The TEEB Valuation Database: overview of structure, data and results

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Final report

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Preface and acknowledgements

As a contribution to the TEEB study (www.teebweb.org) the authors developed a searchable database with estimates of monetary values of ecosystem services. The design of the TEEB Database is largely based on the findings and recommendations of the TEEB Scoping the Science report (Balmford et al. 2008) and the Costs of Policy Inaction report (Braat and Ten Brink 2008) and database (Ten Brink et al. 2009). In total 267 publications have been used for data entry and 1310 estimates are shown in the final version of the database[1]. A selection of 582 of these estimates has been used for the overview of "Estimates of monetary values of ecosystem services" published as Appendix 3 (De Groot et al, 2010a) in the TEEB D0-report (Kumar, ed. 2010).

In this Final Report we present an overview of the structure of the database, the methods used to select, screen and analyse the data, a short summary of the main results and a discussion on the conclusions and insights gained. In addition, Appendix 1 gives a detailed overview of the tables and variables used and Appendix 2 and 3 give an overview of the 1310 monetary values, in original units, found per biome. The TEEB Valuation Database can be found on the website of the Ecosystem Service Partnership (URL: www.es-partnership.org; direct link to the database: www.fsd.nl/esp/77979/5/0/30).

We would like to thank Matt Rayment, Martijn van der Heide, Luke Brander and Pieter van Beukering who helped with clarifying conceptual and methodological aspects of setting up the database.

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[1] In addition, a large number of publications still need to be screened as well as data from other sources [see De Groot et al 2010a for more details]; keeping the database up-to-date is an ongoing effort supported and coordinated by the Ecosystem Services Partnership (www.es-partnership.org)

1. Introduction

This report presents the main structure and variables used to develop a searchable database on ecosystem services values, the methods used to select and analyse the data and discusses the monetary values found for ecosystem services for the main biomes[2] identified in the TEEB study. These main biomes/ecosystem-complexes are: marine systems, coral reefs, coastal systems, mangroves, inland wetlands, rivers and lakes, tropical forests, other forests, woodlands, grasslands and polar systems. For each biome, all 22 ecosystem services identified in the TEEB-study were taken into account in the data collection. In total 267 publications were screened and over 1310 data-points (monetary values) stored in a database specially designed for the TEEB-study (see chapter 2 for details)

To make the TEEB Valuation Database useful for planning and decision making, it is not merely a bibliography of case studies on economic valuation of ecosystems and their services but it contains original values in monetary units organised by service and biome. Furthermore, it is a relational database enabling linkage between any of the data-fields. This flexibility makes it suitable for many uses such as benefit transfer, meta-analysis, modelling and scenario-analysis. This database also enables to enter data from a large variety of valuation case study types and accommodates the different ways in which these studies have been published and the data has been presented. The database structure also allows to analyse data coverage and to identify gaps in data availability by making queries.

The TEEB Valuation Database can be found on the website of the Ecosystem Service Partnership (URL: www.es-partnership.org; direct link to the database: www.fsd.nl/esp/77979/5/0/30) At this moment, a simple version of the database is available in excel for users to select relevant values and case studies.

Chapter 2 gives more details on the development and structure of the TEEB Valuation Database which includes information on, among others, case study context and economic variables, biome type, ecosystem type, ecosystem services and sub-services, valuation method, reference details and the location details of case study. The design of this TEEB Database was, among others, based on the findings and recommendations of the TEEB Scoping the Science report (Balmford et al. 2008) and the Costs of Policy Inaction report (Braat and Ten Brink 2008), and database (Ten Brink et al. 2009). In addition, other databases and data sets on economic valuation of ecosystem services were used (see chapter 3 which describes the methods used for data collection and data analysis).

Chapter 4 gives an overview of the data found. In total 1310 data points (original ecosystem service values) from 290 case study locations and 267 publications have now been included in the database, and analysed (see Appendix 2 for details). These

[2] Throughout this chapter we use 'biome' as shorthand for the 11 main types of ecosystem-complexes for which we analysed the monetary value of the services they provide. Each biome can be split into several ecosystems, each with their own set of ecosystem services, but for the purpose of this study, data on monetary values was aggregated at the biome-level (for details see Appendix 3)

include more than 100 new values that were added to the database after publication of the TEEB D0-report (Kumar, ed., 2010) (see section 3.3. for further explanation). The unit to represent the estimates in Appendix 2 is *local currency/ha/yr.* The main reasons for doing so are the consistency with the original publications and the ease for future use of the data. To use these monetary value estimates for calculations or further analysis they need to be standardized though purchasing power parity (PPP) and inflation correction (the method of standardization used for the TEEB study is described in detail in Chapter 3).

Finally, Chapter 5 discusses the results and reflects on some insights, one of which is of course that the monetary values found should be used with great care: although we double-checked the data presented in Appendix 2, all values are very time and context dependent and each new policy case should ideally use original data (which is, of course often impossible due to time and financial constraints which is why the development of reliable data bases and meta-analysis techniques is so important (see box 1).

In addition to these practical issues, there are still some fundamental problems to overcome. Economic, especially monetary values have many shortcomings and limitations, not only in relation to ecosystem services but also to man-made goods and services. They are by definition instrumental, anthropocentric, individual based, subjective, context and state dependent, and usually marginal (Goulder and Kennedy, 1997; Baumgartner et al 2006, Barbier et al, 2009, EPA., 2009). For a detailed discussion of the shortcomings and assumptions involved in economic valuation of ecosystem services, see the TEEB D0-report (Kumar (ed.) 2010), especially Chapters 1 (De Groot et al 2010a) and 5 (Pascual and Muradian 2010).

However, as long as these fundamental issues in economic theory and practice have not been solved, information about the monetary importance of ecosystem services is a powerful and essential tool to make better, more balanced decisions regarding trade-offs involved in land use options and resource use.

Box 1. The concept of Total Economic Value

Since the early 1990's a steady growing number of articles and reports on the economic valuation of natural resources, ecosystem services and biodiversity is published by a large variety of institutions and for many purposes. These publications cover a large number of ecosystems, types of landscapes, different definitions of services, different service areas, different levels of scale, time and complexity and different valuation methods. In addition, a number of independent bibliographies and summaries for different ecosystems and methodologies have been compiled by different authors or institutes. In many of these studies the concept of Total Economic Value (TEV) is used to combine the results of several case studies in order to present a theoretical framework for the monetization of the ecosystem goods and services of an ecosystem (for more information see Chapter 1 of the TEEB D0 report).

In addition, in the past decade the application of the framework of meta-analysis (Glass 1976) has increased considerably in the field of environmental economics. This framework is a more elaborated approach designed to draw conclusions on basis of a variety of valuation case studies.

In this study the concept of Total Economic Value is applied. There are two reasons for doing so. First, this concept is generally applicable due to the absence methodological requirements of the data. Second, due to the lack of valuation studies for many of the ecosystem types it was not possible to consistently perform meta-analyses for all ecosystem types. In Chapter 4.2 an overview of the TEVs for the ecosystem types is given. In the next paragraph we introduce the framework of meta-analysis and in Chapter 4 a general overview of the monetary values and valuation studies used for this analysis is presented.

Meta-analysis: purpose and brief literature review

Meta-analysis is the quantitative analysis of statistical summary indicators reported in a series of similar empirical studies. It is a method of synthesizing the results of multiple studies that examine the same phenomenon, through the identification of a common effect, which is then “explained” using regression techniques in a meta-regression model (Stanley, 2001). Meta-analysis was first proposed as a research synthesis method by Glass (1976) and has since been developed and applied in many fields of research, not least in the area of environmental economics (Nelson and Kennedy, 2009). It is widely recognised that the large and increasing literature of economic valuations of ecosystem services and environmental impacts has become difficult to interpret and that there is a need for research synthesis techniques, and in particular statistical meta-analysis, to aggregate information and insights (Stanley, 2001; Smith and Pattanayak, 2002; Bateman and Jones, 2003).

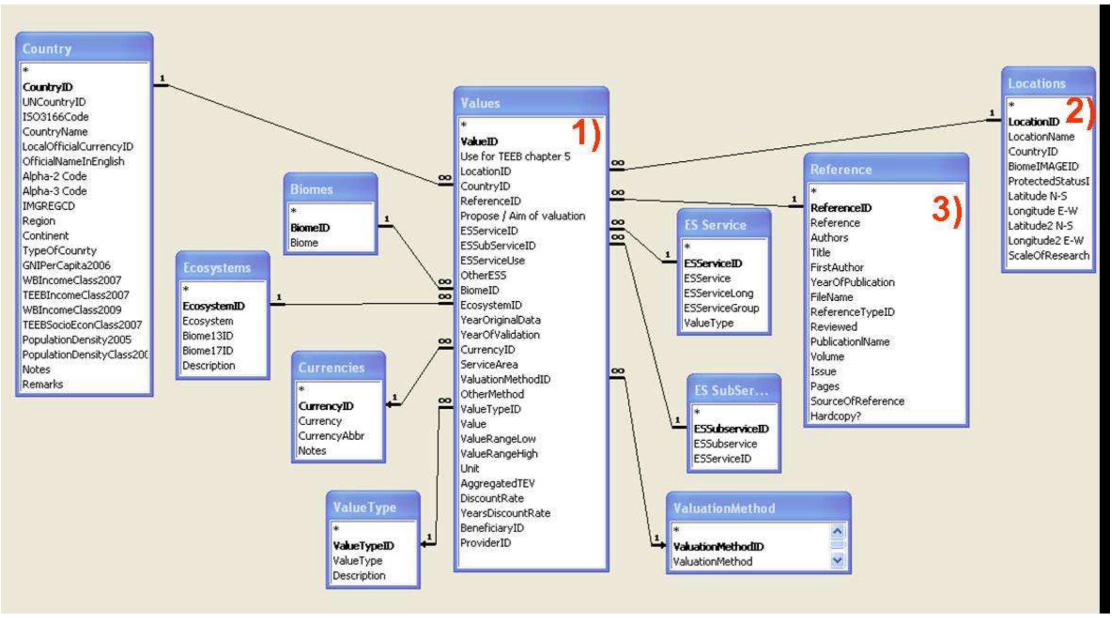
In addition to identifying consensus in results across studies, meta-analysis is also of interest as a means of transferring values from studied sites to new policy sites. Estimated meta-analytic value functions can be used to estimate context specific values for unstudied “policy sites” by adjusting transferred values for important bio-physical and socio-economic characteristics. Several meta-analyses have been conducted in the field of economic valuation of environmental resources, impacts, and services, for example for wetlands (Brouwer et al. 1999; Woodward and Wui, 2000; Brander et al., 2006, Ghermandi et al., 2007, Enjolras and Boisson, 2008), coral reefs (Brander et al., 2007), forests (Zandersen and Tol., 2009), woodland recreation (Bateman and Jones, 2003), biodiversity (Nijkamp and Vindigni, 2003), outdoor recreation (Rosenberger and Loomis, 2000; Shrestha and Loomis, 2001), water quality (van Houtven et al., 2007), urban air pollution (Kaoru and Smith, 1995), and environmental valuation studies (Gen, 2004).

2. The TEEB Monetary Valuation database: structure and variables

The starting point for the development of the TEEB Monetary Valuation Database was the COPI Valuation Database (Braat and Ten Brink, 2008), as the basis for the Costs of Policy Inaction-report (Ten Brink et al., 2009) and recommendations given in the TEEB Scoping the Science Report (Balmford et al., 2008).

The TEEB Monetary Valuation database is a relational database developed in Microsoft Access. Figure 1 provides an overview of the tables and their relationships. This means that the relational links between tables makes it possible to extract combined data from the tables and present detailed information on all estimates or for a selection only. Data entry is standardized with a form to limit mistakes as much as possible.

Figure 1 - A relational representation of the TEEB Valuation database



The database consists of 3 main tables for data entry: 1) the ecosystem service value table, 2) the location table, and 3) the publication table. These tables are discussed in more detail in the three sections 1-3.

An overview of the main variables is presented in Table 1 and in Appendix I all variables in the TEEB database are described and the classifications are shown. For most of these variables, defined categories were used to enter the data from case studies in the database to enable systematic and reproducible analysis. In the database these classification tables are linked to the data entry forms in order to limit mistakes with data entry.

The main advantage of the use of a relational database is that selection of data can be done quickly and precisely on the basis of both the original data and linked to additional data. Also unit conversions can be changed easily and multiple classifications can be used without changing the underlying original data structure.

The following paragraphs provide a more detailed description of the database structure and the used variables.

Table 1 - Overview of the main data types in the database

Estimate	
Unique ID number	Auto number: for identification of the estimate
Publication	
Reference	Both short and full citation
Publication year	Year of publication of the article or report
Publication type	Classification of different publication types
Peer-reviewed publication	Yes/No
Location	
Location name	Description of location of the case study
Country	Selection from country/territory list
Location coordinates	Location coordinates in WGS datum
Scale of the case study	i.e. Local ecosystem/municipality, landscape, province, country, continent, world
Protected status	Level of protection of the study area / landscape. Three categories: unprotected, partially, completely protected or unknown.
Ecological information	
Biome / ecosystem type	Using the TEEB Classification of different biome / ecosystem types
Ecosystem	Using the TEEB subclassification of different ecosystems per biome
Ecosystem Services	Using the TEEB subclassification of ecosystem services
Ecosystem service specification	Using the TEEB Classification of ecosystem services
Service area	Area (in hectares) for which the service value was estimated (as described in the publication)
Economic information	
Valuation method used for the value	Using the TEEB classification of valuation methods
Economic Value	Value as presented in the publication
Discount rate and years	Indicated when stock, PV, NPV and available in publication.
Unit	Unit used in the publication: e.g. AS$/ha, USD/yr or INR/ha/yr
Currency	Currency used in the publication
Year of value	Year of validation of value
Other	
Used for TEEB?	Indication of the selection for the TEEB overview of estimates of monetary values of ecosystem services (De Groot et al., 2010a)

(1) Ecosystem Service Value table

This main table of the database describes the variables of a single estimate of a monetary value for an ecosystem service. The economic variables in this table are among others: the monetary value, the original units of measure (for example Yuan/ha, USD/ha/yr), the value type (i.e. annual value, stock value, PV, NPV); the year of estimation, the original currency of the estimate, the validation year, the discount rate, the numbers of years of discounting and some remarks on calculation procedure. The table also includes variables to describe the non-economic information of the valuation study. It consists of different variables including information regarding the service area, location, biome, ecosystem sub-service and services.

***Biomes and Ecosystems*:**

The biome and ecosystem classification scheme that is used is described in TEEB D0-report Chapter 1 (De Groot et al. 2010b) which identifies 12 main biome types (see *Appendix 1: Classification of ecosystems used in TEEB*). Although the database includes a classification with more biomes, only ten are included in the TEEB overview of estimates (De Groot et al. 2010a). These biomes are: open ocean, coral reefs, coastal systems, coastal wetlands, inland wetlands, fresh water rivers and lakes, tropical forests, boreal and temperate forests, woodlands and grasslands. An additional eleventh biome is discussed as well: the high mountain / polar systems. For this biome no estimates were included in the database, but due its importance and size it is incorporated in the text. Due to time constraints no estimates were found for the three excluded biomes (desert, tundra, urban) which met the selection criteria and could be presented in the Appendix 3 of the TEEB D0-report (De Groot et al. 2010a).

In comparison with the biome classification of D0 Chapter 1 the final classification used for the TEEB Valuation Database (shown in Appendix 1 in table I.9) three biomes / ecosystems types are presented differently because of different ecological or economic arguments. For example, the coral reefs were not included in the coastal systems biome but treated as a separate biome because of both the ecological uniqueness and importance for conservation. In addition, mangroves and tidal marsh ecosystems were included as a separate category 'coastal wetlands' biome and not within the 'coastal systems' biome because of their many distinguishing services and their outstanding socio-economic importance. Finally, following most literature overviews the Forest biome was split in two biomes because of the large ecological and socio-economic differences: tropical forests and boreal/temperate forests.

***Ecosystem Services and Ecosystem Sub-Services*:**

In *t*he TEEB Valuation Database the ecosystem service classification categories is used as presented in TEEB D0 Chapter 1 (De Groot et al. 2010b), which describes 22 services divided in four main categories: provisioning, regulating, habitat and cultural services. In tables I.10 and I.11 in Appendix 1 overviews of the classifications of the Ecosystem Services and Ecosystem Sub-Services are shown.
In addition to these 22 main ecosystem services, the TEEB Valuation Database describes eight so-called *combined ecosystem services* to enter estimates on ecosystem services that are difficult to put explicitly under one of the 22 ecosystem services (e.g. studies that provide estimates on the total economic value (TEV) or for a bundle of provisioning services). Estimates belonging to one of these 8 categories were not selected for the overview of estimates of ecosystem service.

As shown in table I.11 in Appendix 1 the 30 Ecosystem Services are subdivided into 87 more specific services to provide more information on the nature of the service. These so-called subservices have not been not used for further data analysis or processing, because the limited number of estimates per subservice.

Valuation Methods:

This variable states the specific valuation method used to value a given ecosystem service. The TEEB database takes 12 main categories for valuation methods into account (see Appendix 1, table I.7 for an overview).

Value type:

At present the TEEB database includes 10 value types, i.e. annual value, stock value, PV, NPV (see Appendix 1, Table I.8). Related to the *value type* are the *discount rate* and the *number of years of discounting* which are needed to convert the Present Values into annual values.

