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1. Introduction

1.1 Background to TESS

TESS is about creating a decision support system to help humanity improve its environment, starting in Europe. The need for humans to protect desirable species and their habitats has been recognised in protection laws for more than a millennium in some nations (Gadgil & Guha1992, Bagader et al. 1994), and probably in local community taboos for much longer. In the modern era conservation supported by legislative and management measures began in the 19th century as a national initiative but rapidly became internationalised in the 20th century (Adams 2004). most notably in the form of the Convention on Trade in Endangered Species (1975), the Bern Convention for the Conservation of European Wildlife and Natural Habitats (1979), the Convention on Migratory Species (1979) and the Convention on Biological Diversity (CBD, 1992).

Some 17% of the land area of the EU is now designated as part of Natura 2000, which started life as the Bern Convention's Emerald Network. The EU has also introduced Directives for Environmental Impact Assessment (EIA) of defined projects, complemented by Strategic Environmental Assessment (SEA) of plans and programmes having a significant effect on the environment. Under the CBD, Biodiversity Action Plans at EU and national level have been instigated. Yet severe biodiversity decline continues at local level across Europe (Thomas et al. 2004) and will not be halted by the 2010 target date (Dimas 2009).

The current problem is not lack of protection from deliberate persecution or over-exploitation (except in the case of some marine fisheries), but of change in land-use outside protected areas. Farmed and forested ecosystems are being managed intensively for provisioning services that are provided by narrow numbers of species and genomes (e.g. Pain & Pienkowski 1997, Pretty 2001). Species vanish as natural colonisation across fragments cannot keep pace with loss of local wildlife-rich marginal habitats, the diversity of cultivated habitats declines and even amenity areas and gardens suffer from tidying by efficient machines adhering to uniform sets of advice from the mass-media. The provisioning services of ecosystems for humans are enhanced, but often at a cost of damaging the regulating and supporting services of those ecosystems (MEA 2005). The cultural value of those ecosystems has also declined with the biodiversity, which formerly offered people greater opportunity for hunting and fishing, as well as flowers, fruits and fungi to gather or simply a richness of animals and plants to admire. In landscapes devoid of biodiversity, people lose interest in the natural environment, as shown by fewer people engaging in wildlife-related activities in the most urbanised parts of Europe (Kenward & Sharp 2008), fewer in Europe than in the more rural USA, and as time progresses fewer in both these large developed areas (Martinez et al. 2002, USDI, FWS & USDC 2007).

The loss of interest in nature may also be detrimental to human survival. Well-informed people in democratic governments may wish to make environmentally beneficial decisions, but electoral support for increases in state expenditure and the taxes to enable them is now very difficult to obtain (even for supposed essentials such as health, education and defence). Human survival needs more people to care about their environment, and not merely to protect it as conservation requires positive actions too.

Studies across Europe have shown how relatively small changes in cultivation practices can often have major benefits for biodiversity with relatively little reduction in production, and sometimes even benefits through reducing pest damage (Boatman & Sotherton 1988, Reimoser & Reimoser 1997, Newton 2004). The EU has moved the budget that supports the Common Agricultural Policy, currently some €55 Billion annually, towards maintaining the supporting and regulating services of ecosystems, though the original plan to allocate 20% of the funds to Pillar 2 (rural development) was modified to 12%. Moreover compulsory set-aside, well known for its positive environmental side-effects, was recently abolished thus giving the green light to more intensive farming. There is also private spending of more than €40 Billion annually on hunting, fishing and watching wildlife, equivalent to more than €200 per hectare of cultivated land (Kenward et al. 2009a,b). Thus there is funding available to manage land in ways that support more biodiversity, even though it may be under pressure. Enhanced biodiversity would support more cultural ecosystem services whose beneficiaries engage most frequently in other environmentally-friendly actions (Peyton et al. 1995, Ericsson & Heberlein 2002) and are most likely to help build support for governments that make biosphere-friendly decisions.

However, the management of land to optimise income from a high diversity of uses is more complex than either protecting it or maintaining intensive cropping. Adaptive management (Holling 1978, Walters 1986), which involves regular monitoring of results from science-based management, is an approach identified by ecologists for some three decades. Science-based management typically involves predictive modelling and then testing of outcomes by monitoring, as is the basis of work on climate change. In both cases the modelling is spatially specific, requiring maps. The most accurate models for species populations are individual based (Sutherland 1996, Goss-Custard & Sutherland1996), but to model a community of species from large to small also requires fine-scale mapping. Predicting the effects of use requires socio-economic inputs too, which has been done for relatively focussed systems such as grouse-moors (e.g. Redpath et al. 2004) but is even more challenging for multi-use farmland and forests.

The efficacy of adaptive management, which is fundamental to the CBD's Principles of an Ecosystem Approach (2000) and Addis Ababa Principles and Guidelines for Sustainable Use (2004), was shown in the TESS team's previous project on Governance & Ecosystem Management for Conservation of Biodiversity (Manos & Papathanasiou 2008). GEMCONBIO found that quality of ecosystem services, sustainability and biodiversity in local areas and wildlife-related activities was positively linked to adaptive management promoted in association with external knowledge leadership (Karacsonyi et al. 2008). The challenge of TESS is to build a system that is so effective in helping local communities to manage their land adaptively that it incentivises them to enhance the quality of their monitoring to the point where it can contribute information to central policy and decision making, where current indicators are underdeveloped and underinvested (Walpole et al. 2009). This would be akin to the community-central cooperation now recommended for conservation (Ostrom et al. 1999, Berkes 2007). It would give scope to go beyond protection, which merely seeks to halt biodiversity loss, by emulating the success of projects that have reversed loss and restored ecosystem services (Benayas et al. 2009). It would solve the problem identified by Pimm et al. (2001) that "Paradoxically we are not limited by lack of knowledge but failure to synthesis and distribute what we know." It could also, through promoting citizen-science for the environment, enhance understanding and support for necessary policies to combat climate change.

1.2 The TESS project

TESS aims to assist the integration of information about biodiversity and related environmental matters from the local level into planning and land-use decisions. At the same time it aims to encourage local people to collect such information in order to maintain and restore biodiversity ecosystem services. To achieve these aims, a decision support system will be designed to exchange information required in environmental assessments at all levels for information that benefits local recreation and livelihoods.

Thus, a particular objective is to identify areas where governance, including consultation processes, and future provision of information, could best support not only government-based policy but also local decision-making that benefit both the environment and livelihoods. When people benefit from something, there is scope for a transaction, in this case the transmission of information between local and central governments and local stakeholders. In order for government at any level to require complex assessments to develop and implement policy (e.g. through SEAs), they need to integrate environmental outcomes of local decisions on development subject to EIA, on other land-use planning, or on the myriad daily decisions of those who manage land or species. In order for individuals to make small scale assessments and enlightened decisions, they need complex knowledge that government can provide to local communities. This two-way interaction is the basis for a Transactional Environment Support System (TESS).

TESS first listed and analyzed government information requirements at national and intermediate levels and identified local information needs. It then created a database of models suitable for bio-socio-economic predictions and identified gaps in the supply of models and data, compared 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 national government and local practices, in the 27 EU member states plus Norway, Switzerland, Turkey and Ukraine, 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.

2. Information requirements for environmental decision making

There are many sorts of environmental decisions, made by different parts of society. Much of this information is still on paper, and much still resides as “local knowledge” and will be lost unless recorded in a permanent and readily accessible form. TESS aims at handling all such data in a way that encourages its transfer to digital format. Land-managers and science field-workers, need not face the prospect that the knowledge they have acquired will eventually dissipate. Instead it can be used to benefit their work area and the biosphere and humanity living there.

To produce a system capable of handling such information, we need to be able to handle a variety of digital information, and we need to be able to deliver it to those who need it in a way that is easy for them to use. It will take many years to build a system that can predict a large range of environmental contingencies, and continuing human development will require constant updating of the system as well as the information in it.

However, in order to design a system that will be sufficiently attractive to fund its continued development the initial design needs to prioritise among many possible capabilities. This is to be done by attempting not only to identify where current issues already create high information flows, but also by predicting which nascent flows could develop quickly. It is also important to identify and provide support for best governance practises. This identification started in the FP6 project GEMCONBIO and continues in TESS, through a pan-European survey at national and local level by questionnaires, but also in local projects that bring in a little “learning through doing” from interactions with local communities.

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

2.1. 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 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?

2.2. 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 has been made in TESS, and will continue through an EU-wide survey and local case studies. It is chiefly the study of information flows that we address here. There is a need also to consider the impact of information flows, 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 standardised data are used in this report, and in the linked TESS D3.2 report from Work Package 3 to provide diagrams that illustrate the main patterns of information flow. Details of data collection are given in the TESS Synthesis Report D3.3 and not repeated here. Likewise, details of governance (e.g. consultation processes) and type and quality of information are to the found in that much more extensive report.

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.

2.3. 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 2.1. 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.

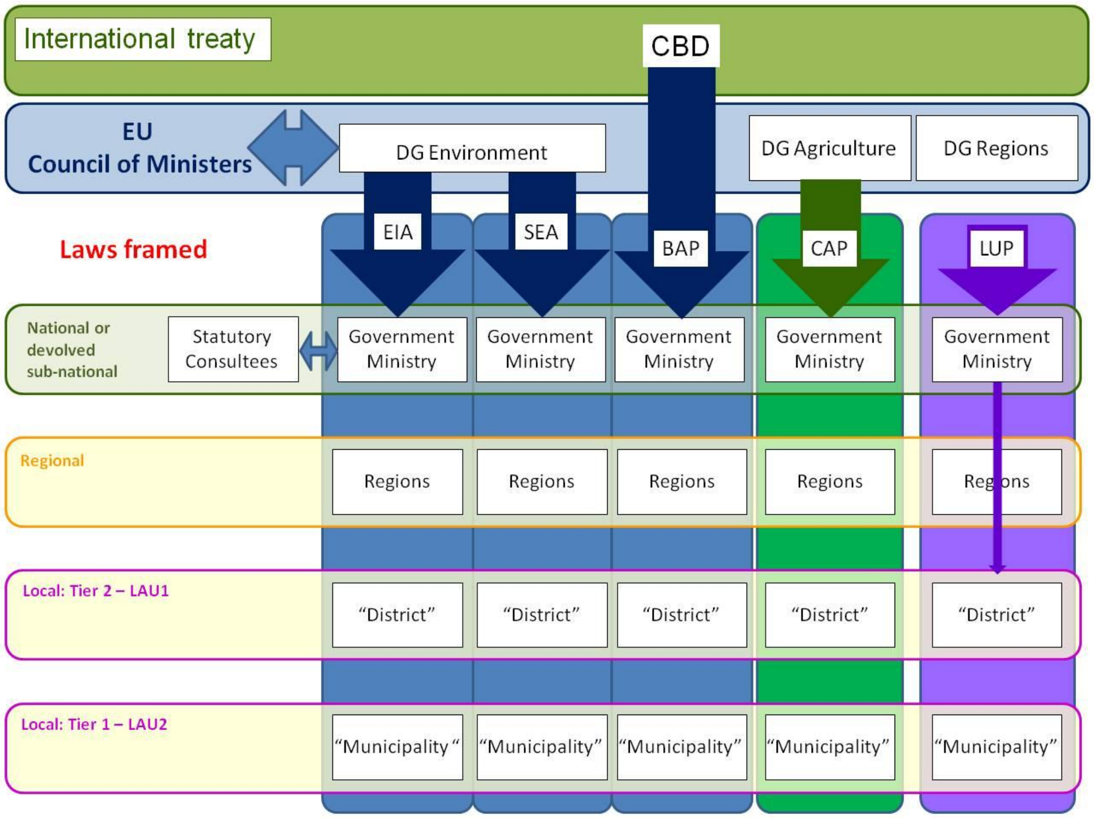

Figure 2.1. Except for Land Use Planning, instructions for framing environmental laws and procedures now come primarily from international level.

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 2.2 shows where approvals are given for EIA, SEA, CAP and LUP, and indicates much more variation in the implementation of the instructions within each state.

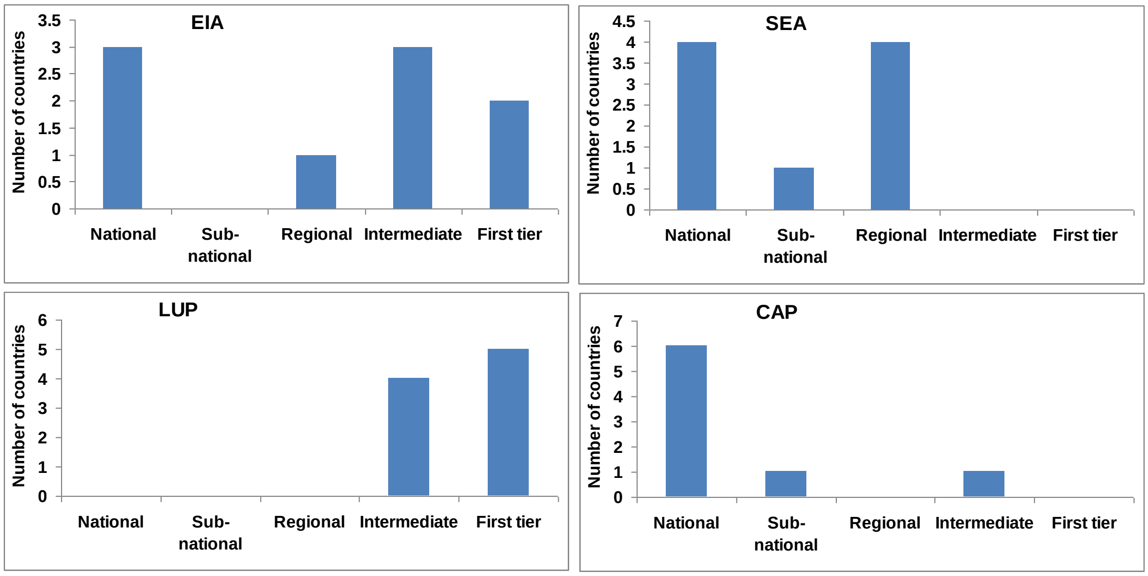

Figure 2.2 The variation between states in the lowest level at which approval is given for EIA, SEA, LUP and CAP subsidies. Data are available for 9 countries on the first three aspects but for only 8 on CAP which does not apply in Turkey.

The format of Figure 2.1 is used to combine all the information in Figure 2.2, and also on BAP processes to display information flows in Figure 2.3. 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.

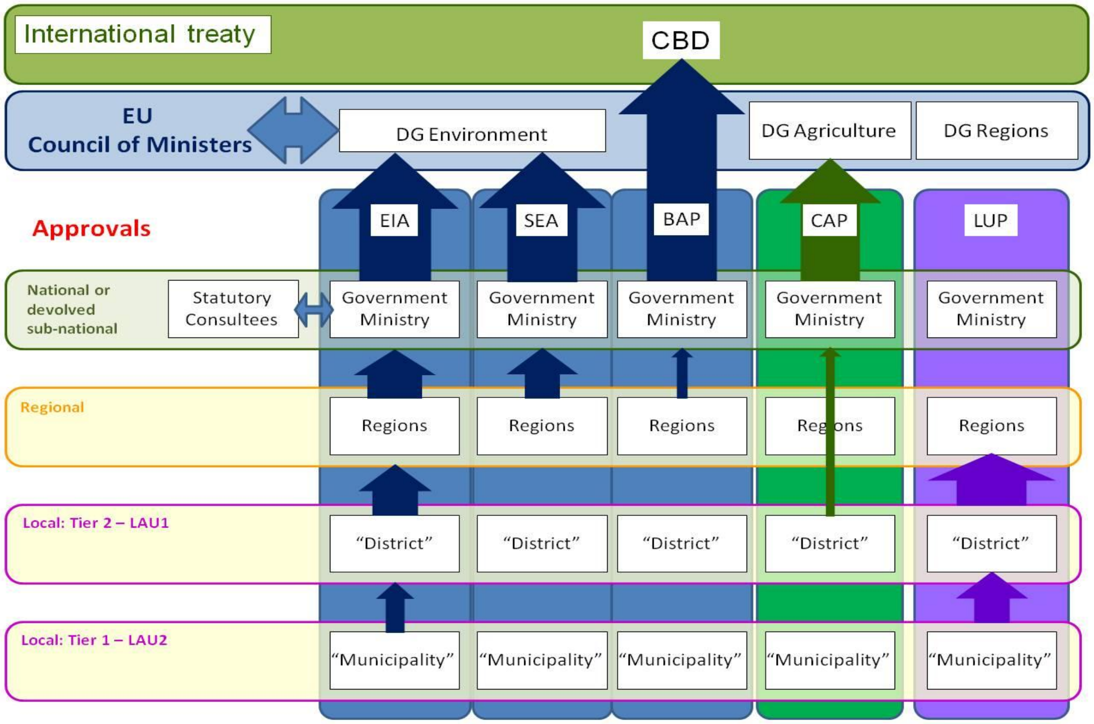

Figure 2.3 The reporting on EIA, SEA, BAP, CAP and LUP, to higher authorities.

The levels at which decisions are made is indicated better by the levels where consultation occurs, shown in Figure 2.4.

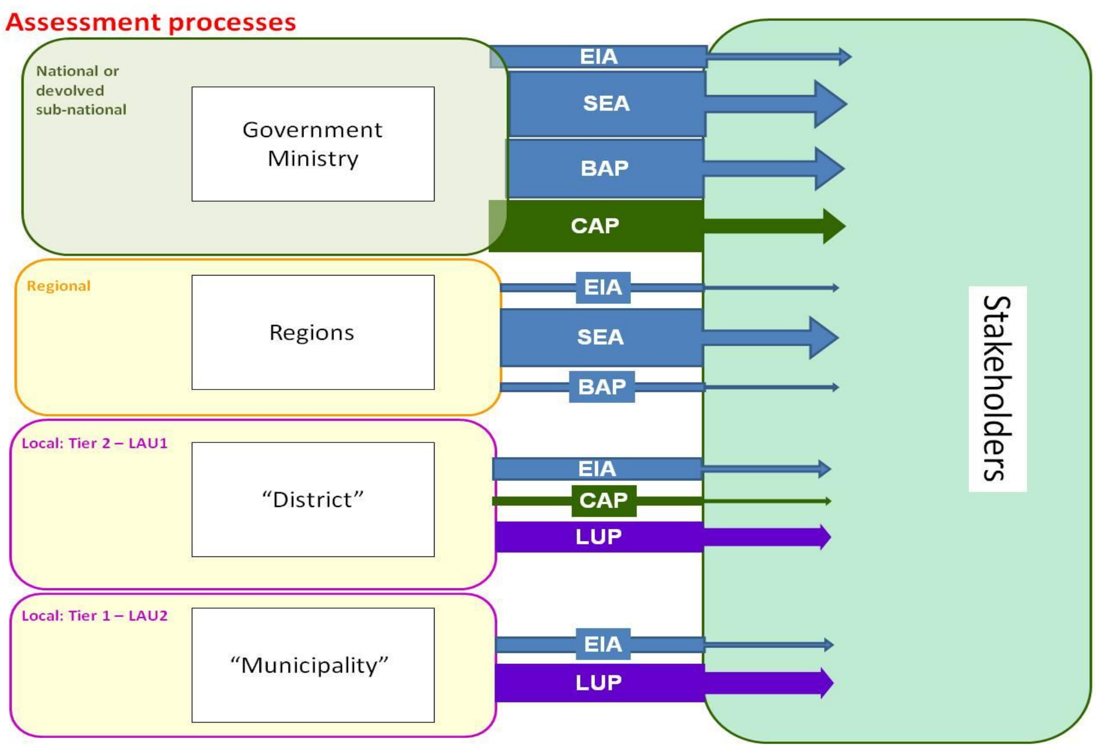

Figure 2.4 Levels at which consultation occurred for EIA, SEA, LUP, CAP & BAP

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 2.4), the information flows between stakeholders and government are more complex. These flows, together with other information sources used by stakeholders are shown in Figure 2.5.

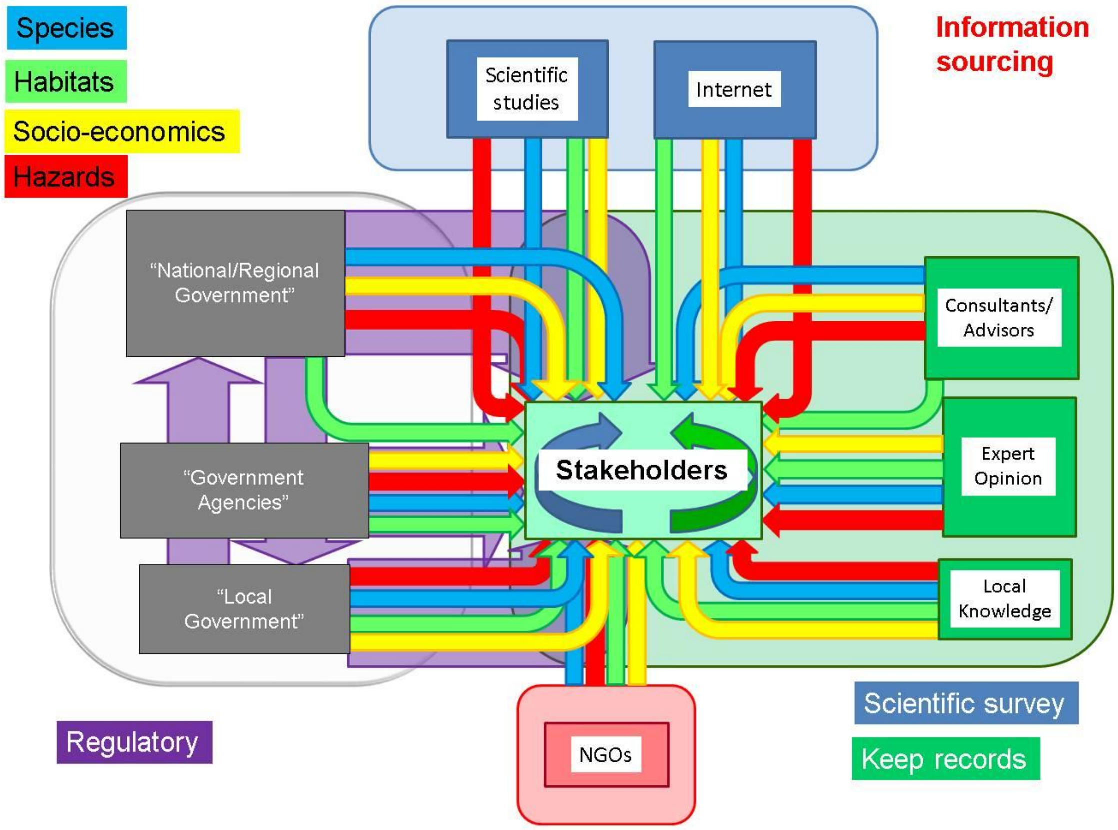

Figure 2.5 The information sources used by stakeholders when assisting government with statutory decisions and when making informal decisions within an envelope of government regulations.

Figure 2.5 shows that 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. However, the stakeholders also obtain information on species, habitats, abiotic environmental factors (including fire, flood and weather hazards) and socio-economic factors from these sources, and potentially also from NGOs, researchers, the internet and a variety of advisors. 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. In the linked report D3.2 "Model of the local decision making process", the width of information arrows will be varied, as in Figures 2.1, 2.3 and 2.4 here, to reflect the number of countries for which each type of information flow was recorded.

2.3. Conclusions from modelling information flows for central policy

A conclusion from Figures 2.1 and 2.3 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 being promoted through the EIONET run by European Environment Agency (EEA) and plans to create a Single Environment Information Space (SEIS). It is EEA that will provide such 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, this information is not a flow to central government, which (as depicted in Figure 2.3) is mainly responsible for reporting completion of statutory processes to higher levels.

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 (see TESS D3.3), although individually perhaps of less impact. This was the reason why a precursor to this survey, by Centre for Ecology and Hydrology in 2002-3 to examine the potential use of environmental models, concluded that the main points for delivery of environmental information needed to be at national level and locally, to help local communities and individual stakeholders manage land and species.

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. The TESS model database

Transactional Environmental Support System (TESS) is an RTD project which, among other expected results, must collect and analyse the existing modelling and data sources to enable generation of a conceptual platform for decision support software solutions. Kenward *et al.* (2010) 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.

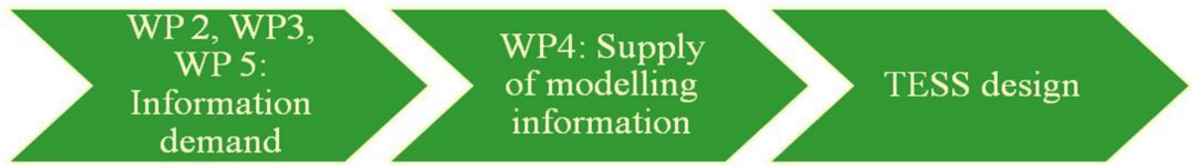

Figure 3.1 Information flow through work package 4 of the TESS project.

