CHAPTER 2

The COPI methodology and Valuation Database

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Summary
The COPI analysis covers a chain of scenario-driven changes. The first step is to develop projections with the OECD-scenario and IMAGE-GLOBIO-model of changes in land use, biodiversity and ecosystem services over the period to 2050. At the same time, a database of values of ecosystem services is developed that can be applied to the land use changes. Development of a spreadsheet model allows the combination of the ecosystem service values and the land use changes, and the quality factors based on a measure of biodiversity of the land use types. To deal with data gaps this also includes methodological solutions for benefits transfer, up-scaling and gap-filling. Given that the GLOBIO model focuses on land-based biomes, the evaluation results are only a partial representation of the total global ecosystem services losses that come from biodiversity and ecosystem function losses. Hence, complementary analysis of benefits and losses across other biomes was carried out. These steps are complemented by a policy analysis, which seeks to see the OECD- baseline scenario in a policy perspective, help clarify the drivers for biodiversity losses and create a platform for policy recommendations.

2.1 Introduction

The COPI analysis covers a chain of scenario-driven changes (*figure 2.1*). For each part of the conceptual model a basic "conceptual" framework has been used to organise the data, information and knowledge. These frameworks are discussed in Section 2.2. Details of the models, indicators, databases and information sources are presented in the chapters where they are most pertinent.

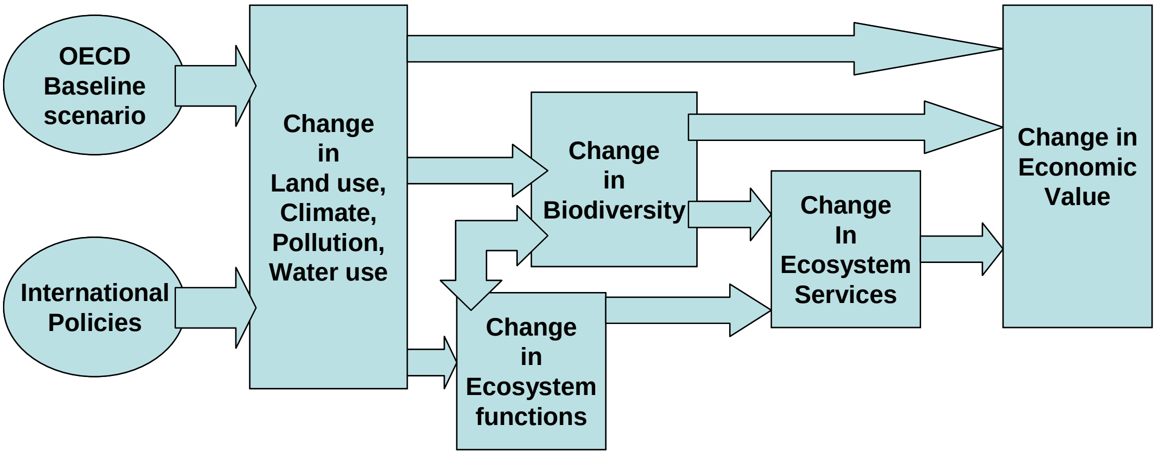


Figure 2.1 The conceptual model of the COPI analysis

The key steps of the COPI Analysis are:

1. **Develop projections with the OECD-scenario and IMAGE-GLOBIO-model** of changes in land use, biodiversity and ecosystem services over the period to 2050. The details of this are in Chapter 3, 4 and 5.
2. **Development of a database of values** of ecosystem services that can be applied to the land use changes. These therefore need to be in a Euro/hectare/year format. The unit values in the database are derived from two types of sources – one is a wide literature survey, and the other is primary research on the forestry biome. Details on the former are given in section 2.3, and details of the latter in Annex 1.
3. **Development of a spreadsheet model** that allows the combination of the ecosystem service values and the land use changes, and the quality factors based on a measure of biodiversity of the land use types. To deal with data gaps this will need to also include methodological solutions for benefits transfer, up-scaling and gap-filling. The model is available in electronic form and the steps in the analysis are presented in the Chapter 6, section 6.2.
4. Given that the GLOBIO model focuses on land-based biomes, the evaluation results presented in Chapter 6 will only be a partial representation of the total global ecosystem services losses that come from biodiversity and ecosystem function losses. Hence, some **complementary analysis of benefits and losses** across other biomes was carried out, presented in Chapter 6.

These steps are complemented by a policy analysis, which seeks to see the OECD- baseline scenario (see Chapter 3) in a policy perspective, help clarify the drivers for biodiversity losses and create a platform for policy recommendations.

2.2 The role of existing frameworks in the COPI analysis

2.2.1 The OECD Baseline Scenario

Quite a few organisations have worked at creating scenarios for future developments in land cover. A number of global studies have been published in 2007, e.g. IPCC (Intergovernmental Panel on Climate Change, 2007) and Global Environmental Outlook (United Nations, 2007) and in the first few months of 2008, e.g. IAASTD (International Assessment of Agricultural Science and Technology Development, 2008) and OECD Environmental Outlook to 2030 (OECD, 2008). They constitute essential contextual frameworks for the COPI analysis.