(2) Case Study Location Table

This table contains information on the location of a case study and includes location information, biome type, protected status and the scale of research. This enables to check whether more estimates of this case study location are available from other publications. In addition these variables enable further socio-economic interpretation of the monetary values.

Location information:

This table includes information on study area such as the country name, location name and the latitude and longitude coordinates of the case study location (when available). The UN country classification was used to develop the list of countries and regions (UN 2008a). For linkages with other databases, GIS applications or models the coordinates (in WGS84 datum) of each location of the case studies are provided in the location description. In order to be able to relate an estimate of an ecosystem service to the socio-economic context of a case study location, two variables were included in the Country table, namely Gross National Income (GNI)/capita and population density. For categorizing countries on the bases of population density, the UN population density estimate of 2005 for each country is taken (UN 2008b). For countries without estimate, other sources such as Word Bank (2007) were used.

Protected status:

Many of the data points in the valuation database pertain to case studies in protected areas (PAs). Although values derived outside PAs might be useful for analysis within PAs, the end-user might choose to select only these PA data points. The classification of the protected status is divided in 4 categories: fully protected, partially protected, not protected and unknown.

Scale of research:

To indicate the scale of the research or the size of the study area, a classification was designed (Table 2). Although this scale is sensitive to subjectivity, differences between the categories are quite large and have proven useful for interpretation.

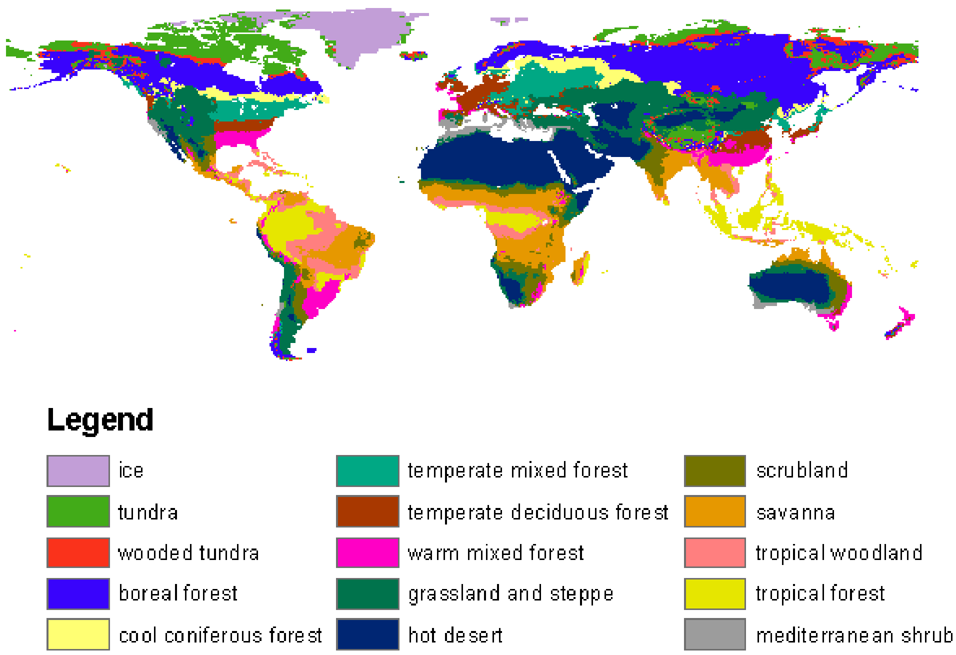
Table 2 - List of the scales of research used in the database

Plot	Very small study area, part of ecosystem.
Local	Case study at ecosystem level (a forest/coral reef/ wetland level)
Municipality / city	Study at the level of a municipality. Including several ecosystems.
Landscape / district / water basin	Study at landscape level Including several municipalities, multiple ecosystems
Province / Region	Study at the level of a province or region of a country.
Country	Study at country level.
Region	Study at the level of several neighbouring countries
Continent	Study at the level of a continent (or a large part of it)
Global	Study at the global level.

Biome type:

In addition to the classification of the real or 'on the ground' ecosystem type, for every estimate the more 'theoretical' biome type has been recorded as well. The commonly used definition of a biome is *"the world's major communities, classified according to the predominant vegetation and characterized by adaptations of organisms to that particular environment"* (Campbell 1996). Therefore biomes are climatically and geographically determined and are described by factors such as plant structures, leaf types, plant spacing (forest, woodland, savannah), and climate.

Figure 2 - Distribution map of the 15 biomes as used for the IMAGE Model.
Source: Leemans and Van den Born (1994)



Because the TEEB Valuation Database is meant to accommodate data exchange with spatially explicit databases and models, the IMAGE classification of biomes has been included (Alkemade et al. 2009). The distribution of biomes used within the IMAGE model differs substantially from the WWF classification (Olson et al. 2001, Spalding et al. 2007 and Lehner and Döll 2004). A map of the biome distribution and a complete list of IMAGE biomes are shown in figure 2.

(3) Publication Table

This table describes the publication details. The variables include basic bibliographic information like the first author name, the year of publication, the title, the type of document (e.g. reviewed article, working paper, report, theses). Every record in the table is stored with a unique ReferenceID. The reference table is linked to the ES Case table by a combined ReferenceID. The separate entry and description of publications enables a check for double entry of publication.

Table 3 - Overview of the Variables in the Publication Table

ReferenceID	Every publication is assigned a specific ID; this enables that multiple publications can refer to a single location and it is a way to check whether a reference has already been entered in the database (and therefore the values as well).
Reference	Family name of first author + year of Publication + extension (for multiple publications of this first author in one year) [i.e. Ploeg2009, Ploeg2009b]
Authors	Full names of the authors.
Title	Full title of the article / chapter / report (including journal name when article or book name when chapter)
FirstAuthor	Family name and initials of the first author. For example: Van der Ploeg, S.
YearOfPublication	Year of publication
PublicationTypeID	Type of publication: scientific article, book chapter, thesis, MSc thesis, working paper, note, table, box etc.
Reviewed	Is the publication scientifically reviewed? Yes/No
PublicationName	Name of journal/book in which the article/chapter has been published.
Volume	When published in a journal: Volume number of the journal.
Issue	When published in a journal: Issue number of the journal
Pages	The page numbers or number of pages of the article or chapter
PDF	Is a softcopy (PDF) of the publication available?
FileName	Filename of the softcopy, when available.

3. Methodology for data collection and analysis

One of the main purposes of the TEEB valuation database is the possibility to use the values for up-scaling and scenario-analysis at the global level. Therefore it is essential that the values are suitable for benefit transfer given the fact that there is still a very uneven distribution of available information across ESS, biomes and geographical regions. To fulfil these requirements, and to avoid double counting, the database presents data on economic values that are comparable and explicit with respect to the specified ecosystem services. This implies that a standardized unit for the economic value is used, which is the ecosystem service value in monetary units per hectare per year. This unit-standardization means that only those publications and data-sources were used that enabled selection, or re-calculation, of estimates from case studies for which the value is or can be presented on a per ha/year basis and for which the biome, ecosystem service and location are explicitly specified.

In total 1310 data-points (original ecosystem service values) from 290 locations and 267 references have now been included in the data base. Of these, 582 were used for the analysis presented in the TEEB D0 Appendix 3 (De Groot et al. 2010a).

There are two reasons why not all values in the data base have been selected for the analysis. First: those not selected did not meet the criteria (see section 3.2). Second: the not-selected values had not been double-checked at the time of publication of the D0 report

3.1 Data gathering

For the collection of data on economic valuation studies three approaches were adopted: 1) literature search, 2) "mining" existing data sets, and 3) analysing recommended publications by valuation experts for every biome

1) Literature search

Methods for literature retrieval included searching existing databases, bibliographies, biome-specific meta-analyses and electronic journal databases[3]. The literature review of the TEEB report 'Review on the economics of biodiversity loss' (Balmford et al. 2008) was used as an important starting point. In this study electronic journal databases were searched with a combination of keywords: "Biodiversity + Economic Loss", "Biodiversity + Economic Cost" and "Biodiversity + Economic Valuation". Subsequently the articles including all the terms in the text and published between 2005 and 2008 have been selected. A total of 132 publications were gathered, covering a wide variety of biodiversity issues, including management,

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[3] The literature review of ecosystem service valuation research and other ecosystem service databases thus far included: COPI (Ten Brink et al. 2009), EVRI (1997), ENVAlue (2004), EcoValue (Wilson et al. 2004), Consvalmap (Conservation International 2006), CaseBase (FSD 2007) ValueBaseSwe (Sundberg and Söderqvist 2004) and ESD-ARIES (UVM 2008), FEEM (Ojea et al. 2009) and additional relevant studies on valuation and meta-analyses (o.a. Costanza et al. 1997, Braat and Brink 2008, Brander et al. 2006, De Groot et al. 2002, Hein and De Groot 2007, and Ansink et al. 2008)

ecology and ecosystem / landscape valuation theory. Of these, thirteen new articles contained valuations of ecosystem services with enough detail (and complying with our criteria (see 3.2), of which 5 articles had already been entered in the database

2) Mining" existing data sets

The main sources of case studies, review articles and valuation reports were three existing datasets, namely the Cost of Policy Inaction (COPI) database (Brink et al. 2009), the primary data of the article Costanza et al. (1997) and CaseBase (FSD 2007).
The original publications of case studies in the COPI-database were re-examined and only those studies were selected which met the data entry criteria. This was done to assess the estimates from the original publication (units, service area, location etc), to ensure data suitability for the meta-analysis and to add additional information to the improved TEEB database. Similarly the original case studies from Costanza et al. (1997) were retrieved, screened and included when they met the selection criteria. In addition, the original calculations made for some ecosystem services by Costanza et al. (1997) as published in the primary data notes were included as well when these provided enough detail. Thus, none of the benefit transfer values from the Costanza-article were used in the TEEB database when these were not based on original calculations in the article. The majority of the original case studies from both data sets (COPI and Costanza) have been used. Yet some of the original publications found could not be used because these were either not available in printed or digital format or did not provide enough detail for the analysis. In addition, the CaseBase (FSD 2007)[4] was searched for economic valuation studies from peer reviewed publications as well as grey literature (official reports / working papers from research institutes, universities, WRI, World Bank, IUCN, WWF etc). A considerable number of ecosystem valuation studies have been identified in Casebase, of which 53 studies have been used.

3) Expert panel

The third source of valuation data and case studies was a panel of experienced valuation scientists. For every biome, several valuation experts were approached to suggest relevant case studies and publications and to review the corresponding biome paragraph. The lead and contributing authors suggested a large number of publications and values, which have been screened and discussed amongst the authors of the biome paragraphs (see Appendix 2 and 3 for the results).

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[4] CaseBase is a case study database which has been developed by the Nature Valuation and Financing network (www.naturevaluation.org) to encourage the sharing of results, best practices and lessons learned on ecosystem services valuation, financing and management. Unfortunately, the web-version is currently not accessible due to technical problems but the newly founded Ecosystem Services partnership (www.es-partnership.org) is aiming to restore the database and make it web-accessible again

Finally it should be noted that not all available publications could be entered into the TEEB database and that most likely some important studies are not included yet due to time limitations and other constraints. If you are aware of missing key-publications contact the corresponding author or go to www.es-partnership.org to see the latest version of the database.

3.2 Criteria for data selection

For the selection of publications and value-estimates for the TEEB Valuation Database the following criteria were used: studies should:

1) Refer to original case studies and global estimates.
2) Provide a monetary value of a given ecosystem service or ecosystem sub-service which can be attached to a specific biome/ ecosystem and a specific time period.
3) Provide information on the surface area to which the ecosystem service value applies in order to make it possible to convert the monetary value to US$/ha/yr.
4) Provide information about the ecosystem service valuation methodology used.
5) Provide the location of the case study, the service area and the scale of research (local, country, region, continent and global).
6) Be peer reviewed literature, official reports , working papers or theses coming from reliable sources such as World Bank, WWF, IUCN, WRI, universities and other research institutes.

The estimates that were represented in other formats than annual values per hectare (/ha/yr) (criterion 3) were also entered in the database for sake of completeness and later study, but these have not been selected for the analysis in the TEEB study. In addition – concerning criterion 1 - not only estimates from local case studies have been entered in the database but also publications presenting original global values were included which can be used for global studies.

Following these criteria several types of valuation studies could not be included in this study. The main reasons for these are that the interpretation of these values has a theoretical or methodological constraint or that the conversion of these values to the value/ha/yr unit was not possible without subjective interpretation of the data by making assumptions on missing information.
(a) The first type of valuation studies that were not used are those which focus on the stated willingness to pay (WTP) for the conservation of a threatened or indigenous species. In general in this type of publications the service area for which the (conservation) value is revealed is unknown or a clear description of a specific ecosystem is missing.
(b) Most of the studies which investigated a stated WTP could not be included, because these only provided an estimate per household and many of these could not

be converted into /ha/year values. Estimates were only included when the authors had converted them in /ha/year values in the same publication or when they could be converted with the provided information on the ecosystem area and the relevant population size.

(c) Most of the estimates of benefit transfer studies and literature reviews were excluded when these studies did not provide new calculations for the ecosystem services. In this type of studies the estimate are based on one or more actual case studies and therefore these studies would in fact be double counting some of the original case study-values in the database. These benefit transfer study publications were, however, used as source for other, original case studies.

3.3 Double checking of publications and values

To avoid duplication of case studies, and thus estimates, the studies from the three datasets were cross-checked. In addition, before entering data from a new publication into the database the new publication was automatically compared with both the list of references and the list of locations of the case studies in the database.

Another quality check was done by asking the Lead and Contributing Authors of Appendix 3 of the TEEB D0 report (De Groot et al. 2010a) to not only provide new data but also check the data that was previously collected. Through this review process several values were eliminated from the database, but also new values were added or existing ones adjusted. Available estimates were used when they were regarded as representative for the ecosystem service and methodologically sound. It should be noted that some of the new values which were added to the database on suggestion of the Lead and Contributing Authors and which were used for calculations have not been double checked. The authority of the Lead Authors has been used as leading principle. In Appendix II these values are shown *in italics* and in the database they are clearly marked as well. In addition the units of these values are not those as presented in the original publication but in the standardized unit (Int.$/ha/yr (2007-value))

3.4 Value standardization

After the selection of estimates for the TEEB analysis they were standardized. Ecosystem service values have been reported in the literature in many different metrics, currencies and referring to different years (e.g., WTP per household per year, capitalized values, marginal value per acre, etc). In order to enable comparison between these values they were standardized to 2007 International dollars[5] per hectare per year using a general standardization technique (Braat and Ten Brink

[5] The international dollar, or the Geary-Khamis dollar, is a hypothetical unit of currency that is used to standardize monetary values across countries by correcting to the same purchasing power that the U.S. dollar had in the United States at a given point in time. Figures expressed in international dollars cannot be converted to another country's currency using current market exchange rates; instead they must be converted using the country's PPP (purchasing power parity) exchange rate. 1 Int.$ = 1 USD

2008, Ghermandi et al. 2007, Brander et al. 2007, Brink et al. 2009, Elsasser et al. 2009, Woodward and Wui 2001).

A general problem in standardizing ecosystem service estimates is the distinction between average and marginal values, both of which can be expressed as a monetary value per hectare. The majority of the valuation studies have estimated average ecosystem service values but there are also a number of estimates of marginal ecosystem service values. Small changes in ecosystems should be valued using marginal changes whereas average values may be useful for comparing the aggregate value of an ecosystem area relative to the size of the area.

Second, by expressing ecosystem service values in a per hectare unit the impression is given that each hectare in an ecosystem is equally productive, or in other words that ecosystems exhibit constant benefits for a specific ecosystem service, which for most services is not the case. Due to this difference no marginal values were included in the TEEB analysis if it was not possible to convert marginal values to average values on the basis of the original publication.

The following procedure was used to standardize the estimates into 2007 USD values. All estimates were converted into the official local currency when needed, then these values were adjusted to 2007 values and finally they were converted to international dollars using the purchase power parity (PPP) conversion factor ('local currency per international $' series). The official exchange rates, GDP deflators and PPP conversion factors from the World Bank World Development Indicators 2009 were used to standardize values estimated in different years and different currencies[6].

For the first step of the standardization the values were converted into the local currencies of the respective country using the official historic annual exchange rate of the reference year[7]. This was done, because in many studies the values were expressed in US Dollar or Euro instead of the local currency and can therefore not be corrected for PPP in a standardized manner[8]. For case studies that covered more than one country (non-national), a continent or the world the US dollar was used as default currency (also using the PPP corrections for the US Dollar).

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[6] The World Bank Development Indicators series 2009 used for GDP deflators and purchasing power parity converters are respectively ´GDP deflator (base year varies by country)´ and ´PPP conversion factor, private consumption (LCU per international $)´. For the conversion to local currencies the series ´Official exchange rate (LCU per USD, period average)´ was used. When rates / conversion factors for a country or year were not available in the series another official source was used to (the Penn World Table, the US Federal Reserve Bank or other National Banks) or values were based on linear regression of the available values.

[7] Many of the case studies only provide estimates in USD or Euro. For overseas territories or dependent states the currency of the corresponding independent state was used in the cases that no local currency was used.

