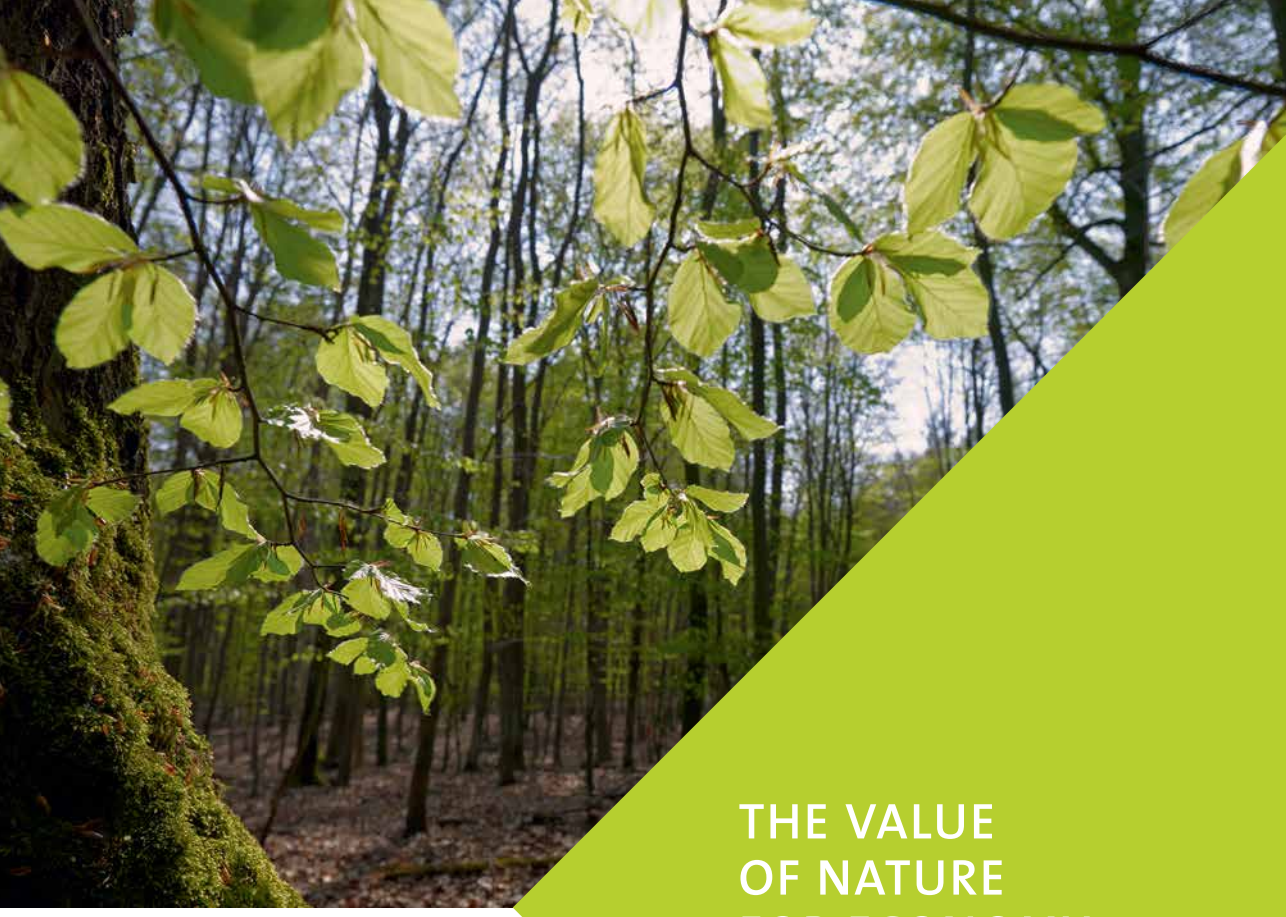

# THE VALUE OF NATURE FOR ECONOMY AND SOCIETY

## AN INTRODUCTION

NATURKAPITAL
DEUTSCHLAND – TEEB DE

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## AN INTRODUCTION

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**Natural Capital Germany – TEEB DE**
»Natural Capital Germany – TEEB DE« is an interdisciplinary project that applies the issues and findings of the international study on The Economics of Ecosystems and Biodiversity (TEEB) to the conservation of biodiversity and ecosystem services in Germany.
The international TEEB study was jointly initiated by Germany and the European Commission during Germany's 2007 G8 presidency. It was hosted by the United Nations Environment Programme (UNEP) and carried out in collaboration with numerous other institutions. The Study Leader of TEEB International was the Indian economist Pavan Sukhdev.
The Study Leader of »Natural Capital Germany – TEEB DE« is Prof. Dr. Bernd Hansjürgens of the Helmholtz Centre for Environmental Research – UFZ in Leipzig. Like TEEB International, Germany's TEEB study is based on voluntary cooperation of numerous scientists and practitioners. The project is supported by an Advisory Board whose role, apart from providing advice, is to help promote a wide public debate concerning the project's main topic. In addition, a Stakeholder Committee supports the participation of relevant societal groups in the project.

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The views expressed in this report are solely those of the authors and in no way reflect the official views of the participating organizations.

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»Natural Capital Germany« is a metaphor for the values entailed by our natural environment and for the ecological services that it can produce – services that form a key basis for our economy and our quality of life. Our natural capital is a finite resource, and if we exhaust it the ecosystem services it provides will no longer be available to us.

Hence »Natural Capital Germany« is a name that was consciously chosen for the continuation of the international TEEB process in Germany. It is also a name that represents a major challenge. For many current issues related to land use, like the German Energiewende (energy transition) or the future of agriculture, are inextricably linked with the impact of human activity on biodiversity and ecosystem services. We need to bring to light the trade-offs between ecosystem services, the vested interests of various groups of users, and the complex ecological interactions in this domain. »Natural Capital Germany« aims to show that in addition to its intrinsic value as well as its aesthetic and emotional values, nature is also of major economic importance – a fact of which we are often less aware than we should be.

»Natural Capital Germany« is seeking to change this, in partnership with the Helmholtz Centre for Environmental Research – UFZ and all other project participants. This brochure provides an introduction to the topic. Further publications and activities are in the pipeline, with the goal of equipping society with the means to incorporate the values of nature into decision making in politics, administration as well as business and private consumption – for the good of us all.

We invite you to read this brochure and hope the case studies will inspire and motivate you. For the fact of the matter is that each and every one of us can and should do our part to safeguard the values of Germany's natural capital. As I see it, this is not only our responsibility and obligation with respect to future generations, but also because it makes good economic sense to do so, starting today!

**PROF. DR. BEATE JESSEL**
(President, Federal Agency for Nature Conservation)

# 1 AN ECONOMIC PERSPECTIVE ON NATURE'S SERVICES

FROM AN ECONOMIC POINT OF VIEW, NATURE IS AN ASSET WHICH SHOULD BE PRESERVED. WE HAVE TO LIVE FROM THE INTEREST AND NOT FROM THE CAPITAL ITSELF.

MEMORANDUM ECONOMICS FOR NATURE CONSERVATION (2009)

FOR FAR TOO LONG WE HAVE HELD THE VIEW THAT THERE ARE (...) ONLY TWO TYPES OF CAPITAL, NAMELY FINANCIAL AND HUMAN CAPITAL. (...) FOR A LONG TIME NOW, WE HAVE DELUDED OURSELVES INTO THINKING THAT THERE IS NO SUCH THING AS ENVIRONMENTAL CAPITAL AND THAT WE CAN USE THE ENVIRONMENT FOR FREE AND DO NOT NEED TO REINVEST IN THIS CAPITAL STOCK.

KLAUS TÖPFER, SEPTEMBER 6TH 2005, 5TH ANNUAL CONFERENCE OF THE GERMAN COUNCIL FOR SUSTAINABLE DEVELOPMENT, BERLIN

**KEY MESSAGES**

- Biodiversity and nature's benefits – our natural capital – are the pillars of our economy and well-being. Nature, along with human and manufactured capital, is an asset that provides us with essential services.
- The value of nature is often hidden from view because its services appear to be available for free in unlimited quantities. This is why, despite legal requirements for nature conservation, the value of nature is not sufficiently taken into account in societal and economic decisions. This has far reaching consequences, for nature is only able to provide its valuable services sustainably if the processes and functions that are essential for these services are safeguarded.
- An economic perspective helps to shed light on the value of nature and its myriad services and will hopefully encourage both private and public sector decision makers to adopt solutions that take nature's value sufficiently into account. Such a perspective is also a source of economic arguments for the conservation of »natural capital« that complement the relevant ethical and ecological arguments.
- »Natural Capital Germany – TEEB DE« is Germany's contribution to the international TEEB process (The Economics of Ecosystems and Biodiversity). This brochure provides an introduction to this topic and a starting point for work on further in-depth reports.

## 1.1 NATURAL CAPITAL FOR OURSELVES AND OUR CHILDREN

The immense value of nature is readily apparent whenever you take a walk in a forest, bite into an apple, or observe kids' fascination with the creatures that live in brooks and streams. But few of us are aware of the fact that nature is indispensable for our prosperity and well-being, as well as for countless activities in the agricultural, forestry, and fisheries sector, and many more besides. The lives of most inhabitants of industrialized nations such as Germany are dominated by technical systems that keep the cogs of daily life turning; one need only think of communication, traffic as well as supply and disposal systems. The internet, satellite TV, high speed trains, and the availability of abundant fresh food year round all help to create the impression that our needs can be largely met without factoring nature into the equation. But nothing could be further from the truth. In countless domains our -> WELL-BEING and prosperity are directly or indirectly dependent on nature's services.

Nature provides us with a broad spectrum of services (-> section 2). Nature in all its diversity (-> box 1) is many things: a key driver of innovation in areas such as R&D for new medications and industrial raw materials; an »inventor« whose ingenuity we draw upon for technical advances such as bionics; and a gene pool that will help us to provide enough food for the Earth's population for generations to come. Such ecosystem services (-> box 1) also include greenhouse gas sequestration, for example in forest wood and peatland soils, as well as the provisioning of clean groundwater. Nature also provides various kinds of protection: natural floodplains reduce the risk of flooding, while mountain forests help to prevent avalanches. Nature also contributes to our health and provides us with -> CULTURAL SERVICES. Diverse natural areas help to improve our quality of life and promote employment, particularly in the sphere of ecotourism in coastal areas, mountains or in large-scale protected areas like national parks, biosphere reserves, and nature parks.

The products and services of nature have long been regarded as a given and have mostly been used free of charge. But the finite nature of natural resources and the damage being sustained by -> ECOSYSTEMS are becoming ever more readily apparent and are proving to be very costly to our society. This is clearly illustrated by numerous examples around the world.

BOX 1

FIGURE 1 ▸ Small tortoiseshell.
(Photo: Metronom GmbH)

**Biodiversity and ecosystem services**

Biological diversity (in short: biodiversity) refers to the diversity of life on our planet. It means the variability among living organisms and the ecological complexes of which they are part. -> BIODIVERSITY includes the following three aspects:

- Ecosystem diversity, i. e. diversity of communities, habitats and landscapes
- Species diversity
- Genetic diversity within the various species

In contrast, ecosystem services constitute the direct and indirect contributions of ecosystems to human well-being – which is to say goods and services that directly or indirectly provide us with economic, material, health or psychological -> BENEFITS. In contradistinction to the term -> ECOSYSTEM function, the term ecosystem service focuses on an anthropocentric perspective and is related to the benefits of ecosystems for human beings. The focus of »Natural Capital Germany« is on ecosystem services, with the goal of finding new and complementary ways of looking at biodiversity conservation.



BOX 2

**Impacts on environment and nature at the global level**

According to the Millennium Ecosystem Assessment, two thirds of the world's ecosystems have been degraded (MA 2005). Thus the services they would ordinarily provide are greatly impaired – a phenomenon that in some areas has a catastrophic impact on those concerned. In this process, we are bound to see an increase in many of the drivers of the destruction of nature:

- Climate change is already having a far reaching effect on both terrestrial and marine ecosystems, owing to reduced water supplies in many parts of the world, soil degradation, declining agricultural productivity, heat stress in urban areas, and the increasing risk of extreme events (IPCC 2007).
- Worldwide water consumption increased six-fold between 1930 and 2000, while climate change and water pollution have reduced the available supplies of fresh water. It is estimated that by 2020 up to 40 percent of all Asian and sub-Saharan African nations will be suffering from severe water shortages (UNESCO 2012).
- Between 2000 and 2010, net annual forest loss amounted to 5.2 million hectares, despite massive afforestation efforts; this is equivalent to more than the area of the German state of Lower Saxony (FAO 2010A). This loss increases carbon dioxide emissions, affects the regional water balance, provokes biodiversity loss, and destroys the livelihoods of millions of people.
- Fish are the main source of protein for around three billion people. However, owing to unsustainable fishing practices 32 percent of all fish populations are currently overfished, while 53 percent are completely depleted (FAO 2010B). Management practices aimed at regenerating fish populations would not only conserve the food sources for the populations affected, but would also make the fishing industry 50 billion US dollars more profitable.
- Overuse and destruction of invaluable mangrove, coral reef and other ecosystems make the populations in the regions affected more vulnerable to floods, storms and the like, impinge on their food sources (coral reefs occupy 1 percent of the world's oceans but provide habitats for 25 percent of the marine biomass) and threaten the existence of the habitats of rare species.

FIGURE 2 ▸ In many countries fish plays a central role in people's diet as the main source of protein.
(Photo: mlehmann78, fotolia.com)

FIGURE 3 ▸ Coral reefs are places of great biodiversity but endangered by climate change.
(Photo: Mahmoud Habeeb)

**FIGURE 4** ▸ Poppy bud. (Photo: Metronom GmbH)

Conservation and the sustainable use of nature and biodiversity pay off – also economically. For stewardship of the very underpinnings of human well-being and livelihoods is far less cost intensive than attempts to restore destroyed ecosystems or replace natural resources – if this is at all possible. The goal here is not to put price tags on flora and fauna or calculate a single monetary value of all of our **-> NATURAL CAPITAL** (-> section 3), but instead to raise awareness of the value of natural capital (-> box 4), with the goal of taking this value better into account in private, corporate and public decision making – particularly in light of our moral obligation to future generations. To this end, illustrative cases will be presented of how decision makers in politics and business can deal with Germany's natural environment in an economically sensible manner.

Many ecosystem services are increasingly endangered owing to the heavy pressure they are subjected to, and despite existing conservation laws. Of particular concern in this regard is that these vital services are threatened on a global scale (-> box 2).

But in Germany as well, despite certain successes such as in the field of water quality of rivers and lakes or the establishment of protected areas, we are seeing a steady loss of biodiversity and the services of an intact natural capital (-> box 3). Global warming is causing changes in precipitation patterns, is having a negative impact on parts of agricultural and forestry production and is placing increased pressure



BOX 3

**Selected ecological problems in Germany**

Nonstop nutrient input from industrial production processes, fossil fuel combustion, transport, and agriculture induce high levels of soil, groundwater, surface waterbody and ocean pollution resulting from nitrogen and phosphate. The result is that Germany's coastal areas and in particular inshore waters exhibit poor waterbody statuses as defined by the EU Water Framework Directive criteria (Nausch et al. 2011). Despite the massive financial resources that have been poured into ameliorating this situation, we are nowhere near to reaching our goals.

- Constructions on Germany's rivers have permanently impaired the natural flood retention capacities of floodplains, which in turn exacerbates high-flow phenomena and results in greater damage than would otherwise be the case. It has been estimated that only 10 to 20 percent of the former floodplains on large stretches of the Rhine, Elbe, Danube and Oder rivers are still usable for flood retention. This necessitates technical flood protection which increasingly reaches its financial and technical limits. Only around 1 percent of the original surface areas of natural floodplain forests are still in a natural state, and even a lesser amount of the original floodplains of former wet grasslands are still in existence (BMU/BfN 2009). These developments translate into less recreational areas and biodiversity loss.

- Nearly 75 percent of Germany's 690 biotope types are classified as »endangered«, i.e. they are on the so called Red List of endangered biotope types (BMU 2009), while more than one third of Germany's vertebrate species are classified as »extinct«, »untraceable« or »currently endangered« (BfN 2009). Of the remaining 65 breeds of the key farm animal species (horses, cows, pigs, sheep and goats), 54 are classified as »endangered« (BLE 2010). And so while biodiversity is being lost, we remain in the dark as to the possible repercussions of this evolution.

- The transformation of semi-natural areas and farmland to build roads and houses continues to the tune of some 70 hectares per day in 2014 – the equivalent of around 100 soccer fields (STBA 2015). This results in, among other things, soil sealing and soil loss, landscape fragmentation, and negative effects on water run-off and the microclimate. When zoning boards decide which areas to allow construction in, they often underestimate such effects, as well as the costs of building and maintaining public infrastructures for such areas.

**FIGURE 5** ▸ The Eurasian Eagle Owl (bubo bubo) was nearly extinct in Germany in the early 20th century. But thanks to species protection programs, the populations of this species were considerably increased. The Eurasian Eagle Owl favours highly structured landscapes with a mix of open space and forests. The species is endangered by factors such as collisions with power lines and electrocution by under-built and unsafe electrical pylons. (Photo: Katherine Haluska, Fotolia.com)

on flood control and other infrastructure systems. Ecosystems, and thus directly or indirectly human populations as well, are increasingly being confronted with environmental pollution, while habitat fragmentation and land use attributable to urban sprawl and increased transport are provoking the loss of heretofore intact, connected ecosystems and green spaces. Intensive food production often undermines soil and biodiversity conservation. And in recent times, biofuel crop cultivation has exacerbated this process. Also, we need to bear in mind that we Germans are part of a world community and that our consumption habits and lifestyles ultimately contribute to environmental problems on a global scale.

## 1.2 WHY AN ECONOMIC TAKE ON NATURE CAN HELP

No reasonable person would contest the proposition that nature is an asset in itself that we need to safeguard, for we have a moral and constitutional obligation to safeguard the natural resources that form the basis for our very livelihoods. »Natural Capital Germany« is exploring the ways in which an economic perspective can promote appreciation of the values of nature (-> section 3 and box 19) – in addition to and beside its »intrinsic« value and without neglecting or even replacing the goal of preserving nature as a value in and of itself.

