THE VALUE OF NATURE FOR ECONOMY AND SOCIETY

A SYNTHESIS OF NATURAL CAPITAL GERMANY – TEEB DE

NATURKAPITAL
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Bernd Hansjürgens, Christoph Schröter-Schlaack,
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Authors
Bernd Hansjürgens, Christoph Schröter-Schlaack, Augustin Berghöfer, Heidi Wittmer, with assistance from Urs Moesenfechtel

»Natural Capital Germany – TEEB DE« coordination group
Bernd Hansjürgens (Helmholtz Centre for Environmental Research – UFZ), Christoph Schröter-Schlaack (UFZ), Christa Ratte (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – BMU), Burkhard Schweppe-Kraft (Federal Agency for Nature Conservation – BfN)

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PAVAN SUKHDEV
Study Leader of TEEB
(The Economics of Ecosystems and Biodiversity),
Founder-CEO of GIST Advisory,
Goodwill Ambassador for
UN Environment

PREFACE BY PAVAN SUKHDEV

It is in many ways a landmark and a privilege for me to write this foreword to »TEEB Germany«. The origins of the TEEB initiative lie in the interest of Germany and the European Union Commission, a decade ago in 2007, to promote a study of the economic rationale for biodiversity and ecosystem conservation, inspired by the »Stern Review«, a 2006 report on the economic rationale for early action on climate change. The German government was the first funder of the TEEB initiative; German institutions such as GIZ have steadfastly supported interest amongst developing nations in using the TEEB approach; and today German support for implementing the evaluation framework of the new »TEEB for Agriculture and Food« study will no doubt go a long way in mainstreaming TEEB's emphasis on making externalities visible in the strongly inter-connected arenas of ecosystems, agri-food systems, rural livelihoods, climate stability and human health.

We have come a very long way from times only a decade ago when nature's quiet but very valuable contributions to poor rural communities around the world were dismissed or lost in the loud and false din of the so-called »trade-off between environment and development«. Today, TEEB's »GDP of the poor« concept is widely understood and has become a well-tested metric that repeatedly shows that nature's services are vital for rural livelihoods. The quality of human health is now recognised as connected to how we treat nature; the stability of climate and the reliability of the planet's vital freshwater systems are seen as dependent on the health of ecosystem functions; and the economic invisibility of nature's very sizeable gifts to humanity is no longer dismissed as »externalities«, but rather, seen as a challenge that policymakers, business leaders and civil society must collectively solve, and with some expediency.

Thinking back over this remarkable decade reminds me of the genesis of my interest in the invisible economics of nature. As a young banker working in Asia's emerging markets in the 1990s, I saw the blossoming of many »tiger« economies, many fast-growing cities, and I saw entrepreneurs make vast private fortunes. At the same time, I could not ignore the palpable ongoing loss of Asia's ecology and its effect on citizens« lives and on their common wealth. The Yellow River ran dry for 9 months in 1997, the Yangtze flooded disastrously in 1998. Vast smoke clouds from burning peatlands in Sumatra repeatedly clogged the air in Singapore, where I lived. But what grabbed the headlines globally was the Asian debt crisis, the collapse of Thailand's stock markets, the riots in Indonesia, and Malaysia tearing up its international currency and replacing it with exchange controls. What was it about Natural Capital that made it so invisible, so unlike the Financial Capital of my world of global markets? Why was private wealth

worth chasing, and worth reporting if it was lost, but not public wealth?

These questions made me understand that we really did not measure what we thought we managed: human well-being. The root causes of biodiversity loss lie in the nature of the human relationship with nature, and in our dominant economic model, which promotes and rewards more versus better consumption, private versus public wealth, human-made capital versus natural capital. This is the »triple-whammy« of self-reinforcing biases that leads us to uphold and promote an economic model in which we tend to extract without fear of limits, consume without awareness of consequences and produce without responsibility for third-party costs, the so-called »externalities« of business. Of course, we would not adopt any such damaging behaviours if our relationship with nature were one of co-existence and responsible stewardship. However, increasing urbanisation, which creates both physical and emotional distance from nature, and our dominant »take-make-waste« economic model defeats that possibility.

It was against this backdrop that I had gladly accepted to become Study Leader of TEEB, which adopts the position that a new awareness of nature can and should be encouraged by describing our economic existence in broader terms than the neoclassical paradigm permits. The familiar »mantras« of market supremacy, efficiencies of privatisation and globalisation, GDP growth and so on, were the toolkit of the 20th century. They worked for a limited time and purpose and have indeed improved the standard of living in many societies. But at the same time, they have created enormous negative externalities, such as climate change and ecological scarcities which hang over the whole of humanity like the sword of Damocles. The development paradigm of the last 50 years is not a great success story from a humanitarian perspective either: the number of the world's poor increased, not decreased, if »poverty« is considered in terms of »well-being« as defined by the Millennium Ecosystem Assessment. A key problem with today's society is that we have become obsessed by »GDP growth« as the all-important measure of success. This economic compass is faulty and must be radically updated to reflect the role of human capital and natural capital in sustainable development, and to ensure that the costs and benefits of conserving nature are more fairly distributed.

In order to flesh out a broader holistic economic approach, which recognises the existence and significant socio-economic effects of natural capital, TEEB argues that economic valuation of Nature's public goods and services flows is both necessary and ethical, and that shadow prices can and should be calculated and presented, all in the proper context. Firstly, evaluations of any kind are a powerful

»feedback mechanism« for a society which has distanced itself from nature, upon which its very health and survival depends. Economic valuations, in particular, communicate the value of ecosystems and biodiversity and their largely unacknowledged flows of public goods and services in the language of the world's dominant economic and political model. Secondly, we cannot but recognise the all-pervasiveness of economic valuation. In the words of David Pearce »all decisions have costs and hence all decisions to incur that cost imply that benefits exceed costs«. Abstaining from explicit valuation, on apparently valid scientific or ethical grounds, often amounts to no more than an acceptance of someone else's implicit valuation – trade-offs are then made on the basis of that implicit economic valuation. And thirdly, so deep-seated and widespread is modern society's inherent market-centric mind-set that the mere device of demonstrating economic value for the public wealth that nature delivers can itself become an important strategy for the change we seek. The construction of »shadow prices« for public goods and services can take on a life beyond the quiet workspaces of academic research and enter the turbulent halls of public policy debate. Such valuations call into question the accepted dogmas of neo-classical economics, if we can demonstrate significant value flowing from nature to human society in terms of welfare benefits, employment and solutions to poverty.

TEEB's view is that we should acknowledge the weaknesses of valuation methodology in calculating such shadow prices but we should not shy away from stating best available estimates of value using the most appropriate of reviewed methodologies. This is because the alternative is in fact ethically worse: to permit the continued absence of prices to seep even further into human consciousness and behaviour as a »zero price«, and thus of no value. However, TEEB does not suggest that estimating shadow prices must lead to tradeability of natural assets. That is a separate and very serious societal choice which potentially threatens survival of species as well as the livelihoods of people. Placing blind faith in the ability of markets to optimise social welfare by privatising the ecological commons and letting markets discover prices for them is not at all what TEEB is about. In fact, we oppose that thinking, and what TEEB instead offers is a toolkit for integrating good stewardship because it also makes good social and economic sense.

Since the launch of the TEEB reports, various countries have initiated TEEB inspired studies to demonstrate the values of their ecosystems and to encourage policy-making that recognises and accounts for their ecosystem services and biodiversity. Again, Germany was one of the first countries to start its own assessment: »Natural Capital Germany – TEEB DE«. The loss of peatlands due to rainforest burning in Indonesia has no doubt grabbed global news headlines over the past

few years, but CO_2 emissions from drained peatland are an important concern in Germany as well. They emit around 41 Mt CO_{2e} per year (30 % of Germany's agricultural GHG emissions), but account for just 8 % of land used for agricultural purposes. The TEEB DE report on natural capital and climate policy notes that rewetting of farmed peatlands is a significant mitigation measure which can be implemented at fairly low cost compared with other CO_2 avoidance options. Researchers calculated that a programme of measures for rewetting 300,000 hectares of peatland in Germany would avoid economic damage amounting to € 217 million annually.

Another major ecological problem with significant economic costs is the ongoing loss of floodplains. Conversely, floodplain restoration provides both ecological and economic opportunities. Potential synergies can be achieved between biodiversity conservation and climate change mitigation through the rewetting of carbon-rich alluvial soils. Furthermore, floodplains contribute to climate change adaptation by lowering flood peaks and reducing flood damage. Their other ecosystem services include reducing nutrient loads and improving habitat function for wildlife. Calculations for a programme for the renaturation of floodplains on the Elbe river showed, by taking these effects into account, that economic benefits of € 1.2 billion and a benefit-cost ratio of 3:1 could be achieved. And there are many other examples in the TEEB DE suite of reports that illustrate the value to society and businesses of recognising and demonstrating the values of ecosystem services.

Germany has already achieved high environmental standards, has become an international frontrunner in decarbonising its energy system with the Energiewende-vision and is investing reliably in international nature conservation and development cooperation. However, there are still big challenges ahead: if everyone in the world would consume as Germans do, we would require three planet Earths. And that talk on greening the economy is cheap was made clear when NOx emissions of German diesel cars were found to be several times the legal limit. It is encouraging however that public consensus in Germany for resolving such challenges remains strong, and the TEEB DE suite of reports presents several informative analyses that could feed such consensus.

I am very hopeful that the results of Natural Capital Germany will increase the recognition of the economic importance of biodiversity and ecosystems for well-being and development in Germany as well as in the rest of the world, and not just among economists but at the level of policymakers, administrators, businesses and the public.

PAVAN SUKHDEV

AUTHORS' FOREWORD

The success of environmental policy and nature conservation in Germany is by any standard impressive. Forest dieback has been halted, the quality of our air and our lakes and rivers has been improved, the lynx and wild cat have been reintroduced; all these achievements are the result of major effort.

And yet we can see that globally – even in Germany – environmental pollution is in many cases increasing or, despite ambitious targets, only very slowly being reduced. Species are still dying out, genetic diversity is steadily diminishing, land use is being intensified, soils are eroding or losing their natural fertility and aquatic ecosystems continue to suffer from inputs of substances that are severely polluting areas such as the North Sea and the Baltic Sea. Biodiversity loss is proceeding at a rate unprecedented in the history of our planet. Viewed in economic terms we are consuming our natural capital instead of conserving it like other assets – and we are doing this while often being unaware of the diverse ways in which our well-being and our economic development depend on a rich and intact natural environment.

It is becoming ever more obvious that arguments in favour of conserving the environment and the natural world have limited impact. Set against the incentives of the market, the short-term decision horizons that currently prevail and the alleged requirements of economic policy, they often carry little weight. And yet the consequential social costs of our present economic practices are becoming more evident – as a result of climate change, the loss of pollinating insects, the costs of treating drinking water and the eutrophication of lakes and seas – despite legal regulation and environmental and nature conservation policy. At the same time, concepts such as »the bio-economy«, »nature-based solutions« and »green infrastructure« illustrate the opportunities inherent in the expansion and sustainable use of natural capital – opportunities that include lower-cost climate change mitigation and adaptation, the conservation of fertile soils, independence of fossil fuels and resources, food security landscapes worth living in and contributions to social equity both locally and globally. All this is possible if we live and work with nature, rather than battle against it. Investment in natural capital is not only good for the environment; it also enhances human well-being. Landscapes rich in species and natural structures provide attractive recreational opportunities, public green spaces improve living conditions in our towns and cities and benefit human health, and innovations that conserve energy and resources promote Germany's economic development.

This is the starting point of the international TEEB study (The Economics of Ecosystems and Biodiversity) and the German follow-on

project »Natural Capital Germany – TEEB DE«. The macro-economic perspective of TEEB sheds new light on familiar problems of environmental protection and nature conservation and translates them into an economic context that is easier to grasp for many people. Even those who may not regard nature per se as particularly important can understand that business as usual is not a worthwhile option. By identifying the societal costs of degrading ecosystems and their services and by demonstrating how unequally these costs are distributed TEEB illustrates the consequences of the wasteful use of our natural capital. Economic metrics reveal that it is often more cost-effective to avoid environmental damage than having to bear the resulting costs to society. An economic perspective also opens our eyes to previously untapped synergies between nature conservation measures and other societal objectives, such as climate change mitigation and adaptation, water pollution control and safeguarding unpolluted sources of drinking water, improving the quality of life in rural and urban areas and establishing a viable agricultural system. This helps to form new alliances to ensure the sustainable use of natural capital. It also provides important pointers to areas in which the established decision-making rules and incentives need to be changed if natural capital is to be used to the benefit of society rather than to the advantage of only a few.

An economic perspective on nature is not uncontroversial: it raises questions about the scope of its arguments, the methodology used and interpretation of the results. Pavan Sukhdev refers to this debate in his preface. How can people's diverse values in relation to nature be compressed into economic metrics? Let alone into monetary units that suggest that one thing can be set off against another and seem to turn everything into a commodity? In places such as developing countries where ownership rights are poorly regulated, how can we ensure that new markets for ecosystem services – such as the voluntary carbon market – do not result in traditional user groups being stripped of their economic livelihood through appropriation of land? These justified questions have been the subject of lengthy debate in which we have played an active part; in the course of the natural capital project we have given frequent consideration to the arguments that have been raised. One thing is clear: although economic values trigger associations with banknotes in many people's minds, the economic concept of value is much broader than just money. And it is also clear that TEEB is certainly not advocating blind trust in existing markets or the introduction of new ones for natural capital. Its concern is rather to draw attention to the currently hidden values of nature and highlight the need for new and different rules for dealing with nature in the interests of the common good. Only rarely can markets perform these tasks. In our view, therefore, too much importance has been attached in recent years to the question of whether

an economic approach to nature is appropriate at all. The key question is rather in what contexts and decision-making situations an economic perspective can be appropriate and helpful in order to realize a sustainable use of nature and its services.

Nature has a value. Regardless of whether this is an instrumental value or a value in itself, the cost of maintaining this value is an important criterion in the decision about what nature, and how much nature, we want to maintain. The enquiry into costs is not a question of a neoliberal understanding of society that aims to subject everything to the market; it is an entirely practical question. When there are decisions to be made – including decisions about conservation of the environment and the natural world – these costs are often considered from a narrow micro-economic perspective. For example, how much productive land does a farmer lose when peatlands are restored? If restrictions are imposed on fertiliser use, how does this reduce agricultural yields? How much property tax revenue is lost as a result of providing public green spaces? »Natural Capital Germany – TEEB DE« shows that conserving nature often costs society much less than the restricted micro-economic perspective suggests. This is because safeguarding natural capital preserves ecosystem services that help to reduce costs elsewhere – by protecting against floods and erosion, mitigating greenhouse gases, providing opportunities for recreation close to home, performing pollination services and so on. In all these cases the economic perspective is a valuable tool that helps to highlight the breadth of issues involved in the decision-making situation. It provides a rectification of one-sided micro-economic and often short-term cost assessments of environmental regulation. In the sometimes ideologically charged debate about values and the valuation of nature, »Natural Capital Germany« sets out practical examples that shows how society benefits from conserving nature.

With regard to the key challenge, the various stakeholders and representatives of different environmental and nature conservation positions are ultimately in agreement: the rules for dealing with nature and its services must be rewritten to better harmonize individual and societal decision-making rationales. We must not gamble with public natural capital in an attempt to boost private profits in the short term; we cannot going on – despite knowing better –to shift the consequential costs to people in other countries or to future generations, and to do so at an ever-increasing rate. Changing our attitude to natural capital is not only a question of fairness between those who profit from its exploitation today and those who must bear the adverse consequences now and in the future. Conserving natural capital and adopting sustainable economic practices in harmony with nature, its diversity and its services also opens up numerous opportunities. Our project has compiled good arguments for these propositions, and we

summarise these in this synthesis. We hope that the examples in »Natural Capital Germany« make clear that nature forms the foundation of our very existence and must be consciously considered in all our activities. Without its services life will become more expensive or, in the worst case, impossible.

BERND HANSJÜRGENS,
CHRISTOPH SCHRÖTER-SCHLAACK,
AUGUSTIN BERGHÖFER,
HEIDI WITTMER

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This Synthesis Report brings the five-year project »Natural Capital Germany – TEEB DE« to a close. The project was special in many respects. Firstly, it was not a research project; instead it aimed to collate existing knowledge of the importance of natural capital in Germany. Secondly, a feature of the project – as of the global TEEB study – was its open architecture: it was not simply the work of individual researchers but involved numerous academics, experts in practical nature conservation and specialists in business and public administration as authors and reviewers. This network of voluntary participants formed the basis for the broad coverage and analysis of the existing knowledge, balanced presentation of it and the derivation of recommendations for action. Finally, the project was transdisciplinary: it aimed not only to provide a knowledge base that encompasses a range of academic disciplines but also to involve important stakeholder groups from politics, public administration and civil society with the aim of creating an effective stimulus for more sustainable management of our natural capital. Such an ambitious project required a high level of commitment from everyone involved. I should therefore like to express my thanks at this point.

For their involvement in preparation of the reports in »Natural Capital Germany – TEEB DE« I should first like to thank the authors and reviewers for their dedication and effort. It is as a result of their unpaid and untiring collaboration and support that the reports bring together the whole spectrum of knowledge of the importance of nature and its ecosystem services. All the authors and reviewers are listed again at the end of this Synthesis Report.

In addition, I should particularly like to thank the following individuals and groups:

- the **report leaders and their colleagues**. With their expertise they have helped define and shape the issues covered in the individual reports. It was through their motivation and through being approached by them that the authors involved in »Natural Capital Germany – TEEB DE« were brought on board. Workshops were organised in which the structure of the individual reports was created and refined, content was pre-structured and versions of individual sections were circulated and discussed. I am aware that this required an enormous amount of effort and went far beyond the normal scope of an editor's tasks.

- the **coordinators of the individual report chapters** for bringing together the many individual sections and subsections, giving shape to »their« chapters and taking careful note of the many comments

from the reviewers. These were all time-consuming tasks that called for great care, stamina and patience.

- the **project advisory board**, which supported us throughout the project with helpful suggestions, provided a safe space for argument and discussion and assisted not only with the content of the project but also with its presentation and dissemination. The members of the advisory board were: Stefanie Engel (Osnabruck University), Uta Eser (Office for Environmental Ethics), Karin Holm-Müller (Friedrich Wilhelm University, Bonn; member of the German Advisory Council on the Environment – SRU), Beate Jessel (President of the Federal Agency for Nature Conservation – BfN), Marion Potschin (Nottingham University), Christian Schwägerl (scientific, political and environmental journalist), Karsten Schwanke (meteorologist and moderator), Antje von Dewitz (CEO of VAUDE) and Angelika Zahrnt (Honorary President of Friends of the Earth Germany – BUND).

- the **project stakeholder group (PAG)** comprised of representatives of major stakeholder groups in society who discussed and commented on the content of all the reports: they were frank and prepared to be controversial but always fair and constructive. Against the backdrop of the broad scope of the issue of natural capital and the differing points of view on many of the aspects of it that are raised in public debate, the PAG contributed to a balanced presentation of the issues and recommendations. There were some changes among the representatives of the stakeholder groups in the course of the project. The members of the PAG were: Hans-Ulrich Bangert (Federal-Länder Working Group on Nature Conservation, Landscape Management and Recreation – LANA, Saxony State Ministry for the Environment and Agriculture), Rüdiger Becker (Municipalities for Biodiversity, city of Heidelberg, Office of Environmental Protection, Trade Supervision and Energy), Axel Benemann (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – BMU), Carolin Boßmeyer (Biodiversity in Good Company Initiative e. V.), Ann Kathrin Buchs (Federal-Länder Working Group on Water – LAWA, Lower Saxony Ministry for the Environment, Energy and Climate Protection), Deliana Bungard (German Association of Towns and Municipalities), Andreas Burger (German Environment Agency – UBA), Wiltrud Fischer (project-executing office of the Federal Ministry of Education and Research – BMBF at the German Aerospace Centre), Claudia Gilles (German Tourism Association – DTV), Alois Heißenhuber (Advisory Council of the Federal Ministry of Food and Agriculture – BMEL on biodiversity and genetic resources, Munich Technical University), Udo Hemmerling (German Farmers« Association – DBV), Till Hopf (Nature and Biodiversity Conservation Union – NABU), Barbara Kosak (BMEL), Jörg Mayer-Ries (BMU), Günter

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BERND HANSJÜRGENS
Study Leader Natural Capital Germany – TEEB DE
Helmholtz Centre for Environmental Research – UFZ

THE PROJECT »NATURAL CAPITAL GERMANY – TEEB DE«

The project »Natural Capital Germany – TEEB DE«, which has been running since 2012, is the German follow-on study to the international TEEB study (The Economics of Ecosystems and Biodiversity), which explored the links between the ecosystem services of nature, economic activity and human well-being. By adopting an economic perspective, »Natural Capital Germany – TEEB DE« aims to make the potentials and services of nature visible and more measurable. The economic assessment of ecosystem services is an important tool to mainstream the economic and social significance of nature in private and public decision-making processes. »Natural Capital Germany« demonstrates that conserving biodiversity and promoting the variety of ecosystem services has significant positive societal effects that underpin the transformation towards sustainable development. Thereby the project also fosters implementation of sustainability, environmental and nature conservation objectives and strategies, especially Germany's National Biodiversity Strategy.

The project is financed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Agency for Nature Conservation. The coordination of the study is based at the Helmholtz Centre for Environmental Research – UFZ; the study leader is Prof. Bernd Hansjürgens. As the principal product of the collaboration of more than 300 authors and over 150 reviewers from academia, associations and politics, a number of reports and brochures have been produced that highlight the economic and social value of nature and its services in Germany (see www.naturkapitalteeb.de). The voluntary participation of the authors and reviewers was vital to this.

FIGURE 1 ▸ Available reports and brochures by »Natural Capital Germany – TEEB DE«

- Natural Capital Germany – TEEB DE (2012): The Value of Nature for Economy and Society – An introduction. ifuplan, Helmholtz Centre for Environmental Research – UFZ, Federal Agency for Nature Conservation – BfN, Munich, Leipzig, Bonn.

- Natural Capital Germany – TEEB DE (2013): The Business Perspective – Being prepared for new challenges. Pricewaterhouse Coopers, Helmholtz Centre for Environmental Research – UFZ, Federal Agency for Nature Conservation – BfN, Berlin, Leipzig, Bonn.

- Natural Capital Germany – TEEB DE (2015): Natural Capital and Climate Policy – Synergies and conflicts. Edited by V. Hartje, H. Wüstemann and A. Bonn. TU Berlin, Helmholtz Centre for Environmental Research – UFZ, Berlin, Leipzig.

- Natural Capital Germany – TEEB DE (2016): Ecosystem Services in Rural Areas – Basis for human well-being and sustainable economic development. Edited by C. von Haaren and C. Albert. Leibniz University Hanover, Helmholtz Centre for Environmental Research – UFZ, Hanover, Leipzig

- Natural Capital Germany – TEEB DE (2016): Ecosystem Services in the City – Protecting health and enhancing quality of life. Edited by I. Kowarik, R. Bartz and M. Brenck. TU Berlin, Helmholtz Centre for Environmental Research – UFZ, Berlin, Leipzig.

»Natural Capital Germany – TEEB DE« is supported by a project advisory board whose members provide specialist advice to the project. The members of the board are prominent individuals from academia, business and industry, society and the media. There is also a project stakkeholder group that informs and links stakeholder within society and involves them in the project. The group includes representatives of environmental and business associations, government departments, the federal states and municipal interests.

This Synthesis Report brings together important findings of »Natural Capital Germany – TEEB DE« and forms the conclusion of the project.

SUMMARY

Nature – a valuable form of capital

Nature provides a wide range of ecosystem services on which our health and well-being depend and that form the foundation of our economic prosperity. These services include the provision of clean air, fertile soil and clean water and also landscape amenity, protection against floods, reduction of harmful greenhouse gases and creation of a healthy climate in our towns and cities. From an economic point of view nature is a capital, similar to human capital or real capital. This »capital« yields »dividends« in the form of ecosystem services. It is important that we do not exhaust this capital: instead we must maintain it and – where necessary – restore it.

Growth at the expense of natural capital is not sustainable. Technical progress and intensification of the way in which we use our natural resources have led to an unprecedented level of supply that has been a key driver of the prosperity that Germany has achieved. At the same time, this intensive land use is placing ever more obvious strains on nature and the environment: biodiversity is dwindling, fertile soils are being lost through erosion and sealing, surface water and groundwater is being polluted by nutrient inputs and the flood retention capacity of flood plains is being reduced as the land is being surfaced and built on. And that's not only through for Germany: our economic activities often result in the overuse of natural capital in other countries as well.

By contrast, the case studies presented in this Synthesis Report show that **using ecosystem services in ways that set out to preserve the natural capital delivers many societal benefits.** In the long term we avoid the cost of adaptation and substitution by preventing damage to the natural environment. We can implement low-cost solutions in areas such as climate change mitigation and adaptation and the provision of drinking water. And with nature-based solutions we can contribute to a number of social objectives simultaneously.

Damage to nature and ecosystem services results in significant costs to society. Additional illnesses caused by lack of access to nature result in costs to the health sector; increased greenhouse gas emissions raise the cost of abatement and adaptation; soil erosion causes lost production and lower yields; flooding leads to loss of homes and insurance claims, and providing drinking water becomes more expensive on account of elevated nitrogen levels.

The stock of natural capital must be safeguarded, because it makes vital contributions to the achievement of social objectives including

the provision of food, water and renewable resources, cost-effective climate change mitigation and adaptation, recreation and sport, nature conservation, water pollution control, agreeable living and working environments, and social equity. Moreover, it is becoming increasingly evident that preventing damage to nature and ecosystem services is cheaper than having to bear the consequential costs to society.

We must not consider individual ecosystem services in isolation but instead look at natural capital as a whole with all its potential functions to the benefit of society. The way in which land is used usually influences a whole range of different ecosystem services. Land management systems, though, often seek to optimise individual services – for example, the aim may be to maximise the production of food and animal feed or the production of biomass for energy and industrial feedstock. While this yields revenue from the sale of produced goods, it impacts adversely on other ecosystem services, for example by increasing nitrate levels in groundwater or creating desolate agricultural landscapes in which soil erosion is a major risk. The challenge – and the opportunity – to achieve more sustainable management of our natural capital involves considering the impacts on all ecosystem services when making decisions on land. This must include impacts on ecosystem services that are not traded on markets, for which there are no minimum standards or that need to be safeguarded and developed to a level in excess of that ensured by existing standards and incentives. »Natural Capital Germany – TEEB DE« has drawn up a range of recommendations for action.

Recommendations and conclusions: adjusting the conditions for use and preservation of natural capital

There are a number of objectives, instruments and measures that contribute to the conservation of nature and to the sustainable use of natural resources. They are a key pillar of nature conservation, but they are not in themselves enough to halt the loss of biodiversity. Nature conservation suffers from weak implementation as a result of inadequate funding and competing political priorities.

