

**End Ecocide in Europe**  
**- Ideas for Communication -**

**Source: Literature search – academic papers and professional reports**

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# 1. Ecosystem Services

## Definitions of ecosystem services

The benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al., 1997).

The benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005).

The aspects of ecosystems utilized (actively or passively) to produce human well-being (Fisher, Turner, Morling, 2009)

## Ecosystem services (Fisher, Turner, Morling, 2009, p. 645)

„The key points are that 1) services must be ecological phenomena and 2) that they do not have to be directly utilized. Defined this way, ecosystem services include ecosystem organization or structure as well as process and/or functions if they are consumed or utilized by humanity either directly or indirectly. The functions or processes become services if there are humans that benefit from them. Without human beneficiaries they are not services.“

## (Costanza et al., 1997, p. 257)

„A large part of the contributions to human welfare by ecosystem services are of a purely public goods nature. They accrue directly to humans without passing through the money economy at all. In many cases people are not even aware of them. Examples include clean air and water, soil formation, climate regulation, waste treatment, aesthetic values and good health, as mentioned above.“

## Categories of ecosystem services (Barbier, 2007, p. 182)

„Although in the current literature the term ‘ecosystem services’ lumps together a variety of ‘benefits’, economics normally classifies these benefits into three different categories: (i) ‘goods’ (e.g. products obtained from ecosystems, such as resource harvests, water and genetic material); (ii) ‘services’ (e.g. recreational and tourism benefits or certain ecological regulatory functions, such as water purification, climate regulation, erosion control, etc.); and (iii) cultural benefits (e.g., spiritual and religious, heritage, etc.).“

## 2. Classifications of Ecosystem Services

**Ecosystem services classification (Millennium Ecosystem Assessment, 2005, pp. 56-60)**

### *Provisioning Services*

„These are the products obtained from ecosystems, including:

- Food and fiber. This includes the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, jute, hemp, silk, and many other products derived from ecosystems.
- Fuel. Wood, dung, and other biological materials serve as sources of energy.
- Genetic resources. This includes the genes and genetic information used for animal and plant breeding and biotechnology.
- Biochemicals, natural medicines, and pharmaceuticals. Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems.
- Ornamental resources. Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined.
- Fresh water.“

### *Regulating Services*

„These are the benefits obtained from the regulation of ecosystem processes, including:

- Air quality maintenance. Ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality.
- Climate regulation. Ecosystems influence climate both locally and globally. For example, at a local scale, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases.
- Water regulation. The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas.
- Erosion control. Vegetative cover plays an important role in soil retention and the prevention of landslides.
- Water purification and waste treatment. Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
- Regulation of human diseases. Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes.
- Biological control. Ecosystem changes affect the prevalence of crop and livestock pests and diseases.
- Pollination. Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators.
- Storm protection. The presence of coastal ecosystems such as mangroves and coral reefs can dramatically reduce the damage caused by hurricanes or large waves.“

## ***Cultural Services***

„These are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including:

- Cultural diversity. The diversity of ecosystems is one factor influencing the diversity of cultures.
- Spiritual and religious values. Many religions attach spiritual and religious values to ecosystems or their components.
- Knowledge systems (traditional and formal). Ecosystems influence the types of knowledge systems developed by different cultures.
- Educational values. Ecosystems and their components and processes provide the basis for both formal and informal education in many societies.
- Inspiration. Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.
- Aesthetic values. Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, “scenic drives,” and the selection of housing locations.
- Social relations. Ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies.
- Sense of place. Many people value the “sense of place” that is associated with recognized features of their environment, including aspects of the ecosystem.
- Cultural heritage values. Many societies place high value on the maintenance of either historically important landscapes (“cultural landscapes”) or culturally significant species.
- Recreation and ecotourism. People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area.“

## ***Supporting Services***

„Supporting services are those that are necessary for the production of all other ecosystem services.