In the OECD Environmental Outlook to 2030 a set of demographic and economic scenarios are used, of which the so called "Baseline Scenario" is used in the COPI study. As the COPI study is about the cost of "inaction", a scenario was selected which uses realistic, mid range projection for population and economic development, with associated changes in the consumption of resources (including energy, land and ecosystems). The Baseline Scenario is a *no-new- policies* scenario: while "deep" drivers (efficiency improvements, demographic change) continue to evolve, no policy initiatives are included that would change dynamics. Policies in the pipeline that are currently decided upon and believably instrumented are included in the baseline. Compared to scenarios as developed by IPCC-SRES, the Millennium Ecosystem Assessment and the Global Environment Outlook, the OECD Baseline can be characterized as middle-of-the-road. The OECD Baseline is defined worldwide, in terms of 34 economic and 24 environmental regions. The policy horizon is 2030, the impact horizon 2050. In economic terms, the OECD baseline is quantified using the ENV-Linkages model of OECD. This model is derived from the Linkages model of the World Bank and part of JOBS, GREEN and GTAP tradition of models. Analysis of the OECD Baseline in physical terms has been mainly developed by NEAA/MNP (Bakkes & Bosch, 2008). This includes intermediate projections such as areas of cropland and grazing land (see Chapter 3).

In the COPI study we distinguish between various classes of policies within the Policy Landscape (biodiversity conservation, mitigating policies with respect to environmental pressures and economic development policies) and between stages of policy development (intention/goal statement, agreement / signature, instruments and financing). As to the range of policies included in the scenario, the notion is that policies currently in place are included, new policies, currently with the status of "under discussion" are not included.

2.2.2 The Driver-Pressure-State-Impact-Response framework

The Driver-Pressure-State-Impact-Response framework has proven to be a useful tool for characterising the inter-linkages between cause and effect for biodiversity loss (e.g. EEA, 1995). The changes in area and quality of ecosystem services (see Chapter 5), which in varying degrees determine the changes in economic value of biodiversity to society (see Chapter 6), result from the interactive and cumulative effects of a number of social and economic drivers including biodiversity conservation and economic development policies, next to, of course, autonomous ecological processes. In the GLOBIO model (see Chapter 4) the changes in biodiversity indicators are calculated on the basis of projected changes in such drivers and processes. The "feedback loop" from the perceived and experienced impacts to the previous elements of the framework is the so called response step, including legislation, economic instruments and technology as well as social action (see *figure 2.2*). In Chapter 7, we discuss options and their implications to address the consequences of a Baseline future.

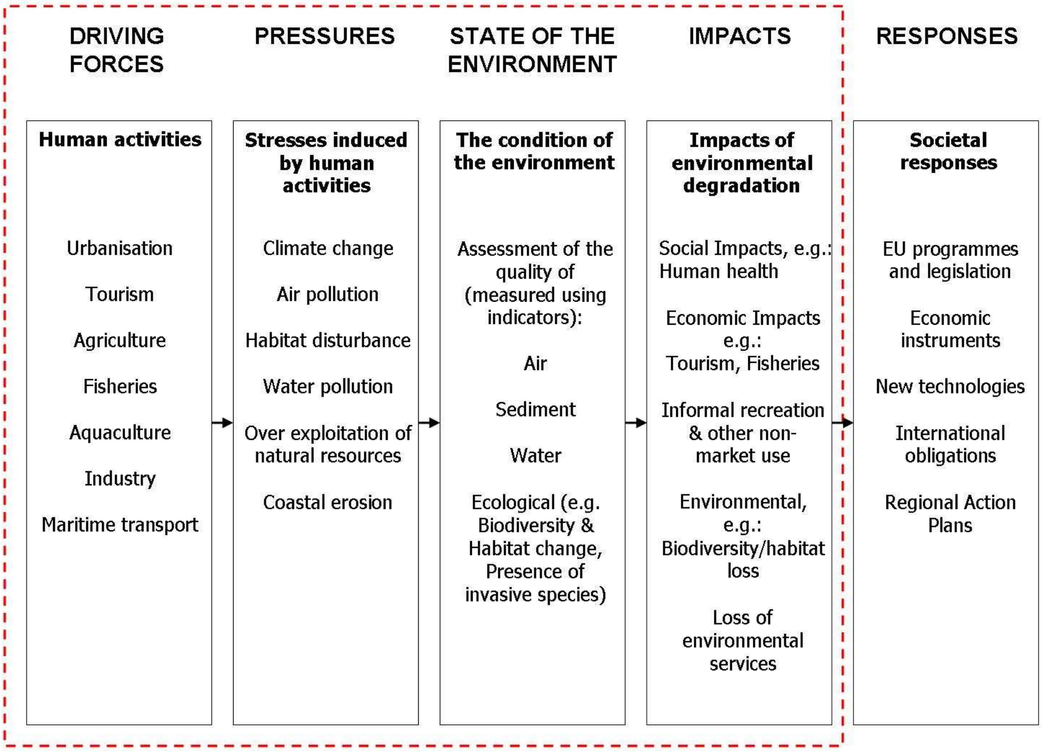


Figure 2.2 The DPSIR Framework

2.2.3 Indicators of Biodiversity change

The Convention on Biological diversity (CBD) has led to the development of sets of operational biodiversity indicators (*see table 2.1*). As a support to the Conference of Parties 8 the CBD has produced a 2nd Global Biodiversity Outlook (CBD, 2006). Part of the outlook was based on analyses with the Global Biodiversity model (GLOBIO; Ten Brink et al, 2006) which expresses the change in "biodiversity" in terms of the indicators "Mean Species Abundance" and "Extent (area) of ecosystems", accepted by the CBD and EU as part of the Headline Indicator Framework (see EEA, 2007). The indicators used by the Convention on Biological Diversity and adopted by the European Commission cover a wide range of biodiversity aspects ranging from ecological to social, cultural and economic, and the policies set in motion by the European Commission and described in detail in Action Plans of the Biodiversity Communication (EC, 2006). Several of these indicators are used to present the consequences of the Baseline scenario developments of economic and social drivers for biodiversity (see Chapter 4).