[8] It should be noted that some countries have changed currency or have adjusted the official exchange rate (for example when pegged to another currency). All used currencies have been checked on and adjustments have been made to correctly convert the local currency into

In the second step, the values were adjusted to 2007 values using the GDP deflators of per country[4]. For overseas territories or dependent states the GDP deflator of the corresponding independent country was used in the cases that no deflator was available. Most valuation studies provided explicit information on reference year of the economic value. However, in cases where the reference year of the estimate was not explicitly stated, the year of data collection was used when mentioned. If not, the year of publication of the study has been taken as a reference year. For the conversion of the 'non-national' estimates of these case studies the GDP deflators were used for the respective continent using the WB data to calculate the deflator for 2007 values. Finally, the 2007 values were converted to international dollars using the PPP conversion factor of 2007 (local currency per international $)[6].

Box 2 - Guidance for use of the data and link with TEEB reports D1-D4

Background

The rationale for developing the database of value estimates was to provide an input to policy appraisal. Specifically, the database was set up so as to provide where possible not only a range of *total* values for a biome on a per hectare basis but also, where data are available, values *disaggregated on the basis of ecosystem services* [ESSs]. This set-up was applied so as to facilitate the application of the Ecosystem Approach. A further benefit of this disaggregation is that it allows policy-makers to determine which of the ESSs are pertinent to their particular policy perspective.

We pre-suppose that the objective of the policy-maker using this database is to find a monetary value for the benefits of conserving a particular habitat. However the decision as to whether to choose conservation versus the extractive alternative depends on a number of factors, some of which are linked to the nature of individual ESSs. The database-user may thus decide to *filter* the values outputted.

The TEEB Valuation Database can be found on the website of the Ecosystem Service Partnership (URL: www.fsd.nl/esp/77979/5/0/30). At this moment a simple version of the database is available in excel for users to select relevant values and case studies. All variables can be used to filter the values but because the present version of the database is not suitable for an online and interactive filter, not all features described below are available at this moment. It is planned to develop a new version of the database in 2011 which enables an interactive selection procedure on the website of the Ecosystem Service Partnership (www.es-partnership.org).

Filtering for appropriate data points

Some of the filters that might be considered are set out below and the database-interface has been set up to facilitate filtering. Once a biome is selected, the total number of available data points/value estimates will be presented. This is important in that filtering only really works if there are sufficient data points for the biome in question. At each stage below the number of studies pertaining to each choice are presented to the user.

Locally-derived ESSs versus globally derived ESSs

After the user has determined the biome to be considered, a choice presented is between (i) ESSs for which benefits are in the main locally-derived benefits, (ii) ESSs that are in the main globally-derived and finally (iii) ESSs that are local and global in nature, i.e. all ESSs. Links are provided to provide definitions and explanations for the different ESSs to allow the user to select./de-select options.

The reason for allowing this first stage of filtering is that policy-makers might want to focus on ESSs that benefit local people *and local people alone*. This does not imply that these policy-makers do not care about global benefits, only that they might look to global donor agencies to fund the positive global externality.

Tourism

There is enormous variability in the value estimates per hectare and one of the reasons for this is that some sites are valued based in part on tourism revenues. Thus the choice presented pertains to whether values that either (i) include leisure and tourism as an ESS or (ii) exclude it are a better match for the choice the policy-maker is seeking valuation estimates for. It would be appropriate to pick (i) if there is the *potential* for tourism activity.

Protected Area designation

Many of the data points in the valuation database pertain to protected areas (PAs). Although values derived outside PAs might be useful for analysis within PAs, the filtering allows the user to select only these PA data points. Again, it would be appropriate to pick PA if a policy-maker is considering the establishment of a PA.

High income/low income

There is evidence from meta-analyses carried out in the environmental economics literature that studies carried out in higher income countries realise a higher value estimate on average. Thus a broad high-income/low-income choice is offered.

The user can define which of these filters (if any) to apply. The output at the end of this process is presented in one of two ways: (i) a global map showing the location of the study sites which provide values, given the choices made; (ii) a value range. The value range is likely to be more reliable but the end-user may decide to choose one or two individual values from specific geographical regions.

Appropriate use of the findings

The database of environmental values for biomes and ESSs within these biomes is one of the most extensive databases of its kind. All values within the database have been screened with respect to the methodological integrity applied in the primary literature sources. Notwithstanding this, caution must be applied in using the values revealed in searches owing to the inherent limitations of benefits transfer (see Chapter 5). The results are intended to provide an *indicative* value, not *the* value. Even a primary valuation study cannot offer a precise value for a non-traded ESS, and benefits transfer adds an additional layer of abstraction.

Where the outputs may be particularly useful in the policy debate is in considering the relative value of different ESSs. So even if (say) we do not have a reliable, precise value for 'water purification' we can assess broadly how valuable it is as an ESS relative to others.

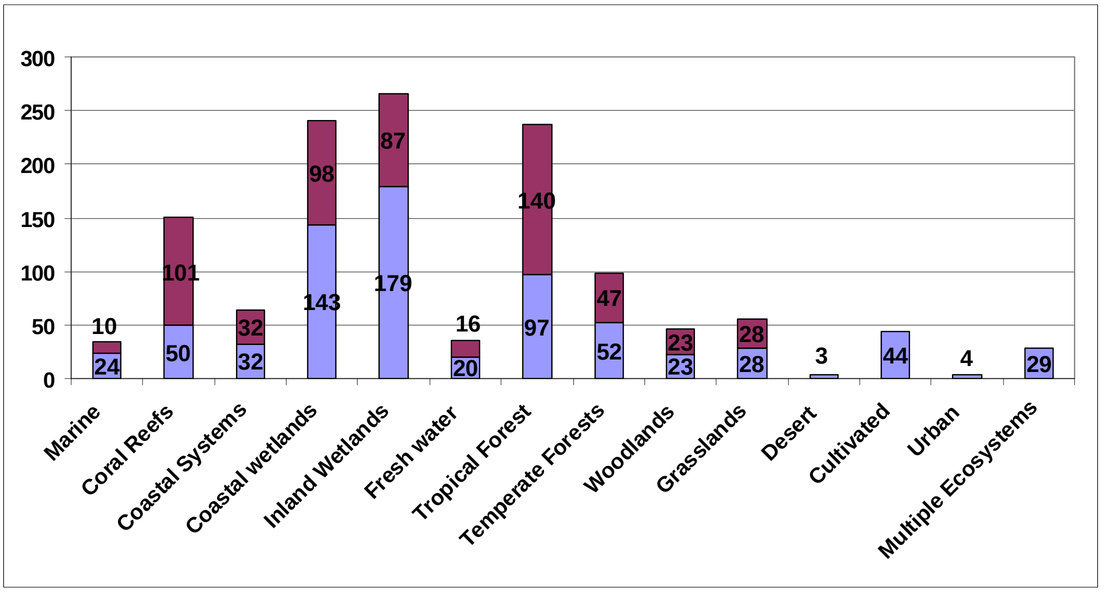
4. Overview of data and results

4.1 Introduction and some descriptive statistics

The TEEB database contains 1310 values from 267 publications. Figure 3 shows the total number of monetary values per biome and figure 4 gives an overview of the geographic distribution of the valuation data used[9]. Figure 5 gives an overview of the number of values used for the 30 services categories (See paragraph 2.1).

The values presented in this report differ slightly from those used for the analysis in TEEB D0 appendix 3 (De Groot et al., 2010a). This is the result of a thorough additional review of all values after which some errors have been corrected and a few values have been de-selected. No major changes needed to be made and the resulting values are in the same order of magnitude.

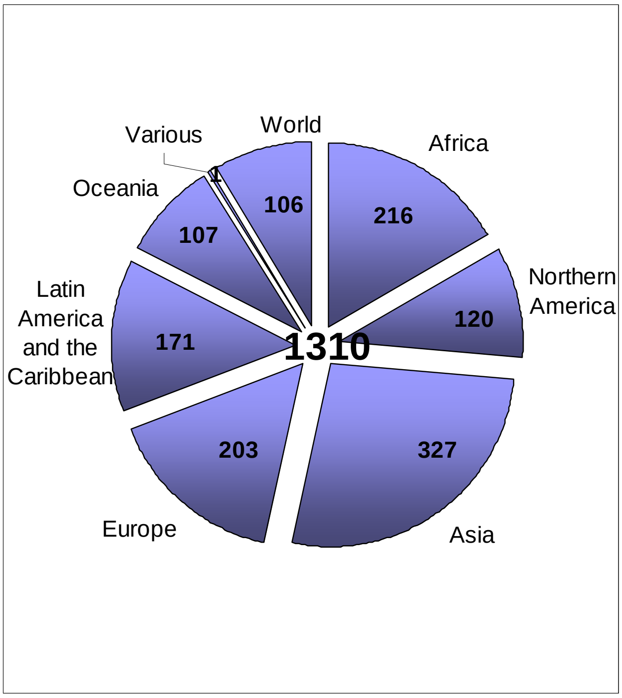
Figure 3 - Total number of monetary values used per biome.



In red: the number of estimates used for the TEEB overview (De Groot et al. 2010). In total 582 values were selected; In blue: the additional number of estimates in the TEEB Valuation Database.

[9] Ideally, the actual locations of the values and case studies found could be integrated into a web-based mapping-tool to enable users to correlate values found to the environmental and socio-economic context. An example of such a tool is ConsValMap (www.consvalmap.org) developed by Conservation International.

Figure 4 - Overview of the geographic distribution of the 1310 estimates.

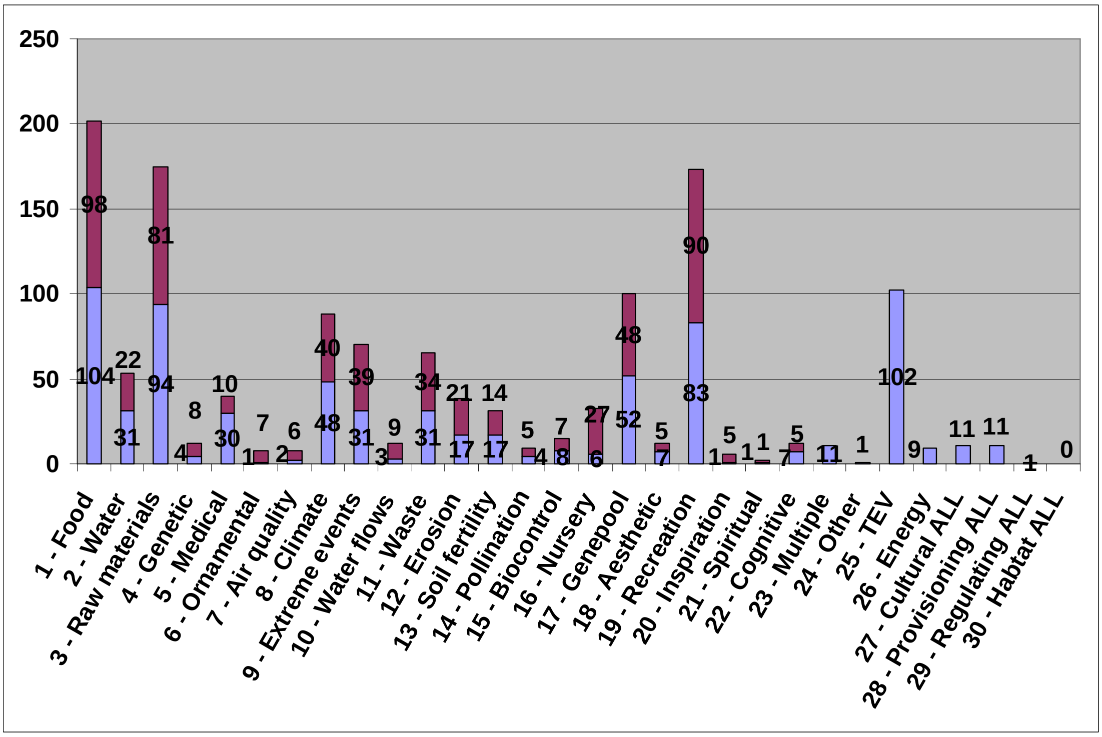


Various = estimate for more than one continent, but not global. The Arabian Peninsula is part of Asia.

It is important to keep in mind that value estimates are based on individual case studies and in some cases this leads to big value ranges. For example, the most economically important service of coral reefs is tourism which, based on 35 studies, represents an average monetary value of almost 68.500 $/ha/y. The value range however is very big: from a little more than 0 USD (for small, remote reefs) to more than 1 million US$/ha/y for heavily visited reefs with many uses. This illustrates that the use of average values in benefit transfer between locations or extrapolation to the global scale must be done with great care. However, due to increasing scarcity of pristine and undamaged reefs and a still growing human population (and thus demand) even less accessible or attractive reefs may become economically interesting in the future. Average values from meta-analysis studies should therefore be seen as *potential sustainable use* values – the realisation of these values is, as has been mentioned on several occasions, very time and context dependent and should ideally be calculated through empirical research for each individual case.

It should also be realised that studies that satisfy the criteria for the data base selection as described in chapter 3 are not always available for developing countries or are published in other languages (therefore not easily accessible). This bias might have consequences for the final estimates resulting from the meta-analysis. In addition, the magnitude of the value will also vary depending on the type of study (main goal, type of publication and valuation method).

Figure 5 - Number of monetary values used for the 22 services[10] and 8 additional service groups



In red: the number of estimates used for the TEEB overview (De Groot et al. 2010a); In blue: the additional number of estimates in the TEEB Valuation Database.

Another issue to be aware of is that values should be based on sustainable use levels which we tried to verify but that was not always possible (see also Chapter 5 for other discussion points).

[10] In the table the shorted names of the Services are used. The full names are: 1 - Food provisioning; 2 - Water provisioning; 3 - Raw materials; 4 - Genetic resources; 5 - Medicinal resources; 6 - Ornamental resources; 7 - Influence on air quality; 8 - Climate regulation; 9 - Moderation of extreme events; 10 - Regulation of water flows; 11 - Waste treatment / water purification; 12 - Erosion prevention; 13 - Maintenance of soil fertility and nutrient cycling; 14 – Pollination; 15 - Biological control; 16 - Lifecycle maintenance (esp. - nursery service); 17 - Maintenance of genetic diversity (gene pool protection); 18 - Aesthetic information; 19 - Opportunities for recreation and tourism; 20 - Inspiration for culture, art and design; 21 - Spiritual experience; 22 - Information for cognitive development (science and education);

4.2 Results

Taking due note of all the limitations of aggregation and extrapolation of ES values (described in Chapter 5), this section gives a summary of the ecosystem service values found for 10 biomes, which have been corrected as much a possible following the considerations (chapter 5). More detailed information on the values and their sources are shown in Appendix 2 and 3.

Table 4 – Total benefits per biome

	No. of estimates	Total of Service Means (TEV) (Int.$/ha/y)	Total of St. Dev. of means (Int.$/ha/y)	Total of Median Values (Int.$/ha/y)	Total of Minimum Values (Int.$/ha/y)	Total of Maximum Values (Int.$/ha/y)	No. of Single estimates	Total of Single estimates (Int.$/ha/y)
Open oceans	6	49	50	49	13	84	4	9
Coral reefs	96	105.126	280.205	18.327	2.214	1.195.592	*5*	*206.881*
Coastal systems	27	27.948	34.629	27.845	2.143	79.580	*5*	*77.798*
Coastal wetlands	96	47.542	50.605	11.276	1.995	213.752	*2*	*960*
Inland wetlands	81	15.752	15.925	9.860	981	44.977	*6*	*282*
Lakes	12	7.433	7.420	7.290	1.779	13.488	*4*	*812*
Tropical Forest	139	5.088	8.303	1.912	91	23.222	*1*	*29*
Temparate Forest	40	1.261	2.123	200	30	4.863	*7*	*1.281*
Woodlands	17	792	958	573	16	1.950	*6*	*5.066*
Grasslands	25	1.244	1.255	874	297	3.091	*3*	*752*

Table 4 summarizes the main results per biome and the totals are shown. These totals values have been calculated by averaging all selected values (see chapter 3 on methodology) per ecosystem service. Subsequently these ecosystem service values were added up. The main total is the TEV, which is the biome total of the mean ecosystem service values. In addition the number of used estimates per ecosystem service has been summed up, as well as the median, minimum and the maximum values.