We must replace our defective »economic compass« and prevent false incentives driving our use of natural capital. Despite the plethora of rules and regulations, decisions in society are often dominated by partisan interests, a focus on short-term profits and thinking that remains confined by sectoral boundaries. We must reformulate our decision-making rules to place greater emphasis on the common good beyond what is required by law, to attach greater importance to the long-term perspective and to focus on the totality of ecosystem services – not on maximising individual services selectively. To protect

our natural capital and ensure that it is used sustainably, we therefore need to seek out methods and instruments for incorporating the diversity of ecosystem services more effectively into our decisions. Specifically this requires

- **information** on ecosystem services and the development of natural capital
- **increased cooperation** between different policy sectors
- clear and implementation-oriented **targets**
- a **coherent system of standards and economic incentives**
- the assumption of **corporate responsibility** for the conservation of natural capital and
- efforts to **reduce Germany's ecological footprint.**

Improve the information base. Existing methods of collecting data on ecosystem services at government and municipal level should be expanded to include quantitative appraisals and incorporated into a permanent monitoring system (»natural capital accounting«). Corporate accounting systems should also be developed further. Where it is not already the case, the recording and assessment of impacts on natural capital and ecosystem services should be included on a mandatory basis in regulatory impact assessment, in environmental assessments and in spatial planning systems. This will help to ensure better identification of those who benefit from and are affected by changes in natural services; it will also enable appraisal decisions to be taken in a manner that is more balanced and underpinned by completed economic data. Ten selected examples of the assessment of ecosystem services are presented in this report. In compiling them it became clear that in many other areas and policy fields there are still significant knowledge gaps or a lack of practice-oriented elaboration of such knowledge. In this respect there is still considerable need for research.

Promote cooperation and policy integration. Economic sectors and policy areas beyond the field of environmental and nature conservation are not only relevant as drivers of the decline in biodiversity; they are also directly dependent on ecosystem services. Maintaining natural capital yields synergies in the fields of agriculture, energy and climate policy, water pollution control and health. Utilising the existing synergies requires increased cross-sectoral cooperation. Experience shows that such cooperation is not easy to establish and often encounter many obstacles. Appropriately designed funding rules can provide an important stimulus here. Providing money for joint

projects and cross-sectoral measures that promote natural capital and ecosystem services in combination with other social tasks and objectives will foster the implementation of cooperative approaches.

Formulate and implement clear targets. State regulation that promotes conservation of nature and the environment does not inhibit economic development and prosperity. Quite the opposite: it safeguards business opportunities and future economic prosperity by preserving valuable natural capital. Environmental pressures that have complex impacts, such as nitrogen inputs and land take, are already subject to quantitative policy objectives. However, these objectives must be formulated in implementation-oriented form and incorporated into action programmes in which responsibilities for action are clearly determined. Existing environmental objectives are often too general and only set at a strategic level. Even if there are quantified goals, they are often not implemented further down the line because the necessary rules are not in place, responsibilities are not adequately specified or funds for supportive measures are not provided.

Shape standards and incentives consistently. Standards such as statutory prohibitions and requirements (e.g. caps on emissions, rules on good agricultural practice in connection with fertiliser use, farm management stipulations) are important because they provide a mandatory frame of reference for land users. They not only define what is not allowed and must be avoided but also set out the framework for the permitted use of nature. They are also important for determining and rewarding additional conservation action that goes beyond the standards. Moreover, economic incentives pto achieve reductions in environmental pressures beyond the minimum levels should be performance-based and provided in a cost-effective way. On the other hand, the provision of ecosystem services – should be adequately rewarded and the level of payments should be systematically linked to the provision of public services. There is hence an urgent need to reorient the EU's agricultural policy in the light of these considerations.

Meet corporate responsibility. Many companies depend directly or indirectly on ecosystem services: the maintenance of these services is therefore a key factor in the companies« profitability. Often, however, businesses are insufficiently aware of these dependencies. Tools to identify and assess these linkages are now being pursued, for example the Natural Capital Protocol. The aim of such accounting procedures is to highlight companies« dependence on natural capital and integrate it into their corporate financial reconciliation activities. Involvement in biodiversity conservation – through support for civil-society or public-sector initiatives, but particularly in the company's own activities – is also an aspect of corporate responsibility.

Reduce Germany's ecological footprint. There is nothing to be gained from preserving natural capital and ecosystem services in Germany if at the same time our production and consumption causes excessive pollution and destruction of natural capital elsewhere. Consumption patterns in Germany – including the strong demand for animal products – can result in the degradation of agricultural land and the loss of water resources abroad. The high level of meat consumption in Germany and the production model of industrialised animal husbandry must be urgently corrected in order to protect natural capital both here and in other countries. Although Germany's influence on the preservation of natural capital abroad is limited, there are nevertheless opportunities for intervention. They include import provisions that apply without infringing WTO rules, certification schemes and development cooperation aimed at maintaining natural capital.

1 NATURE – A VALUABLE FORM OF CAPITAL

»IT IS OFTEN SAID THAT NATURE CONSERVATION AND ECONOMIC ACTIVITY CONFLICT WITH EACH OTHER. I AM NOW CONVINCED OF THE OPPOSITE: NATURE IS CAPITAL – PROBABLY THE MOST VALUABLE CAPITAL THAT WE HAVE IN THE WORLD.«

»THIS NATURAL CAPITAL IS CONSTANTLY IN NEED OF SAFEGUARDING, OF REINVESTMENT. IT MUST NOT BE USED THOUGHTLESSLY. WE OFTEN ONLY BECOME AWARE OF THE ATTENDANT RISK TO ECONOMIC PROSPERITY AND PEOPLE'S WELL-BEING WHEN DIVERSITY IS ALREADY ENDANGERED.«

FORMER FEDERAL ENVIRONMENT MINISTER KLAUS TÖPFER,
»HOW GREEN IS GERMANY REALLY?«,
ESSAY, DB MOBIL, 11/2016, PP. 32 – 35

1.1 WHY WORRY ABOUT BIODIVERSITY LOSS?

Biodiversity is declining, in Germany and all over the world. Genes, species and ecosystems are disappearing, and a vital basis of our economic activities and human well-being is being lost with them. This also constrains our ability to cope with future challenges. The national and international strategies and programmes adopted so far have been unable to halt this trend.

Nature provides humankind with a wide range of services; it contributes to our health and well-being and provides the basis for economic development and prosperity. The list of ecosystem services is long. Fertile soils are essential for the production of food and raw materials. Forests sequester carbon and provide timber and other valuable services. Floodplains purify water and protect against floods. Natural landscapes are sought out for purposes of tourism and recreation. In urban settings, shade-giving trees provide protection from heat.

Despite this, more and more species are disappearing. Globally almost two-thirds of ecosystems are so severely damaged that their ability to provide beneficial services is drastically restricted (MA, 2005; Costanza et al., 2014; Steffen et al., 2015). In Germany a similar picture applies in many quarters: species diversity and landscape quality are continuing to decline, especially in agricultural settings (BMUB, 2015a; 2017b). As a result of land use, technical progress and the intensification of agriculture, there is heavy pressure on nature and hence on ecosystem services: the rate of land take for settlement and transport remains high, and we are still a long way away from the target of 30 ha/day envisaged in the German Sustainability Strategy. Intensive agricultural use is accompanied by substantial inputs of nutrients and pollutants; the state of rivers, lakes and groundwater is unsatisfactory, and pollution levels in towns and cities as a result of noise and transport emissions often verge on the intolerable. Environmental targets are being missed, sometimes by a very long way. These things do not only affect nature; directly and indirectly they also affect our living conditions. Burdens on nature and the environment impact on our health, reduce well-being, restrict quality of life and deprive us of opportunities for coping with future challenges such as climate change.

There is no lack of political objectives and strategies: the international framework is laid down in documents such as the Convention on Biological Diversity (CBD, 1992), the Strategic Plan for Biodiversity 2011–2020 (which includes the Aichi Targets) and the EU Biodiversity Strategy to 2020 (EC, 2011). In addition, there are in Germany a whole range of political objectives and strategies designed to conserve biodiversity, safeguard the livelihood base and promote sustainable development: they include the National Strategy on Biological Diversity

of 2007 (BMU, 2007), the Integrated Environmental Programme 2030 of the Environment Ministry (BMUB, 2016a), the National Sustainability Strategy (Bundesregierung, 2017), the Climate Action Plan 2050 (BMUB, 2016c) and the Forest Strategy 2020 (BMELV, 2011).

Despite all these strategies and the existing legal instruments (e. g. nature conservation law, water law, agricultural legislation, forest legislation), and in spite of subsidy programmes and some successes (e. g. in the conservation of individual species and habitats), a comprehensive turn for the better has not yet been achieved. Conservation of nature and the environment lacks funding, enforceability and consistent implementation. Concrete measures often founder in the face of other political priorities or opposition from particular stakeholder groups, for example in situations involving infrastructure projects or the designation of building land. The economic perspective can provide supplementary arguments here.

FIGURE 2 ▸ Course of river Bode. (Photograph: André Künzelmann)

1.2 NATURE AND THE ECONOMY – HOW DO THEY GO TOGETHER?

Viewed in economic terms, nature represents a stock of capital from which ecosystem services are provided and that, like human or physical capital, needs to be maintained. Yet the predominant economic system sees market prices as the most important expression of value, thereby overlooking the public goods and services that nature provides free of charge and outside of markets. The state attempts to counter this tendency by laying down rules and through its own investment, but it is questionable whether this can do enough to prevent the overuse of nature and its services and hence the dissipation of natural capital.

Nature is a form of capital, like physical capital and human capital. It is necessary to care for this capital and build it up, or at least prevent its depletion and destruction. From it flow »dividends« in the form of beneficial ecosystem services – a »healthy« capital stock is the basis of human well-being and economic development. This means that preserving natural capital is not just about nature and/or biodiversity – i.e. the diversity of species, ecosystems and genetic resources; it is mainly about preserving nature as the basis of human livelihoods and an important factor in prosperity, quality of life and economic development.

Important causes for the lack of consideration given to the services of nature arise from the fact that biodiversity and ecosystem services are often »public goods« and that adverse impacts often arise only in the long term – at which point, however, they are frequently difficult or impossible to reverse. Maintaining and restoring ecosystems and their services usually benefits the whole of society or at least many people simultaneously. For example, structural elements on agricultural land have positive impacts on the landscape and its recreational potential; they protect against soil erosion and provide habitat for pollinators and other beneficial organisms. However, it may take some time for the benefits of conserving them or creating new structural elements to be felt – in part because the erosion processes that they prevent are insidious and long-term. By contrast, the costs to the individual farm in the form of reduced yields or expenditure on adaptation of the machinery fleet have to be borne in the short term. Conversely it is true that overuse of nature – for example through intensive land use, which may be driven by ecologically questionable financial incentives (such as incentives to plough up grassland in order to grow maize as an energy crop) – generates high individual profits but may be detrimental to many people or to future generations (pollution of lakes and rivers, species impoverishment). The people affected by this are usually unable to assert any individual rights.

They must bear the negative external effects of the overuse of natural resources, unless policymakers succeed in reducing these effects to a socially acceptable level that is compatible with sustainability objectives. Essentially it becomes clear, that the economic compass by which we have navigated in the past is inadequate: short-term perspectives dominate over long-term thinking, individual interests over communal ones, and quantitative market data frequently take precedence over the significance of vital public environmental goods. This is not necessarily true only of private-sector stakeholders; in some cases it also applies to policy-making.

Even in public decision-making it is difficult to balance individual interests and economic benefits on which a monetary value can be put against societal concerns of biodiversity conservation and long-term sustainable management. Typically, public decisions and investment opportunities are evaluated by costs, yields, jobs and income effects, while losses of natural capital and ecosystem services are difficult to be expressed in comparable units. This is a crucial disadvantage. Because the positive social and economic effects of conserving nature are not recognised or not identified adequately, it is quickly concluded that nature conservation is a cost burden and hence an obstacle to investment. Economic development and conservation of nature and the environment appear to be opposites and are often presented as such in public debate. In addition, politicians and policymakers often set short-term priorities in which conservation of nature plays a relatively minor part.

Figure 3 exemplarily uses the loss of floodplains to illustrate the results of thinking primarily in narrow economic terms without considering the multifaceted services of nature. If the decision on whether floodplains should be diked and eventually approved for building on is based only on the impacts on which a direct economic value can be put, then the construction and investment costs are the only disadvantages (costs) to be set against the advantages (benefits) of the additional dwellings, transport infrastructure, jobs and tax revenue. As a result, the floodplains are diked and there is a steady increase in the area of the former floodplains that is used for settlement and transport purposes, as has been happening for decades in real life. By contrast, a broader macro-economic TEEB perspective would probably have come to a different conclusion at an earlier stage, because consideration would have been given to factors such as the loss of soils, the increased greenhouse gas emissions as a result of draining the land, the increased flood risk, the reduced mitigation of the nutrient load in water bodies and the loss of recreational landscape.

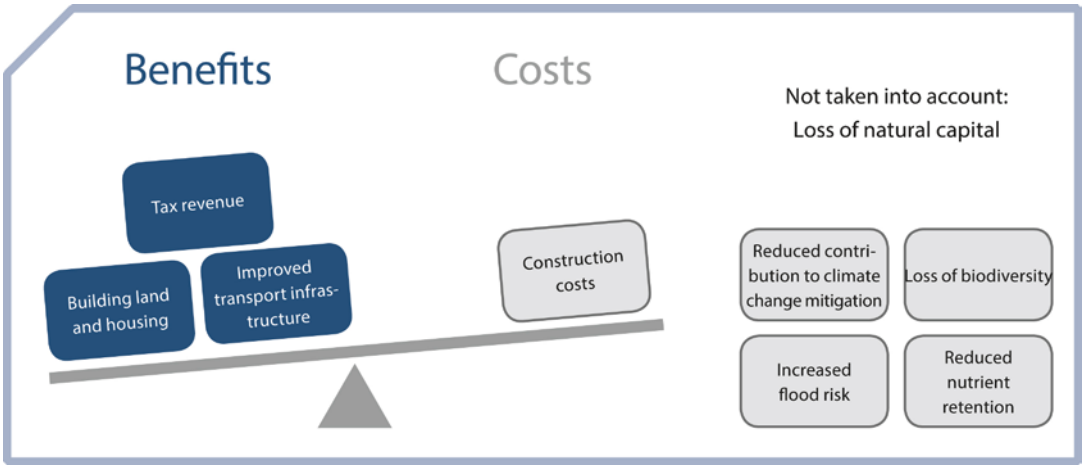


FIGURE 3 ▸ Distorted consideration of social benefits and costs in profitability assessments, using diking and development of floodplains as an example. (Source: adapted from ifuplan in Natural Capital Germany, 2012)

Decisions »good« for society include all relevant aspects in the calculation in line with their social weighting. They must also consider and measure – including in terms of extent and significance – the impacts on those services of nature that are not currently quantified or tradable on markets but that nevertheless make significant contributions to human well-being. Factors must also be included that have only long-term effects. Monetary valuations of natural capital and ecosystem services can be useful in this context, since they enable very different categories of benefits and costs (such as investment costs, benefits from climate change mitigation measures, water retention, etc.) to be considered in one »currency« and hence in principle on an equal footing and in comparable terms. In this context it is clear that monetary values only ever represent one aspect of the many values of nature (see Infobox 1).

INFOBOX 1

Critique of the economic valuation of nature

The economic valuation of nature and in particular the monetisation of its services often provoke criticism and opposition. Many points of criticism are entirely justified; for example, critics are right to draw attention to the limits of economic valuation methods and to the focus on willingness to pay as a yardstick of value.

But they often overlook the fact that in many situations in which decision-makers refrain from explicit economic valuation, implicit (economic) valuations are performed – frequently to the detriment of nature. Intensive land use and other interventions are frequently justified by reference to economic growth, jobs and prosperity. In a decision-making

situation of this sort, a powerful argument FOR conserving nature can be made by pointing out that we – as individuals and as a society – suffer a macro-economic loss if we »deselect« nature and the diversity of its ecosystem services, and that we are weighing things up incorrectly if we ignore the benefits of nature conservation and consider only its costs.

Valuation is after all only a means to an end. If the end is to provide a full and complete basis for decision-making, a comprehensive description of the value of nature and its manifold ecosystem services for human well-being and sustainable economic activity, then this means should be used – supplementing other methods that have long been in use.

Furthermore, »Natural Capital Germany – TEEB DE« is concerned less with monetary valuation than with raising awareness of the ecosystem services of nature and with demonstrating what the advantages are of preserving the services that ecosystems provide (in whatever units this is meaningfully possible), who the beneficiaries are, how diverse the benefits are, and also who must ensure that ecosystem services continue to be provided and what costs are involved. Monetisation is only one method of making the diverse benefits of preserving nature and its ecosystem services visible – and a method at that that is only usable in very limited circumstances.

Finally, it should be made clear that methods of economic valuation do not by any means boil down semi-automatically to markets. The aim of many valuation studies is rather to highlight where markets fail and thus support arguments for state action. What consequential social costs arise from the destruction of nature and the loss of ecosystem services, and who bears them? What benefits does conservation of nature and the environment confer on society, and for whom? Why do prices not tell the ecological truth? How can natural capital be safeguarded in ways that are cost-effective for society?

Achieving the sustainable use of ecosystem services can be based both on statutory regulation and public planning processes and on instruments that use the market mechanism to create incentives for private provision of ecosystem services and cut costs. Whether a market intervention instrument should actually be brought into play is a political question, the answer to which can be facilitated by comparing it with other instruments and analysing instrument design.

FIGURE 4 ▸ Restoration of a former open pit mine: Birch forest at Neue Harth near the town of Zwenkau. (Photograph: André Künzelmann)

When considering the ecosystem services of nature, it is important not to maximise selected individual services but to view the balanced set of ecosystem services as a whole. This can be seen particularly clearly in the agricultural use of landscapes (see Figure 5): near-natural ecosystems usually perform less well in terms of providing the population with food or resources (left-hand picture). Intensive farming, by contrast, results in significant productivity increases that can be used in particular to supply markets (middle picture). However, these productivity increases are often at the expense of other socially relevant ecosystem services and may even result in their loss. While greater consideration of the non-provisioning services of farming methods that emphasise nature conservation may result in reduced yields, it also results in higher levels of other ecosystem services (right-hand picture). It is important that these effects are not just depicted theoretically but are measured quantitatively and empirically.

FIGURE 5 ▸ Synergies and trade-offs in the provision of ecosystem services: largely natural ecosystems, intensively used farmland, diverse cultural landscape.
(Source: by the authors, based on Foley et al., 2005, p. 573)

Considering the entire range of ecosystem services and using nature sustainably yields contributions to many societal objectives simultaneously: low-cost climate change mitigation and adaptation measures, fewer pesticide residues in food, recreation, utilisation of sustainable resources, conservation of fertile soils, water pollution control, agreeable living and working environments and social equity. Furthermore, it is usually more cost-effective to avoid environmental damage in the first place than to have to bear the resulting costs to society.

1.3 THE OBJECTIVE OF TEEB DE AND STRUCTURE OF THIS REPORT

One of the objectives of the »Natural Capital Germany – TEEB DE« project is to make visible the many and varied services of nature in Germany – the macro-economic valuation of ecosystem services can contribute substantially to that objective. This involves identifying the services of nature and evaluating them on a societally sound basis so that they can gain relevance for our actions. A second objective is to integrate the services of nature into private and public decision-making – which ultimately means valorising ecosystem services by means of appropriate strategies, instruments and measures (see Naturkapital Deutschland, 2012).

Chapter 2 below presents the key findings of case studies of the importance and valuation of selected ecosystem services in Germany. Most of these case studies are taken from the main reports of »Natural Capital Germany – TEEB DE« and have been streamlined and edited for this synthesis. They illustrate in compressed form the issues involved in economic valuation of the services of nature and the associated methods and results.

Chapter 3 sets out the overarching core messages as conclusions from these case studies and on the basis of the overall project.

Recommendations for action with starting points and measures aimed at valorising the services of nature in Germany and beyond are the subject of **Chapter 4** of this Synthesis Report.

The report concludes with an outlook presented in **Chapter 5**.

2 SELECTED CASE STUDIES ON THE ECONOMIC IMPORTANCE OF NATURE

2.1 CONSERVATION AND RENATURATION OF FLOODPLAINS: MAKING ROOM FOR RIVERS

For details see Naturkapital Deutschland – TEEB DE, 2015, pp. 125–128.

Core messages

- Two thirds of Germany's former floodplains have been lost due to dike construction and river development; 4% of floodplains are built up.
- This trend was a contributing factor in the extremely high level of damage cause by flooding disasters in Germany over the past decades.
- Dike relocation measures and floodplain renaturation not only strengthen flood defence, they also benefit biodiversity, climate action and water body protection. Up to now, their economic and ecological potential has not been sufficiently tapped.

The issue

Near-natural water bodies and floodplains provide a range of socially important ecosystem services: They help improve water quality, provide habitat for many animal and plant species and act as retention areas for precautionary flood protection. They are also valuable as places of recreation and for experiencing nature (Naturkapital Deutschland TEEB – DE, 2016b, p. 207f.).

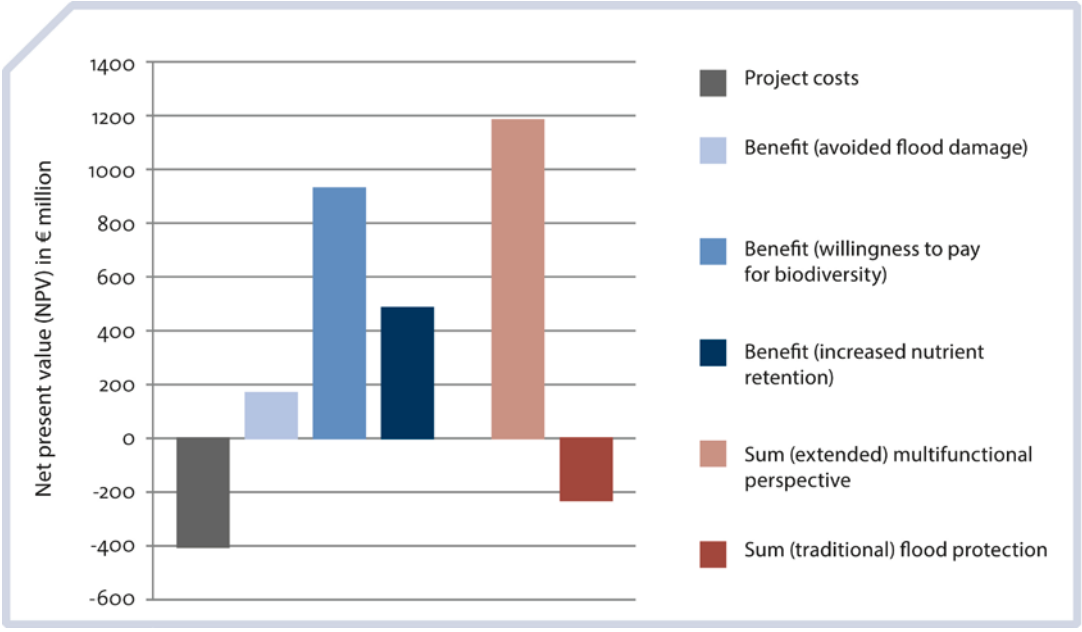
Germany's 79 largest rivers have lost two thirds of their flood zones due to dike construction and water engineering (BMU and BfN, 2009). Today, in many sections of Germany's major rivers, only 10 to 20 % of the original floodplains are available during floods (Bronotte et al., 2009). At the same time, construction on floodplains has been gaining pace. These two developments have had dramatic consequences: In 2002, the floods in the Elbe and Danube river basins caused economic damage of around 11 billion euros. Over 370,000 people were affected, 21 people lost their lives. The floods in 2013 caused nearly 7 billion euros worth of damage. It is to be anticipated that heavy rain and flood events will become more and more frequent because of climate change (Hattermann et al., 2014).

FIGURE 6 ▸ Under water: the 2013 Elbe floods.
(Photograph: André Künzelmann)

Economic analysis

A case study for the central Elbe from Dresden to Lauenburg showed that dike relocations as nature-compatible flood defence measures have an economic benefit three times higher than the cost of their implementation (cf. Grossmann et al., 2010 and chart). However, a cost-benefit analysis which is based solely on flood control effects and ignores other ecosystem services would conclude that these measures are not worthwhile: Investment costs of around 407 million euros (factoring in the costs saved on dike maintenance) would be uneconomical compared to avoided flood damage of just 177 million euros. On the other hand, if the analysis considers the additional services to society that floodplains provide, dike relocation yields a substantially larger net benefit than technical flood defence measures.

FIGURE 7 ▸ Costs and benefits of dike relocation measures for climate change adaptation
(Source: Naturkapital Deutschland – TEEB DE, 2014, p.54, based on Grossmann et al., 2010)



Conclusions

The conservation and renaturation of flood plains can advance the goals of the EU Water Framework Directive, the Directive on Flood Risk Management and the Habitats and Birds Directives. These measures also have a positive impact on climate change through the conservation and development of wetlands, grasslands and forests. Their many effects have a high economic benefit. To tap this potential for society, it is vital that policy areas which up to now have been treated separately such as flood protection, climate change adaptation, nature conservation, agriculture, settlement development and shipping are integrated and coordinated more closely. Profitability calculations which only look at flood control do not go far enough.

Floodplain renaturation and dike relocation over the past 25 years have only increased floodplain area by 1%. The 30 interregional dike relocation projects, made up of more than 70 individual initiatives plus over 60 measures for controlled flood retention under the 2014 national flood protection programme are aimed at significantly enlarging the retention areas. The Federal Blue Ecological Network Programme (Bundesprogramm Blaues Band Deutschland), which focuses on renaturing federal waterways and their floodplains, can provide important impetus for the implementation of a multifunctional flood control system. Renaturation of water bodies and floodplains is a long-term and profitable investment in our future.

2.2 ARABLE FARMING ON PEATLANDS AND PEATLAND REWETTING: COSTS AND BENEFITS

For details see Naturkapital Deutschland – TEEB DE, 2015, pp. 140–141.

Core messages

- Agricultural use of drained peatlands results in the loss of many ecosystem services.
- Electricity generation from energy crops grown on organic soils does not advance climate action. On the contrary, the climate balance is negative.
- Rewetting of drained or former peatlands is cost-effective climate action which delivers further ecosystem services.

The issue

Organic soils are very important for combatting climate change. This is especially true of peatlands with a high level of sequestered carbon which has built up in peat-forming processes over many thousands of years. Peatlands are the only ecosystems that can accumulate carbon and store it in the soil over long timescales. An estimated 550 billion

FIGURE 8 ▸ Moor frogs. (Photograph: André Künzelmann)

tonnes of carbon is sequestered in peat soils worldwide. This corresponds to around 30 % of global soil carbon, even though peatlands only account for 3 % of the Earth»s terrestrial surface (Parish et al., 2008). If drained, on the other hand, organic soils become significant sources of climate-damaging greenhouse gases (Joosten et al., 2013). When the water level of peatlands is lowered for purposes such as agriculture or forestry, the carbon that has accumulated over hundreds or even thousands of years is released in the form of carbon dioxide.

