GERMAN NATIONAL COMMITTEE
ON GLOBAL CHANGE RESEARCH

Proposition for national funding measures relating to

Ecosystem services and biodiversity 2020: ecological, social and economic developments and strategic options of action in times of global change

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Executive summary adopted at the 54th meeting of the National Committee on Global Change Research (NKGCF) on February 10th 2011, amended on February 22nd, 2011.

NKGCF

The proposition was prepared in cooperation with experts from the fields of economics, ethics, biology, law, agricultural sciences and marine research. The proposition is aimed at all funding organizations and its objective is to obtain financial support for coordinated inter- and transdisciplinary research to implement options of action for the protection of biodiversity and ecosystem services.

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The biodiversity of ecosystems decisively determines their present and future benefit for human health by providing goods and services relating, amongst other things, to the provision of food and drugs, the prevention of erosion, the preservation of water quality and tourism and recreation opportunities. Biodiversity is the very basis of human health.

Global change and a plethora of political, economic and social decisions and activities have a direct and indirect impact on biological diversity. In order to counteract the acute loss of biodiversity and ecosystem services, the parties to the CBD (Convention on Biological Diversity), of which Germany is one, adopted a global strategy for the protection of biodiversity and habitats for the period of 2011 – 2020 at the 10th Ordinary Meeting of the Conference of the Parties in the Convention on Biological Diversity (CBD COP 10, Nagoya 2010). Essential objectives include governmental protection and designation of 17 % of terrestrial areas and 10 % of marine habitats as natural ecosystems as well as the renaturation of at least 15 % of degraded ecosystems. At the same time, the CBD parties agreed on the downsizing of environmentally harmful subsidies and on the sustainable use of land and sea areas. Germany, along with other countries, will also set aside the necessary financial resources and implement laws aimed at meeting these targets.

In order to make a decisive contribution to encoding the recommendations of COP10[1] and the CBD Strategic Plan as well as European and German objectives the German National Committee of Global Change Research urgently recommends the implementation of substantial national funding measures in the area of “ecosystem services and biodiversity 2020: ecological, social and economic developments and strategic options of action related to global change”.

Background

The regional impact of global change and the non-sustainable use of ecosystems services on biodiversity can be influenced by numerous national and international options of usage and strategic action. Close interactions exist between global factors such as the globalization of economic activities, the integration of markets through global trade or climate change and regional factors such as the availability of land surface, human and natural resources, and future human lifestyle and demographic developments.

Even though all models relating to the global development of biodiversity predict the continuous loss of animal and plant species and ecosystems in the 21st century, there is nevertheless agreement that a broad range of effective strategic options of action are available that must be increasingly

[1] One of the COP 10 goals explicitly relates to promoting and encouraging basic research and relevant technologies on the conservation and sustainable use of biodiversity and ecosystem services. In addition, COP 10 recommendation 3(g) (Decision X/2) advocates the regular monitoring of biodiversity and ecosystem services and develop methods and indicators for monitoring progress towards selected targets, support the work of the future Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) as well as strengthening the interface between science and politics.

implemented and further developed. Such options include, for example, the designation of nature reserves, the environmentally conscious regulation of subsidies for agriculture, fishery and energy as well as the development of new market mechanisms for preserving existing forests (e.g., www.teebweb.org).

The development of a framework for implementing such measures is a major scientific challenge for global change research. One of the most important tasks is the selection, application and evaluation of indicators and models that enable the comparative investigation of the regional development of ecosystems and their services whilst taking into account different regulating factors and the precautionary principle. Biotic and abiotic environmental factors as well as social and economic aspects all need to be analyzed.

All this requires the implementation of integrative funding measures, which will bring together existing competencies in universities and non-university research institutions in the fields of biodiversity, global change and sustainability as well as integrate relevant stakeholders in order to bring basic research closer to action-oriented research.

The overall objectives of suitable funding measures are:

I. The development and comparison of biodiversity and ecosystem service scenarios of different regions, which also include the different local, national and international options to implement the CBD resolutions agreed on in 2010.
II. The evaluation of models and indicators relating to the development of biodiversity and ecosystem services in different regions and their application for substantiating, communicating and evaluating the implementation of national and international strategies and CBD objectives.
III. The analysis of evaluation frameworks and strategic options including the development of options of actions for decision-makers on different levels.

Future scenarios and principles for regional global change models should be selected jointly with other stakeholders, taking into account social and economic factors. The changes in ecosystem services should be pinpointed on the basis of the Millennium Ecosystem Assessment approach and related research activities. Past trends will need to be taken into account when substantiating the validity and reliability of the assessment base for developments that occur in monitored ecosystems up to 2020. These trends might also be of use for making projections on the habitats for the period up to 2050.

The funding measures should predominantly focus on the investigation of different regional ecosystems in Germany as they are one of the European regions that are most affected by loss of diversity[2]. In addition, an excellent data pool can be expected to come out of previous monitoring programmes. Major focus will be put on all larger ecosystem and land-use types, including mountains, deciduous and coniferous forests, agricultural areas (fields and grassland), cities, freshwater (lakes, rivers), coasts and oceans. In addition, the research projects should also focus on regions of the earth that are directly or indirectly affected by Germany's political and economic

[2] National Strategy on Biological Diversity (BMU, 2007)

regulations (e.g. subsidies, land- use changes, CO_2 certification) and for which mainly long-term data are available.

The present funding proposition is aimed at all national funding organisations. It builds upon the European and German biodiversity goals as stipulated in the "2007 National Strategy on Biological Diversity" and the 2009 BfN (Federal Agency of Nature Conservation) recommendations on "Climate change, land use and biodiversity – identifying opportunities, using synergies" (only available in German). Also the upcoming results of the projects that are part of the newly established federal programme "Biological Diversity" need to be incorporated as much as possible into the information and data pool.

The proposition also connects up with the Millennium Development Goals (MDG), it can support the debate of the CBD's intergovernmental scientific advisory body (Subsidiary Body on Scientific, Technical and Technological Advice, SBSTTA) and is seen as a major contribution towards the implementation of the CBD 2020 objectives. It also builds a bridge to international programmes such as ILTER, Geo-BON and DIVERSITAS international. The proposition can also be seen as an integrative contribution to the "Grand Challenges for Global Sustainability" of ICSU-ISCC and will directly support the work of the future Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

The research projects are expected to generate the following results:

- Development of **global change scenarios** for different regional ecosystems and for the analysis of strategic options for their protection and sustainable use
- Identification, cataloguing and analysis of important social, **political and economic (direct and indirect) impact factors** and **strategic options** for regions.
- **"Good practice" definition** of region-specific indicators and monitoring strategies, including the comparison of indicators of biodiversity, function and service of ecosystems, land use and socio-economic trends.
- Documentation and analysis of **interactive processes** relating, for example, to the way stakeholders can be successfully involved (limits, systematic evaluation), the integrative research process, the consultation of decision-makers and the development of good practice recommendations
- Analysis and further development of **concepts for the social evaluation** of ecosystem services
- Development of **concepts relating to dealing with the non-quantifiable values of services** (precautionary strategies)
- Significant **further development of the German contribution to international biodiversity research** in the context of global change and with a special focus on integrative research groups.
- **Development of strategic region- and society-specific options of action** for the protection and sustainable use of regional ecosystems.

