ECOSYSTEM SERVICES IN RURAL AREAS

BASIS FOR HUMAN WELLBEING AND SUSTAINABLE ECONOMIC DEVELOPMENT

Summary for decision-makers

NATURKAPITAL
DEUTSCHLAND – TEEB DE

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View of the village of Eslohe in North Rhine-Westphalia, 13 May 2015. Eslohe in the Upper Sauerland region is surrounded by fields, hills and forests. It is a government-recognised climatic health resort. (Photograph: Hans Blossey, euroluftbild.de)

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CONTENTS

NATURAL CAPITAL GERMANY – TEEB DE: OVERALL PROJECT AND POSITIONING OF THIS REPORT

Natural Capital Germany – TEEB DE« is Germany's follow-up study to the international TEEB study (The Economics of Ecosystems and Biodiversity) which examines the relations between nature's services, economic value, and human wellbeing. By adopting an economic perspective, »Natural Capital Germany – TEEB DE« aims to identify nature's services, and to elucidate both synergies and conflicts in the use of ecosystem services and the conservation of biodiversity. The services provided by nature should be incorporated more effectively into private and public decision-making, so that the natural foundations of life are permanently protected. The project therefore draws on approaches and instruments existing in Germany and elsewhere in the world. Finally, the project supports the fulfilment of environmental, sustainability, and nature conservation objectives and strategies, particularly the German National Strategy on Biological Diversity.

The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Federal Agency for Nature Conservation (BfN) are funding this project, to which numerous authors and experts have contributed. The study is led by Prof. Dr. Bernd Hansjürgens of the Helmholtz Centre for Environmental Research – UFZ.

»Natural Capital Germany – TEEB DE« centres around four thematic reports written by teams of experts from the academic world and from the field. These four main reports draw on the available studies, concepts and case studies of the services provided for humans by Germany's ecosystems, focusing on:

1) Natural Capital and Climate Policy – Synergies and Conflicts

2) Ecosystem Services in Rural Areas – Basis for Human Wellbeing and Sustainable Economic Development

3) Ecosystem Services in the City – Protecting Health and Enhancing Quality of Life

4) Natural Capital Germany – A Synthesis

The first report on »Natural Capital and Climate Policy« was published in 2015; the principal results are outlined in a summary report for decision-makers. An introductory brochure and a brochure for companies have also been published.

- The Value of Nature for Economy and Society – An Introduction
- The Business Perspective – Being Prepared for New Challenges

»Natural Capital Germany – TEEB DE« is supported by a Project Advisory Board, with high-level members from academia, business, society and the media. An associated Stakeholder Committee has also been tasked with informing, interlinking and involving social interest groups in this project, including representatives from environmental and trade associations, government departments, Federal Länder and public stakeholders.

This summary report outlines some of the key findings from the second TEEB DE report on the importance of ecosystem services in rural areas (Natural Capital Germany TEEB DE, 2016). The comprehensive academic report was coordinated by Prof. Dr. Christina von Haaren, Institute of Environmental Planning (Landscape Planning and Nature Conservation Division) at Leibniz University Hanover. All authors and reviewers of the academic report are listed on page 105 below.

Both publications seek to raise awareness of the relations between the multiple services provided by nature and human wellbeing, recognising the services and demonstrating the values of nature in rural areas, and suggest ways of capturing ecosystem services values in private and public decision-making. By providing information and raising awareness an economic imperative is elaborated that can help permanently protect natural capital in Germany's rural areas, and in turn safeguard human wellbeing, sustainable economic development, and social wealth.

FOREWORD AND ACKNOWLEDGEMENTS

Many of us associate rural areas with proximity to nature or the landscape of our childhood. Rural areas are also seen as the antithesis of overcrowded, fast-paced urban spaces. In reality, however, the demarcations between town and country are often far more fluid. Today, rural areas are major residential and industrial locations, centres for recreation and tourism, the providers of multiple services such as clean drinking water, flood control and carbon storage, and last but not least, producers of a reliable supply of food, raw materials and energy. In short, they are extremely diverse: from their naturalistic features, to their economic power, to economic and demographic development trends.

Rural areas are currently headline news: On the one hand, population levels in some areas of Germany are shrinking due to demographic development, and the trend is likely to continue for the foreseeable future, particularly in remote areas. On the other, land use in rural areas continues unchecked: for settlement and transport purposes, for agricultural and forestry use in order to produce food, feed and energy crops, for (local) recreation and tourism, and last but not least, for nature conservation. As agricultural land becomes scarcer and productivity demands escalate, agricultural structures and cultivation methods are changing, and intensive use is on the increase. As soils and natural resources are more intensively used, they become more polluted.

These trends are transforming rural areas into engines of production and progress, but at a cost. If we allow the aforementioned side effects to continue, gains in productivity will be offset by losses in productive capacity, such as the loss of a diverse landscapes and small farms, and of near-natural areas, which provide a retreat for fauna and flora species. Ultimately, we will also be harming ourselves, and losing vital services that Mother Nature provides to us, such as clean air, soil and water, the regulation of water outflow, soil fertility, and pollination services by insects. These ecosystems will then need to be restored or replaced with high-tech alternatives at great expense, as is the case, for example, when water becomes polluted with nutrients and contaminants. What is more, we are losing valuable spaces for recreation and nature-based leisure activities. Ultimately, therefore, this affects the very foundations of human wellbeing and economic development in rural areas. Such processes often occur insidiously without us even noticing; the cumulative effect of many such small changes can significantly transform the overall picture.

We want this publication to draw the reader's attention to these issues. The ecosystem services concept aims to elucidate the multi-

faceted nature of these services in rural areas. As well as supplying the population with food, fuel and energy, they also provide a diverse range of regulating and cultural services often not recognised in decision-making. By adopting an economic perspective, the natural capital project aims to raise awareness of how important these particular services are for society, and determine whether this is adequately reflected in the existing regulatory framework for nature and its diverse services. This report is therefore primarily concerned with identifying and documenting the full range of ecosystem services, and ensuring that they are given appropriate consideration in decisions over land use.

This summary report draws on selected findings from the comprehensive academic report »Ecosystem services in rural areas – Basis for human wellbeing and sustainable economic development« (Natural Capital Germany – TEEB DE, 2016). Furthermore, the report on »Natural Capital and Climate Policy – Synergies and Conflicts« has already outlined synergies between nature conservation and climate protection and adaptation, such as the restoration of peatland soils and the renaturation of floodplains.

More than 130 individuals from academia, politics, administration and society contributed to the academic report, both as authors and as reviewers, and we would like to take this opportunity to thank them. We would particularly like to thank the coordinating authors of each chapter. All authors and reviewers of the academic report are listed at the end of this summary report.

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The views expressed in this brochure reflect the opinions of its authors only, and should in no way be interpreted as the official stance of the organisations involved.

Hanover and Leipzig, January 2016

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KEY MESSAGES

Ecosystems and their services – Recognising our natural capital in rural areas

- Decisions regarding the use of ecosystems tend to systematically underestimate both the economic importance of ecosystem services and their relevance to human wellbeing. By adopting an economic perspective, this report on Germany's natural capital aims to elucidate the multiple benefits of the protection, sustainable use and restoration of biodiversity and ecosystems, and the cost of losing them. This approach helps to uncover underlying (misplaced) incentives and decision-making deficits, and to develop solutions for the long-term protection of natural capital in rural areas.

- Rural areas are pivotal to human wellbeing and economic development: as providers of food, wood, water, raw materials and energy; as places of recreation; for protecting our climate; and for conserving biological diversity. Ecosystems in rural areas can help to mitigate environmental pressures and natural threats. Nature is often fundamental in this regard: we must preserve our natural capital if we are to continue using these services in future.

- Both synergies and conflicts may arise from the use of ecosystem services. In many areas, focusing on provisioning services only has led to a loss of small-scale farms and diverse landscapes, a diminishing range of species, and reductions in other ecosystem services. Using soil to produce food, raw materials and energy, however, could be organised in a way that promotes soil fertility and enhances landscape diversity, while at the same time ensuring a balanced water regime and conserving groundwater and surface waters. The challenge is to use ecosystem services in a way that meets society's diversity of requirements and objectives, while simultaneously maintaining natural capital in the long term.

Natural capital is a worthwhile investment

- **Grassland is multi-talented.** Grassland supports the supply of numerous ecosystem services, such as climate protection, water protection and protection from erosion. High Nature Value (HNV) grassland is also vital for conserving biodiversity. On the other side of the coin, ploughing up grassland entails significant costs for society, estimated at between 440 and 3,000 Euro per hectare and year. From society's perspective, therefore, it is indispensable to conserve our grassland (particularly HNV grassland).

- **Using land in harmony with water protection: Cost-effective solutions for the nitrogen problem.** Excessive nitrogen emissions impair human health and damage the environment. More than 50 % of reactive nitrogen compounds in Germany enter the environment as a result of intensive agriculture. In many drinking water catchment areas, land use has been optimised to protect water resources, proving that avoiding nutrient emissions at the source, i. e. at the farmers' level, is many times more cost-effective than treating raw water afterwards for use as drinking water. What is more, ecological land use practices provide additional benefits in terms of conserving surface waters, rivers, and the sea, preserving biodiversity, and protecting the climate. For example, a study by TU Berlin found that current nature conservation measures to minimise the impacts of nutrients in floodplains, peatlands and agricultural landscapes save around 230 million Euro each year. The study further estimates that farther-reaching nature conservation measures based on the German national biodiversity strategy targets would save a further 150 million Euro per year by reducing polluting nutrients alone.

- **Small areas – big impacts.** Structural elements such as hedges and extensively used or unused field margins and riverbank buffer zones are valuable elements of the cultural landscape, which support species conservation and provide a wide range of ecosystem services which benefit both farmers and society. Leaving even a small area unused can produce huge benefits: Wind protection hedges can boost yield by up to 50 % in the lee of the hedge, which may be 15 to 25 times its height. Few people realise that Germany's fertile soil is being lost at a faster rate than it is naturally created. Small structures and soil-friendly, sustainable agricultural practices can help to reverse this trend. A study in Lower Saxony revealed that the economic benefits of riverbank buffer zones for protecting surface waters, marine ecosystems and biodiversity are at least 1.8 times their investment costs. The challenge is to share the cost of preserving and creating such elements effectively and equitably between farmers/landowners and society.

- **Cultural ecosystem services – essential for a sense of place, recreation and tourism.** Nature is more than just a provider of raw materials and resources. Cultural ecosystem services cover a wealth of services that contribute to regional identity, a sense of place, aesthetics and inspiration, as well as being a key location factor for economic development.

More than 94 % of the German population »completely« or »mainly« agrees with the statement that nature is part of a good life, and plays an essential role in both health and happiness. It is therefore worth investing in the diversity, beauty and uniqueness of the landscape and culturally important landscape elements. The benefits for the region extend well beyond its own boundaries; people in urban regions and cities also reap the rewards.

- **»National natural landscapes« (national parks, biosphere reserves, nature parks) are significant economic factors for the region.** These large nature reserves are designed to safeguard Germany's most valued ecological sites. Alongside their crucial role in biodiversity conservation, they also provide ecosystem services such as climate regulation and groundwater protection. At the same time, their high importance for recreation and tourism helps to create value for the region. For example, tourism in the Bavarian Forest National Park generates an estimated real net output of 13.5 million Euro per year for the region, more than the revenues lost as a result of restricting forestry use.

Managing natural capital in rural areas more effectively

- **Providing information, encouraging communication, increasing acceptance**. The ecosystem services concept can help raise awareness of nature's value, beyond its important role in conserving species and habitats, while at the same time communicating environmental and nature conservation objectives. This is important in making the importance of nature known to a broader audience of decision-makers and the public. It also improves the foundations for decision-making in regional planning and licensing processes, and decisions on land use.

- **Halt the loss of nature by addressing its drivers and achieving set targets.** We cannot conserve natural capital unless we put a halt to the destruction of nature throughout Germany, and place at-risk areas under special protection. To this end, we must meet our target of limiting land used for human settlements and the transport infrastructure to 30 hectares per day, take action to reduce the nitrogen surplus, and ensure that grassland is permanently preserved.

- **Link farming subsidies more closely to societal benefits.** Direct payments under the first pillar of the EU Common Agricultural Policy are to be phased out in the medium term. In its current form, the linking

of certain direct payments to ecological services, including the designation of ecological priority areas, has only very limited benefits for conservation. Public payments to private sectors should be confined to additional public services, except during transitional periods when a degree of cushioning is needed. Consistently rechannelling subsidies to effectively and efficiently reward ecological services under the second pillar of EU Common Agricultural Policy would mobilise significant potential among farmers to conserve ecosystem services and natural capital.

- **Push for policy integration.** The ecosystem services approach and an economic analysis of the social benefits of integrative, nature-based solutions (e. g. for climate, flood, water protection, air pollution control and protection against erosion, as well as recreation and regional economic development) play a pivotal role in appreciating nature's importance as the basis of human well-being and economic development. However, merely highlighting the macroeconomic pros and cons of such solutions is not enough: What we need are mechanisms for policy integration, joint administrative action, and integrated support across sectoral boundaries to pave the way for the effective protection and restoration of natural capital in rural areas. Institutional changes (e. g. in funding policy) which encourage integrative, cross-sectoral viewpoints and solutions are pivotal for ensuring that biodiversity and ecosystem services in rural areas are adequately protected, developed and considered in decision-making.

1 A CENTRAL CHALLENGE IN RURAL AREAS: MANAGING NATURAL CAPITAL

1.1 NATURAL CAPITAL IN RURAL AREAS: CONFLICTS IN THE USE OF THE MANIFOLD ECOSYSTEM SERVICES

Around 90 % of Germany's natural territory could be described as rural. Around 44 million people, just over half of Germany's population, live in such areas (BMEL, 2014a). Rural areas are often seen as the counterpart to cities and conurbations; their differentiating features include population density, economic activities, the importance of agriculture and forestry, and their naturalistic features (BMVBS and BBSR, 2009). For the purposes of this study, a precise delimitation of rural areas is both unnecessary and difficult, as the boundaries between urban and rural are becoming increasingly blurred. Instead, selected structural, quantitative and qualitative differences compared with urban regions will suffice: Rural areas may be characterised by a comparatively low population density, a settlement structure based on villages and small towns, and a disproportionately high share of farmed open landscapes and forests, lakes and rivers (see Box 1).

This reflects public opinion. People appreciate rural regions for their lower living costs, attractive landscape, high quality of life, varied leisure opportunities and experience of nature (BMEL, 2014a). 83 % primarily associate recreation and leisure with »rural areas« (ibid). City-dwellers often spend their leisure time in rural areas, either as short-term visitors or as holiday guests who stay a little longer. What sets rural areas apart in particular are their relative proximity to nature, and the many and varied services they provide for humans, known as -> Ecosystem Services (see Box 2).

BOX 1

Facts and figures on Germany's rural areas

How we distinguish rural areas from urban areas depends on which yardsticks we use; the transitions tend to be fluid. Population density and human settlement structure are often used as delimiting criteria. The semantics of referring to »rural areas« rather than THE rural area are also important. Individual rural areas within Germany differ significantly – for example, the Lake Constance area is completely different from Mecklenburg-West Pomerania. Key characteristics of rural areas include the following:

FIGURE 1 ▸ Traffic route causing landscape fragmentation. (Photograph: Manfred Antranias Zimmer, pixabay.com)

- Rural areas account for a large proportion of Germany's national territory; more than half of the German population (44 million people) lives in rural areas (BMEL, 2014a). Some 23 million people – around 60 % of the working population – work in rural areas (BMVBS and BBSR, 2009).

- On average, human settlements and the transport infrastructure account for around 9 % of total land in rural regions, compared with 16 % in urban areas, based on data from the Federal and Länder Statistical Offices, 2010). Land use for human settlements and the transport infrastructure currently totals 73 ha per day for Germany as a whole (sliding four-year average for the years 2010 to 2013). Land use for human settlements and the transport infrastructure is growing fastest in rural parts of the old Länder: just under 3.5 %, compared with just under 2 % in the conurbations of the new Länder (BBSR, 2014; StBA, 2015a).

- Agricultural and forestry land accounts for 85 % of the total territory of rural areas, and therefore characterises many regions. In some rural areas, agriculture and forestry are important economic sectors and contribute up to 15 % of real net output (BMEL, 2015a). Overall, however, agriculture, forestry and fishing in Germany's rural areas contribute less than 1 % to average gross national output, and with a workforce of just under 250,000 employees less than 1 % of the working population subject to social insurance contributions (StBA, 2015b).

- Rural areas provide nature and recreation. In certain districts of Germany, recreational land accounts for up to 15 % of the total area (BMEL, 2014a). In many rural areas, therefore, recreation and tourism play a significant role, both economically and culturally.

- This is also true of Germany's 16 national parks. They only cover around 0.6 % of Germany's total territory (BfN, 2015a), but visitor numbers in these regions exceed the 50 million mark each year. Gross turnover in these areas is just over 2.7 billion Euro. Some 85,000 jobs in the tourism sector are dependent on Germany's national parks alone (figures exclude the two areas in the Black Forest and Hunsrück-Hochwald; cf. Metzler et al., 2016).

BOX 2

Nature and human wellbeing – The ecosystem services concept

With its living and non-living elements, nature is a capital asset – our -> Natural Capital – and a source of many and varied services, so-called »ecosystem services« that benefit humans. The definition of ecosystem services as used in the Millennium Ecosystem Assessment (MA, 2005) distinguishes between -> Provisioning Services (e. g. production of food, wood, energy raw materials), -> Regulating Services (e. g. water or climate regulation), -> Cultural Services (e. g. recreation, education, nature's spiritual values) and supporting services (-> Basic Services e. g. photosynthesis) (Naturkapital Deutschland, 2012). A region, or a section of landscape, generally provides a whole bundle of services, to varying degrees.

The concept is a useful system for identifying the diverse services provided by nature and the interactions between them, and raising awareness of the fact that man and his wellbeing are dependent on these services. The core message is that nature offers numerous benefits to humans by contributing to their health and wellbeing, and often facilitates or promotes economic development. Human intervention is usually needed, firstly in order to use the benefits, and secondly, to ensure their permanent availability. This anthropocentric-instrumental perspective is just one of the arguments in favour of nature conservation (cf. Eser et al., 2011; Naturkapital Deutschland, 2012).

In particular, the global -> TEEB study »The Economics of Ecosystems and -> Biodiversity« highlighted the economic significance of these correlations (see TEEB, 2010).

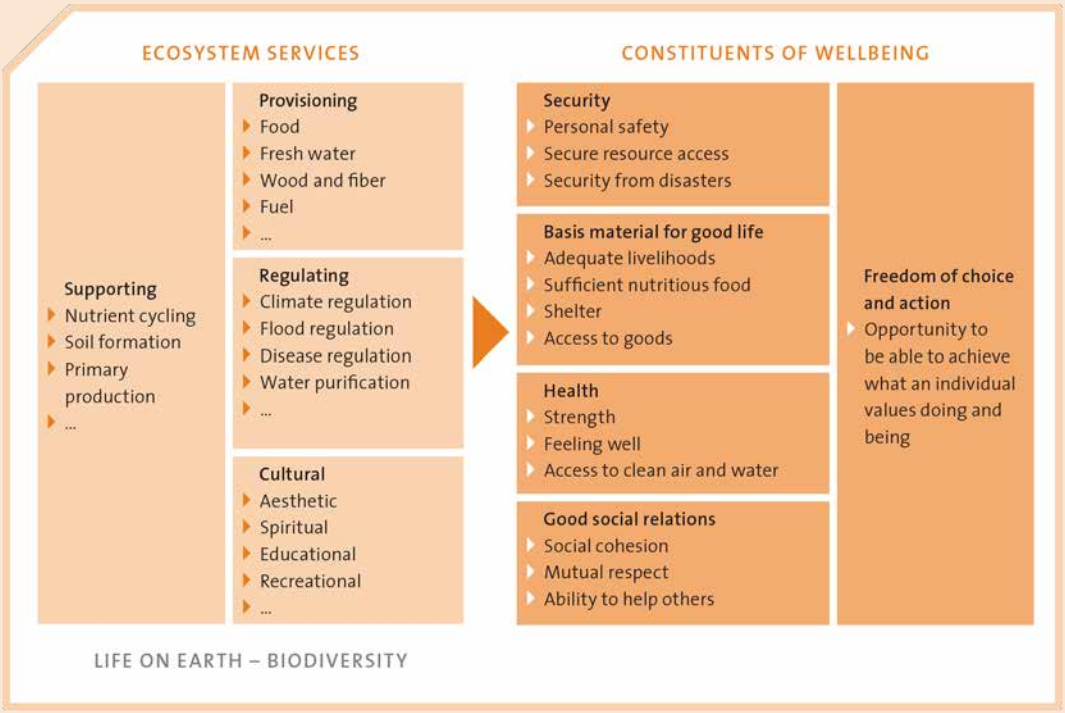


FIGURE 2 ▸ Correlations between ecosystem services and human wellbeing.
(Source: modified according to MA, 2005)

This national TEEB report on Germany focuses on a selected bundle of ecosystem services in rural areas. Selection was based, firstly, on a desire to highlight less obvious ecosystem services which have tended to be ignored in market decision-making; and secondly, on the range of information and data resources available, because many ecosystem services lack adequate information. The ecosystem services considered are:

- Provisioning services, e. g. food, timber, animal feed
- Regulating services such as nutrient retention, erosion control, pest control, pollination, climate protection, and climate regulation (e. g. with regard to flooding, drought and heat)
- Cultural services such as recreation and education.