In Germany there are around 1.8 million hectares of organic soils (UBA 2016, p. 534). The hydrological balance of over 95 % of peatlands has been markedly impaired by drainage measures for agriculture, forestry and peat extraction (Naturkapital Deutschland TEEB DE, 2015, p.125f). These drained peatlands release around 41 million tonnes of CO_2 equivalents each year, accounting for 30 % of German agricultural climate gas emissions, or around 4.4 % of Germany's annual gross total emissions. This is despite the fact that peatlands only represent around 5 % of Germany's area or around 8 % of farmland (Naturkapital Deutschland TEEB DE 2015, p.125f).

Economic analysis

Over 70 % of drained carbon-rich soils in Germany are farmed (UBA 2016, p. 535). Since 1990, their main use as grassland has increasingly been replaced by arable farming, currently practiced on nearly 30 % of peatland sites. Between 1999 and 2007 there was a general increase in the cultivation of winter wheat and energy crops such as maize and rapeseed (Naturkapital Deutschland TEEB DE 2016b, p. 94). One reason for the increase in maize cultivation are the high feed-in tariffs under the Renewable Energy Sources Act (EEG), which particularly

promoted bio-based energy generation, especially in the years 2004 to 2011. An economic analysis of arable use of organic soils shows that revenues from agriculture are countered by the high social costs. The costs to society from growing maize for biogas production are incurred through climate gas emissions, water pollution and subsidies paid to farmers and operators of biogas installations. These social costs are around four times higher than the commercial gains. The ratio is only slightly better for the cultivation of maize as dairy cattle fodder (see chart). The figures do not reflect the importance of peatlands for biodiversity.

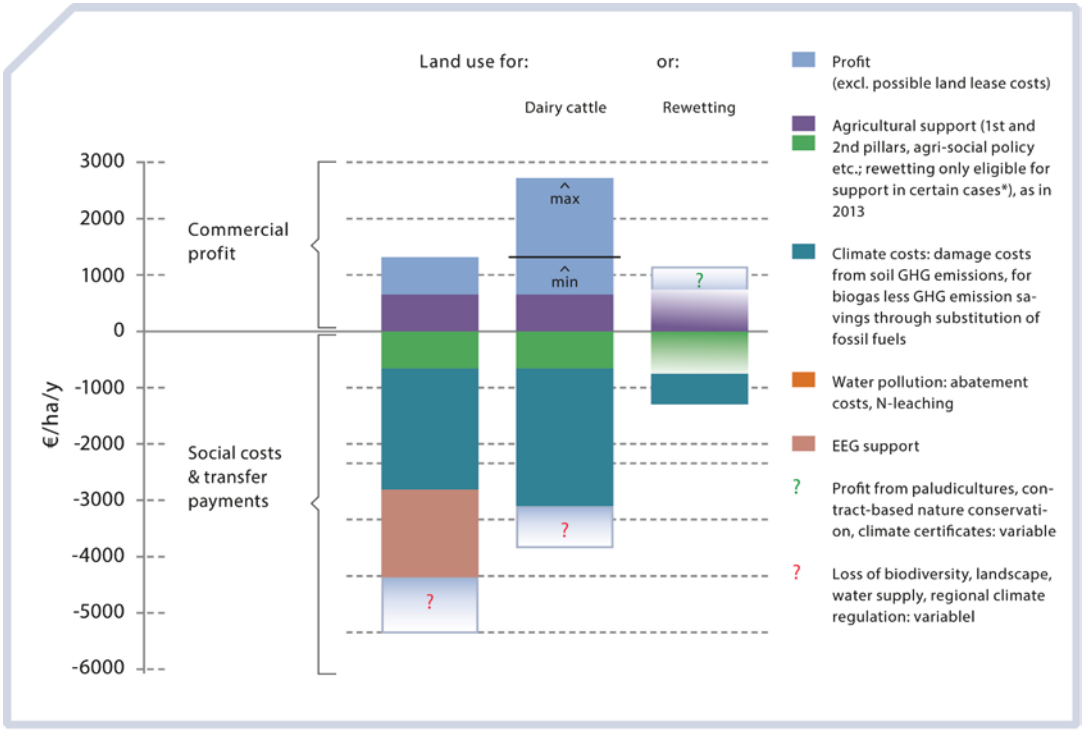


FIGURE 9 ▸ Earnings from agriculture, social costs and transfer payments (agricultural support) for land use on drained fenland in Lower Saxony. Estimated values in euros per hectare per year.
(Source: Berghöfer and Röder in Naturkapital Deutschland TEEB DE, 2015, p. 141 f.)

Conclusions

Agricultural use of drained organic soils destroys natural capital and results in the loss of ecosystem services. Generating electricity from energy crops grown on peatlands clearly damages the climate: Draining peatlands for energy crop cultivation causes significantly more emissions than are avoided by replacing fossil fuels with energy crops. Government incentives for farming drained peatlands are counterproductive and must be discontinued.

Rewetting peatlands means their greenhouse gas emissions can be largely avoided (Freibauer et al., 2009). Compared to options such as wind energy, renaturing peatlands can be a cost-efficient climate measure (Schäfer, 2009) which at the same time has positive effects

on water body protection and biodiversity conservation. Using peatlands for paludiculture like reed or black alder cultivation can also be beneficial if nature-friendly methods are followed.

Special contract-based climate action programmes and stronger investment in rewetting and in the management of rewetted peatlands can generate momentum for managing organic soils in a way which benefits biodiversity, the climate and other ecosystem services. Financing the renaturation of peatlands through the voluntary carbon market is an innovative nature conservation strategy (Joosten et al., 2013) which can supplement government measures.

2.3 PLOUGHING UP GRASSLAND: A LOSS TO SOCIETY

For details see Naturkapital Deutschland – TEEB DE, 2016a, pp. 125–128 and Naturkapital Deutschland – TEEB DE, 2016b, p. 38 f.

Core messages

- Grassland provides a number of ecosystem services.
- Grassland area in Germany has been declining for years and is currently stagnating at a low level, with continuing loss of HNV grassland.
- The conversion of grassland into arable land, especially through ploughing up of HNV grassland, causes net follow-up costs to society of between 440 and 3,000 euros per hectare per year.
- In the interests of society, therefore, it is imperative to conserve grasslands (especially HNV grassland).

The issue

Grassland benefits a number of ecosystem services. Grassland sites provide habitat for a range of animal and plant species (BfN 2014, p. 5). The year-round cover gives grassland a high humus content and good water storage capacity. Grasslands protect against wind and water erosion. On the margins of water bodies, grassland can reduce the input of nutrients and pollutants into the water from the surrounding area. It therefore plays an important role in protecting surface waters, groundwater and drinking water (UBA 2015, p. 27). The high carbon content of the soil also has positive impacts on climate change.

Up to 2013, the proportion of farmland used for grassland had been declining steadily in Germany. Whereas in 1991, more than 5.3 million hectares were managed as permanent grassland, by 2013 this figure had fallen to just over 4.6 million hectares (BMEL 2015, Table 86).

FIGURE 10 ▸ Many ecosystem services are affected when grassland is converted into cropland. (Photograph: Gerd Ostermann, NABU)

Species-rich grassland with a high nature value (HNV grassland) is particularly affected by this trend: Between 2009 and 2015, the amount of HNV grassland nationwide decreased by 8.9 % (BfN and PAN, 2016). Under current legal provisions and funding terms (e.g. EU agricultural support) further ploughing up of grasslands, including HNV grassland, cannot be ruled out.

Economic analysis

Most grassland is lost due to conversion to arable farmland. This weakens the carbon sequestration function of the soil. Water bodies become more vulnerable to erosion and nutrient loads. In the case of HNV grasslands especially, the habitat of many species is destroyed. In economic terms, the problem is that these »costs« are generally ignored in farmers» decisions; ultimately, however, they are borne by society as a loss of ecosystem services.

A comparison of the operational and social costs and benefits in terms of agricultural yield, climate action, groundwater quality and nature conservation highlight the economic advantages of preserving grassland rather than ploughing it up for arable land (see Figure 11). The net benefit to society of preserving grassland, i.e. the difference between lost business revenues and the social benefits, is between 440 and 3,000 euros /ha/year for HNV sites. If its nature conservation value is not taken into account, normal grassland would represent a smaller loss of 140 to 2,000 euros. In the case of grassland

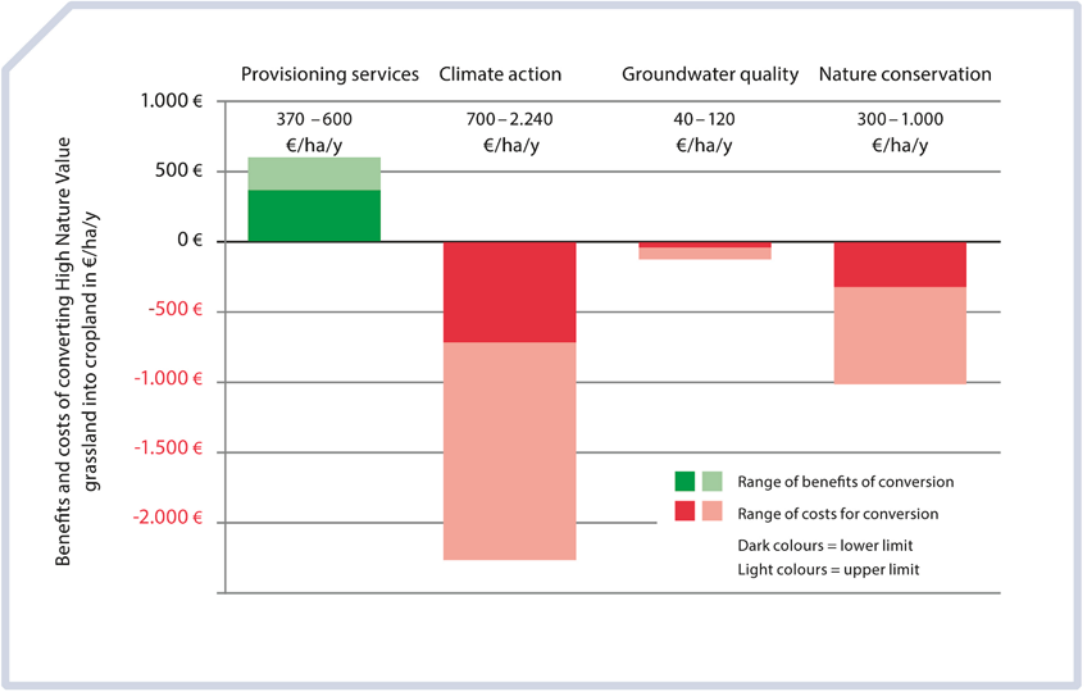


FIGURE 11 ▸ Costs and benefits associated with changing selected ecosystem services and willingness to pay for grassland-related nature conservation in connection with the ploughing up of HNV grassland per ha and year.
(Source: Naturkapital Deutschland – TEEB DE, 2016b, p. 38)

sites which are of less value in terms of arable farming, it is generally of greater advantage to conserve them. Factoring in other ecosystem services such as protection from erosion would further tip the balance in favour of grassland conservation.

Conclusions

The social costs of converting species-rich grassland in particular are generally greater than the earnings made from its use as arable farmland. Grassland is especially high-quality natural capital and it is vital that we protect it. Considering the in some cases large costs incurred in other contexts for climate action, water body protection and the conservation of biological diversity, it is particularly counterproductive financially to accept further loss of grasslands.

The impacts of the recently amended provisions on the conservation of the remaining permanent grassland must be evaluated. Current knowledge indicates that the new regulations will not be able to prevent the continuing loss of HNV grassland. Suitable instruments and provisions, or their appropriate implementation, are still lacking. These measures are needed to make the conservation of biodiversity and grassland ecosystem services sufficiently profitable for farmers as well.

2.4 POLLINATION: DIVERSE FLORA AND FAUNA ENSURE A DIVERSE DIET

Core messages

- The vast majority of indigenous crops and wild plants are dependent on insect pollination. The economic value of products reliant on insect pollination is estimated to be between 235 to 577 billion US dollars worldwide.
- There has been a stark decline in the diversity and frequency of pollinating insects due to intensive farming and landscape changes.
- New studies underline the importance of wild bees and other insects for pollination. Promoting flower-rich habitats and small-scale farmland habitats is essential for sustainable food security and helps to safeguard ecosystem services and biodiversity conservation.

The issue

Almost 80 % of indigenous crops and wild plants are dependent on insect pollination (Ollerton et al., 2011), which makes it an essential basis for agricultural production and food security. Crops reliant on insect pollination include not only fruit trees and fruit crops such as blueberries, but also field crops cultivated on a larger scale such as rapeseed, sunflowers and broad beans.

The rise in intensive farming has led to a decline in small-scale farms and a loss of heterogeneous landscapes. This has had negative impacts on biological diversity (Tscharntke et al., 2005). In Germany, 53 % of the country's 560 species of wild bees are now classified as

FIGURE 12 ▸ Wild bees are important pollinators. (Photograph: Anyusha, pixabay)

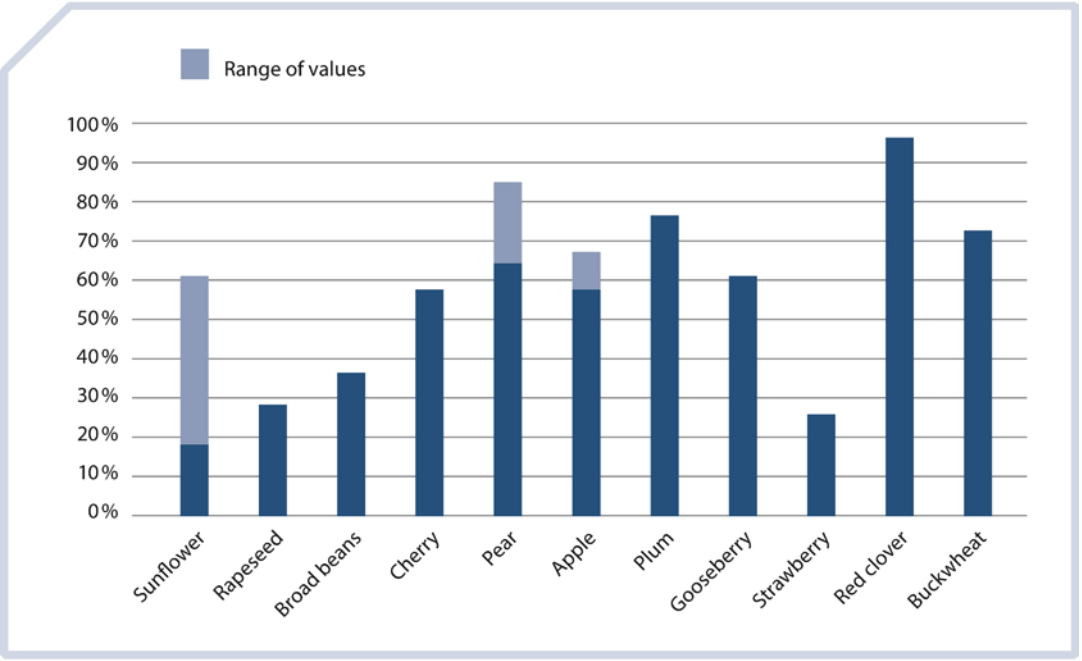


FIGURE 13 ▸ Yield loss in absence of bee activity on certain cultivated crops.
(Source: BfN, 2017b, p. 37)

endangered (Westrich et al., 2011). The population of honey bees has also fallen. At the start of the 1990s there were still approximately 1 million bee colonies in Germany. The colonies dropped to their lowest level in 2009 with 600,000 colonies. In 2016, numbers grew to 750,000, which is approximately 75 % of the original population (Deutscher Imkerbund, 2017 a). Alongside age structure of beekeepers and parasites such as the varroa mites, one reason for this decline is intensive farming, in particular the use of plant protection products such as neonicotinoids (Gill et al., 2012).

Economic analysis

On a global scale, the economic value of products dependent on insect pollination is estimated to be in the range of 235 to 577 billion US dollars (IPBES, 2016). Within the EU, the pollination of plants by insects accounts for 12 % of the average annual profit from harvested crops. In Germany the share is estimated to be 13 % which corresponds to 1.1 billion euros (Leonhard et al., 2013). The absence of honey bee pollination alone would incur a yield loss of over 90 % for individual crop species (see Figure 13).

However, the role of the honey bee in the provision of pollination services is often overestimated. New studies have shown that wild bees are the only suitable pollinators for certain cultivated crops, or at least are better suited than honey bees. A study carried out in the United Kingdom has shown that honey bees only carry out a third, at most, of the pollination services required (Breeze et al., 2011). Another

study showed that only a few hundred female European orchard bees are needed to pollinate one hectare of apple trees compared to several tens of thousands of worker honey bees (Vicens and Bosch, 2011). It was also proven that due to their behaviours, resource utilisation and hours of activity – which all differ from those of the honey bee – wild bees and other wild pollinators drive up the yields from pollinated plants irrespective of the presence or frequency of honey bees (Garibaldi et al., 2013).

Conclusions

To halt the loss of particularly important wild pollinators, we need interlinking flower-rich and small-scale farming landscapes that offer nesting sites and a continuous and diverse supply of food (FiBL, 2016). However, providing habitats for wild bees is often linked to yield losses and additional costs for farmers which may exceed the economic benefits gained from pollination (Ghazoul, 2013). It is thus important, in this context too, to take the entire package of ecosystem services into account, including water body protection through the reduction of nutrient discharges, protection from erosion etc. Due to the major role wild pollinators play in biodiversity conservation through the pollination of wild plants, the provision of such habitats should be promoted and the use of plant protection products (including neonicotinoids) should be significantly reduced. The use of plant protection products should be prohibited, particularly in protected areas, as advocated in the National Action Plan on Sustainable Use of Plant Protection Products (BMEL, 2013). For instance, in the United Kingdom it became clear that the established agri-environmental programmes are not enough to ensure effective support for the populations of wild bee pollinators (Wood et al., 2015). Other priorities should therefore include establishing flower strips specifically to promote pollinators.

2.5 RIVER BANK BUFFER ZONES: MULTIFUNCTIONAL USE FOR SOCIETY

For details see Naturkapital Deutschland – TEEB DE, 2016a, p. 349.

Core messages

- River bank buffer zones protect against nutrient discharges, are natural habitats, including for pollinators, and enrich the landscape.
- According to a study in Lower Saxony, the economic benefit of unfarmed river bank buffer zones in terms of water body protection, prevention of discharges into the marine environment and biodiversity conservation, is around 1.8 times higher than the costs incurred.

The issue

To achieve the goals set out in the European Marine Strategy Framework Directive, nutrient discharges into the sea via water bodies must be significantly reduced. The eutrophication of the seas caused by nutrient discharges can be seen, for instance, in large-scale algal bloom, the growth of oxygen-poor zones where some species can no longer survive, and shifts in species composition. Eutrophication combined with overfishing has also played a role in the massive increases in jellyfish numbers (Naturkapital Deutschland – TEEB DE 2016a, p. 192 f.).

FIGURE 14 ▸ Near-natural configuration of a buffer strip.
(Photograph: André Künzelmann)

Eutrophication of the seas is largely due to the nutrient contamination of water bodies arising from agricultural practices. Establishing river bank buffer zones with a strict ban on fertilisers is an effective way of reducing direct and indirect nutrient discharges. If left in a near-natural state – in a similar way to hedges and copses – river bank buffer zones, as part of the cultivated landscape, can provide a number of ecosystem services on a relatively small area. As well as protecting water bodies and the marine environment from nutrient discharges, river bank buffer zones also help prevent erosion, provide habitats for pollinators, enhance the landscape and protect species which are becoming scarce in cultivated landscapes.

Economic analysis

Marggraf et al. (2015) carried out a cost-benefit analysis of the establishment of river bank buffer zones along small (3rd order) watercourses in Lower Saxony on which farming and fertiliser use were strictly prohibited. The analysis examines the economic viability of a hypothetical programme of measures to reduce nitrogen emissions into the North Sea. The analysis concludes that the benefits of the measure for the marine environment alone would only slightly exceed the costs (1.1: 1). This might have led to the measure being dropped due to the low cost-benefit ratio compared to other measures aimed at improving the marine environment. However, if other

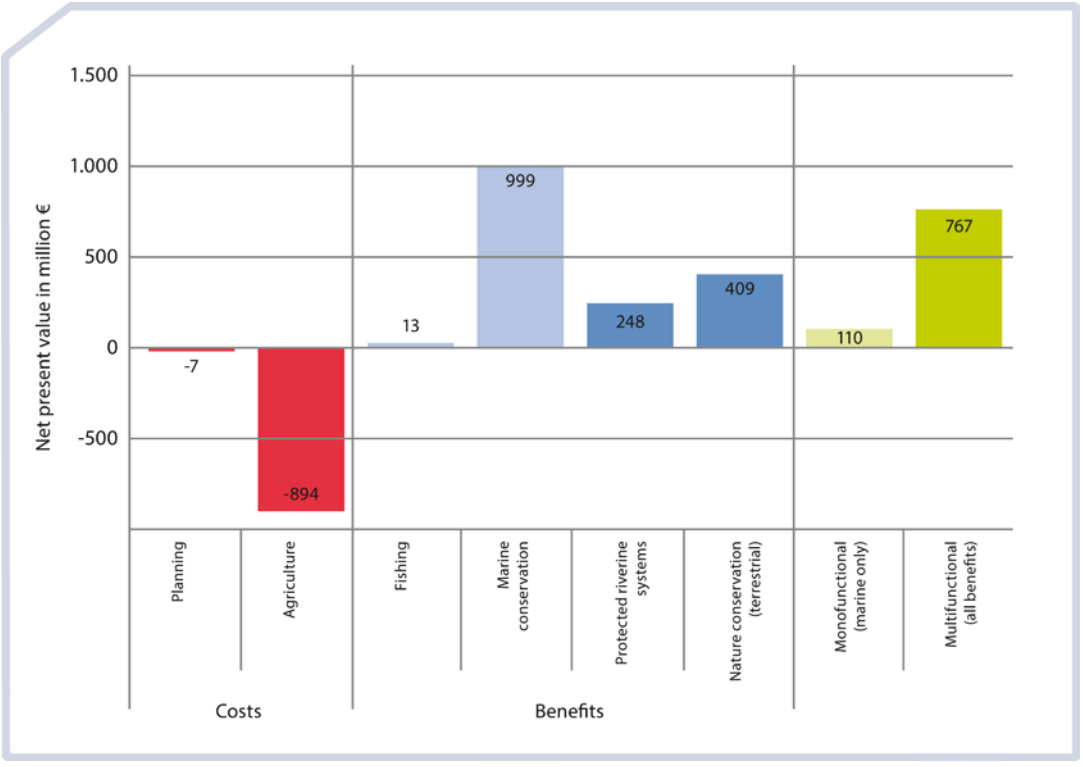


FIGURE 15 ▸ Costs and benefits of river bank buffer zones in Lower Saxony in terms of marine conservation and from a multifunctional perspective. All data given as net present value (NPV) over a 20-year period with a 2 % discount rate. (Source: Naturkapital Deutschland TEEB DE, 2016 a, p. 349, based on data of Marggraf et al., 2015)

environmental benefits are taken into account, such as improving watercourse quality and biodiversity conservation on the river bank buffer zones, the ratio of benefits to costs rises significantly to 1.8:1. Over the 20-year period covered by the analysis, the economic benefits of the measure would exceed the costs by more than 760 million euros (see Figure 15). This figure does not even factor in other benefits of the buffer zones such as their erosion protection effect, provision of habitats for pollinators and the part they play in pest control.

Conclusions

If the many ecosystem services arising from nature-based approaches are taken into consideration, other evaluation criteria emerge which in turn lead to new, socially worthwhile options for action. This was demonstrated for river bank buffer zones by the Lower Saxony example after it was considered from a multifunctional angle. A measure bringing little benefit in terms of marine protection alone became a very economically viable investment once other ecosystem services were taken into account. Better knowledge of further effects would probably have resulted in an even greater benefit, thus improving the cost-benefit ratio further. A water-optimised agriculture is indispensable for reducing nitrogen surpluses (Naturkapital Deutschland – TEEB DE, 2016 b, p 40 ff.). Creating buffer zones along river banks with a strict ban on farming and fertilisers can make a substantial contribution to achieving this goal.

2.6 NITROGEN SURPLUSES: CAUSE OF ENVIRONMENTAL POLLUTION AND HIGHER DRINKING WATER PRICES

For details see Naturkapital Deutschland – TEEB DE, 2016a, p. 124.

Core messages

- The high level of nitrogen pollution in Germany, mainly caused by the use of fertilisers in agriculture, damages the environment and harms human health.
- The social costs of these nitrogen surpluses outweigh the benefits of increased agricultural production.
- For water utilities it is often more cost-effective to pay farmers to reduce nitrogen inputs on their land than to treat raw water that has been more heavily polluted.

The issue

Excessive nitrogen emissions in the air, soil, waterbodies and seas contaminate the groundwater and hence drive up the costs of drinking water purification. They also cause biodiversity loss and marine pollution. Moreover, nitrogen compounds have a direct adverse impact

on human health: ammonia leads to the formation of particulate matter, nitrogen oxides encourage the formation of ground-level ozone, nitrate residues and carcinogenic nitrosamines can occur in foods (SRU, 2015, p. 69 f.).

In Germany, agriculture accounts for nearly 80 % of nitrogen emissions in surface waters and over 50 % of nitrogen emissions into the air (SRU, 2015, p. 175). In 2013, the EU»s average gross nitrogen balance in agriculture was 51kg N per hectare of farmland per year (Eurostat, 2016, p. 126). In Germany, on the other hand, the sliding average is currently 95kg (Bundesregierung, 2017, p. 65). The instruments used so far have not succeeded in lowering Germany's nitrogen surplus to the target value set out in the National Sustainable Development Strategy. Instead of the original target of 80 kg N/ha/year by 2010, the aim now is to achieve 70kg by 2030. (Bundesregierung, 2017, p. 35). For groundwater too, many years of efforts have failed to reverse the trend and reduce nitrate concentrations: For the 2012 – 2014 reporting period, 28 % of the monitoring stations in the EU network for measuring nitrates recorded concentrations exceeding the permissible limit value of 50mg nitrate /litre (BMUB and BMEL, 2017, p. 40).