The database of models was generated and analysed according to the information demand from work packages 2, 3 and 5 of the TESS project (Figure 3.1). The database and its analyse is targeted for work package 6 and further activities which design the TESS.

3.1 Scoping: determination of the work package targets and boundaries.

3.1.1 Need analysis

The exact scoping of the work package applied the analysis of information flows delivered from work packages 2 (central policy environment) and 3 (local environmental information). Case studies in local communities (work package 5) provided more specific information on needs for environmental decision support.

In the preliminary survey for 9 states, Hodder et al. (2009) found that managers have good knowledge of ecosystem supporting services such as maintenance of soil quality, and ecosystem regulation services such as avoidance of hazards, while they require information on wild species and habitats (Figure 3.2). Local administrations (Tier 1 and Tier 2) also required such information and were relatively more interested in environmental hazards. On this basis, although all ecosystem health aspects were considered, special efforts of this work package targeted on wildlife as well as natural and semi-natural habitats.

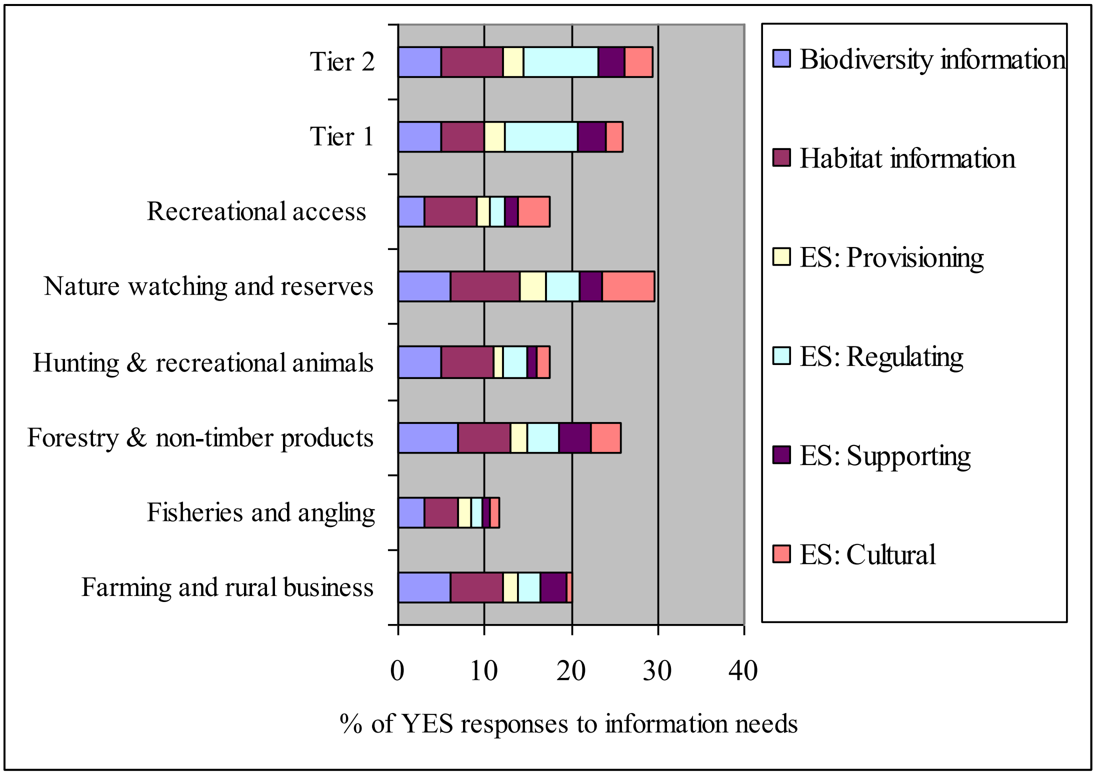

Figure 3.2 The types of environmental information needed by the different categories of stakeholders and representatives of local government (Tiers 1 and 2), categorized by biodiversity information and ecosystem services (ES). The results are combined for all case studies of TESS project (Hodder et al., 2009).

In terms of ecosystem services, commonly required information included that relating to water, wild meat and fish, and fibre (e.g. timber), disaster management (e.g. floods), and capacity for tourism and recreation. Less commonly required was information on wild plants and fungi, cultivated crops, soils and impacts of tourism and recreation. However, to achieve completeness of the database, these aspects were still integrated to the database of models.

In the randomised survey across a majority of European states, Kenward et al. (2010) found that there was very great variation in the availability of necessary information (Figure 3.3) to the most local (Tier 1) administrations.

The Czech Republic, Germany and Hungary stood out in having most of their needs met, whereas Austria, Bulgaria, Latvia and Malta were being especially poorly served. Information requirement on ecosystems for provisioning (crops, medical, biofuels), regulating (flood/fire/disease hazards) and supporting (water/air/ soil quality) services was especially variable, whereas information on cultural services (amenity, recreation, tourism) was generally in high demand (except for Italy, which was most interested in natural hazards). Information on biodiversity (protected and harmful species and habitat maps) was also generally in high demand, except for Italy and Lithuania.

Kenward *et al.* (2010) also indicated that local land-managers weakly use Internet while local authorities use GIS well. Their report also showed that local authorities in many Western European countries as well as in Estonia have high digital enablement. However, they discuss if the digital decision support should be focused to these countries or rather to countries with good biodiversity status. Thus, this project has not focussed on any particular group of member states. Hodder et al. (2009) reported that of various environmental issues local governments identified socio-environmental issues (Figure 3.4). Hence, while compiling the database, conceptually broad environmental models, containing economic terms and socio-cultural dimension, were a particular search target.

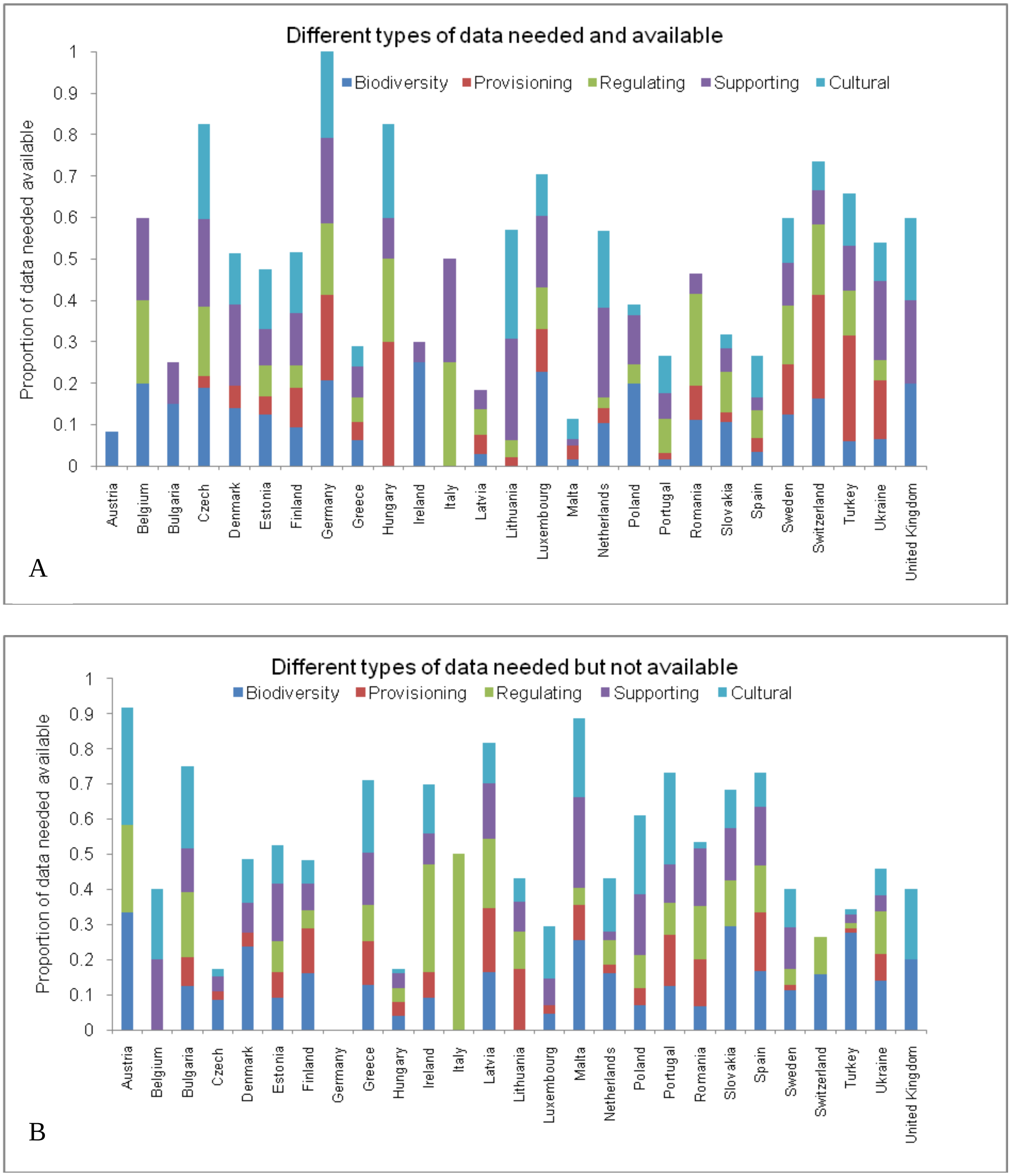

Figure 3.3 The proportions of different types of data needed by local administrations to make environmental decisions (Kenward *et al*., 2010). A Data which were available. B Data which were not available.

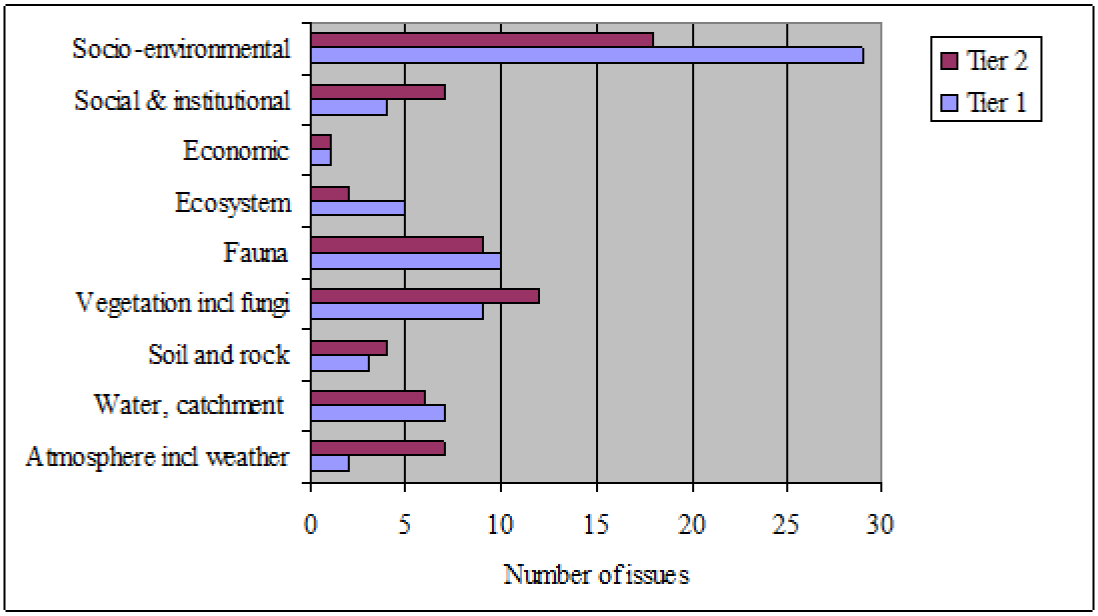

Figure 3.4 Environmental issues identified by representatives of local government in the partner countries sorted into subject categories compatible with categories of environmental models used to analyse and predict the impacts of decisions in TESS WP4 (Hodder et al., 2009). Each issue could be assigned to more than one category.

3.2.2 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 small-scale consequences (Figure 3.5).

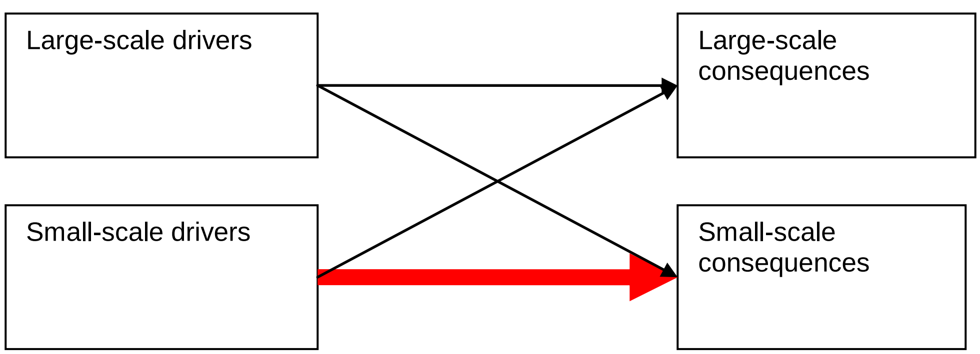

Figure 3.5 Interactions between large-scale and small-scale issues limit the efficiency of local actions (red arrow)

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.
Of the variety of ecosystem services, several ones, such as genetic resources and primary production, prove purely global. However, several services, such as provision of materials and pollination, have also great local significance (Figure 3.6). Hence, this database was targeted on the management of ecosystem services which generate local benefits. Thus, we focused on promoting health of ecosystems.

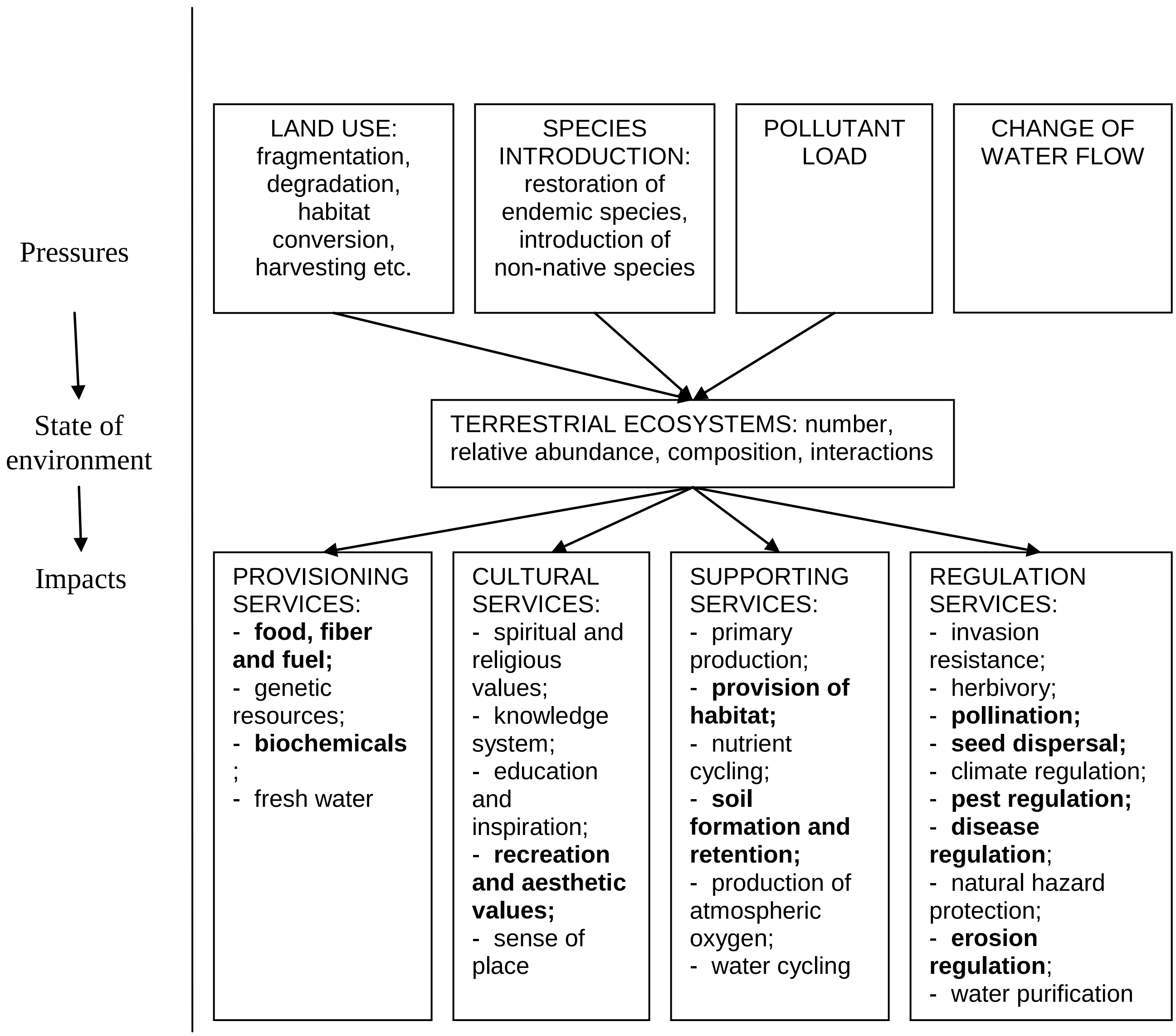

Figure 3.6 State of ecosystems in DPSIR network. Bold font indicates services which generate mostly local effects, conforming thus to local management

Outside the “tragedy of commons’, several other obstacles hinder sustainable management of ecosystem services. Short-term (tactic) interests often compromise long-term (strategic) interests. Ecosystem health is usually a long-term issue, requiring strategic planning. Due to natural buffers, the consequences of different management scenarios to ecosystem health tend to lag. Managers might, thus, need tools to assess ecosystem health issues. We identified three most significant economic areas where sustainable local ecosystem management might bring direct revenues: farm-scale agriculture, estate-scale timber production, and on-site management of recreational objects (Table 3.1). The aim of the database was to provide information tools for these management challenges for the entire EU. Thus, we focussed our search on models to address productive ecosystem services and revenue-bringing cultural services.

Table 3.1 Interest areas of TESS WP4 database

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

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

A literature study was conducted, resulting with a research paper (Piirimäe, 2011). The study concluded that conventional types of EDSSs, 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 that decisions 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) As 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 (Table 3.2).

Table 3.2 Hypothetically successful EDSS design strategies resulting from the studies of human intuitive reasoning

Intuitive mechanism	**Subsequent implications for EDSS**
Learning	Good presentation of internal knowledge, high quality syntax, mnemonic names of variables, possibility to add comments in model text
Social domain	Integration with social issues, transformation of environmental questions to social questions
Imitation	Demonstration of best practice examples
Social contracts	Focus on legislative and moral aspects
Precaution	Focus on risks and hazards
Creativity	Relaxing, creative virtual environments

5) EDSS could provide variable types of assistance in various decision steps (Fig 7). Issue definition and criteria setting require articulation of the problem by universal decision frameworks and the Socratic method. Option generation needs creativity support by the provision of various creative environments. In the option assessment step, computers can support by arithmetic computations, deductive reasoning and stimulating intuition.

6) Due to conceptual and technical inconsistencies, pipelining of all simulation tools to a universal environmental supermodel is impossible now and will be extremely challenging to achieve for the future. However, a toolbox approach might organise various independent tools in the issue definition phase, and with careful planning can start a process of integration.

7) Decision quality can improve by the involvement of experts of different knowledge domains, reasoning types, creativity types, decision steps etc. This further involvement of social control appears to be another promising perspective.

Compared to the preliminary project concept which aimed to integrate various simulation tools, this study suggests a much broader approach, in which simulation models might be only one component among various decision support tools. More specifically, simulation models fall mostly under ’arithmetic computations’ which, together with other types of software tools, aid human reasoning. This, in turn, forms only a part of the sequence of steps in a decision-making process (Figure 3.7. Potential functions of computer to assist environmental management throughout decision steps). Hence, an integrated decision support system might functionally partiton to various tools aiding specific decision steps. The metadatabase approach of WP 4 needed to take account of this overarching consideration.

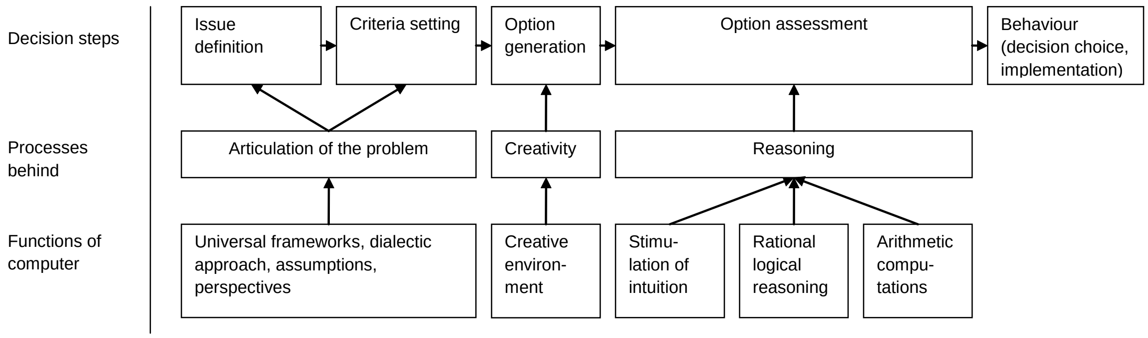

Figure 3.7. Potential functions of computer to assist environmental management throughout decision steps

3.2 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 3.8). 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.

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 (Box 1).

Box 1. Main abilities of each toolkit
A Analytical abilities

1. Assistance in system definition, including system type and boundaries. A management system might be (a) function-oriented (e.g. provision of timber), (b) region-oriented (e.g. management of a certain estate or a certain farm), (c) agreement-oriented (e.g. relations with customers, contractors, authorities etc.).
2. Assistance in definition of information demand, including identification of internal and external drivers for the demand
3. Assistance in defining system scale, including spatial and temporal scale
4. Assistance in spatial specification including ecoregion and climate zone
5. Assistance in question definition. Question types comprise strategic planning, capital investments, design and development, communication and marketing, operational management.
6. Assistance in definition of the aspiration of manager: conservation of status quo, continuous improvement, aggressive change etc.
7. Assistance in the definition of level of control, and degree of freedom in decision making.
8. Assistance in locating decision step which might be either issue definition, criteria setting, option generation, option assessment, or final decision.
9. Finding proper decision-making tools. Depending on the aim of a manager, a suitable tool might be cost-benefit analysis, cost-effective analysis, a checklist, an optimization model etc.
10. Finding proper model(s) for data obtaining and processing as well as presenting information. These models comprise allocation models, mass balance models, material balances, dispersion models, dose-response models, evaluation models, fate models, ecological models, normalization models, uncertainty analysis, scenario development, backcasting etc.
11. Combination, coordination, organization, integration, interlinking and synthesis of models. Each toolbox would contain relational databases, integrating several formalized models.
12. Assistance in involvement of experts and stakeholders to management and modelling

B Holistic abilities

13. Assistance in context definition including sensitivity of the issue, culture of stakeholders etc.
14. Ideation (idea generation): provocations, associative stimulations, confrontations (forced combinations), systematic ideations
15. Thematic query
16. Advanced web search
17. Other information

It is 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 3.8). 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.

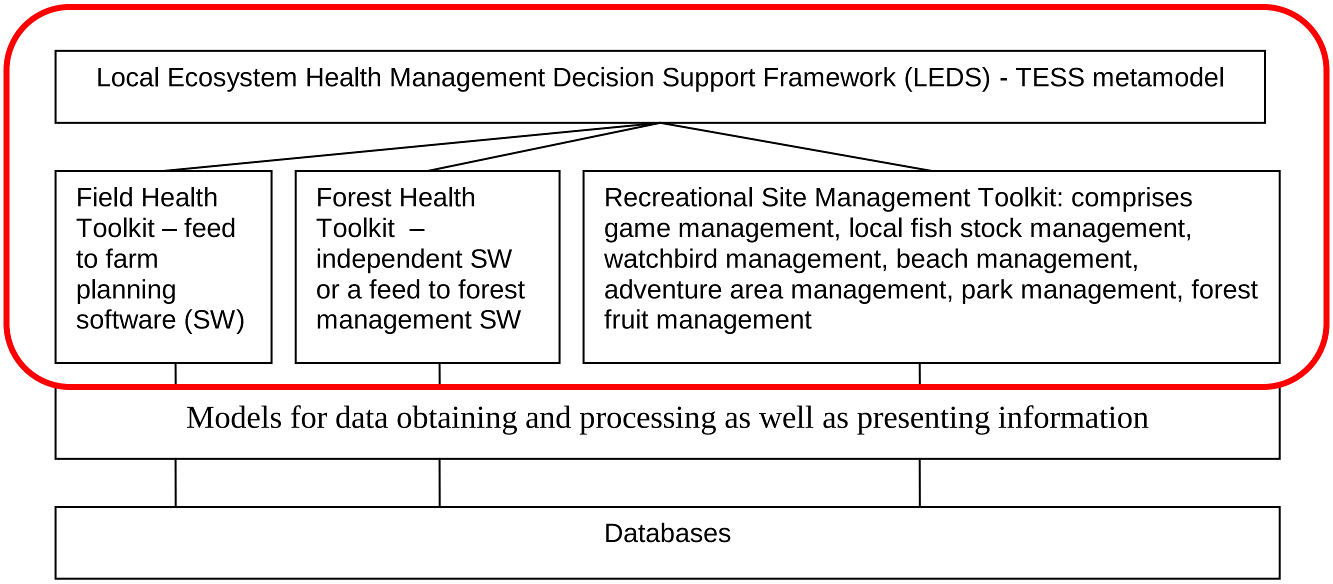

Figure 3.8 Structure of TESS metamodel. Red outline indicates borders used in WP4

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 aspects of the decision support required 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.

