Rubicode: Conservation of Biodiversity and Ecosystem Services in Europe

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1. Introduction

The RUBICODE project (www.rubicode.net) has collated and reviewed information on ecosystem services for the main terrestrial and freshwater ecosystems in Europe. Ecosystem services are the benefits that people obtain from ecosystems. They support, directly or indirectly, our survival and quality of life. Some ecosystem services are well known, such as those which are essential for life (e.g. clean air and water, food and fuel) or those which improve our quality of life (e.g. recreation and beautiful landscapes). Other services are often taken for granted, such as natural processes (e.g. pollination and flood regulation). The Millennium Assessment (MA) concluded that 60% of ecosystem services are being degraded or used unsustainably, often resulting in significant harm to human well-being., and photosynthesis.

The main aim of the RUBICODE project was to provide frameworks for aiding decision making for biodiversity conservation, taking account of the dynamic nature of ecosystems and constraints due to limited land and resources. By identifying the importance of biodiversity to the provision of ecosystem services, the project sought to increase understanding of the value of biodiversity services and, consequently, of the cost of losing them. This will give decision-makers a more rational base and will help the understanding of the need for adequate conservation policies.

2. Project description

Each element of the project undertook three main coordination activities. Firstly, a review of the relevant concepts, methods and results from previous projects, literature, databases, experts and policy documents. Secondly, the evaluation of concepts and methods through workshops and case studies. Here, the review papers were used as background documents to compare methods and identify gaps in knowledge. Thirdly, findings were synthesised in order to develop further concepts and strategies to address gaps in knowledge.

The review of ecosystem services included: (i) a summary of the history/background to ecosystem service assessment; (ii) clarification of definitions and terminology; (iii) a description of the services provided by the main terrestrial and freshwater ecosystems in Europe; and (iv) a discussion of methods for quantifying the contribution of biodiversity to service provision (Vandewalle et al. 2008).

The delivery of ecosystem services depends in many cases on the maintenance of biodiversity, but specific information on the biological units that provide the services is limited. Identifying the organisms and their characteristics that provide services is crucial to developing policies which will protect them. It is likely that key species or groups of species that perform particular ecological functions have a major role in delivering ecosystem services.

Evidence was collected on the variety and relative magnitude of the services provided by the main terrestrial and freshwater ecosystems in Europe, in addition to past trends in their status and human use (Harrison et al. 2010). A review of ecosystem valuation concepts was drafted including sections on the policy relevance of benefit assessment for ecosystem services, definitions of core terms, clarification of the terms 'valuation' and '(e)valuation', a typology of values and preferences, and deliberative techniques. A database was designed to structure information from existing papers on the valuation of ecosystem services into consistent categories including method used, welfare measure estimated, region, ecosystem service, temporal scale, sampling, payment vehicle (Skourtos et al 2010, Harrington et al 2010). An integrated framework based on the Drivers-Pressures-State-Impact-Response (DPSIR) framework, the concept of Social-Ecological Systems (SES) and the SPU concept was introduced as a means of examining the impacts of environmental change drivers on ecosystem service provision and the policy and management responses (Rounsevell et al

2010). That a service depends as much on the attributes of the people whose well-being benefits from the service as on the attributes of the biology providing the service is an important step in integrated social-ecological thinking. The dynamics of ecosystem responses to drivers of change was explored using Social-Ecological Systems (SES) theory. This can provide a useful framework for articulating contrasting drivers and pressures on ecosystems and associated service provision, spanning different temporalities and provenances. Here, system vulnerabilities (defined as exposure to threats affecting the ability of an SES to cope in delivering relevant functions), can arise from both endogenous and exogenous factors across multiple time-scales. Vulnerabilities may also take contrasting forms, ranging from transient shocks or disruptions, through to chronic or enduring pressures. Recognising these diverse conditions, four distinct dynamic properties emerge (*resilience*, *stability*, *durability* and *robustness*), under which it is possible to maintain system function and, hence, achieve sustainability. These concepts are discussed in Dawson et al. (2010).

The synthesis highlights future research needs in relation to drivers of change that affect the provision of ecosystem services (Bryson et al. submitted). Research needs were identified based on the literature review, the expert workshop and the e-conference. Four key areas for future research were highlighted: (i) further information and knowledge on indirect drivers; (ii) dealing with uncertainty through the use of scenarios; (iii) investigating scale issues from a multi-scale perspective and addressing time-lags and constraints; and (iv) identifying Ecosystem Service Beneficiaries (ESBs), undertaking institutional analysis, developing theoretical frameworks and guidelines and integrating agent-based modelling. A review of existing pan-European habitat and species management strategies identified the primary and relevant explanatory documents as developed by the EU, Council of Europe and IUCN (Haslett et al. 2010). It provided an overview of the established protected areas and networks approach to habitat management for biodiversity conservation in Europe (e.g. the Pan European Ecological Network, Natura 2000 and the Emerald network) and the main legislative instruments involved, such as the EU Birds and Habitats Directives and the Bern Convention of the Council of Europe.

