TESS Environmental Information Workshop was held on 7 October 2010 in Tallinn, Estonia. It presented the database of predictive models for the management of European biodiversity. The workshop assessed performance and scalability of the models and compared the availability of different categories with the need for prediction revealed by surveys at all levels of government and society. To integrate experience of various research projects, invited speakers discussed a variety of current solutions and challenges in the modelling of terrestrial ecosystems. The total number of persons attending the meeting was 41. Participants were experts from the 13 TESS partner institutions and from other EC-supported projects concerned with environmental prediction, as well as invited representatives from national and local governments.

On May 25th, 2011, a Conference was organised by the European Parliament Intergroup on Climate Change, Biodiversity and Sustainable Development in the European Parliament (run jointly by the European Bureau for Conservation and Development-EBCD and the International Union for Conservation of Nature-IUCN) in Brussels, where TESS project and its results were presented to EU policymakers and other interested parties.

Among the 60 participants were experts from the 14 TESS partner institutions, survey coordinators from the European Union 27 and neighboring countries, presenters and invited representatives from national and local government and wild resource beneficiaries. Keynote speakers included Prof Jacqueline McGlade, Executive Director of the European Environment Agency and Dr Morten Thorøe, former Executive Director of the Confederation of European Forest Proprietors.

In February 2011, EC requested TESS to be included in FP7 project success stories. The partners welcomed the idea, as this presents a great opportunity for the dissemination of the project and the valorization of the achieved results.

Overall TESS has been a thoroughly Pan-European collaboration. Although much more research about information needs and technical development of decision-support mechanisms is required, we are moving into a practical implementation phase.

On Friday 22 July at the Game Fair in Oxfordshire, UK, a final survey to design a knowledge portal aiming to deliver decision support for local people, empowering them to reverse the trend of the loss of biodiversity experienced in Europe during the last decades went live at http://www.naturalliance.eu, the continuation portal of TESS project.

Furthermore, 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 in the longer term.

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 land-managers are not the problem but the solution to conserving and restoring Europe's biodiversity.

6 Project details

TESS started on October 1st, 2008, and covered a period of 33 months with the support of the European Commission (FP7-Environment programme, grant agreement no. 212304). Partners are:

- Aristotle University of Thessaloniki - coordinator (Greece, web.auth.gr)
- Bournemouth University (United Kingdom, http://www.bournemouth.ac.uk/ccee)
- NERC-Centre for Ecology and Hydrology (United Kingdom, http://www.ceh.ac.uk)
- Anatrack Ltd (United Kingdom, http://www.anatrack.com)
- ERENA, Ordenamento e Gestao de Recursos Naturais Ltd. (Portugal, http://www.erena.pt)
- Tero Ltd (Greece, http://www.tero.gr)
- European Sustainable Use Specialist Group (Belgium, data.iucn.org/themes/ssc/susg/sub/europe.htm)
- Federation of Associations for Hunting and Conservation of the EU (Belgium, http://www.face.eu)
- Pro-Biodiversity Service (Poland)
- Centre for Cartography of Fauna and Flora (Slovenia, http://www.ckff.si)
- Szent Istvan University, Institute for Wildlife Conservation (Hungary, http://www.vvt.gau.hu)
- Institute of Sustainable Technology at Tallinn University of Technology (Estonia, http://www.ttu.ee)
- Danube Delta National Institute for R&D (Romania, http://www.indd.tim.ro)
- WWF Turkey (Turkey, http://www.wwf.org.tr)

For further information:

http://www.tess-project.eu

or directly contact:

Professor Basil Manos (Coordinator)

Department of Agricultural Economics

Faculty of Agriculture

Aristotle University of Thessaloniki

54124 Thessaloniki, Greece

E-mail: manosb@agro.auth.gr

Tel.: +30 2310 998805

Fax: +30 2310 998828

Ms Olivia Chassais (Scientific Officer)

European Commission

Unit RTD-I-2 Environmental Technologies

E-mail: olivia.chassais@ec.europa.eu

CDMA 3/18, 21 rue du Champ de Mars

B-1049 Brussels

Tel.: +32 2 299 2794

Professor Robert Kenward (Science Supervisor)

Anatrack ltd, 52 Furzebrook Road

Wareham, Dorset

BH20 5AX, United Kingdom

E-mail: reke@ceh.ac.uk

Tel.: +44-7720843684

Fax: +44-(0)1929-553761

Mr. Eustratios Arampatzis (Dissemination Manager)

Tero Ltd

Antoni Tritsi 21

57001, Thessaloniki, Greece

E-mail: sa@tero.gr

Tel.: +30 2310 804900

Fax: +30 2310 804904

Dr. Jason Papathanasiou (Deputy Coordinator)

Department of Marketing and Operations Management

University of Macedonia

Agiou Dimitriou 49, 58200, Greece

E-mail: jasonp@uom.gr

Tel.: +30 23810 51756