The question of system complexity is one of the major challenges of the TESS project. Addressing numerous environmental problems all over the EU as well as integrating different model approaches requires rather complex thinking. In the same time, the target groups – local managers – will include persons without special training or education in environmental issues and modelling. In principle, they should nevertheless be able to work with a given toolbox while understanding calculations and other processes in it.

For solving the question of system complexity, we adopted the model of hierarchical complexity (MHC, Commons et al. 1998) which quantifies the order of hierarchical complexity of a task based on mathematical principles of how the information is organized. MHC defines at least 14 universal discrete stages of complexity which might also define human cognitive development, regardless of cultural context.

The toolkits should generally not operate above a formal level which corresponds to the order 10 in MHC (Table 3). Order 10 includes rational and analytical processes using empirical or logical evidence. Formal logic, however, remains linear and one-dimensional. Order 10 allows for relationships between variables, hence correct scientific solutions. More complex models, such as multivariate systems and fuzzy relationships, should either be avoided or require good explanatory support from the system (e.g. for uncertainty).

Table 3.3 Framework of complexity in TESS project

Cognitive framework (order, Commons)	Modelling framework (types of model)	Application in TESS project
10 Formal	Formalised models	Operation of toolkits and ecological models within these
11 Systematic	Metamodels	Architecture of WP4 metamodel and its toolkits – organises the application of ecological models
12 Metasystematic	Integral frameworks	TESS project implementation

While the toolkits would operate at formal level 10, their architecture and the metamodel would work at systematic level (11) which includes multivariate matrices and contexts. As far as the toolkits operate in order 10, our WP4 metamodel itself does not need to operate higher than order 11. It is worth noting that the TESS project itself, organizing the metamodel, operates at the 12th level, which is metasystematic: constructing supersystems, multi-systems and metasystems out of disparate systems.

3.2.1 Creation of the classification structure for models

Which criteria classify environmental decision support models better? Apart from visualizations and conceptual models, research communities differentiate mathematical models predominantly by temporal and spatial complexity, geographical limitations, decision type, environmental theme, computational and technological approach (e.g. Jörgensen & Bendoricchio, 2001). To select the most useful of these, we needed model classification metacriteria, i.e. criteria for classification criteria. Depending on the need, our model classification might be according to the labour or expertise required by models, which wuld relate to whether they serve research, educational, management or other needs. We needed to classify models to generate a conceptual platform for decision support software. Hence, we chose classification criteria which functionally facilitate the design of decision support systems, for which complexity is an important consideration.

Stage 1. Organisation of knowledge according to vertical complexity. After finalising the general architecture of the metamodel, the collection, organization and integration of decision tools required further classification. Aiming towards integrated toolkits, we classified the tools according to ease of integration, i.e. vertical complexity. The resulting classes were: ‘conceptual frameworks’; ‘metamodels (integration concepts)’ – including toolkits; ‘models’ – including higher rating ‘computer programmes’ as software tools and lower rating ‘raw models’ such as regression formulae; ‘variables’; and ‘data’ (Figure 3.8).

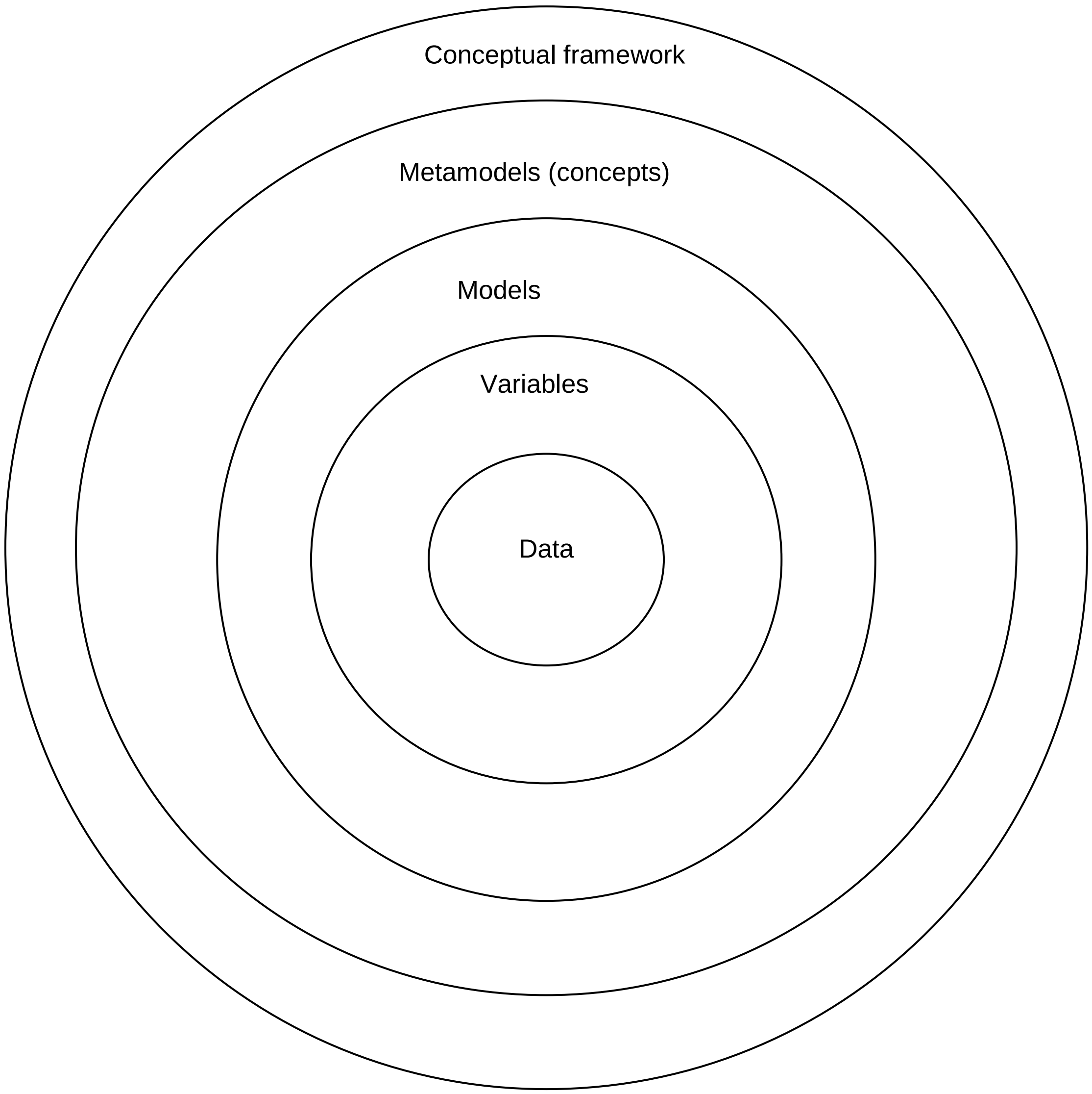

Figure 3.9. Holarchic organisation of knowledge in local ecosystem management

Models serve as building blocks of toolkits. In WP4, we aimed to find, classify and organize decision support models for the services of toolkits. The existing useful models fall under several category of complexity. Advanced models work as user-friendly smart computer programmes, able to automatically calculate outputs from input data. Our task is to find conceptual solutions for integrating these programmes to toolkits. For instance, SILVA is an individual tree-oriented management software model. Our challenge is to integrate it with statistical forest management models. We should also consider that instead of providing solutions for concrete management situations, the main benefit of management models might be training the user to make better decisions (Walker, 2002).

Some environmental management issues nowadays lack decision support programmes. These cases require searching for research results such as published regression formulae and information on significant processes determining output values. Typically, these raw models have no names. Usually they need programming to integrate into toolkits and computer models. Our task is to set these programming strategies. For instance, if there were a lack of user-friendly models for game management, an extensive literature review might reveal conceptual and quantitative models determining population density of and income from various game species. We could then develop strategies to integrate these raw game population models into the relevant toolkit.

Thus the project needs to work in lower levels of complexity in order to feed the designated toolkits. In spite of literature search, some raw models will probably remain missing. Even the variables for a required output might be unknown. Such knowledge gaps require mapping. Where models are highly necessary, then we could probably build up the preliminary versions of such raw models ourselves. For instance, population dynamics of brown bears might not yet be modelled. The main factors likely to control the dynamics could emerge as a result of our research, revealing a preliminary raw model.

Finally, in the most extreme cases, crucial data might be missing, hindering proper functioning of models. Such situations potentially require us to search for or estimate such parameters, constants or other background data.

Based on the above described context, the handled knowledge falls into categories of vertical complexity, forming a holarchic system (Figure 3.9). According to Koestler (1967), a holarchic system (hierarchy of holons) consists of holons whereas each holon is both a part and a whole. For instance, models form a holon which is an organization of variables while models themselves could be organized to metamodels, which is one holon higher level of knowledge organization. Such system correlates approximately with Model of Hierarchcial Comlexity (MHC, Commons et al., 1998) and the framework of complexity in WP4.

Stage 2. Organization of models according to commensurability. As concluded above, the classification of models in WP4 assumed a need to integrate commensurable models and databases to generate hybrid supermodels and relational databases. GIS data from different geographic locations should transform and link to a standard pan-European platform (e.g. through INSPIRE). As much as possible and relevant, various regression models need to integrate to bigger units such as Forest 5 (Robinson & Ar, 2003). The vision of such technical integration and pipelining directed our model classification. A group of models which enable such pipelining is defined as commensurable, and should fall into a distinct model cluster in the metadatabase. In contrast, incommensurable models should classify to different clusters, but perhaps be linkable in user-mediated or holistic ways.

Temporal and spatial commensurability. Environmental decision support models might differ according to spatial and temporal criteria. Temporally, model categories comprise static (lumped), steady-state and dynamic models. The latter class, in turn, often splits in short-term (tactical) and long-term (strategic) models. Spatially, models divide between 0D (non-spatial), 1D (linear), 2D (plane), 3D (spatial) models (Figure 3.10). The subdivisions might include small-scale and large-scale models.

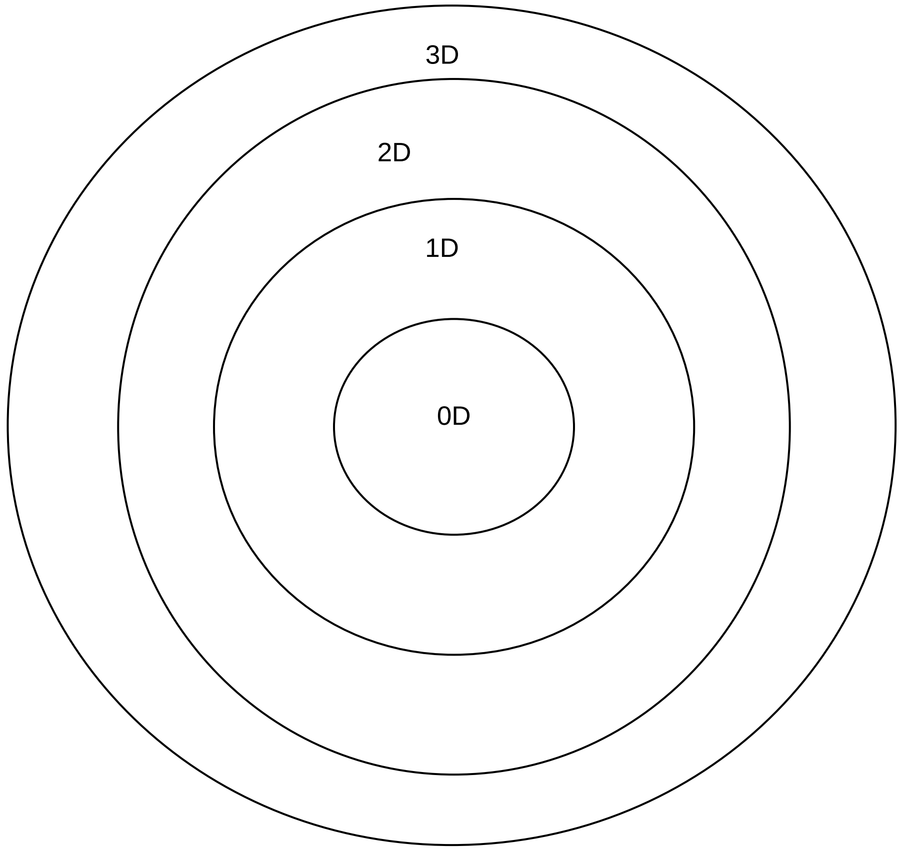

Figure 3.10 Holarchic relationship between models of different spatial type – all appearing in principle commensurable

A more complicated cluster can involve simpler relations. For instance, a spatial model can involve non-spatial relationships. Hence, a complex spatial model might commensurate with spatially simpler models (including those without a spatial component). The principle of commensurability suggests that the most spatially complex model defines the spatial complexity of the entire cluster and resolution emerges analogously.

The WP4 metamodel excludes large-scale problems and focuses on field-scale issues. We should address the specific aims of only local management issues. Our context excludes spatially scalar classification

Based on graphical technology, spatial models divide between raster models (including cellular automata) and vector models. In principle, these two graphical solutions commensurate but in practice great care is needed to avoid serious loss of information and increase of computational requirements. Often, raster models are used for cellular automation calculations (of relationshipswithin and between neighboring pixels) while vector models relate various shapes. This can make these two graphical approaches seem practically rather incommensurable (falling to two different model clusters). However, this problem can be solved by using vector GIS where possible, and ten using vector-raster conversion at the required scale before calculations. Of course, non-GIS (aspatial) models can feed both vector and raster approaches.

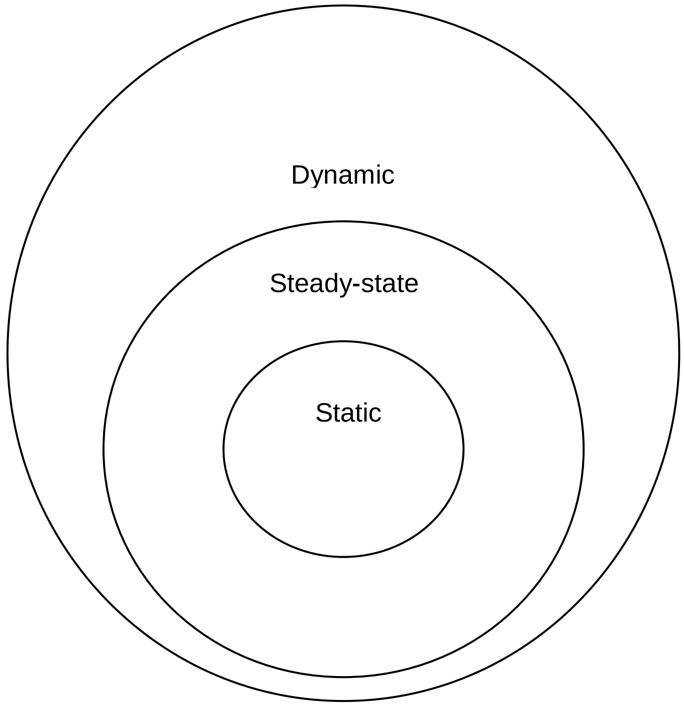

Figure 3.11 Holarchic relationship between models of different temporal type – all appearing in principle commensurable

Applying holarchic logic, static (lumped), time-independent models can join time-dependent models while steady-state models match within the dynamic cluster. Hence, a dynamic cluster should be able to host both static and steady-state models (Figure 3.11).

In conclusion, in spatial and temporal terms, vertical complexity of a model cluster could be defined by vertically the most complex model within the cluster. For example, if spatially the most complex model operates in 2D then the entire cluster should operate in 2D. Similarly, the resolution of the cluster should be defined by the resolution of the finest model. For instance, if the finest model in the cluster has a timestep of one day then the resolution of the entire cluster should be also one day.

However, short-term and long-term processes and management issues might differ completely (e.g. Poch et al., 2004). Short-term issues involve optimization of operational management and tactical problems with short feed-back. In contrary, long-term issues involve capital investments, strategic planning, design and development. Long-term models are able to show environmental consequences of management alternatives. Therefore, it might appear necessary to divide the models between short-term and long-term clusters. Some models, however, might apply in both clusters, as for example short term models that iterate effectively for long term predictions.

Computational commensurability. Individual-based (agent-based) models contrast with regression models. In principle, individual-based situations (such as descriptions of state of each individual in a population) are transferable to statistical terms (such as population density). However, the simulation approaches in and management situations of these two model types tend to differ. Regression models aim to reasonably simplify and unify numerous diverse events. One critical assumption of regression models is that individual differences, fluctuations and exceptions are negligible in determining the system outputs. Hence, regression models work with bulk amounts, counting units of interest. In practice, regression models tend to work well in larger systems with enormous number of individuals or individual events. In contrast, individual-based models assume that individual differences do not average out but generate significant changes to the entire system. Consequently, individual-based models apply different set of approaches such as game theory, Monte Carlo Methods etc. In practice, such models describe well smaller systems where the number of e.g. individual trees or animals is relatively low, and can be especially powerful for forecasting beyond the typical range of data in regression-based models. Such principle differences might suggest splitting all models into regression and individual-based cluster. However, this will depend on the application because, like regression-based models, individual-based models can be used to generate relationships with error terms.

A technical challenge might be pipelining of several high-resolution models which independently run fast enough but together slowly. For instance, a static model with high spatial resolution and a 0D model with high temporal resolution might work independently well but the cluster of high both temporal and spatial resolution might malfunction when pipelined. Solutions could include distributed rather than sequential modelling, reduction of time or space resolution in the best models to synchronise, or user-defined compromises.

In conclusion, with two categories of three classification criteria, the useful models might break up into eight clusters (Table 3.4). Computationally demanding models might also fall out from each cluster. On the other hand, vector-raster conversion, iteration and simplification of agent-based simulation to regression-like output could provide convergence.

Table 3.4 Summary table of classification of models into commensurable clusters

Classification criterion	# of classes	Classes
Graphical mapping technology	2	a) vector graphics b) raster graphics
Time horizon	2	a) short-term b) long-term
Simulation technology	2	a) regression b) individual-based
Total	8 model clusters	

Stage 3. Organization of models according to user needs. In a decision support system (DSS), technological classification and clustering of models might differ from the appearance of the system, visible to users. As described above, functionally, according to user needs, the TESS WP4 metamodel was split into three toolkits: Field Health Toolkit, Forest Health Toolkit, and Recreational Site Management Toolkit. Each toolkit, in turn, has several tools attributed to it. Each model could work in more than one toolkit and each toolkit could if necessary involve more than one model cluster, perhaps linked holistically (instead of algorithmic links, a toolkit might involve links to menus running different models).

If relevant, the interfaces of toolkits might classify models to information classes such as atmospheric class, hydrospheric class, geological class (including soils), sessile class (plants), locomotive class (animals), economic class, sociocultural class etc. However, each toolkit should also clearly indicate all incorporated models.

3.2.2 A questionnaire for collecting the models

Classification according to the structure and architecture of the metadatabase generated important questions for description, and subsequent search of decision tools. The resulting questionnaire was created as two consecutive web-pages, asking contributors 4+16 questions (http://tess.ttu.ee/). The first page asked the most critical questions while the second page collected additional useful information about each model. The questionnaire was uploaded to

Internet and linked to TESS project website. The link was communicated to TESS project partners as well as other potential contributors.

3.2.3 Creation of the database of models

Based on the questionnaire, the database was structured, designed, coded and uploaded to the Internet (http://tess.ttu.ee/, Figure 3.12). It is a MySql database with 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.

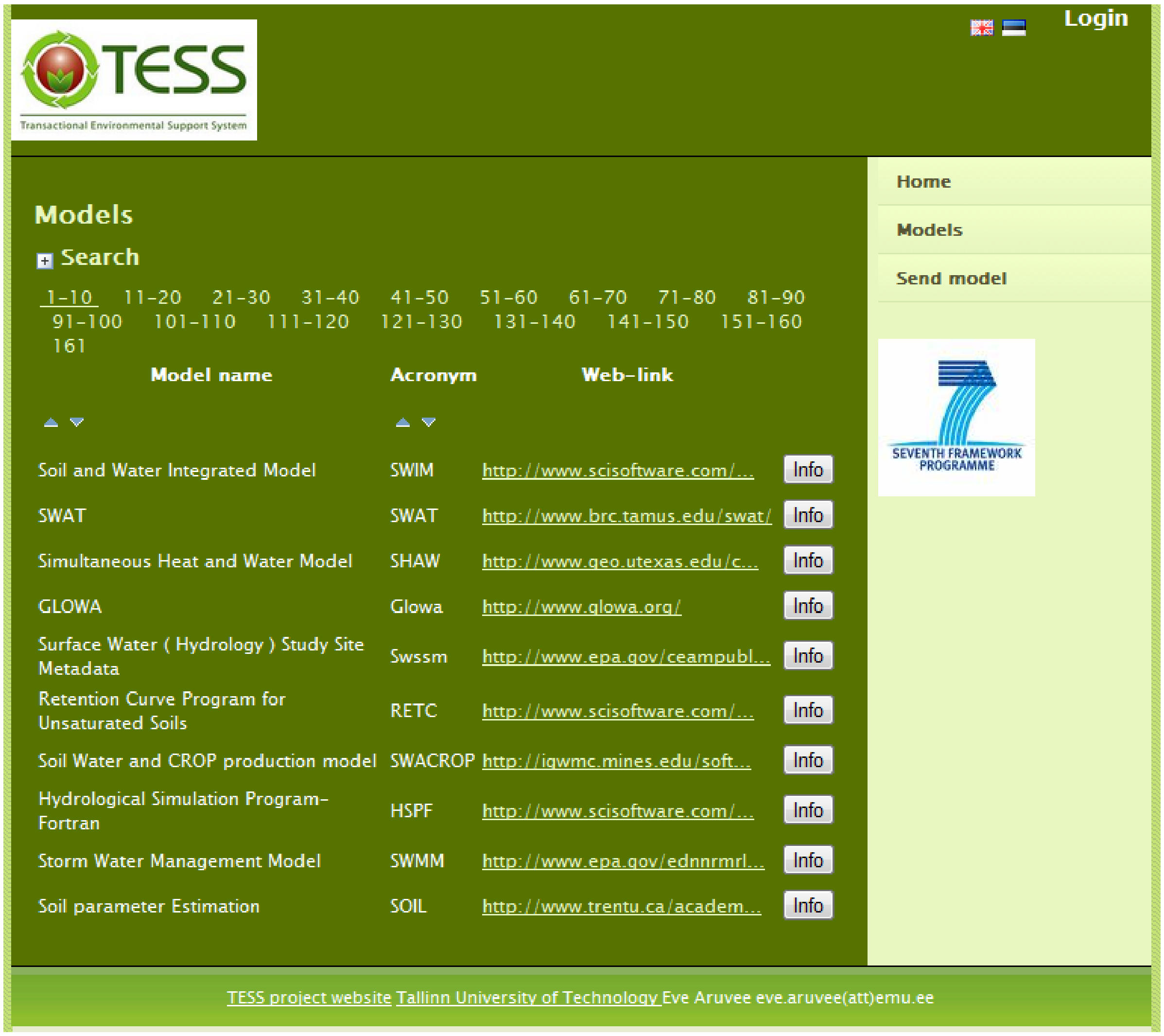

Figure 3.1. Interface of TESS database of models

3.2.4 Collection of 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 (www.google.com) was used to find further models. A network of experts around TESS project partners was used to find additional modelling tools. Scanning 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.

3.3 Results

Although the database of models is still expanding, this analysis considers the 165 models which were selected by May 2010. Approximately half of these did not specify all the metadata that was in the questionnaire. As the architecture of the database and some questions in the questionnaire are conceptually relatively complicated, probabilities of controversial interpretation and classification were quite high. For instance, 'vertical complexity', 'modelling paradigm', and 'simulative predictive approach' could be understood differently among various contributors. Moreover, some contributors might lack experience in operating with such concepts. Hence, some of those classifications are still preliminary and require reclassification by the project team after selection of the most useful tools for the toolkits. Until that, the database remains a relatively inconsistent mix of models suitable for the toolkits and models that may not be suitable.

Availability of information about selected models. Half of the software applications in the database are freely downloadable and well described on the Internet. However, small fraction of the models are very poorly described, with only short description of their purpose on the Internet and no information about the mathematical aspects or what input variables the model needs. Most of the models do not have output parameters, which is a very important requirement when creating an EDDS.