They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. (Some services, like erosion control, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people.) For example, humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production. Similarly, climate regulation is categorized as a regulating service since ecosystem changes can have an impact on local or global climate over time scales relevant to human decision-making (decades or centuries), whereas the production of oxygen gas (through photosynthesis) is categorized as a supporting service since any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time. Some other examples of supporting services are primary production,

production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.“

**Functions, goods and services of natural and semi-natural ecosystems (de Groot, Wilson, Boumans, 2002, pp. 395-397)**

<b>Functions</b>	<b>Ecosystem processes and components</b>	<b>Goods and services (examples)</b>
<i>Regulation Functions</i>	<i>Maintenance of essential ecological processes and life support systems</i>	
1 Gas regulation	Role of ecosystems in bio-geochemical cycles (e.g. CO <sub>2</sub> /O <sub>2</sub> balance, ozone layer, etc.)	1.1 UVb-protection by O <sub>3</sub> (preventing disease). 1.2 Maintenance of (good) air quality. 1.3 Influence on climate (see also function 2.)
2 Climate regulation	Influence of land cover and biol. mediated processes (e.g. DMS-production) on climate	Maintenance of a favorable climate (temp., precipitation, etc) for, for example, human habitation, health, cultivation
3 Disturbance prevention	Influence of ecosystem structure on dampening env. disturbances	3.1 Storm protection (e.g. by coral reefs). 3.2 Flood prevention (e.g. by wetlands and forests)
4 Water regulation	Role of land cover in regulating runoff & river discharge	4.1 Drainage and natural irrigation. 4.2 Medium for transport
5 Water supply	Filtering, retention and storage of fresh water (e.g. in aquifers)	Provision of water for consumptive use (e.g.drinking, irrigation and industrial use)
6 Soil retention	Role of vegetation root matrix and soil biota in soil retention	6.1 Maintenance of arable land. 6.2 Prevention of damage from erosion/siltation
7 Soil formation	Weathering of rock, accumulation of organic matter	7.1 Maintenance of productivity on arable land. 7.2 Maintenance of natural productive soils
8 Nutrient regulation	Role of biota in storage and re-cycling of nutrients (eg. N,P&S)	Maintenance of healthy soils and productive ecosystems
9 Waste treatment	Role of vegetation & biota in removal or breakdown of xenic nutrients and compounds	9.1 Pollution control/detoxification. 9.2 Filtering of dust particles. 9.3 Abatement of noise pollution
10 Pollination	Role of biota in movement of floral gametes	10.1 Pollination of wild plant species.

		10.2 Pollination of crops
11 Biological control	Population control through trophic-dynamic relations	11.1 Control of pests and diseases. 11.2 Reduction of herbivory (crop damage)
<b><i>Habitat Functions</i></b>	<b><i>Providing habitat (suitable living space) for wild plant and animal species</i></b>	
12 Refugium function	Suitable living space for wild plants and animals	12.1 Maintenance of biological & genetic diversity (and thus the basis for most other functions). 12.2 Maintenance of commercially harvested species
13 Nursery function	Suitable reproduction habitat	13.1 Hunting, gathering of fish, game, fruits, etc. 13.2 Small-scale subsistence farming & aquaculture
<b><i>Production Functions</i></b>	<b><i>Provision of natural resources etc.</i></b>	
14 Food	Conversion of solar energy into edible plants and animals	14.1 Building & Manufacturing (e.g. lumber, skins). 14.2 Fuel and energy (e.g. fuel wood, organic matter). 14.3 Fodder and fertilizer (e.g. krill, leaves, litter).
15 Raw materials	Conversion of solar energy into biomass for human construction and other uses	15.1 Improve crop resistance to pathogens & pests. 15.2 Other applications (e.g. health care)
16 Genetic resources	Genetic material and evolution in wild plants and animals	Genetic support of wild relatives to maintain the productivity of cultivars
17 Medicinal resources	Variety in (bio)chemical substances in, and other medicinal uses of, natural biota	17.1 Drugs and pharmaceuticals. 17.2 Chemical models & tools. 17.3 Test- and essay organisms
18 Ornamental resources	Variety of biota in natural ecosystems with (potential) ornamental use	Resources for fashion, handicraft, jewelry, pets, worship, decoration & souvenirs (e.g. furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)
<b><i>Information Functions</i></b>	<b><i>Providing opportunities for cognitive development</i></b>	
19 Aesthetic information	Attractive landscape features	Enjoyment of scenery (scenic