**FIGURE 6** ▸ Semi-natural floodplains mitigate damages by floodings. At the same time, they may serve for agricultural purposes, e. g. as meadows for livestock. (Photo: Metronom GmbH)

In Germany, legal requirements have been on the books for many years concerning the stewardship of nature as well as ecosystem services. And so the question arises as to why it is necessary to also explore an economic view on nature. »Natural Capital Germany« is predicated on the thesis that ecosystem services are not sufficiently factored into social and economic decisions because (among other reasons) these services are freely available as -> PUBLIC GOODS and their economic value is neither known, quantified nor assessed adequately. But this is not to say that these public goods should be privatized (-> box 5). Important from an economics point of view is that nature's values are identified and insofar as possible quantified, so that these benefits and values can be increasingly incorporated to their full extent – including their economic dimension – into decision making at all levels. The current neglect of this economic dimension is yielding policies and practices in many domains that come at the cost of -> BIODIVERSITY and ecosystem services. One need only think of intensive farming, designation of new residential and commercial areas in river floodplains, and economic-feasibility assessments of projects and installations: the decisions made in these domains rarely if ever factor in all of nature's values and services (-> section 3 and boxes 15 and 21).

By retaining flood waters, semi-natural floodplains mitigate damage to buildings and infrastructures and thus reduce private and public sector costs and improve the bottom lines of insurers. But as these



BOX 4

**Natural capital and ecosystem services**

Natural capital is a concept that encompasses nature and all the diversity of its species, communities and ecosystems. Moreover, natural capital – besides technical capital (machines, production facilities and so on) and human capital (knowledge, labour) – forms the basis for economic value creation and prosperity. Ecosystem services are indispensable for the production of myriad goods and services; they also promote health and thus form the basis for human well-being.

Nature constitutes »capital« in the economic sense of the term, and its services can be regarded as »dividends« that our society receives. Stewardship of our stock of natural capital will ensure that these dividends are durably available for future generations as well. Nature conservation and sustainable use of natural resources are thus imperative to economic farsightedness and responsibility.

The terms natural capital and ecosystem services have strong »anthropocentric« connotations. They stem from an utilitarian perspective unlike the concept of nature's »intrinsic value«, which is »biocentric» or »ecocentric« (-> section 3 and box 19).

economic benefits are rarely if ever ascribed to floodplains, the purported economic benefits of converting or diking them are often illusory. In many such cases, systematically factoring in all of the costs saved would have helped to allow for the conservation of floodplains that otherwise fall victim to the zeal of construction engineers.

Another example, which is discussed in greater detail in section 2, is converting grassland to cropland. This is often profitable for growers but can also increase greenhouse gas emissions, as well as the degradation of ground water and surface waters. The individual farming benefits resulting from the conversion of a grassland ecosystem to a cropland ecosystem make farming operations more profitable. But unfortunately, the loss of grassland filtering and sink services generates costs that society as a whole has to defray in the guise of additional water purification and greenhouse gas mitigation measures. Conducting an across the board cost-benefit analysis in this domain would provide additional impetus for more sustainable agricultural practices.

Further examples can easily be found: urban green spaces reduce healthcare costs; picturesque landscapes in tourist areas are good for the restaurant business; and swimming in a clean lake is more popular

nowadays than paying to swim in a swimming pool. The same problem arises in all these cases – namely that the economic values of services that are provided free of charge are not taken into account or ascribed to ecosystems.

BOX 5

**Economic valuation of nature versus »commodification« of nature**

Many environmentalists have reservations about or reject economic analyses of nature, mainly out of a fear of turning nature into a commodity by putting price tags on its various components that would ultimately result in their commercialization, potentially leading to a »fire sale« of these elements.

There is a concern that the manner in which we quantify nature's value will also affect – or perhaps more accurately infect – our attitudes and behaviour toward nature. And as all such valuations are part of a social and cultural context and are driven by vested interests, valuating nature in monetary terms could potentially undermine the goal of nature stewardship (TEEB 2010A). And indeed, this take on things appears to be borne out by what has actually occurred in the field of climate protection. Counting forests as carbon sinks in connection with international climate policy instruments such as REDD (Reducing Emissions from Deforestation and Degradation) that are currently under discussion raises expectations of enhanced values of the forests concerned. In many developing countries, this phenomenon has provoked, among other things, real estate speculation that has driven up land prices, with often untoward consequences for local populations – and for the natural environment, in the guise of monocultures.

Taking a critical view of economic valuation can prevent us from jumping to conclusions concerning such instruments when applied to nature and its ecosystem services. For economically assessing nature's value does in no way necessarily lead to privatization and marketing of our natural capital, but can instead show us that we need to strengthen regulatory and planning instruments in order to safeguard nature as a public good. In other words, economic valuation needs to be carried out cautiously and responsibly. By no means is the goal to posit equations where the »values« of ecosystem services are offset against each other without taking into account the relevant ecological settings and nature's intrinsic value. In terms of economic incentives and markets, the key factor is to create the institutions (such as designing property rights, liability rules, and resource access) that promote the desired outcomes in terms of environmentally and socially compatible production and consumption.



The main goal of recognizing, demonstrating and capturing the economic significance of nature's services is not to assess these values in monetary units (-> MONETIZATION). What is fundamentally involved instead is clearly showing how important it is to fully take account of the qualitative and quantitative significance of ecosystem services; whereby monetization is only one method among many. Moreover, an economic approach is often unjustly reduced to its valuation aspect alone, despite the fact that this approach involves more than first meets the eye. The -> ECONOMIC VALUATION process involves not only quantitative and monetary valuation or assessment per se, but also identification of the impact of a measure, project or environmental change and ascertaining the impact of such elements through the use of suitable indicators or metrics (-> section 3). Oftentimes, identifying the features of the natural environment and biodiversity as well as systematically and comprehensively documenting environmental change can matter more than the economic valuation itself. Moreover, the issue as to which factors have which effects to whom and how these effects unfold is more important for decision making than knowing the pecuniary benefits of a particular element (-> box 5). In other words, the purpose of an economic valuation is not to hang a price tag on the »features« of nature. What actually matters is this: raising awareness of the multi-functionality of various ecosystems; identifying, determining, and fully taking into account all services that come into play; and analyzing how the costs and benefits of these services are distributed to all concerned. And indeed, expressing the economic value of the benefits of keeping ecosystems intact in a metric other than money may ultimately provide greater clarity than would be the case if only monetary value is used. In this process, we need to bear firmly in mind that much of the damage to our environment is irreversible and that nature's products and functions are not exchangeable at will – if only for ecological reasons.

**FIGURE 7** ▸ Picturesque landscapes attract tourists.
(Photo: eyewave, fotolia.com)

**FIGURE 8** ▸ Parks are local recreation hot spots open to everybody.
(Photo: micromonkey, fotolia.com)

Thus an economic take on nature and its ecosystem services takes account of their economic value, apart from their ethical and cultural value – and thus can show that nature is a form of capital, similar to manufactured and human capital (-> box 4). It then becomes possible to show which stakeholders benefit from nature's services and which end up bearing the costs of conservation and the sustainable use of nature. These insights can in turn be used to formulate arguments in favour of conservation, with the goal of convincing stakeholders who have yet to go to bat for conservation or who are not aware of their decisions potentially having a deleterious effect on natural capital and ecosystem services. This applies both to conservation measures such as peatland restoration as well as to more systematic incorporation of biodiversity objectives and concerns into other policy sectors (an approach that many have been urging for some time now) with the goal of achieving an environmentally sustainable economy.

## 1.3 NATURE AND ECONOMICS – AN INCREASINGLY HOT TOPIC

The insight that ecosystems and ecosystem services are one of the main underpinnings of well-being and can be studied from an economic viewpoint is by no means new. It has been the subject of debate among experts for decades and has attracted worldwide attention via the Millennium Ecosystem Assessment (MA 2005). Economic arguments are taking on an increasingly important role in this domain, as the international TEEB study has clearly shown (-> box 6).

The importance of ecosystems and ecosystem services has also been a fixture of policy debates in recent years, one example being the fact that ecosystem conservation and restoration count as biodiversity objectives for the EU and at the global level. The EU Biodiversity Strategy (European Commission 2011) calls, amongst others, for ecosystems and their services to be maintained and enhanced by establishing green infrastructure and restoring at least 15 percent of degraded ecosystems by 2020. In this process, EU member states are to map and assess the state of ecosystems and their services in their national territory by 2014.

Efforts are already underway in some countries such as Switzerland and the UK to assess natural capital at the national level (see UK NEA 2011; Staub and Ott 2011). National TEEB studies are increasingly being launched – for example in the Netherlands, Norway, Brazil and South Korea.

»Natural Capital Germany«, which is Germany's contribution to the TEEB process, aims to accomplish the following:



BOX 6

**The international TEEB study**

During its G8 presidency in 2007, Germany initiated jointly with the European Commission an international study on »The Economics of Ecosystems and Biodiversity« (TEEB). In a meeting in Potsdam, the G8+5 environment ministers agreed to analyze the global economic benefit of biodiversity and the costs of the loss of biodiversity. The vision of the TEEB process was expressed in these words: »Biodiversity in all its dimensions – the quality, quantity and diversity of ecosystems, species and genes – needs to be preserved not only for societal, ethical or religious reasons but also for the economic benefits it provides to present and future generations. We should aim to become a society that recognizes, measures, manages and economically rewards responsible stewardship of its natural capital.« (TEEB 2010B: 29).


**FIGURE 9** ▸ The logo of the international TEEB study

The results of the TEEB study were published between 2008 and 2011 (-> www.teebweb.org). The series of TEEB reports addresses the needs of major user groups: They are directed at policymakers at various levels, representatives of international and intergovernmental organizations, representatives of business, science, civil-society organizations and cities, as well as the individual citizen.

- Shed light on the interplay of nature's services, economic activities and human well-being.
- Provide impetus for identifying, mapping and assessing nature's services, demonstrating nature's values and increasing their visibility in Germany.
- Investigate options and develop recommendations as to how natural capital can be better captured and integrated into private and public sector decision making, with the goal of promoting long-term stewardship of biodiversity and the natural basis of life.

**FIGURE 10** ▸ River scenery. (Photo: Rolf Quandt)

Thanks to our National Biodiversity Strategy (BMU 2007), our National Sustainability Strategy (Bundesregierung 2012), our environmental regulations, and the instruments developed for them, Germany has already laid the groundwork for the stewardship of natural capital and ecosystem services. »Natural Capital Germany« also aims to promote the implementation of these national objectives and strategies.

This project mainly involves compiling and synthesizing existing knowledge concerning nature and its services. To this end, a network is being established and processes are being launched with the goal

of ensuring that the value of nature and its services are better incorporated into decision making processes than has heretofore been the case. This project is being supported by various groups, including a project Stakeholder Committee and an Advisory Board (-> section 4 and box 7).

Section 2 first points out that Germany has a wealth of ecosystem services and then discusses the importance of some of them for prosperity and well-being in our society.

Section 3 discusses and classifies various economic approaches to valuation and -> CAPTURING VALUE, and then explains how an economic perspective can contribute to nature conservation in Germany.

Section 4 provides further information concerning the goals, structure and process of »Natural Capital Germany«.



BOX 7

**An interview with TV anchorman Karsten Schwanke**

FIGURE 11 ▸ Karsten Schwanke, ARD TV meteorologist and journalist, is a member of the »Natural Capital Germany« Advisory Board. (Photo: Ralf Wilschewski)

▸ **You have committed yourself to serving as a consultant and ambassador for »Natural Capital Germany«. What made you decide to do this?**

Germany is richly endowed when it comes to nature, which is a form of capital whose value is underestimated far too often. I decided to advocate the project for two reasons. On the one hand, I would like to raise the awareness of my fellow citizens for the wealth of Germany's nature; and on the other hand that nature is not »just« eye candy, but also has an economic value that goes beyond mere beauty. Our nature is also a financial treasure of our society that we need to take good care of.

▸ **I imagine that as a TV journalist, you must find nature fascinating, and endlessly varied and changeable. So isn't this focus on the economic value of nature far too limiting?**

To the contrary: For me, being fascinated with how nature looks is not nearly enough, it is too limited. Reducing nature to a Sunday stroll in the park makes us blind to nature's true value and importance. We need nature and are dependent on it. That's why we need to substantiate this significance with figures – and also in order to create a new awareness of nature in society at large.

▸ **What role do you think the media should play in terms of conservation and the sustainable use of nature?**

Well, if I may I would like to draw a comparison here with the Stern report (on global warming). This report provided the media with facts and figures that enabled the climate debate to move to a new level and to be conducted by members of the general public from all walks of life. I am hopeful that Germany's contribution to the TEEB process will also increase our understanding of nature and will promote more multi-facetted discussions of it. We journalists are grateful for background information and for facts and figures. If »Natural Capital Germany« can also provide this, then nature will be on the agenda not only in the media, but also in our entire society – and the debate will be more substantive than has ever been the case.

▸ **In your view, who do you think should read and internalize the envisaged reports within the framework of »Natural Capital Germany«?**

I imagine that the project as a whole will probably be studied solely by political and social decision makers in politics and society, by scientists, and by representatives of nature conservation organizations. However, interested members of the general public should be afforded the opportunity to read the key findings in the guise of an executive summary. I also imagine that a ten-point document containing the key data would find a wide readership.

# 2 NATURE AND ECOSYSTEM SERVICES: THE BASIS FOR OUR ECONOMY AND WELL-BEING

**SOCIETY MUST URGENTLY REPLACE ITS DEFECTIVE ECONOMIC COMPASS SO THAT IT DOES NOT JEOPARDIZE HUMAN WELL-BEING AND PLANETARY HEALTH THROUGH THE UNDER-VALUATION AND CONSEQUENT LOSS OF ECOSYSTEMS AND BIODIVERSITY.**

PAVAN SUKHDEV, MAY 29TH 2008, CBD COP9, BONN

## KEY MESSAGES

- Germany is endowed with countless ecosystem services. These supporting, provisioning, regulating and cultural services are the underpinnings of our economy and the well-being of each and every one of us.
- Ecosystem services interact with each other, and depending on their uses can either complement or compete with each other. This also applies to their interactions with biodiversity.
- Examples show how the conservation of ecosystem services can also work to the benefit of nature and biodiversity conservation.



This section provides a brief overview of Germany's key -> ECOSYSTEM SERVICES, via a discussion of selected examples of the economic value of such services and of biodiversity. These examples illustrate the various -> PROVISIONING, -> REGULATING, -> CULTURAL and -> SUPPORTING SERVICES of Germany's -> ECOSYSTEMS, as well as their relationship to -> BIODIVERSITY.

## 2.1 WHAT WE LIVE FROM

Germany's natural environment and the ecosystem services it provides form the basis for our -> WELL-BEING and in many spheres are a matter of survival. Ecosystem services constitute the underpinnings of our food supply, as well as the manufacture of products in a host of disparate sectors such as high tech, energy, and recreation. Ecosystem services have major economic significance.

No ecosystem service can exist without supporting services, which make it possible for ecosystem services to function in the first place. Against this backdrop, a distinction can be made between provisioning, regulating and cultural ecosystem services. Habitats or species communities directly or indirectly create the conditions that allow for the existence of various ecosystem services. But unfortunately, these conditions are increasingly endangered by intensive land use. Thus in this section we particularly focus on the ways in which ecosystem services can be used without degrading the conditions that support them.

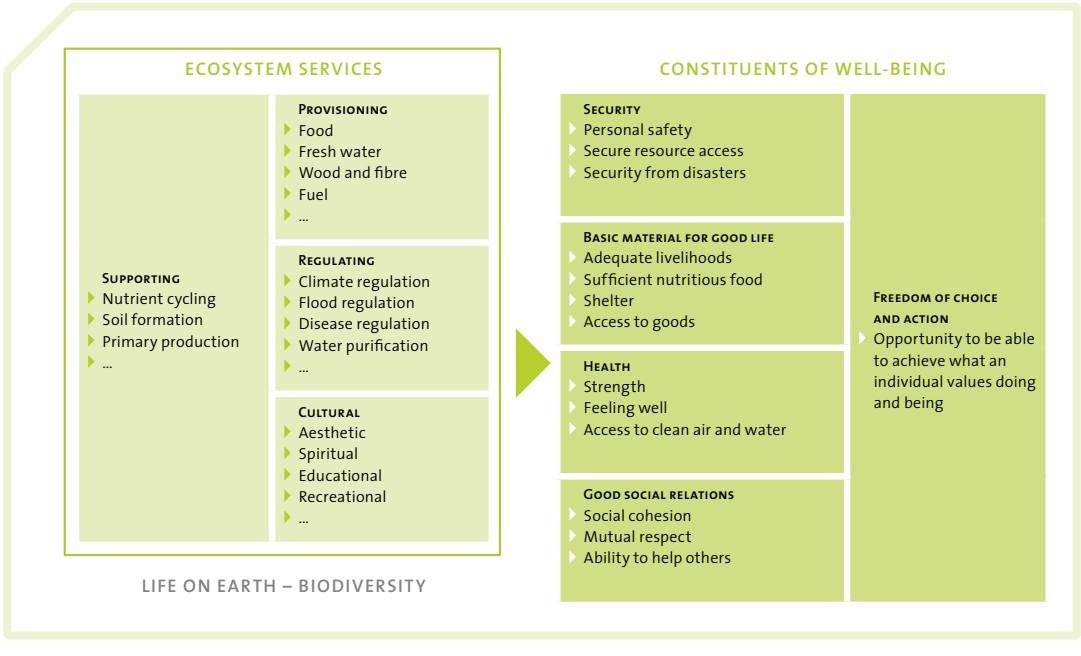


**FIGURE 12** The Millennium Ecosystem Assessment (MA 2005) elaborated a classification system for the world's ecosystem services, as well as for the role they play in our well-being. According to it, ecosystem services form the basis for security, basic materials for a good life, health, good social relations, and freedom of choice and action.

## 2.2 PROVISIONING SERVICES: WHAT NATURE GIVES US

The term »provisioning services« refers to elements such as food, water, firewood, and construction timber, i.e. goods that are produced directly by or on the basis of ecosystems. While substantial portions of today's crop and cattle production involve an extensive input of labour and manufactured capital, these elements are highly dependent on ecosystem services and would be unthinkable without them.