The ecosystem services in rural areas not only benefit those who live there or who visit them at weekends or on holiday; they also perform vital functions on behalf of towns and conurbations. Most of our food and raw materials are supplied by rural areas, which also regulate the balance of water and elements and help protect the climate. They also protect against extreme events such as flooding or heat.

Our efforts to preserve – or if possible, enhance – the attractiveness of rural areas for -> Human Wellbeing and their contribution to sustainable economic development must therefore consider the ecosystem services provided by nature in such areas. Rather than adopting a one-sided perspective, it is a matter of appreciating the diverse tasks performed by rural areas: As places to live and work, as places for the production of food, raw materials and energy, but also as places of recreation, leisure and for experiencing nature, as well as -> Biological Diversity. In the long term, rural areas can only continue to perform these tasks if measures are taken to preserve natural capital (natural resources) and its ability to provide a range of ecosystem services (especially the regulating and cultural services currently disregarded by markets and programs) (BMEL, 2014a). Just like material or human resources, natural capital is to be used sustainably if it is to pay dividends in the form of ecosystem services.

Germany faces some major challenges here, with natural capital shrinking due to the growth in land used for human settlements and the transport structure, and also because the intensification of land use threatens the multifunctionality of rural areas and the diversity of their ecosystem services. Escalating, and often competing, demands on nature and the way land is used in rural areas are the main culprit (see Box 3): On the one hand, Mother Nature must continue to supply food and (increasingly) energy; yet on the other, in many regions, a single-minded focus on provisioning services often means that land is used in an extent and intensity which limits the range of regulating, cultural and supporting ecosystem services. In the long term, this may well compromise human wellbeing and economic development in rural areas. The framework conditions and incentives associated with intensification must therefore be reviewed from a macro -> Economic Perspective and adjusted where necessary, in order to preserve natural capital and the long-term performance of rural areas.

BOX 3

Land use in rural regions – Facts and problems

- Of the 16.7 million ha (approximate) of agricultural land in Germany, just under 70 % (approx. 11.8 million ha) is cultivated (BMEL, 2014b). Of this, more than 2.1 million ha, or more than one-sixth, is used to grow bioenergy crops such as corn and rapeseed (FNR, 2014).
- There is growing competition between the production of food and animal feed and the supply of renewable raw materials, as well as between used and unused land, e. g. between land intended for development, »near-natural« grassland (so-called high nature value grassland), and agricultural land.
- Around 30 % (approx. 4.6 million ha) of Germany's agricultural land is grassland. Between 2003 and 2012, overall, the proportion of grassland decreased by around 5 % (BfN, 2014). The annual average is more than the area of the city of Frankfurt am Main (approx. 25,000 ha) (BBSR, 2014), although rates vary considerably between regions.
- 90% of the rivers and lakes in Germany fall short of the good ecological status which the EU Water Framework Directive requires them to have met by 2015 (BMU and UBA, 2013). Rural areas are affected by this, not only because they are home to rivers and lakes, but also because their emissions (especially surplus nutrients from fertilisation and agrotoxins such as herbicides and insecticides) and structural measures (e. g. river straightening) are among the key causes.
- Soils store huge amounts of climate gases: Worldwide, the soil has more than four times the storage capacity of forest vegetation (IPCC, 2000), and in Germany too, soil plays a vital role in climate protection, particularly in conjunction with agricultural use (see Naturkapital Deutschland, 2015).
- Intact, peat-accumulating peatlands in Germany have been reduced to 1 % of their original (post-Ice Age) size (Joosten, 2012). Although they only account for around 6 % of agricultural land, drained peat soils account for around 37 % of greenhouse gas emissions from agriculture (including animal husbandry), or just under 43 million tonnes (Joosten et al., 2015; Naturkapital Deutschland, 2015; UBA, 2014). In other words, peat soils are responsible for 54 % of CO_2 emissions from agricultural soils and 37 % of total CO_2 emissions from farming. In Mecklenburg-West Pomerania, for example, peat soils account for more greenhouse gas emissions than transport and industrial activity put together (LUMV, 2009).

FIGURE 3 ▸ Biogas plant near Leipzig. (Photograph: Urs Moesenfechtel, UFZ)

FIGURE 4 ▸ Cotton grass in Raakmoor nature reserve near Hamburg. (Photograph: Gaby Stein, pixabay.com)

These challenges are most pronounced in agricultural land use: As more and more land is used for human settlements and the transport infrastructure, coupled with the persistent demand for cheap produce and Germany's realigned energy policy, farmland in Germany (and worldwide) is coming under growing pressure. In conjunction with direct payments from the European Agricultural Guarantee Fund (EAGF), land lease prices have risen, which in turn increases the exploitative pressure on land. Farming practices have intensified; although this means more provisioning services, other near-natural land is being lost, with adverse impacts on biological diversity (for details of the correlations between biodiversity and ecosystem services, see Box 4) and at the expense of regulating, cultural and supporting ecosystem services.

BOX 4

On the correlations between biological diversity and ecosystem services

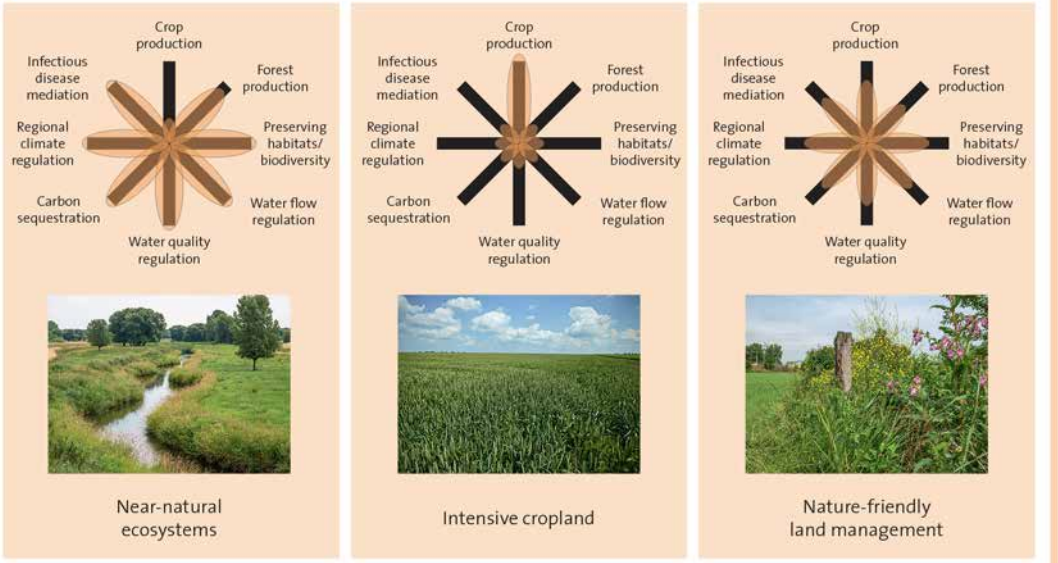
Reciprocal dependencies, both -> Synergies and -> Trade-Offs, exist between biological diversity and ecosystem services, as well as between individual ecosystem services (cf. for example Elmqvist et al., 2010; Mace et al., 2012). Many aspects of the correlations between biodiversity and ecosystem services remain unknown and are currently being researched.

The so-called Jena Experiment (www.the-jena-experiment.de) was set up to analyse the consequences of the loss of biological diversity from a scientific perspective, and has discovered that as biodiversity decreases – simulated in this experiment by manipulating the range of flora species on grassland – a wide range of processes change (Allan et al., 2013): The diversity of other organism groups is reduced (Scherber et al., 2010), and biomass production and feedstuff quality deteriorate (Marquard et al., 2009; Roscher et al., 2005). Even under intensive management, the number of species positively affects biomass production (Weigelt et al., 2009). The soil also has more capacity to store carbon in species-rich grassland (Lange et al., 2015). Similarly, the recharge rate and quality of groundwater is higher in species- and structurally rich grassland, thanks to the increased porosity and infiltration rate (Fischer et al., 2014), and the leaching of nitrogen is reduced (Scherer-Lorenzen et al., 2003).

FIGURE 5 ▸ Lumber storage near Bad Düben.
(Photograph: André Künzelmann, UFZ)

The ecosystem services approach is particularly well-suited to illustrate these conflicts of use. It demonstrates that ecosystem use tends to be multifunctional, in other words, ecosystems perform multiple functions simultaneously, which benefit humans in the form of ecosystem services either directly (e.g. in the form of provisioning services such as food, energy or raw material plants, and cultural services such as recreation and tourism) or indirectly (e.g. via regulating services such as water and nutrient cycles). As such, ecosystem services always occur in bundles. Synergistic relationships exist in some cases, i.e. the supply of one ecosystem service (e.g. the forest supplies wood as a provisioning service) simultaneously promotes other ecosystem services (e.g. carbon fixation in the wood helps protect the climate; summer heat is ameliorated by a local cooling effect; soil erosion and the risk of landslides on sloping ground is prevented). In other cases, however, there are conflicts of use: If the supply of one ecosystem service is encouraged by land use (e.g. cultivation of a monoculture on a field), other ecosystem services (such as the land's retention function or the landscape picture) and biological diversity may be adversely influenced; these effects are known as trade-offs.

Our aim must be to increase the potential to supply various ecosystem services, assess the whole bundle of ecosystem services, and ultimately, optimise the combination of services depending on the situation. This requires an integrated approach based on the principle of differentiated land use, which is capable both of promoting multifunctionality and of prioritising particularly valuable, sought-after or endangered functions. At the same time, side-effects on other services must be minimised. In other words, we need to identify and minimise the economic trade-offs between the different services in land use (see Figure 6 for a conceptualisation of trade-offs in land use).



Explanation: Near-natural ecosystems tend to provide minimal services in terms of supplying the population with food or raw materials (left-hand picture). By contrast, intensive land management significantly increases the productivity of marketable provisioning services in particular (middle picture). However, these productivity gains are often achieved at the expense of other socially relevant ecosystem services. As such, nature-friendly land management which gives greater consideration to non-provisioning services may lead to reduced yields, but it also increases the supply of other ecosystem services (right-hand picture).

FIGURE 6 ▸ Synergies and trade-offs in the supply of ecosystem services for selected forms of management.
(Source: Own compilation according to Foley, 2005: 576. Photographs: André Künzelmann, UFZ)

A global meta-analysis by Howe et al. (2014) showed that trade-offs are particularly prominent when provisioning services play a key role and/or when producing standard market goods. However, the trade-offs and options for minimisation can only be assessed on a case-by-case basis in relation to the individual landscape section or area.

Some of these adverse consequential effects for nature and the environment are widely evident in Germany:

- The indicator for species diversity and landscape quality in the German National Sustainability Strategy and National Strategy on Biological Diversity suggests that biodiversity has fallen from 100 in 1990 to 63 in 2011, its lowest level since records began (BMUB, 2015a). Two-thirds of all species in Germany are now classified as endangered. Among habitat types, the figure is almost 75 % (Riecken et al., 2006).

- In many parts of Germany, pollution levels in watercourses and groundwater with nutrients, particularly nitrate, remain persistently

FIGURE 7 ▸ Riparian forest northwest of Leipzig. (Photograph: André Künzelmann, UFZ)

high, and have led to the initiation of violation proceedings by the European Commission against Germany for failing to implement the EU Water Framework Directive. These pressures on water quality not only affect inland waters, but also the North and Baltic Seas (BMU/BMELV, 2012).

One of the conclusions that we can draw from these trade-offs between provisioning and other ecosystem services is that society should have a vested interest in weighing up the pros and cons of land use and management alternatives across all relevant ecosystem services. Ultimately, the aim must be to preserve our natural capital as the basis for human wellbeing and sustainable economic development.

1.2 THE ECONOMIC PERSPECTIVE: OBJECTIVES AND APPROACH

This is where the economic perspective comes into play, by considering the diverse ecosystem services as comprehensively as possible, and improving the information basis for decision-making. One particular strength of the economic approach is its ability to identify synergies and trade-offs, and find ways of dealing with conflicts of interest to create win/win situations. Where expediently possible and helpful, alternative options can also be valued in monetary terms and used to devise efficient solutions. The economic perspective is an important part of general wellbeing for society as a whole, and also reveals how individuals and population groups are affected by certain measures. However, it is important to remember that the economic approach is not a cure-all and is liable to mis-interpretation (see Box 5 and Box 6).

BOX 5

Ecosystem services and the economic perspective

The concept of ecosystem services was first used in a publication by Ehrlich and Ehrlich (1981) (for details, see Daily, 1997; de Groot, 2002; MA, 2005; Ring et al., 2015; TEEB, 2010). It also serves as a bridge concept for translating human appreciation of nature and its services into economic terms (Costanza et al., 1997; Gomez-Baggethun et al., 2009). From an economic perspective, it views nature in a similar way to physical capital and human resources, as a form of capital (»natural capital«) from which certain services (»ecosystem services«) originate. Nature must be conserved in order to permanently safeguard the flow of ecosystem services, and in areas where its existence also depends on use, it must be utilised in a way which allows it to permanently provide these services.

There are four aspects of the ecosystem services concept and its economic approach to nature which are often overlooked or misinterpreted. They are highlighted here because this report is characterised by a **broad-based interpretation of economic value**:

- Firstly, the ecosystem services concept should not be equated with economic valuation. Identifying and demonstrating the services provided by nature is a separate step, and such services are classified e. g. into provisioning services, regulating services, cultural services and supporting services (see Figure 2). An economic valuation comparing the benefits and costs of a modified provision of ecosystem services may build on this as a subsequent step, but is by no means compulsory. Depending on the purpose of the assessment, nature's services may also be identified and demonstrated by other measurement variables and indicators.

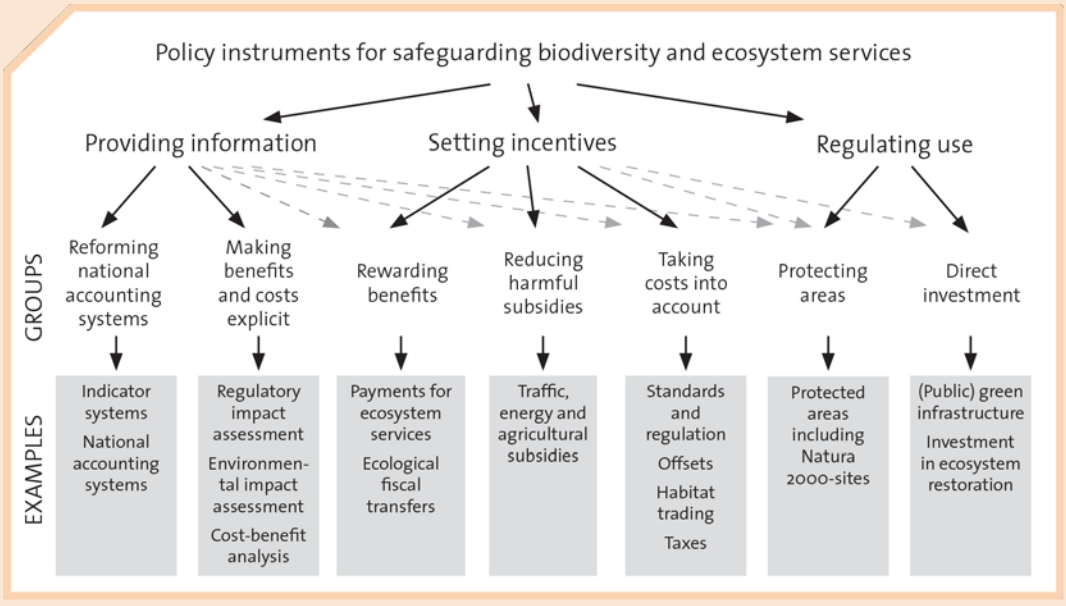
- Secondly, an economic valuation (e. g. in the form of a cost-benefit-analysis) is more than just a monetary assessment (the »ascribing of value«). An economic valuation is preceded, firstly, by identifying all the pros (benefits) and cons (costs) associated with a given change in nature, and all the individuals and groups affected by it (cf. inter alia Hansjürgens and Lienhoop, 2015). For example, an economic valuation helps us to gauge which ecosystem services are relevant to humans, and which individuals or population groups are affected by changes in them. It is also important to consider the framework conditions for using nature: What is the composition of ecosystem services? Who uses them? Who behaves how and why? How can these framework conditions be altered to facilitate a more sustainable handling of natural capital, and one which is better for society as a whole?

- Thirdly, economic valuation is not confined to the consideration of markets and prices as mechanisms for managing natural capital (cf. inter alia Hansjürgens, 2015a). In most cases, those ecosystem services currently disregarded in decision-making are unlikely to be protected via the establishment of markets. Economists use the term -> »Public Goods« when the available market incentives are inadequate (in this case, for corresponding land use decisions to conserve natural capital), or where -> External Effects outside the individual's decision-making scope affect uninvolved third parties where market relationships do not apply. Germany has an effective range of instruments at its disposal for improving nature conservation. For example, imposing command and control-regulations and management standards, rewarding voluntary additional nature conservation services by private land users, as well as planning mechanisms, and the designation of protected areas (e.g. -> Natura 2000 areas on 16 % of Germany's territory), together with information/public education and communication (see Figure 9).

- Fourthly, the framework conditions outside of nature conservation policy are crucial (cf. Hansjürgens, 2015b). For example, the regulations and incentives associated with agricultural, human settlement and transport policy have a major influence on nature. The ecosystem services concept and the economic perspective can help to convince other relevant sectors and policy-making areas of the societal benefits of nature-friendly production methods and a balanced bundle of ecosystem services (mainstreaming or -> Policy Integration), and make decision-makers more aware of the trade-offs involved.

FIGURE 8 ▸ Making Money Talk: Values can only be identified and determined by societal discourses. To achieve a well working dialogue you have to come together and look into the same direction. (Photograph: Esther Merbt, pixabay.com)

FIGURE 9 ▸ Policy instruments to protect biodiversity and ecosystem services. (Source: translated according to Hansjürgens et al., 2011: 71)



BOX 6

Values and prices are not the same

The term »value« is often equated with the **exchange value** of a commodity on the market, in other words, its **price**. A commodity with a high (low) exchange value has a high (low) price. If we confine value to meaning »exchange value«, anything not traded in markets has no economic value.

This approach, however, is limited and out of step with current economic thinking. There is no such thing as one single **value**. Rather, people have different material, moral, spiritual, aesthetic and other interests that shape their thoughts and attitudes towards nature and that are reflected in their own values for a good or service.

This was elucidated by Adam Smith, the father of economics, in his book »The Wealth of Nations« more than 200 years ago (using water as an example). He distinguished between **value in use** and value in exchange (price), using water and diamonds as examples: Water generally has a low or no price, but as soon as it becomes a scarce resource, its value in use becomes very high. Diamonds, on the other hand, have a very high price but a low value in use. As such, the value of water as a commodity tends to deviate from its price. And this realisation not only applies to water; many commodities which are not traded on markets and which therefore have no price (public goods) may nevertheless have a significant economic value for individuals and/or benefit for society as a whole.

When ascribing value to ecosystem services in rural areas, therefore, allowance must be made for the diversity of perceived values, since these values are location-, time- and context-dependent. Secondly, alongside the values in exchange achieved by the markets, which primarily reflect the values of provisioning services, consideration must also be given to the values of regulating, cultural and supporting services.

Against this background, three key aspects of the economic perspective were elemental to »TEEB – The Economics of Ecosystems and Biodiversity« (see also Naturkapital Deutschland, 2012; TEEB, 2010).

1. **Many adverse impacts on ecosystem services are inadequately considered** by private and public stakeholders in **land use decisions**. The value of provisioning services is expressed, for example, in the price of agricultural products or wood. An increased supply of these services therefore leads to a growth in income for land users. By contrast, many regulating services, cultural

services or supporting services do not generate any additional income for land users, and reducing the supply of these ecosystem services does not usually reduce operating income, partly because there are no associated legal requirements (e. g. within the context of intervention regulations under the Federal Nature Conservation Act) or economic incentives. In economic terms, these external effects arise when there is a disparity between private and social costs and benefits, and that are therefore disregarded in commercial decisions.

To give an example: Land users cite private loss of income from discontinuing agricultural activity as an argument against peatland restoration. However, this disregards effects such as the sequestration of greenhouse gases, waterbody purification and microclimate – i. e. the societal benefits – and the savings for society e. g. of permanent dewatering (exploitation costs, peat soil settlement). The cost-benefit-ratio is therefore distorted.