To achieve these results the following aspects need to be taken into account:

- The development and verification of models and concepts used in sustainability research with regard to biodiversity and ecosystem services
- The further development and verification of programmes and concepts in ecological long-term monitoring and biodiversity monitoring in Germany.
- Systematic consideration and reflection of phenomena of uncertainty and insecurity with regard to biodiversity and ecosystem services on the biophysical and socio-economic level
- Examination and comparison of effectiveness, efficiency and practicability of political measures and tools as well as of the effect of socio-economic regulations
- The involvement of relevant stakeholders/players
- The transfer of knowledge into the IPBES process and the implementation of the COP 10 strategies on the national level

Implementation

The present proposition is aimed at all science and research organisations as well as established knowledge transfer networks (e.g. NeFo) and data acquisition platforms (e.g., NetPhyD, LTER-D, German Butterfly Monitoring). In order to enhance the implementation and acceptance process, the conceptual funding framework needs to be developed in cooperation with scientists from university and non-university research institutions, with international experts as well as with political players and practitioner. It is recommended that a working group be established at the very start of the project to manage cross-sectoral tasks such as scenario design and to facilitate the exchange of information between project groups.

A two-tier tendering procedure is recommended for the quality-oriented selection of transdisciplinary research groups. The research groups are to be selected according to the following criteria, which must also take regional priorities and aspects relating to the overall goals of the funding measure into account:

- In the **first phase** of implementation, the basic principles and assumptions of future scenarios of biological diversity need to be jointly developed and determined. The scenarios must take into account global and regional processes as well as social, political and economic (direct and indirect) factors that impact the different regions. The regional research groups will develop a selection of integrative methodological approaches and required data and models relating to the past. Furthermore new indicators and monitoring systems required for the future monitoring of biodiversity and ecosystem services will be developed in agreement with the monitoring parameters, indicators, species lists (for which Germany is responsible) and hotspots of biological diversity worked out by BMU/BfN/UBA. The future scenarios developed jointly in the first phase represent the framework for the ongoing work of the regional project groups.
- In the **second phase**, the results obtained with models, monitoring data and selected indicators relating to the development of biodiversity and services of different ecosystems will be analysed and evaluated. These results will constitute the basis for examining

ecosystem services and the biodiversity of individual regions as well as for identifying the interactions between global and regional environmental factors and strategic options.

- The **third phase** will mainly focus on the validation and evaluation of the results, and will be carried out in cooperation with the national stakeholders and players. This will allow the analysis of strategic options and the formulation of options of action for decision-makers on different levels.

Criteria for the selection of research groups:

It is recommended that 6 to 8 research groups be selected to focus on regional issues and one research group to coordinate and implement the cross-sectoral tasks. Successful research groups are required to:

- pursue integrative research approaches that bring together the necessary disciplinary and interdisciplinary expertise required for achieving the overall research goals (I-III),
- have access to primary data derived from the long-term monitoring of at least one regional ecosystem in which the direct integration of expertise gained from long-term monitoring activities (e.g. ILTER, exploratories or other biodiversity infrastructures) and the German federal biological diversity programme is deemed to be of major advantage,
- link university and non-university research as well as act as an interface with other players, practitioners and stakeholders,
- promote young scientific talent, especially in the fields of interdisciplinary integration, transdisciplinary consideration of problems, methods for the analysis of trends and the modelling and assimilation of monitoring data relating to biodiversity research,
- guarantee the continuous involvement of relevant (global/regional/local) stakeholders during the entire research process, in particular with regard to achieving the third goal,
- engage the transfer of knowledge and the implementation of research results.

B Ecosystem Services and Biodiversity 2020: ecological, social and economic developments and strategic options of action in times of global change – Detailed information –

1. Background

Field studies, models and scenarios suggest that the effects of global change will increasingly lead to a loss in species diversity and natural ecosystems as well as changes in the distribution and abundance of species and biomes if the Earth system is pushed beyond certain tipping points (Global Diversity Outlook, 2010). Based on the objective of finding more effective ways to counteract the acute loss of biodiversity and ecosystem services, the 10th Ordinary Meeting of the Conference of the Parties in the Convention on Biological Diversity (CBD COP 10, Nagoya 2010) adopted an ambitious global strategy for the protection of biodiversity and ecosystems that covers the period from 2011 – 2020. The meeting also formulated a clear vision for the future, specifying targets and action objectives for all biodiversity-related topics. The target deadlines were later revised and will now apply up until 2050. The objective of the Convention on Biological Diversity (CBD), which came into force in 1992, is to conserve biological diversity, to ensure the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. The Convention approaches the protection and sustainable use of biological diversity on an ecosystem, species and genetic level, which goes far beyond the traditional concerns of nature conservation conventions, both in terms of objectives and scope. Following a recommendation made by the Parties in the Convention on Biological Diversity (CBD) at a meeting held in October 2010, the UN declared 2011 – 2020 the UN Decade of Biodiversity with the intention of communicating the urgency of this issue on a global level.

The CBD requires each party, in accordance with its particular conditions and capabilities, to implement the Convention's 20 or so objectives into national strategies, plans or programmes as well as to integrate biodiversity into relevant national policies. In this way, the Convention aims to ensure that the protection and sustainable use of biodiversity is given due consideration and becomes an integral part of all plans and decisions. The German government adopted the German National Strategy on Biological Diversity[3] in November 2007, in close connection with its existing national sustainability strategy to prioritise the conservation of biological diversity through protection and sustainable use. In future, a set of indicators[4] will be used to assess the progress of the national biodiversity strategy.

[3] The German National Strategy on Biological Diversity (NBS) is a concrete vision for the future with around 330 qualitative and quantitative targets and 430 measures in 16 action areas for implementation by state and non-state actors with the objective to promote the conservation and sustainable use of biological diversity. The German NBS is a strategy designed to span four legislative periods whose achievements are regularly validated on the basis of a set of indicators and reports.

[4] 12 out of a total of 19 indicators (e.g. indicators related to the surface area of forests) used to gather information about biodiversity trends and whether or not targets have been reached; the targets are usually associated with a quantitative target value and a specific target year, such as 2010, 2015 or 2020 – see Indicator Report 2010 (2010))

The CBD is based on the precautionary principle and has for this reason implemented the **Ecosystem Approach**[5] that enables the effects of anthropogenic ecosystem usage on ecosystem functions and productivity to be assessed. This approach represents a strategy involving the integrated management of land, water and living resources that promotes conservation and sustainable use in order to reach a balance of ecological sustainability, economic development and social justness. The concept of ecosystem services provides an important overall approach that looks predominantly at biodiversity functions, and hence at the contribution of biodiversity to ecosystem services and its importance in maintaining human health. The term biodiversity encompasses ecosystem diversity, species diversity and genetic diversity. The Millennium Ecosystem Assessment (2005) differentiates between provisioning services (such as food, water, timber, fibres and oil), regulating services (affecting climate, floods, diseases, water and water quality), cultural services (providing recreational, aesthetic and spiritual benefits, e.g. through coral reefs or mineral springs) as well as supporting services (soil formation, photosynthesis and nutrient cycling) (see Fig. 1). The importance, valuation and assessment of biodiversity with regard to regulating and cultural services is often not very visible and often also difficult to assess, in particular with regard to potential future values in areas such as genetic resources, for example.