		roads, housing, etc.)
20 Recreation	Variety in landscapes with (potential) recreational uses	Travel to natural ecosystems for eco-tourism, outdoor sports, etc.
21 Cultural and artistic information	Variety in natural features with cultural and artistic value	Use of nature as motive in books, film, painting, folklore, national symbols, architect., advertising, etc.
22 Spiritual and historic information	Variety in natural features with spiritual and historic value	Use of nature for religious or historic purposes (i.e. heritage value of natural ecosystems and features)
23 Science and education	Variety in nature with scientific and educational value	Use of natural systems for school excursions, etc. Use of nature for scientific research

„**Regulation functions:** this group of functions relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other biospheric processes. In addition to maintaining ecosystem (and biosphere) health, these regulation functions provide many services that have direct and indirect benefits to humans (such as clean air, water and soil, and biological control services).“

„**Habitat functions:** natural ecosystems provide refuge and reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and evolutionary processes.“

„**Production functions:** Photosynthesis and nutrient uptake by autotrophs converts energy, carbon dioxide, water and nutrients into a wide variety of carbohydrate structures which are then used by secondary producers to create an even larger variety of living biomass. This broad diversity in carbohydrate structures provides many ecosystem goods for human consumption, ranging from food and raw materials to energy resources and genetic material.“

„**Information functions:** Because most of human evolution took place within the context of undomesticated habitat, natural ecosystems provide an essential ‘reference function’ and contribute to the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, recreation and aesthetic experience.“

**Ecosystem services – experienced at the individual human level (Wallace, 2007, p. 241)**

- Food (for organism energy, structure, key chemical reactions)
- Oxygen
- Water (potable)
- Energy (eg, for cooking – warming component under physical and chemical environment)
- Dispersal aids (transport)
- Protection from predation
- Protection from disease and parasites

*Benign environmental regimes of:*

- Temperature (energy, includes use of fire for warming)
- Moisture
- Light (eg, to establish circadian rhythms)
- Chemical

*Access to resources for:*

- Spiritual/philosophical contentment
- A benign social group, including access to mates and being loved
- Recreation/leisure
- Meaningful occupation
- Aesthetics
- Opportunity values, capacity for cultural and biological evolution

### 3. Ecosystem Valuation

#### **Ecosystem valuation (Farber, Costanza, Wilson, 2002, p. 376)**

„...ecosystem valuation represents the process of expressing a value for ecosystem goods or services (i.e. biodiversity, flood protection, recreational opportunity), thereby providing the opportunity for scientific observation and measurement.“

#### **Value of ecosystems (Barbier, 2007, p. 182)**

„The literature on ecological services implies that natural ecosystems are assets that produce a flow of beneficial goods and services over time. In this regard, they are no different from any other asset in an economy, and in principle, ecosystem services should be valued in a similar manner. That is, regardless of whether or not there exists a market for the goods and services produced by ecosystems, their social value must equal the discounted net present value (NPV) of these flows.“

#### **Why ecosystem valuation? (Costanza et al, 1998, p. 68)**

„Why would one want to measure the aggregate value of ecosystem services, whether at local, regional, national or global scales? This is a reasonable and necessary exercise to the extent that human welfare depends on whether these services improve or deteriorate. We may have more houses, but if that means we have fewer trees and less viable forests, something is seriously wrong with an accounting system that only adds up houses and presumes that this is a full measure of welfare change.“

„... one must be able to directly compare the value of ecosystem services lost with the value of other economic services gained.“

#### **Concepts of ecosystem value (Millennium Ecosystem Assessment, 2005, pp. 128-129)**

„Ecosystems have value because they maintain life on Earth and the services needed to satisfy human material and nonmaterial needs. In addition, many people ascribe ecological, sociocultural, or intrinsic values to the existence of ecosystems and species.“