2. **Nature conservation interests often fail to assert themselves.** This is because the benefits of environmental and nature conservation measures are often widely dispersed, occur well into the future, and are uncertain, whereas any loss of income or threat to jobs associated with enforcing nature conservation concerns are directly visible and immediate (TEEB, 2011). Although many people support the idea of nature conservation, as indicated by the »2015 Nature Awareness Study« (see BMUB and BfN, 2015), their interests are often disregarded at the implementation stage when making decisions and weighing up the options. Consequently, environmental and nature conservation interests find it difficult assert themselves over financial interests, particularly because the benefits of the latter are more immediate and tangible (cf. Kirsch, 2004; Olson, 2004). This is further exacerbated by the fact that in practice, decisions are made on a case-by-case basis, whereas the **loss of biodiversity and ecosystem services often only becomes apparent as the cumulative result of many individual interventions.**

3. **Many ecosystem services are disregarded completely, or only inadequately considered, within the framework of existing regulatory mechanisms.** Many ecosystem services lack any market. What is more, the current range of regulatory mechanisms does not value ecosystem services at all, or only minimally. Their benefits and the cost of losing them are therefore not reflected in the decision-making calculations of responsible land users. There is a lack of mechanisms, regulations and instruments for incorporating the external costs of diminishing biodiversity and restricted ecosystem services into the individual calculations

of decision-makers. Sometimes, the opportunities available are not fully exploited, e. g. within the context of management conditions, liability regulations or planning processes. Worse still, government incentives sometimes further exacerbate the economic forces driving the intensification of land use. Examples include the commuter allowance which indirectly supports living in rural regions, subsidies for fattening farms, or previous funding for corn cultivation for energy under the Renewable Energies Act.

1.3 STRUCTURE, CONTENT AND TARGET GROUPS OF THIS REPORT

This report is primarily aimed at political decision-makers at all levels of government, particularly in sectors with a decisive influence on land use, representatives of administrative bodies, interest groups and other NGOs, as well as interested citizens who are concerned with conserving natural capital and the sustainable use of ecosystem services.

Specifically, this summary for decision-makers is designed to:

- Highlight the diverse services provided by nature, value creation and development opportunities for rural areas and human well-being and, where expedient and feasible, attempt to estimate the associated benefits and societal costs of impairing these services;
- Encourage more accurate measurement of the services and values of nature in rural areas and highlight the synergies and trade-offs of ecosystem services, and
- Suggest ways of incorporating nature and ecosystem services more effectively into private and public decision-making processes, to ensure that the natural foundations of life and biological diversity in rural regions are preserved in perpetuity.

The authors would like to encourage a more effective assessment of the long-term consequences (and consequential costs) of current land use decisions for the supply of ecosystem services and the conservation of biological diversity, and their consideration when weighing up alternatives. In this way, conflicts of interests can be balanced more effectively, and the future viability of rural areas secured.

Readers will note that this summary report focuses mainly on agriculture and the ecosystem services of farmed land, while forest management is only a peripheral consideration, even though forests account for around 30 % of Germany's land. This is because much of the potential for improving the supply of various ecosystem services, such as groundwater quality, reducing soil erosion and recreational quality, primarily concerns agriculture. Nevertheless, the forest also

offers multiple opportunities for optimising and valuing ecosystem services (see chapter 6 of the academic report, and Box 11 in this report).

Chapter 2 illustrates a number of synergies between nature conservation and the sustainable use of nature and other societal objectives using various examples to underscore the value of investing in the natural capital of rural areas, particularly from an economic perspective. While modifying land use in favour of a more socially balanced bundle of ecosystem services may reduce the supply of provisioning services, this is outweighed by the numerous additional benefits of other ecosystem services, making them socially desirable.

Chapter 3 gives recommendations for managing the natural capital of rural areas by strengthening and developing the range of instruments in environmental and nature conservation policy. The aim is to highlight the benefits, initiate and implement suitable measures, and achieve better policy integration, so that other sectors give greater consideration to nature interests, and to promote sustainable, -> Integrated Rural Development.

Chapter 4 contains a few conclusions on protecting the natural capital of rural areas.

FIGURE 10
Nature reserve.
(Photograph: Martina Berg, fotolia.com)

2 REVEALING THE VALUE OF NATURAL CAPITAL IN RURAL AREAS: IT PAYS TO INVEST

In the following sections, we use examples to illustrate which ecosystems can be maintained and utilised more effectively to the benefit of society by investing in -> Natural Capital and modifying the way land use is managed in rural areas.

Of course this does not purport to be an exhaustive list of the possible economic and social benefits to be gained from protecting, conserving and developing -> Ecosystem Services. Further examples may be found in the report on »Natural capital and climate policy – -> Synergies and conflicts« (Naturkapital Deutschland – TEEB DE, 2015), which addresses, inter alia, the areas of peatlands and floodplains.

2.1 PRESERVING NATURE'S MULTI-TALENTED RESOURCES: ENSURING MORE EFFECTIVE PROTECTION OF SPECIES-RICH GRASSLAND

Grassland is crucial for conserving -> Biological Diversity and for providing a wide range of ecosystem services (BfN, 2014) above and beyond its role in agricultural production. Grasslands provide habitats for more than half of all the species occurring in Germany (UBA, 2015). Because it is covered all year round, grassland has high humus levels and a high capacity for water storage. Unlike arable land, therefore, it offers better protection against dehydration and erosion by wind and water. Rainwater tends to seep away more easily in grassland soils than on arable land, which means that erosion can be avoided even on sloping ground. On the periphery of waterbodies, grassland plays an important buffering role, and prevents the input of

nutrients and contaminants. It is therefore pivotal to the protection of surface waters and drinking water (UBA, 2015).

However, **for years the proportion of agricultural land allocated to grassland has been in decline.** Whereas in 1991, more than 5.3 million ha (just over 31% of all agricultural land) was managed as permanent grassland, by the end of 2013 this had decreased to just over 4.6 million ha (just under 28% of agricultural land) (BMEL, 2015a). Species-rich grassland with a particularly high nature value (HNV grassland) has been similarly affected: Between 2009 and 2013, the amount of HNV grassland nationwide decreased by 7.4%, or more than 82,000 ha, just over half the size of the state of Hamburg (BfN, 2014).

The **key driving forces behind the ploughing up of grassland** are the intensification of dairy cattle farming in Germany, and the growing profitability of field crops, including energy crops (Schramek et al., 2012); furthermore, agricultural land as a whole is also shrinking:

- The **intensification and concentration of milk production** associated with the rising milk yield of cows and more stringent requirements on feed quality are transforming the intensity of grassland use and increasing the importance of corn silage at the expense of grassland management for cattle feed. It is also feared that the discontinuation of the EU milk quota from 2015 will see an end to dairy cattle farming in less profitable locations, such as the highland regions. This would accelerate the current trend to phase out extensive uses such as sheep and goat grazing, and lead to further losses of HNV habitats such as oligotrophic and dry grasslands or heathland (BfN, 2014).

- In addition, **the cultivation of energy crops for biogas production (primarily corn**) has expanded at an exceptional rate in recent years, often concentrated in grassland-rich regions. Often in conjunction with silage corn production, this has prompted the conversion of grassland into arable land. The growing demand for energy from biomass has therefore intensified the pressure on permanent grassland (Schramek et al., 2012). The reformed 2014 Renewable Energies Act eliminated input material-based fee scales, and for the most part halted the further expansion of biogas production. Nevertheless, the demand for energy crops seems unlikely to diminish any time soon, given that existing biogas plants are protected for 20 years (UBA, 2015).

- Finally, the relentless **growth in land used for human settlements and transport infrastructure** has occurred primarily at the expense of agricultural land, particularly cropland. However, faced with diminishing land resources, coupled with a high demand for food, feed and energy crops, farmers are compensating for the loss of cropland by ploughing up grassland: Whereas agricultural land overall decreased by more than 600,000 ha between 1990 and 2010, over the same period, around 300,000 ha of grassland was ploughed into cropland (see Figure 11 and Tietz et al., 2012), and the decrease in grassland is therefore disproportionately high.

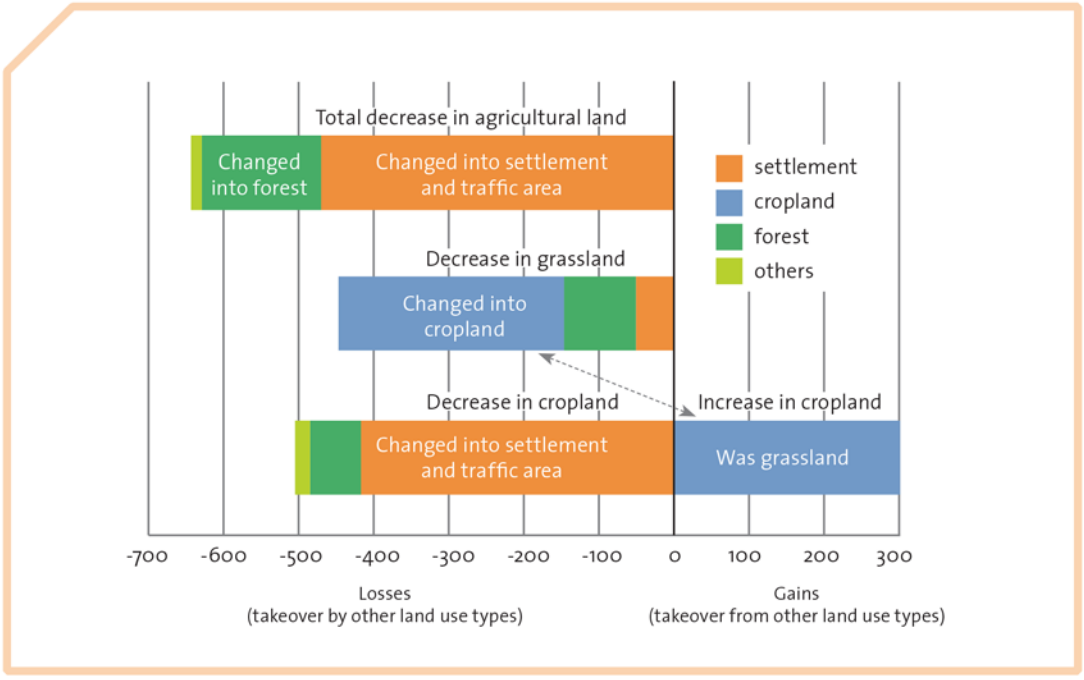


FIGURE 11 ▸ Land use change on agricultural land in Germany 1990–2010.
(Source: Tietz et al., 2012: 13, slightly changed)

The observable decrease in grassland has adverse consequences for the conservation of biological diversity and numerous ecosystem services. For example, the climate gas storage function of grassland is destroyed when it is ploughed, as is its importance for groundwater purification and as a habitat for a large number of species. Large sections of the population benefit from the supply of these ecosystem services – in the case of climate protection, mankind as a whole – yet the costs (or lost profits) associated with conserving and maintaining grassland rest with the local farmers. The problem is that the ploughing up of grassland is not exempt from valid grants and legislation, leading to the aforementioned adverse consequences for ecosystem services. The farmer's business decisions do not consider the costs of a reduced supply of these ecosystem services, yet they are ultimately borne by society.

A monetary comparison of costs and benefits elucidates the economic benefits of preserving grassland versus ploughing it up (see Figure 12). For -> Provisioning Services, we based our calculations on the average additional yield of arable use versus grassland (data taken from Osterburg et al., 2007); for climate services we compared the average CO_2 emissions from soil under grassland with those from arable use and extrapolated these with different compensation levels (data taken from Matzdorf et al., 2010; Osterburg et al., 2015; Ring et al., 2015; UBA, 2013); for contributions to groundwater protection, we estimated the cost of measures needed to reduce elevated nutrient and contaminant levels with arable use to the equivalent level with grassland use (data taken from Osterburg et al., 2007). Finally, grassland's contribution to protecting -> Biodiversity can be valued based on the German public's -> Willingness To Pay for a programme for the permanent maintenance, creation and upgrading of grassland (data taken from Meyerhoff et al., 2012).

The summary in Figure 12 (Box 7) clearly shows that **grassland conservation has major societal benefits**, which more than outweigh the high revenues from ploughing up grassland and alternative crop cultivation. Depending on the local conditions and the underlying assumptions made in the valuation, the **net benefit to society of preserving grassland** (difference between the lost business revenues and the social benefits) **is thought to be somewhere between 440 and 3,000 Euro/ha/year**. Grassland conservation is particularly beneficial in HNV locations with sensitive soil conditions, such as low storage and buffer capacity for nutrients and contaminants, and locations at risk of erosion which tend to be less profitable for arable farming.

BOX 7

Benefits and costs of ploughing up High Nature Value grassland from a societal perspective

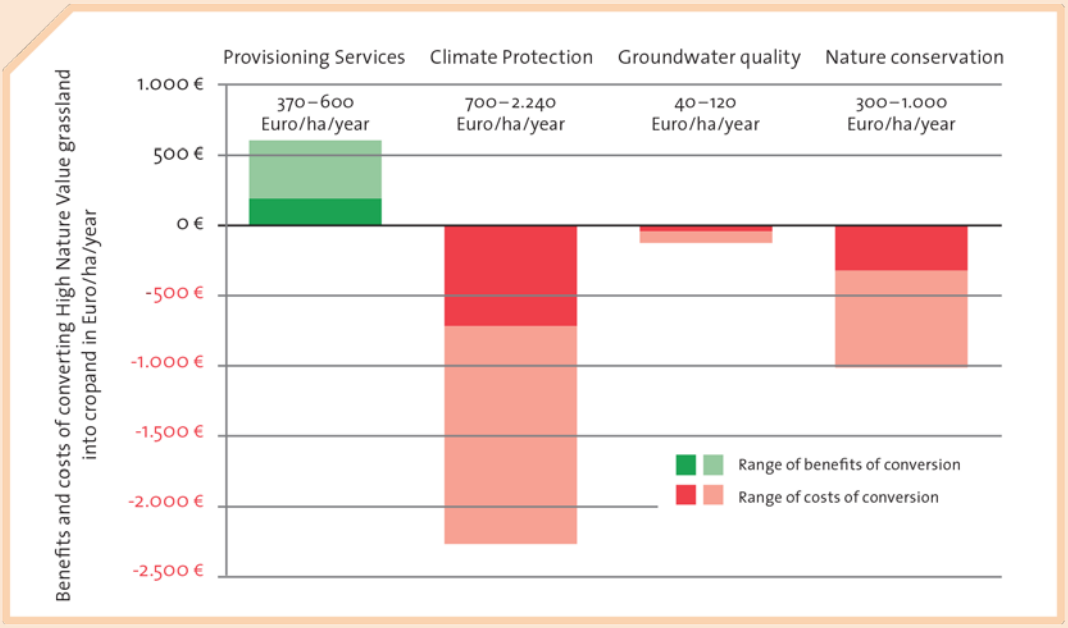


FIGURE 12 ▸ Sample representation of the costs and benefits associated with changing selected ecosystem services, and the willingness to pay for grassland-related nature conservation when ploughing up HNV grassland, per ha and year.

Calculation and sources for Figure 12:

Provisioning services

Compared with use as grassland, many sites are capable of generating higher operating revenues with other agricultural crops, due to the aforementioned drivers (particularly the profitability of corn as an animal feed and energy crop as usable agricultural land becomes ever scarcer). Osterburg et. al (2007) estimate that, depending on the local conditions, arable use can increase revenues by between 370 and 600 Euro per year, per 1 ha of grassland. The Federal Agency for Nature Conservation estimates this figure at 435 Euro/ha/year (BfN, 2014).

Climate protection: Reducing greenhouse gas emissions

Matzdorf et al. (2010) calculated that ploughing up grassland and converting it to arable land (e. g. corn fields) would release an average of 8.8–18.7 t CO_2/ha/year over 10 years (area-weighted) (cf. also Osterburg et al, 2015: 109). Assuming a compensation rate of 80 Euro/t CO_2 as recommended by the UBA (2012), the global damage costs of these additional emissions are valued at around 700 to 1,500 Euro/ha/year. Using the higher cost rate proposed in »Naturkapital Deutschland – TEEB DE

Klimabericht« of 120 Euro/t CO_2 (Ring et al., 2015: 57), the costs rise to between 1,050 and 2,240 Euro/ha/year.

Groundwater quality
Arable use tends to produce higher nutrient emissions than grassland, which contaminates groundwater and surface waters. Osterburg et al. (2007) estimate the cost of cost-effective counteractive measures at around 40 to 120 Euro/ha/year.

Nature conservation
A representative survey (Meyerhoff et al., 2012) found that the German public is willing to pay between 1.35 and 5 bn. Euro/year for a programme designed to protect, plant and upgrade 4.8 million hectares of grassland so as to preserve biodiversity – depending on which assumptions are used to extrapolate their findings to all households in Germany. This equates to an average willingness to pay of 300–1,000 Euro/ha/year.

FIGURE 13 ▸ Ploughing up grassland. (Photograph: agrarfoto.com)

Against this background, current **mechanisms to protect grassland under the EU Common Agricultural Policy appear inadequate** (cf. Nitsch et al., 2012). We lack suitable instruments and regulations to valorise biodiversity and the ecosystem services provided by grassland, above and beyond its provisioning services.

Given Germany's extensive efforts in the areas of climate protection and water pollution control in order to implement the European Water Framework Directive, the ongoing ploughing of grassland is extremely counter-productive. Species-rich grassland must be better protected so as to preserve its multiple talents. After all, conserving grassland is not just a matter of improved nature **conservation, but also an economically worthwhile undertaking.**

2.2 IMPLEMENTING COST-EFFECTIVE SOLUTIONS: REALISING SYNERGIES BETWEEN LAND USE AND WATER PROTECTION

Nitrogen (N) is an essential nutrient for plants, and the production of food, energy and raw materials relies on an adequate supply of nutrients to field crops. Human actions which overload and unbalance the natural nitrogen cycle can cause huge environmental damage (cf. inter alia SRU, 2015). On a global scale, the **eutrophication of waterbodies and oceans caused by high nutrient emissions is a crucial factor in decreasing biodiversity** and the shortage of fresh drinking water resources (cf. inter alia Foley et al., 2005; Rockström et al., 2009).

What is more, nitrogen compounds are harmful to human health and therefore impact -> HUMAN WELLBEING in multiple and complex ways (SRU, 2015): Nitrogen oxides in the air can be directly harmful to human health: Together with ammonia, they form a health-damaging fine dust, and also encourage the formation of ground-level ozone. In drinking water and foodstuffs, nitrate can threaten health (if converted into nitrite, for children in particular), and nitrosamines are thought to be carcinogenic; furthermore, nitrate contamination in drinking water increases the cost of treatment; nitrogen emissions are a key factor in the eutrophication of lakes and oceans, with blue algal bloom leading to toxic contamination and adversely affecting commercial and recreational fishing and tourism; and there are health risks associated with bathing in contaminated waters or consuming contaminated fish or seafood (see Naturkapital Deutschland 2016, chapter 7).

In Europe, Germany is one of the main emitters of nitrogen compounds (EEA, 2010). Agriculture is the main culprit, and is responsible for almost 80 % of nitrogen emissions into surface waters and more than 50 % of nitrogen emissions into the air (SRU, 2015). Between 1991 and 2012, the nitrogen surplus in agriculture over a sliding 3-year average decreased from 130 kg N/ha/year to just over 100 kg N/ha/year, with higher levels tending to concentrate in regions with a high density of cattle (see Figure 14; UBA, 2015). By comparison with the rest of Europe, Germany is in the top one-third, with an average nitrogen balance surplus of 47 kg N/ha/year for the EU 28 (Eurotat, 2015). Despite good agricultural practice regulations, especially the Fertilisers Ordinance, efforts to reduce the nitrogen surplus on farmed land to the German Government's target value, as outlined in the National Sustainability Strategy, of 80 kg N/ha/year have so far failed. It is becoming increasingly apparent that the costs to society of the nitrate surplus outweigh the benefits of increased agricultural production (see Box 8).

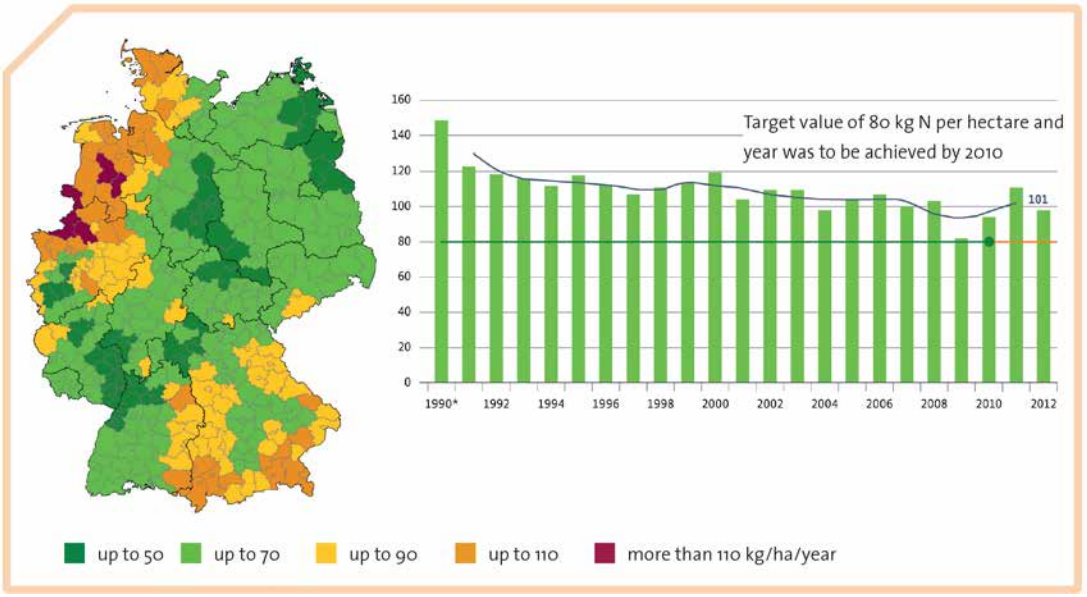


FIGURE 14 ▸ Nitrogen surpluses in kg/ha/year and their regional distribution in Germany. (Source: BMUB, 2015a: 78; UBA 2015: 15)

BOX 8

Costs and benefits of nitrogen fertilisation

A cost-benefit-analysis of nitrogen fertilisation was prepared within the context of the European nitrogen assessment (Sutton et al., 2011). The result: Around 11 million tonnes of reactive nitrogen are currently applied to fields in Europe in the form of synthetic fertiliser. A further 17 million tonnes (approx.) of nitrogen enter the ecosystem as a result of organic fertilisers (liquid manure, fermentation residues, green manure) and atmospheric discharges. The estimated value of total agricultural products produced is increased by 45–180 billion Euro/year. However, the external costs of surplus reactive nitrogen compounds entering the environment are estimated at 70–320 billion Euro/year, which is around 0.5–3 % of Europe's gross national product (Sutton et al., 2011). Three-quarters of this figure results from damage to health (Brink et al., 2011). A study by van Grinsven et al. (2013) likewise confirms that **the costs to society of surplus nitrogen outweigh the (predominantly private) benefits of increased agricultural production.**

The persistently high **nitrogen emissions into surface waters and groundwater are problematic for drinking water extraction** in some regions. The German Government's nitrate report (BMU and BMELV, 2012) indicates that 14 % of measuring sites in the national monitoring network for reporting to the European Environment Agency exceed

admissible nitrate levels of 50 mg/l, and 40 % of measuring sites actually showed an increase in concentration levels between the 2004/2006 and 2008/2010 monitoring periods.