The following statement applies to all ecosystem services and their interactions: sustainable economic activity on a regional, national and global level is a prerequisite for the ability to maintain human wellbeing now and for future generations. The results of the Millennium Ecosystem Assessment and related research projects and analyses (see MA 2005; EASAC 2009; Daily et al., 2009; SEI, 2009, De Groot et al., 2010; TEEB, 2010) have already identified a broad range of actions that are needed to enhance the conservation and sustainable use of ecosystems and their contribution to human wellbeing, including for example the need for more basic research in the fields of social research, ethics, law, economics, biodiversity and ecosystem research. Also arising from the Millennium Ecosystem Assessment and related projects are calls for the implementation at governmental level of environmental and nature conservation measures as well as economic and political measures. In addition, increasing focus is being put on the potential limits of the concept of ecosystem services (see Gomez-Baggethun et al., 2010; Norgaard, 2010) as well as on the limits of knowledge in general. The way we are dealing with gaps in knowledge and especially with the fundamental uncertainty as far as complex human-environmental systems are concerned represents a huge challenge.

[5] "A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. An ecosystem approach is based on the application of appropriate scientific methods focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems" (MA, 2005).

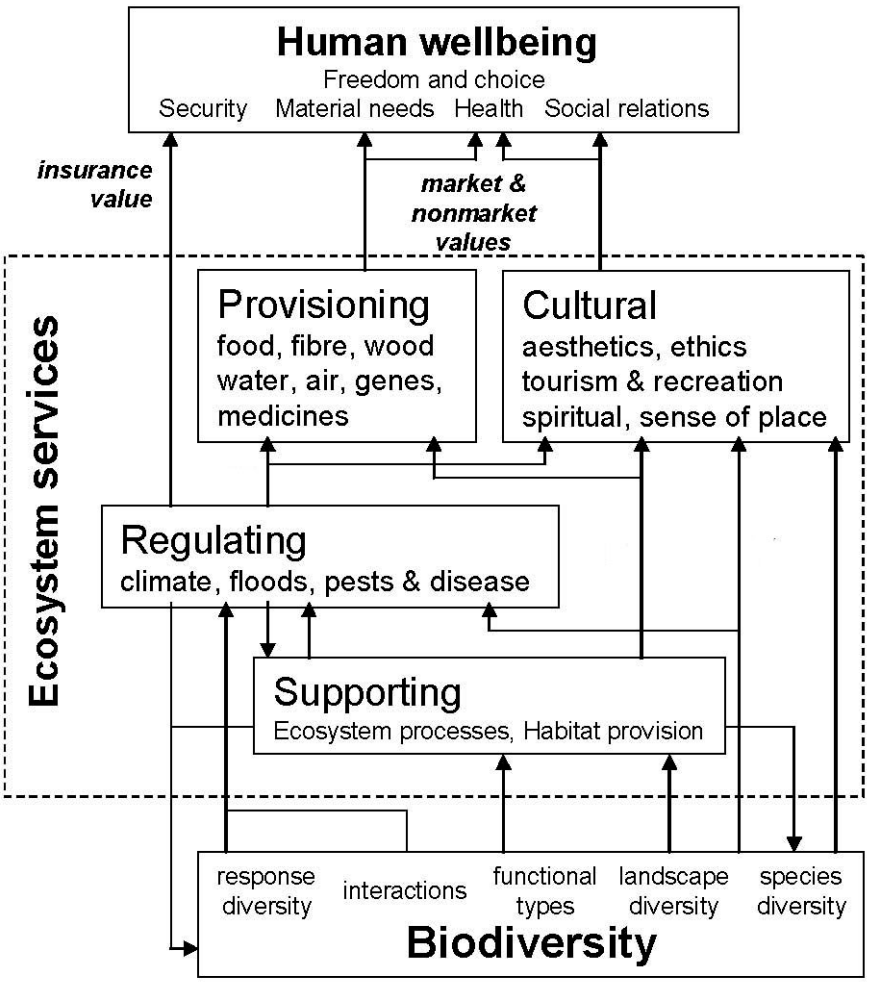

Fig. 1: State and trend of ecosystem services and human wellbeing according to Scholes et al. (2010). Please note that the arrows in the figure represent a network of interactions whose quantification in different ecosystem types and regions is a major unmet research need.

The following chapters summarise the **current state of knowledge and urgent research priorities** that are building up around the issues of biodiversity and ecosystem services in the context of global change, including the growing demand for food and natural resources (wood, timber, fibre, fuel) as well as the use of land and oceans. Each section will be complemented by a short literature survey; a comprehensive reference list is provided in the discussion paper entitled "Biodiversität und globaler Wandel – Aktuelle Herausforderungen in der interdisziplinären Biodiversitätsforschung" ("Biodiversity and global change – current challenges in interdisciplinary biodiversity research"; pdf-file (in German) available at http://www.nkgcf.org/biodiversity.php).

The third section will provide further details on the **goals, key issues and work programme of funding measures**, all of which are of a transdisciplinary nature due to the complexity of research questions arising.

Further reading:
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EASAC- European Academies Science Advisory Council (2009): Ecosystem services and biodiversity in Europe. Report, EASAC, URL http://www.easac.eu
Gómez-Baggerthun, E. et al. (2010): The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes.- Ecological Economics 69 : 1209-1218
TEEB (2010): The economics of ecosystems and biodiversity: ecological and economic foundations. Earthscan, London.
Scholes, R. et al (2010): Assessing state and trends in ecosystem services and human well-being. In: Ecosystem Services and Human Wellbeing: A manual for Assessment Practitioners; Island Press, Washington DC.
SEI – Stockholm Environment Institute (2010): Ecosystem assessments in Europe. Report to the EEA. URL: http://sei-international.org/publications?pid=1823

2. Current knowledge and findings obtained during the last ten years

2.1 Knowledge deficits in the field of ecosystem services and biodiversity

The Millennium Ecosystem Assessment (MA, 2005) marked an important step forward in available knowledge on ecosystem services, both conceptually and as an overview of the existing data pool. Nevertheless, the MA also showed that a lot of knowledge is still lacking, both in basic research and problem-oriented research. Numerous boards and analyses have since identified research needs that merit higher priority – both on a national and international level (see Carpenter et al., 2007, 2009; Neßhöver & Görg, 2007; EPBRS, 2007, 2011; Anton et al., 2010; ICSU, 2010).

There is a growing demand for integrative, i.e. interdisciplinary and transdisciplinary research approaches that deal with the trade-offs between the use of different ecosystem services and in particular take into account the social and economic context. Another challenge was highlighted in "The economics of ecosystems and biodiversity" (TEEB) study which draws attention to the global economic benefits of biodiversity (TEEB, 2010). The study found that although many methods and tools are available to enable ecosystem services to be taken into account in economic decisions, basic data as well as broad experience in the implementation of projects are still missing (Kumar, 2010; TEEB, 2010). In order to redress this situation, the authors call for a combining of expertise in the fields of policy, science and economics to make practical actions possible and the establishment of an objective global standard basis for natural capital accounting, as has been suggested by the CBD, and other organisations.

Further reading:
Anton, C. et al. (2010): Research needs for incorporating the ecosystem service approach into EU biodiversity conservation policy. Biodiversity and Conservation 19, 2979-2994.
Carpenter, S.R. et al. (2006): Millennium Ecosystem Assessment: research needs. Science 314: 257-258.
Carpenter, S.R. et al. (2009): Science for managing ecosystem services: beyond the Millenium Ecosystem Assessment. PNAS 106, 1305-1312.
De Chazal, J. Rounsevel, M.D.A. (2009): Land use and climate change within assessments of biodiversity change: a review. Global Environmental Change 19, 306-315.