„Ecosystems and the provisioning, regulating, cultural, and supporting services they provide have **economic value** to human societies because people derive utility from their actual or potential use, either directly or indirectly (known as use values). People also value ecosystem services they are not currently using (non-use values). This paradigm of value is known as the utilitarian (anthropocentric) concept and is based on the principles of humans' preference satisfaction (welfare).“

„Another set of values placed on ecosystems can be identified as the **sociocultural** perspective: people value elements in their environment based on different worldviews or conceptions of nature and society that are ethical, religious, cultural, and philosophical. These values are expressed through, for example, designation of sacred species or places,

development of social rules concerning ecosystem use (for instance, “taboos”), and inspirational experiences. For many people, sociocultural identity is in part constituted by the ecosystems in which they live and on which they depend—these help determine not only how they live, but who they are. To some extent, this kind of value is captured in the concept of “cultural” ecosystem services. To the extent, however, that ecosystems are tied up with the very identity of a community, the sociocultural value of ecosystems transcends utilitarian preference satisfaction.“

„A different source of the value of ecosystems has been articulated by natural scientists in reference to causal relationships between parts of a system—for example, the value of a particular tree species to control erosion or the value of one species to the survival of another species or of an entire ecosystem. At a global scale, different ecosystems and their species play different roles in the maintenance of essential life support processes (such as energy conversion, biogeochemical cycling, and evolution). The magnitude of this **ecological value** is expressed through indicators such as species diversity, rarity, ecosystem integrity (health), and resilience.“

### **Three types of ecosystem values (de Groot, Wilson, Boumans, 2002, pp. 402-403)**

„The importance (or ‘value’) of ecosystems is roughly divided into three types: ecological, sociocultural and economic value.“

**Ecological Value.** „The capacity of ecosystems to provide goods and services depends on the related ecosystem processes and components providing them and the limits of sustainable use are determined by ecological criteria such as integrity, resilience, and resistance. The ‘Ecological Value’ or importance of a given ecosystem is, therefore, determined both by the integrity of the Regulation and Habitat Functions of the ecosystem and by ecosystem parameters such as complexity, diversity, and rarity.“

**Sociocultural Value.** „In addition to ecological criteria, social values (such as equity) and perceptions play an important role in determining the importance of natural ecosystems, and their functions, to human society. In a report by English Nature (1994), social reasons are mentioned as playing an important role in identifying important environmental functions, emphasizing physical and mental health, education, cultural diversity and identity (heritage value), freedom and spiritual values. Natural systems are thus a crucial source of non-material well-being and indispensable for a sustainable society.“

**Economic Value.** When there are markets for ecosystem services, economic value is „exchange value that ecosystem services have in trade.“ „When there are no explicit markets for ecosystem services, we must resort to more indirect means of assessing values. A variety of valuation techniques can be used to establish the (revealed) Willingness To Pay (WTP) or Willingness To Accept compensation (WTA) for the availability or loss of these services.“

### **Intrinsic and instrumental values of ecosystems (Farber, Costanza, Wilson, 2002, p. 376)**

„The distinction between intrinsic and instrumental value is an important one. On the one hand, some individuals might maintain a value system in which ecosystems or species have intrinsic rights to a healthful, sustaining condition that is on a par with human rights to

satisfaction. The value of any action or object is measured by its contribution to maintaining the health and integrity of an ecosystem or species, per se, irrespective of human satisfaction. On the other hand, instrumental values reflect the difference that something makes to satisfaction of human preferences. Instrumental values, such as economic values, are fundamentally anthropocentric in nature. Policies toward the environment will always tend to be based on a mix of intrinsic and instrumental value systems. In this paper, we deal with both.“

**(Farber, Costanza, Wilson, 2002, p. 387)**

„We also recognize that economic and ecological measures of value may at times be at odds with one another. As humans are only one of many species in an ecosystem, the values they place on ecosystem functions, structures and processes may differ significantly from the values of those ecosystem characteristics to species or the maintenance (health) of the ecosystem itself. The intrinsic values of natural system features and processes within the natural system itself may possess different abundance and functional value properties than their corresponding economic values.“

**Categories of environmental values (Bolt, Ruta, Sarraf, 2005, pp. 12-14):**

Total economic value of environment:

1. Use values
  - 1.1. Direct use values
  - 1.2. Indirect use values
  - 1.3. Option values
  
2. Non-use values
  - 2.1. Bequest values
  - 2.2. Existence values

„**Direct use values** derive from the consumptive or non-consumptive use of the resource. The individual directly enjoys the resource either by consuming it (i.e., logging the forest to obtain fuel wood or fishing for subsistence) or by gaining enjoyment from the resource stock itself (i.e., recreation value of a park or the scenic vista of a coastal area).“

„**Indirect use values** are those resulting from the use of a resource’s services. For example, a forest provides watershed protection, and the ozone layer protects the Earth from ultraviolet (UV) radiation. The distinction between direct and indirect use values is not always clear.“

„**Option values** derive from the potential future use of a good, if the need arises. The concept is very popular in finance where options are sold for the right to sell a stock-market commodity at a specified price at a specified time in the future. The concept applies to natural resources as well. For example, the conservation of a natural area is an option, giving us the possibility of transforming the area in the future, or keeping it, according to the new information gathered on the relative value of the natural area.“

„In 1967, in a very influential essay, John Krutilla identified another category of values, which were to become an important area of research in environmental economics: non-use or

passive use values. These values are the manifestation of people's willingness to pay for a resource regardless of their ability to make any use of it now, or in the future. Such values may arise because of altruism towards future generations (**bequest value**) or because of the simple knowledge that something exists (**existence value**) even if individuals never plan to use it.“

„Example: Total economic value of a tropical forest:

- Direct-use values: Timber, fuelwood, fruits, ecotourism
- Indirect-use values: Ecosystem services, birdwatching, soil, protection, carbon-sink
- Option values: Pharmaceutical products
- Bequest values: Timber + recreation benefits for next generations
- Existence values: Enjoyment regardless of the use of the forest“

## 4. Estimated Values of Ecosystems

### The value of the world's ecosystem services (Costanza et al., 1997, p. 259)

„We estimated that at the current margin, ecosystems provide at least US\$33 trillion dollars worth of services annually.“

„What this study makes abundantly clear is that ecosystem services provide an important portion of the total contribution to human welfare on this planet. We must begin to give the natural capital stock that produces these services adequate weight in the decisionmaking process, otherwise current and continued future human welfare may drastically suffer. We estimate in this study that the **annual value of these services is US\$16–54 trillion**, with an **estimated average of US\$33 trillion**. The real value is almost certainly much larger, even at the current margin. US\$33 trillion is **1.3 times the current global GNP**. One way to look at this comparison is that if one were to try to replace the services of ecosystems at the current margin, one would need to increase global GNP by at least US\$33 trillion, partly to cover services already captured in existing GNP and partly to cover services that are not currently captured in GNP. This impossible task would lead to no increase in welfare because we would only be replacing existing services, and it ignores the fact that many ecosystem services are literally irreplaceable.“

### Value of ecosystem services for major biomes (Costanza et al., 1997, p 256)

Biome	Total annual value per ha in USD	Total annual global flow value in trillion USD
Open ocean	252	8.381
Estuaries	22,832	4.110
Seagrass/algae beds	19,004	3.801
Coral reefs	6,075	0.375
Shelf	1,610	4.283
Lakes/rivers	8,498	1.700
Tropical forest	2,007	3.813
Temperate/boreal forest	302	0.894
Grass/rangelands	232	0.906
Tidal marsh/mangroves	9,990	1.648
Swamps/floodplains	19,580	3.231

### The value of ecosystem services for tourism in Maldives (Spangenberg, Settele, 2010, p. 329)

„...tourism, based on marine biodiversity and coastal ecosystem services, provides the basis for the Maldives economy, accounting for 20% of the GDP and 40% of the employment. Including associated services, the sector generates 74% of the GDP, 60% of foreign exchange earnings, and 90% of the government revenues.“

**The value of ecosystem services – coral reefs and coastal wetlands (Spangenberg, Settele, 2010, p. 331)**

„...(annual) value of coral reefs due to their coastal protection service at several US\$ 100,000 km<sup>2</sup> in Indonesia and at nearly US\$ 1,000,000 km<sup>2</sup> in the Philippines, and of coastal wetlands, providing flood protection and water purification services at US\$ 2500 ha for Sri Lanka.“