One obvious solution for reducing nitrogen surpluses would be to **establish water-optimised farming practices**, characterised not only by lower nitrogen inputs, but also by greater fertiliser efficiency. This makes sense particularly with regard to reducing the cost of drinking water purification: Rather than installing and maintaining time-consuming, expensive »end-of-pipe« purification systems, **agreements have long been in place between water utilities and farmers with regard to water-friendly farming practices.** These agreements supplement and implement the conditions which often apply e. g. to the zones surrounding water protection areas ('Biodiversity in Good Company' Initiative, 2015). Modified, water-friendly farming practices help to prevent overuse of the geologically specific purification services of the covering layers. These programmes give farmers financial compensation for a potential loss of revenues; while for water utilities they offer real cost savings, which may ultimately be passed on to the customer. For example, the Leipzig water utility estimates that cooperation in the catchment areas of its wells is up to seven times cheaper than the alternative of technically treating heavily polluted groundwater (see Box 9). Similar cooperation programmes to promote water-friendly farming also exist in many other water catchment areas.

BOX 9

Considering water protection in farming:
Limiting the cost of drinking water production
(Based on Box 5.9 in chapter 5 of the academic report and the case study »organic farming as a life insurance policy for drinking water protection« at www.naturkapital-teeb.de)

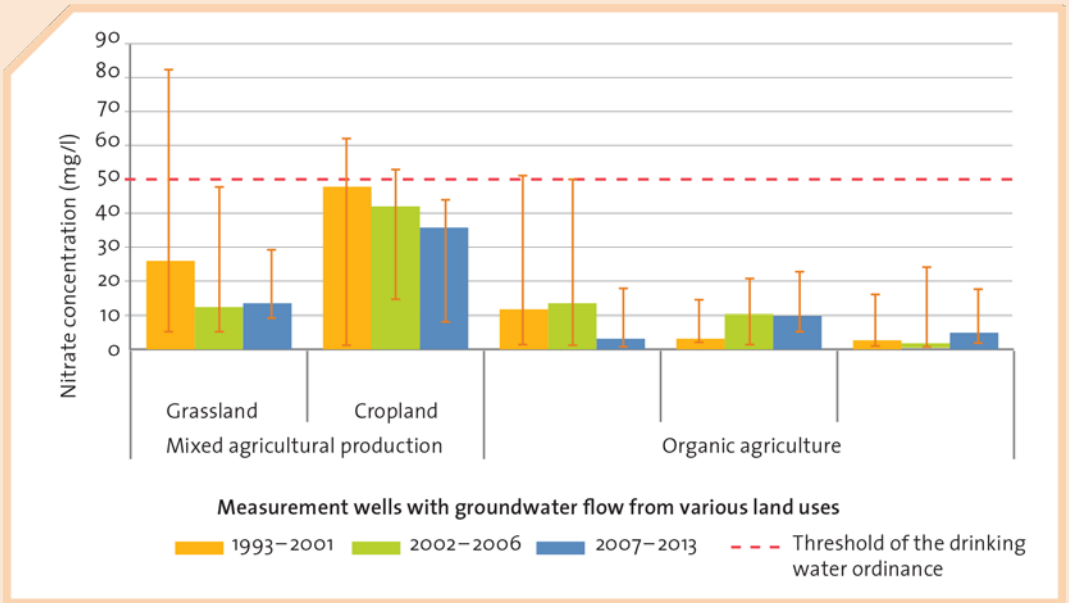
Kommunale Wasserwerke Leipzig GmbH (KWL) supplies more than 630,000 people in the Leipzig region with drinking water from predominantly agricultural catchment areas. Farming practices are vital to the quality of the surrounding waterbodies and groundwater, and hence also for economical drinking water extraction. KWL uses two different measures in its catchment areas to permanently reduce nitrate levels: (1) Water-optimised farming on its own land and (2) Compensatory payments to surrounding farms which initiate water-protecting measures.

The city of Leipzig purchased land in the immediate vicinity of its wells back in 1907, and since 1992 has practised water-optimised organic farming there. The primary aim is to achieve unpolluted groundwater recharge through water-optimised farming. Nitrate concentration levels in the water have been significantly reduced, and monitoring of the catchment area and the wells indicates that these farming practices can buffer the locational, operating structure- and crop sequence-related risks to water protection from conventional farming in the surrounding area (mixed farms, in some cases with 1.4 units of cattle/ha) (Jäger, 2012; see Figure 16).

Furthermore, in its drinking water protection areas, KWL bears the cost of water protection adjustments and revenue losses by farms associated with prescribed land use restrictions, above and beyond its compensation obligations under water legislation The compensation payments, including the administrative costs, amount to around 1 cent/m³ drinking water. This includes the cost of compliance with the operational guidelines for raw water quality, and for meeting the environmental quality standards for groundwater (actually a government task), as required e. g. by the EU Nitrates Directive and EU Water Framework Directive. By contrast, the potential savings from not having to treat the water are estimated at around 7 cents/m³ drinking water. On balance, these compensation payments are the most cost-effective means of ensuring raw water quality and hence of minimising nitrate levels (Loth, 2008).

FIGURE 15 ▸ Groundwater monitoring: Stephan Lange of Leipzig's Municipal Waterworks (KWL) is taking samples. (Photograph: LVV GmbH)

FIGURE 16 ▸ Analysis of nitrate concentrations in mg/l from water samples taken from measurement wells with groundwater flow from various land uses. (Source: Measurements and diagram: Kommunale Wasserwerke Leipzig GmbH, slightly modified according to Jäger, 2012)



The Lower Saxony cooperation model between farmers and the water industry, introduced in 1992, addresses the idea of joint target achievement at the state level (see Quirin, 2014). In 2012, the cooperation model comprised 376 drinking water extraction areas on farmland totalling 310,000 ha, equivalent to around 12 % of Lower Saxony's total agricultural land. Cooperation primarily takes the form of voluntary agreements with farmers, plus additional advice on water protection. Between 1998 and 2012, the nitrogen surplus in the drinking water extraction areas covered by the cooperation model decreased from 95 kg/ha to 64 kg/ha of agricultural land. Between 2004 and 2012, the cost of voluntary agreements and water protection advice totalled an average of 17.2 million Euro/year; the cost of reducing the nitrogen surplus under the cooperation model was less than 2 euro/kg nitrogen. By contrast, the cost of technical water treatment is around 5–15 euro/kg nitrogen, even when using the cheaper purification techniques (Grossmann et al., 2010).

Marggraf et al. (forthcoming) used a cost-benefit-analysis to examine the **establishment of riverbank buffer zones** on 3rd order watercourses where farming and fertilisation are strictly prohibited, focusing on a hypothetical programme of measures to reduce emissions of nitrogen into the North Sea. They found that creating buffer zones on river banks which are not (or no longer) farmed not only leads to an improvement in the marine environment; what is more, the calculated **benefits exceed the costs by more than 760 million Euro** (see below, Box 13 in section 3.3).

There is still plenty of technical potential for optimising the use of fertilisers. For example, the take-up of nutrients by crops can be improved by around 20 %, by using the slurry injection technique rather than broad spreading. Furthermore, discharges of phosphorus via drainage etc. and emissions of ammonia into the atmosphere are also reduced (Kayser et al., 2015).

Even measures implemented primarily for nature conservation often benefit water protection. Studies by TU Berlin and University of Greifswald (Wüstemann, 2011; Wüstemann et al., 2014) assessed which nature conservation measures are necessary in order to achieve the principal objectives of the National Biodiversity Strategy (see Table 1 on page 44). Where corresponding data is available, they ascertained the influence of these measures on reducing nitrogen inputs into leachate. The reduction in nutrient discharges totals around 128 million tonnes/year. Since Germany must significantly reduce its nitrogen discharges in future, the economic value of this reduction can be calculated from the alternative avoidance costs. With an average cost of 3 euro/kg nitrogen to reduce nitrogen discharges in agriculture, the nature conservation measures outlined can be valued at

around 384 million Euro/year, for their nitrogen reduction effects alone. Part of these measures have already been implemented. Using the same methodology, their contribution to water protection was valued at around 230 million Euro/year.

A combination of different measures to capture the value of **the whole range of ecosystem services provided** would appear expedient when **implementing water protection-optimised farming** (cf. also section 3.2). On the one hand, we must aim to reduce the overall intensity of fertilisation, and hence of nitrogen, in agricultural production, which entails considerable external costs. On the other, solutions are needed which accommodate individual locations and give added protection to particularly sensitive areas. Voluntary cooperation arrangements, e.g. in drinking water catchment areas, may be one solution. However, it should be noted that in such constructs, a small group of individuals (farmers) receives a payment from society for not polluting a vital public commodity, in contravention of the »polluter pays« principle.

In summary, we can assert that **water protection measures in agriculture are a fairly inexpensive way of reducing nutrient discharges.** The above examples elucidate the fact that in many locations, the savings in drinking water production alone are sufficient to compensate for any losses in agricultural production, even without the other additional benefits to society of water-optimised land use (such as the conservation of biodiversity, or reducing eutrophication). Yet studies suggest that these additional benefits could be substantial. Summary: Water-optimised land use not only offers reduced costs for drinking water production; it also offers numerous other opportunities for promoting ecosystem services (soil fertility, landscape, climate protection). By using land in harmony with water protection, it is possible to achieve cost-effective solutions to the nitrogen problem.

TABLE 1 ▸ Estimate of the extent and monetary value of nitrogen reduction as part of a study into the costs and benefits of implementing nature conservation targets (*1).
(Source: Self-compiled and calculated on the basis of Wüstemann, 2011)

Measures		Area (ha)	Reduction in N load (kg/ha) (*2)	Total N reduction (t/year)	Alternative avoidance costs (Euro/year) (*3)
Field	Contract-based nature conservation	357,000	20	7,140,000	21,420,000
	Agri-environmental measures and organic farming	3,570,000	20	71,400,000	214,200,000
Grassland	Development of species-rich grassland	45,000	20	0	0
	Planting of new orchard meadows	9,500	10	95,000	285,000
	Extensive use of intensive grassland	565,040	10	5,650,400	16,951,200
Floodplains	Modified use of floodplains	4,456	100 (mean)	445,600	1,336,800
	Restoration of dynamics	50,000		5,000,000	15,000,000
	Re-purposing of arable land	23,800		2,380,000	7,140,000
	Regeneration of floodplains	891		89,100	267,300
Peatlands/peat soil sites	Renaturation	50,000	100 (mean)	5,000,000	15,000,000
	Raising the water levels on grassland	154,960		15,496,000	46,488,000
	Raising the water levels and modifying the use of fields	154,700		15,470,000	46,410,000
Sum total of measures		**4,985,347**		**128,166,100**	**384,498,300**

*1: Of these, measures with an estimated coverage of 4.8 million hectares, a reduction potential of 76,646 t N/year and an equivalent value of just under Euro 230 million/year were implemented in 2007.
*2: Reduction of the N load in leachate
*3: With average alternative annual avoidance costs of Euro 3 / kg N in leachate

FIGURE 17 ▸ Wind erosion after preparing a seed bed. (Photograph: R. Funk)

2.3 INVESTING IN LANDSCAPE ELEMENTS: SMALL AREAS – BIG IMPACTS

Extensively used and unused structural elements such as hedges and field margins are a valuable part of the cultural landscape. At a regional level, their numbers in rural regions is declining to such an extent that they must not only be preserved, but expanded. These types of landscape elements are vital for preserving the species diversity that relies on them. Alongside the intrinsic motivation of preserving such species, they also provide important ecosystem services, and therefore benefit farmers and society in diverse ways. As an example, consider the services provided by hedges in an agricultural landscape.

In a well-structured landscape, ground-level wind is weakened by natural obstacles, thereby ensuring that **soil fertility is preserved.** Harmful erosion effects on the soil and crops are prevented or minimised. Particularly in spring when the soil is fallow with a fine-crumbed structure after preparing the seed bed, hedges are the only form of wind protection. In Brandenburg, for example, landscape elements reduce the proportion of significantly threatened land from 40.7 % to 17.5 % (Funk et al., 2004). On its sandy soils, wind speeds of just 6 m/s are sufficient to cause wind erosion. At higher wind speeds, the wind is capable of eroding over 100 t/ha in a single event. In addition to these extreme events, however, the cumulative effects of damage over time can significantly impair soil fertility.

In addition to soil loss, wind erosion causes a sifting of soil particles according to size and density, leading directly to a loss of clay, silt and organic substance, together with their bound nutrients and pesticides. Experiments have shown that up to 70 % of a pre-emergent herbicide (herbicide applied just before the crop appears) may be blown away and displaced by an erosion event (Clay et al., 2001;

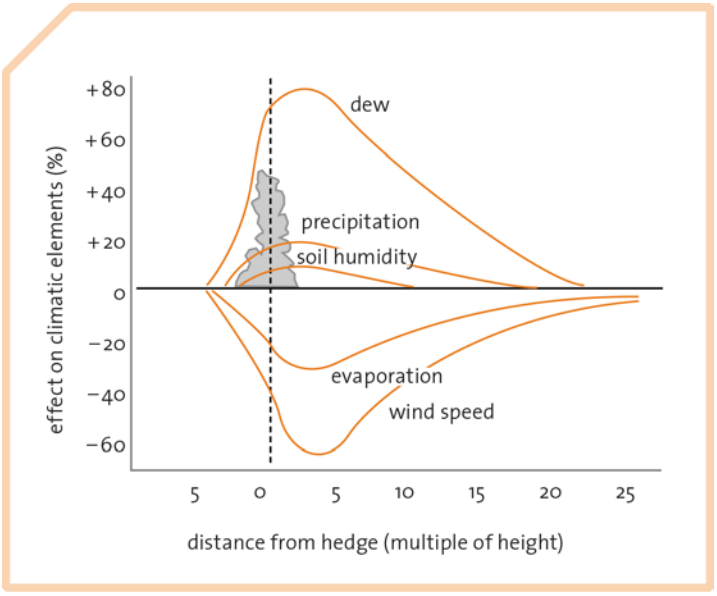


FIGURE 18 ▸ Effects of a hedge on the surrounding climate.
(Source: According to MLR, 1987)

Schöning, 2000). **Wind protection hedges therefore preserve fertile soil and the production resources used by the farmer. At the same time, they prevent eroded material from being deposited in adjacent areas and habitats with the associated adverse consequences.** Generally speaking, the microclimate within the hedge's sphere of influence is also modified (see Figure 18). Reduced evaporation, increased dew formation and higher soil humidity may have a beneficial effect on crops and crop yields, especially in a continental climate. Wind protection hedges can boost yield by up to 50% (Grahlmann, 1987) in the lee of the hedge, which may be 15 to 25 times its height. The best wind protection effect is achieved when hedges are arranged at right-angles to the prevailing wind direction and comprised of trees flanked by bushes, with the hedges being linked to other landscape elements.

FIGURE 19 ▸ Flowering field margin.
(Photograph: C. Saure)

Just like unused field and path borders, hedges with a versatile range of flowers and a sufficiently large field margin also provide an important retreat and overwintering habitat for various beneficial insects such as spiders, ladybirds, ground beetles and numerous other insects. In spring, the flowering plant species in the field margins (see Figure 19) are often the first source of food for visiting insects (such as hoverflies, parasitic wasps), before moving on to the plants in the field and path borders over the course of the summer. From the field margins, the beneficial insects colonise the fields at a distance of up to 100 m during spring, and can significantly reduce the spread of pests (see Figure 20). In order to achieve large-scale colonisation of intensively farmed arable land with beneficial insects, since 2000 agri-environmental policy has promoted the wildflower strip concept to provide stepping-stones inside the fields as well (Mante and

Gerowitt, 2007). By contrast, small-scale farms and extensive farming practices tend to achieve more intensive exchange processes and populations of beneficial insects are better able to regenerate in the fields. This is illustrated by a simulation model: Without the predator insects, insecticides would need to be applied over roughly twice this area (see also chapter 5 of the academic report).

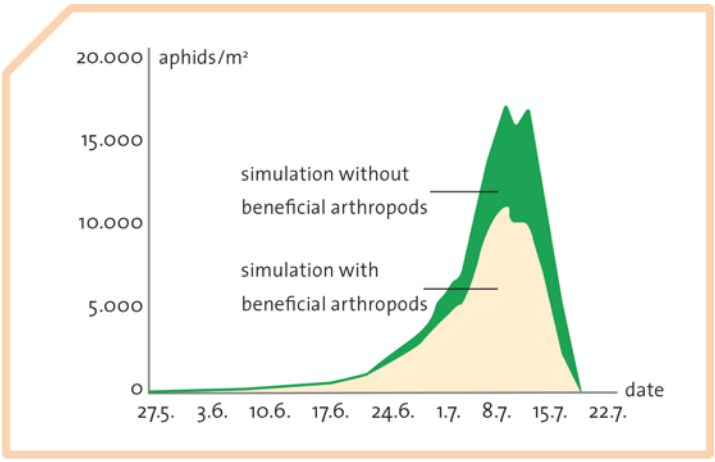


FIGURE 20 ▸ Assessment and simulation of aphid attacks on wheat with and without beneficial arthropods, example from the Magdeburger Börde region, 1999. (Source: Freier et al., 2002)

Hedges with flowering shrubs and field margins also provide valuable habitats for wild and honey bees (see Figure 21). As pollinating insects, these are a vital link in the ecological chain. Many wild plants depend on wild bees for pollination and dispersal, but they also play a vital role in agricultural crops: Rapeseed, sunflowers, broad beans and strawberries, for example, can increase their yield by up to 40 % with animal pollination. **In fruit cultivation, up to 90 % of the yield is dependent on animals** (Klein et al., 2007). International research shows that bumblebees and other wild bees can enhance the fruit set and quality of the fruit even if honey bees are already being used (Bartomeus et al., 2013; Garibaldi et al., 2011 and 2013; Holzschuh et al., 2012). Through interaction and additional direct pollination, wild bees can actually double the effectiveness of honey bees in crop cultivation (Greenleaf und Kremen, 2006). As well as the number of individuals, the diversity of species is a key factor (Greenleaf and Kremen, 2006; Klein et al., 2003).

However, wild bees in particular need a suitable habitat. They need continuous flower strips plus suitable nesting sites. The shrubs and field margins of hedges provide overground-nesting wild bee species with favourable nesting conditions in the form of dry branches, pithy stems, rotten wood and clearance cairns. Other species favour sunny open patches of ground. Examples include unpaved field paths, earth embankments and soil mounds (Berger and Pfeffer, 2011). Nesting sites and year-round flower strips should be interlinked and no more

FIGURE 21 ▸ *Lasioglossum sexnotatum.* (Photograph: S. Kühne and C. Saure)

than 200 m apart. Many wild bee species cannot cover larger distances (especially the smaller species), or only with a significant impairment to reproduction levels (e. g. Zurbuchen et al., 2010).