**FIGURE 13** ▸ The EU Water Framework Directive calls for all European waterbodies to achieve good ecological and chemical status by 2015. (Photo: ifuplan)

### Drinking water

Our need for this ecosystem service is enormous. According to government statistics (STBA 2009), German water utilities provide their customers with an average of around 5 billion cubic meters of water a year, around 70 percent of which is derived from groundwater and wells; the remainder is sourced from surface waterbodies (22 percent) and bank filtrate (8 percent). In 2007 some 122 litres of water were consumed per person and day in Germany. An adequate supply of acceptable-quality water is indispensable for human life, as well as for plants and animals. Water quality in this context is mainly determined by the usage intensity and regulating services of our soil, the quality of our waterbodies, and the status of our wetlands. Thanks to Germany's climate, the supply of water is usually sufficient although regional and seasonal shortages can become more prevalent owing to climate change. Consequently forest and wetland ecosystem services – and in particular their capacity to store water, slow runoff, purify surface waterbodies and replenish groundwater supplies – will take on greater importance in the coming years. Groundwater quality remains a problem in many areas – a problem that could and should be solved through sustainable land use (-> section 2.3).

**FIGURE 14** ▸ The 52 percent of Germany's surface area that is used for farming provides around 1.1 million jobs. And while Germany's agricultural sector accounted for only around 0.6 percent of gross value added (GVA) in 2009, this sector's actual importance for our national economy is far greater in that in 2010 agricultural activities reached 42.2 billion euros in turnover. (DBV 2010, Photo: ifuplan)

### Food

Our natural environment forms the basis for agriculture and provides us with products vital to our existence such as fruit, vegetables, milk and meat. In the agricultural sector, food and raw materials are in some cases produced on an industrial scale. But even here, ecosystem services make an invaluable contribution to crop production, as well as via forage and grazing plants for livestock production. In order for agricultural activities to be carried out, soil functions must be intact and stable, and sufficient water and nutrients must be durably available for crop growth.

Ecosystem management targeted for maximum yields can degrade the very underpinnings of agricultural production. For example, overuse of fertilizer reduces natural soil fertility; the use of heavy machinery results in increasingly compacted soil; the destruction of peripheral elements such as hedges and field margins promotes wind and water erosion (-> box 8 and -> section 2.3).



### Hunting and gathering: they still matter

Direct ecosystem services include products that are hunted and gathered such as berries, medicinal plants, fish and game. These products, which are mainly used in connection with leisure time and recreational activities, require relatively little additional labour or capital. While such products are of relatively minor economic importance in Germany, they constitute a key supplemental usage modality in connection with recreational activities (-> section 2.4).

BOX 8

**Ecosystem services in the agricultural sector: more than just food production**

Agriculture can be practiced in such a way that the land being used can provide, in addition to provisioning services, other essential products and services such as water filtration, recreation facilities, and plant and animal habitats. Organic farming is a prime example of how agriculture can be a multi-functional activity. Germany currently has around a million hectares of organic farmland, which represents around 6 percent of the country's total farmland. The federal government aims to increase this figure to 20 percent. The turnover generated by the organic farming sector in Germany has risen steadily, while the amount of organic farmland has quadrupled over the past 16 years. Moreover, demand in Germany for organic products is increasingly exceeding supply, and thus the deficit is covered by imports. Since, in the final analysis, without fertile soil (an important supporting service) there can be no agriculture, organic farming can derive long term benefits from this ecosystem service, thanks to judicious soil management via crop rotation without the use of chemical fertilizers or chemical synthetic pesticides. And this reduces costs in other areas such as water purification at sewage treatment plants.

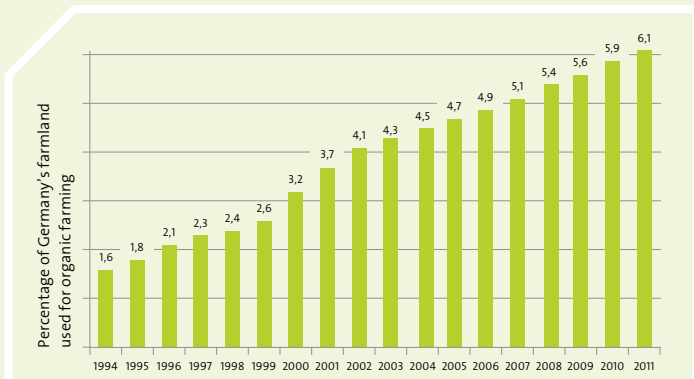


**FIGURE 15** ▸ Development of the organic farming sector. Organic farming safeguards ecosystem services. Percentage of Germany's farmland used for organic farming. (data based on UBA 2009; BÖLW 2009–2012)

**FIGURE 16** ▸ Wood has served as a resource for a long time, e. g. as construction material and fuel. (Photo: Maksym Gorpenyuk, Fotolia.com)

## Plant raw materials

### Wood

Wood is extremely versatile in that it constitutes a renewable resource for energy, construction materials and paper. Germany's forests, which cover around a third of the country's surface area, play a key economic role.

Around 11.1 cubic meters of new wood per hectare of forest are added to Germany's annual production. Thus, Germany's 11.1 million hectares of forest produce about 120 million cubic meters of new wood annually. Between 2002 and 2008 an average of 70.5 cubic meters of wood were felled (timber harvested, excluding bark, within the usual recovery limits). Thus around 93 percent of exploitable new growth was used (Polley et al. 2009), two thirds of it as rough timber and the remainder as industrial wood (DHWR 2012). Although Germany's wood industry accounted for only 0.1 percent of gross value added in 2003, the industries that use wood as an intermediate product accounted for 3.4 percent of gross value added (BMELV 2011). Wood is currently taking on renewed importance as a raw material, energy source and production material, because its carbon footprint is virtually nil, processing it requires relatively little energy, and it is 100 percent recyclable. The pressure to commercially exploit forests increases in Germany, as is also the case elsewhere. However, the fact remains that forests are far more than wood production areas (-> box 9, -> Figure 17).

### Energy resources

Agricultural and forestry products such as corn, rape, and wood are increasingly being used as energy resources. It is estimated that in Germany in 2011 more than 2.28 million hectares (around 19 percent

**FIGURE 17** ▸ Apart from being a raw material, wood is also vital to the existence of countless plant and animal species. In Germany alone, around 4,600 plant, animal and fungus species inhabit wood, especially deadwood. It has been estimated that various forest ecosystems need anywhere from 30 to 40 cubic meters of deadwood per hectare of forest (in mountain forests up to 60 cubic meters) in order to preserve a fairly complete deadwood biota. (Moning u. a. 2009, Photo: Christoph Moning)



BOX 9

**Forest ecosystem services: more than just wood**

The use of wood for fuel and as raw material allows for the avoidance and/or reduction of carbon emissions, providing that at the same time wood replaces materials that are petroleum based or whose production is energy intensive. In addition, existing forest ecosystems exert a regulating effect on hydrological services, and serve as recreational areas, as well as bastions of biodiversity. Near-natural forests with a preponderance of hardwood at altitudes up to those of submountain areas, are highly resistant to storm and beetle damage (more resistant than monocultures). If they are managed properly and sufficient areas are left unused, these forests can provide many of the aforementioned ecosystem services concurrently.

**FIGURE 18** ▸ Forests are important recreational areas. (Photo: Phil, Fotolia.com)

of all arable land) was used primarily for biomass crops (FNR 2012A). But this practice sometimes conflicts with food crop cultivation, conservation efforts – and particularly in the case of corn biomass – with groundwater protection. And if, for example, grasslands are converted to cropland for corn biomass production, conflicts with climate protection may arise (-> section 2.3). In other words, ecosystem services may be in competition with each other in some cases. But it does not have to be this way. Biomass plant cultivation (-> Figure 21) affords opportunities for environmentally sustainable use of suitable plant species without ecosystem degradation via mixed crops or by adopting the practice of mowing biodiverse meadows only twice a year for use as an energy resource.

**FIGURE 19** ▸ The various flowering plants shown here (from a seed mixture) can be used for biogas facilities, as an alternative to corn biomass cultivation. Unlike cornfields, these plants also provide food for myriad insect species. (Photo: Christoph Moning)

BOX 10

FIGURE 20 ▸ A purple coneflower (Echinacea purpurea) being visited by a Red Admiral butterfly (Vanessa atalanta). This medicinal plant is used to treat respiratory and urinary tract disorders, and for wounds that do not heal properly.
(Photo: Thomas Stephan, BLE, Bonn)

**Herbal medicine**

Herbal medicine has become a major worldwide industry. Around 400,000 tons of medicinal plants worth an estimated 60 to 80 billion US dollars are sold annually around the world. Some 50,000 to 70,000 plant species are harvested – 15,000 of which are endangered owing to the use of non-sustainable gathering methods (Jessel et al. 2009). Hence sustainable use through controlled and targeted gathering is the decisive factor when it comes to durable conservation of this ecosystem service and keeping endangered species from becoming extinct. Around 40,000 tons of material from 1,500 plant species from more than 100 countries are imported by Germany annually. In Germany, the gathering of medicinal plants (whose use for therapeutic purposes is subject to strict quality and origin documentation requirements) is of minor economic importance. Of Germany's around 440 native medicinal plants, around 75 are cultivated. The amount of land used for this purpose increased from around 5,000 hectares in 2001 to 10,000 hectares in 2011 (FNR 2012B). Organic farming of spice and medicinal plants was carried out on around 704 hectares of land in 2003 (Röhricht et al. 2003); but this amount is likely to have increased appreciably in the intervening years.

FIGURE 21 ▸ The mixture of winter cereals and hairy vetch shown here is also suitable for use in biogas installations. According to a field study, all field birds observed in this mixture exhibit higher colonization density than in control areas.
(Photo: Kathrin Ammermann)

### Seafish

In 2010, Germans consumed around 1.3 million tons of fish and fisheries products; this corresponds to around 15.7 kilograms per head. Two thirds of this consumption was accounted for by sea-fishing products. According to fishing industry estimates, per head consumption of fish and fisheries products is set to rise to 17.5 kilograms soon.

In the German sea-fishing industry in 2010, the catch in foreign territorial waters amounted to just under 167,000 tons, while the catch in Germany's territorial waters was 66,000 tons (FIZ 2011). These figures clearly show how dependent German fish consumption is on the world's fisheries (for more on the dependence of domestic well-being on worldwide ecosystem services, see -> box 11).

Sea fishing is a prime example of the deleterious economic consequences of ecosystem overuse. More than three quarters of the world's fish populations are either being fished to their limits or overfished (FIZ 2011). It has been estimated that overfishing of sea fisheries results in an annual 50 billion US dollar loss, relative to a scenario involving sustainable use. If 20 to 30 percent of the world's oceans were protected so as to allow fish populations to regenerate, fishing revenue would increase by 70 to 80 billion US dollars a year (TEEB 2009).



As with agricultural and forestry products, fish products also have their ecolabels concerning sustainable production methods that promote natural and biodiversity stewardship. According to the German Environment Agency, in 2014 about 60 percent of the wild caught fish sold in Germany stem from fisheries that have certified ecolabels such as FOS (Friend of the Sea) or MSC (Marine Stewardship Council) (UBA 2016). These certifications prove that sustainable fishing methods are being used. According to a 2010 survey, 36 percent of German consumers had seen the MSC logo at that time at least once – a substantial improvement in only two years in that this logo's estimated familiarity gradient in 2008 was a mere 11 percent (UBA 2014). The MSC ecolabel is also becoming far better known in other countries as well; yet Germany represents the biggest market worldwide (www.msc.org).

## 2.3 REGULATING SERVICES: HOW NATURE LENDS US A HELPING HAND

Regulating services are ecosystem services that impact ecosystem components and processes, and are thus of indirect benefit to us. Examples of such services include the following: soil layer filtering, which improves groundwater quality; reduced soil erosion thanks to hedges; reduced flooding thanks to the water retention capacities of floodplains; and cleaner air thanks to urban trees and green spaces. All these services have no price, but their economic value is enormous.

FIGURE 22 ▸ Until recently, crab fisherman Uwe Abken paid little attention to the by-catch in his nets. But Abken, who hails from Neuharlingersiel in East Frisia (which is close to the Dutch border), pays closer attention to his by-catch nowadays. At the behest of biologist Kai Wätjen from Alfred Wegener Institute for Polar and Marine Research – AWI, Abken and his first mate keep records of which exotic and rare migratory fish end up in their crab nets. The goal is to gain greater understanding of fish species populations and migration patterns, so as to allow for the use of North Sea food resources in a manner that conserves biodiversity.
(Photo: Waetjen Slöschke, Alfred-Wegener-Institut 2012)

**FIGURE 23** ▸ The footprint serves as a symbol for our use of resources – the mark we leave on our ecosystems. (Photo: ifuplan)

BOX 11

**Ecological footprint: Claiming natural capital – in Germany and beyond**

The example of fisheries clearly shows that German businesses and consumers need to assume responsibility for establishing a situation where ecosystems are used sustainably – both in Germany and elsewhere. Our standard of living also impacts ecosystem services beyond Germany's borders. We avail ourselves of production services in other countries and thereby indirectly affect further ecosystem services, by virtue of the production conditions that prevail in these locations. Our meat consumption may serve as an example. Moreover, we influence the climate through our energy consumption in Germany and elsewhere.

A very illustrative approach to show these various interrelationships is the »ecological footprint«. This accounting system incorporates standard of living-driven ecosystem service use, determines the consequent land use and relates it to the amount of actually available land. On average, each inhabitant of our planet has 1.9 hectares to meet their needs. But in Germany, this figure rose from 4.6 in 1995 to 5.1 in 2007, and has remained at this latter level since then (WWF 2016). From the standpoint of this model, Germany uses around 2.7 times more ecosystem services relative to the surface area that is actually available for such services for each inhabitant of our planet.

## Water and soil self purification mechanisms

Waterbodies and soil have the capacity to degrade, filter out or store contaminants. These ecosystem services have a decisive impact on groundwater and surface waterbody quality. Depending on their specific situation, floodplains can degrade, convert, or store anywhere from 0.2 to 18 kilograms of nitrate per hectare of floodplain.

Around 25 percent of Germany's raw water can be used as drinking water only after undergoing the relevant pretreatment process. Water quality is predominantly degraded by nitrate inputs from intensive farming. Nitrogen and phosphate nutrients are essential for plant growth. But a surfeit of these soil nutrients can result in groundwater and surface waterbody pollution (including ocean pollution), and reduces biodiversity by extirpating low-nutrient sites. In 2007, Germany's nitrogen surpluses were mainly attributable to the use of chemical fertilizers, at a rate of 105 kilograms per hectare and year (UBA 2012A). The current rate (2012) is still near 100 kilograms. Most of this pollution is attributable to arable land use. Nutrient discharges necessitate cost intensive sewage plant water treatment, which costs 5 to 15 euros per kilogram of nitrogen, for »budget« sewage plant



measures (see Grossmann et al. 2010). But it does not have to be this way. Methods such as plant analyses aimed at improving fertilizer management, or planting catch crops to avoid nutrient discharges from intensively fertilized farmland cost only 0.4 to 2 euros per kilogram of nitrogen (Osterburg and Runge 2007). In addition, using land as meadows and pastures rather than cropland abates contaminant inputs, particularly if it is used as High Nature Value Greenland. On the basis of the above mentioned abatement costs it was calculated that not converting grassland into cropland saves from 40 to 120 euros per hectare and year (Matzdorf et al. 2010).

Thanks to the self-purification capacity of peatland and waterbodies with near-natural floodplains, contamination from nutrients and other substances can be appreciably reduced – thus improving groundwater and surface waterbody quality. The economic impact of such ecosystem services is shown using the example of floodplain areas in -> box 21 in section 3.

## Pollination and natural pest control

Of the around 260 main crop plant species used in the EU, 84 percent are directly dependent on insect pollination (Williams 2002; Williams 1994). In other words, this ecosystem service is indispensable for our food supply. Fruit, vegetable and oleaginous crops that can only ripen after being pollinated are worth 153 billion US dollars a year globally (Gallai et al. 2009) and in Germany are worth around 2.5 billion euros (AID 2010).

Environmental toxins and the elimination of near-natural structures threaten pollinator populations and can have substantial economic effects on fruit crops in particular. This is attributable to the fact that as the destruction of natural habitats increases, the biodiversity of natural pollinators falls off dramatically. They are then lacking at least to some extent as an alternative to honeybees as pollinators. This phenomenon has been borne out by two international studies (Garibaldi et al. 2011; Klein et al. 2012) that were conducted under the auspices of Leuphana University of Lüneburg. Under such conditions, parasites such as the varroa mite, which can carry off entire bee hives, can have a devastating effect on farming.

**FIGURE 24** ▸ Pollination of crop plants through insects makes an essential contribution to food security, also in Germany. (Photo: André Künzelmann)

Most flower pollinators that live in the wild rarely stray more than 1 kilometre from their nests. As a consequence, in large scale monocultures, there can be no continuous pollination but rather intermittent or greatly varying pollination instead. As a result, not all flowers are pollinated and fruit production suffers. This can have serious repercussions, as Klein et al. (2012) showed: fruit yield averaged 16 percent lower at a distance of 1 kilometre from the nearest natural area (Leuphana University of Lüneburg 2012).

Natural pest control in the forestry and agricultural sectors are equally important as pollination. There are numerous pests that can decimate productivity and thus a grower's bottom line. It has been estimated that the propagation of 99 percent of existing pests could be controlled using natural predators such as spiders, birds, bacteria or fungi (DeBach and Rosen 1991). But unfortunately, landscape change and more intensive management methods are destroying the habitats of these natural predators. The absence of their free-of-charge services reduces crop yields, which can only be offset through the use of cost intensive pesticides, which however have harmful ecological consequences.