FIGURE 16 ▸ The use of fertilizers is an important source of nitrogen emissions.
(Photograph: André Künzelmann)

Economic analysis

It is estimated that the use of synthetic nitrogenous fertilisers in the European Union (EU 27) yields additional net revenues from agriculture (extra earnings minus costs) of 20 to 80 billion euros per year. Social costs, in the form of damage to human health, the climate and ecosystems (e. g. water bodies, seas and other sensitive ecosystems), are put at between 20 and 150 billion euros (Brink et al., 2011, p. 534). As nitrate surpluses in Germany are significantly higher than the EU average and can be expected to result in lower additional revenues and higher damage costs,the cost-benefit ratio for Germany's high nitrogen surpluses is likely to be considerably worse.

Excessive nitrate concentrations in the groundwater push up the costs of drinking water treatment. Treating groundwater that is contaminated with nitrates costs between 55 and 76 cents per cubic metre. This can raise the water bill for a single-family household by 32 to 45 % (Oelmann, 2017). A calculation for Leipzig has shown that reducing nitrate concentrations by switching to water-optimised practices such as organic farming (see Figure 17) on the land in the vicinity of wells is around seven times more cost-effective than the technical treatment of contaminated raw water. Regions with large-scale intensive livestock farming require more far-reaching measures.

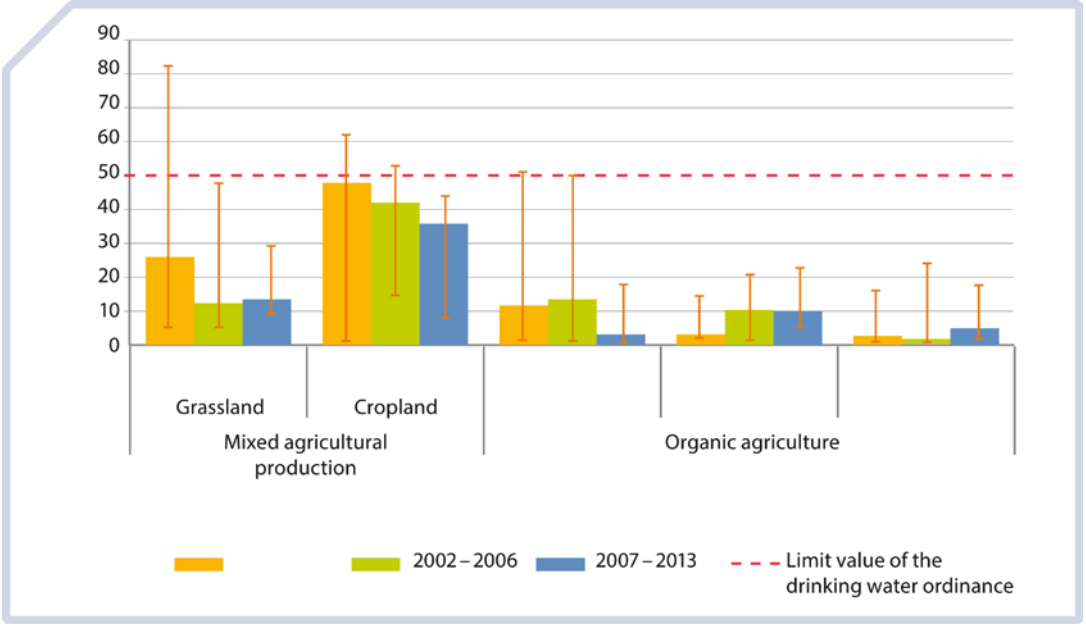


FIGURE 17 ▸ Analysis of nitrate concentrations in mg/l from water samples taken from measurement wells with groundwater flow from various land uses. »Mixed agricultural production« refers to farms that manage both grassland and arable land conventionally. The three bar groups for organic agriculture are the values for three different measurement wells from which drinking water is extracted. (Source: Measurements and diagram: Kommunale Wasserwerke Leipzig GmbH, further information in Naturkapital Deutschland – TEEB DE, 2016a, p. 124)

Conclusions

A transition to low-nitrogen agricultural practices is crucial for reducing nitrate contamination in surface water and groundwater. Such a transition is economically viable as it substantially cuts the costs of drinking water treatment. Instead of retrofitting and maintaining expensive purification technology, water utilities lease land themselves or reach voluntary agreements with farmers on agricultural practices which reduce nitrate inputs. This approach aims to supplement and implement the water conservation provisions that are often already in place. These voluntary agreements compensate farmers financially for potential loss of earnings, while the water utilities benefit from cost savings which can be passed on to consumers. Further recommended measures include the creation of river bank buffer zones where farming and fertilisers are strictly prohibited and improvements in crop rotation and fertiliser use. Measures aimed primarily at conserving and developing habitats for endangered species and implementing the European protected area network Natura 2000 often also have positive impacts on water body protection (Naturkapital Deutschland – TEEB DE 2016a, p. 45 f.).

2.7 FORESTS: MULTIFUNCTIONAL ECOSYSTEMS

Core messages

- Economic valuations of the ecosystem services provided by forests in Germany have shown their significant benefits both as a result of timber production and by providing public goods.

- The total combined value assigned by the population at large to the forests' recreational function, their role in biodiversity conservation and their carbon sequestration function exceeds that of the monetary value of timber production.

- The multifunctional forest model, the value of which derives from the multitude of ecosystem services provided, is not only established in law and reflects the political will but is also backed up by economic analyses.

The issue

Approximately one third of Germany's territory is covered by forests, with a slight upward trend (Statistisches Bundesamt, 2017). The vast majority of forests are used for silvicultural purposes. However, the German Federal Forest Act (BWaldG) in Paragraph 1(1) highlights the importance of forests with a view to the multitude of utility, protective and recreational functions they provide. Forests are to be maintained for their silvicultural uses as well as for their significance for maintaining the functional capacity of the natural environment, for landscape amenity, and for recreation.

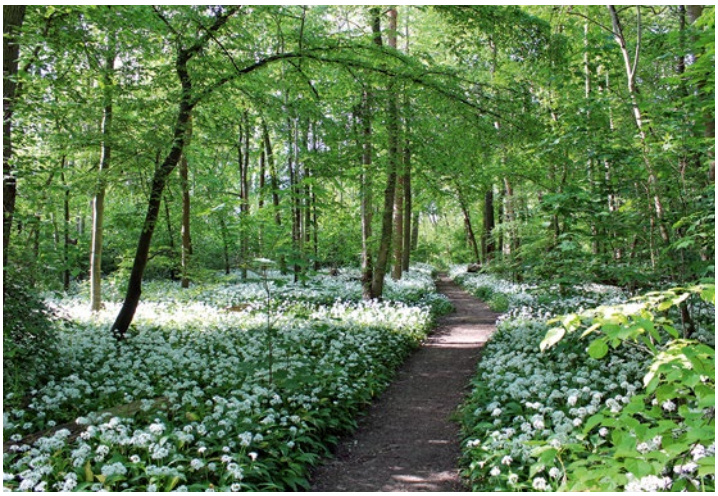


FIGURE 18 ▸ The riparian forest close to the city of Leipzig is a major spot for local recreation. (Photograph: Anne Wessner)

The realisation of the multifunctional forest model necessitates that silvicultural management mitigates conflicts between different forest functions and capitalises on potential synergies between different functions. Coniferous tree species such as spruce are important timber species but a monoculture spruce plantation, due to its higher rates of evapotranspiration, produces less groundwater recharge than a deciduous forest on a comparable site (Duncker et al., 2012). Carbon sequestration by forest ecosystems plays an important role in climate change mitigation. In 2015, the living forest biomass and forest soils in Germany sequestered more than 57 million tonnes CO_2 equivalents net (UBA, 2017). Targeted promotion of the forests« climate change mitigation function would result in shorter production cycles and a focus on fast-growing tree species (Rock and Bolte, 2011); this would however come at the cost of negative impacts on biodiversity. For example, forest trees only become important habitat elements for some species of conservation concern, e. g. various woodpecker species, after they have exceeded the rotation age customary in commercial forestry.

Economic analysis

The fact that the value to society of forest ecosystems goes well beyond timber production is also backed up by the findings of economic evaluations of selected additional functions, such as the forests« CO_2 sequestration function, the importance of natural and semi-natural forests for biodiversity, and the forests' recreational function (see Figure 19). The studies show that the public assigns significant value to these functions as well and that this value significantly exceeds that of the timber's market value. This does not yet take account of other ecosystem services such as groundwater recharge, the provision of a buffer against pollutants, or slower water discharge during rainfall events. While the various direct and indirect methods used in these

studies to determine the public's »willingness to pay« are certainly not beyond reproach as to their theoretical foundations, they clearly allow for the conclusion that ecosystem services going beyond timber utilisation are important to the public and that our forests should be maintained in their multifunctional state.

Of all the forest ecosystem services, the markets at present essentially only remunerate timber production and hunting. All other services have a public goods character and are, such as in the case of well-maintained forest trails for recreational users, (seemingly) provided for free. While the associated societal benefits are not taken into account in assessments of operating profitability, private forest owners must nonetheless bear the associated costs. There is therefore a risk that the forests« public services provision is not sufficiently taken into account in management decisions. The expansion of support programmes for the provision of non-marketable ecosystem services going beyond current forest management practices is therefore prudent from a societal point of view and can help safeguard the multifunctionality of German forests.

Conclusions

Forests produce raw materials, provide habitats for a range of flora, fauna and fungus species, and provide numerous other services to society. The manner in which forests are managed is important to maintaining biodiversity and to the provision of the variety of other beneficial services. A range of monetary valuation studies have shown that ecosystem services going beyond timber production are so highly

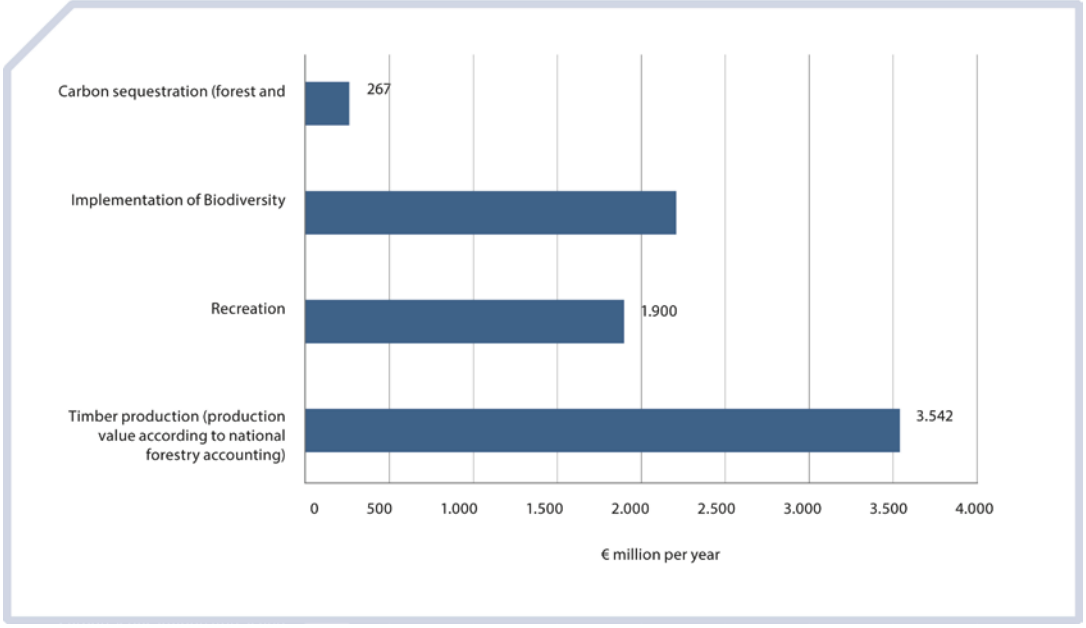


FIGURE 19 ▸ Aggregated monetary value of a variety of forest ecosystem services in Germany, using different valuation methods.
(Source: Naturkapital Deutschland – TEEB DE, 2014, p. 166)

important that they must not under any circumstances be neglected. The monetary evaluation of these functions may contribute to strengthening the multifunctional forest model and to countering a dominance of focal bias, e.g. a focus on solely maximising carbon sequestration or timber production. Even though the current forms of forest management already ensure the provision of a range of ecosystem services, there is still room for improved reconciliation between commercial and public interests. Remuneration should be payable for special forestry services that go beyond current rules and regulations for sustainable forest management and good silvicultural practice.

2.8 LARGE-SCALE PROTECTED AREAS: PROTECTED NATURAL AREAS GENERATE REGIONAL VALUE

For details see Naturkapital Deutschland – TEEB DE, 2016b, pp. 58 – 62.

Core messages

- Large-scale protected areas in Germany safeguard biological diversity, provide important ecosystem services and help generate regional value.
- Taking the Bayerischer Wald National Park as an example, we can see that regional value generated by nature tourism more than compensated for lost revenues from forestry and timber.
- While a number of studies have examined the positive effects of large-scale protected areas on the regional economy, there are no comparable studies for ecosystem services (e.g. recreational benefits, climate action, flood protection and water purification) which would highlight further economic benefits.

The issue

Germany's large-scale protected areas (national parks, nature parks, biosphere reserves) safeguard biological diversity and provide important ecosystem services (e.g. regulating services such as climate regulation). As magnets for recreation and tourism, these areas contribute significantly to the creation of regional value. Large nature reserves play a major role in regional development, particularly in rural areas (Metzler et al., 2016), as they encourage additional revenues and business start-ups in the tourism sector which have additional multiplier effects in the region. The region's image is also enhanced. A value-added analysis was conducted in recent years in all German national parks and selected biosphere reserves to examine the effects of tourism on income (Job et al., 2009). The findings: Large-scale protected areas have a positive influence, both on the number of visitors and their average daily expenditures. Among national parks, gross tourism turnover ranged from 1.9 million euros in the Unteres

FIGURE 20 ▸ The Western Pomerania Lagoon Area National Park is a popular touristic destination. (Photograph: Anne Wessner)

Odertal National Park, to more than 1 billion euros in Schleswig-Holsteinisches Wattenmeer National Park (Metzler et al., 2016). Nevertheless, the designation of large-scale protected areas is often met with resistance as people fear loss of income in other economic sectors.

Economic analysis

Looking at the Bayerischer Wald National Park as an example we can see that tourism attributable to the protected area can generate added value at regional level that is higher than losses from land use restrictions e. g. relating to forestry and timber (Job and Mayer, 2012, see Figure 21). The total expenditure of the national park visitors in 2007 generated an added value of approximately 13.5 million euros (Mayer et al., 2010). Without national park status and the associated infrastructures and visitor facilities, the annual regional value generated from tourism would only be around 2.9 million euros. This means that the additional tourism generated through national park status is approximately 10 million euros. If there were no national park, alternative revenues could be generated from forestry and timber industries. Depending on the estimated cubic metres of timber that can be

harvested each year, the assumed round log and sawn timber prices and the real net output of the wood-processing industry, these revenues would range from 5.4 to 6.8 million euros per year.

The total real net output from national park tourism ranges from 3.8 to 5.2 million euros per year. Aside from the regional economic effects, visiting tourists generally enjoy additional benefits in the form of special recreational services. This, along with other ecosystem services, has not been taken into consideration in the above calculation.

Conclusions

The regional economic effects of large-scale protected areas can exceed revenues from alternative sources such as wood production and processing. While the economic effects of tourism from national parks and biosphere reserves on regional development have been examined in a number of studies, no comparable studies are available for ecosystem services such as recreational benefits for visitors, climate action, flood protection or water purification. Even the Natura 2000 network of protected areas in Europe, covering almost 16 % of Germany's national territory and one of its top nature conservation instruments, still requires more research to pinpoint and evaluate these additional benefits. A monetary valuation could further reinforce the economic benefits of protected areas beyond their central role in the conservation of biological diversity and natural heritage in Germany, thus helping to alleviate acceptance problems.

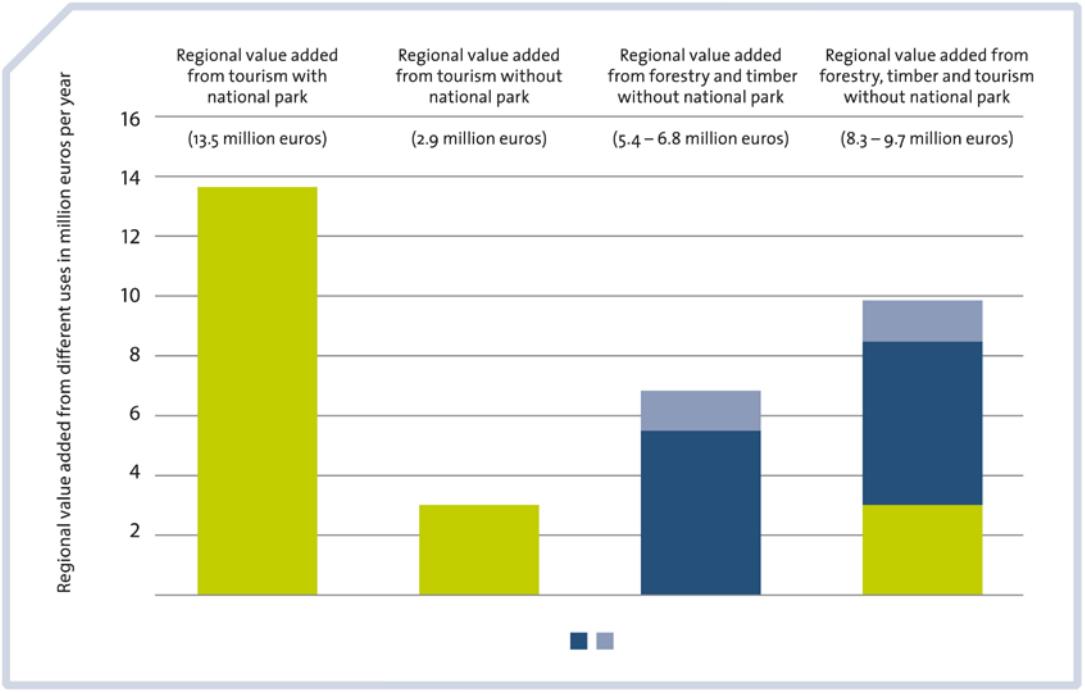


FIGURE 21 ▸ Regional value added of different uses of the Bayerischer Wald in millions of euros per year. (Source: own diagram based on data from Job and Mayer, 2012)

2.9 HEAT STRESS AND POLLUTANTS: URBAN NATURE REDUCES HEALTH COSTS

For details see Naturkapital Deutschland – TEEB DE, 2016d, pp. 51–61.

Core messages

- Urban heat islands form in cities during heatwaves, which have harmful effects on human health. Heat stress and air pollution in cities lead to impaired quality of life, elevated health care costs and higher mortality rates.

- Urban nature, especially parks, provides cool islands (cold air masses) which have a cooling effect on the buildings in the surrounding area. Trees along avenues and in parks create shade and evaporation and therefore contribute to cooling. Urban nature also supports air pollution control and provides other ecosystem services.

- In order to give adequate weight in planning processes to urban nature and its services, it is necessary to record the effects as fully as possible and develop comprehensive strategies. Economic evaluations can help in this regard.

The issue

Due to their high proportion of sealed land and large number of buildings, cities and their surrounding areas have a very different climate to rural areas. Particularly on warm summer days, urban heat islands can form, with temperatures that only fall slightly during the night. Heat stress has particularly adverse effects on people with cardiovascular and respiratory diseases. Not only does the number of cases of acute illness increase, mortality rates also rise in cities during heatwaves. In summer 2003, Europe was hit by heatwaves which caused an estimated 50,000 to 70,000 additional deaths (Robine et al., 2008). In 1994, during a heatwave lasting three weeks in Brandenburg and Berlin, the death rate on some days was 10 to 30 % and in some districts in Berlin even 50 % higher than normal for that time of year (Gabriel and Endlicher, 2011). The effects of heat stress are further exacerbated by additional air pollutants such as nitrogen oxide, ozone and particulate matter (Burkart et al., 2013). Air pollution is linked to a wide range of adverse health effects. For example, particulate matter pollution causes around 47,000 premature deaths in Germany per year (Kallweit and Wintermeyer, 2013) and a large number of incidences of cardiovascular and respiratory disease requiring treatment.

Economic analysis

Urban green and open spaces perform important regulating services for air quality and the urban climate. The latter will become even more important in the context of climate change (Naturkapital Deutschland – TEEB DE, 2016 c, p. 56 ff.). On warm and wind-still days, records show that green spaces measuring between 50 and 100 metres wide are 3–4 °C cooler than the adjacent buildings (Bruse, 2003). On clear nights, larger green spaces can reduce the air temperature by about 5–10 °C. The cold air circulates in the surrounding built-up area and reduces temperatures. This is another reason why parks are very important for their immediate vicinity (see Figure 22).

Urban green can also reduce pollutants in the air as gases and particulate matter are deposited on leaf surfaces or absorbed by foliage. Large-scale studies have not yet been carried out in Germany, however, in Barcelona it was found that urban nature binds 166 tonnes of particulate matter (PM 10) per year, accounting for 22 % of dust emissions incurred within the city (Baró et al., 2014). Urban nature is thus an important flanking measure for improving air quality and reducing pollution loads from traffic.

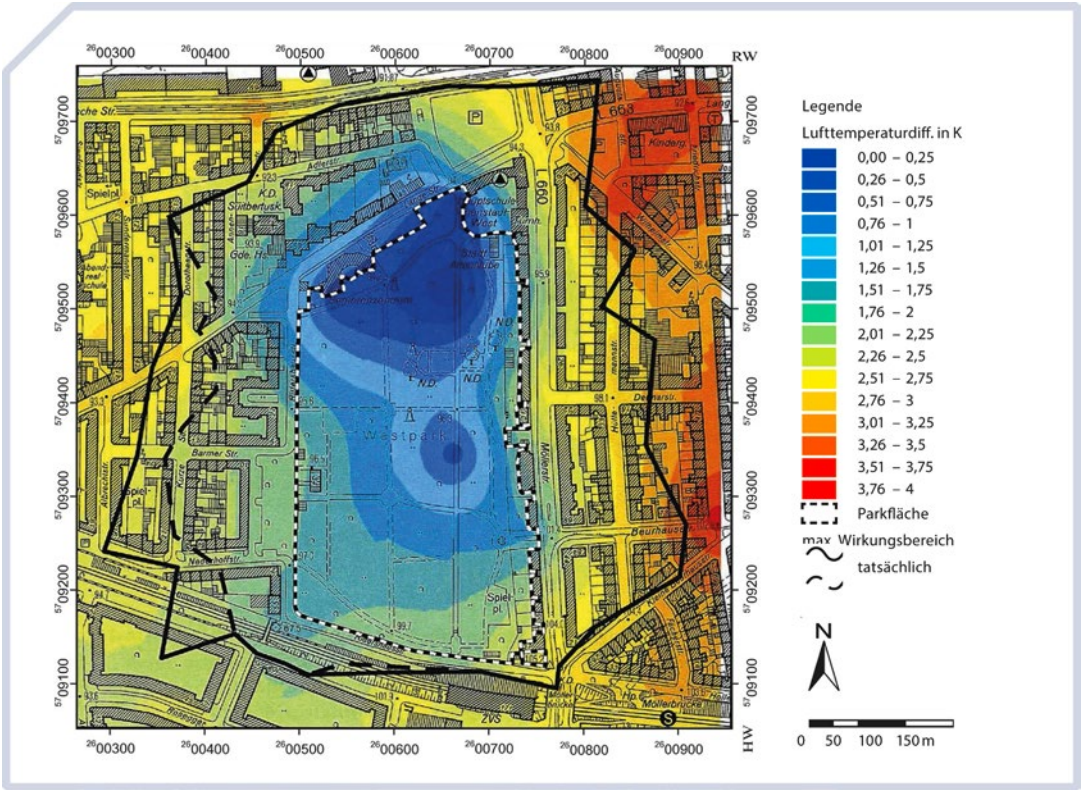


FIGURE 22 ▸ Lower night air temperatures in a Dortmund park and their effects on the surroundings.
(Source: Bongardt, 2006)

Conclusions

Urban nature's contributions to regulating the urban climate and air hygiene are only two examples of its services. Urban nature is accompanied by a whole host of ecosystem services and contributions to different targets: aside from preserving biological diversity, these services include promoting health, social cohesion and nature experiences for children and youth, provisioning services for the population and making cities a more attractive location to live and work (see Naturkapital Deutschland – TEEB DE, 2016). Urban nature does not just refer to parks, open green spaces and urban forests, but also to trees on streets and green areas around public and private buildings. In the further development of our cities in line with the principle of qualitative inner development the aim will be to create additional living space and, in doing so, preserve and develop the »green lungs« of our cities and curb the use of land on city outskirts. To this end, the positive effects of urban nature need to be better integrated into urban development processes. Developing methods to evaluate the ecosystem services of urban nature from an economic perspective will help shed light on their benefits for society.

FIGURE 23 ▸ Green backyards are vital components of urban nature. (Photograph: Jasmin Honold)

2.10 GREEN SPACES NEAR HOME: URBAN NATURE INCREASES LIFE SATISFACTION

For details see Naturkapital Deutschland – TEEB DE, 2016c, pp. 296–302, and Naturkapital Deutschland – TEEB DE, 2016d, p. 28.

Core messages

- Urban nature and the accessibility of green spaces near homes are important factors for health and well-being.
- Economic analyses of the relationship between life satisfaction, income, the provision of public green spaces and other parameters show that the value of one hectare of green space for people living in the surrounding areas can be almost twice as high as the land's commercial value as a building plot.
- The promotion of inner development should therefore not just strive to reduce external growth of human settlements, but also, under the principle of qualitative inner development (doppelte Innenentwicklung) should aim to preserve and develop urban green areas and enable short distances to green spaces near residential areas.