Space-forming and space-dividing structural elements may also help to make agricultural landscapes in general more diverse, which in turn enhances their **experience and recreational value** (Roser, 2011; Roth and Gruehn, 2006; von Haaren, 2004). The landscape provides a backdrop for every type of human activity in the countryside; looking at a beautiful landscape is considered recreational. The Federal Nature Conservation Act (BNatSchG) recognises this, for example, by listing the protection of diversity, characteristic features and beauty of nature and landscapes, as well as their recreational value, among the purposes of nature conservation and landscape management (§ 1 (1), no. 3 of the BNatSchG). Nohl (2001) classes hedges as well as old, single trees, groups of trees and avenues as particularly aesthetically pleasing landscape elements (cf. also Hoisl et al., 2000). In addition to their spatial effect, shrubs can add colour with their flowers and autumn leaves. Alongside their visual appeal, flowering plants can also appeal to the olfactory sense and (pollinated) fruiting varieties to the sense of taste, adding another layer to the landscape and nature experience (von Haaren, 2004). According to Hoisl et al. (2000), alongside hedges and shrubs, a wildflower field margin can also contribute to a landscape's recreational value. As well as increasing the species diversity, structural elements can also shape the uniqueness of a landscape. In some regions, hedges in particular have special cultural-historical importance (cf. Dannenbeck, 2008: 22 ff.; Wiegand, 2002: 101). Against this background, landscapes containing typical structural elements can create a sense of place and identity (Hoisl et al., 2000: 140 f.; Wöbse, 2004: 247).

FIGURE 22 ▸ Structural elements in an agricultural landscape. (Photograph: S. Kühne)

Ultimately, we must ask who rewards the provision of ecosystem services, and how the cost is distributed? The fact is that, under the current framework conditions for farmers, the business benefits of ecosystem services are not always convincing (Bianchin, 2011; Brand-Sassen, 2004; Knauer, 1990). For example, as well as being a habitat for useful insects, field margins may also harbour pests, or unwanted weeds and/or wild grasses (critical discussion in Kühne et al., 2000). Additionally, as pesticides are comparatively inexpensive and reliable in their ability to control pest, farmers are unlikely to discontinue their use; consequently, direct cost relief is not necessarily felt (critical appraisal in Brand-Sassen, 2004). Furthermore, in the current usage situation, not all agricultural land has the same demand for potential ecosystem services. For example, crops which could benefit from pollination by wild bees are currently only cultivated on around 10 % of Germany's agricultural land (Horn et al., in chapter 5.2 of the academicreport). Similarly, shrubs do not create only positive impacts for farmers, and ultimately, the benefits of such structures may vary significantly according to location (critical discussion also in Knauer, 1990). For example, the wind protection effect of hedges is a key important argument, particularly in the lowlands of North Germany, where wind erosion is a widespread problem due to an abundance of sandy soils and large fields. In Germany as a whole, around 25 % of arable land is classified as potentially at risk from wind erosion (BGR, 2014).

In any case, farmers' cost-benefit-considerations fail to take account of the social benefits, and under the current framework conditions, hedges are often only economically attractive for farmers if subsidies are offered (Knauer, 1990; Brand-Sassen, 2004). Subsidies can be used to balance the books and achieve the values outlined above (see also Figure 23).

Under the -> EU Greening policy in operation since 2015, around 30 % of direct payments are linked to compliance with certain climate- and environmentally-friendly farming methods. Alongside greening measures such as diversification of crops and conservation of permanent grassland, farmers with more than 15 ha of arable land must set aside so-called »ecological priority areas« on 5 % of the land (BMEL, 2015b). This also includes landscape elements such as hedges and field shrubbery, if subject to the cross-compliance regulation, as well as fallow land, short rotation and intercropping. For a simplified comparison of the cost of these greening components to promote landscape elements e. g. with the cost of 2nd pillar subsidies via agro-environmental and climate protection measures, the 30% direct payment (in Germany approximately 85 Euro/ha/year) (BMEL, 2015b) is referred to the size of the required ecological priority areas. Using the aforementioned 5% as a basis (corresponding to 0.05 ha ecological

priority area per 1 ha of arable land), this would translate into a premium of 1,700 Euro/year per hectare of priority land. If hedges and extensively used field margins are classed as ecological priority areas, the premium is higher. With land weighting factors of 2 for hedges and 1.5 for field margins (BMEL, 2015b), this translates into a payment of 3,400 and 2,550 Euro respectively per ha of ecological priority land, per year. These values are significantly higher than the equivalent amounts for agri-environmental measures. **In other words, the greening premium is a comparatively expensive instrument for the supply of structural elements** (cf. already Matzdorf, 2011).

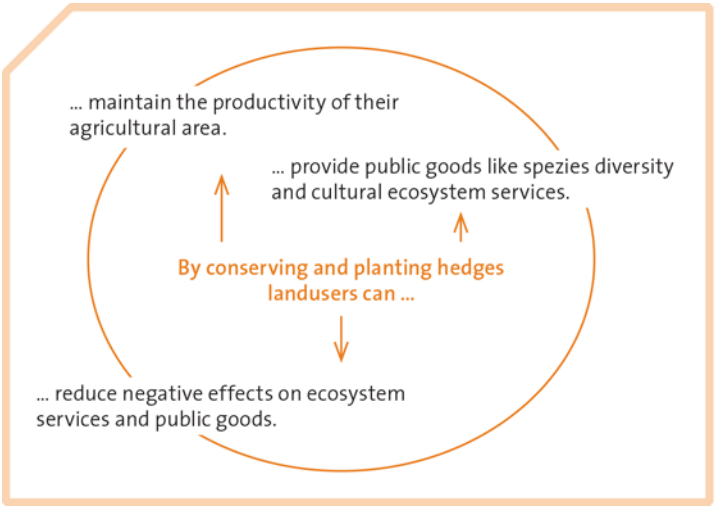


FIGURE 23 ▸ Hedges provide ecosystem services.
(Own illustration based on application of the ecosystem services concept in farmland according to Matzdorf and Müller, chapter 5.2 of the academic report)

It is also worth noting that the greening premium is granted irrespectively of the specific quality of the ecological priority areas. **However, simply setting aside land does not automatically create a large variety of species**, as illustrated, for example, by hedges – only around 45 % are classed as species-rich (Kühne et al., 2000). This estimate for hedges is already several years old, but other structural elements and extensively used or unused land in the agricultural landscape show a similar picture (BMUB, 2015a). However, species diversity is the key intersection between the aforementioned services, and farmers' expectations of cost sharing are justified from an ownership perspective (Matzdorf, 2004). Hence, if there is a societal demand for species-rich structural elements, giving further support to farmers may be both effective and equitable. To this end, additive support with investment and maintenance costs can be provided via agri-environmental and climate protection measures alongside the greening premium for the management of species-rich ecological priority areas; however, farmers' loss of income must not be compensated twice (BMEL, 2015b). It remains to be seen whether an incentive is necessary. If agri-environmental and climate protection measures are combined with a range of advisory services involving the nature conser-

vation authority, and a certain degree of implementation flexibility for farmers, this will create a good basis for effectiveness (Berger and Pfeffer, 2011; Meyer et al., 2015).

Subsidies should not be allowed to erode farmers' and land owners' financial responsibility for preventive management. The cost of providing a diverse range of ecosystem services should be distributed effectively and equitably between farmers and society, since it is possible to make a big impact on a small area.

NOTE ▸ Box 13 shows that buffer zones at riverbanks are another example of creating a big impact in a small area.

2.4 CULTURAL ECOSYSTEM SERVICES: CAPITALISING ON INTANGIBLE BENEFITS

-> Cultural Ecosystem Services **include all types of intangible benefits** that human beings receive from their natural environment (cf. MA, 2005). According to Naturkapital Deutschland TEEB-DE (2012) (cf. also Naturkapital Deutschland – TEEB-DE, 2015, based on Haines-Young and Potschin, 2013), there are four basic categories:

1. Recreation and health – near-natural landscapes, open spaces and green spaces are vitally important for recreation and human health.

2. Inspiration and aesthetics – the joy of looking at nature is part of our culture, as are the references to nature in art. »Wilderness« has a special importance for the German people: Two-thirds believe the wilder the better, where nature is concerned (BMUB and BfN, 2014).

3. Familiarity and a sense of place – identification with the region and feeling at home is often linked to familiar landscapes and the typical fauna and flora, livestock breeds and crops of that region.

4. Education, science and research – nature provides numerous models and materials for applications in technology, medicine, pharmacology and food production.

Germany is predominantly characterised by cultivated landscapes, in which cultural ecosystem services arise from the interaction between natural elements and processes (such as changing floodplain landscapes) and human activities (such as orchard cultivation and cattle and sheep grazing). The Lüneburger Heide and Erzgebirge regions are typical examples.

FIGURE 24 ▸ Cultivated landscape Lüneburger Heide. (Photograph: Gabi Stein, pixabay.com)

Cultural ecosystem services are vital for human wellbeing. The majority of Germans value nature conservation very highly, because nature is pivotal to health and recreation. It allows people to experience

beauty, characteristic features and diversity; the 2015 nature awareness study found that nature is considered essential to a fulfilled life (BMUB and BfN, 2016). Most people also believe that future generations are entitled to an intact natural landscape (67 % of respondents »completely agree«, and a further 29 % »tend to agree«, see BMU and BfN, 2012). The majority of respondents feel closely connected to nature and the landscape in their own region (85 % of respondents, of whom 49 % »completely agree« and a further 36 % »tend to agree«, see BMUB and BfN, 2016) and are irritated if their fellow human beings treat it carelessly (83 % of respondents, of whom 47 % »completely agree« and a further 36 % »tend to agree«, see BMUB and BfN, 2016). Empirical surveys in the Black Forest, Swabian Alb, Lausitz and Hohe Tauern (Austria), which asked residents how the local landscape contributed to their own wellbeing, obtained similar results (Bieleng et al., 2014).

There have been a number of **studies assessing the monetary benefits of cultural ecosystem services** which underscore their major importance, including their economic significance: Grunewald et al. (2012) calculated that visitors to the Eibenstock-Carlsfeld region in the Westerzgebirge mountain range in Saxony spend around 5.5 million Euro/year on travel. These visitors stressed the aesthetically harmonious interplay between the near-natural landscape elements forest and water as the key attraction. It has been estimated that visitors are willing to pay 170,000 Euro/year more in order to protect and develop nature. Willingness to pay was ascertained, not only for landscapes with particular characteristic features, but also for »regular landscapes«, such as woodlands, in the vicinity of the respondent's home. Extrapolated to the total German population, the willingness to pay for recreation in local forests is 1.9 billion Euro/year over 14 years (Elsasser and Weller, 2013).

Cultural ecosystem services also generate significant revenues, as a reflection of their societal value. Arlinghaus (2004) estimates the total direct and indirect income effects of leisure fishing in Germany to be at least 6.4 billion Euro/year. In 2012, turnover in the outdoor sector totalled 928 million Euro (Statista, 2015).

Furthermore, in a developed economy like Germany, **the importance of cultural ecosystem services for human wellbeing is expected to increase still further over the coming decades.** Milcu et al. (2013) confirm a growing awareness among the general public that cultural ecosystem services are very difficult to replace. Last but not least, cultural ecosystem services play an important role in our experience of nature and landscape, particularly for children and young adults: It shapes their perception of nature, and their attitudes towards nature conservation.

FIGURE 25 ▸ Cultural landscape between Tuttlingen and Sigmaringen and its importance for recreation, inspiration and aesthetics, as well as familiarity and sense of place. (Photograph: Rainer Sturm, pixelio.de)

Suitable management measures allow for realising -> SYNERGIES between cultural ecosystem services and regulating and provisioning services. Some examples: -> RENATURATION of wetlands and river meadows encourages groundwater supply and flood control, as well as the development of a diverse, near-natural landscape as the basis for many cultural ecosystem services; eco-friendly organic farming produces food as well as promoting a varied palette of flowering plants by allowing wild flowers to grow on the fields; and the re-watering of peatlands contributes to climate protection while at the same time conserving characteristic regional landscapes.

In order to protect and enhance nature's multiple benefits for humans, **we must preserve, develop and restore landscapes and landscape elements, which are important cultural ecosystem services.** Suitable measures include, firstly, protecting and developing characteristic landscapes and landscape structures, such as the hedgerows in north-west Germany, and secondly, maintaining and developing new types of infrastructure for experiencing and raising awareness of cultural ecosystem services, such as innovative educational apps that deliver environmental information in situ. Clearly, when we put a value on cultural ecosystem services, a wide range of intangible benefits can be achieved.

2.5 INVESTING IN PROTECTED AREAS AND LARGE NATURE RESERVES: CREATING REGIONAL VALUE

»National Natural Landscapes« is an umbrella term for the **national parks, biosphere reserves and nature parks** in Germany with an estimated area of more than 10,000 ha (see Figure 26). Beyond the important role of protecting biodiversity, **the ecosystems in these protected areas also provide a broad range of ecosystem services which benefit society as a whole.** Areas that meet specific requirements (depending on the protected area status) which are to be preserved or developed are designated as protected areas. In nature parks for example, key criteria include diverse and unique landscapes as well as scenic beauty, together with particular cultural-historical importance and its role in recreation and sustainable tourism.

Protecting areas in this way helps to capture the value and enhance the status of historical cultivated landscapes and their ecosystem services: Small-scale structures like hedges are retained, developed and maintained with additional subsidies. Since agro-industrial use often has a lower status in such areas and there is more emphasis on sustainable land use and landscape management, the general pressures on ecosystems associated with harmful emissions from agriculture tend to be lower. -> Regulating Services such as the self-purification functions of waterbodies and soils benefit in particular. As a general rule, these positive effects can also be achieved in smaller protected areas. The European Commission estimates the overall economic benefits of these services for the -> Natura 2000 European-wide network of protected areas at 223–314 billion Euro per year (EU Commission, 2015).

National Natural Landscapes are also used for recreation and offer aesthetic and spiritual experiences (see also section 2.4). These large scale protected areas valorise their ecosystem services with a host of measures and infrastructures: Examples include contract-based nature conservation, special nature offerings for tourism (cf. Figure 27), information centres, and the support of regional brands. Large scale protected areas act as a label (in the sense of a special designation of products) to support regional marketing.

This has been established especially by the introduction of the umbrella brand »National Natural Landscapes« (see Figure 28) for Germany's large scale protected areas. Surveys suggest that the status as protected area is important for tourism, particularly in the case of national parks and biosphere reserves. In the Bayerischer Wald National Park, 45.8 % of visitors are classed as »tourists with high national park affinity«, for whom the protected area played a pivotal role in their travel plans (Woltering et al., 2008). This tourist demand provides an **additional effect for the regional economy** alongside the

FIGURE 26 ▸ Overview of the large nature reserves and »national nature landscapes« in Germany. (Source: Job, 2015)

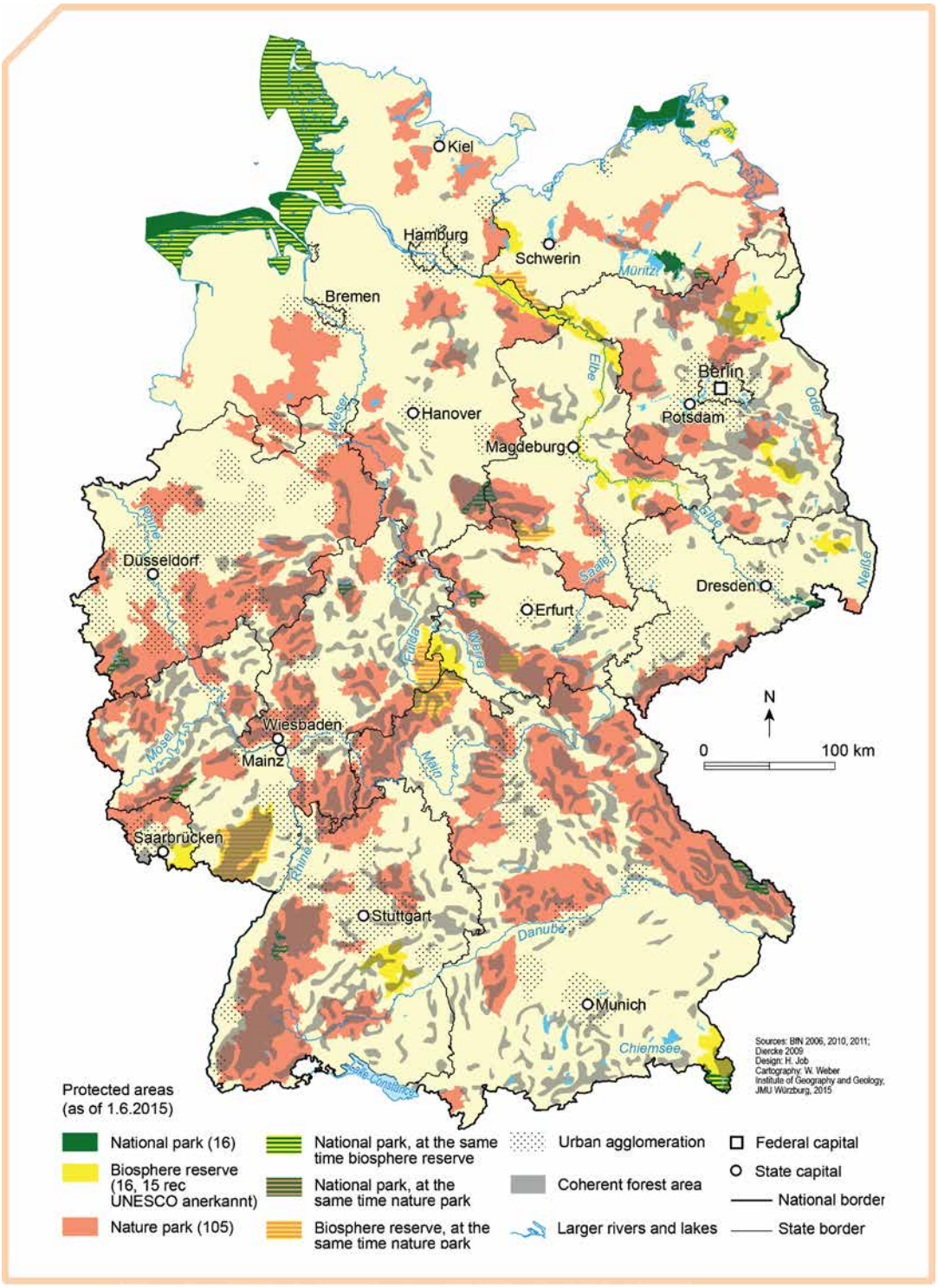


FIGURE 27 ▸ Tourists watching the 2013 crane migration in the Vorpommersche Boddenlandschaft National Park.
(Photograph: Cornelius Merlin)

economic effects listed above. **Tourist expenditure can have a major impact on a regional economy, thanks to direct positive income effects and indirect multiplier effects.**

In recent years, all German national parks and selected biosphere reserves have undergone an economic impact analysis to examine the effects of tourism on income (Job et al., 2009; Job et al., 2013). The result: **Large scale protected areas have a positive influence, both on the number of visitors and on their average daily expenditures.** Among national parks, depending on their size, gross tourism turnover ranges from 1.9 million Euro in the Unteres Odertal National Park, up to more than 27.8 m Euro in Germany's oldest national park, Bayerischer Wald, to more than 1 billion Euro in the Schleswig-Holsteinisches Wattenmeer national park (Metzler et al., 2016). Results for the other national parks and selected biosphere reserves in Germany confirm these financial magnitudes. As well as the natural features, these economic effects also depend on the aforementioned bundle of measures and infrastructures, which allow more intensive use by nature tourists, provide more attractive educational opportunities for sustainable development, and enhance the importance of natural capital in the visitors' perceptions.

Nationale Naturlandschaften

FIGURE 28 ▸ Logo of the umbrella brand »National Natural Landscapes«.

Taking the Bayerischer Wald National Park as an example, we can see **at regional level: tourism attributable to the protected area can generate significant added-value, which exceeds losses from land use restrictions** (Job and Mayer, 2012) e. g. relating to forestry use, including the regional timber processing industry. Depending on the estimated cubic metres (cm) of timber that can be harvested each year in the national park area (150,000–175,000 cm), the assumed round log prices (40–80 Euro/cm), variable sawn timber prices (130–180 Euro/cm) and the multipliers of the wood-processing industries, the lost revenues range from 5.0–10.8 million Euro/year. Compared with the total real net output from national park tourism of 13.5 million Euro/year (Woltering et al., 2008), the lost revenues from regular forestry and timber are more than compensated by the revenues from nature tourism in the national park (Mayer, 2013).

While a number of studies have examined the positive economic effects from tourism on regional development in the National Nature Landscapes, no comparable studies are available for other important ecosystem services such as climate protection, flood protection and 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 mechanisms, still needs more research to pinpoint and evaluate these additional benefits, besides the primary objective of conserving biodiversity. One thing is clear however: Investing in the natural capital of Germany's protected areas creates regional value.