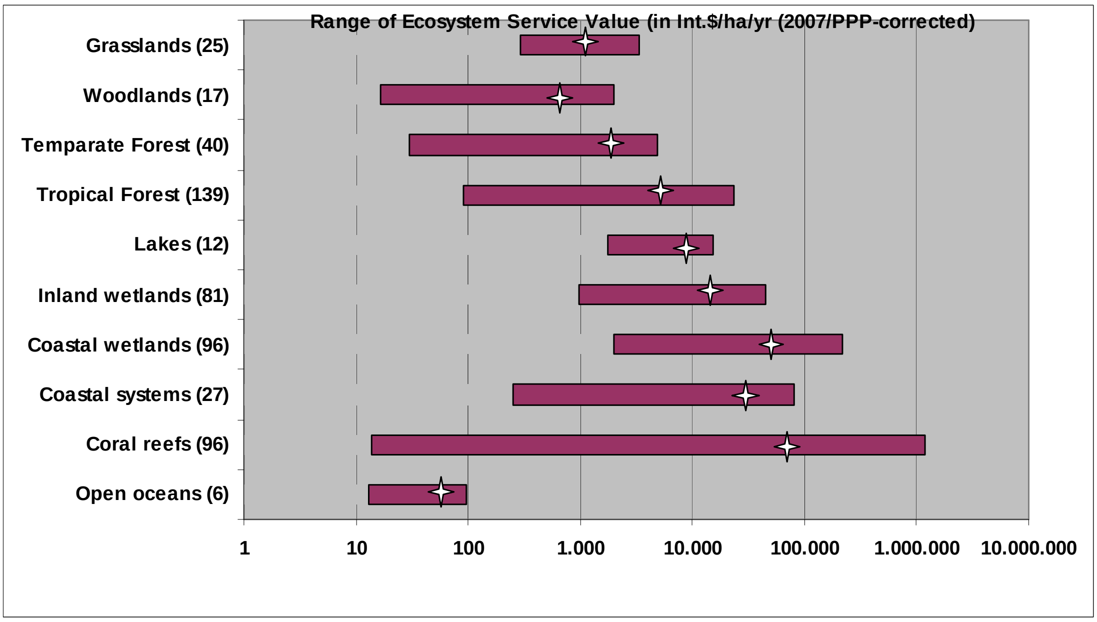
Please note that for all used estimates the units have been standardized into Int.$/ha/yr (2007 value). The methods of standardization are specified in paragraph 3.4. More details of all original values in the database are shown in Appendix II. In these tables it is also indicated whether the value has been used for the analysis.
For more ecosystem service values per biome please see the Biome Summary tables in Appendix 3.

In total 582 monetary values were selected for the data analysis for the 10 biomes. Of these, 539 estimates were used for the calculations of the total values. The remaining 43 estimates were the so-called single estimates. This indicates that for a given service only one value-point was found. These ecosystem services with single estimates were not included in calculations of the totals per biome, but are shown separately. In principle these estimates indicate revealed monetary values of one or more services of a given biome, but it was deemed that a single value for one service is too little evidence to be included in calculations of the totals. Thus, the mean (and median) values are a conservative estimate of the full economic value of the involved biomes.

To represent the ecosystem service values for every ecosystem type, the mean, median, minimum and maximum values were identified for each ESS-biome combination. This allows for assessment of representativeness and hence transferability for each ESS-biome combination. As shown in meta-analyses and theoretical publications, the mean and median ecosystem service values vary considerably by continent and valuation method used (Brander et al (2006)).

Figure 6 graphically shows the range of the potential total economic value (TEV) on a log-scale.

Figure 6 – Range and average of ecosystem service value per biome (in Int. $/ha/yr (2007/PPP-corrected))



NB: a log scale has been used. For exact values see Table 6. The average TEVs are shown as a star.

We have tried to calculate and present the values and averages as transparent as possible in order to allow for a clear discussion and encourage constructive criticism and suggestions for further improvements.

5. Discussion

During the development of the TEEB Valuation Database many methodological challenges had to be solved. In this section an overview is provided of the main issues to keep in mind when making or interpreting an ecosystem service assessment or a meta-analysis.

5.1 Limitations in data availability and reliability

The number of Ecosystem Services (ES) and ES estimates per biome varies significantly (see figure 3 and De Groot et al. 2010a), both due to data limitation (e.g. in theory for most biomes a maximum of 22 services contribute to its total economic value but on average data was found for only about 12 services per biome) and due to data reliability. Ecosystem services for which only one value was found are not included in the calculation of the total value which reduced the number of services taken into account in the calculation to on average 8,5 (out of a maximum of 22) or about 40%.

5.2 Unbalanced distribution of data on services and values over biomes

As Figure 3 shows, the number of ecosystem service estimates found per biome differs greatly: 266 for inland wetlands and 34 for marine ecosystems (and even only 4 for desert ecosystems). There are several reasons for this: a) there is hardly any data available in literature (for example very few studies seem to have been done on the ecosystem services and values of the marine, tundra and desert biomes); b) due to time constraints not all available literature could be screened and analysed and c) a number of values we did find could not be included on the basis of the TEEB selection criteria (see paragraph 3.2).

Future work on the development of the Valuation Database will be focused on finding values for those services and biomes which are now least well represented in the database.

5.3 Value range

Another important issue is the considerable range of values found. For example, the range for tourism and recreation values for coral reefs is exemplary which varies from less than one dollar to more than one million per hectare per year (Ruitenbeek and Cartier 1999, Hargreaves-Allen 2004). This shows the wide range of actual (and potential) uses of coral reefs at different locations (and countries).

For large scale assessments, like TEEB, big ranges of original values are part of the game. There are several causes for this. First, case studies of valuation studies come from a wide variation of locations and countries. Second, a wide variety of valuation methods has been used to obtain monetary values of ecosystem services. Third, the different case studies that we selected for the combination of an ecosystem service and biome describe a variety of sub-biomes (ecosystems) and sub-services. Fourth, the monetary values of services which the selected case studies provide are carefully selected to suit their specific location and time and are in general part of a total value analysis. Therefore it is sometimes difficult to interpret these service values without taking into account the benefits of the other services. Fifth, aggregation of data implies that the nuance of the original case studies is blurred

5.4 Choice of valuation method and preferred methods

Table 5 gives an overview of the monetary valuation methods used for each ecosystem service. As show in the table, for most services several monetary valuation methods were used to asses the economic importance. For the TEEB analysis (De Groot et al., 2010a) only original values were used.

Table 5 –The number of estimates per valuation method and ecosystem service

Number of estimates	Total	AC	BT	CM/CV	DMP	FI / PF	GV	HP	MC / RC	PES	RC	TC	TEV	O / U
TOTAL:	**1.310**	**72**	**457**	**98**	**414**	**64**	**21**	**6**	**12**	**9**	**71**	**19**	**63**	**4**
PROVISIONING SERVICES	**501**	**8**	**133**	**7**	**287**	**36**	**14**	**1**	**1**	**0**	**13**	**0**	**1**	**0**
1 Food	202		43	2	137	7	8	1			4			
2 Water	53	7	18		9	7	3		1		8			
3 Raw materials	175	1	53	2	113	2	3				1			
4 Genetic	12		7		5									
5 Medical	40		9	2	10	18							1	
6 Ornamental	8				7	1								
28 Provisioning values [general]	11		3	1	6	1								
REGULATING SERVICES	**337**	**62**	**152**	**8**	**40**	**8**	**0**	**0**	**9**	**3**	**53**	**0**	**1**	**1**
7 Air quality	8	2	5		1									
8 Climate	88	11	46	2	18	1			5		5			
9 Extreme events	70	28	20	4	3	1			1		13			
10 Water flows	12	1	6		1	2				1	1			
11 Waste	65	8	30	1	3	1			1	2	19			
12 Erosion	38	11	11	1	5	1			2		5		1	0 / 1
13 Soil fertility	31	1	18		3	1					8			
14 Pollination	9		5		3	1								
15 BioControl	15		10		3						2			
29 Regulating [general]	1		1											
HABITAT SERVICES	**133**	**1**	**49**	**37**	**19**	**11**	**5**	**0**	**2**	**5**	**2**	**0**	**0**	**2**
16 Life cycles	33	1	2	1 / 1	16	10					2			
17 Genetic Diversity	100		47	35	3	1	5		2	5				2 / 0
30 Habitat [general]	0													
CULTURAL SERVICES	**216**	**0**	**85**	**40**	**56**	**8**	**1**	**5**	**0**	**1**	**0**	**19**	**0**	**1**
18 Aesthetic	12		2	4	2			4						
19 Recreation	173		67	32	46	8	1	1				18		
20 Inspiration	6		4	1	1									
21 Spiritual	2			2										
22 Cognitive	12		3		6					1		1		1 / 0
27 Cultural values [general]	11		9	1	1									
ADDITIONAL AND GENERAL SERVICES	**123**	**1**	**38**	**6**	**12**	**1**	**1**	**0**	**0**	**0**	**3**	**0**	**61**	**0**
23 **Multiple services**	11	1	2	5	2								1	
24 **Other**	1						1							
25 **TEV**	102		35	1	6								60	
26 **Energy (not in TEEB classification)**	9		1		4	1					3			

The acronyms for the valuation methods are: AC - Avoided Cost; BT - Benefit transfer; CM / CV – Choice modelling and Contingent Valuation; DMP - Direct market pricing; FI /PF: Factor Income / Production Function; GV - Group Valuation; HP - Hedonic Pricing; MC / RC - Mitigation and restoration Cost; PES – Payment for Ecosystem services (not a valuation method, but separated from DMP) ; RC – Replacement Cost; TC - Travel Cost; TEV – Total Economic Value; O / U: Other methods and Unknown method (shown to include all values)

A general finding of this analysis is that provisioning services are mainly valued through direct market pricing methods. For regulating services mainly three methods were used: avoided cost, direct market pricing and replacement cost. The Habitat service was mainly valued through direct market pricing and factor income, and cultural services mainly through direct market pricing and travel cost. De Groot et al. 2002 discuss the results of a similar analysis of the methods used in the Costanza study (Costanza et al. 1997). Which method is best to use for which service depends very much on the purpose of the valuation and socio-economic and environmental context.

5.5 Difference in socio-economic context

Monetary estimates for ecosystem services are mostly based on local studies, and have their practical meaning in cost-benefit analysis and decision making at the local level. At the local level, the economic (monetary) value of a service (e.g. collecting fuel wood) will be very different depending on the livelihood circumstances, income levels and other socio-economic conditions such as population density. This can partly be corrected though Purchasing Power Parity (PPP) conversions, as done for the analysis of Chapter 5 Appendix C (De Groot et al. 2010a), but this cannot capture all differences in social and economic circumstances.

When interpreting monetary values of ecosystem services it is important to realise that the socio-economic context has a big influence on the value placed on a given ecosystem service: many (financially) poor people depend directly on ecosystems services (such as provision of food or clean water) for their livelihood but will not place much monetary value on that service, because they can not afford to pay for it or because there is no market for the good or service and therefore has no monetary value.

Similarly, population density will influence the value placed on ecosystem services; generally speaking, the demand for ecosystem services (like food, water, clean air, opportunities for recreation) will be higher in areas with a high population density than in areas where few people live. Consequently, one would expect monetary values to be higher in countries with high population density. On the other hand many countries, or regions, with high population densities usually a large proportion of the population will have low income, thus lowering the “willingness (or better: ability) to pay” for a given ecosystem services.

Thus finding clear correlations between combinations of socio-economic indicators and estimates of ecosystem service values will not be easy. The TEEB Valuation Database was screened for these factors but there are still too few data-points per service to make a statistically meaningful analysis and even with sufficient data it is questionable if general conclusions can be drawn at the global level.

5.6 Local versus global beneficiaries

An important aspect to consider is the distribution of values among local and foreign (or even global) beneficiaries. The potential to support tourism and recreational activities, for instance, does not necessarily entail that the values or the derived revenues are equitably attributed to the local community. On the other hand, the benefits from moderation of extreme events and nutrient cycling generally directly accrue to the welfare of local communities.

Indeed the valuation studies themselves may differ by either concentrating entirely on local community values or by incorporating local values together with international ones. The assessment of the values of ecosystems and of the tradeoffs entailed in policy actions should take into account that in many areas the welfare of the local population is vulnerable to changes in the provision of ecosystem services.

5.7 Potential values

The recognition of the extent and distribution of the potential values can help in guiding the management of ecosystems and ultimately will improve social welfare. It should be realized that the values found are for those areas that are in actual use for that particular service. In local trade-off analysis and decision-making situations it can be argued that the total value of the bundle of, actual *and* potential, services involved in the decision (e.g. converting a coastal system into cultivated or urban land) represents the opportunity cost of the conversion and provides important information to come to better, more sustainable decisions.

5.8 Interactions between service-use and influence of management

It is important to understand that ecosystem services can not always coexist under particular management regimes. These are the so-called competing or non-competing uses or services. For example, forests managed for eco-tourism may not be usable for timber extraction; forests conserved for the supply of genetic information from the canopy can similarly not be converted to other uses, and so on. However, this information was of course not always possible to retrieve in which case we used conservative estimates and in principle the TEV found should reflect the value of the total bundle of services that can be provided simultaneously by a given ecosystem.

Yet, it is important to underline the conclusion of the Secretariat of the Convention on Biological Diversity report 'Values of forest ecosystems' (SCBD 2001), in which it is stated that: "*It is very important not to construe [TEV] tables as being representative of all forest areas. At best the numbers indicate the kinds of value that could materialise if markets were created. In turn, market creation assumes that certain features of the forest are present: thus tourism values are not relevant for remote and inaccessible forests, although carbon values would be. Nor can values be added simplistically since some uses are competitive*". Of course this conclusion applies to all other biomes as well.

5.9 Other factors

The monetary value of some services may not be recognized yet (e.g. carbon sequestration only became economically valued during the past decade) thus leading to undervaluation of the economic importance. On the other hand, scarcity combined with a high demand may lead to overvaluation, and thus overexploitation of the service (e.g. ivory or rare ornamental species). When interpreting the value of ecosystem services in a meta-analysis, these distortions should be taken into account by acknowledging the potential use of currently undervalued services, and the overvaluation of services that are used in a non-sustainable way. Ideally, the Total Economic Value should be based on information on potential sustainable use levels.

It is also important to realise that people's perceptions and preferences, and thus values, change over time, as well as dependencies on services (e.g. harvesting wild food items like mushrooms and berries in most European countries is now a recreational activity, and not for subsistence needs anymore).

There is also a relationship between monetary values and the extension of the area: e.g. Oteros-Rozas (pers. comm., 2010) found that services in small forests are significantly higher valued than the same services in bigger forests.

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Appendix I Detailed overview of variables and used classifications in the TEEB Database and Analysis

Table of Contents:

Table I.1 - List of the Variables in the Value Table

General information	
ValueID	Automatically generated ID number of the Value. A Value is one valuation of a single ecosystem service of a single ecosystem with one valuation method.
Location	Every Location is assigned a specific ID; this enables that multiple publications can refer to a single location and it is a way to check whether a location has already been entered in the database (and therefore the values as well). See Locations worksheet for more information on the content provided in the Locations Table
Country	Name of Country/region/continent/World. A lookup is used to the reference list of countries to prevent spelling mistakes.
Reference	Reference details of the cited publication. This enables to check whether a publication has already been entered in the database. See the Reference Table for more information on the content provided in the database on References
Purpose or aim of valuation	Short description the aim of the valuation as described by the author(s) [CBA, valuation for planning, scientific research on methods etc.]

Service and Ecosystem information	
ESServiceID	Main Ecosystem Service classification. Services are subdivided in SubServices. See appendix 1, table **ES Service**
ESSubServiceID	Second level classification of Ecosystem Services. See table see appendix 1, **ES SubService**
ESServiceUse	Description of the actual purpose of use of the ES Service or Good (i.e. subsistence food, local house construction, commercial timber, ply wood)
OtherESS	When you choose Other ESS you can specify the service here.
BiomeID	Main Biome/Ecosystem classification. Biomes are subdivided in Ecosystems. See appendix 1, table **Biomes**
EcosystemID	Second level classification of Ecosystem. See appendix I, table **Ecosystems**
ServiceArea	The area of the case study site that provides this specific ecosystem service in the case study
YearOriginalData	Year in which the original data (value estimated or indicator measured) for the ecosystem services was gathered. Not always relevant, if not a original case study.
Year Of Validation	The year of validation (or standardization) of the value. If not specified same as the year of publication. This year is used to convert value to reference year for standardization (for TEEB this is USD2007)

Economic variables	
Valuation Method ID	List of valuation methods. Indicates how the value was estimated or measured. (see appendix 1, table **Valuation methods** for the list.)
Other Method	When the valuation method described in the publication does not match one of the options in table **ValuationMethod**
Value Type ID	List of value types in which the value can be described. We prefer annual per hectare values, but for some services or ecosystems it is better to express the value in other ways. See table **ValueTypes** in appendix 1 for detailed descriptions of the value type options.
Value Original	The actual value (do not use when a range is presented in the original publication, in this case use Value Range Low and High instead)

Value RangeLow	This variable is the low value of the value range. Use instead of **ValueOriginal**, when the value is presented as a range
Value RangeHigh	This variable is the high value of the value range. Use instead of **ValueOriginal**, when the value is presented as a range
Unit	The unit of Value (e.g. USD/ha/yr)
Currency	The currency in which the value is specified in the publication. Used for further calculations. A standard list is used to prevent spelling or other mistakes
Discount Rate	When the Value Type is a NPV or another discounted value, the discount rate should to be indicated.
Years Discount Rate	When the Value Type is a NPV, the period over which the discount rate has been calculated has to be indicated.
Provider	Ecosystem Service Provider ID; (Potential) Stakeholder/supplier supplying / producing / owning from the ecosystem service (see appendix 1, table Provider)
Beneficiary	Ecosystem Service Beneficiary ID; (Potential) Stakeholder/buyer taking benefit from the ecosystem service (see appendix 1, table Beneficiary)
Used for TEEB?	Indication of the selection of the estimate for the TEEB overview of estimates of monetary values of ecosystem services (De Groot et al., 2010)?