A further study on the effectiveness and appropriateness of existing conservation policies in Europe was undertaken based on an analysis of policy documents, national websites for 20 EU countries and structured interviews (Haslett et al 2010). European policies have to be developed not only by the 27 Member states, but also by many regions that have the executive power in countries such as Germany, Spain, Belgium and the UK. In some countries there is joint responsibility between regional and national governments, whilst others have a more centrally organised policy.

These descriptions of the state-of-the-art of conservation management strategies and policies in Europe, and their limitations, se the background for drafting and testing new ideas that take account of the dynamic nature of ecosystems and the provision of ecosystem services in different major habitat types. All this implies an acute awareness of the dynamic nature of ecosystems and our societal interactions with them – change to any part of the system, biological or socio-economic, from within or external, is likely to have profound consequences for the other components and their relationships. This re-emphasises that it would be naïve to continue to consider biodiversity conservation as something on its own; rather, entire social-ecological systems are the appropriate level for responding to future conservation needs.

In conclusion, the RUBICODE research and discussion with policy-related stakeholders has shown that many present European strategies and policies for biodiversity conservation need changing and adapting to include the elements of ecosystem dynamics and service provision. We need strategies and policies that have "on the ground" flexibility to deal with such dynamic systems, and this is closely interlinked with service provision. A more flexible interpretation of existing legislation and instruments in order to allow for ecosystem dynamics may be part of the answer. To incorporate an ecosystem services approach into conservation policy as a "value-added strategy" requires a focus on governance and institutions and increased communication and integration across the different sectors. Thus the challenges facing biodiversity conservation management strategies and policy remain considerable. There is an urgent need to accept, and deal with, the requirements of protecting species, their habitats and ecosystems and the services they provide that are all continuously changing in space as well as time and a systematic approach encompassing all this would appear to be the challenge for the near future.

3. Conclusions and applications

Scientific and public interest in ecosystem services has increased greatly since the (Millennium Ecosystem Assessment) (MA) demonstrated the importance of ecosystem services for human well-being and the threats facing biodiversity and the services it provides. However, despite the popularity of the ecosystem service approach in the academic world, it has rarely been implemented in decision support systems for biodiversity conservation and needs to be developed into a more practical and transparent framework in order to be useful for decision-makers. One key step in achieving this knowledge transfer between the scientific and policy communities and the development of effective policies, is improvement of the evidence base.

Following discussions with a wide range of scientists and stakeholders during workshops and conferences, a roadmap for future research was developed during the RUBICODE project (Anton et al. 2010). The aim of this roadmap is to build on the framework provided by the MA and increase current scientific efforts to understand and maintain ecosystem services for human well-being. Areas for future research identified in the roadmap are listed below:

- Although it is now widely recognised that ecosystems services play a key role in the conservation and sustainable use of natural resources, much remains to be understood in terms of how ecosystem services are provided and the factors influencing the provision of ecosystem services. Research is particularly needed regarding the quantification of the role of biodiversity, including uncharismatic groups of organisms such as invertebrates, lower plants and fungi, in ecosystem function and service provision.

- Future research should therefore focus on identifying and quantifying the impact of direct and indirect socio-economic and environmental drivers on ecosystem services, and develop tools to design and evaluate policy options for ecosystem service management under uncertain futures.

- There is a clear need to enhance the usefulness of value, price and cost estimates for ecosystem services by: (i) improving database coverage, quality, depth and access; (ii) filling key gaps in valuation evidence; (iii) investigating replication, validity and transfer of functional assumptions and values estimates; and (iv) developing agreed protocols for comparing and transferring value estimates.

- Research should in particular focus on understanding the role of the cultural, economic and policy contexts in ecosystem service assessment, particularly in the choice of: (i) metrics, valuation and appraisal methods; (ii) stakeholder involvement; (iii) required levels of precision; and (iv) policy instruments and decision support tools. Research on governance and institutional contexts should contribute to the development of tools, methods and decision-support systems to assist the multi-level governance of ecosystem services.

- Generally, a more holistic and integrated approach needs to be developed to integrate conservation into sectoral policy (e.g. agriculture, transport, industry, etc) and rural development outside existing protected area networks.

4. Potential EU-Russia collaboration

The development of research and scientific cooperation is taking place at present, for instance in GEO building on the Social benefit Areas as defined in the MA. Biodiversity is one of them. GEO is the Group on Earth Observations that is developing GEOSS, The Global Environmental Observation System of Systems. Within GEO GEO BON is the Biodiversity Observation Network.

GEO BON is proposing a biennial accounting of ecosystem service delivery at national resolution. The key GEO BON activity is the development of databases and tools in support of such efforts. An initial set of services are proposed as the elements of these accounts, based on their economic or social importance, rate of change and availability of data. The issues to be developed on Ecosystem Services are:

- Standards for local and subnational scale methods to present standard methods for collecting data on locally and regionally provided ecosystem services that are not well-tracked by satellite data or national statistics approaches.