Table 2.1 The current set of 2010 Indicators, by Focal Areas of the CBD.

Focal Area	Indicator
Status and trends of the components of biodiversity	Trends in extent of selected biomes, ecosystems, and habitats Trends in abundance and distribution of selected species Coverage of protected areas Change in status of threatened species Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socioeconomic importance
Sustainable use	

	Area of forest, agricultural and aquaculture ecosystems under sustainable management Proportion of products derived from sustainable sources Ecological footprint and related concepts
Threats to biodiversity	Nitrogen deposition Trends in invasive alien species
Ecosystem integrity and ecosystem goods and services	Marine Trophic Index Water quality of freshwater ecosystems Trophic integrity of other ecosystems Connectivity / fragmentation of ecosystems Incidence of human-induced ecosystem failure Health and well-being of communities who depend directly on local ecosystem goods and services Biodiversity for food and medicine
Status of traditional knowledge, innovations and practices	Status and trends of linguistic diversity and numbers of speakers of indigenous languages Other indicator of the status of indigenous and traditional knowledge
Status of access and benefits sharing	Indicator of access and benefit-sharing
Status of resource transfers	Official development assistance provided in support of the Convention Indicator of technology transfer

2.2.4 Change in ecosystem services

The Millennium Ecosystem Assessment (MA, 2005a) has revived the awareness and understanding of the interdependency between human prosperity and well-being and the natural environment through the *economic concept* of ecosystem services. The MA framework (*figure 2.3*) has been used already in many valuation studies and is a basic element in the COPI methodology developed within this study (see Chapter 5).

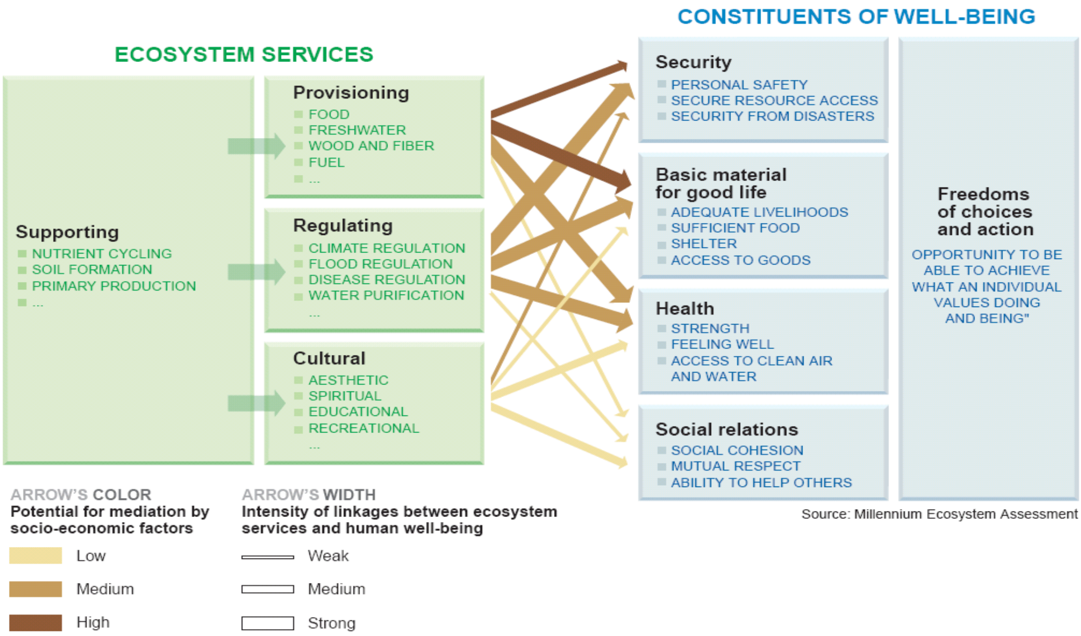


Figure 2.3 The Millennium Ecosystem framework (MA, 2005a)

Many of the studies reported over the last decade in scientific journals, such as Ecological Economics, have dealt with the relationship between ecosystems and economic growth and human well-being, and many case studies have been undertaken to document, quantify and monetise the economic importance of healthy and productive ecosystems. New views on the classification of services in relation to ecosystem processes and use in economic production and human consumption are reported in Rodrigues et al. (2008).

The MA stresses the risk aspects of biodiversity loss. The COPI analysis therefore not only evaluates the monetary costs of more or less continuous ecosystem degradation, but also addresses the costs in case of discontinuities (e.g. critical thresholds being breached). The MA has created a useful conceptual framework and political commitment to put the value of biodiversity into decision making. It has been a motor for new information on the value of biodiversity and associated ecosystem services. The MA classification of ecosystem services and their analyses constitute one axis in the COPI framework of analysis. We are aware that the MA clearly states the difficulty of fully assessing the costs and benefits of ecosystem changes.