Table I.2 - List of the Variables in the Location Table

Location information	
Location ID	Every Location is assigned a specific ID; this enables that multiple publications can refer to a single location and it is a way to check whether a location has already been entered in the database (and therefore the values as well).
Location Name	Name of the location, including province/region and country name
Country ID	Country specific ID; including some internationally recognized territories, which have been added due to geographical differences between some of the counties and the territories
Biome IMAGEID	Biome ID in IMAGE model (see table Biome IMAGE for an overview of the Biomes used in IMAGE). On the Google maps map for the IMAGE Biomes the correct biome can be located. See paragraph I.3 for details.
Protected Status ID	Level of protection of the study area / landscape. Three categories: unprotected, partially, completely protected or unknown.
Latitude N-S	Latitude coordinates of the location of the case study. We use Google Earth to locate and map the case studies and therefore the coordinates are in WGS84 datum.
Longitude E-W	Latitude coordinates of the location of the case study. We use Google Earth to locate and map the case studies and therefore the coordinates are in WGS84 datum.
Scale Of Research	This indicates the level of measurement; includes plot, case study, region, national, continent, globe . We have also included Service area, which is the area for which the value of the ecosystem service has been determined.

Table I.3 – Overview of the Variables in the Publication Table

ReferenceID	Every publication is assigned a specific ID; this enables that multiple publications can refer to a single location and it is a way to check whether a reference has already been entered in the database (and therefore the values as well).
Reference	Family name of first author + year of Publication + extension (for multiple publications of this first author in one year) [i.e. Ploeg2009, Ploeg2009b]
Authors	Full names of the authors.
Title	Full title of the article / chapter / report (including journal name when article or book name when chapter)
FirstAuthor	Family name and initials of the first author. For example: Van der Ploeg, S.
YearOfPublication	Year of publication
PublicationTypeID	Type of publication: scientific article, book chapter, thesis, MSc thesis, working paper, note, table, box etc.
Reviewed	Is the publication scientifically reviewed? Yes/No
PublicationName	Name of journal/book in which the article/chapter has been published.
Volume	When published in a journal: Volume number of the journal.
Issue	When published in a journal: Issue number of the journal
Pages	The page numbers or number of pages of the article or chapter
PDF	Is a softcopy (PDF) of the publication available?
FileName	Filename of the softcopy, when available.

Table I.4 - List of ES providers

Provider of the Ecosystem Service	
Private	private land owners / provider (not one of the other options)
Municipal government	Local / municipal government arranging /providing the service or owning the service area
National government	National government arranging /providing the service or owning the service area
NGO / NFP (green)	NonGovernmental Organization or Not for profit organization arranging / providing the service or owning the service area
NGO / NFP (social)	NonGovernmental Organization or Not for profit organization arranging / providing the service or owning the service area
Company (Local)	Local company arranging / providing the service or owning the service area
Multinational company	Multinational company arranging / providing the service or owning the service area
Not defined	Provider not defined
Other	None of the above

Table I.5 - List of beneficiaries

Beneficiary of the	*Ecosystem Service*
Local (commercial)	Local market for service
Local (subsistence)	Subsistence production (food, fodder, wood)
Landscape/region/basin	Regional market for service. I.e. water for downstream cities/communities
National	National market for service.
(Sub)Continental	Continental market for service
Global	Global market for service. i.e. International tourists; or carbon credits
Not defined	Beneficiary not defined
Other	Non of the above

Table I.6 - List of Scales of research

Scale Of Research	
Plot	Very small study area, part of ecosystem.
Local	Case study at ecosystem level (a forest/coral reef/ wetland level)
Municipality / city	Study at the level of a municipality. Including several ecosystems.
Landscape / district / water basin	Study at landscape level Including several municipalities, multiple ecosystems (services themselves can be)
Province / Region	Study at the level of a province or region of a country.
Country	Study at country level.
Region	Study at the level of several neighbouring countries
Continent	Study at the level of a continent (or a big part of it)
Global	Study at the global level.

Table I.7 - List of valuation methods

Valuation Methods	
Direct market pricing	Estimates economic values for ecosystem services that are bought and sold in commercial markets.
Factor Income	Estimates economic values for ecosystem products or services that contribute to the production of commercially marketed goods
Avoided Cost	Estimates economic values for ecosystem services that are bought and sold in commercial markets.
Replacement cost	Estimate economic values based on costs of avoided damages resulting from lost ecosystem services, costs of replacing ecosystem services, or costs of providing substitute services.
Mitigation and restoration Cost	Estimate economic values based on costs of mitigating or restoring damaged ecosystems or goods and services
Travel Cost	Assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.
Hedonic Pricing	Estimates economic values for ecosystem or environmental services that directly affect market prices of some other good.
Contingent Valuation	Estimates economic values based on asking people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario.
Contingent Choice	Estimates economic values based on asking people to make tradeoffs among sets of ecosystem or environmental services or characteristics, but does not directly ask for willingness to pay.
Group Valuation	Estimates economic values based on asking a group of people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario.
Benefit Transfer	Estimates economic values by transferring existing benefit estimates from studies already completed for another location or issue.
Total Economic Value	Needed to indicate when dealing with a TEV
Unknown	Not indicated in the publication
Other	None of the above

Table I.8 - List of Value Types

Value Type	
Value per annum	The value of the service as the benefits per year
Value per annum (Range)	Same as Annual, but use when the benefit per year is given as a range
Net Present Value	Sum of the present values per year. Please indicate the number of years and discount rate
Capital / stock value	Actual value of the stock; normally not annualized, but can be corrected with a discount rate. Please indicate the number of years and discount rate
Annualized NPV	Value resulting from an Animalization of the NPV; use when available in the article. Do not annualize yourself
Total Economic Value	Use only when you enter an TEV for a aggregation of values of ecosystem services.
Marginal	The change of the value resulting from a specific change of some independent variable (i.e. the availability of the service)
Present Value	Present Value, which is the amount of cash flow at a time corrected with a discount rate; cash flow is cost minus benefits during that period.
WTP/pp or WTP/hh	WTP/person or household, which are not explicitly annualized
Other	Indicate when not any of the values in this list

Table I.9 - List of biomes and ecosystems

	LEVEL 1 (Biomes)		LEVEL 2 (ecosystems)
1	**Marine / Open Ocean**	***1***	***Marine / Open Ocean***
2	**Coastal systems**	***2***	**Coastal systems (excluding coastal wetlands)**
	Coastal systems (#)	***2.1***	***Coastal systems (excluding coastal wetlands and coral reefs)***
		2.1.1	Sea grass/algae beds
		2.1.2	Shelf sea
		2.1.3	Estuaries
		2.1.4	Shores (rocky & beaches)
		2.1.5	Coastal systems (unspecified)
	Coral reefs (#)	***2.2***	***Coral reefs***
		2.2.5	Coral reefs
		2.2.6	Coral islands / atolls
3	**Wetlands**	***3***	**Wetlands – general (coastal & inland)**
	Coastal wetland (#)	***3.1***	***Coastal wetland***
		3.1.1	Tidal Marsh
		3.1.2	Mangroves
		3.1.3	Salt water wetlands (unspecified)
	Inland wetlands (#)	***3.2***	***Inland wetlands***
		3.2.1	Floodplains
		3.2.2	Peat wetlands (Bogs, Fens, etc)
		3.2.3	Swamps and Marshes
		3.2.4	Wetlands (unspecified)
4	**Lakes/Rivers**	***4***	***Lakes/Rivers***
		4.1	Lakes
		4.2	Rivers
		4.3	Riparian zones
		4.4	Open water (unspecified)
5	**Forests**	***5***	**Forests – all**
	Tropical forests (#)	***5.1***	***(Tropical Forest)***
		5.1.1	Tropical Rain Forest
		5.1.2	Tropical Dry forest
	Temperate forest (#)	***5.2***	***(Temperate forests)***
		5.2.1	Temperate Rain or Evergreen forest
		5.2.2	Temperate Deciduous Forest
		5.2.3	Boreal/Coniferous. Forest
6	**Woodland & shrub land**	***6***	***Woodland & shrub land ("dry land")***
		6.1	Heath land
		6.2	Mediterranean Scrub
		6.3	Tropical woodlands
		6.4	Other woodlands
7	**Grass/Rangeland**	***7***	***Grass/Rangeland***
		7.1	Savanna etc
		7.2	Steppe

		7.3	Other tropical natural grasslands
		7.4	Temperate natural grasslands
		7.5	Grasslands [unspecified]
8	**Desert (*)**	**8**	**Desert**
		8.1	Semi-desert
		8.2	True desert (sand/rock)
9	**Tundra (*)**	**9.1**	**Tundra (non-wooded)**
10	**Mountain or Polar (*)**	**10**	**Mountain or Polar**
11	**Cultivated (*)**	**11**	**Cultivated**
		11.1	Cropland (arable land)
		11.2	Pastures
		11.3	orchards / agro-forestry, etc
		11.4	Plantations
		11.5	Rice paddies, etc
		11.6	Aquaculture
12	**Urban (*)**	**12**	**Urban**
13	**Multiple ecosystems (*)**	**13.1**	**Multiple ecosystems**

Source: De Groot el al. (2010)
Based on mix of classifications, mainly MA (2005) and Costanza et al., (1997) which in turn are based on classifications from US Geol. Survey, IUCN, WWF, UNEP and FAO.
(#) These ecosystems are dealt with separately in the monetary valuation (Chapter 7)
(*) These ecosystems are not used in the monetary valuation study (Chapter 7)

Table I.10 - List of all ecosystem services

Ecosystem Services		
PROVISIONING SERVICES		
1	Food	Food provision
2	Water	Water supply
3	Raw materials	Provisioning of Raw materials provision
4	Genetic	Provisioning of Genetic resources
5	Medical	Provisioning of Medical resources
6	Ornamental	Provisioning of Ornamental resources
REGULATING SERVICES		
7	Air quality	Influence on air quality
8	Climate	Climate regulation
9	Extreme events	Moderation of extreme events
10	Water flows	Regulation of water flows
11	Waste	Waste treatment and water purification
12	Erosion	Erosion prevention
13	Soil fertility	Maintenance of soil fertility
14	Pollination	Pollination
15	BioControl	Biological control
HABITAT SERVICES		
16	Life cycles	Lifecycle maintenance (esp. nursery service)
17	Genetic Diversity	Protection of gene pool (conservation)
CULTURAL SERVICES		
18	Aesthetic	Aesthetic information
19	Recreation	Opportunities for recreation and tourism
20	Inspiration	Inspiration for culture, art and design
21	Spiritual	Spiritual experience
22	Cognitive	Information for cognitive development (Education and science)
ADDITIONAL AND GENERAL SERVICES		
23	Various	Various ecosystem services
24	Other	Other
25	TEV	Total Economic Value
26	Energy	Provision of durable/sustainable Energy
27	Cultural values [general]	All or some cultural values combined or unspecified
28	Provisioning values [general]	All or some provisioning values combined or unspecified
29	Regulating [general]	All or some regulating values combined or unspecified
30	Habitat [general]	All or some habitat values combined or unspecified

Table I.11 - List of all ecosystem subservices

Numbers correspond with numbers in the TEEB Valuation database

Ecosystem Subservices			
1	**Food provision**		
		11	Fish
		12	Meat
		13	Plants / vegetable food
		14	NTFPs [food only!]
		15	Food [general]
		16	Other
2	**Water supply**		
		21	Drinking water
		22	Industrial water
		23	Water Other
		25	Irrigation water [unnatural]
		26	Water supply [general]
3	**Provisioning of Raw materials provision**		
		31	Fibers
		32	Timber
		33	Fuel wood and charcoal
		34	Fodder
		35	Fertilizers
		36	Other Raw
		37	Raw materials [general]
		38	Sand, rock, gravel, coral etc
		39	Biomass fuels
4	**Provisioning of Genetic resources**		
		41	Plant genetic resources
		42	Animal genetic resources
		43	Genetic resources [general]
5	**Provisioning of Medical resources**		
		51	Biochemicals
		52	Models
		53	Test-organisms
		54	Bioprospecting
6	**Provisioning of ornamental resources**		
		61	Decorative Plants
		62	Fashion
		63	Decorations / Handicrafts
		64	Pets and captive animals
7	**Influence on air quality**		
		71	Capturing fine dust
		72	Air quality regulation [general]
		73	UVb-protection
8	**Climate regulation**		
		81	C-sequestration
		83	Climate regulation [general]

	84	Microclimate regulation
	85	Gas regulation
9	**Moderation of extreme events**	
	91	Storm protection
	92	Flood prevention
	93	Fire Prevention
	94	Prevention of extreme events [general]
10	**Regulation of water flows**	
	101	Drainage
	102	River discharge
	103	Natural irrigation
	104	Water regulation [general]
11	**Waste treatment and water purification**	
	111	Water purification
	112	Soil detoxification
	113	Abatement of noise
	114	Waste treatment [general]
12	**Erosion prevention**	
	121	Erosion prevention
13	**Maintenance of soil fertility**	
	131	Maintenance of soil structure
	132	Deposition of nutrients
	133	Soil formation
	134	Nutrient cycling
	135	Maintenance of soil fertility [general]
14	**Pollination**	
	141	Pollination of crops
	142	Pollination of wild plants
	143	Pollination [general]
15	**Biological control**	
	151	Seed dispersal
	152	Pest control
	153	Disease control
	154	Biological Control [general]
16	**Lifecycle maintenance (esp. nursery service)**	
	161	Nursery service
	162	Refugia for migratory and resident species
17	**Protection of gene pool (conservation)**	
	171	Biodiversity protection
18	**Aesthetic information**	
	181	Attractive landscapes
19	**Opportunities for recreation and tourism**	
	191	Recreation
	192	Tourism
	193	Ecotourism
	194	Hunting and fishing
20	**Inspiration for culture, art and design**	
	201	Artistic inspiration
	202	Cultural use
	203	Inspiration [general]

21	**Spiritual experience**		
		211	Spiritual / Religious use
22	**Information for cognitive development (Education and science)**		
		221	Science / Research
		222	Education
		223	Cognitive [general]
23	**Various ecosystem services**		
		231	Various
24	**Other ESS than any of the above**		
		241	Other ESS
25	**Total Economic Value**		
		251	TEV
26	**Provision of durable/sustainable Energy**		
		261	Hydro-electricity
		262	Solar Energy
		263	Wind Energy
		264	Other Energy
		265	Thermal energy
27	**All or some cultural values combined or unspecified**		
		271	Cultural values [general]
28	**All or some provisioning values combined or unspecified**		
		281	Provisioning values [general]
29	**All or some regulating values combined or unspecified**		
		291	Regulating [general]
30	**All or some habitat values combined or unspecified**		
		301	Supporting [general]

Appendix II – Detailed overview of 1310 monetary values and their sources per biome

Sander van der Ploeg, Yafei Wang, Tsedekech Gebre Weldmichael and Dolf de Groot

With help and additional input from: Jan Barkman, Pieter van Beukering, Thomas Binet, Luke Brander, Andrea Ghermandi, Salman Hussain, Rosimeiry Portela, Sandra Rajmis, Luis C. Rodriguez, Didier Sauzade, Silvia Silvestri.

Appendix II gives an excerpt of the TEEB Valuation Database which contains 1310 value-estimates found for 13 biomes from 267 publications.
For each estimate the value ID, ecosystem service, the country/region, the year of validation, the valuation method and original reference are given.
The TEEB Valuation Database can be found on the website of the Ecosystem Service Partnership (URL: www.es-partnership.org, direct link to data base: www.fsd.nl/esp/77979/5/0/30). At this moment a simple version of the database is available in excel for users to select relevant values and case studies.

WARNING: THIS APPENDIX IS 134 PAGES! PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING IT.

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Notes:

(0) – The values in italic are values that have been suggested by the biome authors of the TEEB study AND have been used for the calculations, but the original values could not be checked in the original publication. Therefore these values are shown in the standardized unit which was used for calculations (US$/ha/yr (2007-value)) and not shown in the original currency and year.

In the tables the following variables are shown:

(1) – ID - The ID refers to the number in the TEEB database.

(2) – Subservice - Each value is linked to a specific SubService (for a complete list of SubServices see Appendix I). In case the original article does not mention a sub-service the main service name is used

(3) – Value – The monetary values are shown as in the original article; NOT in the standardized unit which was used for calculations (US$/ha/yr (2007-value).

(4) – Unit of the value. For the currencies the three letter abbreviations of the official ISO 4217 currency codes are used (ISO, 2010). Please note that currencies that are presently obsolete are shown as well to represent the currency at the time of the publication of the case study.

(5) – Value Type – Value per annum, NPV etc. For the complete classification of Value types used in the TEEB valuation database, see Appendix I.

(6) – Valuation Method - For the complete classification of Valuation methods used in the TEEB valuation database, see Appendix I.
The acronyms for the valuation methods are: AC - Avoided Cost; BT - Benefit transfer; CV / GV - Contingent Valuation and Group Valuation ; DMP - Direct market pricing; HP - Hedonic Pricing; FI /PF: Factor Income / Production Function; MC / RC - Mitigation and restoration Cost; PES – Payment for Ecosystem services (not a valuation method, but separated from DMP); RC - Replacement cost; TC - Travel Cost and TEV – Total Economic Value (shown to include all values)

(7) - Country / Region. We used the UN classification of countries and overseas territories.

(8) – Year: the year of validation of the value. This is not per se the year of measurement or the year of publication.