## Flood control

In 2010, floods in various parts of the world caused damage worth around 36 billion euros (Munich RE 2011). The 2002 Elbe River floods in Germany induced between 9 and 15 billion euros in damage (European Commission 2002) and resulted in a number of fatalities. Increasing construction in flood-prone areas in recent decades has appreciably ramped up the amount of damage that could potentially be caused by flooding. Many near-natural biotopes such as forests, peatlands, and wetlands, as well as hedges and other small farmland elements slow the rate of rainwater runoff on such land (Schüler et al. 2007). These biotopes in turn reduce flood wave height over a broad area and thus reduce flooding. Vegetation retains precipitation and promotes its evaporation, thus enabling the soil to quickly begin absorbing and storing water again after a heavy rainfall (Sartor and Kreiter 2007). This runoff »braking« mechanism is particularly effective in near-natural floodplains, as was shown by a study of Elbe River renaturing measures (Grossmann et al. 2010), according to which dike removal or relocating reduces flood damage and at the same time promotes improved waterbody nutrient breakdown. The costs thus avoided far exceed the expenditure for the measures taken (-> box 20).

**FIGURE 25** ▸ According to German insurance industry estimates, annual flood damage in Germany averages 500 million euros – a figure that is expected to double over the next decade owing to climate change. (Photo: ifuplan)



BOX 12

**Protection against avalanches, mudflows and landslides**

Protection against avalanches, mudflows and landslides is of great importance in many places around the world. In Germany, the Alpine regions experience these phenomena. Mountain forests can slow them down or prevent them, thanks to their root systems and trunks. This in turn protects life, limb and property, and is far less costly and easier to maintain than the equivalent constructions.

**FIGURE 26** ▸ Descent of an avalanche. (Photo: Galyna Andrushko, Fotolia.com)

## Protection against soil erosion and maintenance of soil fertility

Fertile soil constitutes an indispensable ecosystem resource that forms the basis for agriculture. Our soil is the fruit of natural processes that began in the area that is now Central Europe thousands of years ago during the last Ice Age and are still unfolding today. But unfortunately, according to estimates of Wurbs and Steininger (2011) in the southern parts of Germany using land as cropland results on average in around 3 to 5 tons of fertile soil per ha per year being lost to the effects of water erosion under conventional tillage and around 1 to 1.3 tons under conservation soil tillage; wind erosion not included (Wurbs and Steininger 2011). The natural soil formation through weathering processes is only about 0.1 to 1 ton per ha per year (Blume et al. 2010).

As a result of an imbalance between formation and erosion, the topsoil with its nutrients and humus – and thus the conditions necessary for durably productive agricultural and forestry activities – diminish continuously. Stepping up fertilizer use cannot possibly replace natural soil mechanisms – not to mention the fact that such products use considerable amounts of energy and generate greenhouse gases. That said, ecosystem services can be conserved using various methods. Hedges, thickets, and field margins, as well as sustainable management practices and catch cropping can mitigate soil erosion, while organic farming promotes humus formation. As a rule, such practices also promote farmland biodiversity and protect adjacent waterbodies from undesirable inputs of leached out nutrients.

**FIGURE 27** ▸ Corn is used for food, fodder, and energy biomass. Between 2007 and 2010, the amount of land devoted to corn cultivation increased by nearly 25 percent in Germany. This evolution has a negative impact on erosion-prone soil and slopes. (Photo: Christoph Moning)

## Air quality and climate regulation in urban areas

Air quality and microclimate have a major impact on our well-being. Particulate matter and other air pollutants shorten life expectancy and increase the risk of pulmonary and cardiac disorders. This has been demonstrated by a number of studies (e.g. Voss and Hassauer 2004).

Urban trees and green areas – which filter the air and thus reduce concentrations of particulate matter and other harmful elements (Bruse 2007; Buccolieri et al. 2011) – could be used as an adjunct to anti-pollution measures that are implemented at emission sources such as road traffic.

Our knowledge of the filtering effects of various plants and plant usage modalities is increasing steadily. Using the newest discoveries as a starting point, the Conference of Municipal Parks Departments (GALK 2008) recommended, for example, that trees and other green elements should be deployed on roads in a site appropriate fashion so that the overall positive effect on particulate matter concentration is not undermined by a local reduction in air exchange.

In cities in particular, heavily built up areas, a paucity of green areas, and inadequate air exchange result in appreciably higher temperatures than in the surrounding area. Urban »heat islands« have a negative impact on human health, particularly on individuals with cardiovascular disease. This was proven, for example, in a study that was conducted in Berlin from 1991 to 2003 (Gabriel and Endlicher 2006). The study found that during the heat wave in the summer of 1994, Berlin's mortality rate rose 67 percent relative to the mean during the summer months of the study period as a whole.

Urban landscaping, including on facades and roofs, reduces air temperature thanks to factors such as the evaporation effect of vegetation. Trees along city streets also bring temperatures down by creating shade. Thus green spaces in heavily built up urban areas are taking on increasing importance, particularly in a time of climate change,

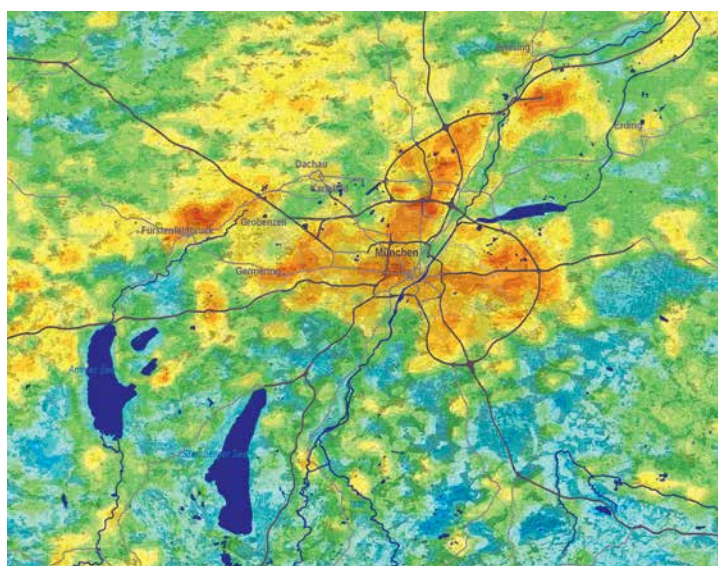


**FIGURE 28** ▸ In this IR-satellite image of Munich and the surrounding region, the red and orange colours indicate higher temperatures, while green and blue indicate lower temperatures. The effect of heat islands and fresh-air zones along the Isar River and in Munich's English Garden is readily discernible. (Source: German Air and Aerospace Centre – DLR)



which is expected to result in lengthier high temperature periods (Mathey et al. 2011). When planning a sustainable urban green space system, it should be borne in mind that the micro-climatic effects of urban green have only a limited capacity to spread out into adjacent built-up areas. Urban-climate studies in Berlin have shown that the effects of parks that are around one hectare in size can be felt in a radius of up to 150 meters. The effects of the grounds of Berlin's Großer Tiergarten, one of the biggest parks of the city, extend more than 1,200 meter into the surrounding residential areas (Horbert et al. 1983).

**FIGURE 29** ▸ Hedges and thickets reduce water and wind erosion. (Photo: Thorsten Schier, Fotolia.com)

### Impact on global climate regulation

Carbon dioxide, one of the most important greenhouse gases, is needed by plants to form biomass and is absorbed predominantly by trees, but also by peatland, and grassland vegetation. The biomass of a century old oak forest can store around 11 tons of carbon dioxide per hectare and year (BMELV 2011). Conversely, large amounts of carbon dioxide are released when peatland is drained for use as farmland or when grassland is converted to cropland.

The conversion of highly biodiverse grassland sites results in an average of 118 tons per hectare of carbon dioxide emissions (Matzdorf et al. 2010). According to the Federal Environment Agency (UBA 2012B), each ton of carbon dioxide causes 80 euros in loss or damage, which means that the loss of highly biodiverse grassland and the consequent climate regulation loss costs society around 9,440 euros per hectare.

One of the best ways to roll back carbon dioxide emissions while providing a habitat for endangered species is peatland rewetting (-> box 13).

## 2.4 CULTURAL SERVICES: HOW NATURE REWARDS US RICHLY

Apart from their key role in supporting our physical existence, ecosystems foster personal development as well as relaxation and enjoyment by providing recreational areas where we can marvel at the wonders of nature and develop our spirituality, if we so choose. Natural areas give us cultural identity, make us feel connected to a place, and provide us with knowledge and insight. Thus they make an invaluable contribution to our sense of well-being, our physical and mental capacities, and our health. They also provide inspiration for many different kinds of design and for the technical refinement we so value in products.

### Health and recreation

Natural stimuli, a calm environment, stimulation of the senses and experiencing nature first hand: all of these things enable us to relieve stress and recharge our batteries (Hartig et al. 2006; Nilsson et al.

BOX 13

**FIGURE 30 / 31** ▸ Peatland restoration, as has been done in the state of Mecklenburg-Western Pomerania, is a low cost climate protection instrument that provides birds such as cranes with quality breeding sites. Climate protection services are traded on a voluntary market as emission certificates called Moor-Futures (-> section 3.5 and box 22). (Photo: Monique Ziebarth)

**Peatland restoration: an effective weapon against global warming**

Currently around 749,000 hectares, or 68 percent, of Germany's peatland is used for agricultural purposes. Intensive use of this land causes around 28 tons of carbon dioxide emissions per hectare annually, although emissions vary considerably from one area to another. If this land was used for rewetting instead, the current level of carbon dioxide emissions would drop considerably. The consequent abatement costs (i. e. the costs plus lost agricultural income or the like resulting from the need to switch to a different usage modality) would amount to an average of 40 euros per ton of carbon dioxide (Röder and Grützmacher 2012). This is considerably less than reducing carbon dioxide emissions by, for example, installing insulation in existing buildings. Calculations based on other parameters and usage scenarios come up with considerably lower abatement costs of 0 to 4 euros per ton of carbon dioxide for rewetting former peatland (Barthelmes et al. 2005).

2007). The healthy effects of nature have been demonstrated in a number of studies (see Abraham et al. 2007; BMU/BFN 2010; Hartig et al. 2006; Health Council of the Netherlands 2004).

Many healthful sports activities such as hiking, bicycling and Nordic walking take place in natural settings. For many of these activities, enjoying nature is just as important as the exercise afforded by the activity (-> box 14). This concept is supported by the finding of a »leisure time and vacation market« survey conducted by the German Hiking Association (DWV), which found that »experiencing nature« was by far the most common element that respondents associated with »hiking« (BMWi 2010). German opinion surveys concerning awareness of nature (BMU/BfN 2010, 2012) also show that respondents feel that conservation is important for recreation and health. In other surveys, including one on the meaning and importance of forests, respondents indicated that health and recreational benefits motivate them to go on forest outings (Baur et al. 2003; Bernasconi and Schroff 2008; Lindemann-Matthies and Home 2007).



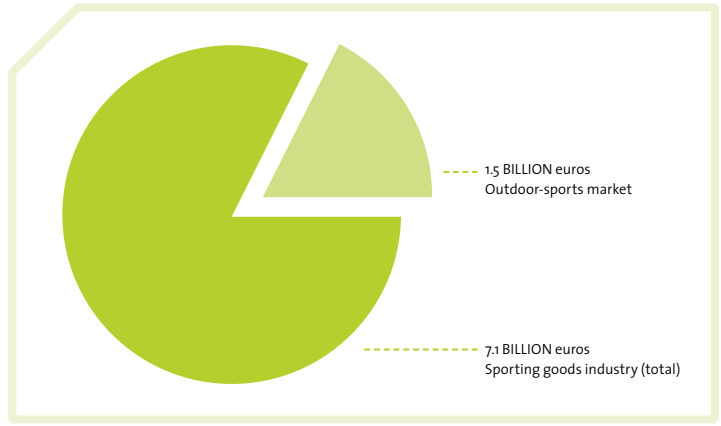


**FIGURE 32** ▸ The outdoor-sports market accounts for a healthy chunk of the sporting goods industry's sales and has good growth potential. (Rühl 2009)

Germany's tourist industry generates gross value added amounting to nearly 100 billion euros a year and directly employs some 2.9 million persons (7 percent of the German workforce), mostly in small and medium-sized enterprises, making this sector a major element in the country's economy as a whole. If related services such as airport, restaurant and similar services are included, tourism accounts for some 4.9 million jobs (12 percent of the workforce) in Germany (Rösner et al. 2012).

Tourism, more than just about any other sector, strongly depends on the availability of an intact natural environment – particularly in

BOX 14

**The precious experience of spending time in nature**

Being excited about and fascinated by nature are key developmental experiences especially for children. It has been proven that for children, spending time in a natural environment, moving around in it, and interacting with adults and other kids there promotes the development of intellectual, motor and social skills (Health Council of the Netherlands 2004; Schemel and Wilke 2008).

**FIGURE 33** ▸ Playing in nature promotes the development of intellectual, motor and social skills. (Photo: Franz Mairinger, Pixelio)

FIGURE 34 ▸ Leisure time and tourist activities constitute a revenue stream for many remote regions. The regional economic benefits of tourism exceed the direct added value generated by restaurants, hotels, mass transit operators and other actors.
(Photo: ifuplan)

economically disadvantaged rural areas. Numerous tourist activities are available in or around the great outdoors, including canoeing, visiting museums and the like, or spending vacation on a farm. Tourism can be beneficial for conservation of biodiversity, climate protection, energy and resource efficiency, and intercultural experience; but it can also cause the degradation of nature and the landscape as well as undesirable social change, and can irreparably damage the natural and cultural heritage to the detriment of future generations. Hence ideally, tourism should create value and help to preserve -> BIODIVERSITY, as well as indispensable ecosystem services such as clean water, improved air quality, and healthy regional products. According to one survey, »experiencing nature« is a »particularly important« reason for travelling (FUR 2011). The solution lies in a strategy that is informed by a vision of an intact natural environment and environmentally friendly use of that environment (see Engels et al. 2010).

## Aesthetics and regional identity

The myriad facets of Germany's natural environment are a wonder to behold, whether it is wild cats in protected areas, the Black Forest hay harvest, or the cliffs of the island of Rügen. According to one survey, 55 percent of all Germans say they spend time in nature because they enjoy contemplating it (BMU/BfN 2010). Research has shown that biodiversity in and of itself contributes to people's aesthetic and psychological well-being (Lindemann-Matthies and Home 2012).

FIGURE 35 ▸ This painter appears to be finding inspiration here on Vilm Island near Rügen. The island, which extends over an area of 94 hectares, has a magnificently varied coastline and centuries-old oak trees.
(Photo: Olaf Weißhuhn)

Humankind has been inspired by the beauty of nature since the dawn of time. The colours and forms of nature are echoed in works of art, as well as in product designs.

Nature also defines and strengthens our sense of belonging to a particular region – for example the Alps for a Bavarian, the sea air for a resident of Mecklenburg, the contours of the Siebengebirge mountain range for a Rhinelander. They are symbolic for the feeling: »This is my home!« Our own personal identities are formed by the people around us, as well as by the natural environment and scenery that we grew up around and that we live and work in.

Vendors of regional products make use of these positive feelings and the opportunity for customers to identify with the natural environment of a particular region, by integrating regional features into their label – for example beavers in Brandenburg, lambs in Altmühltal or classic archetypal landscapes such as heaths in Rhön. Marketing strategies use the identification of consumers with the natural environment or the scenery in a certain region, with the goal of promoting sales of environmentally friendly regional products.



## Science and research

Over the course of evolution, animal and plant species have evolved by interacting with their environment via a continuous optimization process. Design principles, survival strategies, biologically generated substances, and genetic potential provide our civilization with an inexhaustible font of inspiration for innovations in the fields of technology, medicine, energy generation, and food production.

Many useful technical discoveries that make our lives easier are based on imitations of nature – velcro (based on burdock) and suction cups (based on beetles and octopuses) being only two examples. Bionics, which refers to the transfer of the principles of nature to engineering, has become a well established research discipline. All around the world, bionics researchers are striving to decrypt the structural principles of the natural world and the ways things work, with the goal of applying them to technical innovations. Bionics research has become more prevalent in Germany as well. For example, Stuttgart University researchers are working on a flap mechanism that is based on the spruce cone, with the goal of devising shading solutions for buildings (Pfund 2012).


FIGURE 36 ▸ The biodiverse grasslands of Altmühltal valley are conserved through sheep grazing. Regional products from Altmühltaler lambs help to conserve the traditional sheep farming and landscape of Altmühltal valley.

## 2.5 SUPPORTING ECOSYSTEM SERVICES: THE MOTHER OF ALL OTHER SERVICES

Nature's myriad provisioning, regulating and cultural ecosystem services depend for their existence on supporting ecosystem services such as the water cycle, the food chain, photosynthesis, and the breakdown of organic substances by microorganisms. Unlike provisioning, regulating, and cultural ecosystem services, we cannot make direct use of these fundamental natural mechanisms; but their partial or complete loss would have a directly or indirectly deleterious effect on the ecosystem services that depend on these mechanisms. Let's take the example of a forest ecosystem: Environmental harm

FIGURE 37 / 38 ▸ Winglets attached to the wings of modern aircraft help cut fuel costs by up to 6 percent by reducing air vortexes. This innovation was inspired by the wing structure of soaring bird species.
(Photos: Arpingstone/Adrian Pingstone (left); Christoph Moning (right))

such as increased air pollution could degrade tree-leaf photosynthesis over the long term. Such untoward events would provoke irreversible leaf-organ damage, and ultimately entire trees would begin to die off. Regulating services in forests such as carbon dioxide sequestration, air filtration and provisioning services such as wood production cannot function properly unless the forest is in good health. If the forest's basic mechanisms such as photosynthesis are degraded, the ecosystem services that are an extension of these supporting ecosystem services would be crippled or could even be completely disabled.

Photosynthesis is a process whereby green plants produce oxygen, and particularly carbohydrates that form the basis of metabolic processes of most of the animal kingdom, we humans included. Degradation of the photosynthesis process would impact the food chain, and thus our food production (provisioning service). The example of photosynthesis clearly illustrates how complex the impacts of basic natural mechanisms on ecosystems are and how difficult it is to strike a balance when it comes to the -> BENEFITS of these services. Their impact on our well-being and prosperity can only be grasped and evaluated indirectly via the individual provisioning, regulating, and cultural ecosystem services.