FIGURE 29 ▸ Group of visitors in ‚Bayerischer Wald' National Park. (Photograph: Thomas Michler, National park administration Bayerischer Wald (NPV BW))

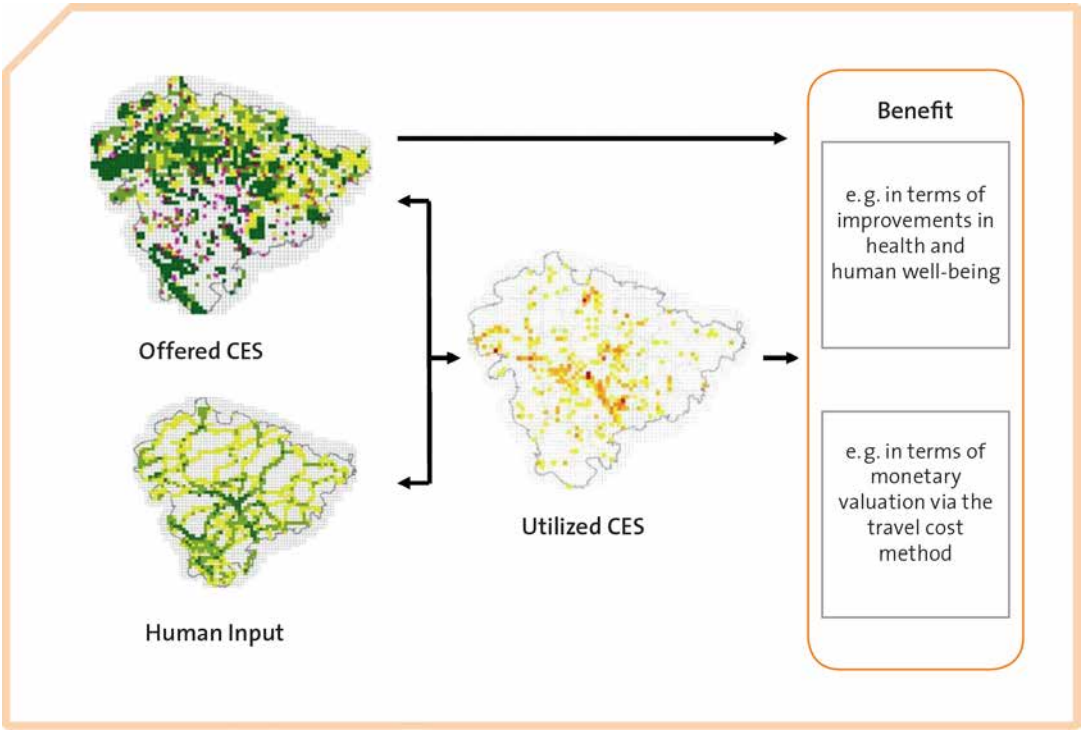
3 SAFEGUARDING THE NATURAL CAPITAL OF RURAL AREAS: HIGHLIGHTING THE BENEFITS, IMPLEMENTING MEASURES, INTEGRATING POLICIES

There are numerous areas where greater consideration could be given to -> Natural Capital and -> Ecosystem Services in rural areas, but we will confine our comments to a few selected aspects. In all cases, incorporating the -> Economic Perspective makes it easier for decision-makers to adopt a cross-sectoral, economic approach, in line with the principle of sustainability. Our recommendations were selected with a view to highlighting the benefits of the economic perspective (3.1), implementing measures to protect natural capital (3.2) and integrating policies (3.3).

3.1 HIGHLIGHTING THE BENEFITS: ADDING AN ECONOMIC PERSPECTIVE OF ECOSYSTEM SERVICES TO ENRICH DECISION-MAKING PROCESSES

The ecosystem services concept, the economic valuation of services, and analysis of the decision-making situation of the relevant stakeholders provides additional information about nature and landscapes and how they are used. **This information may supplement existing assessments and evaluations as the basis for policy and planning decisions, both in the nature conservation sector and other policy areas that make claims on nature (such as agricultural policy, transport policy, municipal land policy)**. The ecosystem services concept and the economic approach facilitate a more quantitative analysis of the interactions, -> Synergies and conflicts of interest associated with the supply of various ecosystem services under alternative land uses. Existing nature assessment methodologies (e.g. in landscape planning) may be supplemented by a comprehensive consideration of ecosystem services, particularly the distinction between supply and demand in services (see Figure 30).

The illustration shows the supply of ecosystem services in the sense of usable potential (top left), the added human input in the form of relevant infrastructures such as footpaths and information boards (bottom left), the ecosystem services utilised (centre), and some of the associated benefits (right). In some cases, supply contributes to wellbeing purely by virtue of its existence, even if it is not currently



used, because humans take satisfaction from the mere fact that wilderness areas or certain species exist. It is also important to remember that supply also helps to ensure -> HUMAN WELLBEING in future, including that of future generations. This information can be used for decision-making processes, e.g. when developing and designing local recreation facilities. On this basis, ecosystem services can be assessed, and conclusions drawn for the wellbeing of individuals or selected population groups.

FIGURE 30 ▸ Cultural ecosystem services for leisure and recreation: Comparison between supply, human input and use.
(Source: Translated and supplemented according to von Haaren et al., 2016)

The ecosystem services concept and economic analysis of the consequences of providing ecosystem services for providers / beneficiaries and originators / affected stakeholders, helps to render the pros and cons of alternative decisions more visible and communicable. The concept therefore helps to highlight the importance of nature and landscape for society as a whole, identify opportunities for conflict resolution and synergies, and initiate collaboration for the protection and sustainable use of -> BIODIVERSITY and ecosystem services, even

with »non-nature« stakeholders (e. g. from different sectors of industry and policy-making areas).

Information on ecosystem services has specific applications at all spatial decision-making levels and within the context of various policy and planning tools, both in the nature conservation sector and beyond.

- At national or Länder level, information on ecosystem services can increase awareness of development trends and support decisions by **policy impact assessments**, for example concerning the effects of management conditions, subsidies or charges (see Box 10).

- At regional and local level, for example, **landscape plans and landscape master plans** may be updated to include analyses of the development of selected ecosystem services. To this end, suitable indicators, methodological approaches and standards should be developed and trialled in demonstration projects.

- Investigations into the environmental consequences of plans and programs in a **strategic environmental assessment** and analyses of projects in an **environmental impact assessment** (EIA) may be linked to the ecosystem services concept, as already envisaged by the EIA Directive (EU Directive 2011/92/EU). Alongside the impacts on environmental media functions usually considered in an environmental impact assessment, analysis could also incorporate the effects on human beings as a protected natural resource, i. e. individuals and/or population groups. Economic analyses e. g. of the actual use of ecosystem services using suitable techniques (e. g. travel cost method) could also contribute to this.

BOX 10

Mapping the supply of ecosystem services at national level

Within the context of implementing the EU biodiversity strategy at national level, a number of research projects have developed indicators for assessing ecosystem services in order to measure the status and development of natural capital against nature conservation policy targets, among other things (Albert et al., 2015a,b). This also entails analysing the supply of ecosystem services. Such information can help to promote nature conservation issues across all protected natural resources at national level, by indicating whether strategic biodiversity and sustainability targets have been met. The BU biodiversity strategy requires the results to be incorporated into the national accounting and reporting systems at EU level by 2020 (EU Commission, 2011).

The following two examples illustrate approaches for assessing ecosystem services:

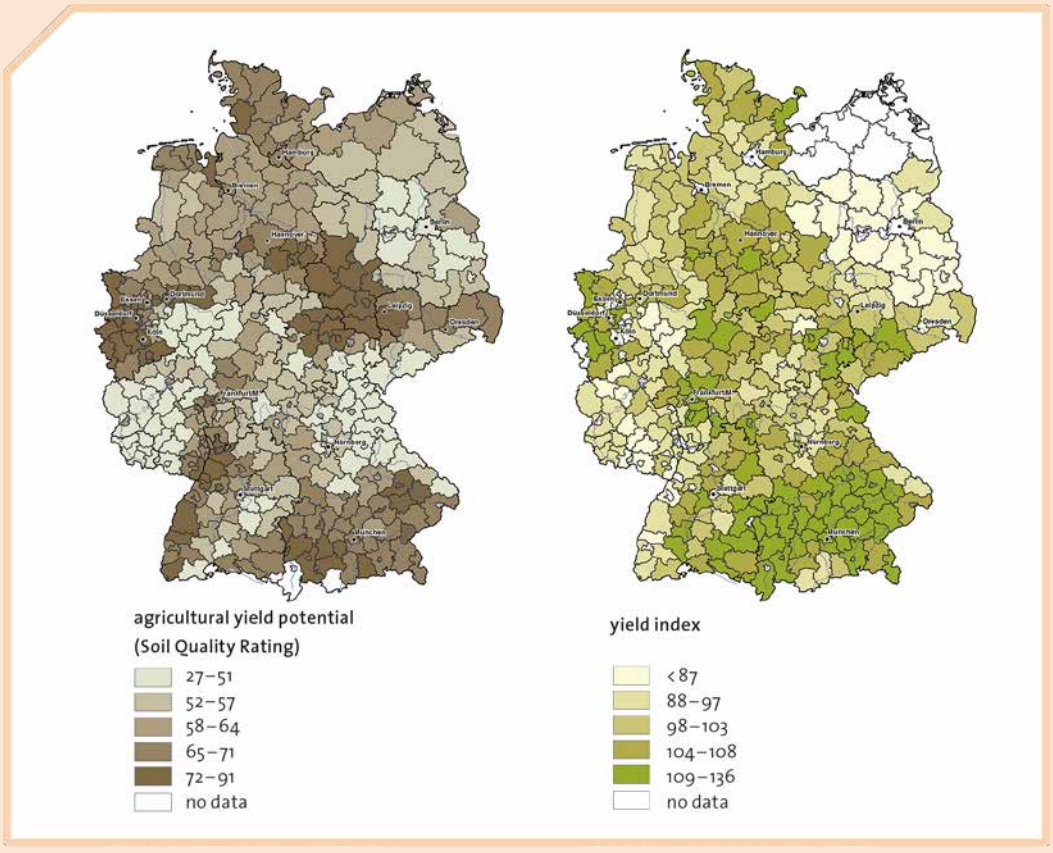


FIGURE 31 ▸ Natural fertility of farmland
(Source: Charts from Ifuplan/ ETH-Zürich, quoted from Albert et al., 2015a)

Figure 31 (left) illustrates the »natural« soil fertility (potential yield) of German districts (which has of course been historically influenced by human activity). The indicator reflects the existing natural capital in this sector. The diagram on the right shows the average yield of farmed land per district. As a used ecosystem service, the yield includes both the »natural input« and the human input (manpower, infrastructure etc.). This visual comparison helps to illustrate the relationships between yield and natural capital.

Natural soil fertility is obviously very important for yield, but is not the sole determining factor. In some regions, yields are now almost »decoupled« from their natural origins (e. g. in parts of Mecklenburg-West

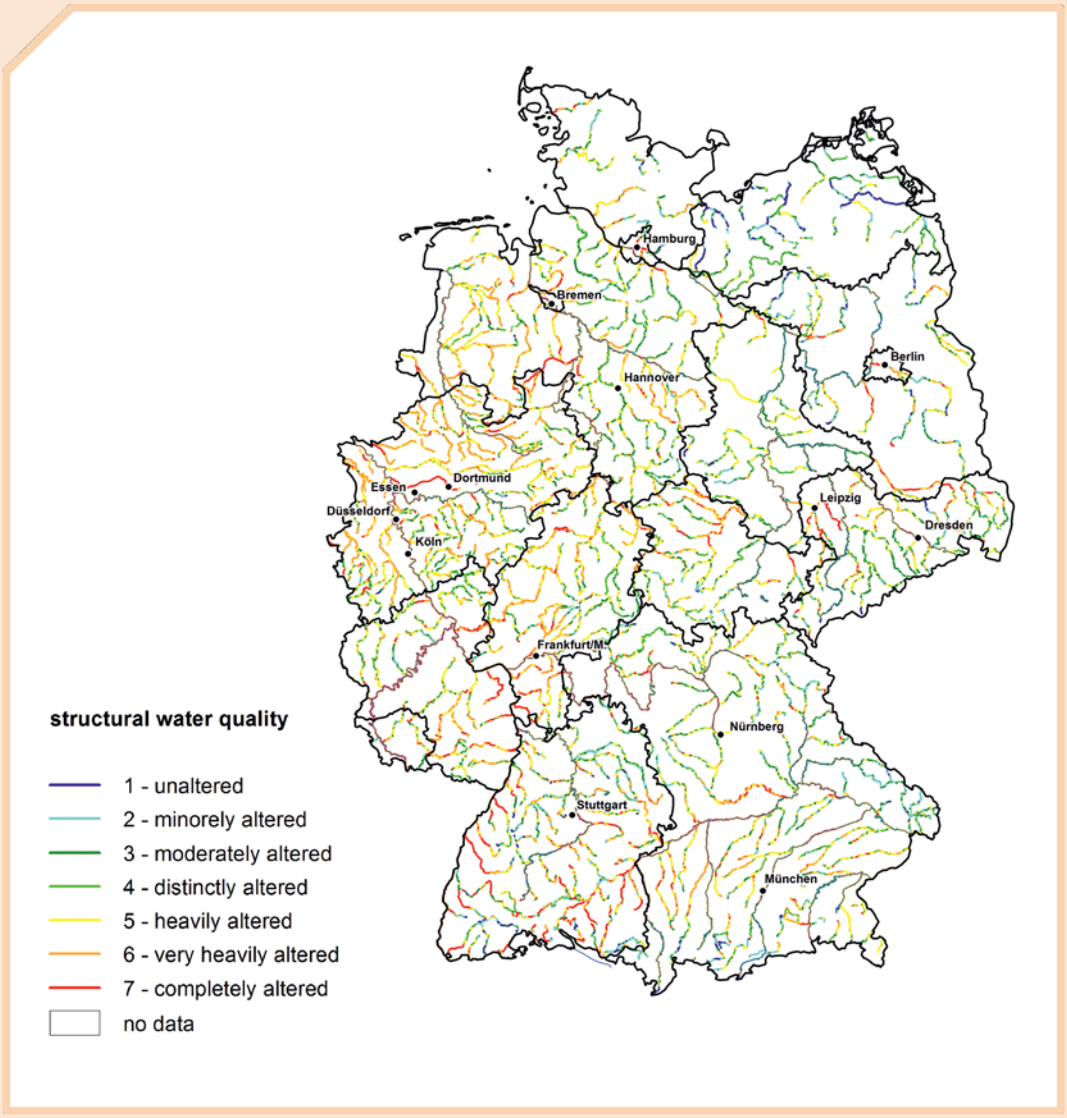


FIGURE 32 ▸ Structural quality of German watercourses. (Source: charts from Ifuplan/ ETH-Zürich, quoted from Albert et al., 2015a)

Pomerania), suggesting either that special crops are cultivated (with specialised demands on location, e. g. in wine-growing regions) or that the high yields are due to the use of fertilisers, pesticides and irrigation (e. g. in the north Hanover region).

Figure 32 illustrates the »self-purification potential of watercourses«. This indicator is formed from the proportion of total waterbody length with good structural quality. The map indicates where the natural supply of ecosystem services is good, in this case in relation to watercourses.

It is particularly significant that an economic perspective can promote an approach that transcends political and administrative boundaries. Regulations to date have either focused on individual cases (regional development) or been very limited in their approach (e. g. the EU Water Framework Directive WFD). The economic perspective highlights the fact that nature conservation is in the interests of society as a whole and therefore worth pursuing, without denying that protecting natural resources costs money. However, it is a matter of viewing these costs within the context of detailed information on the associated individual and societal benefits. It will be informative for public decision-making to disclose the societal disadvantages of a policy path that disregards natural capital protection only because of the short-term costs incurred by private businesses. In short, an economic perspective of ecosystem services enriches and, where necessary, helps to change political decision-making.

3.2 IMPLEMENTING MEASURES: STRIKING A BETTER BALANCE BETWEEN PROTECTION AND USE

3.2.1 Minimising the drivers of natural capital loss: Enforcing environmental targets more resolutely

Three key negative trends in the environmental development of rural regions are (1) the large amount of land used for human settlements and transport, (2) emissions of nutrients from agriculture into waterbodies (including the North and Baltic Seas) and near-natural habitats, and (3) the loss of species-rich grassland. For all three phenomena, the problems have long been recognised, but existing targets have not been met and/or there are deficits in the defined mechanisms.

(1) The **adverse ecological, economic and social consequences of land use for human settlement and transport purposes** have been extensively documented, and have led, inter alia, to the setting of the 30 hectare target as part of the National Sustainability Strategy, which aims to reduce the additional land used for human settlement

and transport purposes from its current level of more than 70 ha to 30 ha/day by 2020. Regardless of whether this target is sufficient to permanently protect Germany's natural resources, the land-saving incentives thus far have been completely inadequate. Although various government incentives for land use, such as the home-owners' allowance, have been phased out, others remain in place, such as the commuter income tax allowance and the dependency of local government budgets on their share of income tax, business tax and property tax revenues, which is population-dependent, and municipal financial equalisation (cf. inter alia Schröter-Schlaack, 2013; SRU, 2002, 2004). As a result, rural communities in particular often designate building and commercial sites in an endeavour to promote economic development and boost the number of residents (also competing with neighbouring communities), even in communities with falling population figures. In principle, regional planning would be a suitable superordinate control mechanism, but in the same way as landscape planning at local government level (Gruehn and Kenneweg, 1998; Heiland et al., 2006; Wende et al., 2009), it tends to exert qualitative control over land use. Many Länder lack the political and legal powers to restrict local government planning sovereignty regarding the extent of land use. In particular, there is a lack of suitable quantitative control mechanisms at supra-municipal level to implement the 30-hectare target (cf. Köck and Bovet, 2011; Köck et al., 2007).

For years, various mechanisms have been debated as possible solutions for **reducing disincentives** and achieving the 30 hectare target, including measures to promote cooperative planning between local governments (Bock et al., 2011), business tax (Fuest and Huber, 2003) and property tax reforms (Bizer et al., 1998; Löhr, 2004), tradable development permits (Bizer et al., 2011; Henger and Bizer, 2010), a combination of tradable development permits and regional planning (Schröter-Schlaack, 2013; SRU, 2004), ecologically-based fiscal equalisation between municipalities (Perner and Thöne, 2007; Ring, 2001, 2008) or the introduction of a Federal Compensation Ordinance (draft: BMU 2013). Intervention provisions under nature conservation law offer incentives to use less land and preserve land with high-quality ecosystem services, such as land with high natural soil fertility, and exempt it from development. A mix of quantitative control instruments like (tradable) permits and the aforementioned instruments of detailed, on-site quantitative and qualitative controls could achieve a more effective control of land use. This would help to avoid mis-investments by the municipalities (e. g. in infrastructures) which put long-term pressure on their budgets.

(2) In the past, there have been extensive efforts to **reduce the pollution of water bodies with nutrient discharges**, as a result of which contamination from point sources, particularly wastewater treat-

ment plants, has been significantly reduced. However, efforts to reduce diffuse emissions from the land in order to preserve biodiversity, achieve the targets of the Water Framework Directive and avoid high treatment costs for current and future drinking water supplies have been less successful. The average nitrogen balance surplus in Germany is still around 100 kg N/ha, around 20 kg N/ha higher than the German Government's sustainability strategy target. Agriculture in Germany is now the largest source of reactive nitrogen emissions into the environment, accounting for 57% (Balzer and Schulz, 2015) (see section 2.2).

FIGURE 33 ▸ Application of pesticides on agricultural land. Querfurter Platte, Saxony-Anhalt. (Photograph: André Künzelmann, UFZ)

A variety of approaches and mechanisms are being debated to resolve or ameliorate this problem. Examples include the definition, tightening and more stringent enforcement of regulations governing the use of agricultural fertilisers, taxes on fertilisers, nitrogen surpluses and pesticides (Möckel et al., 2015), expanding the advice given to farmers, and tighter restrictions on new barn constructions in regions with a high cattle population. One framework control mechanism currently under discussion is to raise the rate of value added tax for meat products, which is currently lower for agricultural products, with the aim of passing on the particularly high consequential costs of animal husbandry to society (Lünenbürger et al., 2013; Möckel, 2006; UBA, 2009, 2013).

At the same time, **environmentally sensitive regions must be given special protection from emissions of nutrients and contaminants**. There are established planning, regulatory and subsidy options in place to implement the necessary management changes in drinking water abstraction areas, in sensitive biotopes such as species-rich, nutrient-poor grassland, or in the buffer zone surrounding near-natural habitats in agricultural landscapes and riverbank buffer zones. Examples include water protection areas with special land use restrictions and subsidies for water-friendly farming under the EU Common Agricultural Policy. This is supplemented by the contractual agreements between water utilities and farmers mentioned in section 2.2. Compensation under the intervention provisions of the nature conservation law can often be combined with water protection targets and implemented in water protection areas, thereby simultaneously promoting both ecosystem services and biodiversity. Once again, consistently reducing nutrient emissions at the source will save significant costs to society.

(3) There are numerous arguments in favour of the **permanent conservation of grassland, particularly grassland with a high nature conservation value**, not least the high costs to society of ploughing it up into agricultural fields. EU agricultural policy and its implementation in Germany aim to preserve permanent grassland and limit its loss to

FIGURE 34 ▸ Landscape at river Saar. (Photograph: Heinz Teuber, pixabay.com)

around 5 % (maximum) of a reference value. Permanent grassland may only be ploughed up if new grassland of an equivalent size is created elsewhere. If more than 5 % of the reference value of permanent grassland is lost despite this regulation, special protection measures and restoration requirements will come into play. Nevertheless, it is theoretically possible for grassland losses to exceed the aforementioned 5 % mark if a sufficiently large number of farmers decide to forego subsidies under the first pillar (direct payments) in favour of grassland ploughing. Quantitative grassland conservation targets should therefore be incorporated into national administrative law and made binding for all farmers. For example, Schleswig-Holstein has adopted a Permanent Grassland Conservation Act (Act dated 7 October 2013, GVOBL Schleswig Holstein, 2013: 387) which prohibits the ploughing up of permanent grassland (into fields), irrespective of any premium entitlement.