The reports of the Millennium Ecosystem Assessment project also provide us with a great amount of assessment information on the state and trends in the world's ecosystems (MA, 2005b). *The COPI analysis on biodiversity change has made extensive use of this information, and some sections of MA chapters have been reproduced in this report, be it in, shortened and adapted versions* (see references in the text throughout the report).

2.2.5. Changes in economic value

An avalanche of publications on the economic valuation of biodiversity, ecosystem services and natural capital has been produced since the early 1990s and recently a number of summaries of current experiences and developments in methodology have been published. The notion of Total Economic Value (TEV; see e.g. CBD, 2007; see *figure 2.4*) is used to set a theoretical framework for the monetization of the ecosystem goods and services (see also Chapters 6 and 7).

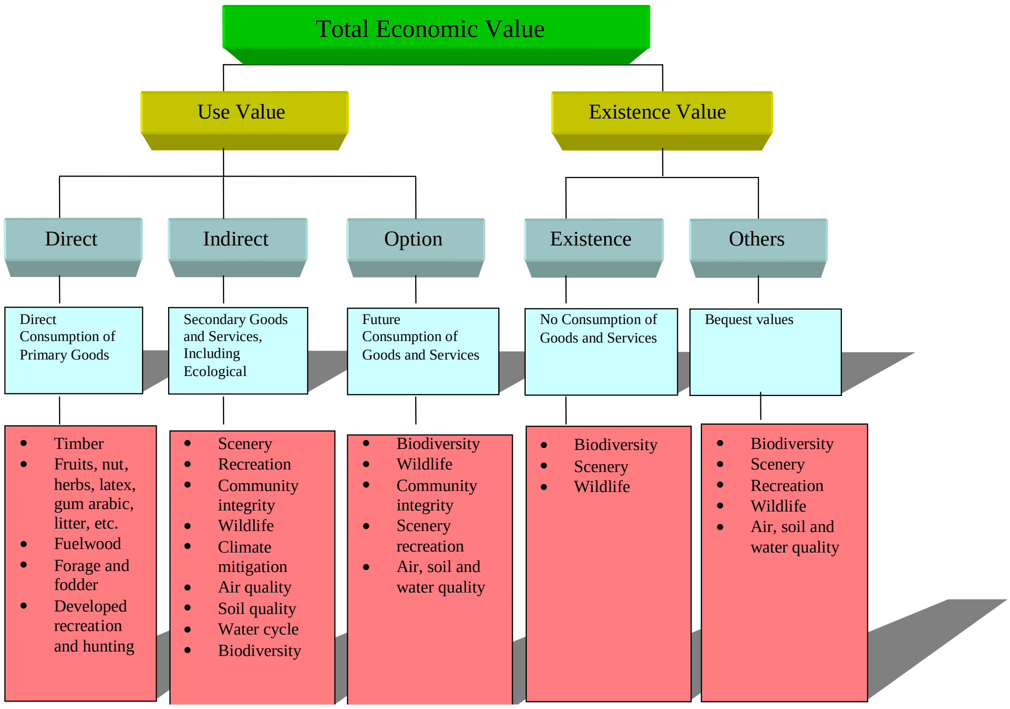
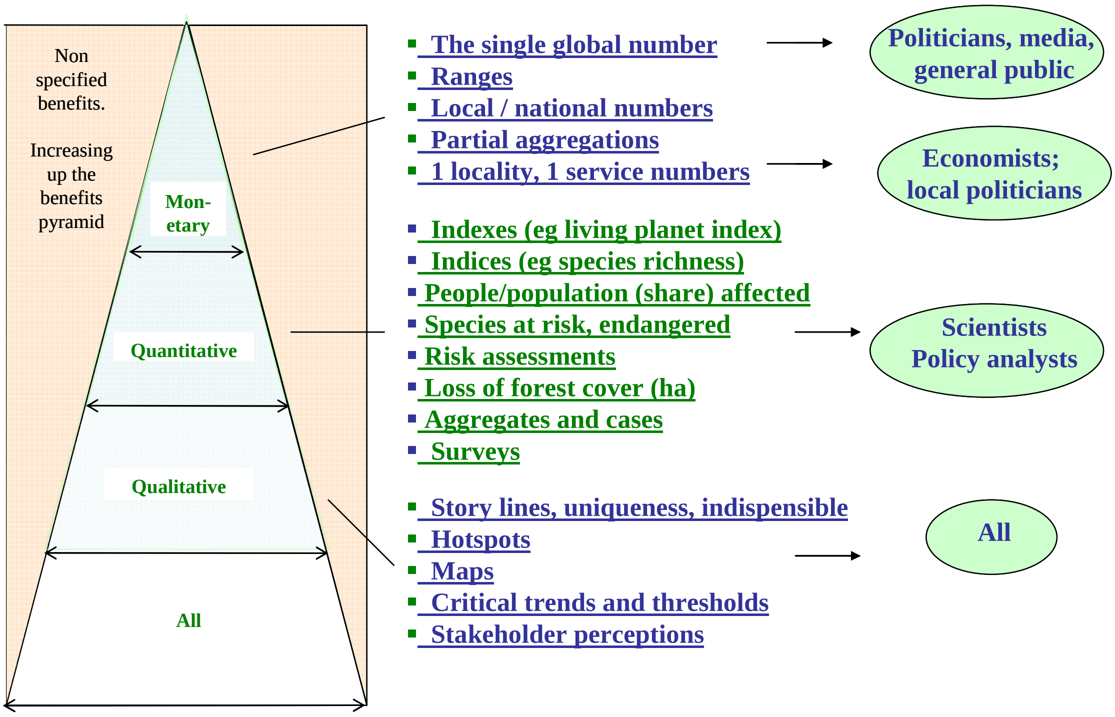