Vertical complexity. The web-sites or external contributors omitted to specify vertical complexity of their filed items in 27 of the 165 cases (Figure 3.). Of those with specified vertical complexity, as expected, most of the items (113) in the database were reported as 'software tools, packaging one or more formulae for practical use'. However, the database contains also 25 items which initially fitted a description as 'decision support systems, organizing or enabling several modelling tools'. Nevertheless, we later classified most of these 25 models too as just 'software tools, packaging one or more formulae for practical use' due to their very limited integration of basic formulae.

Thematic overview. Of submitted tools the database contains 42 items reported as 'forestry' tools, 50 as 'agriculture or apiculture' tools, and 15 targeting to either 'amenity areas' or 'tourism and access-based recreation' (Figure 3.14).

Other elements. Of the submitted models, 36 were reported targeting a long-term time horizon while 36 were short-term. In total 33 models applied raster-GIS while only one model applied vector-GIS. Of various decision support paradigms, we collected 1 expert system, 8 multi-criteria analysis models, 15 optimization processes, 96 simulative predictions and 13 other types. Of simulative predictions, 16 were rule-based systems (e.g. qualitative reasoning, rules, rates, environmental ontologies), 24 were individual/cell-based models, 29 were regression models and 16 were reported as other types of simulative predictions. These are described below.

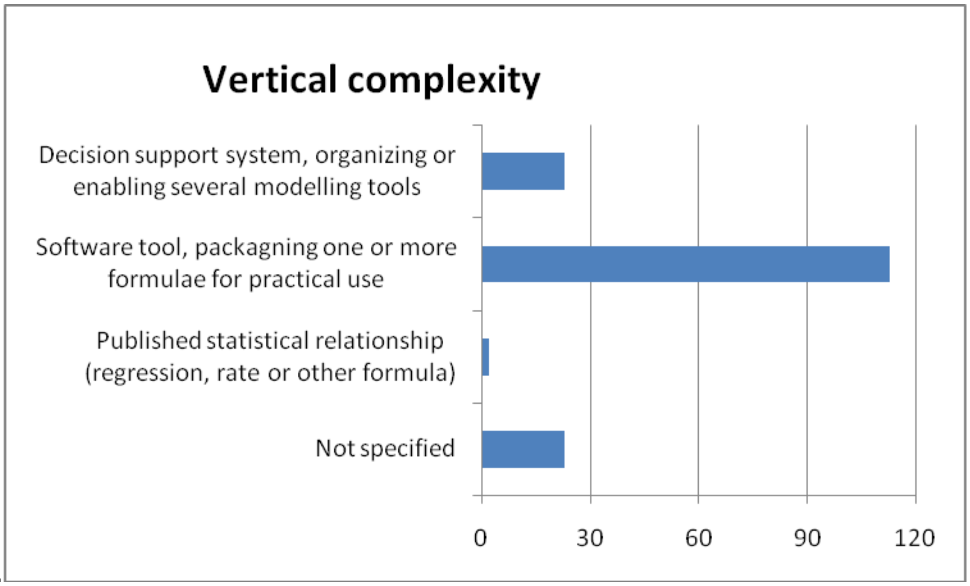

Figure 3.13. Vertical complexity of models.

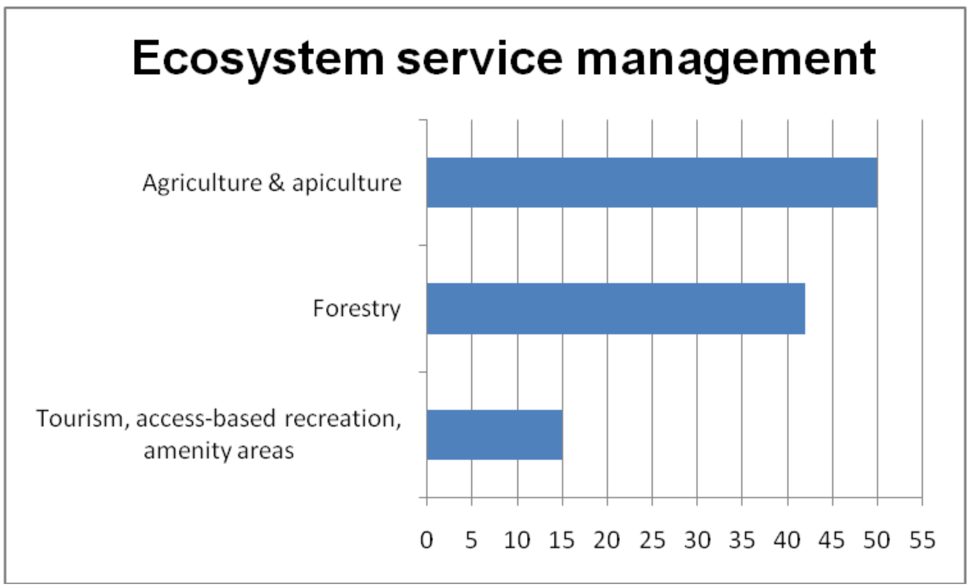

Figure 3.14. Ecosystem Service management division of model.

4. The TESS case studies

TESS aims 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 & restore biodiversity & ecosystem services. In this framework TESS partners were asked to develop local case studies, which consisted of two projects: a) the socioeconomic project and b) the mapping project. The Aristotle University of Thessaloniki is the leader of this Work Package (WP5) and responsible for the analysis and synthesis of the results.

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.

4.1 Local case studies

4.2.1 Municipality of Kerkini (Greece)

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

The area covered by the municipality of Kerkini is well known for the rare species of birds, either settled permanently 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 was decreasing in the past decades, until recently, as 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 and not to migrate. Also, the Womens' Association of Ano Poroia (a settlement part of the Kerkini municipality) is using locally collected herbs and fruits like chamomile, oregano or wild blackberries to produce traditional dishes and beverages. The project aims at helping local people in identifying new sources of income related to tourism activities while protecting the area's biodiversity.

The mapping project attempts to utilize the informal hotel owners' cluster and the local riding horses' owners in order 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 Hunters' association, who have deep knowledge of the various paths around the coastal part and the forests that surround the municipality helped in mapping the wild boars' paths, one of the main games of the area. Wild boars are allowed for hunting certain periods of time every year. The spatial information acquired will contribute to the conservation of the number of wild boars, as this species has been extinct in other nearby areas.

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

In the northern part of Estonia, ~30 km west from Estonian capital Tallinn in a Keila Rural Municipality is located a 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 is developed into popular recreational area among local inhabitants and areas' visitors although no special conditions had not been created for recreational activities (moving paths, ball fields, beach infrastructure etc). The project activities consisted mapping suitable moving paths for recreational use with an objective to fit 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 case study area
- to introduce mapping results to inhabitants
- to gather feedback and input if choosing between different alternatives.

The case study project was carried out in late summer of 2010. Firstly the relevant equipment was acquired which consisted Garmin Edge 705 Bundle GPS bicycle computer and Algiz 7 tablet computer to map the paths. After preparing relevant basis data the mapping with bicycles by bicycling club Velo Clubbers took place during to weeks in August 2010. The paths with adequate length had to be adjusted into the area with the aim of using existent paths and sparing the protected areas' values as much as possible. As a result 2 alternative paths were mapped - 2 km path and 4 km path. After mapping a questionnaire was prepared and a ~40 local inhabitants took part of the survey carried out by local NGO – Laulasmaa Open Youth Centre in September 2010.

4.2.3 Cycle route and flooded area in Bózsva (Hungary)

Bózsva is a small village in the county of Borsod-Abaúj-Zemplén in Hegyköz region in north-eastern Hungary ("Northern Hungary") on the border with Slovakia. Bózsva originally was two different villages, Kisbózsva and Nagybózsva, but in 1977 the two villages were unified. The two parts of Bózsva have not reached each other; the distance between them is 650 m. The town has an area of approximately 16,39 km^2. The 2009 census shows there were 205 people and 103 occupied houses in Bózsva. The average household size was 2,15 people/km^2. 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 Füzéskomlós.
Approximately, 50% of the population is the working-age, 25% of the population is over 60 years, younger decisively are in the school-age and secondary school-age. Nursery school and elementary school are in Füzérkomlós and Pálháza. Many of the local people work in the neighborhood, for example, in Kovácsháza or in Pálháza. Bózsva is located in the middle of the Zemplén Mountains, Bózsva is bordered by forest and cultivated area. Local people are working in the agriculture and forestry, and many of them are officially hunters. Complementary activity

is collecting of fungi, and recent time is village tourism. Useability mineral raw material is the perlite. The only one perlite mine in Hungary is at the border-line of Bózsva, in Kishuta. It has been operated since 1958. In the village there is electricity, gas, water and the disposal of sewage. In Bózsva, there is a positive process presently. More and more young people move there. More and more people buy houses there as a summer-house.

This year was an especially difficult year for the people of Bózsva. Heavy rains caused problems in more villages and towns in Hungary and in Bózsva, there were floods, too. Houses and bridges were collapsed, the product of land rotted off. Not only in the life of the local people caused the flood problems, but in the building of the cycling route, too. The roadbed was taken away by water, so excavations had to be started to rebuilt.

Two different tasks were carried out. The first one was the assessment of the area of flood. Bózsva has been flooded this year because of the large amount of rain. Since one of the main income source of Bózsva is tourism, assessment of flood and its effects has prominent importance not only in terms of natural reserve, but economic, too. The aims were to map the places, where its floods, the position of structures, assessment of endangered natural resources and natural values are important in order to be able to forecast the effect of future floods.

The second one was the mapping of the cycle route and its environment. Cycling is very important in terms of ecotourism. The socio-economic project was to know the implementation of building of the cycle route. Importance of structure a cycling road is unquestionable in terms of ecotourism. The problem is a rubbish-heap located near the cycling road. Clarification of property rights makes the progress more difficult. Task: mapping the bureaucratic labyrinth of Hungary with an aim of achieving its goals.

The case study started in September 2009. A preliminary survey was made, when the task of mapping and the subject of the socio-economic project were talked over. Local people were given information on TESS and on its aims. A measurement was made with three different GPS tools (Garmin Geko 301 (Navigation GPS); THALES Mobile Mapper CE (Developed for field work – GIS- GPS); Garmin Nuvi 770 (car navigation GPS)) in October 2009. The aim of the measurement was to test the accuracy and applicability under foliage of these GPS tools. Evaluation of the GPS test and development of the whole case study were carried out in winter. The work was continued with more consultations in June and July 2010. The necessary changes were talked over on these consultations. Testing of the GPS was continued in July 2010 and filling in the questionnaire was started then. Filling in the questionnaire was achieved in more periods.

4.2.4 Zator (Poland)

The Carp Valley region and its part - the Zator District is characterized by very high values of nature and local economy based on using natural resources. Fishponds and post-gravel gravel water bodies cover over 22 % of the Zator District territory and aquaculture remains the 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 part of TESS team intended to demonstrate the importance of access information on the livelihood level to sustainable management of natural resources, in a way which benefits both nature and people.

In practical terms the case study intended to demonstrate potential for setting up voluntary system of mapping environment and biodiversity 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, as bird watching, angling (fishing), recreational tourism and extensive aquaculture (perhaps organic one) allowing for protection of biodiversity on one hand and economic survival of fishpond production on the other one. This co-existence is the indispensable condition for both long-terms survival of natural values and fishponds and livelihood of various professions linked.

The sustainable use of these resources is complicated by some conflicts between interests of stakeholders, including nature conservations substantially strengthened by establishing Natura 2000 areas over significant part of all water bodies in the Zator District. Bird watchers and other nature conservation groups are mostly interested in maintaining and where necessary improving ecological status of areas concerned. However, other members of the local community look after their livelihoods that provide their income through the use of wild resources.

The conflicts of interest between the ownership, protection and the use of wild resources result from two reasons at least. The first is lack of understanding of what Natura 2000 is and what it does allow for in terms of various land uses. This leads directly to absence of development concept which would result in partnership and co-existence of nature conservation and economic use, ensuring both financial and biodiversity results.

The second reason is lack of proper and transparent information on nature resources, their spatial distribution and business opportunities could be based on these resources. This call directly for developing habitat and species maps which would enable to develop proposal aiming at economic revitalization fishponds, same time providing active protection measures for their biodiversity. Further on, while ensuring implementation of Natura 2000 perceptions, the plan is to look at the multifunctionality of the fishpond complex as a way of diversification of incomes of people living in that area.

The case study was to address above problems, designing a project proposal to promote development of pro-biodiversity businesses based on compromises in resource management among all the stakeholders, and creating this way the conditions to improve management of nature resources of fishponds and local livelihoods.

Achieving this goal requires mapping of information on the spatial distribution of biodiversity, existing and potential risks and threats. Therefore, the two projects planned in the framework of the case study – the development of socio-economic project was closely linked and integrated with mapping project. The latest, apart testing possibilities of setting up volunteers based mapping systems, provides also necessary information on vegetation overgrowth on fishponds of Przyreb complex, which otherwise would not be available.

The work on the case study area began in 2009 while implementing the WP3. The core part of the work was, however, implemented in 2010. The planning of work was, unfortunately, heavily affected by three floods which were seriously limiting cooperation with local stakeholders, including district authorities. The problems with the flood, which came about in beginning of September last time, caused substantial delay in case study execution, in particular mapping. Consequently mapping became the bottle neck to the development of socio-economic project.

To ensure effective implementation of the case study 7 work months were allocated to cover all costs labor input.

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

The project area comprises the territory of the Portuguese municipality of Barrancos, located in SE Portugal. The municipality is economically depressed but includes high value natural areas. 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 to a decline in population, product and increased unemployment. During this period cereal production diminished to irrelevant levels and, at the same time, cattle and iberian pig production raised. The 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 to the local population.

Information about species and habitat is essential to biodiversity management and the need of this information is a potential generator of jobs to local people. In the project area, information about wild-rabbit population, mammal carnivores population or health condition of evergreen oak stands are good and practical examples among many possible others. Particularly important is the information about wild-rabbit population, because of the species importance in Iberian-lynx conservation program. A regular monitoring program of wild-rabbit population is an important component of a comprehensive monitoring program in the project area already active, however with little participation of local people.

However, local people seem to only partially consider the idea that activities related with conservation can be relevant to income and employment. (CIS, 2010) reports that only 10% of the landowners in the region agree that investments in conserving biodiversity can be compensated by EU payments, 60% consider that conservation regulations generate lower "production levels" and are "complicated". 70% consider that conservation regulations bring "new problems" without "pointing solutions". None considers that conservation regulations "contributes to ameliorate the state of natural resources in the region".

In the other hand, 70% of the respondents consider that Iberian-lynx conservation can "increase tourism in the region", 80% considers that the species should be conserved because is "typical of the region" and 40% respond that the species can "increase game estates value". But, for more than 70% the personal involvement in Iberian-lynx conservation activities depends on "compensation in case of income loss" or "amelioration of the estate conditions".

If practical cases of biodiversity activities generating income and jobs, this local perception will probably change. This is the case of Noudar project an agriculture, conservation and tourism project that is generating tourism flow and employment and positively perceived by local people. The essential idea of this socio-economic and mapping project was to evaluate whether local people can incorporate work (paid or voluntary) in wild-rabbit monitoring and other regular monitoring programs in the Barranco´s region, thus contributing to generate a new field of activity for locals. The project should also elaborate on the socio-economic framework of these new activities.

The specific objectives of the socio-economic project were:

a) To identify the socio-economic framework of the project region regarding the foreseeable shift in the productive base oriented to activities linked with biodiversity conservation.
b) Identify the baseline situation of the actual local participation in biodiversity related activities.
c) To identify the stakeholders and the possible evolution of biodiversity management governance models.
d) To identify the new activities emerging in the region associated of 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 evaluate and discuss 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:

a) Compare trained professional with untrained non-professional observers in a concrete wild-rabbit monitoring situation in the study area.
b) Map the results of the test.
c) Evaluate the adequacy of the equipment used in the test.

The preparation of the case study was initiated in April 2010, when the first contacts were established with local population with the objective of presenting both project TESS and the local case study and invite local people to participate. Field work went on until the end of August, when the enquiries to helpers were finished. The time allocated by partner ERENA for the completion of the case study was approximately of 4 man-months.

4.2.6 Sfantu Gheorghe commune (Romania)

Sfantu Gheorghe is a fishermen community, based mainly on fishing 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, this affecting the community livelihoods. The fishermen are still fishing 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 tourists services like boat trips, guiding, accommodation or local cuisine and products.

The project intends to stimulate local community to promote the use of the other alternative natural resources to improve community livelihoods. The goal of the project is 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 will require the collection of the information on the main locations of the resources, species and habitats their abundance and on the risks of exploitation. These data could also be used when designing tourist trails, avoiding a negative impact on the valuable biodiversity resources. The data collected by the local people and stakeholders will be further use 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 by the tour-operators.

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

Specific objectives are:

1. 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
2. to build competence and improve practice of local products-based tourism in the Tulcea region at the Lower Danube
3. to provide a model for the development of sustainable, environmental tourism in Romania as an alternative to the well spread mass tourism.

For planning the project we involved the main local stakeholders and the local people in identifying and evaluate their other exploitable biodiversity resources than fish. We also tried to involve the stakeholders for the socio-economic aspects of the project (potential income and market).

The time period of project simulation has extended for six months started from April 2010 and ended to September 2010, with a total estimated time allocation of 300 person-hours for stakeholders and local community representatives.

4.2.7 Firtina Valley, Rize (Turkey)

Main economic activity in the lower plains and hills of Firtina Valley is tea cultivation due to available weather conditions (semi tropical rainy). It is a traditional agricultural activity being carried out at the areas gained from clear cutting of the forest in the past. Cattle breeding is the secondly 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 there is small scale agriculture, the main impact on natural resources is pollution in freshwaters (especially rivers) due to pesticides used in tee and hay cultivation. The rivers of Firtina basin are water supply for households and tourism sector, besides an 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 are making research on cultivation of sea trout in local fishing farms which can be an alternative income for local people.

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

4.2.8 Egirdir lake, Isparta (Turkey)

Lake eğirdir provides Isparta and Eğirdir with drinking and agricultural irrigation water. Fruit agriculture, 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 Eğirdir 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. It has been recorded that the indicators showing the deterioration of the water quality in Lake Eğirdir, resulting from especially agricultural pollution has been increasing in number and intensity. Besides the increase in biomass (pointing to euthrophication), disruption of sight, decrease in the amount of plankton and fish, various scientific research has shown that there has also been an increase in concentration of polluters like pesticides and heavy metals.
In recent years, it is easy to observe the trend towards projects aiming at decreasing agricultural pollution while maintaining and improving the quantity of production. Transforming the irrigation systems from surface irrigation to drip irrigation, employment of 'early alert systems' in the fight against pests are some of these projects.

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

The return from Arne Parish to the WP3 enquiry on information requirements at local level recorded "Deer damage: crops, gardens, road accidents" as the environmental issue of second highest concern but with highest frequency of attention required by the local council. Deer numbers have increased greatly in the area in recent years, with large herds of introduced sika (*Cervus nippon*) finding refuge on protected heathland and then foraging in nearby fields and gardens, which often involves crossing roads. Control measures by local volunteers operate in some parts of the parish, but elsewhere there is frequent poaching. Conflicts about deer damage and management are exacerbated due to lack of knowledge of exactly where deer are and where they are causing damage. The mapping project therefore aimed to establish if local people can map deer and deer-damage hotspots in a way that helps deer managers, and also to map habitats widely in ways that could be used to model deer populations in the future. After detailed planning in June-July 2010, field work was conducted primarily during August and early September 2010. Extensive further data were provided during a survey, during early September, of all voting parish members for a revision of the Parish Plan.

The 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 km^2 of the 29.6 km^2 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).

4.2.10. Mapping of the European Brown Hare (FACE)

FACE was given the task to report on a mapping project carried out by local hunters within Germany and how it integrates into the national level. The aim of the mapping project is 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 is carried out by local hunters and hunting the hunting area manager.

The monitoring of the brown hare is part of a wider programme within Lower Saxony (*Wildtiererfassung in Niedersachsen* - WTE), which was previously initiated by the hunters collective of Lower Saxony already in 1991 and is scientifically accompanied by the Institute for Wildlife research (*Institut für Wildtierforschung* - IWFo). It is funded through incomes by hunting rights, 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 long term to evaluate the trends of hare populations.

The local mapping project feeds then through the WTE into a German nation-wide monitoring programme, called the *Wildtier-Informationssystem der Länder 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 part of the ecological

environment study. The most important goal is to develop strategies for conservation and sustainable use of wild animals.
The local mapping project in *Leveste* was carried out in 24th February - 5th April 2010. The whole process took about 20 hours (preparation, mapping of the area, hare counting and evaluation)

4.3 Local case studies summary – Conclusions

From the case studies reports it is 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, it is 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 protecting their natural resources. More robust, continually updated and easily and freely accessed databases would be very welcomed, especially if they are capable of providing data for the very local level; it must be noted that the case studies implementation teams recorded a genuine interest of the local populations' willingness to participate voluntarily in such projects.
Across all case studies, local people 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.).
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 have a rather positive and pragmatic attitude towards biodiversity, as indicated by their perceptions of benefits and costs from biodiversity and their responses to the statement that conservation should be 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) was minimally affected across case studies either by their educational level or response to the statement.
Estimates of participation in the activities at LAU1 and LAU2 in the case studies generally underestimated the actual participation of individuals quite strongly. This indicates a considerable lack of information among governance officials about the interests of the local population they represent.
Bearing all of the above in mind, knowledge and data shared by local residents could be integrated from the regional and local level into environmental decision making and support sound elaboration of EIAs and SEAs, as long as local needs in accessible information are met.

4.4 Systematic Pan-European Survey

The following sections of this report describe the methodology applied in the WP5 Pan-European survey. It then compares the relative abundance of informal decisions made by local managers to the formal environmental assessments, and shows the information sources currently used by government authorities and other stakeholders for these decisions. Finally, it describes indicators derived from the governance processes that are being taken forward to be combined, with data from GEMCONBIO and indicators on environmental impact (e.g. the Streamlined European Biodiversity Indicators), for the matrix production and combined analysis that will be a product of Deliverable 6.1.

4.4.1 Survey Methodology

31 Country Coordinators, from the 27 EU states plus Norway, Switzerland, Turkey and Ukraine, were recruited to act as focal points for the surveys in their countries. They were drawn from TESS partners in Belgium, Estonia, Hungary, Greece, Poland, Portugal, Romania, Turkey and the United Kingdom for the countries concerned, while for the remaining countries members or associates of ESUSG kindly agreed to act as Co-ordinators. They worked under the direction of the central team based in the UK who are the authors of this report. Illness and other personal factors affecting Co-ordinators meant that eventually usable returns were received from 24 EU and 3 non-EU countries. Due to the short time period within which the survey was carried out it was not feasible to find replacement Co-ordinators.

4.4.2 Survey levels and types of question

The survey was based on 3 questionnaires, (i) for National Level governments (Appendix 1); (ii) for government at the lowest administrative level (LAU2, Appendix 2); and (iii) for the individual managers of land and species (Appendix 3). In each case, Country Coordinators were required to approach appropriate officers or other individuals and ask them to provide the information for the questionnaires.

At national level, questions were on decision-making for Strategic Environment Assessment (SEA) and Environmental Impact Assessment (EIA) which are conducted to conform with the relevant EU Directives or parallel legislation, Biodiversity Action Plans and Strategies (BAP's, NBSAP's) which are carried out to fulfil obligations agreed by Parties to the Convention on Biological Diversity, allocation of resources from the budget of the EC Common Agricultural Policy (CAP) and other decisions made for Land Use Planning (LUP) that operates within a legislative framework set by government at national level. The questions concerned the department responsible for the decisions of each type, the tier of government at which assessments were made and decisions taken, the guidance provided for administrators and the sources of other information used in decision-making, the data collected in the process of decision-making and the roles of parties involved in this and any monitoring of decision outcomes, and the reporting on numbers and outcomes of decisions.

At local level, questions concerned responsibilities for SEA, EIA, Land Use Planning and any other decisions being made by local authorities; these responsibilities were for protection, management or restoration of biodiversity and ecosystem services on land managed by the authority or others in the administrative areas. Details were required on numbers of decisions and on areas of land affected and on priorities for environment, economics and other social factors when making decisions. Data were also requested on administered population and area, and proportions of land cultivated for farming or forestry. Other questions concerned the extent of consultation about decision-making with higher government, non-government organisations and individual managers of land and species. There were also questions on costs and benefits of wild species as perceived by local people, and on benefits for biodiversity from activities that involved use of land and species, in order to provide indicators of attitudes to natural biodiversity and those using these wild resources. Local authorities were also asked about categories of ecosystem services on which they required information, whether it was available and if so from what sources and in what format.

Individual stakeholders managing land and species were asked about numbers of decisions and areas concerned. Questions to the farmers, foresters, and managers of fisheries, hunting areas and nature reserves also concerned the types of environmental issue that they needed to address most frequently.

Most of the questions used in the survey had been piloted in the original 10 partner countries (also including Slovenia at that time), as reported in D3.3 of TESS. This permitted a reduction in the number of final questions, by elimination of those that were too hard to answer usefully or that gave answers that were too invariable to be useful in comparative analyses. It also enabled a refining of the questions to minimise scope for ambiguous answers. However not all difficulties were avoided and with hindsight it would have been desirable to complete each questionnaire in full in one country before they were finalised.