## 2.6 BY SAFEGUARDING NATURAL CAPITAL WE SAFEGUARD OUR WELL-BEING

The ecosystem services discussed thus far represent only the tip of the iceberg of the ecosystem services that Germany is endowed with. In addition, the impact of our production and consumption habits, as well as our lifestyles, on the natural environment and ecosystem services in other parts of the world could only be touched upon here. Nonetheless, the examples discussed thus far clearly show that

**FIGURE 39** ▸ The photosynthesis of a single deciduous tree produces more than 10 kilograms of sugar, plus around 10,000 litres of oxygen daily – enough to keep around eight people breathing for 24 hours. (Photo: ifuplan)



ecosystem services form a priceless basis for our well-being. If we use nature short-sightedly – that is, by focusing solely on the short term availability of single provisioning services – we will jeopardize the availability of the remaining services and will ultimately degrade the supporting services that form the basis for our very existence. But on the other hand, if we only use the goods and services of nature that in both the short and long term allow for an appropriate balance between the various ecosystem services; and if at the same time we take steps to ensure long term protection of the ecological underpinnings of all of these services, we will succeed in conserving our natural capital and in safeguarding the basis for our well-being. But how can we actually go about accomplishing this? In order for the values of Germany's ecosystem services – often invisible to the naked eye – to be incorporated into political, administrative, corporate and consumer decision making, we need to analyse, capture and assess these values, and incorporate them into decision-making. This is, at the same time, a huge challenge.

# 3 VALUING ECOSYSTEM SERVICES AND INCORPORATING THEM INTO DECISION MAKING

**ALTHOUGH OUR WELL-BEING IS TOTALLY DEPENDENT ON THE CONTINUOUS FLOW OF ECOSYSTEM SERVICES, THEY ARE PREPONDERANTLY PRICELESS PUBLIC GOODS FOR WHICH NO MARKET EXISTS; AND THUS IT IS VIRTUALLY IMPOSSIBLE TO CAPTURE THEIR VALUE THROUGH MARKET FORCES.**

PAVAN SUKHDEV, SEPTEMBER 16TH 2008,

DEUTSCHER NATURSCHUTZTAG, KARLSRUHE

**IT IS BAD POLICY TO REGULATE AND FURTHER UNDERTAKINGS FROM THE TOP DOWN WHEN THEY CAN BE BETTER REGULATED AND FURTHERED VIA PRIVATE EFFORTS; BUT IT IS EQUALLY BAD POLICY TO LET ADOPT A LAISSEZ FAIRE ATTITUDE TOWARD UNDERTAKINGS THAT CAN ONLY BE FURTHERED THROUGH THE INTERVENTION OF THE SOCIETAL POWER [OF THE STATE].**

FRIEDRICH LIST, GERMAN ECONOMIST (1789 – 1846)

**KEY MESSAGES**

- Natural capital and ecosystem services can be conserved in a more targeted manner if we are familiar with their current status and determine the direction they are moving in. In order to assess the economic value of ecosystem services to a satisfactorily reliable degree, we need to determine the current scope and future trends of those services as accurately as possible.
- The development and application of suitable economic valuation methods can enable economists to contribute to elucidating the value of the objects of their assessment. However, any of the manifold economic concepts is only able to deal with a fraction of the diversity of values.
- Incorporating biodiversity and ecosystem services into private and public sector policy decisions can be strengthened through validation and optimization of the relevant instruments.

## 3.1 WHY ARE DECISIONS OFTEN MADE AT THE EXPENSE OF NATURAL CAPITAL?

The question as to why decisions are often made at the expense of -> NATURAL CAPITAL is to some extent addressed in -> section 1. There, we point out that one of the key factors when it comes to selecting policy options is economic impact, which is in many cases reduced to a comparison of private costs and benefits. Alterations of -> ECOSYSTEM SERVICES do not have a direct impact on these costs and benefits; ecosystem services mostly have an indirect effect. They are normally non-commercial in nature; for they are -> PUBLIC GOODS and thus need to be identified and assessed mainly from a social standpoint. We know relatively little about the exact cause and effect relationships between -> ECOSYSTEMS and -> ECOSYSTEM SERVICES; nor has much effort been made to analyze the economic value of these services in detail. As a result, decisions that relate directly or indirectly to ecosystem services are usually made in the absence of sufficient information. And while it is relatively easy to predict the costs of a given project such as building a highway, as well as its direct economic consequences such as revenue generation and job creation, little or no information is available concerning the possible untoward effects of such projects on society as a whole, through their impact for example on the self-purification capacity of waterbodies or the pollination capacities of insects. Such factors – provided free of charge – are often disregarded. Thus the classic economic efficiency parameters generally fail to take ecosystem services into account (-> Figure 40 and box 15).

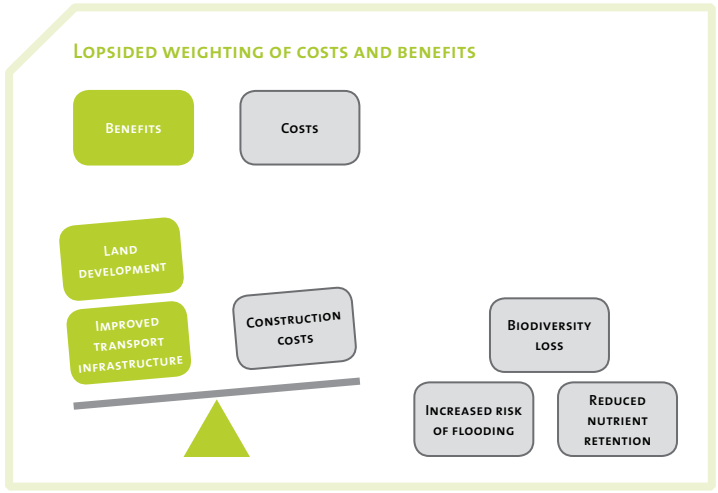


**FIGURE 40** ▸ The oftentimes lopsided weighting of costs and benefits, illustrated here using floodplain use as an example (-> box 15).
(Grafik: ifuplan)

Hence, in order for social policy decisions to take the common good into account, it is necessary to factor in all relevant dimensions – which means also including social concerns in the weighting process. In terms of private sector decisions, the decisive factor is for the government to establish suitable framework conditions such as regulatory requirements and economic incentives. If ecosystem services are not taken into account, decisions might be made that will have a short or long term negative impact on society, ecosystem services, and nature.

One example of this is the increasing use of former river floodplains (-> box 15). While dike construction allows for more intensive agricultural and human settlement land use and reduces the risk of flooding of areas directly protected by dikes, planners have usually failed to allow for the fact that these dikes increase the risk of flooding for up- and downstream users and reduce the river's self purification capacity. Nowadays, planners are beginning to remove or relocate such dikes, so as to allow for the restoration of flora and fauna habitats; for while such dismantling measures are cost intensive, it has been realized that in the long run it is less cost intensive to allow a river »its« space.

Another obstacle in the way of decision making that gives all aspects equal weight is the multiplicity of ecosystem services. For example, peatland restoration not only creates new flora and fauna habitats, but also brings benefits such as hydrological service stabilization (which is in turn beneficial for farming), flood water retention, and reduced carbon dioxide emissions. And while these multiple ecosystem services would at first glance appear to be a good thing, these benefits can only be recognized if planning and decision making processes incorporate all relevant sectors and affected actors. But in a



BOX 15

**Failing to take account of all ecosystem services in connection with waterbody and floodplain projects produces bad decisions.**

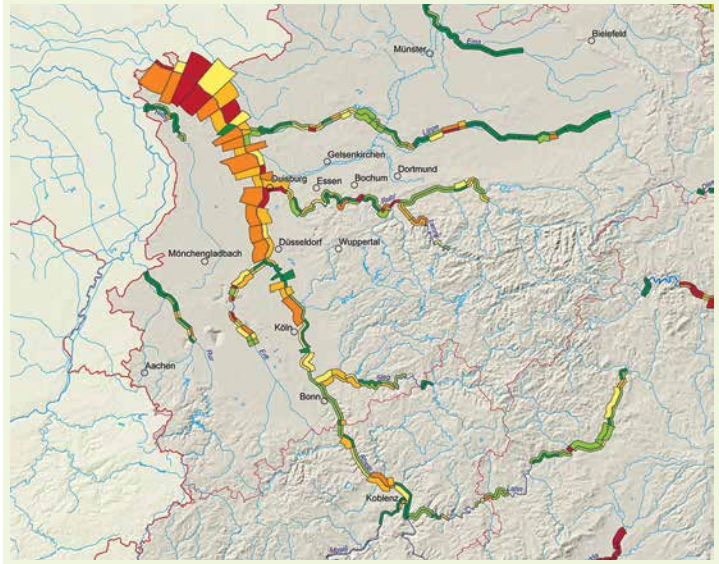


**FIGURE 41** ▸ Floodplain loss on the Rhine River north of Bonn. Floodplain loss increases the risk of flooding at other parts of the Rhine, reduces nutrient retention, and destroys biodiversity.
(Map: Brunotte et al. 2009; BfN 2009)

In many places in Germany, watercourses were straightened, riverbed depth increased, and natural floodplains hemmed in with dikes so as to make them more farming friendly. Such measures made rivers more suitable for use as shipping lanes and promoted greater agricultural production. 54 percent of Germany's once active floodplains are now predominantly or fully hemmed in by dikes and are being used intensively (BMU/BfN 2009; -> Figure 41). Such actions destroyed the habitats of countless endangered flora and fauna species, while the absence of these floodplains increased flood wave height. The consequences of all of this was clearly demonstrated by the 2002 Elbe River floods. Moreover, river dike construction reduced the rivers' self-purification capacities, making it necessary today to spend money on additional water purification measures.

society where specialization is the norm, such multi-disciplinary approaches are usually a logistical headache, with the result that the manifold benefits of ecosystem services are not incorporated into decision making processes. What happens instead is that political (or policy) heavy hitters and their interests prevail, and thus certain ecosystem services fall by the wayside.

Focussing on short term economic benefits (-> box 16) and thus taking an approach that is too narrow is also a problem when assessing economic growth and domestic prosperity by using GDP as a metric. For many years now, opponents of this approach have been calling for measures aimed at incorporating quality of life, -> WELL-BEING and sustainability (keywords: qualitative growth, eco-GDP, beyond GDP or green growth). The EU's biodiversity strategy calls for member states to, in the lead-up to 2020, map and assess their ecosystem services, assess their economic value and promote the integration of these values into accounting and reporting systems. But so far, besides missing data necessary for such measures, the scientific basis

BOX 16

**FIGURE 42** ▸ Trees and forests fulfil various mitigation functions: they reduce pollution and noise, e. g. by traffic and sequester carbon. (Photo: Karl-Heinz Liebisch, Pixelio)

**Well-being is about more than just material prosperity**

Prosperity is one of the key yardsticks for the political success of a government. The national metric for this is usually GDP, which refers to the total value of all final goods and services generated by a national economy over the course of a year. Not factored into the GDP, however, are degradation of the environment, ecosystem services and the balance of natural processes occasioned by the -> EXTERNAL EFFECTS of economic activity. This GDP blind spot results in the destruction of natural capital having a negative impact twice over. For example, if a decision is pending as to whether a forest should be cut down to make for a new highway, under the current paradigm the advantages of the »highway« option will be given the greatest weight in economic-efficiency calculations for the simple reason that the ecosystem goods and services of the »forest« option will not be sufficiently or properly incorporated into the assessment. The result: the highway will be built, and the forest will be cut down. And while this increases GDP, forest ecosystem services such as carbon dioxide sequestration, noise abatement, air filtration, and recreation – all of which contribute to our well-being – go by the wayside, without this quality of life loss being reflected in the GDP. Indeed, just the opposite will happen, in that the loss of some ecosystem services may be offset by construction: a noise barrier replaces the noise abatement effect of the forest, or a swimming pool compensates for the loss of a recreational area. So both of these measures are added to GDP – but in this case precisely because natural capital was destroyed.



and methodological conventions that would meet statistical requirements are lacking. Thus what is being put forward here is for the most part a long term strategy and vision that takes account of current scientific advances.

## 3.2 WHAT IS THE PURPOSE OF ECONOMIC VALUATION OF ECOSYSTEM SERVICES – AND HOW TO DO IT?

We can only preserve and care for elements that we are already conscious of. For the only »goods« (in a wider sense) that are incorporated into decision making processes are those whose value we are aware of – and not those that we simply take for granted. When it comes to nature, awareness and appreciation often require knowledge, or emotional ties, as preconditions. In order for natural capital and ecosystem services to be given their just weight in decision making, it is also helpful to gain greater understanding of the following:

- The current scope of ecosystem services.
- Changes in these services, and the causes of such changes.
- The importance, as well as the current and future value, of ecosystem services.

Doing this entails a three step process.

Step 1: Identify ecosystem services.

Step 2: Where possible, assess the state and scope of ecosystem services using suitable (quantitative) indicators as a basis.

Step 3: Value ecosystem services using suitable methods (-> Figure 43). -> ECONOMIC VALUATIONS are particularly useful in cases where the first two steps are carried out diligently and to a sufficiently comprehensive extent.

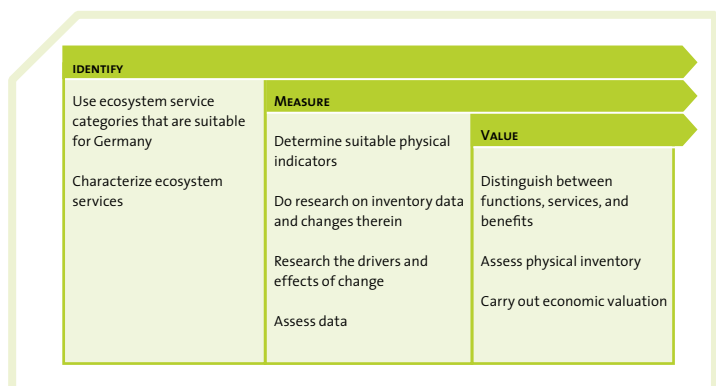


**FIGURE 43** ▸ Ecosystem assessment procedure (Source: own representation)

### Step 1: Identify ecosystem services

As noted in section 2, ecosystem services can be identified by using the following categories: -> PROVISIONING SERVICES; -> REGULATING SERVICES; -> CULTURAL SERVICES; and -> SUPPORTING SERVICES. International studies such as the Millennium Ecosystem Assessment (MA 2005) and the -> TEEB study apply slightly different approaches to categorizing and inventorying ecosystem services. When implemented at the local, regional or national level, these approaches need to be adjusted to natural-environment and social particularities. A possible methodology for Germany that is currently being elaborated and tested is described in -> box 17 and table 1.

### Step 2: Measure ecosystem services

Once ecosystem services have been identified, the next step is to assess their physical state and scope, using a broad range of data, as well as suitable indicators (the latter to ensure process efficiency and replicability). »Suitable« means that the data provide insight into the services the element being investigated delivers under the current ecological, economic and social conditions (e. g. the size of floodplains that can absorb flood waters; the extent to which vegetation forestalls topsoil erosion). This physical assessment also needs to take account of which cycles (e. g. one, two or four year) and for which area (e. g. at the level of a German state or for Germany as a whole) the

**FIGURE 44** ▸ An example of ecosystem service quantification: Park trees can make a key contribution to air purity, particularly in cities with high air pollution. A single 100 year old beech tree exhibits 15,000 square meters of gas exchange surface area; which means that on a sunny day the tree can filter up to 36,000 cubic meters of air. (BfN 2010, Photo: Reiner Sturm, Pixelio)



indicator was measured. To arrive at such indicators, data need to be found that provide insight into the current status of services (current surface area of active floodplains, scope of avoided soil erosion) and its changes (increase or decrease relative to the last measurement). It is also useful to ascertain which parameters impact on a given indicator (e. g. floodplain restoration, changes in grassland status) and the possible unforeseen impact of changes in these parameters (e. g. construction in floodplains, more intensive agricultural production at other sites) so as to obtain as complete a picture as possible.

The assessment of ecosystem services has become a high priority issue of government policy. As noted above and in -> box 17, the European Commission's proposed European Biodiversity Strategy calls for the EU member states to map and assess the ecosystems and their services on their territory in the lead-up to 2014 and to incorporate their economic values into their national accounting procedures by 2020 (European Commission 2011).

The project mentioned in -> box 17 provides a basis for mapping and assessing the physical state and scope (and at the same time serve as monitoring) of ecosystem services in Germany. In doing this, existing knowledge concerning ecosystems, ecosystem services, and their -> BENEFITS for society need to be compiled, insofar as possible. Focusing on selected key German ecosystem services and using available ecological, social and economic data as a basis, indicators concerning the scope and importance of ecosystem services will be developed. These indicators that can be aggregated will provide insights into the changes in natural capital and ecosystem services in environmental reporting systems. Ultimately, efforts will be made to incorporate them in environmental-economic and welfare accounting.

### Step 3: Value ecosystem services

Various methods are available for assessing the social and economic values of ecosystem services (-> box 20). The choice of method will have an effect on which aspects of these values are captured and which are not – and thus on which values remain hidden from sight. This also applies to the various monetary valuation methods. Monetary valuation is not objective or generally applicable, for its outcomes are determined by very specific assumptions.

BOX 17

**Mapping and assessing ecosystem services in Germany**

It has been proposed that one of the six objectives of the European biodiversity strategy could be implemented if each of the EU member states maps and assesses the ecosystems and their services on its national territory in the lead-up to 2014. To this end, a preparatory research project was carried out in Germany in close cooperation with »Natural Capital Germany«, with the goal of identifying our key ecosystem services and characterizing their nature and scope so as to allow for the measurements of future changes in them (-> table 1, Albert et al. 2015). This project required the elaboration of measurement protocols and descriptive indicators for each ecosystem service. The necessary data was compiled insofar as possible and a baseline value for the current scope of the various ecosystem services was determined. This approach mainly focused on regulating and cultural services, as they are particularly endangered by increasing land use for settlement and traffic infrastructure as well as more intensive agricultural production.