Furthermore, the current regulations designed to compensate for ploughing up grassland by creating new grassland elsewhere fail to effectively protect old grassland which is particularly valuable for climate and biotope protection. In newly created grassland, it can take years for the carbon stocks to match the levels of established permanent grassland. Species diversity likewise takes years or even decades to match the quality of established sites, if this is even possible. Additional specific protection measures are therefore needed in order to fully retain the functions and services of established and species-rich grassland, assuming that the land has previously been identified (e. g. in landscape planning). For enforcement reasons, consolidation of the different grassland protection regulations spread across numerous Federal and Länder laws is urgently needed (Möckel et al., 2014). Finally, preserving HNV grassland also requires permanent, habitat-modified management. Financial incentives in the form of contract-based nature conservation or agri-environmental and climate protection measures (see also section 3.2.2), supported by other measures such as special product marketing (hay, beef from extensive meadows and pastures), could make an important contribution in this connection (see also Box 11).

One thing is clear: There are numerous ideas for concerted action to counteract the threats to natural capital in rural regions areas, but it is now a matter of introducing and/or implementing these measures with high priority. Existing reduction targets for land use, nutrient surpluses and the ploughing up of grassland must be highlighted as key economic objectives, given the high costs to society of current development trends. We must minimise the forces that are destroying natural capital, and implement existing environmental objectives more effectively.

BOX 11

Agrobiodiversity – Reinsurance for our security of supply and cultural value

The term -> »Agrobiodiversity« refers to all elements of -> Biological Diversity which are important as genetic resources for food or relevant for agriculture, forestry and fishing. In addition to the diversity of livestock and crops, breeds and varieties, it also includes biodiversity elements which supply key ecosystem services for agricultural and forestry production, such as nutrient cycles, soil formation and conservation, the regulation of pests and diseases, seed distribution and pollination, and the control of soil erosion, the hydrological regime and climate. A growing number of studies indicate that diminishing biological diversity impairs precisely these ecosystem services (cf. inter alia Bianchi, 2014; MA, 2005). For example, pollination services by insects, which are often pivotal to the production of fruit and vegetables, indicate a downward trend in the Netherlands and the United Kingdom, among others (cf. Biesmeijer et al., 2006; Vanbergen/Insect Pollinators Initiative, 2013). Pest control by predators and insects is less pronounced in intensively farmed regions (cf. Tscharntke et al., 2005). Soil management in conventional, intensive farming has also been shown to impair nutrient cycles in the soil and its ability to absorb water (cf. Brussaard et al., 2007; Jongmans et al., 2003).Furthermore, since the 19th century, the spectrum of crop plant species has decreased significantly. At present, the calorie requirements of the world's population are met almost entirely by just 30 plant species, which supply 95 % of all plant-based food (BfN, 2015). Harvests of just three »main sources of nutrition« - wheat, rice and corn - cover 50 % of our energy demands worldwide (BLE, 2008). It is estimated that more than 90 % of crops have been genetically eroded since the start of the 20th century (BfN, 2015). Livestock shows a similar picture: worldwide, over the past hundred years, 1,000 of the 6,500 livestock breeds have become extinct, and in Germany, of the 74 native breeds used in livestock farming, 52 of the five main livestock types are classed as endangered (BLE, 2013).

A high level of agrobiodiversity safeguards the future foundations for human life, by providing a wide genetic pool. Concentrating on just a few species or high-performance breeds, species or varieties can harbour yield risks, e. g. if new diseases or environmental changes emerge. The loss of genetic diversity means that all future breeding opportunities are lost forever, making it more difficult for animals to become resistant and adapt to unforeseen health risks or current and future economic and ecological challenges such as climate change, the shortage of energy resources, changing consumer requirements, and an evolving market situation.

A decrease in agrobiodiversity also means a loss of cultural heritage, since cultivated landscapes with their typical animal breeds and crop varieties are a part of regional identity, with a high experience and recreational value (BfN, 2010).

A diverse range of management and production methods is also closely related to agrobiodiversity, since many of its components inevitably rely on human activities. Anything which is not actively used (cultivated, bred, processed, sold or eaten) is ultimately threatened with extinction (BMEL, 2007). The conditions which forced an increase in agricultural productivity in Europe have changed: The consequences of a globalised economy and the associated pressure to adapt, rather than a lack of food, are leading to a concentration of production, processing and trade, alongside the standardisation and narrowing of products and production techniques (project group »Developing agrobiodiversity«, 2004).

A wide range of measures is needed to counteract the loss of agrobiodiversity, including the development and operation of gene banks to preserve seed varieties that are no longer used. The principle of »protection through use«, i. e. preserving as much diversity as possible in production, is vital (BMEL, 2007). Crucially, we must promote organic farming and other forms of sustainable agriculture, varied crop rotation, conserve and sustainably develop a regional-specific diversity of crop and cattle varieties and breeds, and conserve wild plants and animals for sustainable

FIGURE 35 ▸ Harvesting apples on Bölingen farm near Bonn. (Photograph: Bio Hof Bölingen)

use as food. The diets and demands of consumers are likewise pivotal. Consumers need ecological knowledge and tools, such as certifications and quality assurance systems, if they are to exert influence (BMEL, 2014).

A number of approaches have been devised to make »protection through use« financially attractive, by marketing heritage cattle breeds or other elements of agrobiodiversity: For example, the Schorfheide-Chorin (Naturkapital Deutschland case study, 2015) and Rhön biosphere reserves successfully market certified products from these protected areas. The »Heimat braucht Freunde« initiative by BUND in Lower Saxony helps to alleviate the cost of landscape management in protected areas e. g. by marketing White Polled Heath sheep (cf. Albert et al., 2009). Numerous other approaches for conserving agrobiodiversity have been trialled in model and demonstration projects (see BLE, 2011). We must improve the economic and legal framework conditions for the conservation and sustainable use of agrobiodiversity to preserve cultural values and safeguard our food resources and security of supply.

3.2.2 Rewarding the diversity of ecosystem services: Linking agricultural payments more closely to societal benefits

As well as reducing the adverse impacts of land use on natural capital, incentives such as payments to reward ecological services can also play a vital role in preserving natural capital. In particular, the Common Agricultural Policy (CAP) offers opportunities here, with its dominant influence on ecosystem services in rural areas and substantial budget: Just under 40 % of the funds in the EU budget are allocated to agricultural policy. Efforts to preserve biological diversity and provide ecosystem services could be significantly improved with a **redistribution of existing funds** under the European CAP. Around 70 % of the EU's agricultural expenditure takes the form of direct land-based payments to farmers, and is used primarily to support their income.

Agricultural production is a provisioning service, and also contributes positively to other ecosystem services (such as preserving open landscapes, preserving cultural landscape, encouraging groundwater recharge). However, it is often associated with adverse impacts on biodiversity and other (regulating, cultural and supporting) ecosystem services. Species diversity in the agricultural landscape continues to decline at an alarming rate, farming generates significant emissions of climate gases, and in many areas, water contamination has increased and the aesthetic quality of the landscape has deteriorated further (Pe'er et al., 2014). A UK study estimates the external (i. e. societal) costs of agricultural production in the United Kingdom at more than GBP 2.3 billion per year (Pretty et al., 2000), while for Austria, the external costs have been estimated at around 1.3 bn Euro per year (Schader et al., 2013). These types of financial calculations aid policy-making by highlighting the pros and cons of different policy options in the achievement of environmental targets and the associated external economic effects.

For efficient policy-making, it is important to internalise both the negative and the -> Positive External Effects of agriculture, so that the societal costs and benefits can be incorporated into private decisions. The law defines and distributes so-called property rights (also known as rights of disposal/rights to act/ utilisation rights). Examples include statutory provisions governing the nature and manner in which pesticides and fertilisers are applied, the sequence of cropping, or the preservation of humus levels in soil. Generally speaking, »good agricultural practice« represents the political »dividing line«, below which the polluter-pays principle applies: In order to achieve a politically legitimate environmental target, property rights can either be further restricted, e.g. with tighter regulations on originator obligations in good agricultural practice; or farmers can be rewarded for services above and beyond good agricultural practice standards. For the latter, adequate public funding must be made available. This shows that policy-makers have an opportunity to recharge societal costs to the originator, or conversely, to reward him for benefits to society. Crucially, public funding must be aligned more closely with economic aspects and must focus on achieving a broad, balanced bundle of societal targets; this also includes the relevant biodiversity and nature conservation targets, as set out in the national biodiversity strategy, for example. The two approaches discussed below illustrate how this could be achieved: (1) First pillar of agri-environmental policy: Discontinue, or at least reduce, direct land-based payments and (2) Second pillar of agri-environmental policy: Broaden agri-environmental and climate measures as a performance-based reward, and use them efficiently.

First pillar of EU Common Agricultural Policy: Phasing out direct payments

Agricultural policy first introduced the concept of direct payments in 1992, and it was subsequently modified and reformed over time. The reform replaced the policy of guaranteed government prices which had led to over-production, and become increasingly expensive, given the abolition of external tariffs agreed under the Uruguay round of the General Agreement on Tariffs and Trade (GATT). Instead, direct income subsidies were introduced to compensate for differences from the world market price level, and thereby safeguard farmers' incomes, and from 2003 were decoupled from production. Subsequently, direct payments were no longer justified by socio-political considerations alone, but also by arguing that this would compensate for higher demands on farming (including higher environmental conditions).

Since 2005, part of the direct payments have been linked to environmental conditions (cross-compliance, and more recently »greening«), which supports the application of good agricultural practice in

FIGURE 36 ▸ Meadow orchard in the Swabian Mountains in Baden-Württemberg.
(Photograph: Hans Braxmeier, pixabay.com)

Germany (and several other conditions). Violations are punishable by fines. To date, however, these conditions have failed to effectively reduce the high environmental pressures and loss of biological diversity, including agrobiodiversity, associated with farming (see Box 11) (Scientific Advisory Board on Agricultural Policy at the BMELV, 2010).

Against this background, we must question the appropriateness of direct payments and consider whether the funds currently allocated to the first pillar might better be channelled directly into environmental and nature conservation measures. There are good arguments for a gradual reduction in direct payments: Firstly, as in other areas of environmental policy, the polluter-pays principle should be applied to the environmental problems caused by (intensive) farming. This requires the originator to bear the cost of preventing environmental impairments. The current rules of good agricultural practice in Germany are already well-developed in this regard, but require supplementation and concretisation, for example in the areas of grassland protection, crop diversity, the use of fertilisers and pesticides, and the conservation and restoration of structural elements. In principle, land users must comply with these conditions without financial compensation. In the case of land meriting special protection, recourse must be made to the mechanism of top-down land and property protection. Protecting extensively farmed, species-rich agricultural land and conserving and supplying ecosystem functions and services which require special management measures above and beyond the requirements of environmental law requires significantly more funding than is currently available for agri-environmental and climate measures and contract-based nature conservation.

The current CAP period expires in 2020. In the medium term (beyond 2020), a **continuous reduction in direct payments under the first pillar** (»phasing out«) has been agreed over a defined period. This **money could then be channelled into other measures** – under the aforementioned principle of »public money for -> PUBLIC GOODS« (cf. also Wissenschaftlicher Beirat für Biodiversität und Genetische Ressourcen beim BMELV, 2011; UBA, 2011). In particular, this could secure better funding for the second pillar of the Common Agricultural Policy, which is almost unanimously supported and demanded (cf. also Wissenschaftlicher Beirat für Agrarpolitik beim BMELV, 2010). At the same time, this could create new opportunities for farmers to generate revenues which are not dependent on the development of raw materials markets by providing services e. g. to conserve biological diversity (Wissenschaftlicher Beirat für Biodiversität und genetische Ressourcen beim BMELV, 2008).

Second pillar of EU Common Agricultural Policy: Extent performance-based agri-environmental schemes

By **phasing out the first pillar and simultaneously topping up the second pillar** of agricultural policy, wider support could be given to agri-environmental and climate protection measures to reward ecological services. In particular, the available funds should be carefully deployed to achieve the greatest environmental effects.

A large proportion of funds from the second pillar is currently used to provide general environmental services, often on a nationwide basis. This may allow them to reach areas where they are particularly effective and efficient. For example, organic farming tends to be practised primarily in areas where the positive effects on biodiversity are particularly pronounced (see also Bredemeier et al., 2015). In general, however, these less ambitious nationwide measures merely lead to windfall gains, which in turn reduces the efficiency of the funds used: The main participants tend to be land users who implement the measures with minimal additional input, without creating any notable contribution for biodiversity and ecosystem services above and beyond good agricultural practice.

By contrast, only a small portion of funds is set aside for more ambitious measures that focus on achieving additional results. **The more targeted deployment of public funds from the second pillar, e. g. on land in need of additional action, and a sharper focus on performance-based rewards, could significantly boost the efficiency of agri-environmental and climate measures.** Farmers could become providers of ecological services that the naturalistic potential of their farms or their operating structure makes them particularly well placed to provide. Offering these services to tender in areas which lend themselves to such instruments could help, firstly, to achieve so-

ciety's goals at the lowest financial cost, and secondly, to ensure that farmers are rewarded on an attractive scale. These reward systems also meet the requirements of the World Trade Organisation (WTO).

Further efficiency gains could be achieved if **funding would be focused on multifunctional measures, including species and biotope protection** (Meyer et al., 2015). For example, in the district of Verden, Galler et al. (2015) investigated the efficiency of multifunctional measures on four key landscape functions: Erosion protection, maintaining water quality, climate protection, and nature conservation. Compared with agri-environmental and climate protection measures specialising in water, soil or climate protection, the level of target achievement per unit of land is more than doubled, and the cost efficiency of the multifunctional measure concepts is up to 60 % higher with the same individual target achievement level.

Restructuring the CAP could release additional funds for nature conservation-compliant measures. Wüstemann et al. (2014) calculated a societal benefit of more than 9 bn Euro/year and total costs of around 3.3 bn Euro/year (excluding government expenditure on personnel, calculated for the period 2010 to 2020) for implementing a range of nature conservation targets. Around 1.4 bn Euro/year will be needed for one-time investment projects (e. g. to improve the status of protected areas), and around 1.9 bn Euro/year for the maintenance of existing areas. Put another way, if **part of the EU agricultural subsidies in Germany over the period 2014 to 2020** totalling some 6.3 bn Euro/year (BMEL, 2015b) were to be **re-directed into environmental and nature conservation projects** or used in a more targeted way, we would be able to meet key nature conservation targets, including our international obligations on the protection and conservation of species and habitats.

The current regulations on co-financing are also in need of improvement. Whereas money from the first pillar is 100 % financed by the EU, the second pillar envisages co-financing by the *Länder*, and also Federal Government within the context of the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK). Until now, the Länder have been liable for the entire co-financing portion of ambitious nature conservation measures. Reducing co-financing levels would allow less wealthy *Länder* to fund ambitious environmental and nature conservation measures more extensively.

FIGURE 37 ▸ Documenting biodiversity on a meadow. (Photograph: agrarfoto.com)

At a fundamental level, however, we question an EU policy which provides 100% support for individual incomes under the first pillar, yet demands co-financing for European-wide social interests under the second pillar. The fact that rural areas are indirectly supported via direct payments is not an argument for »watering can« distribution of the funds, if there is an alternative of investing these funds more selectively in rural regions.

One essential accompanying measure would be to **support farmers in documenting the environmental and nature conservation services provided, and give wider support to nature and environmental consulting for farmers**. At present, this form of consulting is not established nationwide. To encourage acceptance of administrative guidelines and special funding measures, such consulting should focus integratively on the diversity of ecosystem services. Similar consulting services should also be offered and financed for forest managers (see Box 12).

BOX 12

Forest ecosystem services – Incentivising forest owners

The German public is highly appreciative of forests, and not only because of their value as a source of timber. Nationwide studies value the benefits of their recreational services and biodiversity conservation at around 2 bn Euro/year in each case, on a par with the raw wood production value (see Meyerhoff et al., 2012; Elsasser und Weller, 2013. Forest and forest management play a key role in the achievement of climate targets (cf. Naturkapital Deutschland – TEEB DE, 2015). When it rains, forests delay water runoff and have a balancing and stabilising effect on the hydrological regime, something which will become increasingly important as we adapt to the effects of climate change. Structural diversity encourages this effect (Schüler, 2007). Groundwater reserves underneath forests are best protected from nitrate emissions, with deciduous forests the most effective at buffering atmospheric nitrogen emissions (Hegg et al., 2004). Groundwater recharge also tends to be higher under deciduous forests than coniferous forests.

FIGURE 38 ▸ Autumn in Westerwald. (Photograph: Oliver Heine, pixabay.com)

Although current forest management and timber harvesting practices already ensure a wide range of ecosystem services, here too there are -> Trade-Offs and synergies with scope for optimisation. Compared with farmers, there are currently few financial incentives for private forest owners to provide non-marketable ecosystem services and nature conservation measures. More extensive funding programmes should not reward the production of goods for which functioning markets already exist. Similarly, no additional financial incentives are need-

ed for the by-products of marketable goods created at no additional cost. Rather, the aim would be to reward ecosystem services above and beyond the current forest management regulations, and whose anticipated benefits exceed the additional costs associated with their supply.

Modifying agricultural policy in this way would make it possible to link agricultural subsidies more closely to societal services, and more effectively reward contributions to the supply of a diverse and socially balanced range of land-based ecosystem services. Financial incentives undoubtedly help to protect Germany's natural capital and biological diversity.

FIGURE 39 ▸ Near-natural cultivated landscape.
(Photograph: Broin, pixabay.com)

3.3 INTEGRATING POLICIES: REALISING ADDITIONAL SOCIETAL BENEFITS

In rural areas, land use is subject to conflicting social interests. For policies that are organised along sectoral lines and collaborative administrative actions, the key challenges include, firstly, identifying shared benefits and, secondly, organising cooperation to achieve multifunctional solutions (cf. Hubo and Krott, 2013). Furthermore, many stakeholders view environmental and nature conservation interests as sectoral targets, rather than the starting point for integrated social solutions that draw on -> SYNERGIES to serve multiple targets. One of the problems is that the benefits are widely dispersed. For example, unlike dyke maintenance, the benefits of renaturing a floodplain are not confined to flood protection, but also contribute to nature, climate and water protection (cf. Dehnhardt et al., 2015).

Where responsibility is shared between different administrations, other practical hurdles arise, such as the distribution of funds (from the finance division) among the individual departments. For one department to advertise (»sell«) a successful programme is not necessarily conducive to joint, cross-sectoral solutions.

Against this background, the EU's **»green infrastructure«** strategy (European Commission 2011; 2013) and related concepts, such as the blue-green infrastructures (Voskamp and van de Ven, 2015), play an important role in safeguarding the natural capital of rural areas. Alongside other objectives (such as health and climate aspects), these types of green infrastructures also help to protect and develop near-natural areas, and are crucial for the long-term protection of biological diversity and ecosystem services. As well as the European -> Natura 2000 network, nature areas outside of protected areas also play a vital role (cf. Fuchs et al., 2010; Maes et al., 2015). Examples include flood plains in river meadows which protect against flooding, or forests and grassland which regulate the hydrological balance, control air pollution and protect against erosion. The **ecosystem services perspective highlights the benefits of green infrastructures (in deliberate contrast to the grey infrastructure), estimates their social value, and supports the preservation and restoration of underlying ecosystems** (cf. Albert and von Haaren, 2014; Kopperoinen et al., 2014; cf. also Box 13). Benefit flows allow us to identify the various user groups that benefit from green infrastructures, and thereby encourage the integration of various sectoral interests and public participation (cf. Schröter-Schlaack and Schmidt, 2015).