EPBRS – European Platform for Biodiversity Research Strategy (2007): Research recommendations on biodiversity and ecosystem services – the Millennium Ecosystem Assessment framework in a European perspective. German Meeting of the EPBRS 20107 URL: http://www.epbrs.org

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ICSU (2010): Ecosystem change and human well-being. Strategy paper. URL: http://www.icsu.org/publications/reports-and-reviews/ecosystem-change-report

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TEEB (2010): Die ökonomischen Bedeutung der Natur in Entscheidungsprozesse integrieren – Ansatz, Schlussfolgerungen und Empfehlungen von TEEB – Eine Synthese.- URL: http://www.teebweb.org/Portals/25/TEEB%20Synthesis/TEEB_Synthesis_german_web%5B1%5D.pdf

2.1.1 Factors that impact the loss of biodiversity and changes in ecosystems

The growth of the world population and increasing material needs of larger sections of the world population, technical transformations, different lifestyles and consumer behaviour all have fundamental effects on terrestrial, limnetic and marine systems. In addition, the changing climate - associated higher average temperatures, altered precipitation patterns, the acidification of the oceans and sea level changes - leads to changes in the living and non-living environment on the land and in the oceans. Such changes have a direct or indirect influence on the provision of vital ecosystem services. At present, it is still difficult to assess the degree and spatial and temporal scales of the losses of ecosystem services as well as the social and economic consequences that can be expected. Similarly to the climate debate, scenarios of expected regional changes within the next 10 to 50 years will be decisive for political action.

Big gaps in knowledge exist relating to the interaction between environmental factors (e.g. climate changes), socio-economic factors (e.g. land-use changes) and their effects on biodiversity and ecosystem services, as well as on synergistic and feedback effects. Future research approaches need to focus particularly on the dynamic interactions between social (e.g. lifestyle and demographic change) and economic (e.g. economic growth, changes in the use of resources, changes in consumption patterns) factors and on the role of environmental influences (e.g. climate change) and political developments.

In order to be able to close these gaps in knowledge, existing ***integrative and quantitative models of socio-economic systems***, also known as “hybrid models” or “coupled models” need to be further developed. Current difficulties in ***combining the models*** due to the different spatial and temporal dimensions of ecosystem processes and institutional processes need to be overcome. In addition, ***data of greater spatial and temporal resolution, in particular on the regional level***, are required for the creation of hybrid models. Meaningful scenarios can only be developed on the basis of area-wide long-term data on the state of species and systems as well as on reliable relationships between land-use forms, biodiversity and ecosystem services. Existing environmental data (about soil, water, air) need to be investigated in detail in order to assess whether they are suitable for analysing the state and trends of ecosystem services. Knowledge about the structural factors of the social environment is also rather scarce. These factors affect the way issues relating to biodiversity and natural resources are dealt with, including cultural and economic factors, political and social interests and the different

approaches used to assess ecosystem services and feedback effects arising from management decisions.

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Sutherland, W.J. et al. (2009): One hundred questions of importance to the conservation of global biological diversity. Conservation Biology 23, 557-567.
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2.1.2 Ecosystem multifunctionality

Natural ecosystems provide services that maintain biodiversity and produce ecosystem goods as well as support life (e.g. forests, moist areas, surface water), including the purification of water, the storage of carbon and the production of fibres and food. Ecosystems and the services they provide are therefore essential to help sustain and fulfil human life. Since the global demands for ecosystem services continue to rise due to the ever-growing world population and the economic growth of industrial and threshold countries, it is of fundamental importance to gain an early understanding of the complex interactions between biological entities at different spatial and temporal scales and social influences in order to be able to assess the regional, national and local effects the changing ecosystems have on human wellbeing.

The consequences of biodiversity loss and efforts to maintain ecosystem services for future generations have generated considerable interest. Existing ecosystem services can only be maintained if the services are first identified, quantified and evaluated. Despite the comprehensive gain in knowledge in many areas of biodiversity research, there is still a huge deficit in the knowledge about the function of biodiversity and the ecosystem services arising thereof. A major challenge is to determine the obvious causal relationships of biodiversity dynamics, ecosystem processes and human wellbeing, for example. It is important to achieve an in-depth understanding of the mutual dependencies and interactions of ecosystem components as well as the direct and indirect (e.g. physical, economic, social) influences on system components in order to be able to put in place measures to counteract the loss of biodiversity and ensure that ecosystems keep functioning and remain stable.

The interdisciplinary concept of ecosystem services is not only a research approach but became also part of the international decision-making processes. For further developments this integration requires the ***identification and evaluation of regional ecosystem services*** in a transdisciplinary context. At this the dialogue with decision-makers is of key importance for reinforcing the transfer of knowledge about the systems, goals and strategies arising from interdisciplinary, integrative research

activities in the natural and social sciences and the humanities. In addition, ecosystem services can only be integrated effectively into conservation programmes if ***adequately resolved spatial and temporal data about the distribution of ecosystem services*** and the ***establishment of criteria for identifying areas of utmost protection*** priority become available. It has to be analysed if areas that provide ecosystem services at the same time support biodiversity. In addition, developing quantitative indicators that reflect the service aspect and developing indicators of future relevance (e.g., precautionary principle, e.g. the quantity of still unknown natural compounds required by the pharmaceutical industry in the future) need to become key issues.

Further reading:
Anton, C. et al. (2010): Research needs for incorporating the ecosystem service approach into EU biodiversity conservation policy. Biodiversity and Conservation 19, 2979-2994.
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2.1.3 Indicators for the development of ecosystem services and their comparison

Indicators are variables that summarise complex data into standardised figures in relation to a reference. They provide quantitative information about the state or development of issues of interest. Indicators that represent the status of biological diversity and its components are pivotal for the assessment of national biodiversity strategies. The determination of ecosystem indicators is based on the assumption that individual representatives of the animal and plant kingdom, or multiple taxa or functional groups of taxa provide information about the state of biodiversity, including how species abundance and ecosystem change over time and following changes in ecological interactions. European biodiversity indicators (such as those used by the pan-European SEBI initiative to assess and provide information on progress towards future targets; Streamlining European 2010 Biodiversity Indicators) are generally based on the DPSIR[6] approach. It is worth noting that the indicators are only in a handful of cases directly related to the state and the impact of biodiversity. In addition, the indicators currently used by decision-makers around the world are not based on sufficient scientific evidence and are usually associated with gaps in knowledge relating to taxonomic, geographic and temporal aspects. It has therefore been suggested that national indicator systems be established. The first German indicators have been defined and their target attainment status been determined (see Indicator Report (BMU, 2010)).

[6] DPSIR is an acronym of driving force, pressure, state, impact and response; in Europe, it serves as a model for the further development of indicators

Knowledge deficits exist with regard to benchmarks and reference values from which states (e.g. species, conversion rates of nutrients, habitats) can be derived. In addition, long-term data about the state of the majority of populations in the majority of regions are lacking, as are indicators concerning the changes occurring on the genetic and ecosystem levels, indicators relating to invertebrates and microorganisms, processes and activities as well as indicators describing the state of developing countries. Moreover, existing indicators do not take into account the utilisation and valuation of ecosystem services. Even less is known about critical threshold values, which is why there is a good deal of uncertainty about the level of anthropogenic changes ecosystems can tolerate before they become irreversibly damaged.