Figure 2.4 The Total Economic Value Framework

In the context of biodiversity and ecosystem services, the cost of policy inaction (COPI) may be defined (arguably a narrow focus definition) as the ‘ecological damage costs occurring in the absence of additional policy or of policy revision’. These damage costs are projected to accrue under existing (sector and biodiversity conservation) policy commitments. Various damage cost estimates are possible to take account of different levels of implementation of the existing commitments – higher damage costs with lower levels of implementation. In addition, it is possible to have a more inclusive COPI valuation - an ‘extended COPI’ - in which the costs of inaction are extended to include wider societal and economic costs, and where the definition of COPI is the ‘total social (private and external) costs occurring in the absence of additional policy or policy revision’. This report presents such an “Extended COPI assessment” which is referred to simply as ‘COPI’ assessment. The COPI assessment is focused on measures of loss of biodiversity and the associated ecosystem services over the projected period, or in particular future years, compared with some reference year and situation. The time profile of this loss over the period (linear or non-linear) may influence the final assessment. Because changes in ecosystems may increase the delivery of some ecosystem services while reducing others, this COPI exercise has also sought to factor in the benefits of inaction (net-COPI).

At the core of the methodology in this study is the “valuation of biodiversity”, in other words the assessment of the (total) value of ecosystems to mankind. *We concentrate on the valuation of the “flows” (the ecosystem goods and services) rather than on valuation of the biodiversity “stock”*. In light of the previous statements, there is a clear need for a comprehensive, qualitative, quantitative and where relevant and possible, monetised, overview of the total value of biodiversity and ecosystem services lost, due to policy-inaction in order to support policy development and decision-making. Depending on the target audience, and the platform of discussion, the COPI results can be presented in one or more formats, appropriate to the occasion (see *figure 2.5*).



Source: Patrick ten Brink (IEEP) presentation at the Workshop: ***The Economics of the Global Loss of Biological Diversity 5-6 March 2008, Brussels, Belgium***

Figure 2.5 Communication of COPI assessment results

2.3 The Valuation Database

2.3.1 Introduction

The overall task of the Valuation Database was to provide a framework that allows for the generation of an inventory of the current state of economic valuation studies of biodiversity and ecosystem services that are suitable for a COPI assessment based on the GLOBIO-model results. The database is not just a compilation of studies dealing with the issue of economic evaluation, as are current databases like EVRI and others, but rather a focused database looking at and categorising ecosystem services values that can be used to arrive at COPI values when linked to a land-use change type model – hence seeking Ecosystem Service (ESS) per hectare values.[1] Furthermore, the work has a role as a scoping exercise in order to get a better picture on the overall data availability and to provide a framework for the general data processing for future work in The Economics of Ecosystems and Biodiversity (TEEB) project. The database also provides the basis for the first indicative assessment of the costs of policy inaction as given in Chapter 6.

The inventory of economic valuation studies is a core foundation for the COPI-project. Its roles can be summarised as follows:

- **structuring the data**: it provides the data in a structured form, from which the integrated COPI assessments at various levels are developed;
- **characterising the data**: it documents the nature of the valuations and the range or forms they can take;
- **identifying gaps and opportunities**: to develop suggestions for new and additional policies and priorities needed in response to insights on ecosystem services across relevant geographical and sectoral examples.

To fulfil these objectives, a database has been developed that meets these key criteria.

- **Contains up-scalable data**: the main precondition for the data recorded in this database is that the numbers can be used for an up-scaling exercise on a global level. In addition, it is essential that the values be suitable for benefit transfer given the fact that there is a very uneven distribution of available information across ESS, biomes and geographical regions. To fulfil these requirements, the database presents data in economic values that are comparable and explicit in respect to the evaluated environmental good to avoid double counting.
- **Identifies data coverage and gaps**: the database is structured in such a way that it clearly indicates which data are available and where data gaps are, to give advice for the phase II.
- **Accommodates future needs**: the database is flexible in a way that new data can easily be added.

To ensure that the above-mentioned criteria are met, the database contains only studies for which data can be presented on a €/ha basis and which can also be attached to a specific biome, ecosystem function and region. These stringent criteria result in a significantly smaller number of suitable case studies. This is necessary to ensure a sound and robust COPI assessment.

[1] Note that other values were collected and collated to allow complementary analysis – eg of coral reefs, wetlands, and invasive alien species though these were not integrated into the structured database.

2.3.2 Methodology

This section describes the methodological features of the database.