(9) – TEEB? - Indication whether the estimate is used in the *TEEB overview of estimates of monetary values of ecosystem services* (De Groot et al., 2010)

(10) – Reference - The full references of the publications are provided in the reference list below each Biome Table.

References:

De Groot, R.S., P. Kumar, S. van der Ploeg and P. Sukhdev (2010a) Estimates of monetary values of ecosystem services. Appendix 3 in: Kumar, P. (ed), "The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations". ISBN-13: 9781849712125, Earthscan, London, UK.

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II.1 ES-Values of Open Oceans

Table II.1 Monetary values per service for Open Oceans

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
199	Fish	12,04	WST/ha/yr	Value per annum	Samoa	DMP	2000	Yes	Mohd-Shahwahid (2001)
1228	Fish	31,82	GBP/ha/yr	Value per annum	UK	FI / PF	2004	No	Beaumont et al. (2008)
1285	Fish	21.660,00	DJF/ha/yr	Value per annum	Djibouti	FI / PF	1998	No	Emerton (1998)
1380	Fish	17,08	GBP/ha/yr	Value per annum	UK	DMP	2005	No	Homarus Ltd. (2007)
520	Food [unspecified]	103,37	ERN/ha/yr	Value per annum	Eritrea	DMP	1997	No	Emerton and Asrat (1998)
1042	Food [unspecified]	15,00	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)
1376	Food [unspecified]	8,85E+08	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
2	**(Fresh) water supply**								
	no values found								
3	**Provisioning of Raw material**								
1229	Other Raw	5,02	GBP/ha/yr	Value per annum	UK	FI / PF	2004	No	Beaumont et al. (2008)
1043	Raw materials [unspecified]	0,08	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)
4	**Provision of genetic resources**								
	no values found								

5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
	no values found								
8	**Climate regulation**								
1230	C-sequestration	39,30	GBP/ha/yr	Value per annum	UK	AC	2004	No	Beaumont et al. (2008)
193	Climate regulation [unspecified]	5,80	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
1375	Climate regulation [unspecified]	8,24E+09	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
1039	Gas regulation	38,31	USD/ha/yr	Value per annum	World	FI / PF	1994	Yes	Costanza et al. (1997)
9	**Moderation of extreme events**								
1377	Prevention of extreme events [unspecified]	4,40E+08	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
	no values found								
12	**Erosion prevention**								
	no values found								
13	**Nutrient cycling and maintenance of soil fertility**								
194	Nutrient cycling	9,40	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
1040	Nutrient cycling	118,05	USD/ha/yr	Value per annum	World	RC	1994	No	Costanza et al. (1997)

1235	Nutrient cycling	32.013,90	GBP/ha	WTP/pp or WTP/hh	UK	RC	2004	No	Beaumont et al. (2008)
1374	Nutrient cycling	1,30E+09	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
14	**Pollination**								
	no values found								
15	**Biological Control**								
195	Biological Control [unspecified]	0,76	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
1041	Biological Control [unspecified]	5,00	USD/ha/yr	Value per annum	World	RC	1994	Yes	Costanza et al. (1997)
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
758	Biodiversity protection	0,64	USD/ha/yr	Value per annum	South Africa	CV	2001	Yes	Turpie (2003)
1234	Biodiversity protection	4,98	GBP/ha/yr	Value per annum	UK	CV	2004	No	Beaumont et al. (2008)
18	**Aesthetic information**								
196	Attractive landscapes	9,84	WST/ha/yr	Value per annum	Samoa	BT	2000	No	Mohd-Shahwahid (2001)
1044	Attractive landscapes	76,00	USD/ha/yr	Value per annum	World	HP	1994	No	Costanza et al. (1997)
19	**Opportunities for recreation and tourism**								
1233	Recreation	730,15	GBP/ha/yr	Value per annum	UK	FI / PF	2002	No	Beaumont et al. (2008)
1378	Recreation	3,40E+09	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
1382	Recreation	4,13	GBP/ha/yr	Value per annum	UK	DMP	2005	No	Homarus Ltd. (2007)
200	Tourism	1,07	WST/ha/yr	Value per	Samoa	CV	2000	Yes	Mohd-Shahwahid (2001)

				annum					
1280	Tourism	3,46	ERN/ha/yr	Value per annum	Eritrea	FI / PF	1997	No	Emerton and Asrat (1998)
1381	Hunting / fishing	12,00	GBP/ha/yr	Value per annum	UK	BT	2005	No	Homarus Ltd. (2007)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
	no values found								
24	**Other**								
	no values found								
25	**Total Economic Value**								
1045	TEV	252,44	USD/ha/yr	Value per annum	World	BT	1994	No	Costanza et al. (1997)
1238	TEV	453,14	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
26	**Provision of durable/sustainable Energy**								
	no values found								
27	**Cultural values combined or unspecified**								
1232	Cultural values [unspecified]	19,67	GBP/ha/yr	Value per annum	UK	BT	2002	No	Beaumont et al. (2008)
1379	Cultural values [unspecified]	4,53E+08	GBP	Net Present Value	UK	BT	2008	No	Hussain et al. (2010)
28	**Provisioning values combined or unspecified**								
	no values found								

29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.2 ES-Values of Coral reefs

Table II.2 Monetary values per service for Coral reefs

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
96	Fish	318,00	USD/ha/yr	Value per annum (Range)	Trinidad and Tobago	DMP	2006	Yes	Burke et al. (2008)
97	Fish	206,21	USD/ha/yr	Value per annum (Range)	Saint Lucia	DMP	2006	Yes	Burke et al. (2008)
101	Fish	96,43	USD/ha/yr	Value per annum (Range)	Belize	DMP	2007	Yes	Cooper et al. (2009)
216	Fish	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Walpole et al. (2001)
219	Fish	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
220	Fish	0,00	USD/ha/yr	Value per annum	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
221	Fish	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
222	Fish	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
239	Fish	30,40	USD/ha/yr	Value per annum	Kenya	DMP	1999	Yes	Emerton and Tessema (2001)
242	Fish	26,22	USD/ha/yr	Value per annum	Jamaica	DMP	2000	Yes	Cesar and Chong (2004)
255	Fish	3,30	USD/ha/yr	Value per annum	Australia	DMP	2006	Yes	Access Economics (2008)
259	Fish	1.165,00	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)

277	Fish	57,69	EUR/ha/yr	Value per annum	Indonesia	DMP	2004	Yes	Hargreaves-Allen (2004)
285	Fish	510,27	USD/ha/yr	Value per annum	Vietnam	DMP	1997	Yes	Nam and Son (2001)
332	Fish	88,00	USD/ha/yr	Value per annum (Range)	Sri Lanka	DMP	1994	Yes	Berg et al. (1998)
406	Fish	239,00	USD/ha/yr	Value per annum	Indonesia	DMP	2002	No	Burke et al. (2002)
407	Fish	238,00	USD/ha/yr	Value per annum	Philippines	DMP	2002	No	Burke et al. (2002)
416	Fish	119,00	USD/ha/yr	Value per annum	Caribbean	DMP	2004	Yes	Burke and Maidens (2004)
451	Fish	84,00	USD/ha/yr	Value per annum	French Polynesia	DMP	2005	No	Charles (2005)
452	Fish	61,00	USD/ha/yr	Value per annum	French Polynesia	DMP	2005	No	Charles (2005)
652	Fish	3.068,00	USD/ha/yr	Value per annum	Jamaica	DMP	1999	Yes	Ruitenbeek and Cartier (1999)
682	Fish	150,00	USD/ha/yr	Value per annum	World	DMP	2001	Yes	Talbot and Wilkinson (2001)
683	Fish	1.500,00	USD/ha/yr	Value per annum	World	DMP	2001	Yes	Talbot and Wilkinson (2001)
840	Fish	0,70	USD/ha/yr	Value per annum	Ecuador	DMP	1983	Yes	De Groot (1992)
1266	Fish	84,00	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)
217	Plants / vegetable food	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
286	Plants / vegetable food	18,33	USD/ha/yr	Value per annum (Range)	Vietnam	DMP	1997	Yes	Nam and Son (2001)
1047	Food [unspecified]	220,05	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1256	Food [unspecified]	15.468,75	PHP/ha/yr	Value per annum (Range)	Philippines	DMP	2002	No	Montenegro et al. (2005)
2	**(Fresh) water supply**								
	no values found								
3	**Provisioning of Raw material**								
188	Other Raw	0,79	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)

189	Other Raw	0,44	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
218	Other Raw	0,00	USD/ha/yr	Value per annum (Range)	India	GV	2002	Yes	Whittingham et al. (ed) (2003)
457	Other Raw	266,00	USD/ha/yr	Value per annum	French Polynesia	DMP	2005	No	Charles (2005)
1048	Raw materials [unspecified]	26,70	USD/ha/yr	Value per annum	World	BT	1994	No	Costanza et al. (1997)
841	Sand, rock, gravel	5,22	USD/ha/yr	Value per annum	Ecuador	DMP	1984	Yes	De Groot (1992)
1405	Sand, rock, gravel	16.710,00	USD/ha/yr	Value per annum	Sri Lanka	DMP	1994	Yes	Berg et al. (1998)
4	**Provision of genetic resources**								
453	Genetic resources [unspecified]	240,00	USD/ha/yr	Value per annum	French Polynesia	BT	2005	No	Charles (2005)
649	Genetic resources [unspecified]	16.419,00	USD/ha/yr	Value per annum	Jamaica	DMP	1999	Yes	Ruitenbeek and Cartier (1999)
5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
441	Pets and captive animanls	243,89	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
446	Pets and captive animanls	125,00	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
450	Pets and captive animanls	288,03	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
1095	Pets and captive animanls	4,83	USD/ha/yr	Value per annum	Kenya	DMP	1999	Yes	Emerton and Tessema (2001)
1293	Pets and captive animanls	0,35	USD/ha/yr	Value per annum	Ecuador	DMP	1990	No	De Groot (1992)
1436	*Pets and captive animanls*	*348,26*	*USD/ha/yr*	*Value per annum*	*Indonesia*	*FI / PF*	*2007*	*Yes*	*Riopelle (1995)*
7	**Influence on air quality**								
	no values found								

8	**Climate regulation**								
454	C-sequestration	90,00	USD/ha/yr	Value per annum	French Polynesia	DMP	2005	No	Charles (2005)
521	C-sequestration	3.600,00	ERN/ha/yr	Value per annum	Eritrea	AC	1997	Yes	Emerton and Asrat (1998)
538	C-sequestration	88.861,59	DJF/ha/yr	Value per annum	Djibouti	DMP	1998	No	Emerton (1998)
182	Climate regulation [unspecified]	5,80	WST/ha/yr	Value per annum	Samoa	BT	2000	No	Mohd-Shahwahid (2001)
9	**Moderation of extreme events**								
98	Storm protection	8.500,00	USD/ha/yr	Value per annum (Range)	Trinidad and Tobago	AC	2007	Yes	Burke et al. (2008)
99	Storm protection	11.818,18	USD/ha/yr	Value per annum (Range)	Saint Lucia	AC	2007	Yes	Burke et al. (2008)
102	Storm protection	1.071,43	USD/ha/yr	Value per annum (Range)	Belize	AC	2007	Yes	Cooper et al. (2009)
278	Storm protection	2,69	EUR/ha/yr	Value per annum	Indonesia	AC	2004	Yes	Hargreaves-Allen (2004)
333	Flood prevention	27.050,00	USD/ha/yr	Value per annum (Range)	Sri Lanka	RC	1994	Yes	Berg et al. (1998)
418	Flood prevention	565,50	USD/ha/yr	Value per annum (Range)	Caribbean	DMP	2004	Yes	Burke and Maidens (2004)
455	Flood prevention	1.140,00	USD/ha/yr	Value per annum	French Polynesia	RC	2005	No	Charles (2005)
185	Prevention of extreme events [unspecified]	34,10	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
245	Prevention of extreme events [unspecified]	2,13	USD/ha/yr	Value per annum	Jamaica	AC	2000	Yes	Cesar and Chong (2004)
1029	Prevention of extreme events [unspecified]	500,00	USD/ha/yr	Value per annum	Philippines	RC	1994	Yes	Spurgeon (1992)
1046	Prevention of extreme events	2.750,00	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)

	[unspecified]								
1440	*Prevention of extreme events [unspecified]*	*6.630,15*	*USD/ha/yr*	*Value per annum*	*French Polynesia*	*RC*	*2007*	*Yes*	*Aubanel (1993)*
1441	*Prevention of extreme events [unspecified]*	*2.800,42*	*USD/ha/yr*	*Value per annum*	*South-Eastern Asia*	*RC*	*2007*	*Yes*	*GEF (1999)*
1442	*Prevention of extreme events [unspecified]*	*58,64*	*USD/ha/yr*	*Value per annum*	*Indonesia*	*RC*	*2007*	*Yes*	*Riopelle (1995)*
1443	*Prevention of extreme events [unspecified]*	*14.192,40*	*USD/ha/yr*	*Value per annum*	*Jamaica*	*FI / PF*	*2007*	*Yes*	*Ruitenbeek et al. (1999)*
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
186	Waste treatment [unspecified]	8,78	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
837	Waste treatment [unspecified]	58,00	USD/ha/yr	Value per annum	Ecuador	RC	1990	Yes	De Groot (1992)
12	**Erosion prevention**								
653	Erosion prevention	1,52E+05	USD/ha/yr	Value per annum	Jamaica	DMP	1999	Yes	Ruitenbeek and Cartier (1999)
1292	Erosion prevention	0,30	USD/ha/yr	Value per annum	Ecuador	DMP	1990	No	De Groot (1992)
13	**Nutrient cycling and maintenance of soil fertility**								
183	Nutrient cycling	9,40	WST/ha/yr	Value per annum	Samoa	BT	2000	No	Mohd-Shahwahid (2001)
14	**Pollination**								
	no values found								
15	**Biological Control**								

184	Biological Control [unspecified]	0,76	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
16	**Lifecycle maintenance (esp. nursery service)**								
839	Nursery service	0,07	USD/ha/yr	Value per annum	Ecuador	DMP	1990	No	De Groot (1992)
17	**Protection of gene pool (Conservation)**								
187	Biodiversity protection	0,06	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
241	Biodiversity protection	8,72	USD/ha/yr	Value per annum	Kenya	FI / PF	1999	Yes	Emerton and Tessema (2001)
261	Biodiversity protection	174,00	USD/ha/yr	Value per annum	Philippines	BT	2002	Yes	Samonte-Tan et al. (2007)
440	Biodiversity protection	27.072,24	USD/ha/yr	Value per annum	USA	CV	2000	Yes	Cesar et al. (2002)
445	Biodiversity protection	2.137,56	USD/ha/yr	Value per annum	USA	CV	2000	Yes	Cesar et al. (2002)
449	Biodiversity protection	1.789,89	USD/ha/yr	Value per annum	USA	CV	2000	Yes	Cesar et al. (2002)
456	Biodiversity protection	50,00	USD/ha/yr	Value per annum	French Polynesia	CV	2005	No	Charles (2005)
625	Biodiversity protection	75,00	USD/ha/yr	Value per annum	Guadeloupe	CV	2005	Yes	Raboteur and Rhodes (2006)
654	Biodiversity protection	45.907,00	USD/ha/yr	Value per annum	Jamaica	CV	1999	Yes	Ruitenbeek and Cartier (1999)
838	Biodiversity protection	4,90	USD/ha/yr	Value per annum	Ecuador	DMP	1990	No	De Groot (1992)
18	**Aesthetic information**								
190	Attractive landscapes	9,84	WST/ha/yr	Value per annum	Samoa	BT	2000	No	Mohd-Shahwahid (2001)
444	Attractive landscapes	22.825,67	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
448	Attractive landscapes	1.839,26	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)

460	Attractive landscapes	5.000,00	USD/ha/yr	Value per annum	French Polynesia	CV	2005	No	Charles (2005)
19	**Opportunities for recreation and tourism**								
461	Recreation	1.654,00	USD/ha/yr	Value per annum	Caribbean	BT	2003	No	Chong et al. (2003)
1257	Recreation	1,70E+09	PHP	Net Present Value	Philippines	BT	2002	No	Montenegro et al. (2005)
94	Tourism	48.500,00	USD/ha/yr	Value per annum (Range)	Trinidad and Tobago	DMP	2006	Yes	Burke et al. (2008)
95	Tourism	54.393,94	USD/ha/yr	Value per annum (Range)	Saint Lucia	DMP	2006	Yes	Burke et al. (2008)
100	Tourism	964,29	USD/ha/yr	Value per annum (Range)	Belize	DMP	2007	Yes	Cooper et al. (2009)
106	Tourism	1.491,67	USD/ha/yr	Value per annum	Vietnam	TC	2000	Yes	Nam and Son (2001)
107	Tourism	34,72	USD/ha/yr	Value per annum	Vietnam	CV	2000	Yes	Nam and Son (2001)
240	Tourism	443,85	USD/ha/yr	Value per annum	Kenya	DMP	1999	Yes	Emerton and Tessema (2001)
243	Tourism	13,78	USD/ha/yr	Value per annum (Range)	Jamaica	BT	1998	Yes	Cesar and Chong (2004)
254	Tourism	0,10	USD/ha/yr	Value per annum	Australia	DMP	2003	Yes	Access Economics (2008)
257	Tourism	2,81	USD/ha/yr	Value per annum	Australia	DMP	2006	Yes	Access Economics (2008)
258	Tourism	835,00	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
274	Tourism	7.037,04	USD/ha/yr	Value per annum	Netherlands Antilles	TC	2003	Yes	Pendleton (1995)
279	Tourism	0,25	EUR/ha/yr	Value per annum	Indonesia	CV	2004	Yes	Hargreaves-Allen (2004)
280	Tourism	7,37	EUR/ha/yr	Value per annum	Indonesia	DMP	2004	Yes	Hargreaves-Allen (2004)
281	Tourism	33,39	USD/ha/yr	Value per annum (Range)	Australia	TC	2003	Yes	Carr and Mendelsohn (2003)
282	Tourism	70,91	USD/ha/yr	Value per annum	Malaysia	CV	1998	Yes	Yeo (2004)