In this context, it is also important to broach the issue of the limits of knowledge and find ways of dealing with the knowledge that does exist according to the ***precautionary principle***. This requires interdisciplinary cooperation between the natural, social and economic sciences and sciences such as ethics and law. In order to safeguard ecosystem services for as long as possible and also secure options on still unused services[7] it is necessary to act according to the precautionary principle. The precautionary principle must be applied in order to protect the environment where there is a threat of serious or irreversible damage, even when full scientific certainty does not (yet) exist. Choosing to accept a false positive prognosis with the aim of preventing irreversible damage must nevertheless be based on scientifically founded considerations and decisions that have to be done on a case-by-case basis (see Goklany, 2001; Foster, 2011).

It is therefore necessary to establish ***indicator systems as the basis for a procedure that seeks to continuously monitor*** biodiversity and ecosystem changes. These indicator systems must be able to reproduce and measure states and developments of biodiversity as well as capture the causes (impact factors or drivers) of changes and their effects on the provision of ecosystem services. ***Indicators must be developed on the basis of the ecosystem approach*** and absolute priority must be given to the development of such indicators. ***Standardised methods to record and generate data*** that can be applied to different biotopes and ecosystems must be available in order to facilitate the comparison of data, and hence enable effective (meaningful, measurable, cross-border) and efficient (cost-efficient) monitoring in order to identify changes in ecosystem services and the advantages of measures put in place to counteract, and eventually stop, the loss of biodiversity. If indicators are to be determined, it is essential to ***involve relevant stakeholders and their interests in order to define prioritised, manageable and generally accepted indicators***. Experimental investigations are one way of developing indicators (e.g. resilience to anthropogenic influences such as increased utilisation of ecosystem services, pollution, exclusion of specific species, weather extremes).

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[7] e.g. protection of the diversity of marine sponges for future access to natural marine substances of biotechnological relevance

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Vandewalle, M. et al. (2010): Functional traits as indicators of biodiversity response to land use changes across ecosystems and organisms. Biodiversity and Conservation 19, 2921-2947.
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2.1.4 Social options of actions and their evaluation

In addition to international treaties (e.g. Ramsar Convention[8], Berne Convention[9]) programmes (such as MAB[10]) and European regulations (such as the FFH[11] Directive put in place to protect nature), active efforts are also being undertaken on international and national levels (e.g. National Strategy on Biological Diversity) to counteract the loss of biodiversity. With the National Strategy on Biological Diversity, adopted by the German government in November 2007, Germany has incorporated the CBD into its national policies and made the conservation of biological diversity through the protection and sustainable use of ecosystems (including forests, wetlands, surface waters) a top priority with the aim of minimising, and eventually stopping altogether the threat to biological diversity in Germany. Biodiversity indicators are of key importance in the monitoring and regular reporting on (global) target achievement. However, the first German "Indicator Report" (BMU, 2010) shows that it is necessary to create a much larger number of different incentives and additional financial resources need to be mobilised in order to come even slightly closer to the target values to be achieved between 2015 and 2020. The German government set up the federal biological diversity funding programme as an additional financial instrument for implementing Germany's National Strategy on Biological Diversity in February 2011. This federal programme will be a driving force behind the conservation and sustainable use of biodiversity in Germany, in particular on the municipal level, and it will contribute to promoting greater acceptance of the biodiversity strategy among the general public. Additional financial means might be made available through the reduction of subsidies given to projects that are harmful to the environment[12].

It is also beneficial to be able to assess the consequences and effects of certain actions and measures on the international level. In order to facilitate the use of suitable tools at an early stage, both new and existing possibilities to conserve biodiversity (e.g. REDD-Plus) and their implementation need to be thoroughly analysed and evaluated. REDD-Plus focuses on the evaluation of forest ecosystem services and provides financial incentives to reduce emissions from deforestation and forest degradation especially in developing countries as well as the creation of sustainable forest management options. The challenge is to ***gain an in-depth understanding of the processes of ecosystem relationships, the interactions between humans and the environment and the effects of***

[8] International treaty of signed in 1971 for the conservation and sustainable utilisation of wetlands, particularly wetland fauna including water and shore birds.
[9] International agreement signed in 1979 for the conservation of European wild flora and fauna and their natural habitats, protection of seriously endangered animal and plant species, especially migratory animals.
[10] UNESCO programme "Man and the Biosphere" of 1971 for the creation of a worldwide network of biosphere reserves.
[11] Fauna Flora Habitat Directive
[12] Subsidies are rated as environmentally harmful if they have a negative effect on climate, air, soil, water, human health, biological diversity and landscapes as well as natural resources (UBA, 2010; TEEB, 2011, chapter 6)

protective measures on the spatial and temporal level. Such understanding is pivotal in the ability to assess the outcomes of these measures. With regard to the increasing global trade of goods and services, further suggestions might be developed that couple trade activities to the provision of ecosystem services in exporting countries and can be integrated into new conservation concepts (e.g. certification). It will also be necessary to expand existing conservation concepts to include the aspect of functionality in order to guarantee that specific ecosystem functions and services are maintained as dynamic environmental conditions change. The success of currently existing, rather rigid, (protection) concepts is primarily derived from the size of protected areas or from special animal and plant species. In order to replace these rigid concepts with ***new and dynamic "function-related" concepts and structures***, a pivotal issue is the recognition and understanding of the values to be protected; relationships need to be made clearer and understood and social, cultural and economic interests need to be taken into account. It is expected that the mainstreaming of existing, and the (further) development of ***alternative valuation concepts*** aimed at improving the communication of the value of biodiversity and its services will play a major role in these values, relationships and interests (TEEB, 2010). Besides the issue of assessment of ecosystem services and ecosystem functions, which is always a subject-related and social task, it is important to focus more closely on the ***investigation of the effectiveness and efficiency (including acceptance) of options of actions***, from a social science (legal and ethical) perspective, and use this knowledge to develop "enhanced" economic tools and toolkits to promote conservation and sustainable resource use (Kumar, 2010).

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TEEB (2011): The economics of ecosystems and biodiversity in national and international policy making. Earthscan, London.

2.1.5 Results of research methods and research collaborations

A pivotal aspect of the primary goal of using implementable options of action for the sustainable protection of ecosystem services is to look at research issues from a broad range of different perspectives. This also means that relevant disciplines in the humanities, social and natural sciences have to be brought together to work on the issues that will arise. Previous experience from diverse interdisciplinary projects has shown that excess values have so far only been achieved in a handful of interdisciplinary forms of cooperation. For example, simply exchanging information between individual disciplines or using knowledge gained in other disciplines for answering particular questions has often only led to the superficial treatment of a certain issue by disciplines other than the primary one. This does not generate "true" collaborations between individual disciplines and the gain in knowledge is minimal. Instead, completely new findings can be achieved by stronger cooperation forms such as ***cognitive integration*** (e.g. using a jointly developed transdisciplinary concept or a common nomenclature) up to the ***integration of methods and results*** (e.g. which can be achieved by way of modelling or data aggregation; the combination or synthesis of individual results). That includes also the analysis and reflection of the normative and evaluative basic principles and conflicts in politics, law, economy and ethics. When used in scientific practice, it is necessary to choose a type of (consistent) integration of disciplines in relation to the issue being worked on.

Successful ***interdisciplinary collaboration depends*** on founded disciplinary knowledge. Previous research efforts have shown that application- and implementation-oriented research – with regard to social issues - can only be successful if it is not only dealt with on an interdisciplinary, but also on a transdisciplinary level.