- Recommendations for new data streams in ongoing local and sub-national processes will suggest new types of ecosystem service data that could be collected through standard, existing programs such as national censuses and sub-global assessments.

- Global maps of service set every two years. One will portray the spatial distribution of individual ecosystem services at national resolution in the year two years prior to reporting. The other will portray the change in individual ecosystem services, at the national scale, since the period of last reporting. The services included in these maps will be those that we can currently map today.

- Ecosystem service bundle maps of initial service set every 2 years. These can be shown in spider diagrams (or other representations) for each country or region, identifying the relative provision of multiple ecosystem services in one map.

- Concept document for open database and modelling toolbox structure; this document will include specification of database protocols, data layers for minimal ES assessments, and coupling interfaces to models (internally coded or external).

- Release of distributed database and modelling toolbox that will provide access to all streams of national statistics that we can secure free access to. The modelling toolbox will provide access to a set of biophysical and socio-economic models that allow modelling and mapping of ecosystem services that are not included (or are not included reliably) in national statistics.

References

Anastasopoulou S, Chobotová V, Dawson T, Kluvánková-Oravská T, Rounsevell M (2007). Identifying and assessing socio-economic and environmental drivers that affect ecosystems and their services. http://www.rubicode.net/rubicode/RUBICODE_Review_on_Drivers.pdf

Anton C, Musche M, Young J, Harrison PA, Feld CK, Harrington R, Haslett JR, Pataki G, Rounsevell MDA, Sousa JP, Sykes MT, Watt A, Settele J (2010). Future research for incorporating the ecosystem service approach into biodiversity conservation. *Biodiversity and Conservation* (on line)

Bryson J, Rounsevell MDA, Dawson TP, Kluvánková-Oravská T, Anastasopoulou S, Harrison PA, Berry PM, Lavorel S (2010). Drivers of change that affect ecosystem services: future research needs. For submission to *Environmental Science and Policy*.

Dawson TP, Rounsevell MDA, Kluvánková-Oravská T, Chobotová V, Stirling A (2010). Dynamics of complex adaptive ecosystems for service provision. *Biodiversity and Conservation* (on line)

De Bello F, Lavorel S, Díaz S et al. (2010). Towards an Assessment of Multiple Ecosystem Processes and Services via Functional Traits. Submitted to *Ecosystems*.

Feld CK, Sousa JP, Martins da Silva P et al. (2010). A framework for improved biodiversity and ecosystem services' assessment in future ecosystems indication. *Biodiversity and Conservation* (on line)

Group on Earth Observations Biodiversity Observation Network (GEO BON) 2010. Detailed Implementation Plan pp171. http://www.earthobservations.org/geobon.shtml

Harrington R, Dawson T, Feld C et al. (2010). Terminology used in the RUBICODE approach to biodiversity conservation. *Biodiversity and Conservation* (on line)

Harrison PA, Vandewalle M, Sykes MT et al. (2010). Identifying and prioritising services in European terrestrial and freshwater ecosystems. *Biodiversity and Conservation* (on line)

Haslett JR, Berry PA, Bela G et al. (2010). Changing conservation strategies in Europe: A framework integrating ecosystem services and dynamics. *Biodiversity and Conservation* (on line)

Lavorel S, Garnier, E (2002). Predicting the effects of environmental changes on plant community composition and ecosystem functioning: revisiting the Holy Grail. *Functional Ecology* 16: 545-556.

Rounsevell MDA, Dawson TP, Harrison PA (2010). A conceptual framework to assess the effects of environmental change on ecosystem services. *Biodiversity and Conservation* (on line)

Skourtos M., Kontogianni A., and Harrison, P.A. (2010) Reviewing the dynamics of economic values and preferences for ecosystem goods and services. *Biodiversity and Conservation* (on line)

Vandewalle, M., de Bello, F., Berg, M.P., Bolger, T., Dolédec S., Dubs, F., Feld, C.K., Harrington, R., Harrison, P.A., Lavorel, S., Martins da Silva, P., Moretti M., Niemela, J., Santos, P., Sattler, T., Sousa J.P., Sykes M.T., Vanbergen A.J., Woodcock, B.A. (2010) Functional traits as indicators of biodiversity response to land use changes across ecosystems and organisms *Biodiversity and Conservation* (on line)

Vandewalle, M., M.T. Sykes, P.A. Harrison, G.W. Luck, P. Berry, R. Bugter, T.P. Dawson, C.K. Feld, R. Harrington, J.R. Haslett, D. Hering, K.B. Jones, R. Jongman, S. Lavorel, P. Martins da Silva, M. Moora, J. Paterson, M.D.A. Rounsevell, L. Sandin, J. Settele, J.P. Sousa and M. Zobel 2008. Review paper on concepts of dynamic ecosystems and their services. http://www.rubicode.net/ .