The questionnaires were applied by Country Coordinators in slightly different ways at the different levels, with some variation between countries. Country Coordinators typically used personal knowledge to identify individuals responsible for the different decision areas at national level (SEA, EIA, BAP/NBSAP, CAP, LUP) and then approached these individuals by e-mail, telephone phone or in person for help completing the appropriate sections; a few coordinators were able to complete the forms mostly from personal knowledge. Due to the way in which government departments and agencies operate there were few if any cases where one focal point within government was aware of all the responsible officials of interest to the survey.

The questionnaires for local administrations were translated by Co-ordinators into national languages to ensure full understanding of the questions. Although questions had been reduced at both national and local level, reduction was maximised at local level to aid their completion with minimal explanation (and hence scope for unwitting bias) required from the Country Coordinators. Local questionnaires were provided to administrations for review, accompanied by a standard introductory letter, either by e-mail or post. They were then completed remotely, by telephone or in a very few cases by personal visit.

4.4.3 Sampling Issues

The variation in cultural history and governance processes across Europe provides a rich field for analysis of associations between social institutions and impacts on the environment. However, robust analyses need statistically representative information and finding a basis for this presented a serious intellectual challenge.

In most of the countries surveyed environmental policy is administered at national level. In these cases at national level, only one ministry or agency was needed to answer specific questions. This was not the case where environmental policy is strongly devolved (e.g. Germany, Spain, UK) where representative but not necessarily comprehensive answers were given.

For the local surveys it was decided at the outset that in each country the aim would be to obtain five completed questionnaires, irrespective of the country's population size, from the lowest level of public administration involving elections, while ensuring that these administrations came from different regions. This would produce c.150 responses to each question, widely spread across Europe and the individual countries. Although TESS, as a decision support system, is relevant to all areas it was considered desirable to target rural areas in order to address the various land management activities mentioned above. Finally these areas would need to have a minimum population size in order for there to be a reasonable prospect of representative activities and attitudes. For example an area consisting wholly of mountain peaks could have almost no resident population and host only a ski facility: this would not be fruitful for the TESS survey.

Although it would have been easier for Country Co-ordinators to make their own selection of administrations on a representative basis, it was decided that to avoid bias and secure statistical rigour lists of the lowest level administrations in each country should be sampled with a stratified, randomised approach. The starting point for this exercise was the classification of regional and local authorities in Europe maintained by Eurostat, the Commission's statistical service. In this classification the most recent terminology for the lowest level is LAU2, with LAU1 being the tier above. The most common terminology for these lowest level units is "municipality", though historically they have been known as communes, gemeinde or parishes and have their origins in the medieval period. Lists of LAU2s were obtained from the Eurostat web site (NUTS 2009) arranged in geographically separated regions for each country and 5 regional lists were selected to give stratification based on landscape and/or culture in nationally recognised regions. For each selected region, a list of 5 LAU2s was produced by random sampling, using the first five that had a population of at least 200 (to achieve a representative administration) and a population density of <150 inhabitants per square kilometre (defined as rural in ESPON 2009, which makes clear that there is no standard definition of rurality for EU policy or statistical purposes). Because Eurostats felt unable to release density information, due to the basis on which it been obtained, it had to be gathered, at considerable cost in project time, by searching Wikipedia and national web-sites for the population and area information (Table 4.1). Another problem was that not all LAU2 units corresponded with administrative units with some form of governance. Some were merely electoral wards within larger authorities.

Table 4.1. Difficulties overcome in the LAU2 sampling

- Lists for all countries not available from Eurostat
  - http://ec.europa.eu/eurostat/ramon/nuts/lau_en.html
  - Missing: Turkey, Switzerland
  - Solution: Wikipedia most up-to-date list
- Area and/or population of LAU2 not available from Eurostat
  - Solution: Wikipedia (some other online sources)
- Area and/or population of LAU2 not available from Wikipedia
  - In particular: Malta, Turkey, UK
  - Solution: Country Coordinator procured data from countries national statistics office
- Restructuring of LAU2 and other administration levels
  - In particular: Denmark
  - Solution: New list published on Wikipedia

Country Coordinators were instructed to ask for participation from the first LAU2 on each list. If that administration was unwilling, the next on the list was approached. If there was no willing partner amongst the five random LAU2's, re-sampling was used to get additional random LAU2's. There were substantial differences in refusal rates. These were still being analysed at the time of the report, with some follow up still necessary where survey fatigue continues to be an issue. Another problem arose for a small number of countries (e.g. Czech Republic, Germany) where LAU2s were not involved in EIA, SEA or LUP processes at all. In these cases the Country Coordinators also interviewed the LAU1 administration one level above the randomly selected LAU2 in order to obtain information specific to these topics.

Although it was possible to sample consistently in areas with population densities below 150/km^2, apart from the very high density communities on Malta and Greek islands (Figure 4.1), there was a huge range of population size among the LAU2 administrations in different countries, ranging from around 10 to 67,000 (Figure 4.2). Generally, there seems to have been a tendency to abolish very small authorities or to encourage them to combine with neighbouring authorities for the delivery of services and professional support. As the small administrations are closest to people, there is a very real tension between democracy and efficiency, the consequences of which are far from clear.

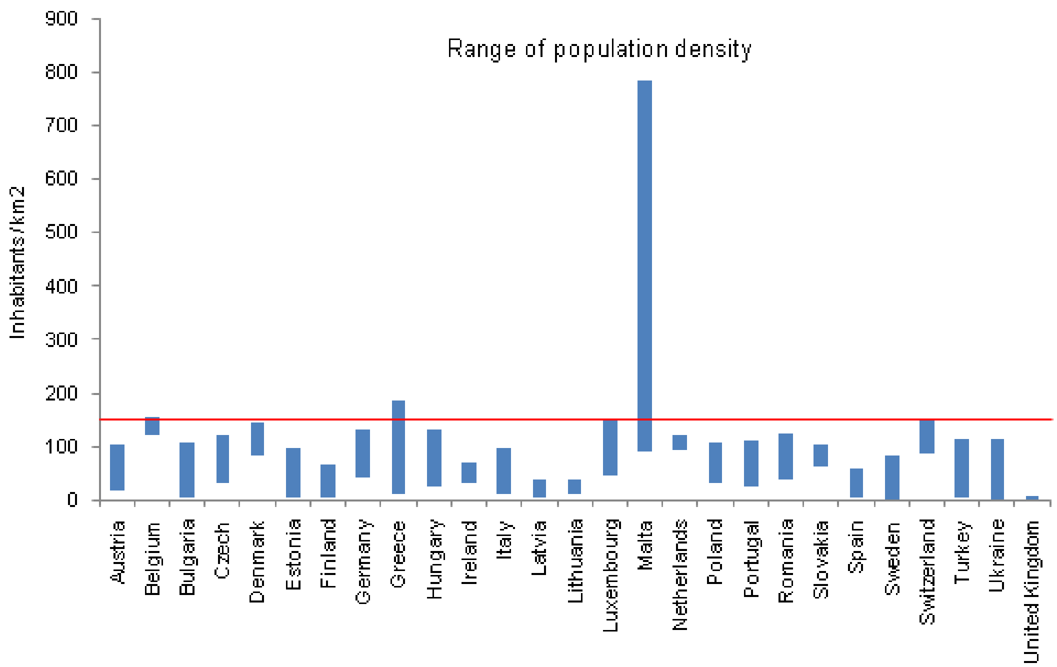

Figure 4.1 The range of human population densities in surveyed local administrations (LAU2).

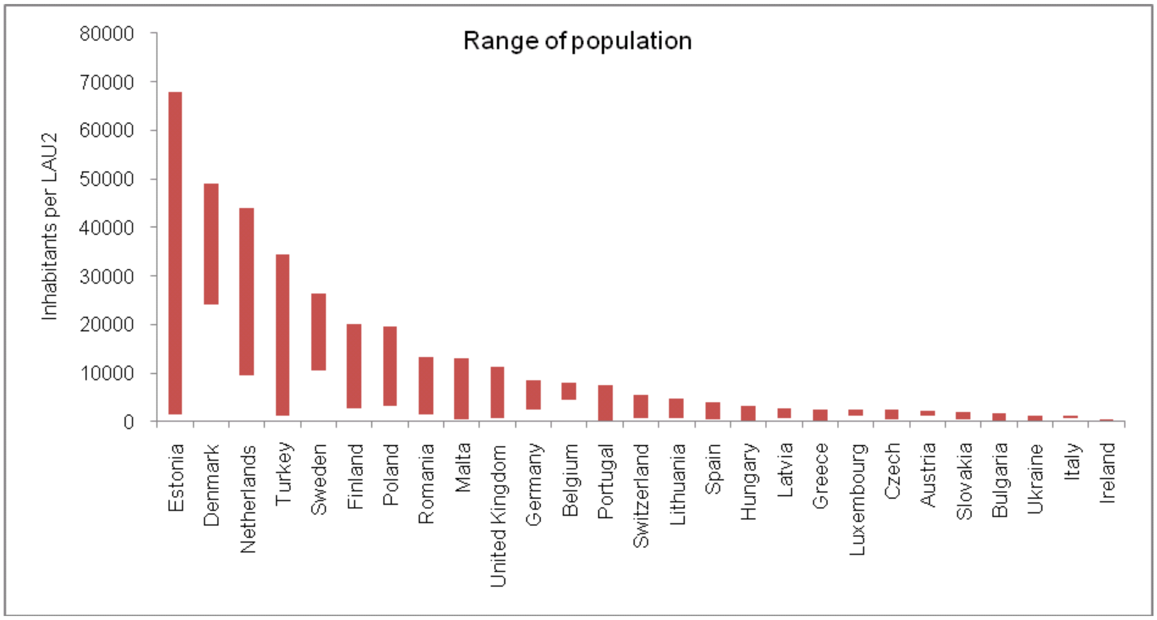

Figure 4.2 The range of population in local administrations (LAU2s) surveyed

Sampling of individual managers of land and species depended on recommendation by the administration of one of the LAU2s. This was likely to bias the sample in favour of the more knowledgeable and responsible individual stakeholders, but should not have greatly affected the number of annual decisions per area of land managed. Analysis of decision intensity was based also on number of managers estimated for each LAU2, using the average area of each management unit and the area of land estimated from the proportion in each LAU, of farmland for farmers, forest for forest managers and both these plus semi-natural habitat for hunters. It was assumed that an average LAU2 would not contain more than one fishing management area or nature reserve. These analyses used only countries with responses from both administrations and individual managers.

4.4.4 Analytic Framework

The derivation of indicators for the analysis matrix in Task 6.1 was based on the analytic framework (Figure 4.3) developed in the FP6 project on Governance and Ecosystem Management for Conservation of Biodiversity (Manos & Papathanasiou 2008).

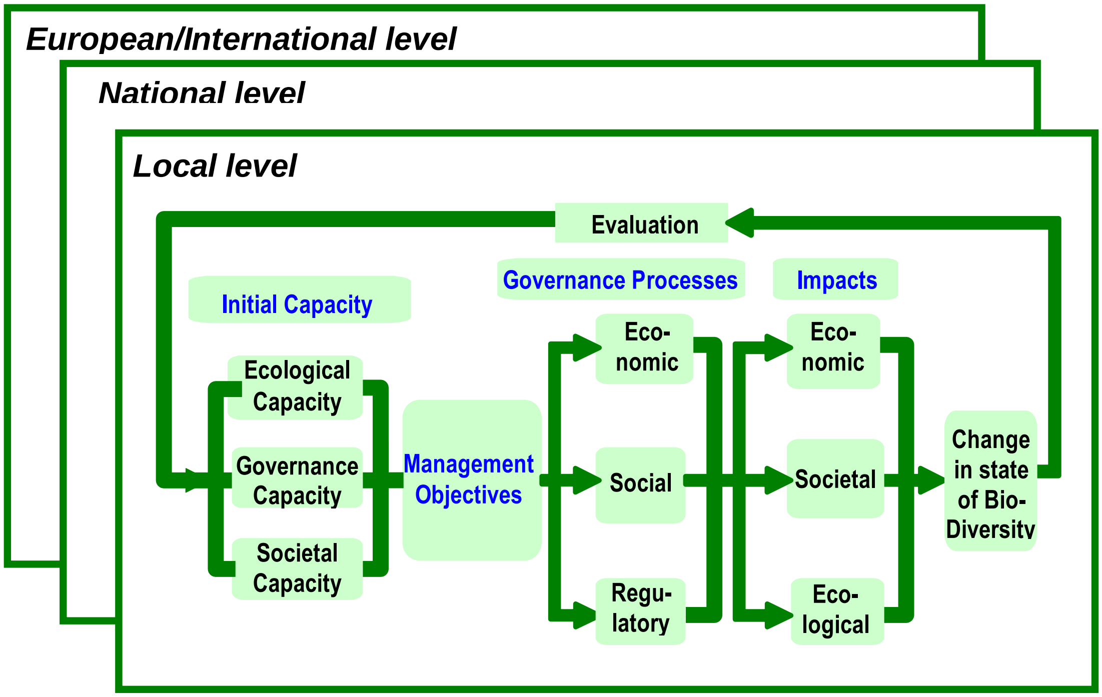

Figure 4.3 The analysis Framework from GEMCONBIO that is used as a basis for the governance indicators derived by the TESS Pan-European survey.

Broadly speaking, the availability of particular institutions and of information in various categories (indicated by its current use) are measures of Governance Capacity, with numbers of stakeholders in various interests as an index of Social Capacity and the proportions of land of various types as an index of Ecological Capacity. These have Management Objectives about which questions were asked directly and indirectly. Economic, Regulatory and other Social Processes are indicated, respectively and *inter alia*, by the provision of agri-environmental funding under the CAP, by the levels at which decisions are made and by presence or absence of different consultation practises. Societal impacts are indicated in these questionnaires by attitudes of local administrations to wildlife costs and benefits, whereas ecological and economic variables come from other sources. Examples are presented in this report for illustration, prior to separate delivery as a data matrix and its analysis in Work Package 6.

4.4.5 Time-frame

Country Coordinators were recruited during the first half of 2009 and invited to the London TESS workshop in September 2009 to discuss draft questionnaires. Revisions then proceeded until mid-November, followed by translation and survey launch on 4 December 2009. By the time of the Krakow TESS meeting in March 2010, completion at all three levels had been achieved by 14 countries, with an estimated 75% of the information available from another 12; five countries had not started the survey. By the end of May 2010, the survey was complete in 23 countries, four still had some information to provide at national level and 1 at local level, and 3 countries were unable to undertake the work due to illness or other indisposition of Country Coordinators.

5. Recommendations and guidelines on biodiversity trends

In framing recommendations and guidelines (in bold type) 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.

5.1 Information for higher-level assessments

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

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

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

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

Biodiversity information, which is available in a wide variety of formats on the internet in many cases, is gathered together in ad hoc fashion for these assessments but then dispersed rather than being added to national or EU level databases. In spite of praiseworthy requirements for

public involvement in SEA and EIA processes, they remain formidable and many local municipalities, much less ordinary land managers, have no experience of them at all.
EIA requirements for assessment of conversion of semi-natural habitats into intensive agriculture could in theory be valuable instruments for conservation in the wider countryside. Regrettably they are generally by-passed, but there is a gradual though non-quantified movement towards environmental assessment based on mapping as a condition of single farm payments under the CAP. It seems probable that the huge number of management decisions taken by farmers, horticulturalists and gardeners are of more significance for the health of Europe's natural heritage than the large-scale developments currently caught by formal EIA. As long as agricultural support systems continue they may be a more effective tool for assessing and influencing land management changes of environmental significance.
Accordingly the following recommendations are proposed when considering how environmental and sustainability assessment should be carried forward through incentives and regulations.

1. The SEA and EIA Directives should be reconsidered with a view to their integration and formal application at 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.

While the requirements for formal assessment are a top-down flow from international and national implementation levels, there is no corresponding flow of information from participants to these levels about the relevant impacts and the effectiveness of the processes. Just as participants often have difficulty in finding the information they need, which is available in a variety of forms and from a range of sources, so authorities setting the rules or enforcing them are in effect discarding the information gathered at considerable expense for each individual assessment. While there has been effort in some countries to harmonise and digitise biodiversity records this has been mostly to assist conservation projects rather than to facilitate decision making by land users. So far there has been little evidence that national level governments appreciate the contribution that information from non-experts or "citizen science" could make to policy or policy outputs in biodiversity related fields. This is probably due to the widespread mindset that information about wildlife is only reliable if provided by experts.
The need for local, regional, national and European frameworks to integrate data and make it easy to use by non-experts is evident. The work of the EEA in this endeavour is of critical importance at European level. In the national context Biodiversity Action Plans (BAP) have brought together government departments and agencies, local government, business interests,

land managers and NGO's to assess the state of biodiversity and to devise and implement plans to restore it, a process which is impossible without data gathering and monitoring over time. In a few countries this collaboration and the necessary structures have been adopted voluntarily at regional and local levels, each with their own targets for habitat and species restoration and thus the need and indeed motivation for appropriate information gathering. If local BAP consortia could be put in place more widely, they could provide the ideal frameworks for harmonizing biodiversity data and making it genuinely accessible to non-experts. Equally data provided by citizens could be integrated into the various formal environmental assessments, thus promoting a genuine two-way transactional approach.

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

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

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

5.2 Understanding information needs and making information available

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

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

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

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

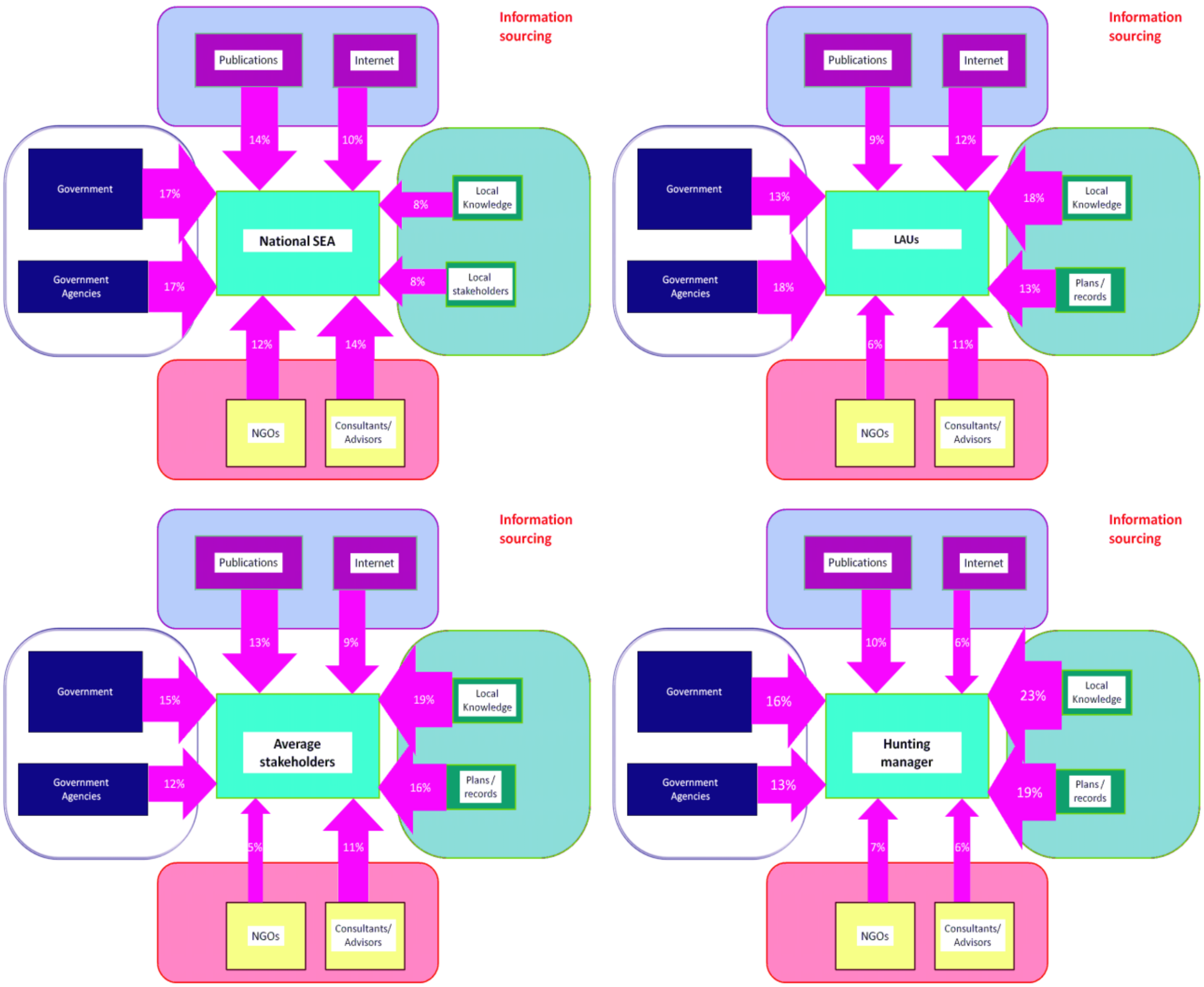

Figure 5.1 The proportion of information on biodiversity & ecosystem services that was sourced from different suppliers by (in central boxes) (i) national government, (ii) local authorities, (iii) private managers of land and species in general and (iv) hunters in particular.

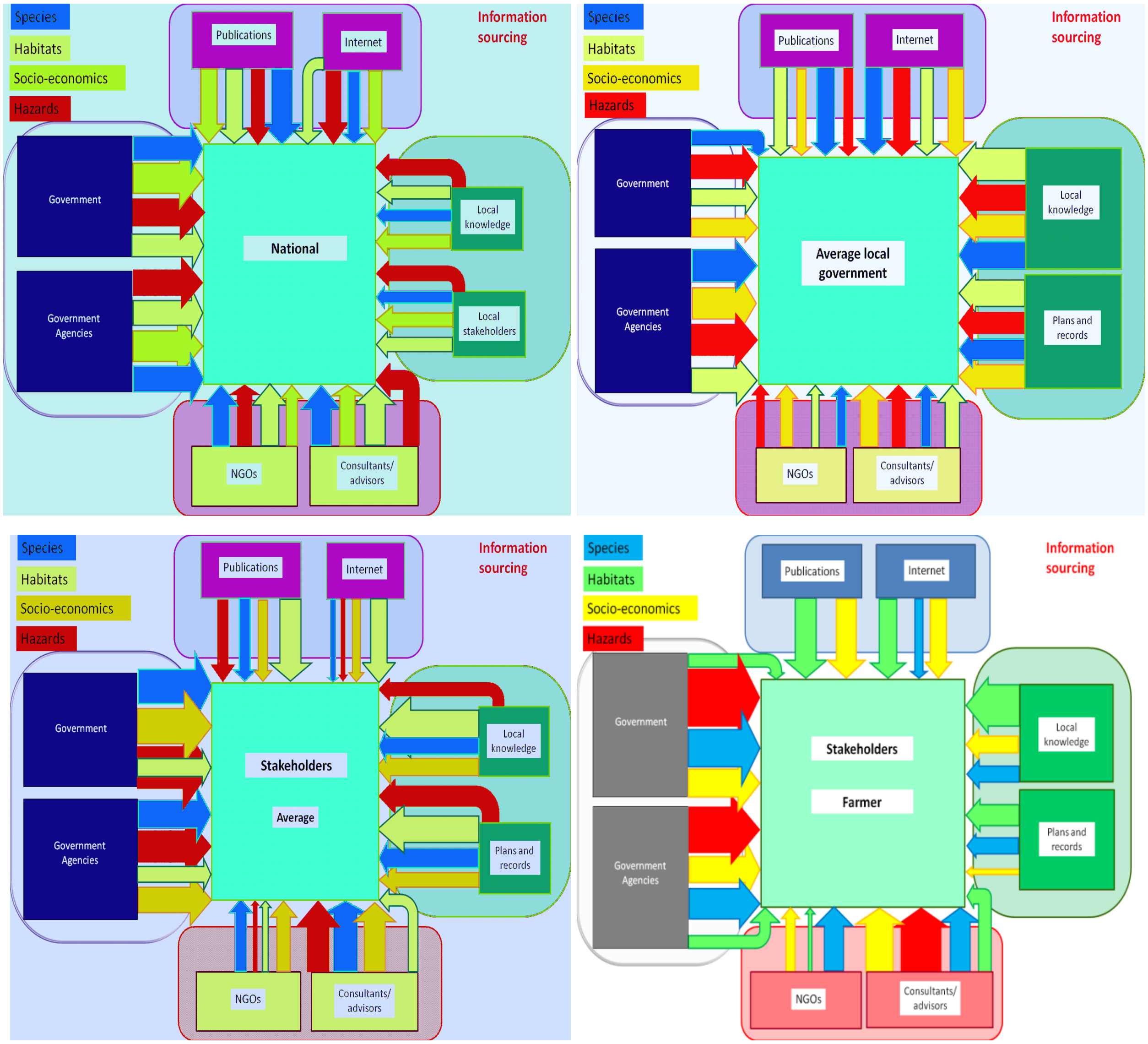

Figure 5.2 The proportion of information on species, habitats, socio-economic considerations and hazards that were provided from different sources to national government, local authorities, private managers in general and farmers in particular.