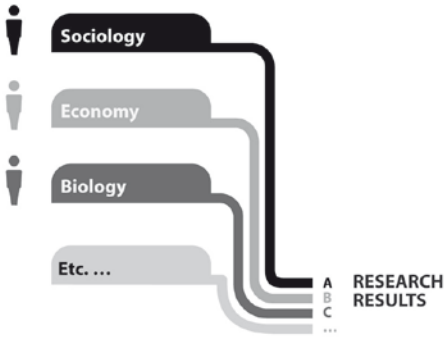
While interdisciplinary cooperation involves numerous disciplines that work jointly on the resolution of interdisciplinary issues, ***transdisciplinary cooperation refers*** to the resolution of problems of the society by the sciences in cooperation with experts outside of the science area (e.g. administration, civil society, politics, economy, etc.; see Fig. 2).

Transdisciplinary collaboration frequently only leads to the successful implementation of results when relevant (local/regional) stakeholders have been involved in the development of scientific research issues. In scientific practice, transdisciplinary cooperation in workshops, for example, targets are defined that reflect scientific interest on the one hand and that might also lead to the practical implementation of the results on the other. These processes need to also take relevant global and international concerns into account in order to guarantee that the objectives are compatible with international programmes and the rules and standards of transdisciplinary processes. It is therefore recommended to base discussions on the ecosystem services concept of the Millennium Ecosystem Assessment which has since also been expanded to the European context[13] in order to define common (scientists and stakeholders') research interests and apply the concept in a concrete context.

[13] such as occurred when the UK National Ecosystem Assessment was established, see http://uknea.unep-wcmc.org, and has also been taken into account by the new EU Strategy on Biodiversity 2020)

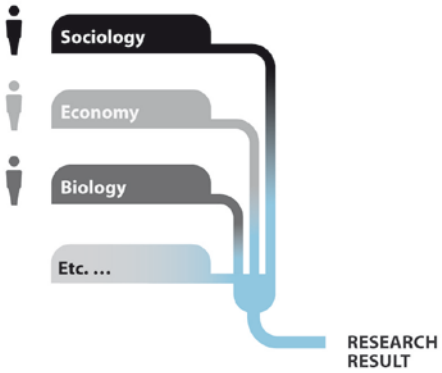
MULTIDISCIPLINARY

Several, usually separate, disciplines retain their own methodologies and assumptions when studying a interdisciplinary topic.



INTERDISCIPLINARY

Several disciplines work jointly on an interdisciplinary topic by developing a common language up to a common research method. An integrative methodological approach by way of e.g. modelling (common basis for economy, psychology, geography) is the highest form of interdisciplinary cooperation.



TRANSDISCIPLINARY

Multiple academic disciplines jointly work with several relevant stakeholders on a socially relevant problem and/or battery of questions using a common (integrative) methodological approach (e.g. frequently used in the field of materials research, energy research, environmental research).

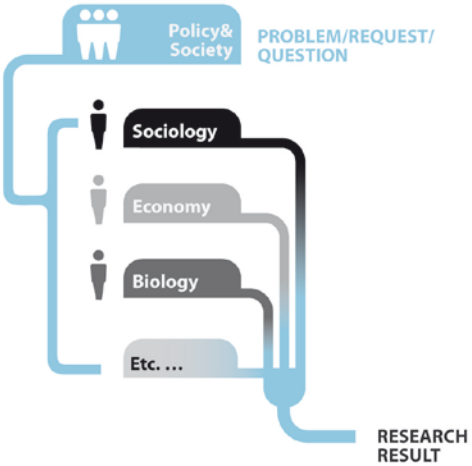


Fig. 2: Definition of how different research collaborations and approaches can work together (multidisciplinary, interdisciplinary, transdisciplinary). (diagram: NKGCF)

3. Research for safeguarding of ecosystem services

Global change is characterised by huge regional differences in the influences, impact mechanisms and resulting effects, all of which interact on a feedback basis. In terms of safeguarding of ecosystem functions for future generations, a pivotal issue is the communication of the value of ecosystem functions and services at all levels. The major interest in maintaining existing ecosystem services is to be able to propose concrete options of action for stakeholders in government, economy and society as early as possible. As mentioned in the previous chapter, considerable deficits of knowledge exist in numerous areas. The aim is to close these gaps to a degree that will enable the objectives of the present proposition to be achieved, i.e. develop manageable indicators as the basis for developing tools that enable concrete recommendations and implementable propositions for regional development and ecosystem types to be made.

The present proposition recommends giving funding priority to projects that deal with and evaluate the transdisciplinarily defined functionality of biodiversity and take into account the entire range of approaches used in the humanities and natural and social sciences. The funded projects should primarily focus on the investigation of different regional ecosystems in Germany that belong to those European regions where biological diversity is at greatest risk of being irreversibly damaged[14]. In addition, an excellent data pool can be expected to come out of previous monitoring programmes and experimental long-term investigations (see p. 28). Major focus will be put on all larger ecosystem and land-use types, including mountains, deciduous and coniferous forests, agricultural areas (fields and grassland), cities, freshwater (lakes, rivers), coasts and oceans. In addition, the research projects will also focus on regions of the earth that are directly or indirectly affected by Germany's political and economic regulations (e.g. subsidies, land-use changes, CO_2 certification) and for which mainly long-term data are available. A well-known example is the introduction of the biofuel E10 – a mixture of bioethanol and petrol - which was launched as a result of a 2009 EU directive aimed at reducing dependency on oil-producing nations as well as reducing carbon emissions. However, as it cannot cover its national demands, Germany needs to import bioethanol from developing countries where the cultivation of energy crops competes with the cultivation of food crops. This in turn leads to increased food prices on the global market as well as to the expansion of agricultural areas and the loss of valuable ecosystems such as the tropical primeval forests.

The objective to establish ***concrete[15] and implementable[16] options of action*** for sustainable future developments must be in line with "***good practice***"[17] procedures. Society-relevant issues need to be dealt with and stakeholders need to be involved in the research process (transdisciplinary research collaborations). Some research questions have not yet been answered, including whether this type of research takes or can take into account all relevant aspects of biodiversity research (especially with regard to global change).

[14] see National Strategy on Biological Diversity (2007)
[15] concrete in the sense of: building on existing mechanisms/regulations, relating to a timescale
[16] implementable in the sense of: ecologically justifiable (the natural sciences), acceptable (ethics), economically justifiable (economy) by taking into account institutional and legal challenges (governance, law), etc.
[17] good practice approaches in the sense of successful procedures under suboptimal conditions

The present funding proposition is aimed at the funding of research projects that make use of empirical (e.g. predictions from trends) and conceptual methods (e.g. development of scenarios.) ***Modelling*** is an integral and indispensable component in research assessing the consequences and effects of changes in biodiversity. As the outcomes of the models will necessarily be associated with huge uncertainties due to the involvement of complex interactions and scenarios (e.g. climate projections), ***future research projects will need to focus on ways to deal with this uncertainty and with systemically unpredictable outcomes***.

3.1 Scientific objectives

It needs to be pointed out that research efforts based on the present proposition must go far beyond a simple analysis of the correlation between ecosystem services and biodiversity. The overall objective of all research efforts must be to create a comprehensive and conclusive framework for problem- and implementation-oriented basic research in order to come up with answers to society-relevant problems.