1. Data gathering:
Because part of the aim of the project is to provide a scoping exercise on what a worldwide COPI assessment could look like in phase II, the literature search tried to use existing databases, such as the Environmental Valuation Reference Inventory (EVRI) to the extent possible. Even though a considerable number of studies have been identified that provide economic values for specific ecosystem services, only a small proportion of these studies provided information detailed enough to be incorporated in the COPI Valuation Database. Hence, in addition, a literature search of scientific databases (Web of Science, Agricola) for peer-reviewed publications was conducted, as well as an internet search for grey literature, to allow the team to have sufficient data upon which to base the COPI illustrative assessment

2. Mean values for ecosystem function:
Taking into account that 19 different ecosystem services (ESS) in combination with 13 different biomes and 14 geographic regions would result in 27,664 necessary values to feed into the COPI-assessment, there is an obvious and urgent need to reduce complexity and fill in gaps. As a first step to reduce the complexity, mean values for different EES-biome combinations across regions were calculated in Euro for the year 2007 using the Purchase Power Parity/GDP index from the OECD study. These mean values serve as a good starting point for the up-scaling procedure presented in Chapter 6. Annex II “the forest study” presents a statistical way to do this assessment if sufficient information is available to undertake a benefit transfer based on transfer functions. In addition for each ESS it has to be checked whether the underlying studies evaluate competing or non-competing uses. In the first case, mean values can be used, but in the latter case the non-competing values must be added together to find the overall value for the respective ESS (see *table 2.3*).

3. Min-max procedure:
To assess the suitability of using the calculated mean values, minimum and maximum values were identified for each ESS-biome combination and compared with the mean. This allowed assessment of representativeness and hence transferability for each ESS-biome combination. The results of this comparison are presented in *table 2.3*. Where the ranges were found to be appropriate, mean values were fed into the COPI assessment. Where value ranges were found to be extremely large, they have been taken into account in the COPI assessment by stating minimum and maximum values to be used for the different scenario calculations.

4. Cross-check of single values:
Available estimates were used when they were regarded as representative and methodologically sound. For some ESS-biome combinations data availability is limited to individual studies. To ensure that these are suitable for the up-scaling procedure, they must be verified.[2] Given the scope of this study, this assessment could not take the form of a statistical procedure, so consisted instead of a basic plausibility check. The underlying rationale here is that economic evaluation studies and their results may not be representative for a specific biome. This is due to the fact that these studies are frequently undertaken to highlight the importance of a specific ecosystem service in the case-study area and to raise awareness in the decision-making process. The results of the studies have therefore to be critically assessed by comparing them with related studies using expert judgement. For an example of what such an assessment might look like, see Box 2-1 (calculation procedure). This assessment eliminated certain economic values from the database, because they represented people’s willingness to pay for a certain ecosystem service at very prominent

[2] Please note that all studies have to pass a quality check in order to be incorporated into the database.

places, i.e. where the reported value is quite likely much higher than the assumed global average value.

5. Fixed data processing procedures:
The database contains several summary tables containing information on (i) the overall count of studies for specific ESS-biome combinations, (ii) the mean value, (iii) maximum and (iv) minimum values as well as (v) sums for selected ESS where the underlying values represent sub-functions of a given ESS that must be summed up to represent the overall value of the function.

6. Filling the gaps:
Filling the gaps is discussed in Chapter 5, where the relation between ESS and Landuse type (and hence a basis for transferring values between Landuse types within the same biome) is described and in Chapter 6, which presents the evaluation results. It is useful to transparently show the results in the context of the up-scaling and gap-filling approaches so that the numbers can be seen in perspective. Note that two scenarios were created – a partial analysis scenario, where there was a lesser level of gap filling/estimation, and a fuller analysis scenario, where more (but not all) of the gaps were filled. The choice of two scenarios reflected the opposing principles – one of theoretical purity (i.e. only use numbers from original data and selective gap filling where fair rationales exist) and one of the ambition of having a representative number (without the gaps filled, the final answers would arguably not be very representative of reality). Details are given in Chapter 6.

2.3.3 The COPI Valuation Database - structure and available data

The COPI Value Database contains the figures to be used for the completion of the monetary biome-landcover sheet in the COPI spreadsheet. It provides the monetary values needed for the eventual COPI assessment and thus represents the core of the COPI spreadsheet. By linking an estimate for a specific ecosystem service to a biome, a land use type and a geographic region, one can assess the overall loss of ecosystem services over the period 2000 to 2050.

The data in the database are displayed in two parts:

- Part 1 is the core of the database. Estimates have been summarised in a seven-column table, from which the values will feed into the monetary biome-landcover sheet. *Table 2.2* represents the synthesis of the Valuation Reference Database.
- Part 2 contains all relevant information that characterises each value/the respective study in detail, e.g. the actual location of the case study. A detailed description can be found in the Annex I.

Table 2.2 Core of the Valuation Database

Used in COPI assessment	Useable value	PPP-adjusted usable values	ESS reference	Biome	Landuse type	Geographic region
1 = yes *0 = no*	*EUR/ha in the year 2007*	*EUR/ha adjusted by PPP to feed into matrix*	*# from ESS table to allow sorting (1-19)*	*# ref to allow sorting (1-13)*	*# ref to allow sorting (1-8)*	*# region from Globio (1-14)*

2.3.4 Values for ecosystem services across biomes

At this moment, the database contains a total of 186 monetary values, split over several biomes, land-cover types and geographic regions. Nevertheless, the literature search for the database revealed a very unequal distribution of the available evidence for the different biomes and ecosystem services. Out of the total dataset, only around 30 values cover scrublands and grasslands, and 20 values cover temperate and tropical forests[3]. A major part of the values cover wetlands, swamps and floodplains (27), mangroves (15) and marine ecosystems such as coral reefs (19). Even though these values cannot be attached to one of the biomes from the GLOBIO model, they have been recorded, because they are valuable information that can be used in the additional estimates (see also Annex III on invasive alien species, IAS). Regarding the regional distribution it becomes apparent that there is a greater number of values available for Europe and America (North and South) than for Africa or Asia. This is not surprising. A look at the regional distribution of the entries in the EVRI database confirms this. An additional literature review has been undertaken to even out this imbalance.The second main issue is that there is considerably variation between the values within one EES-Biome category.