**The value of coral reefs (Conservation International, 2008, p. 1)**

„By one estimate, the total net benefit per year of the world’s coral reefs is \$29.8 billion. Tourism and recreation account for \$9.6 billion of this amount, coastal protection for \$9.0 billion, fisheries for \$5.7 billion, and biodiversity for \$5.5 billion (Cesar, Burke and Pet-Soede, 2003).“

„A 2006 meta-analysis of wetlands valuation studies around the world found that the average annual value is just over \$2,800 per hectare (Brander, Florax and Vermaat, 2006). A 2007 study found that the total value of ecosystem services and products provided by the world’s coastal ecosystems, including natural (terrestrial and aquatic) and human-transformed ecosystems, added up to \$25,783 billion per year (Martinez et al., 2007).“

**Valuation of mangroves (IUCN, 2008, p. 12)**

„Valuation of mangroves in the American Samoa have been estimated at US\$104,000 per km<sup>2</sup> (total value of about US\$50 million a year) but the mangrove only cover an area of less than 0.5 km<sup>2</sup>. Sathirathai and Barbier (2001) derive very high values of US\$2.7 million to US\$3.5 million per km<sup>2</sup> for mangroves in Thailand.“

**The value of mangrove ecosystems in Ban Naca and Ban Bangman villages, Thailand (IUCN, 2008, p. 3)**

„Present value of the contribution of mangrove ecosystems to fisheries production for Ban Naca is US\$ 20,174 per household and US\$ 2,853 per hectare. Present value of the contribution of mangrove ecosystems to fisheries production in Ban Bangman translates to US\$ 30,822 per household and US\$ 12,843 per hectare. Clearly the loss of these benefits would impact the hardest on the communities residing nearby mangrove forests and who are dependent on the fisheries for subsistence and income.“

**The value of mangrove ecosystems in Panama Village, Sri Lanka (IUCN, 2007, p. iv)**

„The study clearly highlights that coastal communities are dependant on a range of mangrove products. Fish, shrimp and fuel wood are the main mangrove products providing cash income and subsistence requirements of the community in the location. Timber and poles, herbs and vegetables and fuel wood are important for their subsistence use. The economic value of mangrove was estimated at Rs. 119,438 (US\$ 1,171) per household per year and Rs. 938,502 (US\$ 9,201) per ha per year.“

## **5. Impacts and Costs of Ecosystem Destruction**

### **Cost of environmental degradation (Sarraf, Larsen, Owaygen, 2004, p. 9)**

„The cost of environmental degradation can be understood as a measure of the lost welfare of a nation due to environmental degradation. Such a loss in welfare from environmental degradation includes (but is not necessarily limited to):

- i) loss of healthy life and well-being of the population (e.g.: premature death, pain and suffering from illness, absence of a clean environment, discomfort).
- ii) economic losses (e.g.: reduced soil productivity and reduced value of other natural resources, lower international tourism).
- iii) loss of environmental opportunities (e.g.: reduced recreational value for lakes, rivers, beaches, forests).“

### **Cost of environmental degradation by country**

#### **(Sarraf, Larsen, Owaygen, 2004, p. 15, p. xiii)**

„The cost of environmental degradation in Lebanon in 2000 is estimated at 2.8 - 4.0 percent of GDP, with a mean estimate of US\$565 million, or 3.4 percent of GDP.“

„In Tunisia, the annual damage cost of environmental degradation in 1999 was estimated at 1.5 –2.7 percent of GDP with a mean estimate of 2.1 percent of GDP, or close to US\$440 million per year.“

#### **(World Bank, 2006)**

„The total estimated annual cost of environmental degradation is nearly US \$850 million or 10.0% of GDP.“

#### **(World Bank, 2001)**

„Environmental degradation, poverty, and economic growth are inextricably linked and that environmental degradation exacts an annual estimated cost of 4–8 percent of gross domestic product (GDP) in many developing countries.“