The overall objectives of suitable funding measures are:

I. The development and comparison of biodiversity and ecosystem service scenarios of different regions, which also include the different local, national and international options to implement the CBD resolutions agreed on in 2010.
II. The evaluation of models and indicators relating to the development of biodiversity and ecosystem services in different regions and their application for substantiating, communicating and evaluating the implementation of national and international strategies and CBD objectives.
III. The analysis of evaluation frameworks and options of action, including the development of actions for decision-makers on different levels.

New forms of collaboration between the humanities and social and natural sciences will be necessary in order to develop new integrative research concepts and achieve the aforementioned objectives. It is expected that the close collaboration between these science areas will enable innovative solutions for problem-solving to be developed and lead to groundbreaking results in the field of functional biodiversity research.

3.2 Social, economic and political relevance

The proposition's primary objective is to investigate possibilities for the long-term protection of ecosystem services and hence contribute to achieving the CBD objectives, enable the sustainable utilisation of existing resources and to maintaining biological diversity in Germany and worldwide. As national activities (such as the global division of labour, political legislation and regulations) have an effect on the ecosystems and biodiversity in other countries, alternatives will be sought to reduce or substitute the loss of biological diversity. The present proposition links up with the Millennium Development Goals (MDG) and it can support the debate of the CBD's intergovernmental scientific advisory body (Subsidiary Body on Scientific, Technical and Technological Advice, SBSTTA). It is also expected that the proposition will make a decisive contribution to the implementation of the CBD

2020 objectives. It also builds a bridge to international programmes such as ILTER, Geo-BON and DIVERSITAS international. The proposition can also be seen as an integrative contribution to the "Grand Challenges for Global Sustainability" of ICSU-ISCC and will directly support the work of the future Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). In addition, the scientific contribution can support the implementation of the National Strategy of Biodiversity, and therefore connects up with the German government's Biological Diversity funding programme.

3.3 Key issues

The research projects are expected to generate the following results:

- Development of **global change scenarios** for different regional ecosystems and for the analysis of strategic options for their protection and sustainable use
- Identification, cataloguing and analysis of important social, **political and economic (direct and indirect) impact factors** and **strategic options** for regions.
- **"Good practice" definition** of region-specific indicators and monitoring strategies, including the comparison of indicators of biodiversity, function and service of ecosystems, land use and socio-economic trends.
- Documentation and analysis of **interactive processes** relating, for example, to the way stakeholders can be successfully involved (limits, systematic evaluation), the integrative research process, the consultation of decision-makers and the development of good practice recommendations
- Analysis and further development of **concepts for the social evaluation** of ecosystem services
- Development of **concepts relating to dealing with the non-quantifiable values of services** (precautionary strategies)
- Significant **further development of the German contribution to international biodiversity research** in the context of global change and with a special focus on integrative research groups.
- **Development of strategic region- and society-specific options of action** for the protection and sustainable use of regional ecosystems.

3.4 Working programme

In order to come closer to the goals stipulated in the present proposition, model concepts and sustainability concepts with regard to biodiversity and ecosystem services need to be to reconsidered, and if necessary developed. The same needs to be done for existing programmes and concepts relating to ecological long-term observations and biodiversity monitoring in Germany. In addition, it is necessary to investigate and compare the efficacy, efficiency and applicability of political measures and tools as well as the effect of socio-ecological regulation measures.

In order to create a global framework in which regionally focused research networks will be able to work together, certain global marginal conditions will be selected and defined. Working with stakeholders, future scenarios and principles for regional models of global change will be selected by taking into account social and economic factors. The involvement of relevant stakeholders and

players is a prerequisite for being able to formulate society-relevant questions. It is expected that this will lead to the creation of acceptance on the regional level and increase the likelihood of implementing necessary measures in good time. Due to many knowledge gaps (on the social, economic as well as biophysical levels), uncertainties and insecurities might arise, which must then be taken into account and communicated in a way that is understood by the target group. In addition, the transfer of knowledge into the IPBES process is a key issue.

Any research network will therefore need to concentrate on the following (five) work packages:

Development of global scenarios across different projects

Jointly defining the global development problem is a necessary prerequisite for all research approaches. This requires a common work framework to be established and made mandatory. The framework must take into account factors including agricultural development, population growth and demographic developments in broader terms, lifestyles and global market politics. It is recommended to establish a working group at the very start of the project to manage cross-sectoral tasks such as the definition and further development of scenarios and to facilitate the exchange of information (e.g. methods and results) between project groups. Another objective of this working group might for example also relate to the development of a framework for ecosystem services in Germany aimed at standardising the different methodological approaches and the measurement of key ecosystem services.

Transdisciplinary development of regional scenarios

Special scenarios on the effects of human-nature interventions will be developed on the regional scale. These regional scenarios will then be subject to the agreement of relevant regional/local stakeholders; global and regionally important processes as well as (direct and indirect) factors that influence social, political and economic issues will need to be taken into account. A joint development process with regional/local stakeholders will then determine on a case-by-case basis whether the scenarios also take into account normative descriptions. It is recommended that the comparative investigation of the outcome of models be taken into account in order to be able to verify the informational value of the scenarios and deduce uncertainties.

In order to integrate natural and social scientific data sets with each other, the regional research consortia will develop integrative methodological approaches that are best suited for the issue in hand. It is highly likely that this procedure will require the development of innovative modelling approaches, which will also need to take into account the changes in ecosystem services identified by the Millennium Ecosystem Assessment and subsequent research. In order to be able to develop a reliable assessment basis for developments prior to 2010, the procedure will also have to take past trends into account. It is expected that these trends will also be suitable for use as a basis for assessing changes in biodiversity and associated ecosystem services occurring up until 2050.

Determination of indicators and ecological long-term observations

As far as indicators are concerned, future work will need to focus on the further development of existing indicators as well as on the definition of new indicators, because currently used indicators are strongly oriented around rare species and are rarely directly related to ecosystem services. The selection and evaluation of indicators could be based on the following:

- biodiversity (e.g. alpha and beta diversity of different groups of organisms, genetic diversity of e.g. nitrogen fixating organisms, and endangerment situation of plant and animal species),
- ecological functions and states (e.g. productivity, CO_2 storage, habitat loss, migration)
- valuation of ecosystem services (e.g. quality of life and health, costs associated with maintenance versus the profit from usage; number of jobs that are closely related to ecosystems; number of people using ecosystems; fundamental legal and ethical aspects related to the utilisation and the valuation of nature, environment and landscape, etc.)

In addition to these aspects, currently used indicators relating for example to the resilience of ecosystems to influences such as increased usage, pollution, the exclusion of certain plant and animal species and weather extremes need to be verified. If existing indicators prove unsuitable, it will be necessary to develop new indicators that reflect the structure and dynamic of ecosystems from experimental investigations, for example. In addition, it is considered useful if the development or identification of new indicators brings existing observation and monitoring systems together, for example systems used in the fields of emission and immission monitoring, forest damage monitoring and biodiversity monitoring.