283	Tourism	600,00	USD/ha/yr	Value per annum	Philippines	TC	2006	Yes	Ahmed et al. (2007)
284	Tourism	4,21	USD/ha/yr	Value per annum	Philippines	CV	2006	Yes	Ahmed et al. (2007)
334	Tourism	1.060,00	USD/ha/yr	Value per annum (Range)	Sri Lanka	DMP	1994	Yes	Berg et al. (1998)
337	Tourism	184,00	USD/ha/yr	Value per annum	World	BT	2006	Yes	Brander et al. (2007)
417	Tourism	808,00	USD/ha/yr	Value per annum	Caribbean	DMP	2004	Yes	Burke and Maidens (2004)
439	Tourism	8,84E+05	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
443	Tourism	10.025,30	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
447	Tourism	3.316,43	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
458	Tourism	10.320,00	USD/ha/yr	Value per annum	French Polynesia	DMP	2005	No	Charles (2005)
651	Tourism	7,38E+05	USD/ha/yr	Value per annum	Jamaica	DMP	1999	Yes	Ruitenbeek and Cartier (1999)
672	Tourism	6.243,00	USD/ha/yr	Value per annum	Thailand	CV	2003	Yes	Seenprachawong (2003)
843	Tourism	45,00	USD/ha/yr	Value per annum	Ecuador	DMP	1990	Yes	De Groot (1992)
858	Tourism	1.115,63	USD/ha/yr	Value per annum	Netherlands Antilles	DMP	1991	No	Dixon et al. (1993)
940	Tourism	1.287,00	USD/ha/yr	Value per annum	USA	DMP	1994	Yes	Hoagland et al. (1995)
941	Tourism	509,00	USD/ha/yr	Value per annum	Australia	DMP	1994	Yes	Hoagland et al. (1995)
984	Tourism	46,30	USD/ha/yr	Value per annum	Australia	DMP	1994	Yes	Pearce and Moran (1994)
1049	Tourism	3.007,50	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1267	Tourism	365,00	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)
1288	Tourism	34.664,83	USD/ha/yr	Value per annum	Caribbean	BT	2003	No	Chong et al. (2003)
1447	*Tourism*	*7.956,18*	*USD/ha/yr*	*Value per annum*	*French Polynesia*	*DMP*	*1994*	*Yes*	*Aubanel (1993)*
1449	*Tourism*	*8.011,12*	*USD/ha/yr*	*Value per annum*	*Malaysia*	*CV*	*2007*	*Yes*	*Ayob et al (200)*
20	**Inspiration for culture, art and design**								
191	Artistic inspiration	0,00	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)

845	Artistic inspiration	0,22	USD/ha/yr	Value per annum	Ecuador	DMP	1990	Yes	De Groot (1992)
1050	Inspiration [unspecified]	0,87	USD/ha/yr	Value per annum	World	BT	1994	No	Costanza et al. (1997)
21	**Spiritual experience**								
844	Spiritual / Religious use	0,52	USD/ha/yr	Value per annum	Ecuador	CV	1990	Yes	De Groot (1992)
22	**Information for cognitive development (education and science)**								
192	Science / Research	0,11	WST/ha/yr	Value per annum	Samoa	BT	2000	No	Mohd-Shahwahid (2001)
260	Science / Research	53,00	USD/ha/yr	Value per annum	Philippines	AC	2004	No	Samonte-Tan et al. (2007)
459	Science / Research	117,00	USD/ha/yr	Value per annum	French Polynesia	PES	2005	No	Charles (2005)
846	Science / Research	2,73	USD/ha/yr	Value per annum	Ecuador	DMP	1990	No	De Groot (1992)
1289	Science / Research	34,99	USD/ha/yr	Value per annum	Caribbean	BT	2003	No	Chong et al. (2003)
1444	Science / Research	61,03	USD/ha/yr	Value per annum	Australia	DMP	2007	Yes	Driml (1994)
1445	Science / Research	1,20	USD/ha/yr	Value per annum	South-Eastern Asia	DMP	2007	Yes	GEF (1999)
1446	Science / Research	120,87	USD/ha/yr	Value per annum	USA	DMP	2007	Yes	Cesar and van Beukering (2004)
442	Education	5.365,67	USD/ha/yr	Value per annum	USA	DMP	2000	Yes	Cesar et al. (2002)
23	**Various ecosystem services**								
	no values found								
24	**Other**								
	no values found								
25	**Total Economic Value**								
247	TEV	1.100,00	USD/ha/yr	Value per annum	Turks and Caicos Islands	TEV	2005	No	Conservation International (2008)
330	TEV	1.400,00	USD/ha	Net Present Value	Sri Lanka	DMP	1994	No	Berg et al. (1998)
331	TEV	75.000,00	USD/ha	Net Present Value	Sri Lanka	DMP	1994	No	Berg et al. (1998)

415	TEV	1.481,00	USD/ha/yr	Value per annum (Range)	Caribbean	DMP	2004	No	Burke and Maidens (2004)
436	TEV	7.274,75	USD/ha/yr	Value per annum	USA	TEV	2000	No	Cesar et al. (2002)
437	TEV	35.113,53	USD/ha/yr	Value per annum	USA	TEV	2000	No	Cesar et al. (2002)
438	TEV	9,16E+05	USD/ha/yr	Value per annum	USA	TEV	2000	No	Cesar et al. (2002)
650	TEV	9,55E+05	USD/ha/yr	Value per annum	Jamaica	TEV	1999	No	Ruitenbeek and Cartier (1999)
759	TEV	1.000,00	USD/ha/yr	Value per annum	World	BT	2006	No	UNEP-WCMC (2006)
760	TEV	6.000,00	USD/ha/yr	Value per annum	World	BT	2006	No	UNEP-WCMC (2006)
1051	TEV	6.075,02	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1226	TEV	17.101,00	USD/ha/yr	Value per annum	French Polynesia	TEV	2005	No	Charles (2005)
1241	TEV	10.923,83	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
26	**Provision of durable/sustainable Energy**								
842	Solar Energy	1,53	USD/ha/yr	Value per annum	Ecuador	FI / PF	1990	No	De Groot (1992)
27	**Cultural values combined or unspecified**								
	no values found								
28	**Provisioning values combined or unspecified**								
1268	Provisioning values [unspecified]	60,00	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.3 ES-Values of Coastal systems

Table II.3 Monetary values per service for coastal systems

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
117	Fish	190,6	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
223	Fish	0,37	USD/ha/yr	Value per annum	India	DMP	2000	Yes	Whittingham et al. (ed) (2003)
262	Fish	63	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
263	Fish	13	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
269	Fish	20,14	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
271	Fish	5,91	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
1252	Fish	1.712,00	USD/ha/yr	Value per annum	USA	FI / PF	2005	No	Hughes (2006)
1255	Fish	2,63E+05	PHP/ha/yr	Value per annum (Range)	Philippines	FI / PF	2002	No	Montenegro et al. (2005)
1259	Fish	1,31E+06	SEK/ha	WTP/pp or WTP/hh	Sweden	RC	2002	No	Sundberg (2004)
1260	Fish	3,86E+05	SEK/ha	WTP/pp or WTP/hh	Sweden	RC	2002	No	Sundberg (2004)
1261	Fish	4,10E+05	SEK/ha	WTP/pp or WTP/hh	Sweden	RC	2002	No	Sundberg (2004)
1262	Fish	8,17E+05	SEK	WTP/pp or WTP/hh	Sweden	RC	2002	No	Sundberg (2004)
273	Plants / vegetable food	660	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
205	Food [unspecified]	21.870,99	ZAR/ha/yr	Value per annum	South Africa	DMP	2000	Yes	Turpie(2003b)

848	Food [unspecified]	450	USD/ha/yr	Value per annum	Netherlands	DMP	1990	Yes	De Groot (1992)
943	Food [unspecified]	68	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Houde and Rutherford (1993)
1056	Food [unspecified]	233	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)
1060	Food [unspecified]	70	USD/ha/yr	Value per annum	World	HP	1994	No	Costanza et al. (1997)
162	Other	1,14	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
2	**(Fresh) water supply**								
356	Water [unspecified]	1.287,00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
3	**Provisioning of Raw material**								
115	Other Raw	0,17	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
164	Other Raw	1,94	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
1053	Raw materials [unspecified]	2	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)
850	Sand, rock, gravel	25	USD/ha/yr	Value per annum	Netherlands	DMP	1990	Yes	De Groot (1992)
4	**Provision of genetic resources**								
	no values found								
5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
	no values found								
8	**Climate regulation**								
1253	C-sequestration	452	USD/ha/yr	Value per annum	USA	RC	2005	No	Hughes (2006)
9	**Moderation of extreme events**								
849	Flood prevention	500	USD/ha/yr	Value per annum	Netherlands	BT	1981	No	De Groot (1992)

344	Prevention of extreme events [unspecified]	67.400,00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
1414	Waste treatment [unspecified]	1.682,00	USD/ha/yr	Value per annum	World	RC	2009	No	Waycott et al. (2009)
12	**Erosion prevention**								
1258	Erosion prevention	1,00E+09	PHP	Net Present Value	Philippines	MC / RC	2002	No	Montenegro et al. (2005)
13	**Nutrient cycling and maintenance of soil fertility**								
357	Nutrient cycling	1.787,00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
1052	Nutrient cycling	19.000,00	USD/ha/yr	Value per annum (Range)	World	RC	1994	Yes	Costanza et al. (1997)
1055	Nutrient cycling	21.100,00	USD/ha/yr	Value per annum (Range)	World	RC	1994	Yes	Costanza et al. (1997)
1058	Nutrient cycling	1.431,00	USD/ha/yr	Value per annum (Range)	World	RC	1994	Yes	Costanza et al. (1997)
14	**Pollination**								
	no values found								
15	**Biological Control**								
348	Biological Control [unspecified]	24.228,00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
358	Biological Control [unspecified]	49	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
942	Biological Control [unspecified]	39	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Houde and Rutherford (1993)
1059	Biological Control [unspecified]	39	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)

16	**Lifecycle maintenance (esp. nursery service)**								
129	Nursery service	27,31	USD/ha/yr	Value per annum	Tanzania	FI / PF	2000	Yes	Turpie (2000)
847	Nursery service	120	USD/ha/yr	Value per annum	Netherlands	DMP	1981	Yes	De Groot (1992)
1254	Nursery service	133,23	USD/ha/yr	Value per annum	Australia	FI / PF	2001	No	McArthur and Boland (2006)
17	**Protection of gene pool (Conservation)**								
209	Biodiversity protection	476	ZAR/ha/yr	Value per annum	South Africa	CV	2000	Yes	Turpie(2003b)
1273	Biodiversity protection	2.716,00	KRW	Value per annum	Korea (Republic of)	CV	2006	No	Chang et al. (2009)
18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
345	Recreation	36.687,00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
851	Recreation	500	USD/ha/yr	Value per annum	Netherlands	DMP	1990	Yes	De Groot (1992)
238	Tourism	1,24	USD/ha/yr	Value per annum	Indonesia	DMP	2002	Yes	Erdmann et al. (2003)
270	Tourism	179,39	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
272	Tourism	0,14	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
275	Tourism	21,22	USD/ha/yr	Value per annum	Seychelles	DMP	1998	Yes	Mathieu et al. (2003)
1237	Tourism	2,17E+07	USD/ha/yr	Value per annum	USA	TC	1990	No	Bell and Leeworthy (1990)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
852	Spiritual / Religious use	15	USD/ha/yr	Value per annum	Netherlands	CV	1990	No	De Groot (1992)
22	**Information for cognitive development (education and science)**								

853	Science / Research	16	USD/ha/yr	Value per annum (Range)	Netherlands	DMP	1990	Yes	De Groot (1992)
23	**Various ecosystem services**								
1263	Various	5,12E+10	JPY/ha	WTP/pp or WTP/hh	Japan	CV	1998	No	Tsuge and Washida (2003)
24	**Other**								
	no values found								
25	**Total Economic Value**								
346	TEV	1,04E+05	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
365	TEV	3.210,00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
1054	TEV	19.002,00	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1057	TEV	22.991,84	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1061	TEV	1.610,00	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1239	TEV	41.055,63	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1240	TEV	34.172,27	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1242	TEV	2.895,04	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1265	TEV	1,07E+05	USD/ha/yr	Value per annum	World	TEV	1999	No	Waycott et al. (2009)
26	**Provision of durable/sustainable Energy**								
1251	Energy other	648	USD/ha/yr	Value per annum	USA	DMP	2005	No	Hughes (2006)
27	**Cultural values combined or unspecified**								
405	Cultural values [unspecified]	59	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
28	**Provisioning values combined or unspecified**								
1264	Provisioning values [unspecified]	2,00E+10	JPY/ha	WTP/pp or WTP/hh	Japan	CV	1998	No	Tsuge and Washida (2003)

29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.4 ES-Values of Coastal wetlands

Table II.4 Monetary values per service for Coastal wetlands

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
46	Fish	2,040.42	LKR/ha/yr	Value per annum	Sri Lanka	BT	2002	Yes	Emerton and Kekulandala (2003)
104	Fish	25	USD/ha/yr	Value per annum (Range)	Belize	DMP	2007	Yes	Cooper et al. (2009)
202	Fish	800	USD/ha/yr	Value per annum	El Salvador	DMP	1997	Yes	Turner et al. (2003)
264	Fish	16	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
265	Fish	33	USD/ha/yr	Value per annum	Philippines	DMP	2004	Yes	Samonte-Tan et al. (2007)
319	Fish	84	USD/ha/yr	Value per annum	Cambodia	DMP	1996	No	Bann (1997b)
463	Fish	62.66	USD/ha/yr	Value per annum	USA	DMP	1983	No	Costanza et al. (1989)
555	Fish	268	USD/ha/yr	Value per annum	Sri Lanka	DMP	1996	No	Gunawardena and Rowan (2005)
556	Fish	493	USD/ha/yr	Value per annum	Sri Lanka	DMP	1996	No	Gunawardena and Rowan (2005)
568	Fish	1,490.00	PHP/ha/yr	Value per annum	Philippines	DMP	1995	Yes	Janssen and Padilla (1999)
677	Fish	1,259.00	USD/ha/yr	Value per annum (Range)	World	BT	1996	No	Spaninks and Van Beukering (1997)
813	Fish	1,426.22	USD/ha/yr	Value per annum	USA	DMP	1994	No	Bell (1989)
866	Fish	102.55	USD/ha/yr	Value per annum (Range)	USA	DMP	1983	No	Farber and Costanza (1987)

889	Fish	56.83	USD/ha/yr	Value per annum	USA	BT	1968	No	Gosselink et al. (1974)
892	Fish	118.61	USD/ha/yr	Value per annum	USA	BT	1970	No	Gosselink et al. (1974)
893	Fish	185.33	USD/ha/yr	Value per annum	USA	BT	1970	No	Gosselink et al. (1974)
909	Fish	150	USD/ha/yr	Value per annum (Range)	Fiji Islands	BT	1993	No	Gren and Soderqvist (1994)
921	Fish	125	USD/ha/yr	Value per annum	Trinidad and Tobago	BT	1974	No	Hamilton and Snedaker (1984)
922	Fish	640	USD/ha/yr	Value per annum	Fiji Islands	BT	1976	No	Hamilton and Snedaker (1984)
923	Fish	50	USD/ha/yr	Value per annum	Indonesia	BT	1978	No	Hamilton and Snedaker (1984)
924	Fish	1,975.00	USD/ha/yr	Value per annum	Australia	BT	1976	No	Hamilton and Snedaker (1984)
925	Fish	280	USD/ha/yr	Value per annum	Thailand	BT	1982	No	Hamilton and Snedaker (1984)
1198	Fish	4.6	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)
1269	Fish	540	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)
1317	Fish	54.9	USD/ha/yr	Value per annum	Thailand	DMP	1996	No	Barbier (2007)
1332	Fish	8,269.00	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
1384	Fish	1.25E+06	VND/ha/yr	Value per annum	Vietnam	FI / PF	2001	No	Do and Bennett (2005)
1398	Fish	108.83	USD/ha/yr	Value per annum	Micronesia	BT	1996	No	Naylor and Drew (1998)
1450	*Fish*	*204.03*	*USD/ha/yr*	*Value per annum*	*Indonesia*	*DMP*	*2007*	*Yes*	*Ruitenbeek (1994)*
125	Meat	0.28	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
1199	Meat	0.01	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)
45	Plants / vegetable food	9,872.88	LKR/ha/yr	Value per annum	Sri Lanka	DMP	2002	Yes	Emerton and Kekulandala (2003)
1202	Plants / vegetable food	0.2	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)