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

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

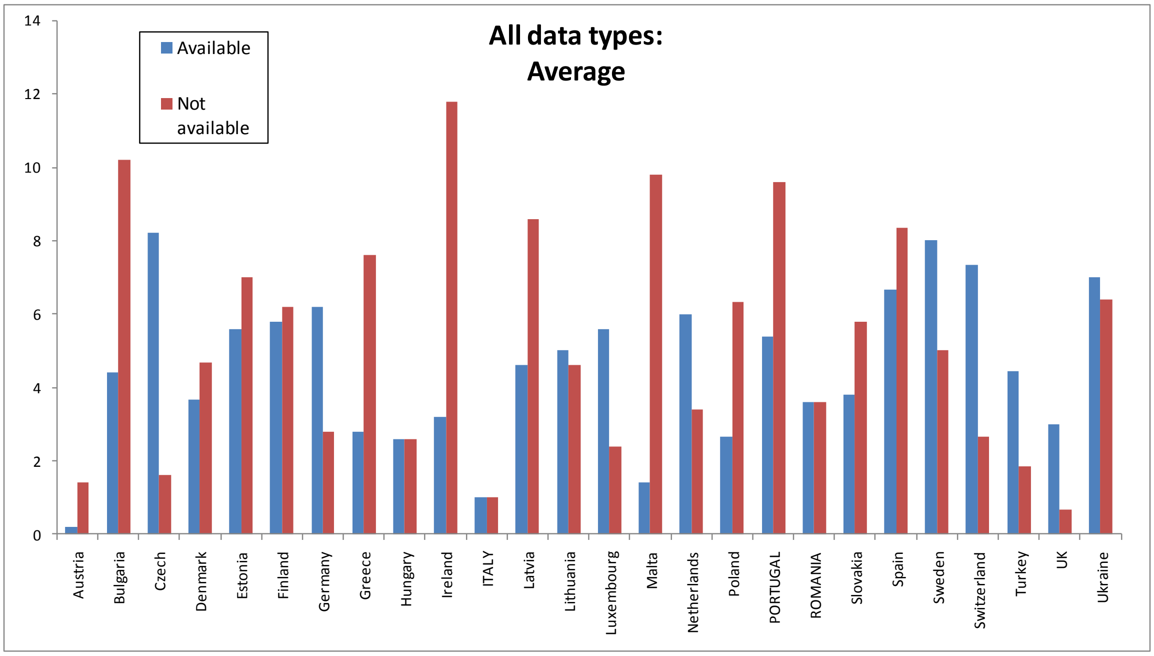

Figure 5.3 The relative demand for data needed to make environmental decisions that was available, and unavailable, in local administrations across Europe.

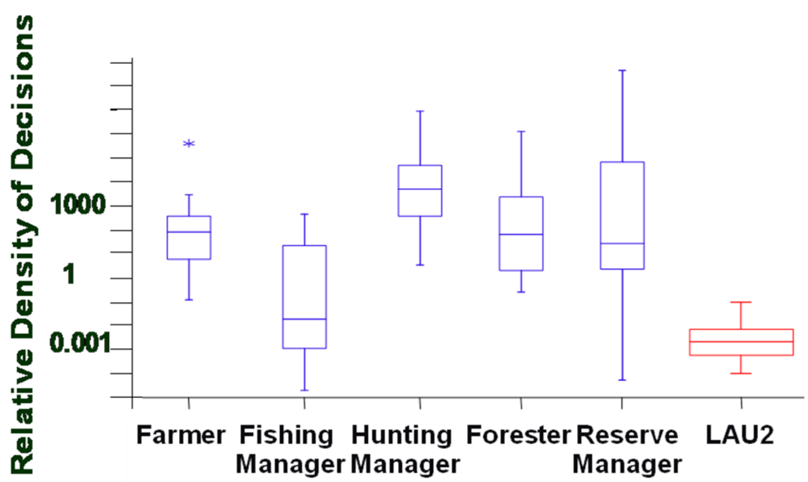

Figure 5.4 The density of decisions, taking account not only of decision numbers per management unit but also the area covered by each decision and relative abundance of different management units, indicates greater importance of private decisions than of those taken by local governments.

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

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

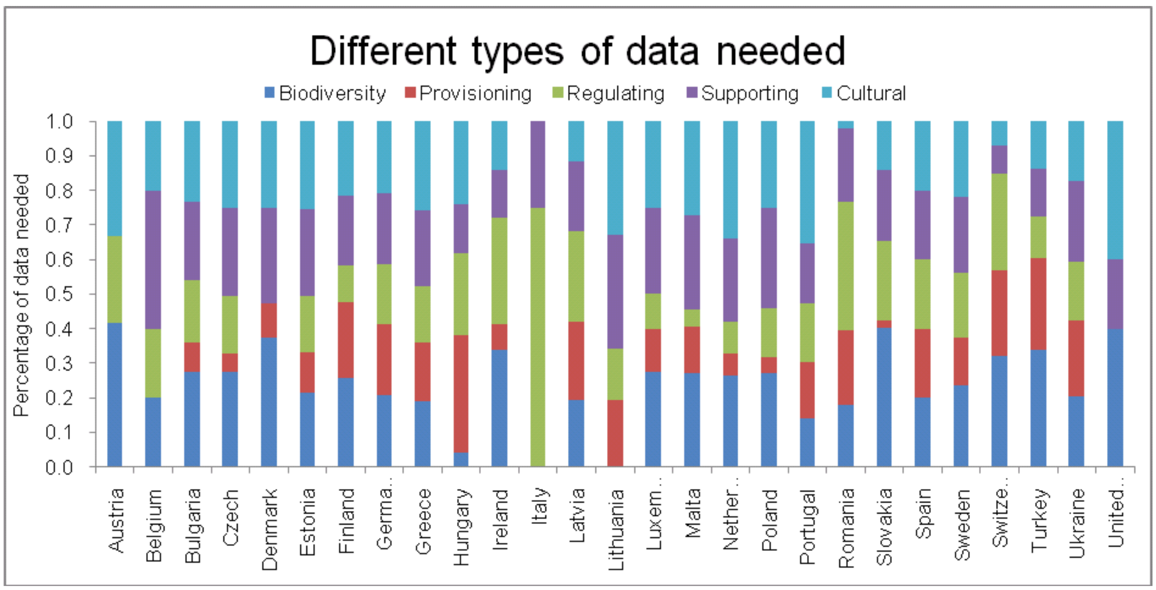

Figure 5.5 The proportions of different types of data for making environmental decisions that were needed by local administrations.

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

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

8. In order to refine information needs for different statutory authorities and stakeholder groups further Pan-European survey work will be needed. This would be enormously facilitated if Eurostat were able to establish rigorous sampling frames across Europe for

the groups of land users identified by TESS and for local governments with specific functions.

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

5.3 Participation in and attitudes towards wildlife-related activities

The local authorities also produced estimates of the prevalence in their communities of households involved in land-use activities. There was very considerable variation between countries in the estimates for every activity. However, the averaged estimates across countries were that 43% of rural households engaged in gardening, 23% in farming, 16% in gathering wild fruits, fungi and invertebrates, 11% in fishing, 8% in hunting and 7% in forestry. Although on average only 5% were thought to go on excursions to watch wildlife, 11% were thought to feed birds at home. The smallest proportion of households (3%) was thought to have members riding horses, but 23% were estimated to use the countryside for other exercise activities.

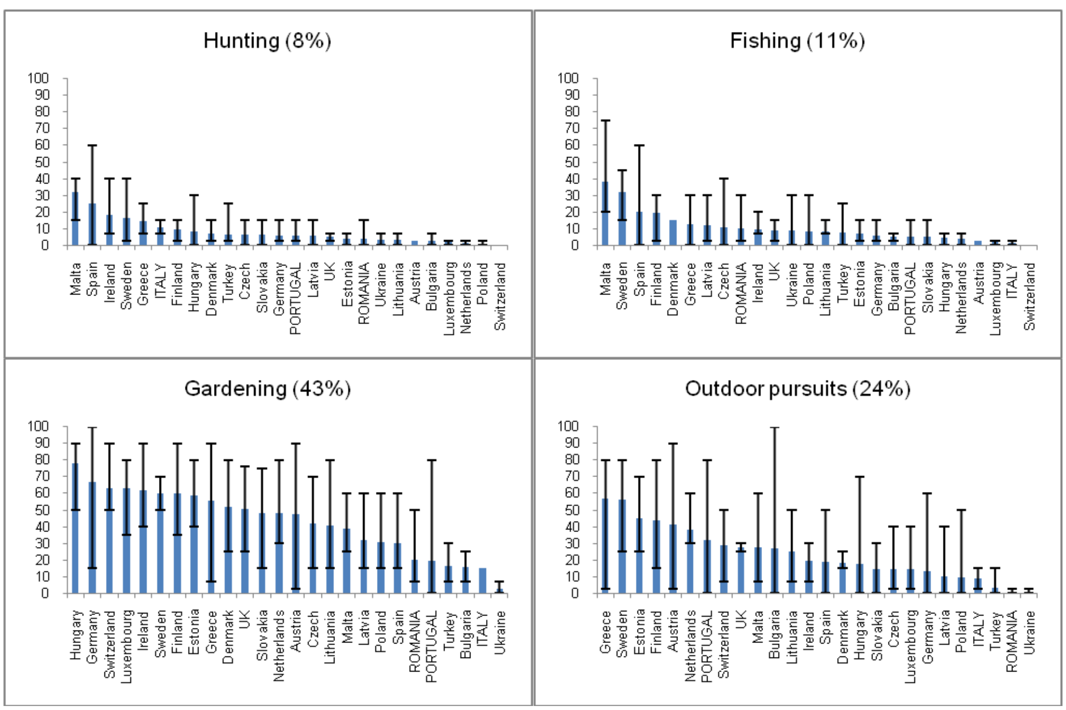

Figure 5.6 Histograms show the average % of local households estimated by LAU2s to have participants in selected activities dependant on land or species (bars are range of values).

When compared to the non-randomly selected rural areas in the local case studies carried out by TESS, where households were directly interviewed by surveyors, these participation rate estimates appear to be very low. Direct interviews revealed 53% of households engaged in gathering, 35% in fishing, 18% in hunting, 11% in horse-riding, 32% in wildlife watching, 47% in attracting wildlife with food and 57% in taking exercise in the countryside (see Figure 5.7 below). This underlines the importance of direct interviewing of individuals by random sampling across EU countries, rather than relying, as TESS perforce had to, on local government estimates of their activities. It also re-inforces the findings of the UNWIRE study that many millions of EU citizens benefit from wildlife-related activities and spend their own money on them.

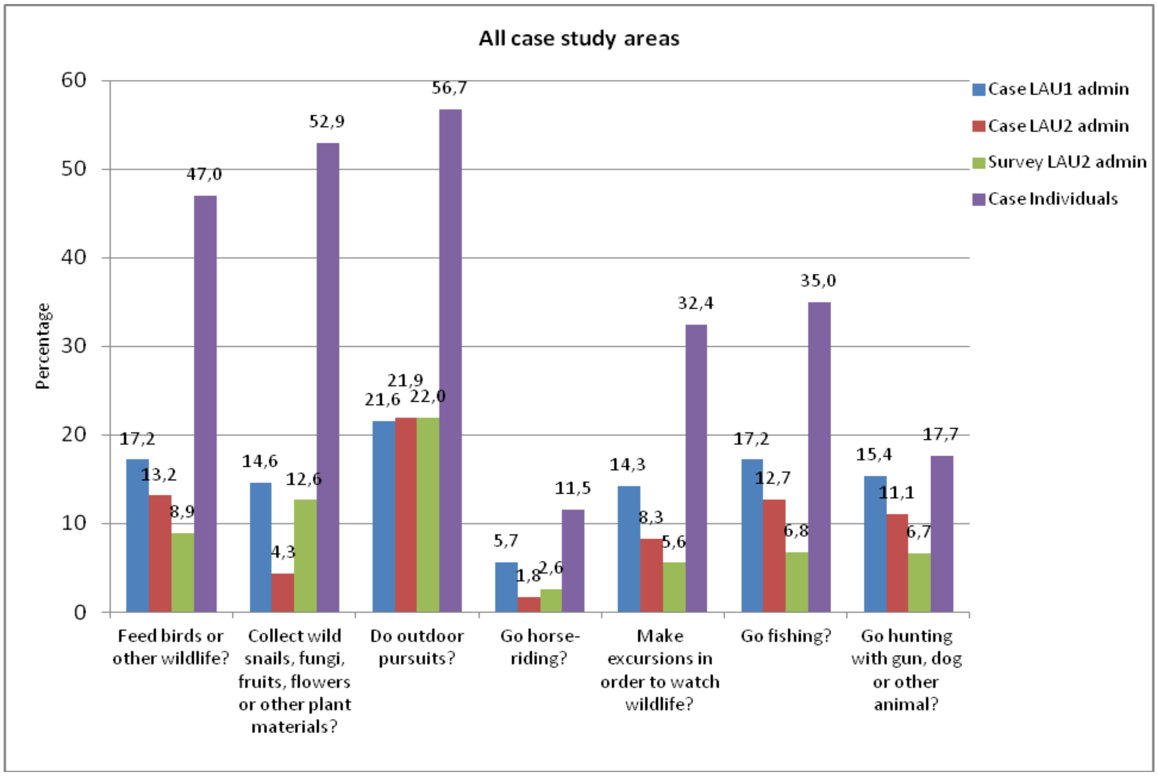

Figure 5.7 Participation rates in wildlife-related activities comparing individual interview results with those from local authority (LAU1&2) estimates.

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

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

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

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.

5.4 Citizen capability for biodiversity mapping

As well as surveying local attitudes to the importance of wildlife, the local case studies encouraged local volunteers to test the use of specially purchased digital tablets suitable for use in sunlight in order to map biodiversity and land use information at local level. This experiment was constrained by the development of the technology available at the time when planning took place (late 2009) and the resources of country partners to engage local people in the experiment. Even though only 46 people in 8 countries eventually took part the results were both interesting and encouraging. The majority of helpers had no previous experience with mapping equipment, which makes their comments especially interesting.
76% rated the mapping hardware favourably and 67% the software. Suggestions for improving the mapping facilities from the users included a need for better GPS capabilities (20%), improved maps (20%), more sensitive touch screens (9%), more visible screens (7%), less weight (7%) and longer battery life (4%). 80% of helpers considered they had gained significantly in knowledge from their participation in the project and a similar proportion would be likely or very likely to participate in such projects in the future. 97% of participants considered that their governments should support mapping projects of this kind. It was notable that the rural case studies showed high interest and competence in citizen-science mapping of habitats and species, together with a high level of engagement in wildlife-based recreational activities which could inform and motivate mapping. Accordingly we make the following recommendation:

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

5.5 Biodiversity trends associated with high-level assessment practices

At the opposite end of the spectrum to these surveys of attitudes and activities at local level, an attempt was made to relate perceived trends in biodiversity, conservation and human development indicators at European level with information derived from the TESS and GEM-CON-BIO projects in order to see whether any potentially significant correlations occurred. This is not an easy task but it is important not just to accumulate information but to see where it may be leading and to take corrective action where feasible. Even where correlations seem surprising or implausible, fresh analysis of Europe-wide indicators may give cause for reflection. This need for reflection applies particularly to recently available CORINE data relating to land cover change across the Continent. Protection status does not yet appear to have any positive effect in reducing the mean rates of conversion from other land-cover categories to artificial surfaces across countries. Artificialisation increased significantly between the periods 1990-2000 and 2000-2006, with no significant differences between areas inside and outside Natura 2000.

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

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

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

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

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

This index, which was available for 28 countries, proved to be strongly related to different capacity, priority and process variables which were in turn associated with SEBI[1] 2010 indicators. The strongest relationship was with the World Bank governance capacity variable 'Political Stability'. Fifty percent of the variation in nature-positivity (controlling for population density) was explained by the 'Political Stability' variable. This was an improvement on a recent Gallup survey where knowledge of the word "biodiversity" was used as a proxy for nature positivity; recognition of the word "biodiversity" provided no significant positive correlations with any impact variables used in the TESS analyses.

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

5.6 Working towards a decision-support system

TESS trawled widely for decision support models already in existence that might be useful for local land managers, and could perhaps be made easily available in exchange for mapping. Of 198 models volunteered or selected as suitable for TESS from about 2,400 in databases, 72% were still traceable on line, 49% were suitable for consultation at a local level and 39% were accessible as downloads or web-services. However, only 5% were considered usable by ordinary people for local level (a proportion which fell below 3% in a larger sample). Only 2 of the 205 traceable used large external databases (both of these were based on data in the USA). The conclusion was that the only substantial decision support available was for agricultural and forestry production. There was little on biodiversity and almost none for non-experts to use. The technology transfer gap in this area is large.
There is also a major language gap. Only one of the models for decision support at local level by ordinary people operated in a language other than English, although there may be models not yet found which do so. To support management decisions to the same standard across Europe requires a system operating in many languages, and bringing together the best models and practice in many languages.

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

While a sophisticated technological tool would be at the heart of a fully-fledged Pan-European environmental decision support system, it would also be essential to consider demand and supply for the information in that tool, the ease of its use for field-based practitioners, what would motivate users to use and possibly pay for it and the costs of building and maintaining it long term. TESS considers that to re-diversify land-use and hence support biodiversity we need

[1] Streamlined European Biodiversity Indicators

a tool that is attractive to a full range of partners: government at different levels, local communities, voluntary associations and individuals. All have contributions to make to assembling information which can lead to knowledge-based decisions, with scientists guiding and helping to organise the process. Maps are increasingly used by all these groups for data collection and are a convenient *lingua franca* between people in different countries. Ultimately, an intelligent web-GIS could link knowledge to maps in ways that are analogous to those by which spelling and grammar are built into word-processors.

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

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

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

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

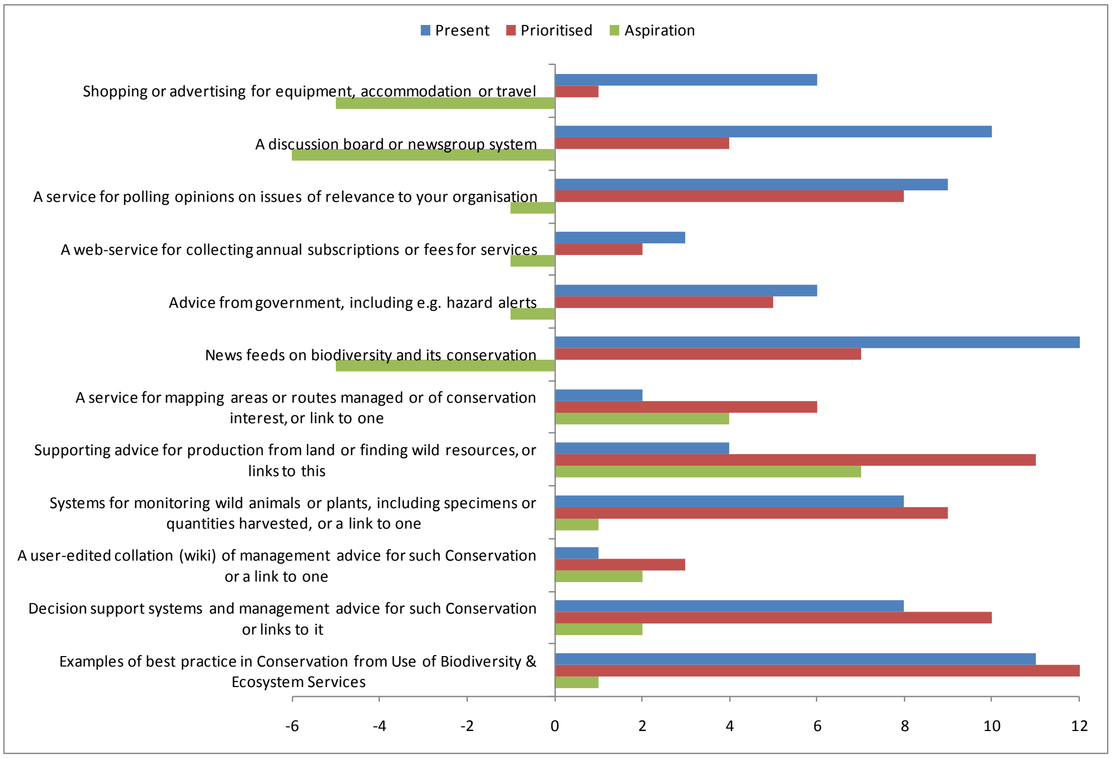

Figure 5.8 Web-services ranked by availability to organisations (blue) and as priorities for a site (red). High requirement relative to availability (green) indicates services important in a new portal.

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

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

A survey of organisations is relatively easy to arrange on SurveyMonkey, but may not indicate the same information requirements as a survey of individuals. Nor can a survey of organisations reveal what individuals might subscribe to in order to help develop a portal for mapping and decision support.
The final TESS survey is therefore now using the portal to find out what information and support individuals want and to provide mapping tools. Resource users and others are also being given the opportunity to contribute to further development of the decision support, best practice

examples and mapping tool that will initially be provided. The intention is to present material in about 25 European languages, building on the network of Country Co-ordinators who provided translations of questionnaires and linked with national and local governments in the TESS Pan-European surveys. The portal also presents links for information on how to benefit from the riches of nature, and how to avoid costs, in order to help develop positive perceptions of biodiversity.

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

6. System Design Technology

6.1. High Level Requirements

The TESS project team held a couple of workshops in Edinburgh and Brussels in order to specify the design of the system. These high level requirements are merely intended to provide a guide to the major issues regarding the system capabilities; this level is the most generalized breakdown of requirements of the system. They are not intended to be specified here at a level that they could be implemented by a developer.

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.

6.2 Domain Model

A domain model in the software engineering discipline 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. It is derived from the higher level requirements; the domain model produced by the TESS team is pictured in figure 6.1.

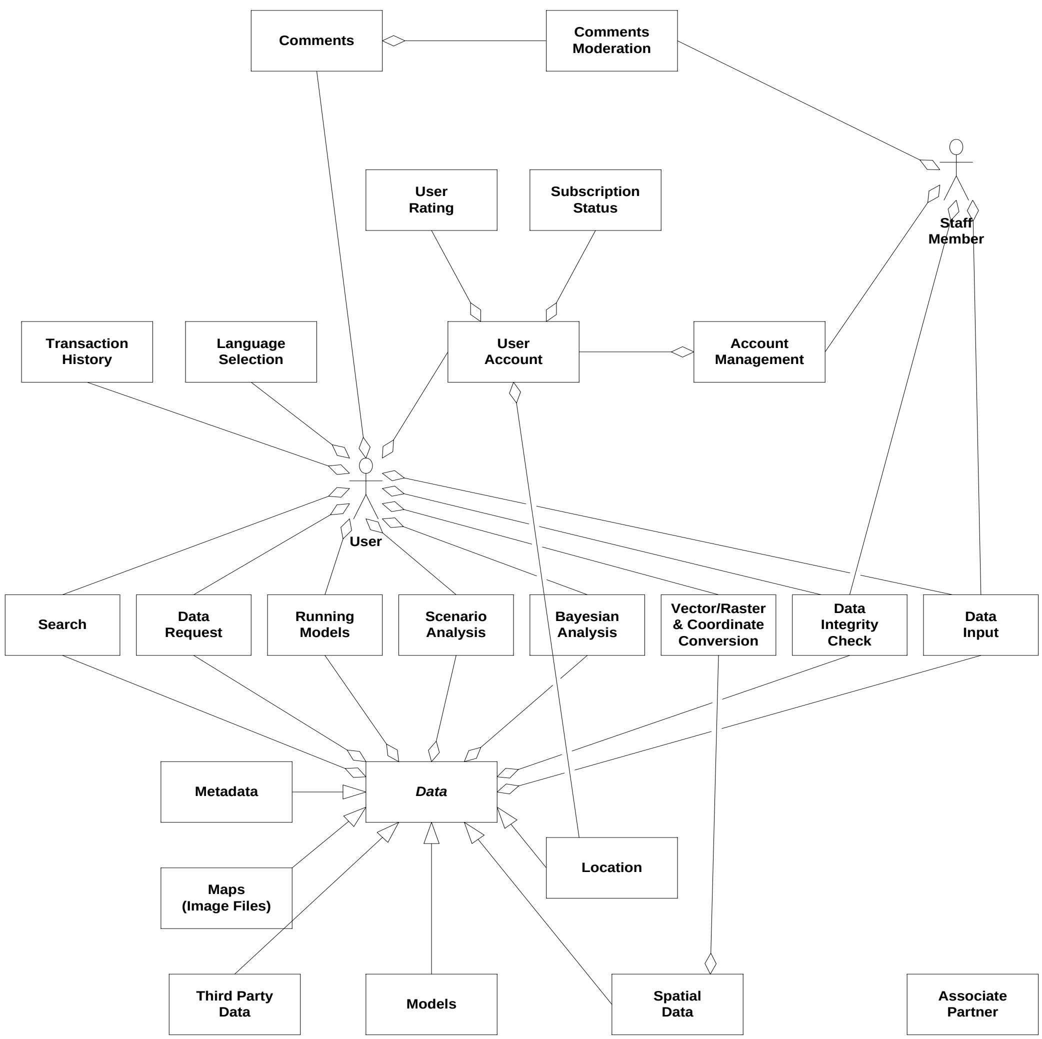

Figure 6.1 TESS system domain model

6.3 System deployment diagram

A UML system deployment diagram is about the physical view of the system; typically they are used to visualize the topology of the physical components of a system where the software components are deployed. In other words, deployment diagrams show the hardware of a system, the software that is installed on that precise hardware, plus the middleware used to connect the disparate machines to one another; figure 6.2 portrays a rough image of the TESS system.