TABLE 1 **Preliminary selection of ecosystem services for an ecosystem service monitoring concept in Germany**

| | |
|---|---|
| **REGULATING SERVICES** | |
| GREENHOUSE GAS REDUCTION | Biomass production removes carbon dioxide from the atmosphere and binds it in plant tissues. Peatland preservation and rewetting help to avoid carbon dioxide emissions from the breakdown process in former peat soil. Avoiding the ploughing up of grassland and enlarging the scope of organic farming promotes carbon dioxide storage in the soil. |
| CLIMATE REGULATION AND AIR FILTERING IN URBAN AREAS | Green spaces promote temperature equalization and mitigate unhealthy elevated temperatures. Trees in particular filter unhealthy particulate matter out of the air. |
| A QUALITY WATER SUPPLY | Non-contaminated ecosystems promote clean drinking water. Near-natural river banks mitigate unduly high waterbody nutrient concentration. |
| POLLINATION | Much of our food supply depends on pollination. |
| NATURAL PEST CONTROL | Forestry and agricultural production are promoted by the regulating effect of the natural predators of pests. |
| EROSION PROTECTION | Land cover, edge strips, and copses help prevent wind and water erosion and preserve soil fertility. |
| FLOOD CONTROL | Floodplain forests and wet meadows serve as flood storage areas and thus help reduce flood damage. |
| WASTEWATER PURIFICATION AND EXCESS-NUTRIENT BREAKDOWN | Micro-organisms in soil and water habitats break down detritus and waste and thus help keep these environmental areas clean. |
| **CULTURAL SERVICES** | |
| RECREATION AND HEALTH | Near-natural landscapes, open and green spaces are essential for recreation and health. |
| THE INSPIRATIONAL EFFECT OF NATURAL BEAUTY | The immense pleasure we derive from the contemplation of nature is an integral part of our civilization, as is the use of nature as a subject in art. Both art and design benefit in countless ways from the inspirational effect of the natural environment. |
| SENSE OF BELONGING | Our sense of belonging and identification with a region is often closely associated with experiencing certain familiar landscapes. |
| SCIENCE, EDUCATION AND RESEARCH | Nature provides us with countless models and materials for technological, medical, pharmacological and food production applications, and is thus an object of research and a font of new knowledge and products. |
| **PROVISIONING SERVICES** | |
| FOOD PRODUCTION | Fertile soils provide favourable conditions for crop plant cultivation, and through animal feed production indirectly form the basis for livestock raising. |
| PRODUCTION OF BIOMASS AND OTHER VEGETAL MATERIALS | Many ecosystems produce a wealth of materials, some of which are also used as sources of energy. |
| PHARMACEUTICAL RESOURCES | Many plants contain medicinal substances that are used in pharmaceutical drugs and body care products. |

BOX 18

FIGURE 45 / 46 ▸ A price does not always reflect the value of a good. For example, water is usually very cheap or does not have to be paid for at all. However, it has a high use value and is of central importance for our existence. Diamonds, on the other hand, are highly expensive but hardly serve any practical purposes in daily life.
(Photo: Metronom GmbH)

**Values, exchange value, and use value**

Values express subjective views and serve to identify aspects of life that we hold dear. Values can be ascribed to either material or non-material elements. Examples of the latter are stewardship of natural resources for future generations, or the pleasure we derive from contemplating nature. Material values, on the other hand, are defined for physical entities that are important to us.

Regardless of whether such values are explicitly articulated or simply recognizable by the way people act in relation to them, they reflect the extent to which we care about or take care of a specific material or non-material element, as well as to how we are affected by its status or condition, e. g. the impact of qualitative or quantitative changes on the element in question. In such situations, the value a particular element has for specific individuals or social groups can be determined by a host of different factors. Moreover, individuals assess the value of a given element in the light of overarching social values, amongst others because in satisfying our own needs we must also take the needs of others into account (Höffe 1992: 303).

People place differing emphasis on the material, moral, spiritual and aesthetic dimensions of life – all of which also influence their attitudes toward nature. Hence there is no such thing as a blanket or »master« value that is or can be attached to or associated with nature. Many economists equate »value« with the market exchange value of a given item, that is the price. A good with a high or low exchange value will also bear a high or low price, as the case may be. Equating »value« with »exchange value« in this manner in effect means that any element that is not exchanged via some kind of market has no economic value.

But this paradigm does not go nearly far enough, nor does it accurately reflect the true economic state of things. Adam Smith, the founder of economics, made this very point more than two centuries ago in »The Wealth of Nations«. Smith pointed out that a distinction must be made between value in use and value in exchange, and illustrated this principle using water and diamonds as examples of goods. Water is normally free or very inexpensive, Smith said, but has a high use value as it forms the very basis for all life. But, he noted, the reverse is true of diamonds by virtue of their high price but lower use value. Hence the value (economic or otherwise) of water as a good indisputably differs from its price. And this principle applies not only to water, but to many goods that are not traded commercially, thus having no price but tremendous economic value for individuals and society as a whole (so-called public goods).



## 3.3 WHICH VALUES DO ECONOMIC VALUATIONS CAPTURE?

Economic values encompass only a portion of the different values that come into play, for the simple reason that economists only ascribe a value to elements that are of use to human beings in one way or another. This is referred to as »benefit« (-> box 18). The term »benefit«, however, is broadly defined by economists. For example, it can refer to the -> EXISTENCE VALUE, which is the benefit that people gain from just knowing that certain things, e. g. untouched wilderness or rare species, exist and continue to exist, without deriving any other advantage from it. It is not taken into account that values may very well exist irrespective of humanity (-> box 19).

Contrary to a view held by many, economic and ethical takes on nature do not contradict each other. For in point of fact the economic view can be regarded as a »prudent« aspect of the ethical perspective in that it is in the true interest of the human race (and thus »prudent«) to conserve nature and thus protect the sources of our own livelihood and well-being. Moreover, economic valuations are predicated on the concept that assessments of nature and the services thereof should take their cues from human preferences (as opposed to expert knowledge) – a so called preference-based approach. The most widely accepted basis for environmental value assessments is the concept of total economic value (TEV). Such assessments seek to capture and quantify, in their entirety, the benefits of nature and its services to humankind. TEV is composed of a number of individual values, which are exhibited in -> Figure 47 (see TEEB 2010A: 195).

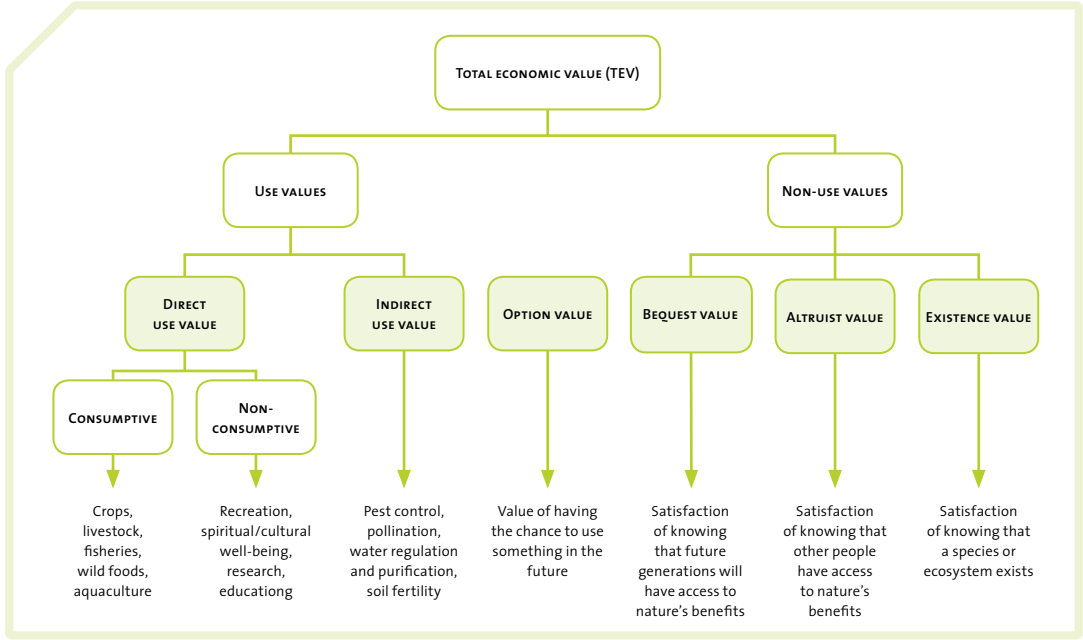


FIGURE 47 ▸ The concept of total economic value (TEV)
(TEEB 2010A: 195, modified)

**FIGURE 48** ▸ Trees have a high use value: they provide wood, filter the air and offer shadow and cooling by evaporation on hot summer days. (Photo: Metronom GmbH)

In the TEV concept, a distinction is made between -> USE VALUES and non-use values. The former relate to the use of natural resources and consist in a direct use value (such as recreation and agricultural products), or an indirect use value (such as pollination by insects and the flood control effects of floodplains). Non-use values are further subdivided into existence value (the desire to preserve an element even if it is not actually used; in other words a benefit is derived from the mere knowledge of its existence), bequest value (the desire to preserve an element for future generations), and in some cases -> ALTRUISTIC VALUE (the desire to preserve an element so that others may use it). Interposed between use and non-use values is -> OPTION VALUE, which refers to the desire to preserve a usage modality regardless of whether it is ever actually used. An example of this is biodiversity preservation in rain forests with the aim of using the available species as a gene pool for the pharmaceutical industry.

The concept of total economic value (TEV) and the related economic concept of benefit have a far broader meaning and include a considerably greater range of values than the colloquial or philosophical concept of benefit. For example in philosophy, experiencing the beauty of nature is considered to be a »self serving, non-instrumental encounter with nature« (Krebs 1999: 44 f.), while in economics it is nevertheless regarded as »benefit.« The same holds true, but to an even greater extent, for altruism that relates to the benefit by other people (altruistic value as it relates to the concept of total economic value). This is not at all related to self serving motives and can thus not be characterized as a means to an end scenario (see Nida-Rümelin 2011).

Hence economic values far exceed the scope of direct material use of nature or use of nature for business purposes only. This take on economic valuation is relevant for nature conservation and the sustainable use of nature in that it also points to indirect and non-material usage components of the natural environment and can thus be characterized as a »moderate anthropocentric stance« (WBGU 1999). However, this concept does not incorporate values that exist beyond human activities, in other words the »intrinsic value of nature« (-> introduction to section 3.3 and box 19).

But in the real world economic valuation only captures the values of a minute number of ecosystem services (-> Figure 49), owing to a lack of data concerning (a) the exact ecological and economic impact of changes in these services and/or (b) the exact preferences of the general public. Of course it is possible to carry out economic valuation in the absence of sufficient information by, for example, conducting opinion surveys where respondents are asked how much they are willing to pay to avert the potentially adverse effects of a particular measure. However, such surveys and in particular attempts to apply



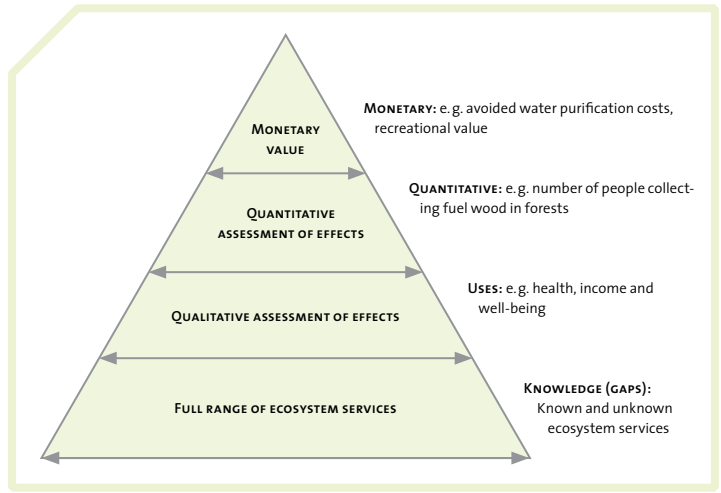


**FIGURE 49** ▸ Biodiversity and ecosystem value capturing (TEEB 2008, slightly modified)

their findings to other situations (»benefit transfer«) raise the question as to whether such results are sufficiently reliable to be used as a basis for decision making.

For practical and methodological reasons, monetization normally takes account of selected values of nature only – an approach that can result in only the tip of the iceberg being visible (and valued). This shortcoming underscores (as was shown in section 2) the fundamental importance of diligently and equably incorporating all ecosystem services that come into play.

BOX 19

**Intrinsic value of nature**

Intrinsic value of nature refers to its value »in itself«. This concept encompasses both living creatures and -> ECOSYSTEM FUNCTIONS that are essential for the natural environment and the processes thereof, regardless of whether these functions are useful to human beings.

Likewise commonly used in this context are the terms anthropocentric, biocentric and ecocentric, which differentiate between the various justifications for nature conservation (see WBGU 1999). According to the anthropocentric view, nature conservation is justified for reasons related to human rights and needs, while the biocentric or ecocentric view prioritizes the well-being of non-human living creatures or ecosystem functions.

Ethical arguments in favour of nature conservation draw upon all of these views (see Eser et al. 2011).

**FIGURE 50** ▸ Ecosystem functions, such as soil formation, are the basis of all ecosystem services. (Photo: Rido, Fotolia.com)

## 3.4 WHAT ARE THE AVAILABLE ECONOMIC VALUATION METHODS?

The various economic valuation methods seek to capture the -> INCOME-EQUIVALENT VALUE of changes in ecosystem services. In cases where ecosystem services such as pollination generate substantial revenue/profits or cost rollbacks, this normally means that financial resources will be freed up for other purposes in proportion to the profits or savings. In cases where people are willing to spend money for the privilege of enjoying ecosystem services (e. g. costs for travel to and stay in national parks), the amount of these expenditures will indicate how much experiencing nature is (at a minimum) worth to these people.

Economic valuations of ecosystem services aim to translate the greatest possible number of ecosystem values into income equivalents, using suitable methods. This involves not only production related services such as farmland fertility, but also (as noted) all of nature's goods that are freely available to all (public goods), as well as non-use values. One example of this is the income loss that people would willingly sustain in order to preserve ecosystems, by virtue of a right to existence or intrinsic value having been ascribed to them.

**FIGURE 51** ▸ The assessment of ecosystem services can provide decision makers with important information and facilitate negotiation processes. (Photo: André Künzelmann)



BOX 20

**Economic valuation methods for ecosystem services**

Economic valuations are instruments to inform decision making, just like non-economic valuations such as multicriteria-analysis based on expert knowledge or deliberative procedures. Economic valuations entail the use of specific methods aiming to capture the preferences of a group of representative individuals. In all cases, a decision must be made concerning the pros and cons of various methods and which method is most suitable for a given situation.

**MARKET PRICE METHOD**

Ecosystem services that are traded in the same or similar form can be assessed from the standpoint of their market prices. One example is fish that is caught and consumed by a weekend angler, or wild game that is killed and used by a hunter. In both such cases, it should be noted that the product being assessed normally accounts for only a fraction of the total benefits derived from the activity. For example, the fact that the angler or hunter derives enjoyment from spending time in the great outdoors is not taken into account. The market price method is mainly useful for assessing provisioning services.

**PRODUCTION COST METHOD**

In cases where changes in ecosystem services translate into reduced production costs, the value of such a change can be determined, albeit reductively, based on such cost reduction. For example, cost reduction in water treatment may be ascribable to the improved self-purification capacity of waterbodies. Possible price effects are not taken into account for this method. If cost reductions trigger substantial changes in quantities and prices, these changes would need to be additionally quantified in the form of -> CONSUMER and -> PRODUCER SURPLUSES.

**DAMAGE COST AVOIDED, ABATEMENT COST, REPLACEMENT COST, ALTERNATIVE COST, AND RESTORATION COST METHODS**

Reduced healthcare costs attributable to factors such as contaminants being filtered out by an urban forest or park (-> Figure 44) can be measured using cost metrics as a basis (avoided damage costs). However, in using this method you need to bear in mind that avoided psychological or physical suffering is hardly ever taken into account; doing so would require the use of additional methods. Ecosystem services can to some extent be replaced by technical measures such as the following: building dikes or increasing their heights in lieu of flood control services provided by floodplains; using technical avalanche protection measures to replace protective forests; or reducing carbon footprints through the use of renewable energy as a replacement for peatland restoration. Insofar as the effectiveness of such measures is on a par with the ecosystem services they replaced, their costs can then be said to correspond to the value of the ecosystem services (replacement costs). In cases where certain mandatory objectives have been set such as good eco-

logical status for waterbody within the EU Water Framework Directive, then ecosystem services such as the improved self-purification capacity of renatured waterbodies can also be valuated based on the costs that alternative measures such as purification in sewage treatment plants would entail – including in cases where measures are not currently implemented but will be with reasonable certainty in the future (alternative costs). Another cost-oriented valuation method is that of restoration costs. Strictly speaking, the restoration cost method can be applied from an economic standpoint only in cases where the development of an environmental problem element and/or policy goals in fact necessitate such replacement today or in the future. It should be noted in this regard that restoring destroyed or degraded ecosystems (assuming that it is even possible to do so) is normally more cost intensive than the costs and temporary unavailability entailed by conservation of the element in question.

**HEDONIC PRICING APPROACH**

Some of the beneficial elements of ecosystem services have detectable effects on the prices of marketed goods, one example being the impact of a »green« residential environment on real estate prices and rent levels. Using statistical methods, it is possible to ferret out from a total price its price elements that are based on ecosystem services. These price elements then constitute the minimum value that local residents ascribe to improvements in their residential environment attributable to natural amenities (-> Figure 52). The actual total amount may be higher than this, since some residents would presumably have been willing to pay more.

**TRAVEL COST METHOD**

This method estimates economic values of recreational benefits associated with ecosystems or sites. It is based on studies of visitor behaviour patterns that apply to selected natural areas or natural areas with specific recreation related natural characteristics. The matters investigated are the amount spent on visits, as well as the number of visits relative to time and money spent, and in more recent variants of this method, relative to key parameters that determine recreation quality.

**FIGURE 52** ▸ The prices of housing in desirable locations adjacent to parks are about 10 percent higher than housing in locations with two kilometres distance to the next green space.
(Calculation based on Hartje et al. 2017. Photo: Gerhard Giebener, Pixelio).



In order to estimate the existence, bequest or option value of species and biotopes or specific landscape elements, it is necessary to conduct surveys, owing to the fact that such values cannot be adequately captured based on prices (e. g. in the guise of member contributions to nature conservation organizations) or on identifiable expenditures such as travel costs.

**CONTINGENT VALUATION AND DISCRETE CHOICE ANALYSIS**

The -> CONTINGENT VALUATION method involves conducting representative opinion surveys on matters such as the additional amount of tax the government should be allowed to raise for a specific purpose such as the conservation of natural monuments. For surveys based on the discrete choice analysis, respondents are given choices related to various amounts that the respondents would theoretically be willing to pay for certain ecosystem services. Income equivalent in terms of willingness to pay for specific environmental services is determined by calculating mean values and applying them to the population as a whole.