Table 2.3 Available data for the different biome/ecosystem service combinations (details on the calculation of means are described in the Box 2-1).

		PPP-adjusted values (EUR/ha) / [number of usable values] / range			
		Biome category			
ESS ref	**Ecosystem service (ESS)**	**Grassland**	**Scrubland**	**Tropical Forest**	**Temperate Forest**
1	Food, fiber, fuel	106 [3] (28 – 243)	779 [2] (515 – 1044)		246/14/99/107 142**
2	Biochemicals, natural medicines, pharmaceuticals	0 [1]		514 [5] (12 – 2394)	3 [2] 2,2-3,6
4	Fresh water			9,6 [1]	
5	Air quality maintenance		793 [2]*		
6	Soil quality maintenance			1176[4] [1]	
7	Climate regulation	36 [3] (0 – 102)	347 [1]		240/ 542/382/240/382**
9	Water regulation	2,4 [1]		503/1356[3] 80-3062	344 [3] 0,2-980
10	Erosion control	23 [3] (1 – 44)	44 [1]		
11	Water purification and waste management	240 [3]*	838 [4]*	104,16 [1]	104 [1]
13	Biological control and pollination	57 [2]*			5 [1]
14	Natural hazards control / mitigation			6 [1]	
15	Cultural diversity and values		112,4 [1][5]	8 [2] (2 – 173[6])	99/25,4/11,9/9,9/11,9**
16	Living comfort due to environmental amenities				
17	Recreation and ecotourism			91 [1]	1,3/1,3/1,3/1,3/1,3**
19	Primary production, nutrient cycling, soil formation			1116 [2]*	12 [1]
SUM	**Individual values extracted from reference database**	**18**	**11**	**15**	**14**

[3] note that for forests, a wider set was used directly in the FEEM led work in Annex II. See annex II for details.
[4] Adjustment of the mean. See Box 2-1 “Assessment procedure”.
[5] Adjustment of the mean. See Box 2-1 “Assessment procedure”.
[6] Adjustment of the mean. See Box 2-1 “Assessment procedure”.

		PPP-adjusted values (EUR/ha) / [number of usable values] / range			
		Biome category			
ESS ref	Ecosystem service (ESS)	Grassland	Scrubland	Tropical Forest	Temperate Forest
SUM	**Values used in COPI assessment**	**7**	**6**	**9**	**7**

* Value is the sum of the different underlying studies as these studies have evaluated different sub-functions of the respective ecosystem function. In these cases, a calculation of a mean would not be appropriate, hence no ranges are presented.

** Values derived from the extra study on forests (see Annex). The different values are referring to the following forest biomes: boreal forests, warm mixed forests, temperate mixed forest, cool coniferous forests, and temperate deciduous forests.

In *table 2.3*, the majority of values are mean values. Nevertheless, there is always a cross-checking necessary to assure that the subsumed values are exclusive or non-exclusive uses. There are cases where an aggregate has been used for the COPI assessment. Here, different sub-functions of the same ecosystem service have been summed up to come to an aggregate value. For instance, food production and the supply of raw materials are two sub-functions under ecosystem service 1 (food, fiber, fuel). These functions can be summed up, because they are distinct and non-exclusive. In cases of identical functions, or when functions exclude each other, mean values have been calculated and were used in the further COPI assessment.

As can be seen from *table 2.3*, some values are well documented, while others are less well documented. In Box 2.1, additional information is provided on the mean values to be used in the COPI assessment and explain in detail how the individual mean values have been developed to ensure transparency of the process.

Box 2-1: Assessment procedure for the final values used in the COPI assessment.

Grassland / food, fiber, fuel [15/1] The mean value was derived from three individual studies. Fleischer et al. (2006) estimate the value of herbaceous biomass for meet production at EUR 243/ha; Costanza et al. (1997)[7] estimate the value of food production at EUR 46/ha (net rent), and Ruijgrok et al. (2006) estimate the value of food, fibre and fuel production at EUR 28/ha (WTP). The estimates stem from Israel, the US, and the Netherlands, respectively. The mean value was calculated without any adjustments.

Grassland / climate regulation [15/7] The mean value was derived from two individual studies. Costanza et al. (1997) estimate the value of climate regulation between EUR 0/ha and EUR 6/ha (opportunity cost), depending on the specific site. Ruijgrok et al. (2006) estimate the value of carbon storage at EUR 102/ha (WTP). The estimates stem from North America and Europe, respectively.

Grassland / erosion control [15/10] The mean value was derived from two individual studies. Costanza et al. (1997) estimate the value of soil formation at EUR 0.81/ha (opportunity cost) and the value of erosion control at EUR 24/ha (net rent). Ruijgrok et al. (2006) estimate the value of erosion control at EUR 44/ha (avoided cost method). The estimates stem from North America and Europe, respectively.