The issue

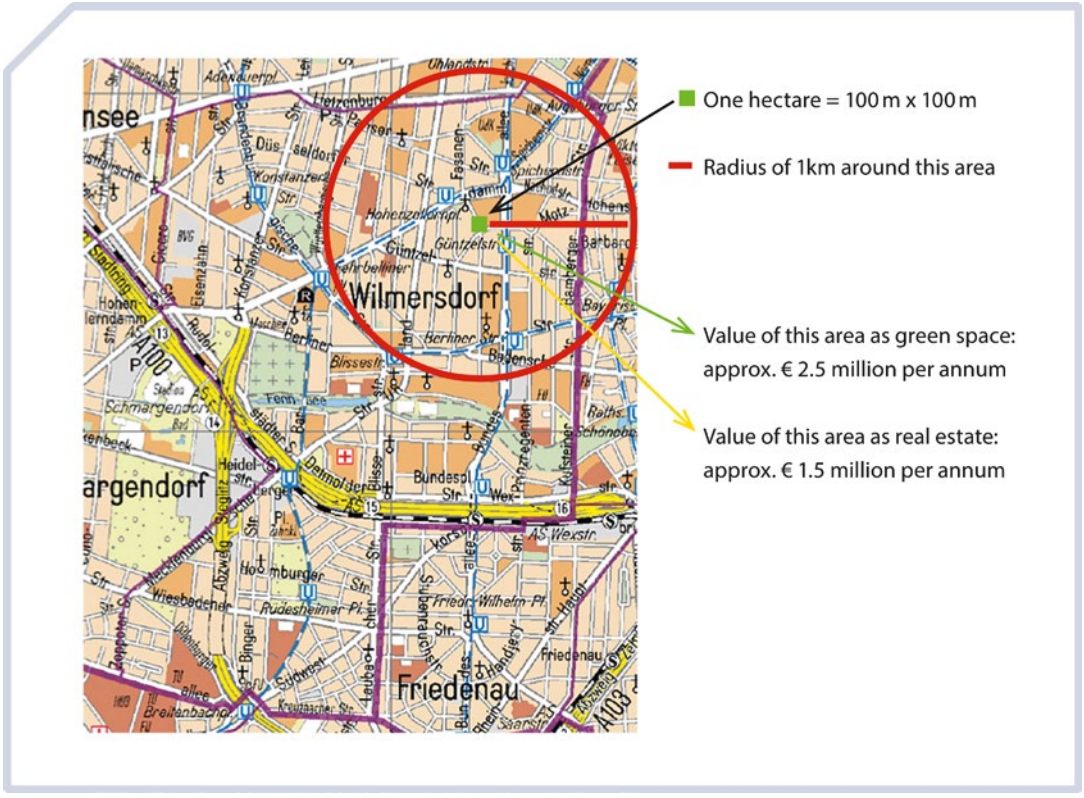
For many years, city planners have used the »inner development over external development« model in efforts to curb the use of land for human settlements and minimise urban sprawl. The success of this approach depends, in part, on the extent to which it can successfully maintain and where possible increase the quality of life in inner city urban areas. There is a risk that decisions on the infill development and re-use of wasteland at former industrial and commercial locations do not take ecosystem services such as urban recreation, the air filter effect and climate compensation adequately into account. Generally speaking, only the economic benefits of a project are identified (e.g. real estate added value and resulting tax revenues), while the costs incurred to society due to the loss of urban nature are not quantified (e.g. adverse effects on health, reduction in the quality of life).

Economic analysis

A study carried out in 32 German cities confirms a clear correlation between people's individual life satisfaction and the proportion of green spaces near their homes (Krekel et al., 2016). Given the well-known correlation between rising income and greater satisfaction with life, in a neighbourhood with an average proportion of green spaces, it has been estimated that one hectare of additional green space corresponds statistically to an additional income of 276 euros per annum and per household in terms of life satisfaction (ibid.).

What this means with respect to the relationship between the real estate price and the value of the land as a green space can be illustrated using a sample calculation for a fictitious decision on one hectare of land in Berlin-Wilmersdorf (see Figure 24). In the district of Wilmersdorf-Charlottenburg there are on average 8,960 households within a 1km radius. For these 8,960 households together, one hectare of additional green space would equate to a value of around 2.5 million euros per year. The average standard land value in this district is about 3,500 euros per square metre or 35 million euros per hectare. With a standard calculatory interest rate of 3 %, a one-off payment of 35 million euros is equivalent to an annual payment of 1.5 million euros (»infinite pension«). The analysis therefore shows that the real estate value of the land is only 60 % of its value as a public green space. The value of the land in the diagram would be much higher as a public green space, as the amount of green space within a 1 km radius is under the standard average figure.

FIGURE 24 ▸ Valuation of public green spaces, as illustrated by the example of an area in Berlin-Wilmersdorf.
(Source: Burkhard Schweppe-Kraft in Naturkapital Deutschland – TEEB DE, 2016d, p.28; map: Geoportal Berlin, 2016)



Conclusions

The principle of qualitative inner development aims to use the potential of cities for further building uses and for improving the quality of residential areas in such a way that conserves nature and ecosystem services in the undeveloped outskirts as much as possible and preserves and improves the quality of life in cities. While the individual effects of green spaces, such as their various health effects, impacts on social cohesion and importance for the physical and psychological development of children, are difficult to quantify, the life satisfaction method makes it possible to also give a brief evaluation of some of the relevant aspects in monetary terms. Identifying the economic benefits of urban green spaces can help support the principle of qualitative inner development (Böhm et al., 2016) e. g. justifying neighbourhood-specific targets for greening urban areas which can then be implemented through planning measures and targeted urban property policy.

FIGURE 25 ▸ Neighbourhood parks increase quality of life in cities. (Photograph: André Künzelmann)

3 KEY MESSAGES FROM »NATURAL CAPITAL GERMANY – TEEB DE«

The following key messages emerge from the reports of »Natural Capital Germany – TEEB DE« and the case studies in Chapter 2:

3.1 LOSS OF NATURAL CAPITAL AND ECOSYSTEM SERVICES RESULTS IN HIGH COSTS TO SOCIETY

Loss of natural capital causes high costs to society: from impacts on health, production losses and costs of clean-up and restoration. Reducing the damage to natural capital is usually cheaper than having to bear the social costs of its degradation.

The consequential costs to society as a result of the intensive use of natural resources are often considerable. This can be seen, for example, in the continuing high emissions of greenhouse gases in Germany, which in the period 2014-1016 amounted to more than 900 million tonnes per year (UBA, 2016). Multiplied by the cost of the damage, which according to the methodology used by the German Environment Agency (UBA, 2013) should be put at EUR 120 per tonne, this results in costs of EUR 108 billion per year. Agriculture is responsible for around 67 million tonnes (7 %) of the greenhouse gas emissions (Naturkapital Deutschland – TEEB DE, 2015; excluding land-use change). This is roughly the same as emissions from industry (UBA, 2016), and applying the UBA's methodology it can be regarded as causing damage to the tune of approximately eight billion euros – which in itself is more than the annual subsidies paid to German agriculture.

Many soils – and hence also the groundwater and rivers, lakes and oceans – are contaminated by excessive inputs of nutrients (such as nitrogen and phosphorus) and pollutants (such as heavy metals, pesticides, traces of pharmaceuticals). The German government's nitrate report shows that 28 % of all rivers and lakes in Germany are excessively polluted with nitrates (i. e. above the limit of 50 mg/l) and another 22 % are severely polluted (i. e. with nitrate levels between 25 mg/l and 50 mg/l, BMUB and BMEL, 2017). This impairs the cleansing ability of the lakes and rivers and gives rise to considerable costs in connection with the provision of drinking water. A report by the German Association of Energy and Water Industries (BDEW) shows that the expensive removal of nitrates can increase the annual water bill of a three-person household by up to 62 % (BDEW, 2017). A study by the UBA underlines this with further data that also reveal the high costs to the economy of providing clean drinking water (Oelmann et al., 2017). The case study of nitrogen surpluses demonstrates that compensation to farmers for operating in accordance with ecological criteria is only about a seventh of (!) the subsequent cost of purifying drinking water. It is therefore far more cost-effective to prevent pollutants entering the groundwater than to treat the water afterwards.

FIGURE 26 ▸ Urban parks reduce heat, noise and particulate levels. (Photograph: Norma Neuheiser)

The negative impacts of heat, noise and dust in towns and cities are hard to measure in monetary terms. However, it is estimated that 4–5 % of deaths in Berlin are linked to summertime heat (Scherer et al., 2013). Across Europe, heart disease and respiratory disorders caused by fine particles and air pollution result in around 350,000 premature deaths annually (EEA, 2010). In Germany the number of deaths attributable to such causes is around 45,000 – more than ten times the number of deaths in road accidents. Adequate green spaces in urban areas are no substitute for addressing the causes of pollution, but they can at least mitigate the effects (see the case study on »Heat stress«).

The case studies show that it is far more cost-effective to reduce environmental pollution and damage to natural capital through appropriate management methods than to bear the consequential costs to society of the reduced provision of ecosystem services.

FIGURE 27 ▸ Meadows provide water retention during flood events. (Photograph: André Künzelmann)

3.2 MAINTAINING AND RESTORING OUR NATURAL CAPITAL IS WORTHWHILE

It is worthwhile not only to maintain natural capital but also to restore and develop it. This is particularly true for peatlands, floodplains and grasslands but it applies also to semi-natural forests and to urban nature.

Investing in natural capital is worthwhile. Rewetting and restoring former peatlands and using them sustainably is an extremely cost-effective way of mitigating climate change as well as a measure that helps to control water pollution and contributes to biodiversity. The macro-economic profits from comprehensive peatland protection are significantly higher than the profits from alternative forms of land use (such as growing maize as an energy crop on former peatlands that have been drained) (see the case study of »Arable farming on peatlands and peatland rewetting«). Restoring floodplains cannot replace technical flood control measures, but in suitable locations it can improve flood protection and provide a semi-natural alternative to it. Preventing the ploughing up of grassland and preserving grass-

land of high ecological quality combines climate change mitigation, protection of lakes and rivers and biodiversity conservation (case study »Ploughing up grassland«). Creating river bank buffer zones contributes to nature conservation and the protection of flowing waters and is important in protecting the oceans against eutrophication (case study »River bank buffer zones«). Sustainable forestry measures – combined with leaving some forest areas unused so that they can develop naturally – result in a dynamic mosaic of diverse habitats that is particularly successful in enabling the forest to fulfil its many functions. Insects are at risk in our cultural landscape, mainly as a result of habitat loss and pesticide use. The pollination services that they provide yield direct economic benefits. Investing in urban green spaces and neighbourhood gardens, too, does not just cost money: it also saves money, for example by reducing the expenditure of the health system, improving social cohesion in the public space and helping to provide the population with products from their own gardens (see the case study on »Green spaces near home«).

3.3 LAND USE STRATEGIES MUST TAKE ACCOUNT OF THE DIVERSITY OF ECOSYSTEM SERVICES

Considering the provision of individual ecosystem services in isolation is not helpful. The crucial point is that nature is multi-functional: it always provides a bundle of diverse ecosystem services that are affected by land-use decisions. We must shape conditions within society in such a way that this diversity – and not the maximisation of an individual service – is at the heart of any decision-making process.

Ecosystems are multi-functional: they often provide numerous ecosystem services simultaneously. Changes in land use do not affect the various services equally; boosting one ecosystem service is often achieved at the expense of others. This is particularly true in agriculture: within the agricultural sector there have for many years been incentives to constantly step up intensive production – with all the attendant disadvantages for other ecosystem services (drinking water, landscape, species conservation, etc.). As the case studies in »Natural Capital Germany – TEEB DE« make clear, intact ecosystems make important contributions to issues such as climate change mitigation and adaptation, the achievement of water pollution control targets and the enhancement of quality of life in urban areas. Often, however, the contributions to individual targets are less than the contribution of specific technical infrastructure.

As the case study »Conservation and renaturation of floodplains« shows, structural flood protection measures, such as raising dike lines, provide more cost-effective protection against extreme events than dike relocation. However, if one takes into account the value of the

FIGURE 28 ▸ Elbe floodplain in Saxony-Anhalt. (Photograph: Anne Wessner)

other ecosystem services associated with the natural solution (creation of retention areas through floodplain renaturation), it becomes clear that the overall macro-economic benefits of the natural alternative are greater. Similarly, the case study on »River bank buffer zones« shows that if the effect of such buffer zones is considered only in relation to marine conservation, the positive cost/benefit ratio is low. If, however, consideration is enlarged to include additional ecosystem services (in the case study the positive impacts on flowing waters and nature conservation), a clearly positive picture emerges. The case study on »Ploughing up grassland« also demonstrates the importance of the whole range of ecosystem services: permanent natural grassland is not just a production input for livestock farming – it also plays an important part in mitigating climate change, conserving biodiversity and reducing nutrient inputs into groundwater and surface waters. And, finally, it is worth pointing out that urban green spaces, green roofs and green facades are not just a way of reducing the volume of wastewater in heavy rain events: their microclimate effects and visual appeal enhance the well-being of people living nearby and in addition, when appropriately designed, they provide habitat for urban flora and fauna.

Steps must be taken to ensure that all the various ecosystem services are considered in a balanced manner and in context. This makes it easier to identify synergies and conflicting objectives in the provision of ecosystem services and to take them into account. This requires adaptation of management instruments as well as changes to public institutions and in the private sector.

3.4 BIOLOGICAL DIVERSITY IS THE FOUNDATION OF OUR NATURAL CAPITAL

Leaving aside the ethical reasons for preserving species and habitats, it is not only because beauty and the aesthetics of nature and landscape are cultural values that biodiversity is important. Species diversity is in many cases also a crucial basis for the functioning of ecosystems and hence a basic service that is vital to many other ecosystem services. Basic services of this sort yield macro-economic benefits, even if these benefits are hard to put a figure on.

Biological diversity supports ecosystem services in various ways. Firstly, the diversity of nature is perceived as an important element of cultural ecosystem services – it is an aspect of regional identity, of the beauty and aesthetics of a varied cultural landscape and of the touristic potential of a region (see the case study on »Large-scale protected areas«). In this context biological diversity is often »attractive« in itself; it provides benefits and in consequence is appreciated by people.

Secondly, biodiversity combines with many other natural processes (such as soil formation, the water cycle) to form the basis for a whole range of provisioning, regulating and cultural ecosystem services. It provides the foundation without which the other services would not even be possible. Although scientists still have a long way to go before all the linkages are fully understood, it is becoming increasingly clear that biodiversity plays an important part in promoting the resilience and stability of ecosystems. It also underpins the ability to adapt to new and changing environmental conditions such as climate change. Greater species diversity increases the likelihood of there being species or genotypes that are adapted to coming changes and can ensure the provision of ecosystem services under future conditions (see e. g. Balvanera et al., 2006; Cardinale et al., 2012; Díaz et al., 2006; Elmqvist et al., 2010; Isbell et al., 2015). Viewed in economic terms, biodiversity provides insurance against the impacts of natural disasters, pesticide-resistant pests and plant diseases and the advance of climate change.

Finally, biodiversity also has potential benefits in the form of »option values« (Baumgärtner, 2007; Bartkowski, 2017). Option values relate to the possibility of deriving new benefits from natural capital, now or in the future, in fields such as bionics, plant and animal breeding or pharmaceuticals. We do not currently know whether the genetic resources will be of use to us in the future, but we keep the option open.

3.5 MONETARY VALUATIONS CAN DEMONSTRATE THE SOCIAL IMPORTANCE OF NATURAL CAPITAL

The monetary valuation of ecosystem services can be, with other instruments, an important decision-support tool. It enables assessing positive and negative impacts on natural capital, in particular on ecosystem services not traded on markets. In addition, identifying who benefits and who bears the costs of altering land use and ecosystem service provision can shed light on social equality impacts. Such information may help decision-makers to create rules for land management that foster long-term social benefits over short-term individual gains.

Many public decisions – such as decisions on new laws, plans or investments – involve weighing up costs and benefits. However, the costs and benefits of preserving natural capital and ecosystem services are usually measured only qualitatively – if they are considered at all. As a result they are either not channelled into decision support mechanisms such as regulatory impact assessment or else given only inadequate consideration. But if the impacts of a law are assessed only in terms of the direct costs to those immediately affected by the rules, and the social benefits of the more sustainable use of natural

capital are ignored because they are not presented in a comparable manner, it is predictable that the decisions made will not be socially appropriate.

Economic valuation studies can help to highlight the benefits to society of protecting nature and its ecosystem services and using them sustainably. They enable the importance of the natural foundations of life and the benefits of preserving them to be expressed in monetary terms. This makes it possible to compare other possible uses by means of monetary parameters (such as regional value creation, sales, employment, etc. Greater comparability of benefits and costs is thus ensured. Monetisation requires concrete measurement of impacts on both sides. Economic valuations can thus influence investment decisions and the design of political strategies, statutory requirements and subsidy policies. The importance of supplementary economic consideration as support for the preservation of natural capital is explored in more detail in Section 1.2.

Of course not all the values of nature can be expressed appropriately in monetary terms. This is not disputed (see e.g. Naturkapital Deutschland – TEEB DE, 2012; 2015; 2016b; also Pascual et al., 2010; Diaz et al., 2015; Hansjürgens, 2016). There is therefore still a need for

FIGURE 29 ▸ Cultural landscapes provide a wide range of ecosystem services.
(Photograph: Anne Wessner)

other methods and instruments that are able to depict environmental values and environmental consequences qualitatively. However, experience shows that the qualitative arguments for nature conservation by themselves are often not sufficient to illustrate the importance of nature in appraisal processes and profitability assessments.

3.6 VALUES MUST BE REALISED

»Natural Capital Germany – TEEB DE« makes clear that simply putting a value on ecosystem services is not enough. These values must also be considered in decision-making. We need rules and incentives for a change of perspective that creates new alliances, promotes cross-sectoral thinking and helps to ensure that existing instruments are systematically applied.

The examples presented in »Natural Capital Germany – TEEB DE« illustrate the importance of an ecosystem service perspective for the long-term conservation and sustainable use of nature. The project identifies the various social objectives to which nature and its ecosystem services contribute simultaneously as well as pinpointing who benefits from maintaining or restoring these services and who may have to bear the costs of the loss of natural capital. An economic valuation of the services concerned can draw attention to the size of the benefits that accrue to society as a result of maintaining or restoring nature and to the technical infrastructure that can be supplemented or even replaced by nature-based solutions with multi-functional benefits.

However, identifying and highlighting social benefits and disadvantages – the valuation – is not in itself sufficient. The crucial point is ensuring that natural capital and its ecosystem services are given appropriate consideration in both public and private decisions: ultimately it is the realisation of value that is vital. We need political instruments that incorporate the importance of nature into appraisal decisions and profitability assessments across sectoral boundaries, thus paving the way for the safeguarding and restoration of natural capital. This policy integration is one of the key challenges to be faced if nature-based solutions and green infrastructure are to be considered as alternatives that are at least of equal value to (and for society as a whole indeed often superior to) traditional investment in grey infrastructure. Germany has many measures and instruments at its disposal (see e. g. Infobox 4) and many others are being discussed. Often, though, they are not energetically supported – either because of a lack of funding and human resources, or because other interests are given priority in political decision-making. Ways must therefore be found of according natural capital the necessary priority and making full use of the available instruments and measures.

4 RECOMMENDATIONS FROM »NATURAL CAPITAL GERMANY – TEEB DE«

»MANY PEOPLE KNOW AND UNDERSTAND THAT ›BUSINESS AS USUAL‹ IS NO LONGER POSSIBLE AND THAT THE UNRESOLVED CONTRADICTIONS WITHIN OUR ECONOMIC MODEL PUSH THE SYSTEM TO ITS LIMITS. THE GREAT TRANSFORMATION CAN GIVE HOPE AND DIRECTION IN TIMES OF DISORIENTATION. AND SO THE STORY GOES: IT IS POSSIBLE TO MAINTAIN OUR PROSPERITY AND TO BREATHE NEW LIFE INTO OUR SOCIETIES, IF WE BECOME ACTIVE AGENTS OF CHANGE AND DO NOT TRY TO EVADE IT. IT IS POSSIBLE TO LIVE A LIFE IN DIGNITY WHILE ALLOWING PEOPLE IN OTHER PARTS OF THE WORLD, AS WELL AS OUR GRANDCHILDREN, TO LIVE SUCH A DIGNIFIED LIFE TOO.«

FORMER GERMAN PRESIDENT PROF. HORST KÖHLER, »THE GREAT TRANSFORMATION IN TIMES OF UNEASE« IN HIS SPEECH MARKING THE 25TH ANNIVERSARY OF THE GERMAN FEDERAL ENVIRONMENTAL FOUNDATION (DEUTSCHE BUNDESSTIFTUNG UMWELT), BERLIN, 2016

For society as a whole, maintaining natural capital is desirable. It is not a matter to be left only to nature conservationists. Other sectors whose activities conflict with the preservation of natural capital or that profit from ecosystem services must also contribute. Why does this not yet happen regularly? Where is potential for stronger implementation? What is needed to ensure that this potential is realised?

The first step involves recognising the importance of ecosystem services, identifying the beneficiaries of these services, recording their value and diagnosing undesirable developments. Recommendations for action must then be drawn up together with instruments and measures for incorporating the objective of sustainable management of ecosystem services into decision-making more comprehensively than has previously been the case.

The following recommendations are based on the assumption that ecosystem services are not being overlooked because their benefits are insignificant. It is rather the way in which we organise our decision-making that results in the diverse services of nature frequently being neglected.

In many cases it is not environmental and nature conservation policy that determines the use of natural resources but other areas of policy that exert a key influence: agricultural and forestry policy, settlement and transport policy, energy and climate policy, trade, financial and consumer policy and public procurement. All of them create the framework for decisions on land use and investment and for consumer choices – a framework geared to the relevant sectors and areas but that also ultimately impacts on natural capital. Viewed in this way, the destruction of nature is an unintended side-effect. The TEEB approach provides starting points for identifying how and to what extent these unintended side-effects can be prevented and how the various sectors themselves can profit from the preservation of natural capital – for example in connection with the design of sustainable farming and forestry systems, adaptation to climate change or land management in urban areas. In order to exploit synergies and mitigate conflicts of objectives, it is essential to consider natural capital and ecosystem services within the sector policies that have been mentioned. The preservation of natural capital cannot be left solely to a progressive nature conservation policy; it affects all sectors that intervene directly or indirectly in nature. We need to develop both information and procedures that support decision-making and standards and incentives for the management and use of ecosystems that always take account of the multi-functionality of nature and its services. Only then can we ensure that the best possible uses for society as a whole are identified and put into practice.

This requires:

Information (Section 4.1)

- Further development of the information base, concrete information requirements and practice-oriented methods of generating information are needed in order to record the relevant ecosystem services properly and consider them appropriately in planning and decision-making processes.

Policy integration and cross-sectoral cooperation (Section 4.2)

- To prevent one-sided and environmentally damaging maximisation of individual uses and achieve synergies from the diversity of ecosystem services, it is necessary to develop cross-sectoral strategies and promote cooperation aimed at the balanced use and maintenance of natural capital.

Clear and implementation-oriented targets (Section 4.3)

- A binding social framework for the preservation of natural capital should be created by specifying clearly defined objectives underpinned by indicators and by defining and assigning responsibilities for implementation. Existing objectives and strategies should be reviewed with this in mind and adapted as necessary.

Statutory standards and economic incentives (Section 4.4)

- Statutory standards and minimum requirements should be further developed as instruments for maintaining natural capital and ecosystem services. Standards and minimum requirements specify what duties and considerations can be expected in connection with the preservation of natural capital. They provide the basis for the definition of voluntary measures that constitute special environmental performance in excess of minimum standards and should be rewarded by society.

- Greater user should be made of economic instruments such as environmental taxes, remuneration for environmental performance and certification systems in all situations in which minimum standards are unsuitable or insufficient for the protection and development of natural capital and ecosystem services.

Corporate responsibility (Section 4.5)

- Supporting the maintenance of natural capital and minimising harmful influences – in one's own business, but also in the public arena – is an aspect of corporate responsibility. The conservation and sustainable use of ecosystem services is a key economic factor for companies.

Preserving natural capital in an interconnected world (Section 4.6)

- Little is gained if we succeed in protecting our natural capital in Germany but in so doing contribute to the destruction of nature in other parts of the world. Business and government should therefore work together to take steps to preserve the services of nature in a globalised economy – for example by developing criteria and certification schemes for products produced in an environmentally friendly way and by boosting the importance attached to environmental aspects in international trade.

4.1 MEASURE THE DEVELOPMENT OF NATURAL CAPITAL AND DISCLOSE LONG-TERM COSTS OF ITS LOSS

Existing approaches for the assessment of ecosystem services should be expanded, including quantitative indicators and developed into a systematic monitoring of natural capital. Methods should be developed that support incorporating natural capital and ecosystem services into regulatory impact assessment, environmental assessments and planning processes on an equal footing with other considerations. Business accounting systems that make the impacts of decisions on nature and ecosystem services clear should be developed further.

National reporting systems and spatial planning

The state of the environment and nature and trends in pollution levels and the economic and social drivers of pollution and environmental degradation are already depicted in various places in reporting systems. At national level there are various reports and indicator systems (including environmental economic accounting, the Sustainable Development Strategy, the National Strategy on Biological Diversity, the National Forest Inventory, climate reporting, reporting commitments under the Water Framework Directive, the Marine Strategy Framework Directive, the Nitrates Directive, the Habitats Directive and the Birds Directive) that consider aspects of natural capital and ecosystem services, although from a different perspective and using a different methodology in each case. Spatial planning systems that, in combination with landscape planning systems, provide the local, regional and national basis for public investment, subsidy policies and concrete land-use decisions (Naturkapital Deutschland – TEEB DE, 2016a) address the range of ecosystem services under headings such as »protected assets of the natural system«, »efficiency of the natural system« and »landscape functions« (Albert et al., 2012). Often, however, the specific ecosystem services are described only in qualitative terms – with the result that they are frequently brushed aside in subsequent appraisal decisions. The national summary of general landscape planning (BfN, 2015a) shows that

such planning takes place virtually nationwide. However, a recent study shows that local landscape plans are implemented only on just over 70 % of the municipal land included in the study (Stein et al., 2014). In addition, the intervals between measurement of landscape functions are very long, and different methods are used in different federal states, which means that a national summary cannot be produced. In many cases there are no links between national indicator systems and spatial planning at federal state and municipal level. Furthermore, important information systems have deficiencies that have been known about for a long time. For example, cases of destruction of nature – such as the loss of floodplains as retention areas – are macro-economic costs that are ignored in the national accounts, but expenditure on technical replacements, such as the construction of dikes for flood protection or the reconstruction of infrastructure after flooding, is included and is even classed as increasing the gross domestic product.

The concept of ecosystem services provides an opportunity to extend reporting systems in order to create a systematic and comprehensive approach that also encompass an economic perspective. This can heighten the importance and impact of the existing reporting and planning systems and underpin them with additional information and material for consideration. By this means the concept of ecosystem services facilitates a more quantitatively oriented analysis of trade-offs and synergies between various ecosystem services (see e. g. Grêt-Regamey et al., 2013). This applies to both the supply (capacity) of ecosystem services and the demand for them, which can yield important additional information (Albert et al., 2015). In this connection, Action 5 of Target 2 in the EU's Biodiversity Strategy (which relates to MAES – Mapping and Assessment of Ecosystems and their Services) formulates requirements that are currently being implemented in the Member States, including Germany. This should be used to develop a comprehensive monitoring programme for ecosystems and ecosystem services at national level: the information obtained could be used to support decision-making at various levels in the state and private sectors (see Albert et al., 2015, p. 7).