Inasmuch as such surveys are hypothetical constructs, there is of course no way of knowing if respondents would express their actual honest opinions. The margin for error that such hypothetical situations can potentially give rise to is estimated by comparing the results of various methods and the results of real world votings (see Bräuer and Suhr 2005; Johnston 2006). Despite methodological advances, the contingent valuation method and choice analysis undoubtedly remain the most controversial methods of those discussed above. Particularly when it comes to public goods, which many people have strong feelings about, a small percentage of respondents refuse to indicate how much they would be willing to pay for specific environmental services, due to their view (among other reasons) that attaching a monetary value to nature is inappropriate.

**BENEFIT TRANSFER**

Researchers are now attempting to develop methods that allow transferring results of the aforementioned valuation methods from one location to another, by adjusting them to the specific ecological, economic and social conditions. The decisive factor for the applicability of this potentially inexpensive approach is the extent to which the relevant studies and the domains to which they would potentially be transferred can be made congruent with each other. The accuracy of such benefit transfers is currently still linked to high uncertainties.

In order to facilitate estimates of ecosystem service income equivalents for the aforesaid values, various economic methods have been developed such as the following: market and cost based methods (based on market prices, production costs, cost of damages, abatement, replacement and alternative costs); behavioural analysis and interpretation (travel cost method, hedonic pricing method) and surveys (contingent valuation and discrete choice analysis; -> box 20).

**FIGURE 53** ▸ Monetary valuation is only one way to represent the values of nature – often useful in decision making but not always appropriate. (Photo: Hagen Kluttig)

The various methods are often combined for assessments of specific projects, in that each ecosystem service is valuated using the method that is best suited for it. For example, the following was done for the assessment of a floodplain restoration project (Grossmann et al. 2010): the flood control effect was estimated using the damage cost avoided method; water body self-purification capacity was valuated based on the lowest expenditures that would have been necessary to attain the same purification effect via technical measures; and recreational and habitat functions were valuated via surveys on respondents' willingness to pay for these functions (-> CONTINGENT VALUATION METHOD). Comparing the foregoing elements with dike relocating and floodplain restoration costs, including agricultural production loss, revealed that increased waterbody self-purification capacity and improved flood control in and of themselves economically justify the dike relocating and restoration measures. The resulting improvement in recreation and species protection functions occasioned another increase in benefits relative to costs (-> box 21).

All of the ecosystems valuation methods discussed thus far are based on assumptions and thus involve uncertainties to one extent or another. Moreover, it is not always possible to capture the values of all ecosystem services in a sufficiently valid and reliable form. Another problem is that economic valuation of ecosystem services raises both methodological and basic concerns (for a detailed discussion of this issue, see Hansjürgens 2003). However, in terms of »Natural Capital Germany«, the following three matters are of central importance:

- Economic valuations relate to more than just marketable products such as food, water, wood and so on. To conduct such valuations, the whole gamut of values of ecosystems and of -> BIODIVERSITY should be captured and valued, particularly regulating, cultural and supporting services, which are far less known than provisioning services. The economic approach can be helpful here; it can provide key additional justifications for nature conservation, apart from the intrinsic value of nature.

- The process of identifying, measuring and valuing ecosystem services should always be seen with respect to a specific real world context, i.e. is in terms of the spatial, temporal, personal and material dimensions of a specific real world problem. There is simply no point in identifying and capturing the values or characterizing ecosystem services in the abstract. What should be done instead is to focus on specifics – namely actual changes caused by specific factors (drivers) in a specific region that have an impact on specific users and other stakeholders. A valuation should always relate to real world options. Centering valuations on the circumstances of specific cases is an important step, not only in terms of accurately and fully measuring the relevant effects per se, but also because this allows for more precise identification of the stakeholders concerned (both directly and indirectly). In many cases, such actors are able to bring in important knowledge and expertise to a valuation study that »external« researchers would be incapable of providing.



BOX 21

**Ecosystem services and monetary values**

The economic efficiency of Elbe dike relocation and floodplain reclamation was investigated via cost benefit analysis (Grossmann et al. 2010), which unlike most economic analyses, compared the cost of dike relocating and the losses entailed by reduced agricultural production on the one hand and the -> BENEFITS derived from ecosystem services on the other. Restoration of natural floodplains reduces flood damage, while at the same avoiding dike maintenance costs. Moreover, natural floodplains retain a larger amount of nutrients that would otherwise have to be removed from waterbodies via cost intensive measures. According to an opinion survey, a further advantage is that greater recreational value is ascribed to the floodplains. This value could also be quantified monetarily via a contingent valuation analysis. The value of all three ecosystem services examined resulting from the reclamation of natural floodplains exceeded the costs of these measures by a factor of three. These findings clearly show that to obtain valid cost benefit analysis results, indicating economic efficiency, it is essential that the maximum number of ecosystem services be incorporated into the analysis. The more extensively such services are taken into account, the better the costs of conservation or development of the ecosystem are put into perspective.

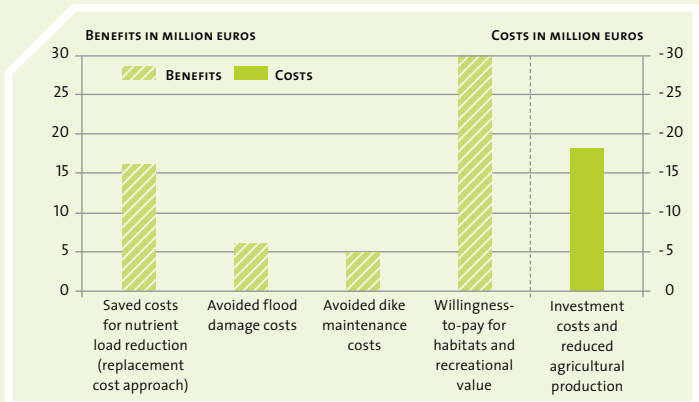


**FIGURE 54** ▸ Annual costs and benefits of dike relocation and floodplain restoration (3 percent discount rate; 90 year calculation period; BfN 2012 after Grossmann et al. 2010)

- Before carrying out an economic valuation, it is necessary to determine the impact of a measure, project or environmental change, and ascertain the impact of such elements through the use of suitable indicators or metrics. In many cases where the aim is to gain insight, raise awareness, and modify behaviours, systematically and fully identifying all effects that need to be taken into account and determining the scope of these effects can be even more important than the valuation per se.

Furthermore, the economics of ecosystems and biodiversity involves far more than a mere valuation (in the sense of identifying ecosystem services, measuring their impacts, and ascribing a value to an element). The truly decisive part is the next step, when the question arises as to how ecosystem services and their values can be incorporated into public and private sector decision making, and which instruments should be used to further this process. Here, it is essential to think in terms of -> CAPTURING VALUE.

## 3.5 INCORPORATING THE VALUES OF NATURE INTO DECISION MAKING IN POLITICS, ADMINISTRATION AND BUSINESS

Ecosystem service assessments, including economic valuations, is a key aspect of »Natural Capital Germany«, but is by no means its sole focus. The ultimate aim is to ensure that nature, -> BIODIVERSITY and -> ECOSYSTEM SERVICES are incorporated into decision making to an extent that is commensurate with the importance of their values. One of the key aspects here is the fact that biodiversity conservation oftentimes goes hand in hand with the conservation of ecosystem service – particularly when it comes to ecosystem services that make little or only indirect contribution to the production of commercial goods. Such services include the flood control effects of natural floodplains; the air filtering effects of city parks; the self-purification capacity of near-natural waterbodies; and the importance of natural habitats for recreation. Fuller incorporation of these ecosystem services through adequate data and suitable assessments would provide further robust arguments as to why stewardship of flora, fauna and their habitats is so very important.

While supplementary data and assessments are both helpful and necessary, they do not go far enough to enable our society to more efficiently and successfully address the issue of livelihood. It is equally important that our social institutions and regulatory mechanisms should be structured in such a way as to enable these data and assessments to become the actual basis for decisions and actions – with the goal of achieving sustainable social and economic development that promotes ecosystem service conservation.



**FIGURE 55** City parks often host an impressive variety of trees. At the same time they provide several ecosystem services, such as recreation, air filtering or heat mitigation. (Photo: Metronom GmbH)

»Natural Capital Germany« is also extensively addressing the issue of the conditions needed to implement policies that prioritize the conservation of our natural capital, in other words with the relevant institutions that shape human behaviour with respect to resource use, with the regulations aimed at ensuring responsible actions and with the instruments that are available now or in perspective. The main instruments in this regard are as follows:

- Regulatory framework (including planning instruments)
- Economic instruments
- Supplemental government instruments, particularly for information dissemination purposes
- Voluntary instruments in the private sector

Germany already has numerous legal provisions concerning species and habitat protection, as well as assessments of various dimensions of ecosystem services. Such regulations are found, for example, in the following domains: (a) nature conservation laws, which also include

statutes aimed at protecting the proper functioning and performance of the natural balance; (b) water law; and (c) laws governing building codes, construction and planning. The extent to which such matters could be better taken into account is to be determined, for instance:

- Through more efficient coordination and cooperation between the relevant stakeholders and authorities in elaborating and adopting measures, so that the diversity and interaction of ecosystem services and their values is given greater consideration.

- Through increased efforts to develop information and assessment instruments, as well as the regulations for implementing them.

- By devising ways to strategically involve the general public and outside experts.

Apart from regulatory and planning instruments, the following types of economic (market based or market oriented) instruments are available (among others) that will better equip us to incorporate the values of nature into decision making: financial incentives via taxes, charges, fees and / or licenses; abolishing environmentally harmful subsidies; improved incorporation of ecosystem services into government supported programs (e. g. payments for ecosystem services, as described in -> box 22).

Implementation of such instruments will help to ensure that the values of nature are incorporated into economic decision making from the get-go. As a complement to existing regulatory frameworks economic instruments are therefore ascribed high potential for innovative and efficient solutions. This approach is already being applied in many policy domains through the use of a constellation of policies mainly comprising regulatory measures and economic incentive instruments, a so called policy mix. The potential of such hybrid approaches within a predominantly regulatory framework should be carefully studied, for it is currently unclear whether they can always achieve the desired results and are cost effective.

So called soft awareness raising and information dissemination instruments such as the following also play a key role in spreading the word about the economic importance of nature, biodiversity and ecosystem services: PR (increasingly over the internet); campaigns aimed at raising the awareness of the general public or specific social groups; educational and training programs for specific social groups; reports, studies and other informational materials (including this brochure, as well as future »Natural Capital Germany« reports). In addition, the government can help to institute labels and/or certificates resulting in greater information on the side of producers and consumers.



BOX 22

**Markets, incentives and cooperation – Examples of market based instruments for ecosystem conservation**

**FIGURE 56** ▸ Viehlassmoos
(Photo: Christoph Moning)

**FIGURE 57** ▸ Peatland restoration in Mecklenburg-Western Pomerania
(Photo: Monique Ziebarth)

Peatland drainage and improper peatland management, as has occurred in Viehlassmoos, Bavaria (-> Figure 56), induce 22 to 44 tons of carbon dioxide equivalent emissions per year and hectare in Germany (Drösler et al. 2011). By contrast, targeted peatland conservation measures in Mecklenburg-Western Pomerania from 2000 to 2008 (-> Figure 57) greatly reduced the state's greenhouse gas emissions, thus avoiding an estimated € 30 million in damage attributable to climate change (Schäfer 2010). Mecklenburg-Western Pomerania has paved the way for the implementation of further measures of this nature via its MoorFutures program (www. moorfutures.de/en), which enables private companies to voluntarily purchase carbon dioxide certificates by funding peatland conservation measures.

In many of Germany's water conservation and water catchment areas, water utilities and growers are now working together to reduce the oftentimes elevated concentrations of nitrate in groundwater. Under these arrangements, water utilities offer support for the extensification of farming, for instance for (a) farming methods that protect groundwater; (b) organic farming; and (c) environmentally friendly grassland management. Such measures are funded via drinking water charges, as well as funds for agri-environment measures. In some cases, such funding schemes are linked not only to certain measures, but also to success. For example, growers that are able to conserve a set number of characteristic grassland species receive additional funding. The idea is to improve the effectiveness of funding and make better use of the know-how of farmers on species protection.

**FIGURE 58** ▸ Cooperation in Lower Saxony's largest water protection area funded by Deutsche Bundesstiftung Umwelt
(Federal Foundation for the Environment; Photo: DBU)

**FIGURE 59** ▸ Cooperation with the municipal utility Stadtwerke München
(Photo: ifuplan)


**FIGURE 60** ▸ Eco labels help consumers make purchase decisions. The labels shown here concern themselves with various dimensions of biodiversity and ecosystem services.

BOX 23

**Consumer decision making can help conserve natural capital**

Popular opposition to the loss of natural capital is on the rise in Germany, while at the same time ever growing numbers of consumers are calling for production practices that avoid natural capital loss or that at least integrate compensatory measures. This evolution is borne out by a recent consumer survey, more than 80 percent of whose respondents indicated that they plan to stop buying products made by companies whose policies are not ecologically friendly and socially responsible (TEEB 2011B). Apart from eco labels of long standing concerning organic farming, sustainable forest management, and sustainable fishing, new such labels are springing up concerning various aspects of biodiversity and ecosystem service conservation, as well as more comprehensive approaches to sustainable business practices. Also the numerous eco labels for Germany's regional products are often based on criteria concerning responsible biodiversity and ecosystem service practices. But despite (a) the proliferation of such eco labels that declare the consideration of biodiversity and ecosystem services exceeding the statutory minimum and (b) consumers' statements of intention in response to surveys, the market share of the products that bear these labels remains small. Ways have to be found to increase this market share, but in a manner that keeps the plurality of eco labels within reasonable bounds so that consumers do not lose sight of their meaning.

For it should be borne in mind that decisions that have a major impact on our natural environment and ecosystem services are made not only by government institutions. Also private companies need to do their share to conserve ecosystem services and natural capital – particularly since countless companies and many industries are directly dependent on biodiversity and the related ecosystem services.

»Natural Capital Germany« is also working with business initiatives such as »Biodiversity in Good Company«. A key business sector instrument, whose biodiversity components could use some strengthening, is environmental management (Beständig and Wuczkowski 2012; Schaltegger and Beständig 2010). Advancement of product labels that serve as a source of consumer information would also help further the cause of biodiversity and ecosystem service conservation (-> box 23).

# 4 OVERVIEW OF NATURAL CAPITAL GERMANY – TEEB DE

**KEY MESSAGES**

- »Natural Capital Germany« is the German successor project to the international study »The Economics of Ecosystems and Biodiversity« (TEEB).
- »Natural Capital Germany« is characterized by independency, an open organizational structure, the establishment of a »Natural Capital Germany« community, as well as targeted communication.
- Four reports and two brochures will be produced between 2012 and 2017. The project's overarching goal is to make visible the values of nature and its ecosystem services and therewith to integrate them better in public and private sector decision making.
- All interested parties are encouraged to take part in the »Natural Capital Germany« process and to participate in the reports production processes.



## 4.1 STARTING POINT: THE INTERNATIONAL TEEB PROCESS

The starting point for »Natural Capital Germany« was the international TEEB process, whose studies, which were carried out from 2007 to 2011 (-> box 6 and section 1), reveal the central importance of the values of nature and of ecosystem services for humanity and its well-being. The studies aimed to accomplish the following:

- Make visible the importance of our natural environment.
- Draw attention to the value of nature and of ecosystem services for our economy and society.
- Equip society with the means to incorporate -> BIODIVERSITY and -> ECOSYSTEM SERVICES into decision making.

The TEEB study provides decision makers in business, politics, administration and society as well as citizens (whose actions knowingly or unknowingly have an impact on nature in one way or another or are dependent on it) with information that can be used to make decisions and formulate arguments. By virtue of the fact that numerous researchers and expert practitioners had a hand in the production of the various TEEB reports and in review processes, a TEEB community was formed that greatly amplified the impact of the study findings being disseminated. This in turn resulted in the following:

- The TEEB reports received extensive media coverage, including cover stories in Der Spiegel in 2008 and The Economist in 2010.
- TEEB was present and discussed at numerous important conferences.
- TEEB has had a major impact on the relevant policy debates and international negotiations in that the issue of the »Economics of Ecosystems and Biodiversity« was incorporated into various sections of the strategic plan for the Convention on Biodiversity (CBD) and the EU Biodiversity Strategy to 2020.
- In a number of countries, programs and funding have been implemented for research into the interaction between biodiversity and ecosystem services and their impact on -> HUMAN WELL-BEING.

The fact that the TEEB study has exerted such wide ranging influence can be attributed to the proactive role played by the study coordinators and the TEEB Advisory Board members, and above all to the following factors:

- Independence from political parties or special interest groups.

- The project's openness, as exemplified by its enlisting the support of a broad range of individuals from the scientific, political and administrative communities to produce the various reports.

- These characteristics allowing for the establishment of a wide ranging TEEB community, whose involvement in the TEEB process promoted a sense of responsibility for the subject matter and spreading the word about it.

- Effective communication, in that TEEB related information was targeted at specific stakeholders in the national and international political communities, as well as regional and local decision makers, private companies, and the general population.

## 4.2 »NATURAL CAPITAL GERMANY«: THE GERMAN FOLLOW-UP TO THE INTERNATIONAL TEEB STUDY

»Natural Capital Germany – TEEB DE« is the German successor to the TEEB study, which investigated the interaction between ecosystem services, economic welfare, and well-being. »Natural Capital Germany« aims to give an impetus to gain greater insight into and make visible the value of nature in Germany. The country's -> NATURAL CAPITAL is supposed to be better incorporated into private and public sector decision making so as to conserve the natural underpinnings of our livelihoods and biodiversity. Hence »Natural Capital Germany« is also promoting implementation of existing approaches and objectives in this domain, such as the National Biodiversity Strategy (BMU 2007), the National Sustainability Strategy, environmental regulations and the related instruments.

The basic idea of »Natural Capital Germany – TEEB DE« is to learn from the positive experiences of the international TEEB study. This means that success factors of the international study are to be applied to Germany, insofar as possible.