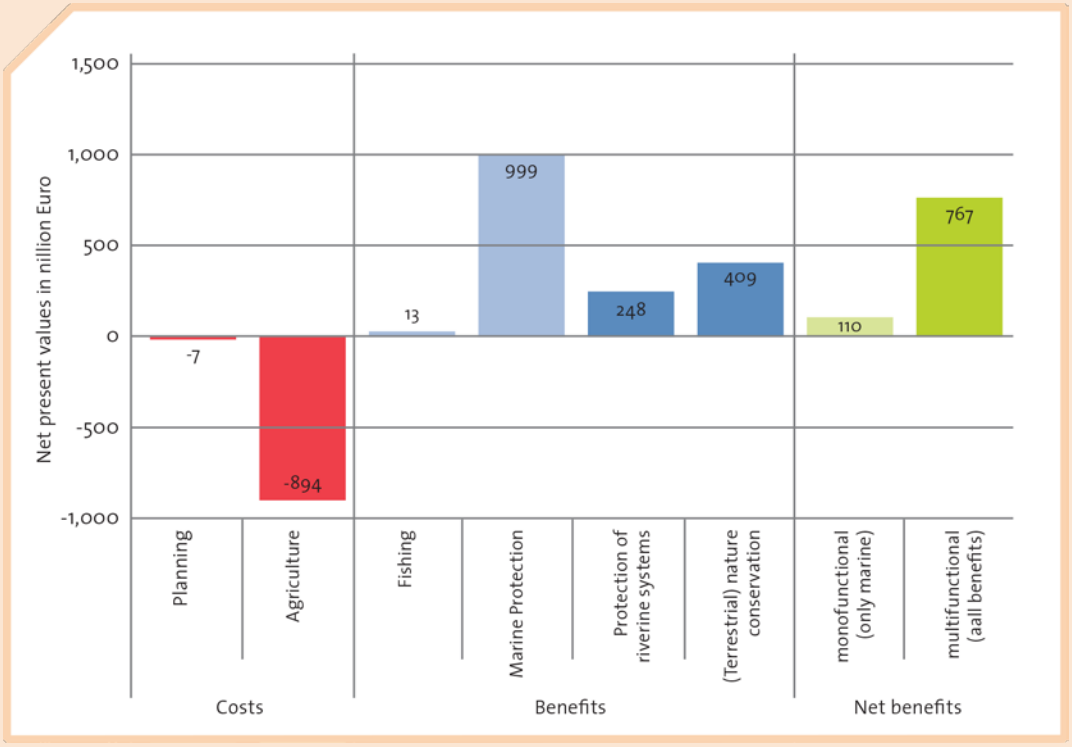
BOX 13

Acknowledge the multi-functionality of green infrastructures: Case study on the benefits and costs of riverbank buffer zones

Riverbank buffer zones should be reviewed for cost effectiveness within the context of implementing the Marine Strategy Framework Directive in line with the Directive's guidelines. An expert report commissioned in this connection (Marggraf et al., forthcoming) concludes that the benefits of this measure for the marine environment only slightly outweigh the costs (benefit/cost ratio: 1.1:1). Ranked against other alternative measures to improve the marine environment, this might have led to the measure being dropped. It was subsequently proposed that, as well as assessing the positive impacts on the marine environment, the effects on watercourse quality and nature protection should also be taken into account. By incorporating these additional benefit components, the measure did not just produce a marginal improvement but a significantly positive result (see Figure 40, benefit/cost ratio of

the multifunctional perspective 1.8:1). Over the 20-year monitoring period, the economic benefits of the measure outweigh the cost by more than 760 m Euro. This calculation excludes other benefit components such as the erosion protection effect described in section 2.3 of this report, the provision of habitats for pollinating insects, or the contribution to pest control, and the longer-term environment and nature conservation effects occurring beyond the monitoring period. A better understanding of the economic dimensions of these effects and/or a longer monitoring period would have revealed even greater benefits, and probably improved the cost/benefit ratio of this measure still further.

FIGURE 40 ▸ Costs and benefits of riverbank buffer zones in Lower Saxony from the viewpoint of marine conservation and from a multifunctional perspective. All data given as net present value (NPV) over a 20-year monitoring period with a discount rate of 2 %.
(Source: Own diagram based on data by Marggraf et al., forthcoming)



The **economic perspective of ecosystem services in rural areas can also be incorporated into preventive environmental plans, such as landscape planning or plans** for implementing the EU Water Framework Directive. Collaboration between the authorities responsible for the various environmental media would depend on a shared environmental information system and/or a modular, joint environmental plan derived from landscape planning. Within the context of promoting regional development, the LEADER projects of recent years illustrated the diversity of solutions for the integrated development of rural regions which are both cost-effective and environment-friendly. If joint solutions can be found, nature conservation and environmental

protection will not be free, but nevertheless significantly cheaper than sectoral strategies. **Regional planning could play a significant role as an interdisciplinary, coordinating agency** between specialist administrations, by combining mechanisms and financing options for -> Integrated Rural Development solutions. One positive example in regional planning is the multifunctional instrument of regional green corridors. As well as protecting land from development, regional green corridors also offer a wide range of options for achieving environmental targets with incentive-based and legal mechanisms.

Similar trends are emerging in EU funding policy. The new **cross-sectional targets for the various EU subsidy funds may encourage greater integration of sectoral policies in rural areas in future**. The LEADER approach has been following this path for many years. The local stakeholder groups in the LEADER projects supported by the EU and the Länder have created structures which showcase the development of regional cooperation networks and may serve as a basis for improvement. One key principle of and prerequisite for support under the LEADER scheme is the involvement of key stakeholders from agriculture and forestry, tourism, regional development and nature conservation. In a similar way, national funding could be linked to the involvement of relevant interest groups or the performance of a multifunctional assessment of a given measure's effects. This could inspire farther-reaching cooperation between sectors. However, when targets above and beyond environmental protection are integrated with other utilisation plans and authorities, it is important to ensure that the interests of environmental protection and nature conservation remain clearly recognisable.

In summary, it is clear that the ecosystem services approach and the assessment of the societal benefits of integrative environmental and nature conservation-based solutions (e.g. for climate, flood, water protection, air pollution control, protection from erosion, recreation and regional economic development) are elemental for fully appreciating nature's importance as the basis for human wellbeing and economic development. At the same time, merely highlighting the social and macroeconomic pros and cons is not enough; **we need mechanisms for -> Policy Integration and joint administrative action to pave the way for protecting and restoring natural capital in rural areas in a way that transcends sectoral boundaries.** Policy integration remains a key challenge, particularly in the areas of agriculture and forestry, alongside energy, settlement and transport policy. An integrated policy could significantly reduce the adverse impacts of land use on nature and ecosystem services in rural areas, both to help us achieve the set environmental and nature conservation targets, and

also to identify and actively exploit synergies. Protecting and developing natural capital also helps to connect stakeholders in the area of integrated rural development in a way that benefits human wellbeing.

FIGURE 41 ▸ LEADER is a European funding programme that has been supporting innovative and participatory local development projects in rural areas since 1991. Based on an inclusive local development concept, projects in all fields of rural development - agriculture, public services, village development, environment, regional development – may be funded.
(Photograph: German Networking Agency for Rural Areas (DVS)/Federal Office for Agriculture and Food (BLE))

4 SUSTAINABLE USE OF OUR NATURAL CAPITAL: AN ECONOMIC IMPERATIVE

Germany's rural areas are characterised by a diverse range of natural areas and supplied with a wide variety of -> Ecosystem Services. However, the diverse and growing demands on the use of rural areas are leading to an intensification of land use. Focusing single-mindedly on the short-term use of selected -> Provisioning Services weakens other ecosystem services (regulating services, cultural services), and often undermines the foundations of production and supply (e. g. soil loss, groundwater contamination).

As a result, in many of Germany's rural areas, -> Natural Capital is in decline. The supply of various ecosystem services cannot be permanently guaranteed. For example, rural areas use more land for human settlement and transport purposes than urban areas. The associated loss of farmland tends to encourage an intensification of production on the remaining land. The production of marketable provisioning services to meet our demand for food, energy and raw materials is displacing, endangering or increasing the cost of the supply of other ecosystem services which markets cannot valorise in the same way. As well as diminishing -> Biodiversity in the agricultural landscape, other effects include a reduced supply of certain ecosystem services, such as -> Regulating Services being lost as a result of developed meadows and sealed soils. Often, we fail to notice the adverse consequences of inequitable competition for land and ecosystems until it is too late, when the ecosystem's performance has already been significantly impaired or lost. These services are not only crucial for the inhabitants of rural areas, but also for urban areas and their residents, as well as for future generations who have no say in the preservation

of -> Biological Diversity and the sustainable use of ecosystem services.

Given the limited supply of land, ecosystems and ecosystem services, decisions concerning the nature, extent and intensity of land use inevitably involve weighing up which ecosystem services are achieved and to which extent. The market cannot do this. Government control must therefore do more to ensure and support the sustainable use of nature and the supply of socially balanced combinations of ecosystem services in rural areas.

Germany offers favourable requirements for this form of control: Environmental awareness among the general population is high, and nature and landscape are comparatively well-protected by the law and administrative regulations. For example, information on the occurrence of and impairments to species, habitats and -> Ecological Balance functions is compiled and made available as the basis for planning and decision-making processes on plans and projects, and the formulation of conservation targets. Legal mechanisms (national, EU) and measures for the sustainable use of natural resources are applied on this basis. The aforementioned factors have helped us to achieve a number of environmental and nature conservation success stories in Germany, and despite the conflicting interests, we have managed to prevent a further degradation of natural resources, unlike other parts of the world where such legal foundations are lacking.

Despite this, Germany continues to fall short of the national and international environmental and nature conservation targets it has committed to, in some cases substantially. The 2014 Indicators Report on the German National Strategy on Biological Diversity showed that the measures taken to date are insufficient to meet the targets set out in the Strategy. Of the 13 indicators which define specific target values, 11 are still far or very far outside the target range (cf. BfN, 2015b; BMUB, 2015a; 2015b).

Although -> Policy Integration has long been a declared political objective, the poor representation of environmental and nature conservation interests in deliberations is a key reason for the failure to meet these targets. When it comes to the sustainable use of nature, the required policy change is still outstanding (BMUB, 2015b), and management conditions and incentive systems continue to give inadequate consideration to natural resources with their diverse benefit flows. Many political sectors outside of specific environmental and nature conservation policy, such as agricultural, energy, climate, settlement and transport policy, fail to adequately incorporate the services provided by nature (cf. Hansjürgens, 2015). Environmental and nature conservation interests are considered sectoral, and often

secondary to economic and social interests. Inadequate weighting is given to the economic importance of environmental and nature conservation and their role in human wellbeing.

The -> Economic Perspective adopted by Naturkapital Deutschland – TEEB DE offers an additional opportunity for a more balanced view of the importance of the various ecosystem services. Economic analyses and assessments indicate:

- The economic costs associated with a loss of natural capital
- The incentives responsible for the current (over-)use of natural capital
- Which individuals and stakeholder groups benefit from which ecosystem services, and how they are affected by environmental changes.

Sometimes economic analyses can give a clearer picture than other assessments of:

- How important the various ecosystem services are for humans and regional development
- Which government regulations and mechanisms can encourage the supply of socially balanced ecosystem service bundles; and finally
- Which -> Synergies can be created between varying societal objectives when different stakeholders and land use sectors collaborate on nature use.

In this way, the economic perspective can become an important link between different policy sectors: Environmental concerns can be described in a »language« that is common to all policy-making and administrative sectors. The economic perspective can also support and complement indispensable analyses and assessments of nature use in line with current legal standards.

However, the available instruments to protect natural capital and promote its sustainable use must be consistently implemented and reinforced by specific application regulations. As illustrated by the examples chosen for this report, there is still substantial room for improvement in this regard. The sustainable use of natural capital is an economic opportunity, not a barrier to development (cf. TEEB, 2010). Ensuring that nature and its ecosystem services are protected and used sustainably is not the sole concern of nature conservation, and

FIGURE 42 ▸ Farm track. (Photograph: Broin, pixabay.com)

is not merely an ethical consideration, but a vital investment in human wellbeing and sustainable economic development for current and future generations.

GLOSSARY

AGROBIODIVERSITY

All the elements of biological diversity which play a role in food and agriculture, forestry and fishing. Alongside crops and livestock, this also refers to aspects of -> biological diversity which support -> ecosystem services such as nutrient cycles, soil formation and conservation, pest and disease control, seed distribution, pollination, and the regulation of soil erosion, the hydrological balance and climate, which are key to agricultural and forestry production.

ALTERNATIVE COSTS

-> Opportunity costs

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 photosynthesis, 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 our planet (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.

CO-PRODUCTION

Simultaneous production of multiple products or the influence of multiple ecosystem services in a single production process for natural or technical reasons, such as agricultural production, and the associated influence on the landscape.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

International convention on the protection of biological diversity, signed at the UN Conference on Environment and Development in Rio de Janeiro (1992). In Germany, the CBD is supported by the German National Strategy on Biological Diversity. The three key aims of the Convention on Biological Diversity, all of which have equal weighting, are: 1) the conservation of biological diversity, 2) the sustainable use of its components and 3) the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

CULTURAL SERVICES

Cultural ecosystem services are a category of -> ecosystem services that impact and are important to recreation, aesthetic perception, spiritual experiences, ethical requirements, cultural identity, a sense of place, knowledge and discovery.

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 around 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.

ECO-ACCOUNT

-> Offset measures designed to compensate for or substitute future -> interventions in nature and landscape are accumulated in an eco-account in the form of eco-points. A land owner can claim eco-points for implementing suitable measures and guaranteeing the permanent protection of the land. A developer can purchase appropriate eco-points to meet his offset obligations depending on the severity and nature of the project's intervention in nature, to avoid having to carry out the compensation and substitution himself. -> Land pool

ECOLOGICAL BALANCE

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

ECONOMIC ASSESSMENT

Assessment of the value of a commodity or service in a specific context, often in monetary variables. The economic assessment is based on the preferences of those affected (anthropocentric assessment approach). Economic assessments are often summarised into cost/benefit analyses. If not all services are or can be assessed in monetary terms, other techniques, such as cost-effectiveness analyses, are used.

ECONOMIC PERSPECTIVE

The economic perspective considers nature and ecosystem services from a scarcity viewpoint. Recommendations are developed for balancing the trade-offs in the supply of different ecosystem services, focusing on benefit/cost aspects. For the purposes of this report, the economic perspective is defined as 1) Being aware of the scarcity of the diverse services provided by nature for humans, and the associated individual and social value, 2) Highlighting the values of nature and ecosystem services to support decisions based on various -> economic assessment techniques and 3) Investigating the framework for action by the relevant stakeholders, and tools and measures for handling -> natural capital more efficiently (-> valorisation).

ECOSYSTEM

Refers to the components of a defined nature area (e. g. Wadden Sea in Lower Saxony) or a specific type of nature area (e. g. low-nutrient watercourses) and the interactions between them. The term may refer to various spatial levels (local, regional) and comprises both (semi-)natural (e. g. undisturbed upland moors), near-natural (e. g. calcareous low-nutrient meadows) and anthropogenically influenced ecosystems (e. g. agro-ecosystems).

ECOSYSTEM SERVICES

Direct and indirect contributions by ecosystems to human wellbeing, i. e. goods and services which offer direct or indirect financial, material, health or psychological benefits for humans. To distinguish it from ecosystem function, the term ecosystem service refers to the anthropocentric perspective, and concerns the benefits of an ecosystem for humans. Also known as »ecosystem goods and services«.

EXTERNAL EFFECTS

Positive or negative effects of economic activities (consumption or production) on uninvolved third parties or on nature and the environment which are not reflected in market prices and which therefore are not taken into account in the originator's actions. -> Internalisation of external effects, -> Negative external effects, -> Positive external effects

GREENING

Under the Common Agricultural Policy, direct payments to the farm-owners who observe climate- and environmentally-friendly agricultural practices. Greening comprises the following measures: 1) Crop diversification, 2) Maintenance of permanent grassland and 3) Designation of Ecological Focus Areas.

HABITATS DIRECTIVE

European Union directive on nature conservation (Council Directive 92/43/EEC of 21 May 1992). The Directive aims to conserve wild species of fauna and flora, conserve their habitats, and develop a coherent system of protected areas (networking, -> Natura 2000 areas).

INTEGRATED RURAL DEVELOPMENT

Integrated rural development aims to simultaneously develop rural areas as places to live and work, as well as for recreation and nature. The various interests should be given equal weighting as far as possible, to ensure that future development does not occur at the expense of individual development objectives. Natural capital in rural areas may play a vital role here.

INTERNALISATION OF EXTERNAL EFFECTS

Measures to incorporate -> external effects, i. e. the disregarded (positive or negative) effects of production or consumption, into decision-making calculations. Examples include financial subsidies for nature conservation measures in agriculture which cannot be compensated via increased market prices for the products generated, or levying a surplus nitrogen charge on farmers to mitigate the adverse impacts on the environment and health of excessive nitrate pollution levels, e. g. in groundwater.

INTERVENTIONS IN NATURE AND LANDSCAPES

Interventions in nature and landscapes, as defined in § 14 of the Federal Nature Conservation Act (BNatSchG), refer to any »changes affecting the appearance or use of areas, or changes in the groundwater table associated with the activated soil layer, which could lead to considerable or lasting impairments of the efficiency of the balance of nature or of the natural scenery«.

INTERVENTION RULING

The intervention ruling is based on the legal foundations outlined in §§ 14 ff. of the BNatSchG. Interventions in nature and the landscape are to be avoided and minimised. Unavoidable interventions should be balanced by compensatory and substitute measures.

LAND POOL

Under § 16 of the BNatSchG, land pools and -> eco-accounts refer to the stocking of advance compensation and substitution measures. This refers to nature conservation and landscape management measures as defined in § 15 (2) of the BNatSchG, which are carried out at no legal obligation, for which no public funding has been claimed, and for which records of the original land condition are available (cf. http://www.bfad-dokumente.de/Downloads/Definitionen_Flaechenpool_Oekokonto_BFAD_2014.pdf).

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 ocean territory.

NATURAL CAPITAL

Economic term for (finite) natural resources, in the same way as physical capital or human capital. Natural capital is a metaphor for the valuable but limited supply of the earth's physical and biological resources and the limited availability of goods and services from ecosystems. 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, if the stock is retained or at least does not drop below critical levels.

NEGATIVE EXTERNAL EFFECTS -> External effects, -> internalisation of external effects

OFFSET MEASURE Offset measures in the sense of »compensation measures« and »substitution measures« as defined in § 15 of the BNatSchG refer to measures implemented in order to compensate for unavoidable and non-reducible interventions. Some Federal Länder allow existing or future nature conservation measures by private or public agencies to be sold to developers in the form of »eco-points«, who can then meet their statutory compensation or substitution obligations in this way. The eco-points are similar to the certificates used in emissions trading. They reflect the value of offset measures implemented, and are sometimes accumulated in a so-called -> eco-account.

OPPORTUNITY COSTS The benefits foregone from failing to select an alternative, in this instance, an alternative use of land and ecosystems. Example: Farming profits which would have arisen, had an area not been renatured as a water meadow.

POLICY INTEGRATION Integration of cross-sectoral tasks that transcend individual policy areas, particularly the consideration of -> natural capital in the »originator sectors«, such as agriculture, energy, climate, settlement and transport policy (horizontal integration) and the mobilisation of potential at various policy levels (vertical integration).

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).

POSITIVE EXTERNAL EFFECTS -> External effects, -> internalisation of external effects

PROVISIONING SERVICES Provisioning services are a category of -> ecosystem services and refer to the contribution of ecosystem services to the production of goods and services for humans (such as food, fresh water, firewood and construction wood) and are often traded via markets.

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 include ecosystem functions which act on (other) ecosystem elements and processes and which offer (direct) benefits for humans, such as the filtering effect of soil strata on groundwater quality, or a hedge's contribution to minimising soil erosion.

RENATURATION

Measures to convert anthropogenically modified habitats into a more semi-natural state.

SYNERGY (PLURAL: SYNERGIES)

Interaction between forces that mutually benefit one another. This may lead to a shared benefit for various goal, 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, e.g. when the supply of one ecosystem service (such as landscape elements like hedges protecting against erosion) encourages other ecosystem services (such as pollinating services, groundwater purification, landscape aesthetics). The opposite of synergies are -> trade-offs, where different objectives or the supply of different ecosystem services conflict with one another.

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 aegis of the United Nations Environment Programme (UNEP). The TEEB study aimed to estimate the economic value of the services provided by nature, to measure the financial effects of damage to ecosystems, and on this basis, to elucidate the costs of a failure to act and outline 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.

TRADE-OFF(S)

Exchange relationships, e.g. relating to the supply of different ecosystem services, between mutually opposing forces: 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. These trade-offs must be weighed up against one another in each specific case. The opposite of trade-offs are -> synergies, as mutually beneficial effects.

VALORISATION	A bundle of measures designed to ensure that the benefits of conserving biodiversity and providing a socially balanced range of ecosystem services are incorporated into decisions regarding the nature, scope and intensity of the use of natural resources. This includes supplying 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.
WELLBEING / HUMAN WELLBEING	This term was coined primarily by the »Millennium Ecosystem Assessment«. It defines what constitutes »quality of life«, and incorporates fundamental material goods, health and physical well-being, good social relationships, security, inner peace and spirituality, as well as freedom of action and decision-making.
WILLINGNESS TO PAY (WTP)	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).
WTP ANALYSIS	An economic technique for measuring willingness to pay, based on surveys. A »contingent valuation« assesses willingness to pay under certain (»contingent«) conditions. Willingness to pay can be established using a variety of techniques, of which the WTP analysis is just one. Unlike many other economic assessment methods, it can also include ecosystem service values that do not depend on their use.

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NOTE ON THE COMPREHENSIVE ACADEMIC REPORT

This summary reports use findings from the comprehensive academic report »Naturkapital Deutschland – TEEB DE: Ökosystemleistungen in ländlichen Räumen – Grundlage für menschliches Wohlergehen und nachhaltige wirtschaftliche Entwicklung«, which was published in 2016 in German language and to which the following authors and experts contributed:

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Part 1: Identifying ecosystem services in rural areas: Fundamental principles and definitions

Chapter 1: Introduction
Christina von Haaren (coordination); Christian Albert, Bernd Hansjürgens, Sebastian Krätzig, Christoph Schröter-Schlaack

Chapter 2: Ecosystem services: Recognising, demonstrating and capturing
Christoph Schröter-Schlaack, Christina von Haaren, Nele Lienhoop (coordination); Christian Albert, Jan Barkmann, Olaf Bastian, Claudia Bieling, Carolin Galler, Karsten Grunewald, Bernd Hansjürgens, Tobias Plieninger

Chapter 3: Ecosystem services in rural areas
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Part 2: Assessing ecosystem services in rural areas

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Chapter 7: Ecosystem services of coasts and oceans
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