Planning and decision-making procedures including strategic environmental assessments (SEA) and environmental impact assessments (EIA)

Quantifying and valuing the services performed by nature in relation to flood prevention, climate change mitigation, pollination, pollutant control, recreation and so on provides an opportunity to enrich appraisals conducted within planning-related decision-making processes, including environmental assessments of plans by means of SEAs and the assessment of projects by means of EIAs (see also Infobox 2). Such an approach has already been discussed in connection with the

EU's EIA Directive (Directive 2011/92/EU). This would supplement the consideration of impacts on the functions of environmental media that is usual in EIAs by also emphasising the importance of ecosystem services for society and the preferences of the general public for nature and the environment. In particular, the explicit consideration of the demand for ecosystem services and the economic valuation of environmental changes by comparison with the other economic impacts of the projects (e. g. savings by individuals as a result of shorter journeys, economic changes in property values as a result of environmental changes) can create a new and improved information base. This includes information on distribution between beneficiaries and people who are adversely affected. However, the recording and valuation of ecosystem services that this involves requires the development of tools (methodologies, reference values, etc.) that help to make information available quickly and cost-effectively and enable ecosystem services to be considered with sufficiently valid values in day-to-day planning and decision-making processes. Another requirement is that the relevant law on approval and planning processes is adapted appropriately. The environmental assessment forms part of the corresponding approval and planning procedures and should help to ensure that environmental aspects are duly considered. The inclusion of ecosystem services in EIAs and SEAs only makes sense, therefore, if approval and planning law makes it possible to take ecosystem services into account in approval and planning decisions.

INFOBOX 2

Refinement of environmental impact assessment in flood prevention planning

One option is to refine the EIA for water management measures, especially in connection with plans for flood prevention facilities. Planners of flood prevention measures should consider whether the prescribed level of protection could be achieved by reinstating natural retention areas or by other environmentally sound means. Where the ecosystem service perspective can help to monetise the additional benefits of floodplain renaturation as a flood prevention measure, it can contribute to the prioritisation of measures. In those circumstances it could also provide a basis for the design of new flood prevention programmes and plans.

FIGURE 30 ▸ Natural floodplain at river Elbe.
(Photograph: André Künzelmann)

Regulatory impact assessment.

Regulatory impact assessment must be designed to quantify not only the direct costs that arise from enforcement and from restriction of the action options open to those bound by the legislation but also the additional advantages and disadvantages for business and society as a result of the rules. These advantages and disadvantages include the

impacts on nature and the environment and the provision of ecosystem services. Calculating these impacts in monetary terms can counterbalance the costs of complying with legislation (see Infobox 3).

INFOBOX 3

Oil tanks in flood control areas

Oil tanks in areas prone to flooding pose a particular risk to buildings and the environment. The tanks may float and damage the basement area; leaking oil pollutes the environment and may cause irremediable damage to buildings. A ban on oil-fired heating systems in flood control areas was initially assessed in terms of costs and appeared to be too expensive to impose. However, including the damage that would be prevented yielded a (clearly) positive cost/benefit ratio. This provided additional arguments for the flood control legislation, contributed to the prevention of production losses and yielded savings for the insurance industry. If similar figures for the loss of natural capital could be taken into account, regulatory impact assessment would benefit hugely.

Corporate accounting systems

At corporate level, operational and company-related reporting needs to be refined to include information on the company's management of nature and ecosystem services. Some important steps in this area have been initiated at EU and national level, e. g. through the CSR Directive (see EC, 2014; 2017; Bundesgesetzblatt, 2017). The methods of »natural capital accounting« are many and varied and in many cases are still at an early stage of development. Their practicability, utility, financeability and broad-scale effectiveness have still to be proven. The limited availability of data, especially of primary data along the value chains, means that it is still very difficult to make robust statements and to quantify complex environmental impacts (Biodiversity in Good Company, 2016). International initiatives in this area include the Natural Capital Protocol of the Natural Capital Coalition and the work of pioneering companies on the European platform Business@Biodiversity, while in Germany there is the dialogue and action platform »Unternehmen Biologische Vielfalt 2020« (»Enterprise Biological Diversity 2020«, UBi 2020), which was launched by BMU in 2013. The German platform aims to boost the involvement of business and industry in implementation of the National Strategy on Biological Diversity and hence in the valorising of natural capital. As well as promoting pilot projects to demonstrate the feasibility of reporting systems, it is necessary to strengthen the obligation to set up and maintain such systems. It is important for corporate reporting to include consideration of impacts throughout the company's entire value chains. For most sectors of the economy, the most extensive impacts on biodiversity and the supply of eco-

system services occur at the level of primary products (see Naturkapital Deutschland – TEEB DE, 2013). The greatest contributions to the sustainable use of nature and its services are frequently to be achieved in the area of procurement. This emphasises the need for companies to assume responsibility on an international basis (see also Section 4.5).

4.2 POLICY INTEGRATION AND CROSS-SECTORAL COOPERATION

Maintaining natural capital is not solely the task of nature conservation. Other sectors and the associated areas of policy (agriculture, climate and energy, water bodies, settlement development) do not just drive the deterioration of the state of natural capital and biological diversity: they are also directly dependent on ecosystem services and can profit from them. The sustainable use of natural capital is therefore in their own interests and should form part of sectoral policy.

Agriculture and the safeguarding of natural capital

Agriculture is by far the largest user of land and therefore exerts a key influence on natural capital and ecosystem services. To safeguard these things, the »polluter pays« and burden-sharing principles should be applied in the agricultural sector more rigorously than they have been. This can be achieved by raising the minimum agricultural standards and focusing farming subsidies on rewarding social performance in excess of the minimum requirements. This will enable the objectives of agricultural policy and those of environmental and nature conservation to be achieved simultaneously.

About 60 % of the agricultural land in Germany is currently used to produce animal feed; 20 % is used to produce food and 20 % to produce renewable resources (mainly for energy generation) (UBA, 2016). The associated burdens on the climate, nature and ecosystem services, over and above their provisioning services, are severe (SRU, 2015; Naturkapital Deutschland – TEEB DE, 2015; WBAE and WBW, 2016). At EU, national and federal state levels, it is therefore a matter of urgency to review agricultural policy with regard to its environmental impacts and to gear it more strongly to the long-term safeguarding of ecosystem services and biological diversity. The EU must give significantly greater weight to the impacts of agriculture in its negotiations on the future form of the Common Agricultural Policy. To achieve this, national coordination mechanisms and the incorporation of national positions into the EU negotiations must be structured in a way that – ideally – equips agricultural and environmental interests with the same resources and skills, so that environmental and nature conservation issues can be represented with the same weight as agricultural ones. The nitrate report produced by BMUB and BMEL (2017) is at least an initial step in the right direction. Strategic cooperation is

FIGURE 31 ▸ Agriculture is the largest land user in Germany. (Photograph: André Künzelmann)

particularly called for in connection with the conservation and sustainable use of soil; here, too, the safeguarding of soil functions and ecosystem services is in the joint interest of both sectors. The aim of an enhanced agricultural policy should be to ensure that agriculture is truly sustainable in the long term. Agriculture of this sort generates social benefits from the provision of agricultural products while at the same time adhering to environmental and nature conservation objectives. If the natural basis of production is maintained in the long term and the limits on the environmental burden are observed, the image of agriculture within society will also be enhanced. To achieve this, it is particularly important to reduce the adverse impacts of intensive agriculture on regulatory ecosystem services (such as the conservation of soil fertility, prevention of soil erosion, conservation of insect populations for pollination), pollution of water bodies (prevention of substance inputs into groundwater and surface waters) and biological diversity. A sustainable, future-oriented system of agriculture has a range of other positive impacts on the environment, climate and nature (Naturkapital Deutschland – TEEB DE, 2014; 2015). However, the conditions under which agricultural enterprises operate must be shaped with this in mind (on this point see also Section 4.4). If the various social benefits of sustainable farming cannot be adequately secured through rules on good agricultural practice, and if the market revenue from sustainably produced products is not sufficient for this purpose, economic instruments such as taxes or rewards for special environmental performance should be used to strike a balance between business practice and social requirements. The system of agricultural subsidies must be fundamentally revised with this in mind (see also Infoboxes 4, 7 and 8).

Ecosystem-based climate policy as an integrating approach

The maintenance of natural capital is essential for climate protection and to mitigate the impacts of climate change. While the state of ecosystems is central to agricultural, forestry, marine and nature conservation policy, it has so far played no more than a minor role in national climate change mitigation and energy policy

German climate policy aims to reduce greenhouse gas emissions by 80–95 % by 2050. Individual instruments of climate change mitigation and energy policy may have adverse impacts on nature and ecosystem services, for example by promoting the cultivation of energy crops or selecting unfavourable locations for wind farms, hydropower plants and power line routes. The cultivation of energy crops bolsters existing trends towards intensification of agricultural production, conversion and more intensive use of grassland and draining of peatlands. This contributes to increased greenhouse gas emissions, reduced biodiversity and the loss of numerous ecosystem services.

By contrast, there is potential for synergies between the sustainable use of natural capital and climate change mitigation and adaptation. An **»ecosystem-based climate policy«** would open up opportunities for reducing greenhouse gas emissions and improving the ability of land-use systems to adapt to climate change while at the same time conserving and promoting biological diversity and the ecosystem services of natural areas.

In **agriculture** there are cost-effective opportunities for preventing greenhouse gas emissions, for example by using fertilisers more efficiently and preserving permanent grassland (see the case study on »Ploughing up grassland«) and producing biomass in ways that are less harmful to nature. The emphasis should be on using residues and waste materials, with conversion to energy occurring only at the end of a cascade. The use of materials arising from landscape maintenance, such as grass cuttings and hedge cuttings, for renewable energy generation could also be expanded.

In addition to **conserving existing peatlands**, an important climate change mitigation measure – and one that by comparison with other CO_2 prevention options is relatively inexpensive – is the **rewetting of peatlands used for farming**, followed by restoration or use that is in line with climate and nature conservation aims (see the case study on »Arable farming on peatlands«).

Sustainable forest management can combine timber production with climate change mitigation and conservation of nature and the environment. Forests in Germany are currently a carbon sink and under the Forest Strategy 2020 and the German government's Climate

Action Plan 2050 (BMELV, 2011; BMUB, 2016c) they should remain so (see also Infobox 4 on the Forest Climate Fund). However, opportunities for further increasing the positive climate effects of forests are limited and should not be considered separately from timber use. Because of the connections between forest carbon sinks, wood-product carbon sinks and substitution of products that damage the climate, there would seem to be little scope for further increasing the existing synergies between biodiversity conservation and climate change mitigation in forest management (WBAE and WBW, 2016). It is therefore all the more important to ensure that forests maintain both their sink function and their importance for biodiversity and the provision of other ecosystem services (recreation facilities, erosion control, water retention and filtering functions and their microclimatic cooling function in conurbations; see the case study of forests, and that they continue do so into the future (as more trees than at present reach the age at which they are ready for felling and as the demand for biomass continues to increase). Instead of expanding the use of (waste) forest timber for energy, we should in future do a lot more to promote cascading use, with the wood being burnt for energy at the end of the cascade (BMUB, 2016c).

The **conservation and restoration of near-natural floodplains** is an important area in which synergies can be achieved between biodiversity conservation and climate change mitigation (e.g. by rewetting carbon-rich floodplain soils) and adaptation to climate change (by capping flood peaks and reducing flood damage) (see also Infobox 4).

FIGURE 32 ▸ Forests are sinks of carbon dioxid and contributing to climate protection. (Photograph: André Künzelmann)

Water policy and nature conservation

Water policy provides numerous starting points for linking improvements in water quality, management of flood risks and improvements to water body structures with issues of nature conservation and biodiversity conservation.

As well as contributing to climate change mitigation and adaptation, **near-natural water bodies and floodplains are multi-functional ecosystems that provide other ecosystem services**, for example for recreation or removing nutrient pollution. The majority of former floodplains have been lost in recent centuries as a result of the straightening of watercourses and dike installation, intensive agricultural use and settlement development, or else their condition has become degraded. Many of the ecosystem services provided by floodplains have diminished as a result.

In view of the non-natural state of the majority of aquatic ecosystems in Germany, there is a major need for renaturation, if only in order to fulfil the statutory requirement to achieve good water status in accordance with the EU's Water Framework Directive. However, many uses and ecosystem services in water bodies and floodplains are in competition with each other. Renaturation therefore often results in conflicts between the interests of settlement development, agriculture, water management, nature conservation and recreation. Floodplains and water bodies must be viewed as an area for combined action in the policies of these sectors in order to ensure the balanced and sustainable use of all their ecosystem services (see also Infobox 4).

The contribution of urban nature to health, environmental justice and quality of life

Decision-makers those in the fields of urban development, health, social affairs and the environment should form alliances for the purpose of safeguarding natural capital in cities in order to improve living conditions and promote environmental justice.

Because of the spatial density and intensive use of urban areas, cities impose considerable burdens on health and the environment as a result of pollutants and noise and also because of insufficient movement. Urban nature yields numerous synergies relevant to health-related and social objectives (Naturkapital Deutschland – TEEB DE, 2016c). Of note in this connection are the effects on healthy development in children and young people who have access to places where they can experience nature (Stopka and Rank, 2013). Urban nature also has a range of **positive impacts on social cohesion**. It improves quality of life in urban neighbourhoods for all social groups (Naturkapital Deutschland – TEEB DE, 2016c). Providing adequate access to

urban nature, including for socioeconomically disadvantaged groups, also makes an important contribution to greater environmental justice in towns and cities.

When devising a strategy to promote the health and quality of life of city dwellers by utilising green infrastructure, it is therefore necessary to bring together different decision-makers on whose concerns urban nature has a bearing. This includes doctors, health insurance funds, welfare associations and health authorities. **Greater collaboration between the health sector and urban green planning** has particularly promising potential in terms of possible cost savings in health care. A good example is the master plan for the environment and health adopted by the state of North-Rhine/Westphalia in March 2016. It contains recommendations for action to improve environment-related health protection and emphasises the advantages of collaboration between the environmental and health sectors; one of the issues it refers to is the need to improve access to nature and gardening for children from socially disadvantaged families (MKULNV, 2016).

To ensure a healthy environment and the attractive provision of green spaces despite the growing demand for living space, plans and programmes relating to urban development and the financing of residential building projects should ensure adequate development and safeguarding of attractive green spaces that improve the quality of the residential environment (BMUB, 2015b; BfN, 2015b).

Improve cross-sectoral cooperation through funding schemes

Simply knowing about possible synergies between different sectors and areas of policy is often not enough. Joint funding programmes can stimulate cross-sectoral cooperation.

Programmes operated by a single government department appear to be of only limited use in promoting synergies between different ecosystem services and sectoral policy objectives (such as climate change mitigation, rural development, nature conservation). From the point of view of an individual sector, nature-based solutions are not the best option, whereas from the perspective of society as a whole and when contributions to various objectives are taken into account they may indeed be the best (see the case studies in Chapter 2 and the conclusions in Chapter 3). Cross-sectoral promotional instruments should therefore be created, with the promotion being organised in a way that encourages cooperation between different sectors. This enables synergies in the maintenance of natural capital to be realised and conflicts between different sectors to be reduced. The LEADER approach that has been established in connection with rural development provides promising examples of this. To be eligible for funding through LEADER, a project must involve the major stakeholders

FIGURE 33 ▸ Many floodplains were lost due to river modifications. (Photograph: André Künzelmann)

from agriculture and forestry, tourism, regional development, nature conservation and so on. In the same way, the provision of funds for green infrastructure and nature-based solutions with the potential to generate a number of natural services for the benefit of society could be linked to the involvement of relevant stakeholder groups, performance of a multi-functional impact assessment and the realisation of synergies through simultaneous achievement of several objectives (see Infobox 4).

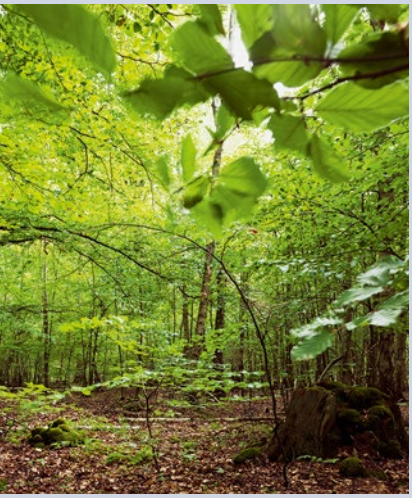


FIGURE 34 ▸ Forest mangement can deliver benefits for biodiversity conservation and climate protection. (Photograph: André Künzelmann)

INFOBOX 4

Examples of cross-sectoral funding of nature and ecosystem services

The **Federal Government Programme »Germany's Blue Belt«** (Bundesprogramm Blaues Band Deutschland), which was jointly developed by the Federal Transport Ministry and the Federal Environment Ministry, aims at funding the restoration of waterways and their associated floodplains along the almost 2,800 km of minor waterways in Germany that have become obsolete for cargo transport while at the same time establishing »ecological stepping stones« in the major waterways. The programme funds measures that combine flood prevention, waterway protection and nature conservation as well as water-based tourism, leisure sports and recreation (BMVI & BMUB, 2017) and endeavours to use for restoration measures those funds that are no longer required for investments into replacement transport infrastructure and other built structures. The Federal Government Programme may thus deliver an urgently needed impetus.

The **Forest Climate Fund** (Waldklimafond), which was established in 2013 under the joint aegis of the Federal Agriculture Ministry and the Federal Environment Ministry and which is funded from the Federal Government's Energy and Climate Fund, finances measures that contribute to climate change mitigation and increase forest adaptability to the impacts of climate change in Germany, with special consideration to synergies with biodiversity conservation (BMELV & BMU, 2013). Since 2013, the project-executing agency in charge of the fund, i. e. the Federal Office for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung, BLE) has authorised funding totalling approximately €58 million for 58 individual and collaborative projects consisting of more than 150 sub-projects (as of January 2018, see BMEL & BMU, 2018) implementing measures aimed at maintaining and raising the CO_2 reduction potential of forests and timber and at adapting forests to climate change. One of the key demands of »Natural Capital Germany – TEEB DE« is that the fund's appropriations be raised and long-term funding be secured (Naturkapital Deutschland – TEEB DE, 2014, p. 199).

Synergies between climate change mitigation, nature conservation and rural economic development could also be achieved by converting land-use on peatland soils to climate-friendly uses. Many carbon-rich soils were drained in the past and are now under arable land use. This has given rise to significant amounts of greenhouse gas emissions (see i.a. Naturkapital Deutschland – TEEB DE, 2014, Chapter 5). A rewetting of carbon-rich soils, which would be useful from the point of view of climate change mitigation, can be combined with the establishment of an adapted peat-conserving (or at least less damaging) form of land-use

(known as paludiculture), e. g. the cultivation of peat moss (Sphagnum) as a renewable resource. Well-designed paludiculture land use may also contribute to nature conservation (Gaudig and Krebs, 2016; Länder-AK Moorschutz, 2017; Wichmann et al., 2013). Agri-environmental programmes should be developed to include a stronger climate change mitigation component in this regard (analogous to contractual conservation management agreements). »Natural Capital Germany – TEEB DE« advocates the establishment of a **Peatland Climate Fund** analogous to the Forest Climate Fund which could support the climate-friendly and ecologically sound development of peatland sites.

The **National Biodiversity Strategy** (NBS, Nationale Strategie zur biologischen Vielfalt) is of particular significance for the national implementation of biodiversity objectives and the restoration of degraded ecosystems. The **Federal Biodiversity Programme** (Bundesprogramm Biologische Vielfalt), which was launched in 2011, supports the implementation of the National Biodiversity Strategy. Given the spectacular failings in some areas (see the second NBS implementation report, BMUB, 2017a), urgent improvements are needed in terms of funding. The Federal Environment Ministry's (BMUB) **Nature Conservation Initiative 2020** (Naturschutz-Offensive 2020) of October 2015 provides for a gradual increase in the annual funding volume from initially €15 million to €30 million by 2020. It is the view of »Natural Capital Germany – TEEB DE« that it would be logical to initially focus on sites offering high levels of synergies between a range of ecosystem services (e. g. climate change mitigation, nutrient retention, cultural services) and biodiversity protection, as restoration measures of this nature would deliver particularly high overall economic benefits.

In 2017, the Federal Environment Ministry as part of its **National Green Infrastructure Concept** (Bundeskonzept Grüne Infrastruktur, BMUB, 2017a) provided €50 million of funding to cities, towns and municipalities for measures designed to improve urban green infrastructure (BfN, 2017a). This funding can be used for the establishment, restoration and interlinking of publicly accessible green spaces and open spaces in the context of the constructional maintenance and development of urban quarters. Ecosystem services of urban nature support climate change mitigation and adaptation objectives and can make important contributions to the development, evaluation and prioritisation of measures required in urban areas. To this end, the **documentation of ecosystem services** (including those that go beyond climate aspects) **as a basis of climate change mitigation and adaptation strategies** should be mainstreamed, e. g. as part of the National Climate Initiative (Schröter-Schlaack et al., 2018).

The **baseline report on environmental justice in the Federal State of Berlin** (»Umweltgerechtigkeit im Land Berlin«, Senatsverwaltung für Stadtentwicklung und Umwelt Berlin & Amt für Statistik Berlin-Brandenburg, 2016) is the first analysis in the country to assess socio-spatial disparities of environmental burden. Core indicators include i.a. noise and air pollution, bioclimatic burdens (e.g. the formation of heat islands) and the accessibility of green spaces and open spaces. These indicators form the basis of a cross-sectoral integrated environmental monitoring. The analysis can at the same time be used as a basis for the prioritisation of urban development measures designed to improve environmental justice in Berlin, and can thus serve as an example to other metropoles.

4.3 VISIBLE AND IMPLEMENTATION-ORIENTED TARGETS

Targets provide guidance for affected stakeholders and legitimise public and private action to protect natural capital. However, the existing targets in international and national strategies often need to be made more concrete and more readily measurable. Priorities and responsibilities must be defined and linked with suitable measures at regional and local level.

Policy objectives in overarching strategies and programmes in various areas (climate and energy policy, sustainability targets, biodiversity strategies, etc.) are important in order to provide guidance and express the will of society. Targets should be formulated as clearly and concretely as possible, and achievement of them should be measurable (e.g. with the help of indicators). In addition, targets should be manageable (there should not be too many of them), and they should define priorities and be linked to actions.

Many **aims in connection with the transformation to a sustainable economic system** that include the conservation of nature and sustainable use of its services **are formulated only in vague and unclear terms**. Examples of this are the calls for a »bio-based economy«, a »green economy« or a »circular economy« or very general references to a »great transformation« or an »urban transformation«. In connection with biodiversity conservation the National Strategy on Biological Diversity (BMU, 2007) contains numerous targets, some of which, however, are **non-specific and virtually impossible to measure**: for example, the strategy calls for the decline in species and the degradation of habitats to be halted by 2010 and for the depletion of peat in regenerable lowland moors to be significantly reduced. Another, more concrete example at EU level is Target 2 of the European Biodiversity Strategy: »By 2020, ecosystems and their services are main-

tained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.« Here the maintenance target is at least accompanied by a quantitative value for improving the situation and the addition of a time frame. The problem lies in the absence of definitions – for example, there is no explanation of what constitutes a »degraded ecosystem« or of how things such as ecosystem services are to be measured.

More concrete targets are required in order to maintain the potential of nature to provide ecosystem services in the long term. In connection with the aim of sustainably reducing pressures on the environment, it is also necessary to introduce absolute restrictions. It is obvious that, in the long term, reducing land take for settlement and transport to 30 ha per day is not sufficient is to ensure that ecosystem services are permanently safeguarded. Ultimately zero net growth of settlement areas is required (see Infobox 6). Load limits for individual activities (such as CO_2 or nitrogen oxide emissions per kilometre driven) are not sustainable limits if the polluting activities (such as the number of motor vehicles and the annual distance driven) are expected to increase. There is now much discussion in scientific circles about the »rebound effect« (Madlener and Alcott, 2009; Maestre Andrés et al., 2012). Targets that permanently reduce the level of pollution must be defined as overall caps that cannot be exceeded, wherever possible with reference to the varying resilience of the specific object of protection. One approach to this involves defining critical carrying capacities for ecosystems with regard to the deposition of various substances (see Infobox 5 for an example). Such targets must be underpinned by ecological research, because the links between burdens on the environment and impacts on ecosystems and their services or on human health are by no means universally known.

Furthermore, when defining targets it is important to state who is responsible for implementing them. Adequate resources in terms of decision-making powers, economic resources and personnel – sufficient to ensure that the targets are actually achievable at the various policy levels – must also be provided. The **targets for the conservation of biological diversity, ecosystems and ecosystem services** that have been defined at international and national level **must be carried down to the level of the federal states and municipalities and underpinned with implementation instruments** (see the example of the 30 ha target in Infobox 6). For targets to be achieved effectively, it is essential to define who is to contribute to their achievement and what funds and instruments are available for the purpose.

INFOBOX 5

Critical loads – ecological carrying capacities for nitrogen deposition

Critical loads represent ecological carrying capacities, e. g. for nitrogen deposition, the exceedance of which may, according to current knowledge, in the long-term result in harmful changes in the structure and function of an ecosystem. Ecological carrying capacities are thus a measure of the sensitivity of an ecosystem and allow for a spatially differentiated appraisal of the level of substance deposition with reference to an ecosystem's resilience.

In 2009, the ecological carrying capacities for nitrogen were exceeded on approximately half of the sites hosting sensitive ecosystems (see Figure 35). Exceedances are particularly drastic in parts of north-western Germany were intensive livestock farming is practiced and where nitrogen deposition is particularly high as a result of local farming structures. Approximately two thirds of nitrogen deposition results from ammonia emissions. Long-term time-series data have shown that the proportion of land in Germany subject to exceedances of ecological carrying capacities declined from 82 % in 1980 to 54 % in 2010. This reduction in environmental burden is largely due to emissions reductions as a result of air quality control measures.