**INDEPENDENCE** – »Natural Capital Germany« is headed up by an independent study leader, as are all of the topic-based reports (see below). The project is being funded between 2012 and 2017 by the Federal Agency for Nature Conservation (BfN) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The project's lead coordinating entity is the Department of Economics at the Helmholtz Centre for Environmental Research – UFZ, whereby the BMUB/BfN are providing ecological and economic expertise and organizational support via a Coordination Group.



**FIGURE 61** ▸ Our natural capital is also the natural capital of future generations. Losing biodiversity may reduce options to cope with future societal challenges. (Photo: Jacek Chabraszewski, Fotolia.com)

**OPEN PROJECT ARCHITECTURE** and establishment of a **»NATURAL CAPITAL GERMANY« COMMUNITY** – Various reports and brochures will be the »products« of the project. It is essential that the publication process allows for the involvement of a broad range of researchers, experts and representatives of the relevant interest groups. To this end, »Natural Capital Germany«, like the international TEEB study, has an open structure: In close consultation with the Coordination Group, report coordinators have been appointed, who will ask scientists, expert practitioners, and representatives of various interest groups to pool in their knowledge concerning the economics of ecosystems and biodiversity in Germany, assess this knowledge and then synthesize it in a comprehensible form for the project's target groups, which are mainly political and business decision makers. This process will be carried out at workshops that a broad spectrum of stakeholders will be invited to attend. The attendees at these workshops will be encouraged to contribute their knowledge with the goal of elaborating the various »Natural Capital Germany« reports via a process that will involve writing and peer-reviewing them. This procedure will allow »Natural Capital Germany« study findings to reach a broad spectrum of the general public, while at the same time ensuring that a German TEEB community is formed and that a maximum number of scientists and experts are involved in the process.

**FIGURE 62** ▸ Bernd Hansjürgens, »Natural Capital Germany« study leader
(Photo: André Künzelmann)

BOX 24

**Interview with Bernd Hansjürgens, »Natural Capital Germany« study leader**

▸ **Does »Natural Capital Germany« aim to hang a price tag on nature? Are you counting animals and measuring ground?**

Many ecosystem services are currently used free of charge, with at times disastrous environmental consequences. »Natural Capital Germany« aims to raise awareness of the fact that this short-sightedness ignores the very underpinnings of our livelihoods and well-being, as well as our economic opportunities. If we recognize and incorporate the values of nature into decision making, then we will be able to do something in favour of nature conservation. But we need not resort to price tags for this. The values of ecosystem services can be captured and assessed using a whole spectrum of approaches and methods, of which monetary valuation is only one.

▸ **In your view, how will an economic approach help to draw attention to such matters?**

An economic approach can provide further justification for nature conservation and the sustainable use of nature, apart from the usual ecological and ethical arguments that are normally advanced. In other words, the aim is not to win the hearts and minds of people who already recognize the value of nature and are doing their share for nature conservation. What we are trying to do instead is reach those who currently overlook the value of nature and are unaware of the extent to which certain actions can be harmful for our natural environment. For the fact is that many of our decisions and actions are driven by economic considerations. That's just the way it is. By reacting to prices and costs in our everyday lives, we reveal the extent to which something is valuable to us. If we can just take advantage of this mindset and (insofar as possible) act in a similar manner in matters concerning the environment and nature conservation, we will achieve that the values of nature are taken greater account of in our everyday as well as political and administrative decisions.

▸ **Who do you feel can or will benefit from this economic take on nature?**

Let's take the example of the foresters in charge of peri-urban forests. They constantly complain that in the perception of the public their work is reduced to logging. But actually this is only a small part of what they do. Foresters also conduct training courses, lead tours for school groups, and make and monitor bicycle paths, bridle paths, and barbecue sites. So this adds up to quite a few services for a peri-urban forest. But such forests also regulate the water cycle, absorb carbon dioxide, and provide habitats for plants and animals. So capturing the values of these services ultimately entails giving foresters sound arguments against budget cuts for the forests that the foresters take care of.

▸ **What kinds of policy instruments might come into play, in your view? Perhaps nature use certificates along the lines of emissions trading?**

First of all, emissions trading has accomplished a great deal in that the idea of avoiding greenhouse gases has now made all the way to corporate boardrooms. Carbon certificates are now regarded as scarce commodities and are traded accordingly. Careful thought is given to how carbon emissions can be avoided or reduced. This mindset was simply non-existent three decades ago, at least not for decision makers. We would benefit immeasurably if this mindset were also to prevail in other environmental and nature protection domains. However, inasmuch as biodiversity and ecosystems are highly complex entities, we cannot simply apply instruments that have been successful in other domains of environmental protection. But we can, on the other hand, draw upon our existing highly developed nature conservation instruments. Hence one of our main aims is to make recommendations as to how these various approaches can be refined and how they can be buttressed by incentive measures aimed at promoting more sustainable use of nature.

▸ **What prompted you, as a scientist, to get involved with such a social policy oriented project?**

There are two main reasons. First, although there is a consensus in the scientific community that our well-being and prosperity mainly depend on ecosystem services, this concept is largely disregarded by business and policy decision making processes. It is at the interface between ecology and economics we want to better understand which ecosystem services are relevant and the extent to which their value can be measured, with the goal of incorporating them more extensively in decision making processes. Second of all, we scientists are part of the citizenry and our society; and in this capacity we feel that it is fitting and necessary for us to go to bat for nature. It is our responsibility to enable our knowledge to be used, to raise awareness of the consequences of ecosystems and biodiversity loss and to demonstrate solution approaches. Thus we are striving to make »Natural Capital Germany« an open process by bringing aboard a host of actors.

**FIGURE 63** ▸ Peri-urban forests offer a lot of services to a city's population.
(Photo: Metronom GmbH)

The following four reports will be produced throughout the »Natural Capital Germany« project:

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| **REPORT 1** | **NATURKAPITAL UND KLIMAPOLITIK – SYNERGIEN UND KONFLIKTE (Natural Capital and Climate Policy: Synergies and Conflicts)**<br>How do biodiversity friendly land use modalities and the related ecosystem services help to reduce greenhouse gases? How can ecosystems be implemented as natural green infrastructures that aim to mitigate, and allow for adaptation to, global warming? What are the challenges for biodiversity and ecosystems in the presence of global warming and the envisaged Energiewende in Germany? |
| **REPORT 2** | **ÖKOSYSTEMLEISTUNGEN IN LÄNDLICHEN RÄUMEN – GRUNDLAGE FÜR MENSCHLICHES WOHLERGEHEN UND WIRTSCHAFTLICHE ENTWICKLUNG (Ecosystem Services in Rural Areas – Basis for Human Wellbeing and Sustainable Economic Development)**<br>Which conflicts and synergies come into play in connection with ecosystem service provisioning, in light of global warming, more intensive agricultural land use, demographic change, and the envisaged Energiewende? What can be done to promote greater recognition and conservation of the whole spectrum of ecosystem services? What is the economic contribution of large protected areas? How does focusing on ecosystem services work to the benefit of land use planning? |
| **REPORT 3** | **ÖKOSYSTEMLEISTUNGEN IN DER STADT – GESUNDHEIT SCHÜTZEN UND LEBENSQUALITÄT ERHÖHEN (Ecosystem Services in Cities: Protecting Health and Enhancing Quality of Life)**<br>What role do biodiversity and ecosystem services play for the inhabitants of urban areas? What is the take of such inhabitants on urban green spaces and peri-urban and nearby recreational areas? What kinds of conflicts arise in these contexts? How can synergies be identified and used? How does the ecological footprint of urban areas look like and how can it be influenced? How can the concept of ecosystem services be used for nature conservation and the optimization of urban development planning? |
| **REPORT 4** | **NATURKAPITAL DEUTSCHLAND – TEEB DE: EINE SYNTHESE (Natural Capital Germany – TEEB DE: A Synthesis)**<br>How can the values of biodiversity and ecosystem services be determined, and then incorporated into decision making processes? What are the potential benefits of an economic standpoint and the concept of ecosystem services for dealing with conflicting objectives? In which concrete situations have the values of nature been taken into account, and how can these best practice examples be applied elsewhere? |



NATURKAPITAL
DEUTSCHLAND – TEEB DE

**FIGURE 64** ▸ The »Natural Capital Germany« logo

A project Stakeholder Committee composed mainly of representatives of environmental protection organizations, industry associations, user associations, federal ministries, states, and municipalities will disseminate information to and establish ties with various interest groups, and will also convey project information to the relevant actors both inside and outside the nature conservation community in the sectors and policy areas most affected.

»Natural Capital Germany« is based on the objectives and processes of the international TEEB study. And although the project also centres around the key concept of ecosystem services, it is not a national ecosystem assessment of the type the EU recently called upon member states to carry out within the framework of the EU's biodiversity strategy (-> section 2.3).

Another primary objective of »Natural Capital Germany« is to form a community comprising scientists, expert practitioners, nature users, and affected parties. The underlying goal of giving nature greater prominence in decision making at all levels can only be achieved by winning the hearts and minds of a large number of stakeholders.

For further information visit www.naturkapital-teeb.de/en.

**FIGURE 65** ▸ Meadows can provide habitats to a great variety of plant species.
(Photo: Metronom GmbH)

BOX 25

**»Natural Capital Germany« Advisory Board**

**PROF. DR. STEFANIE ENGEL**
Professor for Environmental Policy and Economics at the Department of Environmental System Sciences at ETH Zurich. Her research focus is on environmental and resource economy, especially the economics of ecosystem services. At present Mrs. Engel is Alexander von Humboldt-professor and working on the issue »Governance of sustainable socio-ecological systems« at the interdisciplinary Institute of Environmental Systems Research of the University Osnabrück.

**DR. UTA ESER**
Expert in environmental ethics and environmental communication. Long-standing research experience at the boundaries between science, ethics and politics. She works as freelance researcher and consultant in the fields of biodiversity and education for sustainable development.

**PROF. DR. KARIN HOLM-MÜLLER**
Professor for Resource and Environmental Economics within the Institute for Food and Resource Economics of Bonn University, member of the Advisory Council on the Environment (SRU). Her research foci are situated in the areas of monetary evaluation of environmental goods, economic analysis on problems of biodiversity, and in the relation between agricultural and environmental policy.

**PROF. DR. BEATE JESSEL**
Since 2007 President of the Federal Agency for Nature Conservation, Bonn. Before, Professor for Strategy and Management in Landscape Development at the Technical University of Munich (2006) as well as Professor of Landscape Planning at the University of Potsdam from 1999 to 2006.

**DR. MARION POTSCHIN**
Deputy Director for the Centre for Environmental Management at the University of Nottingham, UK. She works amongst others for the European Environmental Agency on implementing the mapping and assessment of ecosystem services for environmental-economic accounting. Participation in the UK National Ecosystem Assessment.



**CHRISTIAN SCHWÄGERL**
Science, political and environmental journalist. He was national correspondent for environmental, energy and science policy for Der Spiegel magazine until 2012.Today, he works as freelance journalist and author.

**KARSTEN SCHWANKE**
Television presenter and meteorologist, moderated the weather forecasts for ARD and the online science portal WQ. The magazine »Abenteuer Wissen« (»Adventure Knowledge«), presented by him, received the Golden Camera as »Best Information and Knowledge Magazine« in 2010.

**DR. ANTJE VON DEWITZ**
Since 2009 CEO of the family business VAUDE, the first outdoor equipment producer that has put its entire production (Base Layer) under the strict environmental standard bluesign® already since 2001. Many years of commitment to improve environmentally and socially sound production and sustainability in the entire product life cycle. Since May 2014, Mrs. v. Dewitz is a member of the board of trustees of the Deutsche Bundesstiftung Umwelt (DBU – German Foundation for the Environment).

**PROF. DR. ANGELIKA ZAHRNT**
Long-time member of the German Council for Sustainable Development (2001–2013) and honorary president of Friends of the Earth Germany (BUND). As economist, she published on the topics post-growth society, ecological tax reform, ecology and economy, women and ecology, sustainability, »Sustainable Germany« (»Zukunftsfähiges Deutschland«).

**FIGURE 66 – 74**
(Photos: ETH Zürich, Gudrun Theresia de Maddalena, Karin Holm-Müller, BfN, Marion Potschin, Christian Schwägerl, Ralf Wilschewski, VAUDE, Uli Staiger / die lichtgestalten)

## GLOSSARY

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| BENEFITS (OF ECOSYSTEM SERVICES) | Arise from the direct or indirect use of ecosystem services by humans and/or have positive significance. |
| BEQUEST VALUE | Benefits from ensuring that certain natural or environmental goods are preserved for future generations. |
| 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. |
| CAPTURING VALUE (OF ECOSYSTEM SERVICES) | 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 (for example in the form of ecologically friendly products or incentives, or by creating markets for biodiversity). 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. |
| CONSUMER SURPLUS | The difference between the price of a good or service (e. g. list price, or the cost of getting to a recreational area) and what a consumer would be willing to pay for the same good or service under the same conditions. In economic theory, the maximum amount a consumer would be willing to pay for specific environmental services equates to the individual benefit of a good. Hence the consumer surplus is the difference between price and benefit. |
| 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. |
| DEMONSTRATING VALUE | Methods that make the various benefits of biodiversity and ecosystem services visible and relevant for public and private decision making. Economic valuation methods can contribute to demonstrating ecosystems' and biodiversity's values |
| DIRECT-USE VALUE (OF ECOSYSTEMS) | The benefits derived directly from the use of ecosystem services, comprising consumptive uses such as harvested crops and non-consumptive uses such as contemplating the beauty of nature (TEEB 2011C after MA 2005A). |



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| 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. |
| 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 valuation techniques and 3) Investigating the framework for action by the relevant stakeholders, and tools and measures for handling -> natural capital more efficiently (-> capturing values). |
| ECONOMIC VALUATION | 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. |
| 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 FUNCTIONS | Encompass all physical, chemical, and biological processes, as well as all interactions that occur in various 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«. |
| EXISTENCE VALUE | The value of a good ascribable to its mere existence, which brings us satisfaction and a sense of well-being, even if the good is never used. The Siberian tiger may serve as an examples: people may reveal preferences (in the form of willingness to pay) for protecting the Siberian tiger without having a chance in life of seeing this animal. |
| 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. |

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| IDENTIFYING ECOSYSTEM SERVICES | Defining the scope and scale of ecosystem service provision. Identifying ecosystem services does not only include the analysis of the natural properties of an ecosystem (»supply side«), but also the identification of relevant stakeholders and their benefits (»demand side«). |
| INDIRECT-USE VALUE (OF ECOSYSTEMS) | Indirect use benefits provided by ecosystem services, usually regulating services, such as erosion protection via ground coverings, or the breakdown of organic and inorganic contaminants via the self-purification mechanisms of waterbodies. |
| 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. |
| MEASURING ECOSYSTEM SERVICES | Assessing the (physical) state and trends in ecosystem services using suitable indicators. Mapping and assessing ecosystem services by 2014 is part of the European Biodiversity Strategy. |
| MONETIZATON | Measuring values (benefits, costs, willingness to pay) using money as a metric. |
| NATURAL BALANCE | Comprises abiotic components (soil, water, air/climate) and biotic components (organisms, habitats and communities) of nature and the interactions between such components. |
| NATURAL CAPITAL | An economic metaphor for the limited stocks of physical and biological resources found on Earth, and of the limited capacity of ecosystems to provide goods and services. |
| NON-USE VALUE | Value that arises from neither direct nor indirect use, including existence values. |
| OPPORTUNITY COSTS | Foregone benefits of not using land or ecosystems in a different (alternative) way, such as the potential income from agriculture that is foregone due to the renaturation of a floodplain. |
| OPTION VALUE | Value (benefit) resulting from the option to use a good in the future (e. g. using a tropical rainforest as a gene pool). |
| PRODUCER SURPLUS | Difference between a good's actual selling price and the minimum price the producer would have offered and sold the good for under otherwise identical conditions. Producer surpluses are occasioned by circumstances such as above average rental or sale prices that can be fetched owing to particularly favourable surroundings of real estate; or low agricultural production costs resulting from particularly fertile soil. |



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| PROVISIONING SERVICES | Ecosystems' contribution to the provision of material goods and services, such as food, fresh water, and wood for building and fuel. They are often traded in the marketplace. |
| PUBLIC GOODS | A good or service in which the benefit received by any one party does not diminish the availability of the benefits to others, and where other persons cannot or should not be excluded from using it. Examples are the public road network, domestic security, clean air, and recreation in a freely accessible landscape. |
| REGULATING SERVICES | The services that ecosystems provide by acting as regulators of (other) ecosystem elements and processes, the latter (directly) benefiting human wellbeing; examples are soil filtering for groundwater quality, and hedges as protection against soil erosion. |
| SUPPORTING SERVICE | Basic ecosystem services such as photosynthesis or nitrogen fixation of nodule bacteria that form the basis for all other ecosystem services (provisioning, supporting, and cultural ecosystem services). |
| TEEB | The Economics of Ecosystems and Biodiversity. The international TEEB study was initiated in 2007 by Germany in the course of its G8 presidency together with the European Commission. Supported by a variety of other institutions, it was implemented under the auspices of the United Nations Environment Programme (UNEP). The aim of the international TEEB study was to assess the economic value of nature's services, to determine the economic impacts of ecosystem degradation and to demonstrate the cost of policy inaction. |
| USE VALUE | -> Direct/indirect use value |
| VALUING ECOSYSTEM SERVICES | The process of putting a value on ecosystem services (or ecosystem services changes). Economic valuation is one form of ecosystem service valuation. Valuing ecosystem services builds on identifying and (physically) measuring those services. |
| WELLBEING / HUMAN WELLBEING | Concept prominently used in the Millennium Ecosystem Assessment (MA 2005). It describes elements which constitute a »good life«, including basic material goods, health and bodily wellbeing, good social relations, security, peace of mind and spiritual experience, and freedom of choice and action (see TEEB 2011C). |
| WILLINGNESS TO PAY | Monetary amount a person is willing to pay for the supply of goods, including public goods, which are not generally traded via markets and therefore do not have a market price (e. g. action programmes to protect endangered species). |
| WILLINGNESS TO PAY (WTP) ANALYSIS – CONTINGENT VALUATION | 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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