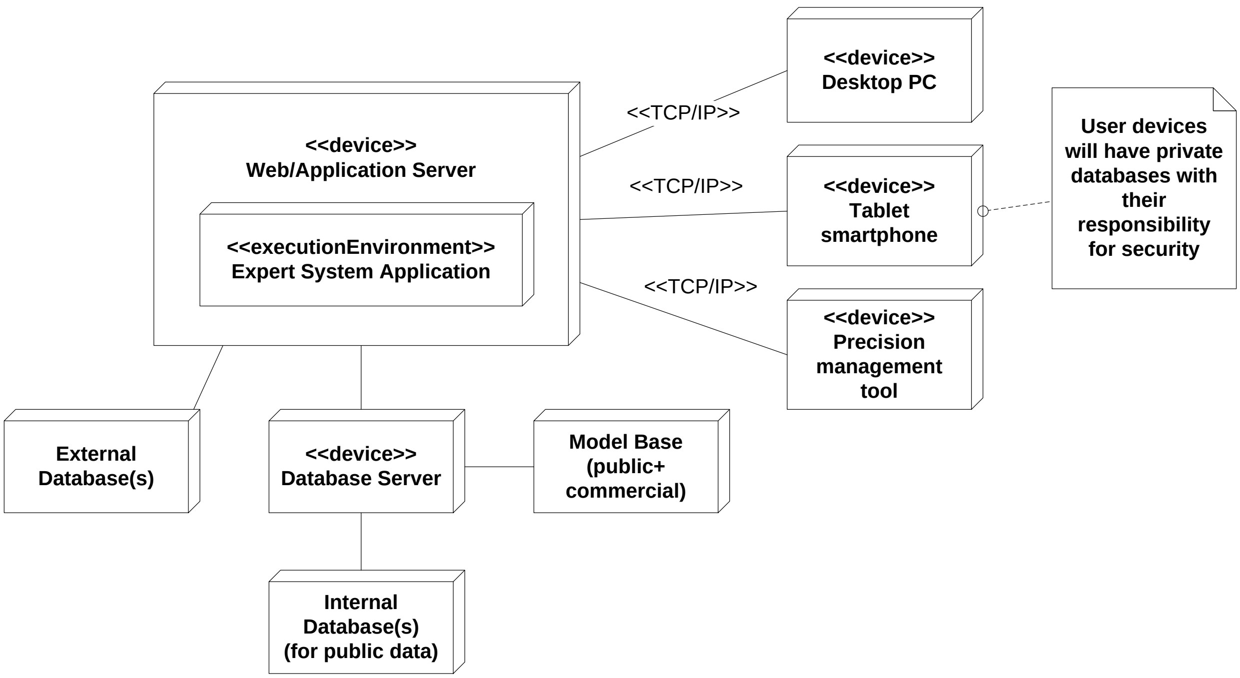

Figure 6.2 System deployment diagram

6.4 Use Cases

The use case view of a system is used to capture the behavior of a system, as it appears to an outside user; it is a partition of the system functionalities into transactions meaningful to actors, 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. Table 6.1 is a list with the TESS system use cases and their authors and figure 6.3 shows the relationships among them; what follows is an analytical description of each use case. The Use Case descriptions are as provided by authors and are purely illustrative; they will be changed in ways that are considered most appropriate when and if a system is constructed.

Table 6.1. TESS system Use Cases

Use Case number	Use Case name	Author
1	Data search	AUTH
2	Data aggregation & disaggregation	AUTH
3	Display outputs	AUTH
4	Bayesian Belief Network (BBN)	CEH
5	Display Bayesian outputs	CEH
6	Data quality assessment	CEH
7	Uncertainty assignment	CEH
8	Language Selection	Anatrack
9	User Login	Anatrack
10	Presenting model text content for translation	Anatrack
11	User Registration	Anatrack
12	Translation	Anatrack
13	Scenario builder	CEH
14	Scenario Output	CEH
15	Credits for data and model use	Tero
16	Spatial Analysis	Tero
17	Wiki Editing	Tero
18	Help and tutorial navigation	Tero

.

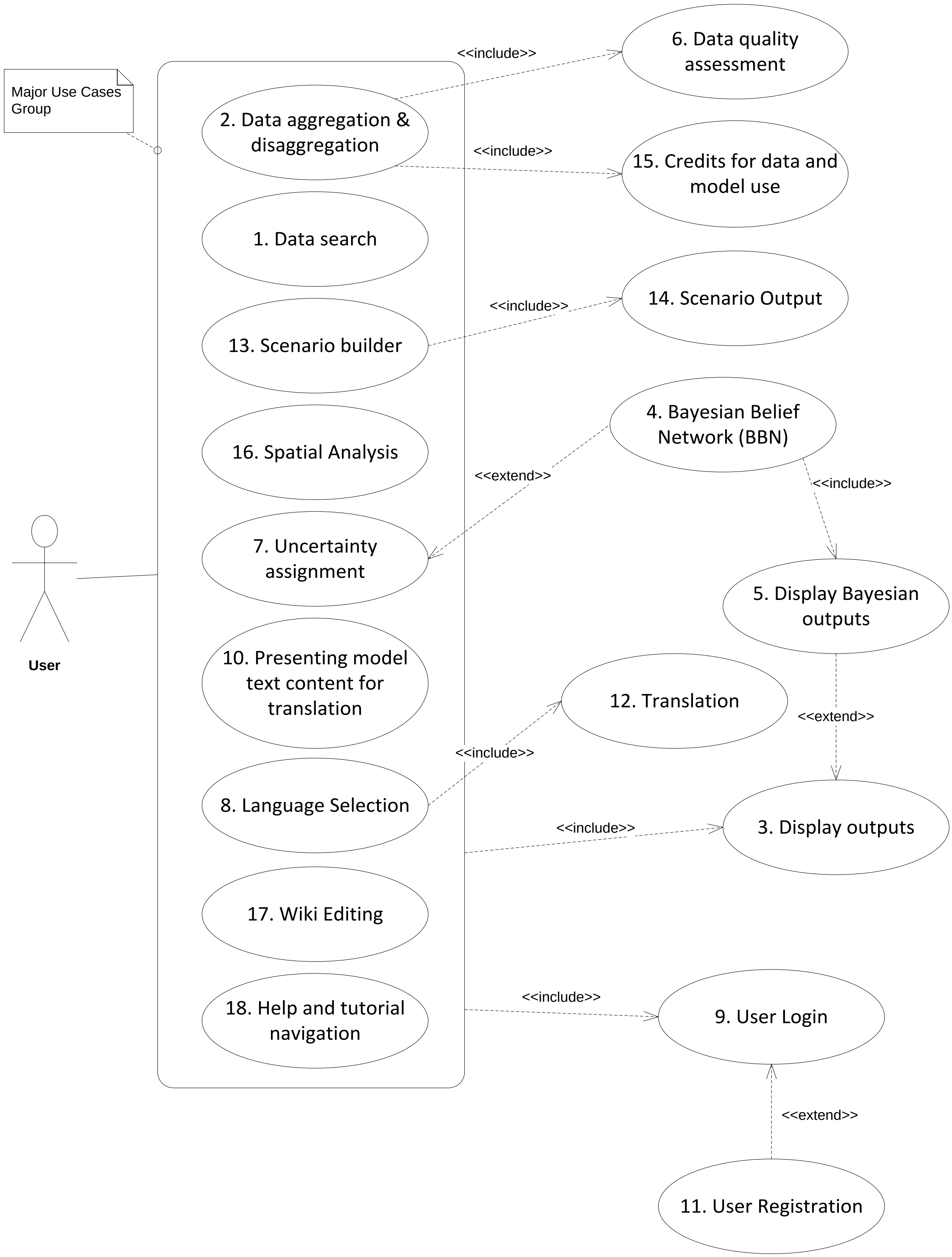

Figure 6.3 TESS system Use Cases

7. Marketing Considerations

7.1 Vision

The vision of TESS is to enlighten, encourage and empower local communities to support biodiversity restoration across Europe, through an internet system that unifies all available knowledge to guide decisions of benefit for biodiversity and livelihoods. This vision will be implemented by cooperation of public and private ventures in accordance with the following.

7.2 Background

Many projects have shown how to restore biodiversity and other services from degraded ecosystems (Benayas et al, 2009). Low cost actions that slightly reduce production can be offset by income gained from public payments to reduce natural hazards and by private payments for recreation: The Common Agricultural Policy is paying some €37 Billion for agri-environment schemes during 2007-13; annually, private spending on wildlife-related activities exceeds €40 Billion, a total of some €300/ha of cultivated land (Kenward et al 2009).
Another problem arises from poor understanding of the Convention on Biological Diversity (CBD), which recognises the importance of protected areas but also addresses extensively the sustainable use of biodiversity, which conserves it for the future. This is significant, not only because about 80% of land in Europe is outside protected area, but also because sustainable use of biodiversity is very widespread. About 30 million European citizens are hunters and anglers, with increases in populations of many species they manage; many millions more collect fungi and wild plant products; some 6 million people watch birds.

The Convention on Biological Diversity defines Sustainable Use as:
"the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations".

A key to restore biodiversity in Europe is to realise that wild resource beneficiaries, often seen as part of the *problem*, can also provide *solutions.* IUCN, for example, recognises that sustainable use can be a tool to motivate conservation. On this basis, **conservation through use of biodiversity** is to improve the conservation status of species or habitats through consumptive or non-consumptive use.
Conserving by using biodiversity is more complex than passing and enforcing protection laws. Extensive knowledge needs to be distributed, to help those who have already started to organise conservation management through hunting, angling, gathering and watching wild fauna and flora, and also to showcase their efforts as examples of best practise. People need to be engaged and motivated, for example to monitor and restore, not just to keep "hands off".

A case example
A fine example of what can be achieved by integrating knowledge and different sectoral interests comes from the Netherlands. The Dutch government recently encouraged formation of

Sportsvisserij Nederland, by combining a state regulatory arm for angling with voluntary angling organisations, endowed with a €40 annual license fee paid by all anglers over 18 years old. There are 2 million Dutch anglers, so this produces €8 million for Sportsvisserij Nederland, which has some 40 ecological and hydrological researchers, engineers and education staff needed to restore aquatic wildlife resources in the Netherlands and educate anglers and others about it, in the media and with a quarterly magazine free for license payers. Much of the work of this state-voluntary hybrid is to enable fish migration (most fish migrate short distances, if not long ones, to spawn in waters safe for small fish) across many Dutch water levels, which is creating industry in things like fish ladders and fish-safe turbines.

Towards this, TESS could first develop comprehensive guidance in all official European languages on best practice in different uses of biodiversity. The ultimate aim would be to build a system to support myriad local decisions (on when and how to manage land, water and biota) that summate to change the environment. This decision support system should help local councils, farmers, foresters, hunters, anglers, those who manage reserve or land access activities, and their many advisory organizations and consultants, in ways as simple to understand as the red or green lines in a word processor.

7.3 Legal form and Management

The developed TESS system could be operated as a non-profit enterprise in a country selected for best reach to European target groups, as well as best taxation status, and eventually to become a Foundation with a Board of Trustees for steering its long-term development. Trustees would be organisations with long experience in governance, in science and technology, and in representing those benefiting from wild resources, ideally with inclusion of appropriate financial and legal institutions. They would be drawn from private and voluntary as well as state sectors; by gaining more from shared success than individual ownership, they should discourage the agenda of any one group from dominating a powerful knowledge system. Trust-building would benefit from cooperation of the diverse organisations, also in committees for guidance of relevant content nationally and of application locally.

The organisations which are actively cooperating for initial system development are Game and Wildlife Conservation Trust to deliver knowledge to local land managers; Anatrack Ltd for secretariat and IT coordination; Tero Ltd for finance and PR coordination; the European Sustainable Use Specialist Group of IUCN (ESUSG) for expert translation and other services. Discussion about possible roles is also proceeding with European Environment Agency for liaison with CBD clearing house mechanism and for aligning the system with other ongoing activities.

An agreement could be prepared for organisations to accept specific responsibilities in building and establishing the portal to be used for the initial provision of information. Care would be needed concerning the country for incorporation of a COUNT Foundation, both in terms of constitutional constraints, annual reporting requirements and taxation, and noting that such aspects can alter when governments change.

7.4 Marketing

The TESS project is designing the socio-economic framework for a decision support system that integrates environmental knowledge. Such a system is likely to achieve wide use only if it works in conjunction with attractive services that people are starting to use already. As present environmental web-services are scattered and monolingual, a one-stop-shop with translation for all official European languages, links to these services and other assistance should be attractive. A survey of services that already help organisations and their members and clients is essential market research for designing such a one-stop shop.

However, the TESS organisations should recognize that the success threshold for the venture is high – it is very difficult to reach the critical mass without strong investment of effort, especially in promoting and communicating the service to the users. The pan-European focus of such an envisioned system creates the constant need to get new areas and new players to join and be willing to pay for it. In this respect, the system should conduct comprehensive marketing programs to support subscriptions and alliance building, and to increase awareness of its brand among the conservation community and all involved parties. These programs would include targeted public relations, online advertisements, print advertisements and articles, direct mail campaigns, industry seminars, white papers, trade shows, etc.

The focus should be on communicating the real-life benefits that may be achieved through the use of the system's services for each involved party. "Laundry lists" of features should be avoided. Instead case examples are to be used extensively, with real-life testimonials integrated into promotional materials. A series of one page Success Stories should be developed that describe how a particular community or business gained using the system's services. These success stories could also be used as the basis for articles.

A comprehensive market research programme in two stages can provide the information to design an efficient and successful service. The first stage of this market research was already conducted in the framework of TESS, in the context of Work Package 6. Issues that have been researched include:

- What proportion of individuals use natural resources and are in relevant organisations;
- What information, guidance and capabilities they need for conserving those resources;
- How much organisations are prepared to pay for the information, guidance & capabilities.

TESS research has already shown that **organisations representing and advising beneficiaries of wild resources** are essential vehicles for achieving success of the envisaged system because they are currently their main sources of relevant information. Involvement of these organisations in recommending subscription and providing content is very important for encouraging use of the system. TESS partners who are expert in different topics (Agriculture & Horticulture, Forestry & Woodland Resources, Angling & Fisheries, Hunting and Recreational Animals, Nature Watching and Reserves) have already asked representative organisations nationally to prioritise services they would seek from the envisaged system from a list of possible features, including:

a. Showing best practice in conservation through use of biodiversity & ecosystem services;
b. Decision support systems and management advice for such conservation;

c. Comprehensive management advice for conservation through use of biodiversity editable by qualified subscribers (a Wiki);
d. Solutions to monitor wild animals/plants, including specimens/quantities harvested;
e. Advice for production from land or finding wild resources;
f. Mapping areas or routes managed or of conservation interest;
g. News feeds on biodiversity and its conservation
h. Advice from government (e.g. hazard alerts);
i. A secure online environment for collecting annual subscriptions of organisations or fees for services;
j. An online environment for polling opinions on relevant issues;
k. A discussion board or newsgroup system;
l. Shopping or advertising for equipment, accommodation, travel and other opportunities.

National organisations were also asked about membership numbers, to assess their coverage in relation to data on participant numbers from other surveys, about conservation projects they organise, their internet-use and willingness to pay for web-services.

The second stage of the market research programme is to be conducted entirely by the organisational entity to impalement the envisaged system (or by an intermediate formation after the end of the TESS project, i.e June 2011), by surveying **local populations** through its internet portal. Whereas the first stage has shown the services for which organisations may be prepared to pay in order to better provide for their members and clients, the second stage should reach out to individuals within organisations and beyond, to find which of the features they would like the system to develop and whether they will pay a membership fee to support the development. For them the message must be:

- persuasive yet informative
- attractive and understandable
- short and focused
- expressing the importance of joining

Promotional activities would be essential to encourage local individuals and organisations to visit the system's portal. The promotional activities to local populations are to be implemented mainly by area representatives, through the involvement of user representatives' organisations, and with the guidance of the TESS follow-up organisations. These organisations would prepare generic templates and services presentations, which the area representatives would be able to customize and implement, according to the types of uses they focus on, the origin of users of biodiversity (local or remote), and other area specific criteria.

The promotional activities should be differentiated in order to target all audiences most effectively and efficiently, taking local liaisons and culture into account. They should aim at taking advantage of the strong vertical links of **organisations** that represent wild resource beneficiaries at European level through federation of organisations at national level that in turn often have organisational structures down to local level. Such organisations typically also have links to biodiversity based businesses, consultancies advising land-based livelihoods and governments and agencies with environment responsibilities at all these levels. These organisations may represent farmers, foresters, anglers, hunters, wildlife watchers and reserve managers, totalling perhaps 50 million people across Europe. A larger number of people enjoy outdoor recreations, including the gathering of wild fungi, flowers, fruits and other plant products, without belonging to organisations. To reach all these people, promotion of the system should also involve communication to **populations** by direct means (local events, mass media coverage, etc).

Promotional activities through **organisations** should include:

- Creation of a database of interested parties;
- Establish online and direct contacts with them, facilitating their accession into the system;
- Printing of a brochure to present the system in all involved countries in their own language.
- Participate in meetings of parties and national/international events related to biodiversity.
- Operating a central portal web site with information on the system's locations for all countries, as well as general system information

Promotional activities to **Populations** should also include:

- Contacting sympathetic reporters and media personalities, and preparing and publishing announcements and press releases in local press and other media (online and print)
- Planning and coordinating a web marketing campaign including the design and utilizations of advertising elements such as banners, as well as search engine optimization.
- Participating in social networking

The table below summarizes the promotional activities that would be implemented and sets targets for their execution:

Promotion Activities	Suggested Frequency
Brochures	Every time a new country enters the system
Social-site postings (e.g. Twitter, Face-Book)	At least once a month for each participating area
Press releases and articles in biodiversity magazines	At least four times a year for each participating area
New web material	At least once a month for each participating area
Talks at national partner meetings and public events	At least four times a year for each participating area
Local TV / radio / print media	According to targets set for each participating area

7.5 Funding

A number of sources have been considered for high and low level funding sources from public (government grants, municipality subscriptions), voluntary (large foundations, diffuse donations) and private (major corporations, individual subscriptions) sectors. With public funding currently compromised, diffuse subscriptions offer the most promising approach. Of course, this approach contains collection and income challenges.

The collection challenge is to be met by using an internet (automated) system for subscription to a service that becomes a one-stop-shop for environmental interests with added appeal as a worthwhile concept ("2010 plus, count on us" wild resource users to restore biodiversity). The challenge of getting enough income is one of attracting enough visitors, partly by free-advertising from media personalities who shoot, fish, cook wild foods or just like a new idea, partly by providing a subscription collection service for the many countryside organisations that lack it, and partly by generating commissions on click-through shopping.

The key to making this model work is getting enough (a) support from organisations who encourage their members to visit the system and pay subscriptions online (some groups may provide online subscription services already, at least in some countries, in which case the system can provide click-through to those services) (b) free-advertising from sympathetic celebrities and (c) content that people find useful.

This should be aided by the absence of any website or portal aimed at bringing together all information on any of the following properties intended for the system's portal:

- Conservation through use of biodiversity and ecosystem services;
- Across all sectors and interests involved with land, water and biota;
- In a combination that involves recording of habitats and decision support;
- In the wider countryside and developed areas as well as protected areas;
- For government, science professionals and all citizens at every level;
- In all official European languages.

The staff required to maintain the portal would be kept small, by contracting development of its components and area management, and by using a Management Group spread across other organisations. In a Foundation, a share of the income is to be reserved to cover Management Group expenses. A share instead of a lump sum fee is used in order to further motivate Management Group members towards the success of the venture. Income shares are suggested to be 2% per participating organisation, up to a maximum of 8 organisations.

7.6 Costs and Revenues during Development

In summary, three distinct phases are proposed for the development of the system:

1. Design of the system to match expressed needs (Design)
2. Deployment of the system to the field and proof of concept (Development)
3. Start of full blown operations and achieving impact (Expansion)

The following table provides a concise summary of the system's targets for all phases:

Design (2010-2011)	Development (2011-2012)	Expansion (2013 onward)
• Consult stakeholders	• Build brand recognition	• Constitute Foundation
• Define operational and business model	• Sign up members	• Broaden and deepen alliances on pan-European / global scales

Design (2010-2011)	Development (2011-2012)	Expansion (2013 onward)
• Secure IP rights	• Sign up commercial links	• Increase subscriptions / revenue
• Build management capacity and software	• Secure conditions for growth	• Build environmental Wiki capabilities
• Ally with conservation organizations and stakeholders	• Create a pan-European / global brand	• Build secure chassis for Back-Office and forecasting engine
• Start operations	• Design Foundation	• Offer mobile & new services

Initial targets for the first phase are being achieved: We are designing a system that meets stakeholder needs, as a result of consultations with user groups and work within the TESS project. A management group is being set up, and negotiations with funding partners are under way in order to start operations.

We have also tested operational use of the system through pilot cases in 9 countries (Estonia, Germany, Greece, Hungary, Poland, Portugal, Romania, Turkey, UK) through Work Package 5. National case-study partners in each area have worked with a local community (a) to study how best to enthuse people for projects on local mapping and species-monitoring and (b) to determine the most needed information and best delivery mode through planning a project to gain socio-economic benefit from biodiversity.

During 2011 the second phase of growth has also started, where the system's portal is being developed and generate subscriptions and revenues. Our key milestones are the following:

- 2011: Create organisation, start operations, sign up 5,000 subscribers
- 2012: Deploy system fully, sign for commercial links and 35,000 subscribers
- 2013+: Operate the system across Europe, sign up 1,000,000+ subscribers

ESUSG has been arranging the portal's translation of content through a network of Country Coordinators. Individuals linked to the system's management group will manage the portal until it becomes clear whether there is enough interest for creation of a Foundation to expand the system, using voluntary subscriptions and any public support that may be available from national governments or the European Commission.

Initial revenue estimates are tentatively based on the assumption that half of the subscribers will pay €5 per year, and half will pay €10 per year. It is likely to need more than one **million subscribers**, or substantial donations or a combination of the two, to build Back-Office facilities; this cost can't be estimated accurately at this moment, but might lie in the range of €5-10 million.

7.7 SWOT

Strengths	Weaknesses
• Sustainable use message is coming of age • Huge practical knowledge-base available	• Complexity of message • Operational threshold high – critical mass may be difficult to reach.

• Internet helps reach mass audience and accumulate small payments • EU-funded project absorbs design costs • Pan-European network already in place	• Strategic partners with high profile in the conservation community are needed. • A brand needs to be promoted to the conservation and wildlife community.
Opportunities	**Threats**
• Significant public funding opportunities. • Potentially >50 million subscribers • Huge knowledge-base to communicate • Virtual cycle of membership generating knowledge attractive for more members	• Technical infrastructure and initial foundation costs might be hard to fund. • Protection ethos (“hands off” approach) may adversely affect the venture.

7.8 Intellectual Property Rights

The envisaged system and its corresponding portal and applications is a work which has the particularity of being presented in a variety of different forms (as a web site, as an online database, as texts, or even as printed material) and of containing different types of works (software, images, texts, etc). Intellectual property rights do not include a specific type of protection for portals and websites. Therefore, a website has the particularity of being covered by different, often complementary, types of protection.

The portal is a structure that can be protected by copyright as an original work, or in some cases by database legislation. The superimposition of various types of content: images, logos, texts, sounds, videos, software, databases, means that the work may be protected either by general copyright or by a specific copyright dedicated to a specific type of work (such as software or a database).

These forms of protection apply automatically and exist without any formalities (such as a deposit or copyright notice). Nevertheless, a copyright notice including the name of the author or the owner of the rights could be useful in order to prove the ownership of the rights in the event of a dispute.

Different original content on the portal may be individually protected by copyright. This would be the case for the texts, images, pictures, logos, and software that are included on the portal. Moreover, the system’s GIS information and the content of its database, even where is not original, may be protected by the sui generis database right. Non-original content may be, for instance, non-original information such as a listing of area monuments, phone numbers of museums, etc. The EU Database Directive (96/9/EC) defines a database as "a collection of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means". The content of the database can be protected when it can be shown that there has been a qualitatively and/or quantitatively substantial investment in obtaining, verifying or presenting such content. The Directive does not define the concept of "substantial investment". Therefore, a specialized lawyer should assist the system’s Management Board as regards the current opinion of the courts of justice on this crucial definition.