#### **(Sarraf, Larsen, Owaygen, 2004, p. 155)**

„In the Asia region, the Pakistan CEA estimates the annual COED (cost of environmental degradation) at about 6 percent of GDP.“

„In Latin America, the annual COED in Peru is estimated at 3 percent of GDP and the COED in Colombia at 3.7 percent of GDP.“

### **Unpriced natural capital costs in primary sectors (Trucost, 2013)**

„Trucost’s analysis has estimated the unpriced natural capital costs at US\$7.3 trillion relating to land use, water consumption, GHG emissions, air pollution, land and water pollution, and waste for over 1,000 global primary production and primary processing region-sectors under standard operating practices, excluding unpredictable catastrophic events. This equates to 13% of global economic output in 2009.“

„The global natural capital cost of **land use** by the primary production and primary processing sectors analyzed in this study is estimated at **US\$1.8 trillion**.“

„The global natural capital cost of **water consumption** by the primary production and primary processing sectors analyzed in this study is estimated at **US\$1.9 trillion**.“

„The global natural capital cost of **GHG emissions** by the primary production and primary processing sectors analyzed in this study is estimated at **US\$2.7 trillion**.“

„The global cost of **air pollution** by the primary production and primary processing sectors analyzed in this study is estimated at **US\$0.5 trillion**.“

„The global **land and water pollution** impact by the primary production and primary processing sectors analyzed in this study is estimated at **US\$0.3 trillion**.“

„The global **waste** impact by the primary production and primary processing sectors analyzed in this study is estimated at just under **US\$50 billion**.“

### Top 10 region-sectors with the greatest impact (Trucost, 2013)

Rank	Impact	Sector	Region	Natural capital cost US\$ Bn
1	GHG emissions	Coal power generation	Eastern Asia	361.0
2	Land use	Cattle ranching and farming	South America	312.1
3	GHG emissions	Iron and steel mills	Eastern Asia	216.1
4	Water consumption	Wheat farming	Southern Asia	214.4
5	GHG emissions	Coal power generation	Northern America	201.0
6	GHG emissions	Cement manufacturing	Eastern Asia	139.9
7	Land use	Cattle ranching and farming	Sothern Asia	131.4
8	Water consumption	Rice farming	Southern Asia	123.7
9	Air pollution	Coal power generation	Northern America	113.4
10	Water consumption	Water supply	Southern Asia	92.0

### Human and economic costs of the climate crisis (DARA, 2012, p. 17)

„This report estimates that climate change causes **400,000 deaths** on average each year today, mainly due to hunger and communicable diseases that affect above all children in developing countries. Our present carbon-intensive energy system and related activities cause an estimated **4.5 million deaths** each year linked to air pollution, hazardous occupations and cancer.“

„Climate change caused economic losses estimated close to 1% of global GDP for the year 2010, or **700 billion dollars** (2010 PPP). The carbon-intensive economy cost the world

another 0.7% of GDP in that year, independent of any climate change losses. Together, carbon economy- and climate changerelated losses amounted to over **1.2 trillion dollars** in 2010.“

„The world economy therefore faces an increase in pressures that are estimated to lead to more than a doubling in the costs of climate change by 2030 to an estimated 2.5% of global GDP. Carbon economy costs also increase over this same period so that global GDP in 2030 is estimated to be well over 3% lower than it would have been in the absence of climate change and harmful carbon-intensive energy practices.“

„Continuing today’s patterns of carbon-intensive energy use is estimated, together with climate change, to cause **6 million deaths** per year by 2030, close to **700,000** of which would be due to climate change. This implies that a combined climate-carbon crisis is estimated to claim **100 million lives** between now and the end of the next decade.“

#### **The total cost of global warming for the United States (Ackerman, Stanton, 2008, p. iv)**

„New research shows that if present trends continue, the total cost of global warming will be as high as 3.6 percent of gross domestic product (GDP). Four global warming impacts alone—hurricane damage, real estate losses, energy costs, and water costs—will come with a price tag of 1.8 percent of U.S. GDP, or almost \$1.9 trillion annually (in today’s dollars) by 2100.“

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