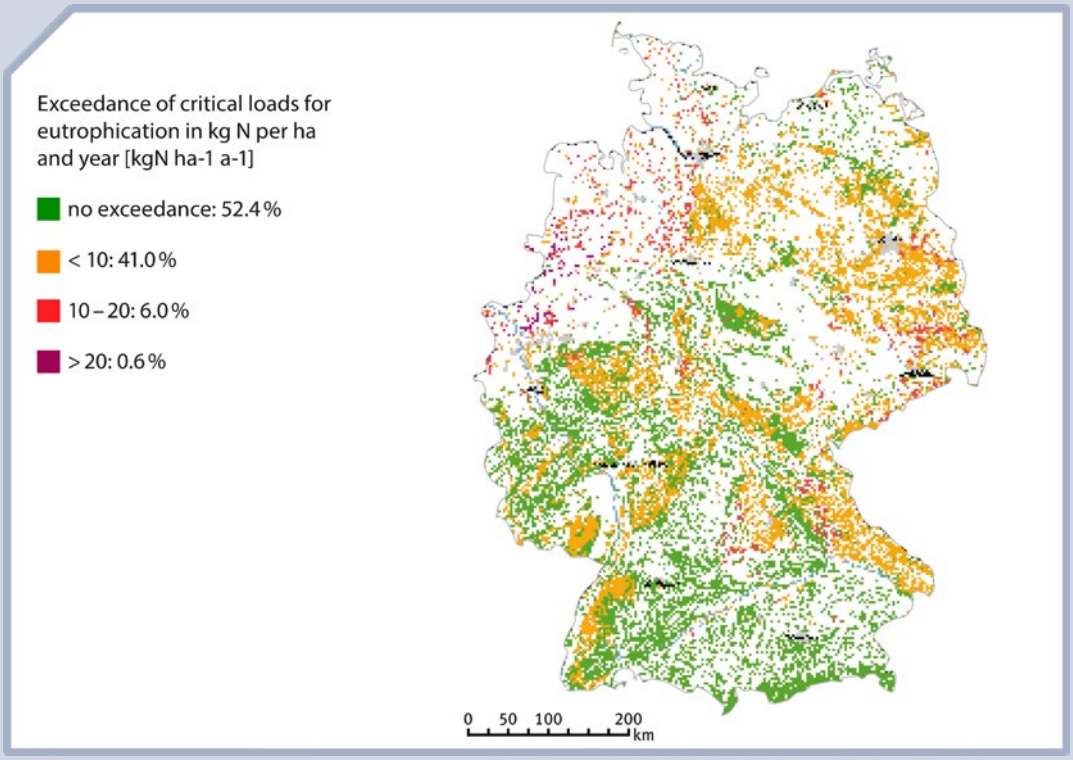


FIGURE 35 ▸ Critical load exceedances for eutrophication resulting from nitrogen deposition in 2009 (Source: Schaap et al., 2015, p. 74)

INFOBOX 6

Implementing the 30 ha target for reductions in land consumption

The goal to limit settlement expansion (»land consumption«) in Germany to 30 ha per day by 2020 has long been a component of the Federal Government's German Sustainable Development Strategy and has repeatedly been reaffirmed. However, the country is far from reaching this purely quantitative target. At the current level of 66 ha per day, land consumption for settlement and transport purposes is more than twice as high as the 2020 target. The new edition of the German Sustainable Development Strategy aims at staying below the target by 2030 (»30 minus X«) and the Federal Environment Ministry's (BMUB, 2016 a) integrated environmental programme aims at a 20 ha/day target (X = 10) by 2030. The Federal Government's Climate Action Plan 2050 is calling for zero net land consumption by 2050.

Many municipalities are still »seeking salvation« by designating land for settlements and commercial use in order to improve their economic development and population trends (in competition to neighbouring municipalities). Studies commissioned by the Federal Environment Agency (UBA) have shown that (taking into consideration the financial impacts on municipal budgets) such new designations often do not make fiscal sense, with costs exceeding the (overestimated) benefits of designating new building land in more than a third of the planned areas (Gutsche, 2017).

The missed targets are due in part to the Federal Government being hesitant in making full use of its legislative powers with a view to reducing greenfield developments by municipalities. It could lay down quantitative conditions, strengthen tools for inner development and offer financial incentives as part of support instruments.

Nationwide tradable statutory land-use specification rights are currently in a trial phase; this is an approach which promises to uphold the municipals« constitutionally guaranteed autonomy while achieving an effective quantitative limit to the growth in settlement area (see i. a. Bizer et al., 2011; Köck et al., 2018).

The federal states (Länder) however could also use their regional planning as well as well targeted funding and information tools in order to limit greenfield development and foster brownfield development as well as regionally coordinated inter-municipal cooperation.

4.4 STATUTORY STANDARDS AND ECONOMIC INCENTIVES

Statutory standards

For natural capital to be permanently safeguarded, agreed targets and measures must be effectively implemented. In many areas this entails a need for new or altered standards – in particular for land use – that are clear and binding for those to whom they apply and enforceable for the administration.

Binding regulatory standards (prohibitions and requirements) play a key part in the sustainable management of natural capital. They support implementation of **universal rules on land use to maintain existing ecosystems and ecosystem services** (on the use of standards to reduce nitrogen inputs see Infobox 7) by restricting what land users can do. They thus represent concrete targets that are carried down to individual users (see Section 4.3). In addition, standards define the boundary between the adaptation burden that must be borne individually and without compensation by the land user (e. g. ‚good agricultural practice«, see below) and action to protect natural capital that goes beyond the standard and should be remunerated by society. It is therefore important to define standards in order to be able to establish incentives – such as subsidies for ecosystem services – that allow flexibility and are geared to the realisation of efficiency gains.

However, a problem with the present structure of regulatory standards, especially in agriculture, is the fragmentation of the applicable law: the rules that must be observed are distributed between numerous laws and directive at different levels (EU, national, regional). A further problem is that the requirements are often formulated only in very general terms that are not readily enforceable (see e. g. Möckel et al., 2014). In addition, the coexistence of state aid standards and regulatory standards leads to misunderstandings, lack of legal clarity and acceptance issues.

Under German nature conservation law, agriculture, forestry and fisheries are only exempt from the provisions of this law (such as the requirement to prevent damage to the balance of nature or, if this is not possible, to compensate for it) if they meet the regulatory requirements of good professional practice (BNatSchG Section 14(2)). This rule results in significant uncertainties in enforcement if some of these requirements are not sufficiently defined. There is a need for considerable amendment and improvement in this regard (see e. g. Möckel et al., 2014; Schuler et al., 2014; Plachter et al., 2005; Winkel and Volz, 2003).

INFOBOX 7

Reducing diffuse nitrogen deposition by setting standards

Efforts to protect aquatic ecosystems (including groundwater) must focus not only on point source pollution such as wastewater treatment plants but also on reducing diffuse (non-point, area-related) deposition of pollutants in order to meet the objectives of the EU Water Framework Directive and avoid high treatment costs for current and future drinking water provision (see case study on nitrogen surpluses). The five year running average of nitrogen surpluses in Germany is just below 100 kg N/ha and thus still significantly exceeds the 70 kg N/ha target for the 2028 to 2032 period as set out by the Federal Government in its sustainability strategy (Bundesregierung, 2017). This makes Germany's farming sector the biggest source of reactive nitrogen entering the environment, being responsible for 57 % of the nitrogen deposited (Balzer & Schulz, 2015). In order to address this issue, a nitrogen strategy should be established that covers the entire nitrogen cycle and includes a bundle of different approaches and instruments to reduce nitrogen pollution. Among other measures, this would include more detailed specifications for fertiliser use in agriculture as well as tighter rules and stronger enforcement as provided for under the new Fertiliser Ordinance, the introduction of a levy on nitrogen surpluses, expanded agricultural extension services, and tighter planning and building regulations for new livestock housing in regions with high livestock concentrations (SRU, 2015; BMUB & BMEL, 2017). The establishment of minimum standards is an indispensable component of this mixed toolbox when it comes to setting minimum requirements for spatially diffuse environmental pollution and to defining a reference point for incentive measures such as the remuneration for environmental services going beyond a certain baseline.

FIGURE 36 ▸ High nitrogen levels in groundwater increase the cost of drinking water provision. (Photograph: André Künzelmann)

Economic incentives: taxes and rewards for environmental performance

Taking social standards for nutrient inputs and land use as a starting point, economic incentives can be introduced in the form of payments that either impose sanctions on the overuse of nature or remunerate the provision of ecosystem services that go beyond a legal standard.

Taxes are particularly appropriate if the required pollution reductions do not need to be identical everywhere. In this situation environmental levies can have a selective incentive function: emitters who can reduce their environmental impact at reasonable cost will cut their polluting activities, while others will continue to use nature as they

did before and will pay a correspondingly high price for doing so. The activity for which a levy is payable is usually defined in relatively general terms, partly in order to keep administration costs low.

The great advantage of a tax-based approach is that it sends out a price signal that **creates a general incentive for all land users to reduce environmental pollution to which each can respond according to their economic conditions. This enables pollution reduction to be achieved at relatively low cost.** Another advantage is that the tax generates revenue that can be used to fund special measures to further reduce pollution that go beyond the statutory minimum requirements. This may be appropriate if the pollution occurs in an area that is particularly sensitive environmentally and the pollution must therefore be reduced to a greater extent than elsewhere. For example, some of the compensatory funding for special requirements on agricultural use in water catchment areas mentioned in the case study of nitrogen surpluses (see Chapter 2) comes from the tax on water withdrawal that is levied in many federal states (Gawel et al., 2011).

Environmental levies are therefore particularly suitable when it is necessary to reduce environmental pollution cost-effectively across the board to an extent greater than that required by general environmental minimum standards and at the same time to generate public funds. The funds raised can be used to implement particular environmental requirements in special areas. Examples of environmental taxes that are currently being discussed are a tax on pesticides and one on nitrogen (Möckel et al., 2015; SRU, 2015); the use of such taxes to maintain natural capital should be considered.

Remunerating environmental performance is an option that is particularly worth considering if **performance in excess of a minimum standard** is required. Payments for ecosystem services can often be deployed with far greater precision than instruments such as minimum standards or environmental taxes. The above-mentioned payments by water suppliers for agricultural land use in drinking water catchment areas that minimises nitrate pollution are an example of this (see the case study of nitrogen surpluses; also Oelmann et al., 2017). The remuneration must be linked to criteria that are clearly defined and verifiable. From an economic perspective, boosting the results-oriented aspect of the remuneration process would seem to be a useful step forward (see e. g. Matzdorf, 2004; Hampicke, 2013; Russi et al., 2016).

In the field of biodiversity and ecosystem services it is frequently the case that pollution reduction standards vary from region to region and that some areas of land require special protection. The combination of universally applicable standards, environmental taxes that

FIGURE 37 ▸ Harvesting crops on a farm near Leipzig. (Photograph: André Künzelmann)

have an impact beyond these standards and remuneration for environmental performance in situations subject to special requirements is therefore a particularly suitable way of implementing the »polluter pays« principle in this area of environmental policy.

By contrast, existing subsidies are often harmful to the environment: they contribute to environmental pollution and the loss of natural capital and ecosystem services. The German Environment Agency regularly publishes summaries of environmentally damaging subsidies that clearly demonstrate this. They show that **environmentally damaging subsidies totalling 57 billion euros were paid out in Germany in 2012** (UBA, 2017). It is particularly alarming that for some of these subsidies it is doubtful whether the social objectives to which they are geared are even achievable, or – if they are achievable – whether there are not less environmentally damaging ways of bringing this about. It should not be forgotten that subsidies are paid for from public funds – in other words, by the general public. They should therefore only be awarded in accordance with the **principle of »public funds for public services«** – in other words, only when actual services in the interest of the public are being provided in return.

The most urgent issue here is the complete reorganisation of **agricultural subsidies**. This is called for, firstly, on account of the high volume of subsidies paid to agriculture from public funds (some 40 % of all EU subsidies) and, secondly, because of the major impact of such subsidies on biodiversity and on regulating, cultural and supporting ecosystem services (see Naturkapital Deutschland – TEEB DE, 2012), which are all too often lost or put at risk by the one-sided focus on provisioning services (see also Infobox 8).

FIGURE 38 ▸ Flowering fields provide habitats for pollinators. (Photograph: Anne Wessner)

INFOBOX 8

Reorientation of agricultural supports

From the beginning of European unification, the EU's Common Agricultural Policy (CAP) has been one of the most important European policy fields. Agricultural funding still accounts for approximately 40 % of the entire EU budget. The CAP plays an outstanding role as a potential steering instrument for the maintenance of natural capital, not least owing to its funding volume of approximately € 6.2 billion for the 2014-2020 period in Germany. Of this total amount, roughly € 4.85 billion per year are devoted to Pillar 1 (BMEL, 2015a) and approximately € 1.35 billion to Pillar 2 – the latter without national co-financing. Pillar 1 payments (»direct payments«) are income supports that are conditional upon compliance with relatively simple »cross-compliance« and »greening« conditions (BMEL, 2015b; BfN, 2017b). The majority of EU CAP Pillar 2 supports, i. e. payments made from the European Agricultural Fund for Rural Development (EAFRD), are provided in the context of specific programmes set up at national or state (Länder) level. Just under 30 % of CAP funding in Germany is Pillar 2 funding. Only a proportion of this funding is used for environmental measures including agri-environmental and climate (AEC) measures and an even smaller share makes a targeted contribution to biodiversity protection. According to preliminary results of a BfN project, a mere € 330 million per year of direct EAFRD funding (including national co-financing and top ups; BfN, 2017b) are specifically used for biodiversity conservation.

Given the still unsolved environmental problems caused by the farming sector (SRU, 2015; BfN, 2017b; Naturkapital Deutschland – TEEB DE, 2016a), these figures clearly show that environmental and conservation concerns are not given due regard in agricultural policy. The Common Agricultural Policy's Pillar 1 only weakly incentivises greater environmental protection, climate change mitigation and nature conservation – windfall effects dominate and the tenet of »public funding for public goods« is blatantly being violated. Moreover, given that current income supports for agricultural holdings are conditional upon rules relating to area-based payments, the objective to secure farm household incomes is only partially achieved (Pe'er et al., 2017).

»Natural Capital Germany – TEEB DE« takes the view that for the reasons outlined above there should be a fundamental reorientation of the CAP and calls for the following changes to be made as part of a reform of the EU agricultural policy:

- Income supports should in future be payable only if they constitute an effective and necessary instrument to prevent »ecological dumping« by world market competitors that apply significantly less stringent environmental standards. The displacement of domestic products by products from abroad the production of which resulted in greater environmental burdens would further bolster the trend toward Germany using and adversely impacting on the global natural capital, a trend that should be prevented.

- Therefore, a detailed assessment should be undertaken to determine the proportion of current direct payments that are justified with a view to meeting the objective of protecting the environment and natural capital worldwide. A simple comparison of additional costs incurred by domestic and foreign producers in order to meet different levels of environmental standards (see Karl and Noleppa, 2017) does not suffice. Instead, there should be an analysis of the actual impacts on competitive positions, incomes and commodity flows. Only in cases where different environmental standards actually result in reduced incomes or in the displacement of domestic products causing lesser environmental impacts would production-neutral income supports that are permissible under World Trade Organisation (WTO) rules be justified as a countermeasure, and only if it was impossible to fend of the competition in question by means of more targeted and more cost-effective measures.

- All other CAP payments that are not in line with the tenet of »public funds for public goods« should gradually be reduced over a defined period of time and should eventually be phased out. At the same time there should be a significant increase in Pillar 2 payments which in a targeted manner remunerate for reductions in environmental burdens and the maintenance of natural capital and ecosystem services. The efficiency of such measures could be increased by steering them towards sites requiring urgent action and by expanding results-oriented remuneration.

- A reorientation of this nature would free up funds for a support policy which would allow agricultural holdings to generate additional income by way of resource conservation, landscape management, and biodiversity maintenance (see i.a. Wissenschaftlicher Beirat für Agrarpolitik beim BMELV, 2010); moreover, in contrast to income derived from normal agricultural commodities, this type of income would be independent of fluctuating world market prices (Wissenschaftlicher Beirat für Biodiversität und genetische Ressourcen beim BMELV, 2008).

- Such a shift could be rendered economically more attractive to farmers if there was a move away from a purely compensatory approach (compensation for higher costs and lower yields). Experts have expressed the opinion that the WTO rules in this regard (WTO-Uruguay Round Agreement, Annex 2) could be interpreted much more flexibly than is currently the case, and could allow for payments based on environmental results or for additional services rendered in the context of contests or tenders (Hasund and Johansson, 2016).

In conclusion: Adherence to CAP payments that are primarily income supports is not justifiable in their current configuration. Future payments should be used to remunerate ecological services and other environmental aspects as well as for the structural development and adaptation of rural areas.

4.5 BUSINESSES: TAKING RESPONSIBILITY AND UTILISING OPPORTUNITIES

All businesses depend directly or indirectly on ecosystem services, although to varying extents. The sustainable use of ecosystem services is an increasingly important condition for businesses to thrive. Supporting the preservation of natural capital and minimising harmful influences – in one's own business, but also in the public arena – should therefore be an aspect of corporate responsibility.

Some companies are currently moving over to a more holistic method of performance assessment and reporting, for example in the form of integrated reporting of Key Performance Indicators as well as sustainability indicators or environmental profit and loss accounts (see also Section 4.1). Companies are increasingly recognising that performance must be redefined and that long-term corporate success is only possible if it is achieved in harmony with the available natural resources. The close interaction between businesses and natural capital is characterised by dependencies and influences and by both market opportunities and market risks.

With a world market share of 14 %, environmental technology »Made in Germany« is outstandingly well placed (BMUB, 2014). There are already almost two million people working in environmental conservation; it is predicted that in 2030 the German environmental technology sector will have a turnover of one billion euros (BMUB, 2016a). There are enormous development opportunities for companies in the development of production technologies that contribute to the sustainable use of nature and the maintenance of ecosystem services. In the short term, too, there is potential for synergies between the responsible use of natural capital and the corporate objectives of resource

efficiency, supply chain management and strategic investment and planning processes (Naturkapital Deutschland – TEEB DE, 2013).

In many areas of environmental protection there have in the past been successes that have been achieved partly through the adaptability and innovation of companies. Specifying the latest technology as the minimum standard for environmentally appropriate action and continuous further development of it through technical innovation has played a crucial part in a number of improvements including the control of smog, the introduction of lead-free petrol, efforts to reduce greenhouse gas emissions and improvements in water quality in lakes and rivers. The success of the combined impact of state regulation and corporate innovation can serve as a model for the maintenance of natural capital.

Corporate action means assuming responsibility, including in the global context. Using imported goods to replace domestic production has never been easier than it is now. Digitalisation, networking and legal harmonisation mean that concluding and implementing contracts across national borders is cheaper than ever. This brings with it the temptation to circumvent environmental standards that increase the cost of production in Europe by outsourcing production. As a result, it is possible for natural capital in Germany to be increasingly well protected while German consumption and German economic activities contribute to the loss of natural capital in other countries (see also Section 4.6). For ethical reasons this is unacceptable and may severely damage the reputation of the companies involved.

The most important impacts of corporate action on nature often arise at the start of the supply chain where the resources or agricultural and forestry products that go into the end product are produced. The intertwining of companies via intermediate products means that supply chain management geared to the careful use of nature can be very complex for individual companies. Drawing up standards for supply chain management – especially with regard to the consideration of biodiversity – is therefore an urgent task. Labelling and certification systems have an important part to play here.

Corporate commitment to nature conservation outside the company effectively complements responsible action in the company's core business, enabling the company's corporate image and its customer focus to be improved. Protecting natural capital requires investment and continuous maintenance that the state often cannot finance on its own. Support from private-sector companies therefore makes a valuable contribution to the realisation of socially rewarding projects for the long-term conservation of natural capital (Biodiversity in Good Company, 2016).

4.6 PRESERVING NATURAL CAPITAL IN AN INTERCONNECTED WORLD

Germany's ecological footprint is leading to the loss of natural capital in other countries too. Nothing is gained for sustainable development by »outsourcing« environmental pollution to other countries. Business and government should therefore work together to take steps to preserve the services of nature in a globalised economy – for example by developing criteria and certification schemes for products and in international trade.

Global environmental consequences of Germany's foreign trade

It is widely acknowledged that Germany uses more ecosystem services than nature in Germany can provide. The »ecological footprint« is an attempt to describe this relationship by calculating how much land each person uses. The latest figures in the Living Planet Report (WWF, 2016) show that resource consumption in Germany has not declined significantly in the last 15 years. Improvements in resource efficiency (e. g. through regulation, technical developments or growing consumer interest in sustainably produced products) have not yet reversed the trend in overall resource consumption. In 15 years during which Germany's population has remained more or less stable, the amount of living space has increased by just under 17 % (2000 – 2015; DESTATIS, 2016a, p. 11 – 13) – living space that needs to be built, heated, furnished and renovated. Furthermore, efficiency gains are often reduced or negated by direct or indirect rebound effects (Madlener and Alcott, 2011) if price reductions or life-style changes lead to increased consumption. For example, if cars had the same engine power in 2015 as they did in 2008, technical progress would have resulted in CO_2 emissions falling by 8.7 % despite increases in the number of vehicles and the distances driven. Instead, emissions have risen by 4.6 %, mainly on account of the increase in vehicles with more powerful engines (DESTATIS, 2016b). In January 2016 there were 20 % more SUVs on German roads than there had been just a year previously (KBA, 2016).

The action options described in Sections 4.1 – 4.5 can slow the loss of natural capital in Germany. But we also need to pay more attention to the environmental burden that Germany imposes on other countries. While the CO_2 balance of imports and exports is currently relatively balanced, a shift of emissions to other countries is to be expected in the medium term (Santarius, 2015).

There are few incentives for producers to make value creation less heavily dependent on environmental resources while there is cheap and easy access to resources in global production chains. Many countries have environmental regulations that are only weakly effective. In addition, there are very few binding rules in international trade

that require environmental resources to be used sustainably. The consequence is that considerable environmental costs in other countries are not priced into value chains. An individual producer who decides to use the environment and its resources sustainably – and hence in the short term more expensively – is significantly disadvantaged in the global competitive arena (BAKBASEL, 2014).

The interplay of different causes is complex. While it is generally acknowledged, for example, that the mining of bauxite and other minerals needed for high-tech-products causes major environmental damage in developing countries, there are many other products and value chains whose impacts on natural capital have not yet been explored.

There is therefore a risk that measures to improve the protection of natural capital in Germany that make domestic production more expensive will simply accelerate the shift of resource consumption from Germany to other countries. The recommendations for action that have been put forward in the past must therefore be extended to ensure that production and consumption in Germany also promotes the better conservation of natural capital elsewhere.

FIGURE 39 ▸ CO_2-emissions from road-bound traffic increased in recent years – despite ambitious climate protection targets.
(Photograph: André Künzelmann)

The international ties of German agriculture

The role of German agriculture will be outlined here as an example. Global food production is now theoretically sufficient to cover the world's need for food (TEEB, 2015). However, the pressure on agricultural land is increasing as a result of population growth and the rising demand for meat. About one-third of global cropland is used to grow animal feed (Steinfeld et al., 2006), which means that this land is no longer available to grow plant foods. Plant calories are converted into animal calories in a ratio of 2:1 – 7:1 (Shimokawa, 2015). Furthermore, around half of the agriculturally used land worldwide is degraded or at risk of degradation (TEEB, 2015). In addition, world trade in foodstuffs is increasingly subject to price fluctuations (FAO, 2015), which enhances the risks to food security in poorer countries. Increasing demand for food, competition for land between plant foods and animal feed production and a growing shortage of good farmland are problems of varying severity in different regions that nevertheless exacerbate the situation overall.

Germany's role in this situation is unclear. Meat consumption in Germany is falling slightly (DFV, 2016) but is still roughly twice the global average consumption figure of 43 kg per person per year (FAO, 2016). At the same time, meat production in Germany has risen by about 25 % in the last ten years to around 8.9 million tonnes per year (Davier and Efken, 2017, p. 3). This growth is driven by exports, which currently account for almost half of total meat production. Intensive land use is not the only consequence of the high level of meat production: economic structures in the importing countries can also be adversely affected via foreign trade. In 2014, meat and milk products worth two billion euros were exported to developing countries (BMEL, 2015c). The impacts on sectors such as poultry production in Africa were the subject of controversy in the press (e. g. DIE ZEIT, 2015). This suggests that the latest reform of the EU's agricultural policy (including the removal of export subsidies) does not do enough to prevent German trade in agricultural products unintentionally destabilising farming and food security in developing countries. However, models of the impacts of individual EU agricultural and trade policy instruments on farming in developing countries do not reach a clear conclusion (Boysen et al., 2016). A broader empirical basis is lacking.

That Germany is importing more and more animal feed and thereby influencing agricultural development in other countries is not disputed. The area of land in other countries that is used to produce feed for German livestock farming increased by 40 % between 2004 and 2014, reaching a figure of almost 2.7 million hectares. This is around 22 % of all the land needed for German production of products of animal origin (DESTATIS, 2016c, p. 9).

FIGURE 40 ▸ Increasing meat consumption drives land use intensity on agricultural land. (Photograph: André Künzelmann)

The importance of foreign natural capital for German agriculture is thus growing. The same trend is observable in water consumption: it is estimated that – via the consumption of imported goods – Germany now uses more foreign water resources in agriculture than domestic ones. For example, imported animal feed needs 48 % of the quantity of water required for the production of all the feed used in Germany, namely around 19 billion m3 (DESTATIS, 2012, p. 13). This only ceases to be a problem if this consumption does not exacerbate water scarcity elsewhere.

Conversely, German meat and cereal exports to water-poor countries such as the Arab nations can reduce the demand for water there (DBV, 2017). As far as we know, no audit has been performed of the various impacts of Germany's foreign trade in agricultural products on water scarcity in other countries.

Foreign currency revenue from agricultural exports can contribute to development and prosperity in the countries of origin, although only if the ecosystems there remain functional. The increasingly international ties of Germany agriculture are partly responsible for this.

Supporting the conservation of natural capital and ecosystems also promotes regional stability and helps to tackle the reasons for migration since this natural capital is – to an even greater extent than in Germany – the basis of people's livelihoods in the countries of origin.

Options for action to tackle the worldwide loss of natural capital

Although it may seem difficult for Germany to actively influence the preservation of natural capital in other countries, there are ways that work: import conditions, certification schemes and/or development cooperation. What is important above all is political will.

Germany's links with the world can be used to protect natural capital. Some options are outlined here:

Import conditions: The European Union is the world's biggest importer of food. The European Commission is mandated to negotiate import conditions with non-member countries. These negotiations are based on European food law, which already aims to ensure that food imports from non-EU countries meet the same standards as European products. These standards relate mainly to food safety but they are increasingly being extended to cover animal welfare issues, environmental aspects and sustainability objectives. This is in keeping with both the internationally agreed 2030 Agenda (UN, 2015) and the EU principle of the coherence of policy instruments in dealings with developing countries (EC, 2015).

Although the monitoring of production conditions (e. g. via obligations to provide supporting documentation) presents a major challenge to consistent application of the conditions, updating these import regulations is a particularly good way of promoting the spread of sustainable production methods and curbing the use of methods and production inputs that are particularly damaging to the environment. The protection of nature and ecosystem services should therefore be explicitly addressed in new trade agreements and existing agreements should be extended to cover these issues.

Production methods in various regions – unlike product characteristics – may have widely differing environmental impacts. Import conditions designed to protect natural capital in other countries should

FIGURE 41 ▸ Imported groceries leave a global footprint. (Photograph: André Künzelmann)

therefore be defined differently for each ecological region and should be appropriate to the specific region. To ensure that existing economic structures and both private and public investment in non-EU countries are not put at risk by this, long-term adjustment of trade policy and suitable transition periods are called for. This should be backed up by development cooperation measures or measures to promote foreign trade in the non-EU countries that are geared to these changes.

Certification schemes: Social and environmental certification is an attempt to encourage more sustainable production and resource use on a voluntary basis and at the same time to boost the demand for sustainable products. German policy on agriculture and consumer protection can strengthen or weaken these endeavours. Coordination processes to standardise different certification standards are particularly to be encouraged, because the competition between certification providers can soften their minimum standards and promote »greenwashing«. In addition, it is essential to support producers, especially during the changeover process, because they not only bear the entrepreneurial risk of the production changeover and the higher production costs that ensue – possibly permanently – but must also pay the certification costs, which are often substantial.