Factors that impact biodiversity and ecosystem services

Direct (e.g., through pollution) as well as indirect (e.g. through globalization, demographic growth) factors have different impacts on biodiversity and ecosystem services. Important social, political and economic factors on the global and regional level need to be identified, catalogued and analysed in order to determine the importance of each factor. The same needs to be done for options of action relating to biodiversity and ecosystem services. Generally speaking, the development of standardized measurement methods (observatories) and the development of databases would benefit from taking the following topics into account:

- climate change (trends of temperature, CO_2, nutrients, wind, precipitation, etc.)
- emission trends
- usage (e.g., harvest yields, fertilization, water removal, etc.)
- protection (regulation of usage, preservation of existing situation, etc.)
- direct options of action based on the CBD goals (subsidies, conversation formalities, etc.)
- social and economic measures and formalities (economic development, supplementary payments for fallow land, etc.)
- lifestyle issues and demographic development
- conflicts relating to values and standards with regard to biological diversity and ecosystem services
- forms of debate and deliberation methods for the socio-political negotiation of issues related to sustainable development

Options of action, communication and self-evaluation

During the synthesis phase, all project groups must have as a primary goal the formulation of suggestions that take into account trade-offs (conflicts of goals) of different services when looking for the best-possible methods and solutions. At the same time, the options of actions proposed must take into account social, economic and ecological interests and involve innovative forms of active shaping.

With regard to the communication of results and options of actions it is important that limits or uncertainties of knowledge arising from the complexity of ecological systems or model projections involved (e.g. climate prognoses) will be communicated in a way that is easy to understand.

During the synthesis phase, the project groups will also have to carry out self-evaluations, i.e. assess their own activities and results. The project groups will document and analyse interactive processes and use this information to assess whether stakeholders are contributing as they should to the project and also to assess the efficacy of the problem-oriented methodological approach used.

3.5 Implementation of the proposition

The conceptual framework relating to the investigation of natural and anthropogenic (i.e. social) factors that affect biodiversity and the resulting consequences for ecosystem functions, and hence the ecosystem services for human wellbeing, have until now been lacking. On the national level, there are deficits in the coordination of such research projects and programmes within the given general framework. The effects of anthropogenic disturbances have so far only been investigated on different spatial and temporal scales[18] and organizational levels. With regard to the overall goal of formulating propositions for implementing the CBD goals and reinforcing the sustainable development of Germany, the topic of ecosystem services must be dealt with in a more stringent and coordinated manner.

The integration of natural scientific, social and humanistic concepts and results is one of the overall goals of the research projects associated with the present funding proposition. Since such an integration will result in new and different collaborations in this area, it is necessary to validate and determine the joint conceptual framework. In addition, it represents a scientific, organizational and partially novel challenge for the majority of disciplines, and must therefore be taken into account in the temporal planning and the course of the funding measures. In addition, it is also necessary to leave room for sufficient freedom for new ideas and concepts. Integration is essential in order to be able to make notable progress in the research of ecosystem services.

A two-tier tendering procedure is recommended for the quality-oriented selection of transdisciplinary research groups. The research groups are to be selected according to the following criteria, which must also take regional priorities and aspects relating to the overall goals of the funding measure into account:

[18] Investigations have shown that the majority of research projects only take into account timescales of less than five years and only focus on processes involving plot sizes of under 100 m^2 (see Stadler and Klotz, ALTERN-Net research reports, WPR3-2005-01, 2005).

- In the **first phase** of implementation, the basic principles and assumptions of future scenarios of biological diversity need to be jointly developed and determined. The scenarios must take into account global and regional processes as well as social, political and economic (direct and indirect) factors that impact the different regions. The regional research groups will develop a selection of integrative methodological approaches and required data and models relating to the past. Furthermore new indicators and monitoring systems required for the future monitoring of biodiversity and ecosystem services will be developed in agreement with the monitoring parameters, indicators, species lists (for which Germany is responsible) and hotspots of biological diversity worked out by BMU/BfN/UBA. The future scenarios developed jointly in the first phase represent the framework for the ongoing work of the regional project groups.
- In the **second phase**, the results obtained with models, monitoring data and selected indicators relating to the development of biodiversity and services of different ecosystems will be analysed and evaluated. These results will constitute the basis for examining ecosystem services and the biodiversity of individual regions as well as for identifying the interactions between global and regional environmental factors and strategic options.
- The **third phase** will mainly focus on the validation and evaluation of the results, and will be carried out in cooperation with the national stakeholders and players. This will allow the analysis of strategic options and the formulation of options of action for decision-makers on different levels.

Criteria for the selection of research groups:

It is recommended that 6 to 8 research groups be selected to focus on regional issues and one research group to coordinate and implement the cross-sectoral tasks. Successful research groups are required to:

- pursue integrative research approaches that bring together the necessary disciplinary and interdisciplinary expertise required for achieving the overall research goals (I-III),
- have access to primary data derived from the long-term monitoring of at least one regional ecosystem in which the direct integration of expertise gained from long-term monitoring activities (e.g. ILTER, exploratories or other biodiversity infrastructures) and the German federal biological diversity programme is deemed to be of major advantage,
- link university and non-university research as well as act as an interface with other players, practitioners and stakeholders,
- promote young scientific talent, especially in the fields of interdisciplinary integration, transdisciplinary consideration of problems, methods for the analysis of trends and the modelling and assimilation of monitoring data relating to biodiversity research,
- guarantee the continuous involvement of relevant (global/regional/local) stakeholders during the entire research process, in particular with regard to achieving the third goal,
- engage the transfer of knowledge and the implementation of research results.

Examples of national and international points of contact

The following networks and facilities represent potential strategic partners:

- ALTER-NET – Long-Term Biodiversity, Ecosystem and Awareness Research Network
- Biodiversitätsexploratorien (DFG)
- ERA-Net "BiodivERsA" (z.B. Pan-European Call zu „Biodiversity and Ecosystem Services")
- EU geförderte Projekte im Rahmen des FP7-Calls, wie z.B. ENV.2011.2.1.4-3: Improved comprehension of the utility of the concepts of value of biodiversity
- GBIF – Global Biodiversity Information Facility
- ipBes – Intergovernmental Platform on Biodiversity and Ecosystem Services
- Life Watch
- LTER-Europe und LTER-D (European Long-Term Ecosystem Research Network), ILTER-NET (International Long Term Ecological Research)
- LTSER – Long-Term Socio-Ecological Research
- MARBEF – Marine Biodiversity and Ecosystem Functioning (EU)
- Geo BON – Biodiversity Observation Network
- NetPhyD – Netzwerk Phytodiversität Deutschland
- NeFo – Network-Forum for Biodiversity Research Germany (BMBF)
- Tagfaltermonitoring Deutschland (UFZ)
- TEEB – The Economics of Ecosystems and Biodiversity (UNEP)
- Tereno – Terrestrial Environmental Observatories (HGF)

International research framework programmes, research priorities and strategies that might be taken into account:

- Man and the Biosphere (UNESCO)
- ESSP, DIVERSITAS international, IHDP, WCRP, IGBP (ICSU)
- Strategiepapier "ICSU Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade" (ICSU, ISSC)
- Strategiepapier "Ecosystem Change and Human Well-being" (ICSU)
- LIFE+ (EU)
- Förderprogramm „Nachhaltige Landnutzung" (BMBF)
- Förderprogramm „BioÖkonomie 2030 – Unser Weg zur bio-basierten Wirtschaft" (BMBF, BMELV)
- Förderprogramm "Biologische Vielfalt" (BfN)
- Research recommendations on ecosystems services, Hungarian Meeting of the European Platform for Biodiversity Research Strategy (EPBRS), URL: http://www.epbrs.org
- Ecosystem Change and human well-being. (ICSU)
  URL: http://www.icsu.org/publications/reports-and-reviews/ecosystem-change-report
- Nationale Strategie zur biologischen Vielfalt (BMU),
  URL: http://www.bmu.de/english/nature/downloads/doc/41253.php
- Our life insurance, our natural capital: an EU biodiversity strategy to 2020 (EU),
  URL: http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm

Annex

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