A Foundation should also choose a name for the system/portal and register it together with an appropriate logo as Trade Marks, so that the system’s name would be used as a trademark in

Europe for promoting biodiversity related information. A trade mark is a sign that distinguishes the goods and services of one trader from those of another and can thus be used as a market tool allowing consumers to identify and recognize the products and services offered by a certain trader. The exclusive right over a trade mark is obtained by registering the sign at a trade mark office. In most countries, trade mark registration lasts 10 years and is renewable indefinitely by 10-year periods. In order to proceed to the registration of a mark, the company will submit an application form to the competent organization with a corresponding payment. For the European Union, the application is submitted to the Office for Harmonization in the Internal Market (OHIM - www.oami.eu.int). The application fee is approx. € 2,000.
A patent can be an option for further protection of the decision support system. Patents are considered to protect technological inventions, either products or processes. A patent provides the patent holder with the right to exploit the invention during 20 years in an exclusive manner. She can also prevent others from producing, offering, selling or using his invention, without his permission. Before applying for a patent, research in online patent databases would be conducted to identify awarded or submitted patents that are in direct conflict with the envisaged decision support system. The following sources should be researched:

- The World Intellectual Property Organization - http://www.wipo.int.
- The European Patent Office - http://www.european-patent-office.org.
- The United States Patent and Trademark Office http://www.uspto.gov/patft/index.html.

The Foundation can also protect its trade secrets by requiring all involved parties with access to proprietary information to sign confidentiality and non-disclosure agreements.
Initial discussions within the TESS group have indicated a willingness of Anatrack Ltd to assume the initial development and operation (and costs) of the portal, after the end of TESS. Ownership specific to the portal would remain with Anatrack Ltd during the development phase, as Anatrack will mainly have the responsibility of developing it. Once 35,000 COUNT members have been recruited, ownership and portal-specific IPRs should pass from Anatrack to a non-profit organisation. If this recruitment milestone is not reached, ownership and IPRs would remain with Anatrack. In this case, Anatrack agrees to make the content of the portal freely available to other parties for non-commercial purposes.

8. TESS Final Conference

A Conference was organised by the European Parliament Intergroup on Climate Change, Biodiversity and Sustainable Development in the European Parliament, Brussels on May 25th, 2011 to present the TESS project and its results to EU policymakers and other interested parties. The Conference served to present the project to a wider audience of policy makers and to discuss the results and potential policy applications emerging from the project.

The TESS conference aimed to address a broad audience, beginning by briefly introducing the project and going on to focus on the application of the results, an explanation of the TESS portal and the potential policy guidelines generated through the TESS project. The conference was attended by a wide range of stakeholders and had a high presence of MEPs in the audience. The conference was hosted by MEP Cristina Gutiérrez-Cortines who advocated the empowerment of local communities and emphasised their role in developing effective environmental policy.

The conference was opened by Professor Basil Manos, who gave the floor to Olivia Chassais (DG RTD) and Cristina Gutiérrez-Cortines (MEP - Co-chair of the Intergroup). OC opened the conference by first commenting on the main merits of the TESS project. These included the timing and relevance of the project given its link to Europe's transition towards a more resource efficient world, and the strong role ecosystem services have to play in this. Secondly, the process/ tool being developed by TESS are considered to have a very real role to play. She commented that resource efficiency has to come from the bottom and be a shared responsibility, requiring public consultation and participation. The tool TESS is developing has the potential to encourage wider public participation. In addition, it was commented that one of the key strengths of the tool is that it is not only for expert use, but is instead accessible to the wider public, which is vital to the development of evidence based policy. It was suggested that the use of the tool and the resulting wider public engagement will allow for better understanding of best practice and the needs of different regions. Further to this, she commented on the project's ability to bring together different groups of stakeholders and land users, including the involvement of the local authorities. The importance of including local authorities in the process was based on the need to have an understanding of the needs of local regions in order to ensure development of effective strategy and policy. She concluded by stating that TESS is a unique project requiring effective dissemination of the results and the resulting tool.

Cristina Gutiérrez-Cortines followed on and discussed why the TESS project is a necessary component of the development of resource efficient policy development. Currently there is no effective system for bridging the gap between local stakeholders and policy makers, something that is key to generation of effective policy. Gutiérrez-Cortines commented on the fact that often local land users and stakeholders don't have an understanding of the language surrounding biodiversity and ecosystem services and therefore rarely understand the holistic and systemic view of biodiversity held by policy makers. Given this, she championed the inclusion of local authorities (LAs) in the process as an important tool for knowledge transfer, identifying LAs as the way in which environmental information and the TESS system could be included in education. She finished by stating that people needed to have a better understanding of the links between biodiversity and development and the holistic approach being proposed by TESS.

Basil Manos went on to welcome the audience and speakers to the conference, introducing the presentation of the results of the TESS project to date. He went on to introduce the conference sessions, highlighting the round table session as an opportunity to discuss the application of TESS to the development of policy.

Session one began with a presentation from Stratos Arampatzis (Tero Ltd.) who gave a brief introduction to the TESS project, the rationale behind the project, the work packages and the deliverables of TESS. The rationale for the project stems from the concerning global loss of biodiversity and the resulting impact on ecosystem services, and that local individuals and stakeholders cannot use formal environmental assessments for decision-making. The aims of TESS were to design a support system for management with a need to establish what each group required. The presentation was concluded with the statement that TESS aims to complement the formal management systems through use of an informal method of integrating information for effective decision making.

Following this introduction to the TESS project, Dr Pedro Beja (ERENA) delivered a presentation outlining the implications of policies on land use and economic activities and the impact these have on trends in ecosystem services and biodiversity. This analysis was conducted in a bid to establish indicators of best practice across a Pan-European Network. The key conclusions of this work were as follows:

- Analysis of the data collected suggested that structural and socio-economic capacity features can have lasting impacts on biodiversity trends and can influence society's perception of biodiversity;

- In contrast, the research suggested that governance processes and management priorities were seen to have weaker impacts on biodiversity, thought to be due to short term approaches being used;

- And finally, that there was variation between countries' approach to environmental management and governance which was thought to reflect a variation in societal perception of biodiversity and use of ecosystem services and processes.

A brief overview of some of the results gathered through case studies (Work Package 5) was presented by Dimitra Manou (Aristotle University of Thessaloniki) and Dr. Ion Navodaru (Danube Delta National Institute for R&D). Dimitra first introduced the case study phase of the project, outlining the objectives of this phase of data collection. The local case studies were conducted in a bid to ascertain how best to meet the decision support needs of local communities, to establish whether local monitoring programmes can meet government requirements, and finally to assess local attitudes and capacity to conduct the environmental monitoring required. She gave a brief overview of the methodologies used throughout this phase of data collection and presented some of the collated results from all of the local case studies conducted across Europe. The floor was then given to Ion who had the opportunity to present some of the results specific to the Saint George Commune Case Study. The aim of the project was to involve the local community in establishing an alternative resource to the traditional activity of fishing. This local case study concluded that biodiversity mapping could be used to include local information in decision making processes. Although another resource was established (the sea-buckthorn), it was identified that the local community would be reluctant to move away from their traditional activities and that this would be a major challenge to the implementation of future projects of this type.

Dimitra continued her presentation; the main conclusions were that local communities expressed a desire to have access to more data and the availability of an accessible data base would be welcome. Although the motivation behind local communities' involvement in the project varied, it was found that local communities were generally willing to participate voluntarily with projects of this type. It was found the local communities could provide valuable information, although, as suggested by Ion's presentation, there are some challenges to the projects of this type such as a lack of IT training and poor relationship between communities and authorities. Finally, it was found that the information provided by local communities could be easily incorporated into environmental decision making.

After this synthesis of the case study results was presented, Professor Mari Ivask (Tallinn University of Technology) presented an evaluation of the currently available models suitable for bio-socio-economic prediction (WP4). This review highlighted the fact that although there were over 198 models identified, most of these were either not fit for purpose, no longer available or were deemed inaccessible to non-experts. Following questions from the audience, it was further explained that these results showed that although the science is being conducted, the resulting models are being used at a professional level and knowledge transfer to local levels is not being facilitated.

The design of the TESS system was presented by Prof Robert Kenward (TESS science supervisor). He introduced the high level requirements that the model would need to meet and gave an overview of how the online model would work. He highlighted the need to build a portal that is accessible, attractive and that benefits the livelihoods of land users. He presented the results of a survey to establish willingness to pay and information priorities from organisations whose members would be using the portal. The key observation was the identification of habitat maps as the primary area in which individuals would welcome more information. He also presented the features that would be most appreciated on the website. All of this information is being used to develop the final TESS portal, the pilot version of which will be online in the coming weeks.

Eighteen draft policy guidelines derived from the results of the earlier work packages were presented by Robin Sharp (Chair Emeritus, European Sustainable Use Specialist Group of IUCN/SSC. He began by linking the objectives of TESS to the CBD Malawi Principles of an Ecosystem Based Approach stating that there needs to be balance, integration and should consider all forms of relevant information. The eighteen draft policy guidelines are aimed at a wide audience including governance and research communities, as well as being accessible to local land users.

Following the presentations from the TESS partners, two key note speakers were asked to take the floor. Professor Jacqueline McGlade (Executive Director of the EEA) gave the first presentation. She began by commenting on the transition that environmental governance is currently experiencing, and highlighted the importance of community involvement in environmental resource management and policy development. She acknowledged that although there are benefits associated with higher levels of community engagement, there are a number of challenges. It was stated that "awareness needs to be harnessed...and there needs to be development of tools and meaningful public consultation". She also commented on the traditional time lag between the development of environmental theory and its incorporation into policy and management strategies. She went on to discuss two EU projects which currently focus on encouraging community engagement with environmental monitoring. These were "Eye on Earth" and "Nature Watch", both of which are interactive systems and are aimed at drawing citizens into science and encouraging a sense of ownership within local communities for their environment. She stressed that she felt there were good links between these existing projects and the objectives of the ongoing TESS project and felt that there was scope for collaboration between the TESS partners and the EEA. She felt that the TESS project offers a 'phenomenal way to reach civil society" and make something of local knowledge and expertise, concluding her presentation by offering the EEA as a "home for TESS".

Morten Thoroe (CEPF) began his presentation by introducing CEPF as the "voice of European forestry" primarily representing small forest owners. Having worked with community based land owners, CEPF have found that encouraging a sense of environmental ownership is key to developing effective policy. Based on his own experience with CEPF, he finished his presentation by identifying a number of potential challenges facing the effective implementation of the TESS system, inter alia on data confidentiality for landowners and data quality of other observers. He finished by providing two questions for discussion in the Round Table Session.

1) Is a focus on species, sites or ecosystems the correct approach to managing environmental resources?

2) Can we really survey an environment that is changing so rapidly?

Once the presentations were complete, the audience were given the opportunity to ask questions and discuss the results and policy guidelines that had emerged from the project. Issues were raised regarding the capacity of local land users to collect high quality data. There were also some questions regarding the lack of IT training and knowledge and the barriers that this presented to the successful dissemination of TESS. The key points to come out of the open discussion session were the need for credible data, the need for effective promotion of the portal among land users and the need to ensure that users are motivated to be involved in the project and that they will use the system. During the question session, MEP Paul Rubig (Committee of Industry, Trade, Research and Energy) emphasized the need for a decision-making system that provides better support for both policy makers and local communities.

Following the talks from the guest speakers and the open discussion session, Robert Kenward presented an overview of the project and reminded the audience of the complexity and challenges of the TESS project. He presented the overall conclusions of the TESS conference and commented upon:

- TESS conducted extensive surveys assessing the governance and information requirements for policy making,

- High levels of interest and competence in citizen based science, and a high engagement in activities that could inform mapping projects,

- There is a current lack of useful and accessible software that could be used to support stakeholder decision making,

- A survey conducted during TESS informed the development of an online portal constructed to provide stakeholder decision making support and to act as a further stakeholder survey. The second survey will assess the efficiency of the portal and allow any necessary changes to be made.
- The development of policy recommendations were based on the findings of the project and support the implementation of a TESS system,
- Finally, that TESS needs to work in closer collaboration with stakeholders and the EEA to provide good environmental governance that encourages and empowers stakeholders.

9. Edited book

9.1 Background

The TESS project partners have decided to publish an edited book titled “Transactional Environmental Decision Support System Design: Global Solutions”, through a scientific publications house to make available the project results to the general public. Towards this, a contract has been signed with IGI publishers (www.igi-global.com) and the book will be available at 2012. The book editors are prof. Robert Kenward, Dr. Jason Papathanasiou, prof. Basil Manos and Mr. Efstratios Arampatzis.

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10 References

Adams, W.M., 2004. Against Extinction: the story of conservation. Earthscan, London

Argent, R.M., Houghton, B., 2001. Land and water resources model integration: software engineering and beyond. Advances in Environmental Research 5: 351-359.

Aruvee, E, & Piirimäe, Kr. 2010. D4.1 Database of models that relate species and incomes to land-use. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Bagader, A.A., El-Sabbagh, A.T.el-C. Al-Glayand, M. as-S. & Samarrai, M.Y.I-D.1994. Environmental protection in Islam. IUCN, Gland, Switzerland & Cambridge.

Beja, P., Kenward,R.E. & Ewald,J. 2011. D6.1
Biodiversity Trends associated with EIA, SIE and SEA Practices. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Benayas, J.M.R., Newton, A.C., Diaz, A. & Bullock, J.M. 2009. Enhancement of Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis. Science 325:1121-1123.

Berkes, F. 2007. Community-based conservation in a globalized world. Proceedings of the National Academy of Sciences 104: 15188-15193.

Boatman, N.D. & Sotherton, N.W. 1988 Agronomic consequences and costs of managing field margins for game and wildlife conservation. Annals of Applied Biology 17: 47-56.

CBD: Convention on Biological Diversity (2000) Malawi Principles of an Ecosytem Approach (Decision V/6). www.biodiv.int.

CBD: Convention on Biological Diversity (2004) Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity (Decision VII/12) www.biodiv.int.

Commons, M.L., Trudeau, E.J., Stein, S.A., Richards, F.A., Krause, S.R. 1998. Hierarchical complexity of tasks shows the existence of developmental stages. Developmental review. 18: 237-278.

CORINE land-cover (http://www.eea.europa.eu/publications/COR0-landcover).

COWI 2009a. Study concerning the report on the application and effectiveness of the EIA Directive carried out by COWI consultants, Kongens Lyngby for the European Commission DG Environment.

COWI 2009b. Study concerning the report on the application and effectiveness of the SEA Directive (2001/42/EC) carried out by COWI consultants, Kongens Lyngby for the European Commission DG Environment.

Derry, J.F., 1998. Modelling ecological interaction despite object-oriented modularity. Ecological modelling 107: 145 – 158.

Dimas, Stravros 2009. Speech to European Biodiversity Action Plan Conference in the European Parliament. http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/09/54

NUTS 2009: Eurostat website: http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/nuts_classification

Ericsson, G. & Heberlein T.A. 2002. Jägare talat naturens språk (Hunters speak nature's language): A comparison of outdoor activities and attitudes towards wildlife among Swedish hunters and general public. Zeitschrift für Jadgwissenschaft 48:301-8.

ESPON 2009. First Interim Report of ESPON Typology Compilation, ESPON 2013 Programme: http://www.espon.eu/main/Menu_Projects/Menu_ScientificPlatform/typologycompilation.html

Ewald, J. Beja, P. & Kenward, R.E. 2011. D5.2 Database of SEA, SIA and EIA factors. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Gadgil, M. and Guha, R. (1992), This Fissured Land: An Ecological History of India. Delhi: Oxford University Press.

Goss-Custard, J.D. & Sutherland, W.J., 1997. Individual behaviour, populations and conservation. In: J.R. Krebs and N.B. Davies (Editors), Behavioural Ecology: An Evolutionary Approach. Blackwell Science, Oxford, pp. 373-395.

Hawken, P., Lovins, A., Lovins, H., 1999. Natural capitalism: creating the next industrial revolution. Little, Brown and Company. 416 pp.

Hodder, K.H., Sharp, R.J.A., Perrella, L., Butters, J., Kenward, R.E. & Ewald, J. 2009. Synthesis report: Central and local information flows and decision making requirements. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Hofman, D., 2005. LIANA Model Integration System – architecture, user interface design and application in MOIRA DSS. Advances in Geosciences 4: 9-16.

Holling, C.S. 1978. Adaptive Environment Assessment and Management. Wiley, London.

Jörgensen, S.E., Bendoricchio, G. 2001. Fundamentals of ecological modelling (third ed.), Elsevier, Oxford. 480 pp.

Karacsonyi, Z. Simoncini, R., Kenward, R. and Arampatzis, S. 2008. Chapter 6. Main Results - Conclusions from GEMCONBIO. Pp. 140-160 in Manos & Papathanasiou (2008).

Kenward R.E., Ewald, J., & Sharp, R.J.A. 2010. D5.1 Report on Pan-European survey of assessment processes. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

R. E. Kenward, M. J. Whittingham, S. Arampatzis, B. D. Manos, T. Hahn, A. Terry, R. Simoncini, J. Alcorn, O. Bastian, M. Donlan, K. Elowe, F. Franzén, Z. Karacsonyi, M. Larsson, D. Manou, I.

Navodaru, O. Papadopoulou, J. Papathanasiou, A. von Raggamby, R. J. A. Sharp, T. Söderqvist, Å. Soutukorva, L. Vavrova, N. J. Aebischer, N. Leader-Williams, and C. Rutz. 2011. Identifying governance strategies that effectively support ecosystem services, resource sustainability, and biodiversity. Proceedings of the National Academy of Sciences 2011: 1007933108v1-201007933.

Kenward, R. Manos, B., Arampatzis, S. & Papathanasiou, J. 2009. A transactional environmental support system for Europe. Pp. **-** in Hřebíček, J., Hradec, J., Pelikán, E., Mírovský, O., Pilmmann, W., Holoubek, I. & Legat, R. (eds.) Towards eEnvironment (Challenges of SEIS and SISE: Integrating Environmental Knowledge in Europe). European conference of the Czech Presidency of the Council of the EU.

Kenward, R. & Sharp, R. 2008. Use Nationally of Wildlife Resources across Europe (UNWIRE). Pp. 82-86 in Manos & Papathanasiou (2008).

Kenward, R., Sharp, R., Manos, B., Arampatzis, S., Brainerd, S., Lecocq, Y., Wollscheid, K. & Reimoser F. 2009. Conservation from use of biodiversity and ecosystem services. Pp. 68-83 in Proceedings of the XXIX International Union of Game Biologists Congress, Moscow, Russia.

Kenward,, R.E., Ewald, J. .& Sharp, R.J.A., 2010. Report on pan-European survey of assessment processes. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Koestler, A. 1967. The ghost in the machine. Penguin Group. 400 pp.

Manou, D. & Papathaniousou, J. 2011. D5.3 Case Studies Results: a Synthesis. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Manos, B. & Papathanasiou, J. 2008. GEMCONBIO: Governance and Ecosystem Management for Conservation of Biodiversity. Aristotle University of Thessaloniki, Greece.

Martinéz, J., Viñuela, J. & Villafuerte, R. 2002. Socio-economic aspects of gamebird hunting, hunting bags, and assessment of the status of gamebird populations in REGHAB countries. Part 1. Socio-economic and cultural aspects of gamebird hunting. Workpackage 1 in Viñuela, J. (ed) Reconciling Gamebird Hunting and Biodiversity (REGHAB) EKV-2000-00637 (http://www.uclm.es/irec/Reghab/inicio.html).

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Moore, R.V., Tindall, I., 2005. An overview of the Open Modelling Interface and Environment (the OpenMI). Environmental Science and Policy 8: 279 – 286.

Newton, I. 2004. The recent declines of farmland bird populations in Britain: an appraisal of causal factors and conservation actions. Ibis 146: 579-600.

Ostrom,E., Burger, J., Field, C.B., Norgaard, R. & Policansky, D. 1999. Revisiting the commons: local lessons, global challenges. Science 284:278-282.

Pain, D.J. & Pienkowski, M.W. 1997. Farming and birds in Europe. Academic Press, London.

Perrella, L., Ewald, J., Kenward R.E. & Hodder, K.H. 2009. D3.2 Environmental information supply and demand at the local level: Conceptual models of information flow. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Peyton, R.B., Vorro, J., Grise, L., Tobin, R. & Eberhardt, R. 1995. A profile of falconers in the United States: falconry practises, attitudes and conservation behaviours. Transactions of the 60th North American Wildlife and Natural Resources Conference, pp. 181-192.

Piirimäe, Kr. 2011. Provision of decision support in environmental management. Int. J. Sustainable Society. X: xxxx.

Piirimäe, Kr. 2010. D4.2 Report on types of models that exist. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Pimm, S.L., Ayres, M., Balmford, A., Branch, G., Brandon, K., Brooks, T. Bustamante, R., Costanza, R., Cowling, R., Curran, L.M., Dobson, A., Farber, S., da Fonseca, G.A.B., Gascon, C., Kitching, R., McNeely, J., Lovejoy, T., Mittermeier, R.A., Myers, N., Patz, J.A., Raffle, B., Rapport, D., Raven, P., Roberts, C., Rodríguez, J.P., Rylands, A.B., Tucker, C., Safina, C., Samper, C., Stiassny, M.L.J., Supriatna, J., Wall, D.H.& D.Wilcove. 2001. Can we defy nature's end? Science 293: 2207-8.

Poch, M., Comas, J., Rodriguez-Roda, I., Sanchez-Marre, M., Cortes, U., 2004. Designing and building real environmental decision support systems. Environmental Modelling & Software, 19: 857-873.

Pretty, J.N. 2002. People, livelihoods and collective action in biodiversity management. In O'Riordan, T. & Stoll-Kleeman, S. (eds), Biodiversity, sustainability and human communities: protecting beyond the protected: 61-86. Cambridge University Press, Cambridge.

Pretzsch, H., Utschig, H., Sodtke, R. Applications of tree growth modelling in decision support for sustainable forest management.

Redpath S.M., Arroyo B.E., Leckie F.M., Bacon P., Bayfield N., Gutiérrez R.J. & Thirgood S.J. 2004. Using Decision Modeling with Stakeholders to Reduce Human–Wildlife Conflict: a Raptor–Grouse Case Study. Conservation Biology 18: 350-359.

Reimoser, F & Reimoser, S. 1997. Game damage and game benefit – objective assessment of the ungulate impact on the forest vegetation. Zeitschrift für Jadgwissenschaft 43: 186-196.

Robinson, A.P., Ek, A.R., 2003. Description and validation of a hybrid model of forest growth and stand dynamics for the Great Lakes region. Ecological modelling, 170: 73-104.

SEBI indicators (http://www.eea.europa.eu/publications/progress-towards-the-european-2010-biodiversity-target-indicator-fact-sheets).

Sharp, R.J.A., Ewald, J. & Kenward R.E. 2009. D2.2 Model of information flows from local & regional to central. Report to the European Commission from FP7 Project #212304 (Transactional Environment Support System).

Sutherland, W.J., 1996. From individual behaviour to population ecology.
Oxford University Press, Oxford, UK.

Sturtevant, B.R., Fall, A., Kneeshaw, D.D., Simon, N.P.P., Papaik, M.J., Berninger, K., Doyon, F., Morgan, D.G., Messier, Cr. 2007. A toolkit modeling approach for sustainable forest management planning: achieving balance between science and local needs. Ecology and society 12(2): 7.

Thomas, J.A., Telfer, M.G., Roy, D.B., Preston, C.D., Greenwood, J.J.D., Asher J., Fox, R., Clarke, R.T. & Lawton, J.H. 2004. Comparative Losses of British Butterflies, Birds, and Plants and the Global Extinction Crisis. Science 303: 1879-1881.

USDI, FWS & USDC. 2007. 2006 National survey of fishing, hunting and wildlife-associated recreation, US Department of the Interior Fish and Wildlife Service, Fish and Wildlife Service and US Department of Commerce Census Bureau, Washington DC.

Walker, D.H., 2002. Decision support, learning and rural resource management. Agricultural Systems 73: 113-127.

Walters, K. 1986. Adaptive Management of Renewable Resources. Macmillan, New York.

Walpole, M. Almond, R.A.E., Besançon, C., Butchart, S.H.M., Campbell-Lendrum, D., Carr, G.M., Collen, B., Collette, L., Davidson, N.C., Dulloo, E., Fazel, A.M., Galloway, J.N, Gill, M., Goverse, T., Hockings, M., Leaman, D.J., Morgan, D.H.W., Revenga, C., Rickwood, C.J., Schutyser, F., Simons, S., Stattersfield, A.J., Tyrrell, T.D., Vié, J.-C. & M. Zimsky. 2009. Tracking Progress Toward the 2010 Biodiversity Target and Beyond. Science 325: 1503-1504.

WSSD 2002. World Summit on Sustainable Development. www.johannesburgsummit.org