Ultimately it is also about continuing to educate consumers: environmentally certified products contribute to the goal of a sustainable economy. They are thus a response to the call for responsible consumption, especially in industrialised societies, about which there is broad scientific and political consensus.

Promoting more sustainable food consumption: Food plays a significant part in the consumption of natural resources in Germany. At the same time there are few countries in which food is as cheap as it is Germany when the relationship between purchasing power and food prices is taken into account. One reason for this is the concentration of trade; another is the lower rate of VAT on food, for which there are historical reasons.

From an economic point of view, low food prices are a contributory factor in food waste. It is estimated that avoidable food waste in German households amounts to 46–60 kg per person per year. In Germany as a whole, avoidable waste of meat, fish and milk products, the production of which is particularly resource-intensive, total more than 500,000 tonnes per year (Kranert et al., 2012, p. 117). Uneaten fresh produce from abroad (such as fruit imported by air) also represents considerable consumption of resources in the course of production, ripening in storage and transport, with no corresponding consumer benefit.

Reducing food waste requires a package of measures that operate via incentives, awareness-raising and price structuring. The National Sustainable Consumption Programme suggests a number of starting points and instruments (BMUB, 2016b, p. 13 f.). The programme is in line with the United Nations« efforts to speed up the shift towards more sustainable patterns of production and consumption (UN, 2017). The starting points and instruments will be mentioned here. From the point of view of »Natural Capital Germany – TEEB DE«, consumer education, product minimum standards and sustainable supply chains are key principles in enabling and encouraging more sustainable consumption.

Supply chain analysis: Outside food production and a few other sectors such as tourism, relatively little is known about the impacts of individual industrial and consumer goods on natural capital. In view of the global nature of production pathways and value chains, studying these impacts is admittedly a complex process. This means, however, that needs for action are hard to prioritise. Which production pathways have a relatively large footprint? What added value do they have over alternative production pathways? And what options are available for substituting for environmentally polluting production methods? Only with this knowledge can needs for action with substantial potential for improvement be identified and prioritised.

To this end, the analysis of international value chains (Bolwig et al., 2010; FAO, 2013) should be extended to include an ecosystem service perspective. Calculating all the environmental costs (»externalities«) is in many cases an extremely complex and laborious task. But considering natural capital along the value chain at all – i. e. measuring environmental impacts qualitatively and/or by means of quantitative approximations, as described, for example, in this report – would result in a significantly more robust knowledge base in situations in which regulation, voluntary commitments or other instruments are needed.

The interaction of economic promotion, development cooperation and international nature conservation: Germany engages with the world in a variety of ways and with various priorities. In some areas, such as the promotion of German solar technology in Asia and Africa, there is considerable overlap between the objectives of the promotion of foreign trade, nature conservation and development cooperation. Nevertheless, the opportunities for using a variety of promotional instruments to complement each other are far from exhausted. Consideration of natural capital can reveal the major potential in this field. This perspective also makes it possible to assess the interaction of different promotional instruments in a region and if necessary

improve coordination between them. For example, counterproductive programmes and unutilised synergies can be identified. In this context it is also important for Germany to exert its influence in order to encourage a coherent approach at EU level.

5 OUTLOOK

The Synthesis Report is the fourth and final report of the national TEEB study »Natural Capital Germany – TEEB DE«. As with the international TEEB study, this does not mean the end of the process of identifying and evaluating ecosystem services and integrating them into policy formulation and decision-making. The German follow-up study that has now been concluded, like the international TEEB study, describes the many facets of ecosystem services. This is done on the basis of individual examples for which comprehensive information is already available. To provide the most complete summary possible of ecosystem services in Germany and their integration into decision-making at political, administrative and economic levels, additional steps are needed.

The type, scope and value of ecosystem services depend on the specific nature of the ecosystems, the way in which they fit into the ecological system, their location within settlement structures and their relation to production sites. In many cases – such as in connection with pollination, the importance of small-scale structures in relation to erosion control and agricultural production, the valuation of health impacts and recreational services and issues relating to marine ecosystems – there seems to be a need for further basic research to enable the scope and value of services to be assessed with sufficient precision. In other areas, such as assessment of the impact of floodplains on flood control, extensive modelling is needed to enable the impacts to be estimated with sufficient certainty. To improve decision-making at the various levels, comprehensive data collection

and assessment at various administrative levels is needed, and practice-oriented data collection and assessment methods must be developed for concrete decisions locally.

Comprehensive collection of data on ecosystem services at national level is currently taking place within the EU as part of implementation of the European Biodiversity Strategy; the results are due to be available in 2019. As part of the same programme, a project was launched in Germany at the end of 2017 with the aim of also valuing some of these ecosystem services economically and including them in the environmental accounts. There are very few initiatives that aim to collect data on ecosystem services at federal state (Länder) or municipal level in Germany. Since 2013 BMU/BMUB has been encouraging a stronger emphasis on biodiversity and ecosystem services in corporate decision-making through the dialogue and action platform »Unternehmen Biologische Vielfalt 2020« (»Enterprise Biological Diversity 2020«). For 2018 BMU is planning a project that will provide the basis for preparation of a strategy for developing and testing practical methods of taking decisions on the ground. In the scientific sector a German network has been formed with the aim of stepping up national research and information-sharing between experts in the field of ecosystem services; this parallels the international Ecosystem Service Partnership initiative.

As in the international TEEB process, it is also necessary in Germany for the concluded German TEEB study to be followed up with further specific studies of implementation of the TEEB approach. The concluded study started out with the aim of analysing existing knowledge of ecosystem services by way of example. Future studies and initiatives could build on this in order to broaden and deepen this knowledge and develop it in practical and implementation-oriented ways.

GLOSSARY

BASIC SERVICES

Basic services (also known as supporting services) are a category of -> ecosystem services. They are the pre-requisite for the supply of all other ecosystem services, and comprise processes such as Photographsynthesis, nutrient cycles and soil formation.

BENEFITS (OF ECOSYSTEM SERVICES)

Arise from the direct or indirect use of -> ecosystem services by humans and / or have positive significance.

BIODIVERSITY

-> Biological diversity

BIOLOGICAL DIVERSITY

The diversity of life on earth (also known as biodiversity) means the variability among living organisms and the ecological complexes of which they are part. It comprises the following levels: 1) the diversity of ecosystems or biotic communities, habitats and landscapes, 2) the diversity of species, and 3) genetic diversity within the different species.

CAPTURING VALUES

Measures designed to ensure that decisions about the nature, scope and intensity of use of natural resources make allowance for the benefits of conserving -> biodiversity and delivering a socially balanced range of ecosystem services. This includes supplying the relevant information for deliberations by public and private decision-makers, such as a (financial) assessment of alternative uses, the definition and application of management conditions, or incentive mechanisms to control the behaviour of private decision-makers.

CULTURAL SERVICES

Cultural ecosystem services are a category of -> ecosystem services of benefit and significance for recreation, aesthetics, spiritual enrichment, ethical requirements, cultural identity, a sense of place, knowledge and cognition.

DISCOUNT RATE

An interest rate used to express the present value of future benefits and costs. For private financial investments, the discount rate is based on market interest rates. Public projects often use the so-called social discount rate (SDR) to calculate the estimated value to society of future uses. Future benefits and costs are usually only discounted if society's wealth will be greater, or at least remain the same, in future.

ECONOMIC PERSPECTIVE

The economic perspective considers nature and -> ecosystem services from a scarcity viewpoint. Handling scarce natural resources means considering the related costs and benefits. For the purposes of this report, the economic perspective comprises the following:

1) Being mindful of the scarcity of the diverse services nature provides for humans, and their associated individual and social value, 2) Highlighting the values of nature and ecosystem services to support decisions using various -> economic valuation techniques and 3) Investigating the framework for action by the relevant stakeholders, and tools and measures for handling -> natural capital more efficiently (-> capturing values).

ECONOMIC VALUATION

Estimating the -> value of a commodity or service in a specific context, often expressed in monetary terms. Economic valuations are based on the -> preferences of those affected (anthropocentric approach). Environmental economics has developed a range of techniques to ascertain changes in environmental quality, both directly (such as -> willingness to pay) and indirectly (for example, such as the prevention or travel costs spent). Economic valuations are often summarised into cost / benefit analyses.

ECOSYSTEM

The components of a distinct physiographic region (e.g. Lower Saxony Wadden Sea) or a specific type of physiographic region (e.g. nutrient-poor watercourses) and their interaction. The term can apply to various spatial levels (local, regional) and covers (near-)natural ecosystems (e.g. natural forest on the edge of the city), near-natural ecosystems (e.g. ancient meadows in parks) and anthropogenically shaped ecosystems (such as roads and railways).

ECOSYSTEM SERVICES

The direct and indirect contributions of -> ecosystems to -> human well-being, i.e. services and goods which directly or indirectly provide economic, material, health or psychological benefits. Distinct from the term »ecosystem function«, »ecosystem services« are an anthropocentric concept, focusing on the benefits that ecosystems provide for humans. Also known as »ecosystem goods and services«.

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental impact assessment (EIA) is the assessment of the environmental consequences (positive and negative) of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action. Environmental impact assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review.

ENVIRONMENTAL JUSTICE

The term »environmental justice« addresses the often uneven (unfair) distribution of environmental pressures (such as noise or air pollutants) between segments of society. A lack of environmental justice can also cause health inequality. Research therefore addresses the differing distribution of environmental pressures, together with its causes, as well as the social and health implications.

GREEN INFRASTRUCTURE

At EU level, defined as a strategically planned network of valuable natural and near-natural areas and other environmental elements which ensure vital -> ecosystem services and help to protect -> biodiversity. In cities, it comprises multiple types of adequate green spaces, unsealed -> open spaces and areas of water, irrespective of their use and origination or ownership situation. It significantly contributes to the quality of life and the services of general interest, and therefore is an important complement of -> grey infrastructure.

GREY INFRASTRUCTURE

Built, technical infrastructure in cities (such as roads, railways, canal systems), e. g. for provisioning and disposal, or for mobility. Generally interwoven with -> green infrastructure to a greater or lesser extent.

HUMAN SETTLEMENT & TRANSPORT INFRASTRUCTURE LAND

Land used for human settlements and the transport infrastructure comprises buildings and related -> open spaces, operating areas (excluding mines), recreational, transport and cemetery land. It cannot be equated with sealed land, because it also includes undeveloped and unsealed green and open spaces.

HUMAN WELL-BEING

This term was coined by the »Millennium Ecosystem Assessment«. It defines what constitutes »quality of life«, including basic material goods, health and physical well-being, good social relationships, security, peace of mind and spirituality, as well as freedom and choice.

INDICATOR

Measured variable. Its status or change allows conclusions to be drawn regarding the status of or changes in another variable that is impossible or too complex to measure (e. g. population changes in selected species as a measurement of changes in biodiversity in a given region).

MONETISATION

Converting values (benefits, costs, willingness to pay) into monetary amounts in an attempt to gauge the extent of certain services or damages. This type of monetary -> valuation often uses a range of techniques to calculate the aggregated willingness to pay of affected individuals.

NATURA 2000

Natura 2000 is the EU-wide network of protected areas (areas defined in the Birds Directive and the -> Habitats Directive), designed for the transboundary protection of endangered, wild, native species of fauna and flora in their natural habitats. In Germany, Natura 2000 areas account for 15.4 % of its land territory and 45.4 % of its marine territory.

NATURAL BALANCE

Comprises the abiotic (soil, water, air / climate) and biotic (organisms, habitats and communities) components of nature, and the interactions between them.

NATURAL CAPITAL

An economic metaphor for the (finite) natural resources, analogous to physical capital and human capital. It refers to the valuable but limited stocks of physical and biological resources on Earth and the limited ability of ecosystems to provide goods and services. Natural capital pays »dividends« in the form of -> ecosystem services. In the long term, ecosystem services will only be able to flow if natural capital is used sustainably, i.e. if the stock is retained or at least does not drop below critical levels.

POLLUTER PAYS PRINCIPLE

An environmental policy principle which states that the costs of environmentally relevant actions should be charged to the (technical) originator, e.g. by requiring compliance with minimum (technical or management) standards or levying charges on environmentally harmful materials or actions. The polluter pays principle may be applied, firstly, for reasons of fairness, where the originator is charged for the cost of avoidance or retrospective remediation, and secondly, for reasons of efficiency, because the originator is often best-placed to avoid or minimise behaviour which is harmful to nature or the environment. The polluter pays principle was established in Germany in 1976 under the German Government's environmental programme at that time. Its opposite is the burden-sharing principle, whereby the costs are borne by the general public (the tax-payers).

PREFERENCE

Giving preference to an alternative, or an individual's predilection for something. A preference expresses a subjective valuation of different options considering their expected supply of needs.

PROVISIONING SERVICES

Provisioning services are a category of -> ecosystem services, referring to their contribution to the production of goods and services for humans (such as food, fresh water, firewood and building materials) that are often traded on the market.

PUBLIC GOODS

Goods that are available for everyone to use (non-excludable) and which may be used simultaneously by different individuals because their use by any one party does not diminish its availability to others (non-rivalrous). Examples include national security, fresh air or open views.

REGULATING SERVICES

Regulating services are a category of -> ecosystem services and refer to the functions of -> ecosystems which regulate (other) ecosystem elements and processes and (directly) benefit humans, such as the filtering effect of soil strata on groundwater quality, or a hedge's contribution to minimising soil erosion.

RESTORATION

Measures to restore anthropogenically modified habitats to a more near-natural state.

REVITALISATION

Regarding waterbodies, »revitalisation« comprises all technical, structural and administrative measures of water remediation. Unlike total -> restoration, this primarily concerns restoring vital processes and functions (such as restoring the continuity of individual sections of waterbodies by removing transverse structures).

SYNERGY (SYNERGIES)

Interaction between mutually beneficial forces. This may produce a shared benefit for various goals, as when multiple societal objectives are attained simultaneously through balanced land use and the associated ecosystem services bundle. Synergies may also arise from promoting various -> ecosystem services, i.e. the delivery of one ecosystem service (e.g. landscape elements such as hedges providing protection against erosion) in turn encourages other ecosystem services (such as pollinating services, groundwater purification, landscape aesthetics). The opposite of a synergy is a -> trade-off, when conflicting objectives or the delivery of different ecosystem services are mutually opposed.

TEEB

The Economics of Ecosystems and Biodiversity. The international TEEB Study was initiated by Germany in 2007 during its presidency of the G8, together with the EU Commission, and carried out with the aid of numerous other institutions under the auspices of the United Nations Environment Programme (UNEP). The TEEB study aimed to assess the economic value of nature's services, determine the economic impacts of ecosystem degradation, and thereby elucidate the costs of inaction, together with the opportunities for action in order to incorporate the diverse values of nature into decision-making processes. Further information can be found on www.teebweb.org.

TEEB APPROACH

The TEEB approach to -> capture the value of -> ecosystem services comprises the following steps: (1) Recognise the value, (2) Demonstrate the value, and (3) Incorporate the -> value of ecosystem services into decision-making. Step (1) is shaped by socialisation and the cultural characteristics of a society. Step (2) is a conscious process that uses suitable approaches and methods to elucidate value. Step (3) aims to create tools and measures to ensure that aspects of nature and associated services are incorporated into private and public decisions, i.e. valorised.

TRADE-OFF(S)

Reciprocal relationships, e.g. relating to the supply of different -> ecosystem services, which are mutually opposed: If one improves, the other deteriorates. There are often trade-offs between the desire to maximise provisioning services (such as the production of food, wood or energy) and other ecosystem services (e.g. regulating services such as water pollution control, or cultural services, such as landscape aesthetics) or the conservation of biological diversity.

Trade-offs between different target dimensions must always be re-evaluated in each specific case. The opposite of a trade-off is -> synergy, which is mutually beneficial.

URBAN HEAT ISLAND

Due to high levels of sealing and other factors, it is normally hotter in the city than in the surrounding area. This effect is known as an »urban heat island«. Over the year, the average air temperature in the city is around 2 °C higher than in surrounding areas. In individual cases, especially during summer nights, the temperature difference between the city and its environs can be as much as 10 °C.

URBAN NATURE

All natural elements occurring in urban areas, including their functional relationships (-> ecosystems). It covers remnants of original natural and cultural landscapes, as well as designed gardens and natural elements that emerge from deep site changes, such as urbanindustrial -> wastelands. The collectivity of vegetation elements in an urban context is often referred to as »urban green«, whilst »urban nature« tends to be used for near-natural elements.

VALUATION

Procedure for determining the -> value of goods or action alternatives, derived from the purpose or occasion of the evaluation. The -> TEEB approach concerns the valuation of nature's services for humans (-> ecosystem services). Valuations are always contextdependent, and every valuation depends on complex framework conditions: ecological, social and cultural circumstances, the -> preferences of individuals, the opinions of society, wealth levels, the economic situation etc. Depending on the context and objectives, various different qualitative and quantitative techniques may be used to value ecosystem services, including valuation in monetary units (-> monetisation).

VALUE

Expresses the importance of a material or immaterial object to an individual or a community. There are several interpretations. One is to equate »value« with price (as the equivalent of a tradable object), which may be expressed in money or other currencies. »Natural Capital Germany – TEEB DE« follows an alternative interpretation of the term in its broader sense, in the meaning of the validity, importance or significance of an object, person, circumstance etc.

WILLINGNESS TO PAY

Monetary amount a person is willing to pay for the supply of goods, including public goods, which are not generally traded via markets and therefore do not have a market price (e.g. action programmes to protect endangered species).

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CONTRIBUTORS TO »NATURAL CAPITAL GERMANY – TEEB DE«

The Value of Nature for Economy and Society – An introduction

Authors
Sabrina Daube, Adrienne Grêt-Regamey, Bernd Hansjürgens, Thomas Köllner, Sonja Macke, Stefan Marzelli, Christoph Moning, Monika Offenberger, Patrick Poppenborg, Sven-Erik Rabe, Irene Ring, Christoph Schröter-Schlaack, Burkhard Schweppe-Kraft

The Business Perspective – Being prepared for new challenges

Authors
Katharina Dietrich, Thomas Kretzschmar, Matthias Retter, Barbara Wieler

Natural Capital and Climate Policy – Synergies and conflicts

Editors of the scientific report
Volkmar Hartje, Henry Wüstemann, Aletta Bonn

Coordinating authors of the scientific report
Christine Bertram, Aletta Bonn, Alexandra Dehnhardt, Ralf Döring, Ulrike Doyle, Peter Elsasser, Bernd Hansjürgens, Dietmar Mehl, Bernhard Osterburg, Katrin Rehdanz, Irene Ring, Mathias Scholz, Katrin Vohland, Henry Wüstemann

Authors of the scientific report
Augustin Berghöfer, Matthias Bösch, Miriam Brenck, Benjamin Burkhard, John Couwenberg, Matthias Drösler, Nils Droste, Johannes Förster, Lisa Freudenberger, Elmar Fuchs, Carolin Galler, Michael Glemnitz, Karsten Grunewald, Christina von Haaren, Ulrich Hampicke, Volkmar Hartje, Jacobus Hofstede, Pierre L. Ibisch, Kurt Jax, Rita Jensen, Jochen Kantelhardt, Timo Kaphengst, Christian Klassert, Reinhard Klenke, Stefan Klotz, Thomas Koellner, Astrid Kowatsch, Stefan Kreft, Ingolf Kühn, Georg Leefken, Bettina Leischner, Horst Liebersbach, Vera Luthardt, Elisabeth Marquard, Stefan Marzelli, Bettina Matzdorf, Insa Meinke, Jürgen Meyerhoff, Bernhard Möhring, Carina Miriam Müller, Karin Naumann, Thorsten Permien, Till Pistorius, Marcus Reckermann, Michaela Reutter, Joachim Rock, Norbert Röder, Sebastian Rüter, Stefan Rüter, Wiebke Saathof, Julia Sauermann, Lena Schaller, Uwe Schröder, Burkhard Schweppe-Kraft, Ralf Seppelt, Franziska Tanneberger, Daniela Thrän, Michael Trepel, Sabine Wichmann, Georg Winkel, Felix Witing

Reviewers
Olaf Christen, Matthias Dieter, Thomas Ehlert, Klaus Glenk, Felix Grützmacher, Ulrich Hampicke, Stefan Heiland, Eckhard Heuer, Thomas Hickler, Karin Holm-Müller, Eduard Interwies, Rainer Kant, Stephan von Keitz, Stefan Mann, Günter Mitlacher, Klaus Müller, Georg Rast, Achim Schäfer, Christian Schleyer, Ernst-Detlef Schulze, Karsten Schwanke, Klement Tockner, Christine Wenzel

Authors of the Summary for decision-makers
Christine Bertram, Aletta Bonn, Alexandra Dehnhardt, Ralf Döring, Ulrike Doyle, Peter Elsasser, Bernd Hansjürgens, Volkmar Hartje, Dietmar Mehl, Bernhard Osterburg, Katrin Rehdanz, Irene Ring, Mathias Scholz, Katrin Vohland, Henry Wüstemann

Ecosystem Services in Rural Areas – Basis for human well-being and sustainable economic development

Editors of the scientific report
Christina von Haaren, Christian Albert

Coordinating authors of the scientific report
Alexandra Dehnhardt, Ralf Döring, Peter Elsasser, Christina von Haaren, Heike Kawaletz, Stephan von Keitz, Bernd Klauer, Johann Köppel, Nele Lienhoop, Bettina Matzdorf, Stefan Schaltegger, Mathias Scholz, Christoph Schröter-Schlaack, Marianna Siegmund-Schultze, Peter Weingarten, Hubert Wiggering

Authors of the scientific report
Christian Albert, Ingrid Albert, Daija Angeli, Andreas Anlauf, Johannes Bachinge, Jan Barkman, Olaf Bastian, Gert Berger, Christine Bertram, Uwe Beständig, Claudia Bieling, Barbara Birzle-Harde, Ralf Bloc, Kristin Bormann, Matthias Bösch, Renate Bürger-Arndt, Benjamin Burkhard, Jutta Deffner, Detlef Deumlich, Martin Drechsler, Mariele Evers, Christian Fische, Jan Freese, Bernd Freie, Elmar Fuchs, Roger Funk, Carolin Galler, Michael Gerisch, Michael Glemnitz, Frank Gottwald, Karsten Grunewald, Wolfgang Günther, Peter Haase, Wolfgang Haber, Bernd Hansjürgens, Helmut Horn, Andreas Jäger, Eckhard Jedicke, Hubert Job, Karin Johst, Andreas Kannen, Christian Kersebaum, Sebastian Krätzig, Stefan Kühne, Franziska Lichter, Martin Lorenz, Melanie Mewes, Jürgen Meyerhoff, Wilfried Mirschel, Stefan Möckel, Christoph Moning, Anja Müller, Felix Müller, Klaus Müller, Roland Olschewski, Holger Pfeffer, Tobias Plieninger, Aranaka Podhora, Heinrich Reck, Moritz Reckling, Katrin Rehdanz, Jessica Reiser, Michaela Reutter, Anne Röd, Christoph Saure, Stefan Schaltegger, Christian Schleyer, Thomas Schmidt, Carolin Schmidt-Wygasch, Uwe Schröder, Bettina Schröppel, Almut Siewert, Ulrich Stachow, Jörg Steidl, Karin Stein-Bachinger, Astrid Sturm, Franziska Tanneberger, Michael Trepel, Frank Wätzold, Frank Wagener, Priska Weller, Wolfgang Wende, Sabine Wichmann, Manuel Woltering, Matthäus Wuczkowski

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Authors of the Summary for decision-makers
Christian Albert, Ingrid Albert, Christina von Haaren, Bernd Hansjürgens, Sebastian Krätzig, Christoph Schröter-Schlaack

Ecosystem Services in the City – Protecting health and enhancing quality of life

Editors of the scientific report
Ingo Kowarik, Robert Bartz, Miriam Brenck

Coordinating authors of the scientific report
Miriam Brenck, Thomas Claßen, Wilfried Endlicher, Frauke Fischer, Bernd Hansjürgens, Stefan Heiland, Claudia Hornberg, Sonja Knapp, Ingo Kowarik, Christa Müller, Stefan Norra, Ina Säumel, Dieter Scherer, Heinrich Schneider, Michael W. Strohbach, Henry Wüstemann

Authors of the scientific report
Robert Bartz, Uta Berghöfer, Reinhard Beyer, Wanda Born, Heike Brückner, Wolfgang Burghardt, Björn Büter, Kristina Dietrich, Thomas Draheim, Stefan Emeis, Kerstin Fröhle, Erik Gawel, Oliver Gebhardt, Dagmar Haase, Volkmar Hartje, Nicole Heinz, Christian Heller, Tobias Herbst, Mathias Hofmann, Corinna Hölzer, Jasmin Honold, Michael Jäcker-Cüppers, Nathalie Jenner, Nadja Kabisch, Andreas Keil, Peter Keil, Christian Klingenfuß, Jens Kolbe, Wilhelm Kuttler, Marcel Langner, Boris Lehmann, Reto Locher, Frank Lohrberg, Christian von Malottki, Juliane Mathey, Elke van der Meer, Diana Möller, Nicole Pfoser, Katharina Raupach, Natalie Riedel, Konrad Reidl, Irene Ring, Dieter Rink, Stefanie Rößler, Hans-Joachim Schemel, Christoph Schneider, Christoph Schröter-Schlaack, Michael Schwarze-Rodrian, Martin Sondermann, Robert Spreter, Knut Sturm, Christian Timm, Manfred Tschöpe, Martin Vaché, Alexandra Weiß, Wolfgang Wende, Peter Werner, Gerd Wessolek, Tobias Wirsing, Silke Wissel, Lutz Wittich

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Martina Artmann, Jan Barkmann, Nicole Bauer, Katrin Bohn, Margit Bonacker, Carolin Boßmeyer, Björn Bünger, Claudia Castell-Exner, Sonja Deppisch, Fabian Dosch, Martina Eick, Ulrich Franck, Marco Fritz, Peter Gaffert, Sonja Gärtner, Rüdiger Grote, Rieke Hansen, Till Hopf, Stefan Hörmann, Dirk Hürter, Hartmut Kenneweg, Stefan Klotz, Stefan Körner, Christian Löwe, Armin Lude, Astrid Matthey, Stephan Pauleit, Michaela Pritzer, Matthias Rothe, Jana Rückert-John, Gudrun Schütze, Elisabeth Schwaiger, Karsten Schwanke, Nina Schwarz, Bettina Schwarzl, Irmi Seidl, Gabriele Sonderegger, Henrik von Wehrden, Ulrike Weiland, Rüdiger Wittig, Angelika Zahrnt, Karin Zaunberger, Markus Ziegeler

Authors of the Summary for decision-makers
Robert Bartz, Miriam Brenck, Bernd Hansjürgens, Ingo Kowarik

The Value of Nature for Economy and Society. A Synthesis of Natural Capital Germany – TEEB DE

Authors
Augustin Berghöfer, Bernd Hansjürgens, Christoph Schröter-Schlaack, Heidi Wittmer,
with assistance from Urs Moesenfechtel

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