Scrubland / food, fiber, fuel [17/1] The mean value was derived from two individual studies. Rodriguez et al. (2006) estimate the value of food, fiber and fuel provision at 1044 EUR/ha

[7] Costanza et al. (1997) values were included in the database analysis, because they are often enough valuable reference points. In addition, they were compiled by highly recommended researchers in the field of ecosystem service valuation and are often based on meta analyses.

(cultural domain analysis). Ruijgrok et al. (2006) value the same service at EUR 515/ha (WTP). The estimates stem from Europe and Latin America, respectively.

Scrubland / cultural diversity [17/15] Here only one value is available. As WTP studies on this issue generally evaluate specific sites of a broader interest, the value can not be used directly. For a simple and pragmatic benefit transfer it was assumed that only up to 10% of all scrublands a specific cultural value can be attached – otherwise they would not be special. (Please note, if more data becomes available the adjustment procedure as presented for the forest values should be used (see Annex).

Tropical forest / biochemicals, natural medicines, pharmaceuticals [20/2] The mean value was derived from four individual studies. Simpson et al. (1996) estimate the values of pharmaceuticals at EUR 13/ha on a global scale (modelling market price), while Costello and Ward (2006) value the same service at EUR 109/ha on a global scale (modelling market price). Costanza et al. (1997) estimate genetic resources at EUR 33/ha (market value). Eade and Moran (1996) estimate genetic material at EUR 24/ha and medicine at EUR 2394/ha. The regional values stem from studies from North and Latin America.

Tropical forest / soil quality maintenance [20/6] Here just one value has been available provided by Eade and Moran 1996, in a case study for the Rio Bravo. As the normed value of the original study (EUR 5880 /ha) seemed to be very high in comparison to the figures available on the value of nutrient cycling (ESS 19) it was assumed that this value is very case-study specific and was hence adjusted. To ensure a conservative calculation only 20% of the original value entered into the final COPI calculation.

Tropical forest / water regulation [20/9] For this EES, three individual studies were available that differ significantly. Kaiser and Roumasset (2002) estimate watershed protection at EUR 926/ha for North America, while Emerton (1999) estimates the value of watershed protection Mount Kenya at EUR 3061/ha. Eade and Moran (1996) estimate the value of flood control in Latin America at EUR 80/ha. As the benefits of flood control highly depend on site-specific conditions such as precipitation but also vulnerable infrastructure, an adjustment of the mean value was undertaken to ensure conservative calculations. In this case, two means where calculated, the one considering all three values will only be used in the higher scenario, while for the lower scenario the mean of the lower two values will be used.

Tropical forest / cultural diversity and values [20/15] Here two values of different natures were available. Costanza et al. (1997) estimate the cultural value at EUR 2/ha on a global scale (CVM). Eade and Moran (1996) estimate the existence value at EUR 173/ha. The latter study stems from Latin America.

Temperate forest / biochemicals, natural medicines, pharmaceuticals [1212/2] The mean value was derived from two individual studies. Rosales et al. (2005) estimate the value of pharmaceuticals at EUR 3.55/ha, while Howard (1995) estimates the same service at EUR 2.24/ha. The studies stem from South-East Asia and Africa, respectively.

Temperate forest / water regulation [1212/9] The mean value was derived from three individual studies. Rosales et al. (2005) estimate the value of flood control at EUR 980/ha (varied methods). Howard (1995) estimates the value of watershed protection at EUR 51/ha. Costanza et al. (1997) estimate the value of water regulation at EUR 0.17/ha (damage costs). The studies stem form South-East Asia and Latin America, respectively.

2.3.5 Insights – strengths, gaps, methods for using values, and needs

The proposed database, structured along ecosystem services and biomes, offers the possibility to generate numbers to feed into the COPI assessment in a transparent and structured way. Nevertheless, in order to qualify for further processing in the COPI database, the valuation studies had to fulfil certain criteria. Firstly, monetary or quantitative values were required on a per hectare and annual basis. Secondly, the values needed to be assignable to a certain biome, landcover type and geographic region. These essential selection criteria reduce the number of usable economic evaluation studies dramatically.

This has been foreseen to some extent, since it is clear that most economic valuation studies have been conducted to evaluate specific conservation programs or specific locations rather than to generate mean values per biome. For this purpose, most studies generate figures more correlated to the project or habitat (e.g. aggregated value of the WTP per visit, or WTP for the protection of a specific area) than on a per-hectare basis. The majority of the available studies corresponds to specific entities like specific forests or lakes and are therefore difficult to transfer or interpret in a more general context. In addition, studies tend to focus on rather attractive or ecologically valuable habitats like wetlands, coral reefs etc., leaving a paucity of evidence for habitats with a lower profile. We must acknowledge that the dimensions of this problem are surprisingly large.

In respect to the aims of the database, it can be concluded that it has been useful to:

- define representative samples of case studies per biome/ecosystem service unit
- analyse relevant samples and insert them in a spatially explicit framework
- ensure the possibility of a benefit transfer
- provide information about knowledge gaps

It seems that a considerable part of the data needed is not or not easily available in the public literature. Currently, for some ecosystem services there are only few corresponding values in the Value Reference Database, e.g. with regard to water supply as a provisioning service. In this respect, the figures that will be retrieved from the final COPI assessment can only be interpreted as a lower-bound estimate. During the second phase of the review, the existing gaps will have to be filled in order to come to more representative figures. In summary, though there are information gaps in the current database, a first approach has been developed that is suitable to further elaboration in a second phase when more resources and time are available.

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