1392	NTFPs [food only!]	35,000.00	VND/ha/yr	Value per annum	Vietnam	DMP	1999	Yes	Tri (2000)
724	Food [unspecified]	290.4	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
896	Food [unspecified]	1,300.00	USD/ha/yr	Value per annum	Italy	BT	1993	No	Gren and Soderqvist (1994)
1062	Food [unspecified]	713.47	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1065	Food [unspecified]	1,388.72	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1397	Other	352.11	USD/ha/yr	Value per annum	Micronesia	DMP	1996	No	Naylor and Drew (1998)
2	**(Fresh) water supply**								
49	Drinking water	1,232.07	LKR/ha/yr	Value per annum	Sri Lanka	AC	2002	Yes	Emerton and Kekulandala (2003)
1341	Water Other	2,339.09	GBP/ha/yr	Value per annum	UK	BT	2000	No	Everard (2009)
85	Water [unspecified]	1,708.00	CNY/ha/yr	Value per annum	China	DMP	2004	Yes	Tong et al. (2007)
728	Water [unspecified]	15,005.40	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1216	Water [unspecified]	3.20E+06	USD	Net Present Value	Mozambique	RC	1999	No	Turpie et al. (1999)
3	**Provisioning of Raw material**								
1201	Fibers	1	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)
126	Timber	13.99	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
554	Timber	24	USD/ha/yr	Value per annum	Sri Lanka	DMP	1996	No	Gunawardena and Rowan (2005)
569	Timber	3,455.28	PHP/ha/yr	Value per annum	Philippines	DMP	1995	Yes	Janssen and Padilla (1999)
676	Timber	18	USD/ha/yr	Value per annum (Range)	World	BT	1996	No	Spaninks and Van Beukering (1997)
861	Timber	233.19	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Dugan (ed) (1990)

900	Timber	615	USD/ha/yr	Value per annum (Range)	Indonesia	BT	1993	No	Gren and Soderqvist (1994)
902	Timber	35	USD/ha/yr	Value per annum	Malaysia	BT	1993	No	Gren and Soderqvist (1994)
926	Timber	70	USD/ha/yr	Value per annum	Trinidad and Tobago	BT	1974	No	Hamilton and Snedaker (1984)
928	Timber	25	USD/ha/yr	Value per annum	Malaysia	BT	1980	No	Hamilton and Snedaker (1984)
930	Timber	215	USD/ha/yr	Value per annum (Range)	Thailand	BT	1982	No	Hamilton and Snedaker (1984)
1277	Timber	14.12	USD/ha/yr	Value per annum	Malaysia	DMP	1989	Yes	Bennett and Reynolds (1993)
1386	Timber	1.42E+05	VND/ha/yr	Value per annum	Vietnam	BT	2001	No	Do and Bennett (2005)
1387	Timber	1.98E+06	VND/ha/yr	Value per annum	Vietnam	BT	2001	No	Do and Bennett (2005)
1390	Timber	6.70E+05	VND/ha/yr	Value per annum	Vietnam	DMP	1999	No	Tri (2000)
1391	Timber	4.40E+07	VND/yr	Value per annum	Vietnam	DMP	1999	No	Tri (2000)
1403	Timber	12.68	USD/ha/yr	Value per annum	Indonesia	BT	1978	No	Burbridge and Koesoebiono (1984)
1407	Timber	388.56	USD/ha/yr	Value per annum	Thailand	AC	1995	Yes	Sathiratai (1998)
47	Fuel wood and charcoal	2,594.52	LKR/ha/yr	Value per annum	Sri Lanka	DMP	2002	Yes	Emerton and Kekulandala (2003)
124	Fuel wood and charcoal	2.84	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
318	Fuel wood and charcoal	3.5	USD/ha/yr	Value per annum	Cambodia	DMP	1996	Yes	Bann (1997b)
903	Fuel wood and charcoal	20	USD/ha/yr	Value per annum	Fiji Islands	BT	1993	No	Gren and Soderqvist (1994)
927	Fuel wood and charcoal	15	USD/ha/yr	Value per annum (Range)	Indonesia	BT	1978	No	Hamilton and Snedaker (1984)
1270	Fuel wood and charcoal	42	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)

1333	Fuel wood and charcoal	2,511.00	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
1360	Fuel wood and charcoal	1.76E+07	SVC	Net Present Value	El Salvador	DMP	1992	Yes	Gammage (1998)
1385	Fuel wood and charcoal	72,456.80	VND/ha/yr	Value per annum	Vietnam	DMP	2001	No	Do and Bennett (2005)
1396	Fuel wood and charcoal	178.3	USD/ha/yr	Value per annum	Micronesia	BT	1996	No	Naylor and Drew (1998)
1401	Fuel wood and charcoal	62,692.79	PKR/ha/yr	Value per annum	Pakistan	DMP	1992	No	Khalil (1999)
1404	Fuel wood and charcoal	6.69	USD/ha/yr	Value per annum	Indonesia	BT	1978	Yes	Burbridge and Koesoebiono (1984)
1343	Fodder	79.07	GBP/ha/yr	Value per annum	UK	BT	2007	No	Everard (2009)
1402	Fodder	10.54	PKR/ha/yr	Value per annum	Pakistan	DMP	1992	Yes	Khalil (1999)
201	Other Raw	25	USD/ha/yr	Value per annum	El Salvador	DMP	1997	Yes	Turner et al. (2003)
464	Other Raw	29.75	USD/ha/yr	Value per annum	USA	DMP	1983	No	Costanza et al. (1989)
860	Other Raw	222.83	USD/ha/yr	Value per annum	Thailand	DMP	1994	Yes	Dugan (ed) (1990)
1348	Other Raw	48	GBP/ha/yr	Value per annum	UK	BT	1997	No	Everard (2009)
1388	Other Raw	3,649.80	VND/ha/yr	Value per annum	Vietnam	BT	2001	No	Do and Bennett (2005)
1393	Other Raw	3,466.67	VND/ha/yr	Value per annum	Vietnam	DMP	1999	No	Tri (2000)
678	Raw materials [unspecified]	131.50	USD/ha/yr	Value per annum (Range)	World	BT	1996	No	Spaninks and Van Beukering (1997)
725	Raw materials [unspecified]	67.80	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1200	Raw materials [unspecified]	0.1	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)
1451	*Raw materials [unspecified]*	*35.09*	*USD/ha/yr*	*Value per annum*	*Bangladesh*	*DMP*	*2007*	*Yes*	*Ahmad (1984)*
1452	*Raw materials [unspecified]*	*818.70*	*USD/ha/yr*	*Value per annum*	*Philippines*	*DMP*	*2008*	*Yes*	*Nickerson (1999)*

1203	Sand, rock, gravel	0.01	USD/ha/yr	Value per annum	Mozambique	DMP	1999	No	Turpie et al. (1999)
1408	Sand, rock, gravel	15.59	USD/ha/yr	Value per annum	Cambodia	DMP	1996	Yes	Bann (1997b)
855	Biomass fuels	3,000.00	USD/ha/yr	Value per annum	Netherlands	DMP	1990	No	De Groot (1992)
4	**Provision of genetic resources**								
1344	Animal genetic resources	6.82	GBP/ha/yr	Value per annum	UK	DMP	2007	No	Everard (2009)
5	**Provisioning of medical resources**								
1389	Biochemicals	77,201.60	VND/ha/yr	Value per annum	Vietnam	BT	2001	No	Do and Bennett (2005)
1453	*Medicinal plants*	*2.25*	*USD/ha/yr*	*Value per annum*		*DMP*	*2007*	*Yes*	*Emerton (2002)*
1454	*Medicinal plants*	*34.86*	*USD/ha/yr*	*Value per annum*		*DMP*	*2007*	*Yes*	*MANR (2002)*
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
730	Capturing fine dust	1,742.60	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
8	**Climate regulation**								
50	C-sequestration	254.24	LKR/ha/yr	Value per annum	Sri Lanka	BT	2002	Yes	Emerton and Kekulandala (2003)
73	C-sequestration	2	USD/ha/yr	Value per annum	Cambodia	AC	2002	Yes	Emerton (ed) (2005)
132	C-sequestration	650	USD/ha/yr	Value per annum	Tanzania	BT	2000	Yes	Turpie (2000)
244	C-sequestration	82	USD/ha/yr	Value per annum	Jamaica	BT	1998	Yes	Cesar and Chong (2004)
731	C-sequestration	16,554.40	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1218	C-sequestration	6.40E+07	USD	Net Present Value	Mozambique	MC / RC	1999	No	Turpie et al. (1999)
1334	C-sequestration	2.46E+06	GBP/ha/yr	Value per annum	UK	BT	2007	No	Everard (2009)
1345	C-sequestration	33.08	GBP/ha/yr	Value per annum	UK	BT	2007	No	Everard (2009)
1406	C-sequestration	2,136.81	THB/ha/yr	Value per annum	Thailand	RC	1995	No	Sathiratai (1998)

87	Climate regulation [unspecified]	398	CNY/ha/yr	Value per annum	China	RC	2004	Yes	Tong et al. (2007)
9	**Moderation of extreme events**								
58	Storm protection	9,468.90	INR/ha/yr	Value per annum	India	AC	2004	No	Badola and Hussain (2005)
71	Storm protection	32	USD/ha/yr	Value per annum	Cambodia	AC	2002	Yes	Emerton (ed) (2005)
105	Storm protection	992.86	USD/ha/yr	Value per annum (Range)	Belize	AC	2007	Yes	Cooper et al. (2009)
320	Storm protection	32	USD/ha/yr	Value per annum	Cambodia	AC	1996	No	Bann (1997b)
557	Storm protection	300	USD/ha/yr	Value per annum	Sri Lanka	RC	1996	No	Gunawardena and Rowan (2005)
864	Storm protection	1.09	USD/ha/yr	Value per annum	USA	AC	1983	No	Farber and Costanza (1987)
865	Storm protection	18.48	USD/ha/yr	Value per annum	USA	AC	1983	No	Farber and Costanza (1987)
1227	Storm protection	7,100.00	GBP/ha/yr	Value per annum	UK	AC	2004	No	Beaumont et al. (2008)
1236	Storm protection	5.45E+05	GBP/ha	WTP/pp or WTP/hh	UK	AC	2004	No	Beaumont et al. (2008)
1250	Storm protection	0.98	USD/ha/yr	Value per annum	USA	AC	1980	Yes	Farber (1987)
1318	Storm protection	8,016.70	USD/ha/yr	Value per annum (Range)	Thailand	RC	1996	No	Barbier (2007)
1412	Storm protection	1,964.59	USD/ha/yr	Value per annum	Micronesia	CV	2003	Yes	Naylor and Drew (1998)
43	Flood prevention	1.58E+05	LKR/ha/yr	Value per annum	Sri Lanka	BT	2002	Yes	Emerton and Kekulandala (2003)
86	Flood prevention	2,288.00	CNY/ha/yr	Value per annum	China	CV	2004	Yes	Tong et al. (2007)

465	Flood prevention	317.02	USD/ha/yr	Value per annum	USA	AC	1983	No	Costanza et al. (1989)
1335	Flood prevention	12,500.00	GBP	WTP/pp or WTP/hh	UK	AC	2000	No	Everard (2009)
1346	Flood prevention	27,863.64	GBP/ha	Present Value	UK	BT	2005	No	Everard (2009)
1411	Flood prevention	2,387.42	USD/ha/yr	Value per annum	Thailand	RC	2003	Yes	Barbier et al. (2002)
1455	Flood prevention	*8312.66*	*USD/ha/yr*	*Value per annum*	*UK*	*RC*	*2007*	*Yes*	*King (1995)*
1456	Flood prevention	*273.27*	*USD/ha/yr*	*Value per annum*	*World*	*RC*	*2007*	*Yes*	*Ledoux (2003)*
325	Prevention of extreme events [unspecified]	845	USD/ha/yr	Value per annum	Malaysia	CV	1999	Yes	Bann (1999)
359	Prevention of extreme events [unspecified]	766	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
656	Prevention of extreme events [unspecified]	77,775.00	THB/ha/yr	Value per annum	Thailand	RC	1995	Yes	Sathiratai (1998)
859	Prevention of extreme events [unspecified]	7336.63	USD/ha/yr	Value per annum	UK	RC	1994	Yes	Dugan (ed) (1990)
1458	*Prevention of extreme events [unspecified]*	*6201.88*	*USD/ha/yr*	*Value per annum*	*South Korea*	*CV*	*2007*	*Yes*	*Pyo (2001)*
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
44	Water purification	54,312.26	LKR/ha/yr	Value per annum	Sri Lanka	MC / RC	2002	Yes	Emerton and Kekulandala (2003)

360	Water purification	13,376.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
735	Water purification	17,599.90	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
894	Water purification	1.85E+05	USD/ha/yr	Value per annum	USA	RC	1974	Yes	Gosselink et al. (1974)
895	Water purification	652.36	USD/ha/yr	Value per annum	USA	BT	1966	No	Gosselink et al. (1974)
1217	Water purification	1.27E+07	USD	Net Present Value	Mozambique	RC	1999	No	Turpie et al. (1999)
1294	Water purification	412	USD/ha/yr	Value per annum (Range)	Sweden	BT	1993	No	Gren and Soderqvist (1994)
1295	Water purification	430	USD/ha/yr	Value per annum	Sweden	BT	1993	No	Gren and Soderqvist (1994)
1330	Water purification	3.04E+05	GBP/yr	Value per annum	UK	BT	2008	No	Everard (2009)
854	Waste treatment [unspecified]	4,500.00	USD/ha/yr	Value per annum	Netherlands	RC	1990	Yes	De Groot (1992)
12	**Erosion prevention**								
72	Erosion prevention	122	USD/ha/yr	Value per annum	Cambodia	AC	2002	Yes	Emerton (ed) (2005)
267	Erosion prevention	672	USD/ha/yr	Value per annum	Philippines	RC	1998	Yes	Samonte-Tan et al. (2007)
1336	Erosion prevention	7,151.00	GBP/ha/yr	Value per annum	UK	BT	2000	No	Everard (2009)
1459	*Erosion prevention*	*96.71*	*USD/ha/yr*	*Value per annum*	*Indonesia*	*DMP*	*2007*	*Yes*	*Ruitenbeek (1994)*
13	**Nutrient cycling and maintenance of soil fertility**								
733	Maintenance of soil structure	1,655.40	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1339	Soil formation	6,269.64	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)

1340	Nutrient cycling	3.30E+06	GBP/ha/yr	Value per annum	UK	BT	2008	No	Everard (2009)
14	**Pollination**								
	no values found								
15	**Biological Control**								
	no values found								
16	**Lifecycle maintenance (esp. nursery service)**								
59	Nursery service	1,198.23	USD/ha/yr	Value per annum (Range)	Mexico	AC	1982	Yes	Barbier and Strand (1998)
131	Nursery service	40.79	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
266	Nursery service	243	USD/ha/yr	Value per annum	Philippines	FI / PF	2004	Yes	Samonte-Tan et al. (2007)
324	Nursery service	526	USD/ha/yr	Value per annum	Malaysia	CV	1999	Yes	Bann (1999)
570	Nursery service	5.67E+05	PHP/ha/yr	Value per annum (Range)	Philippines	DMP	1995	No	Janssen and Padilla (1999)
976	Nursery service	1.49	USD/ha/yr	Value per annum	USA	DMP	1975	Yes	Lynne et al. (1981)
1272	Nursery service	69.7	USD/ha/yr	Value per annum (Range)	Thailand	FI / PF	1993	Yes	Barbier et al. (2002)
1278	Nursery service	2,417.51	USD/ha/yr	Value per annum	Malaysia	FI / PF	1989	Yes	Bennett and Reynolds (1993)
1361	Nursery service	1.58E+09	SVC	Net Present Value	El Salvador	DMP	1992	No	Gammage (1998)
1409	Nursery service	105.71	USD/ha/yr	Value per annum	Thailand	FI / PF	1995	Yes	Sathiratai (1998)
827	Nursery service	181.0522102	USD/ha/yr	Value per annum	Thailand	DMP	2007	Yes	Christensen (1982)
828	Nursery service	603.8822167	USD/ha/yr	Value per annum	Thailand	DMP	2007	Yes	Christensen (1982)
826	Nursery service	362.1044204	USD/ha/yr	Value per annum	Thailand	DMP	2007	Yes	Christensen (1982)
1410	Nursery service	93.34	USD/ha/yr	Value per annum	Indonesia	DMP	2003	Yes	Burbridge and Koesoebiono (1984)
1460	*Nursery service*	*30.36*	*USD/ha/yr*	*Value per annum*	*Italy*	*CM*	*2003*	*Yes*	*Nunes (2004)*
1461	*Nursery service*	*102.33*	*USD/ha/yr*	*Value per annum*	*USA*	*DMP*	*2003*	*Yes*	*Coriel (1993)*
1462	*Nursery service*	*423.95*	*USD/ha/yr*	*Value per annum*	*Caribbean*	*FI / PF*	*2003*	*Yes*	*Dharmaratne and Strand (2002)*
1463	*Nursery service*	*2363.80*	*USD/ha/yr*	*Value per annum*	*Vietnam*	*FI / PF*	*2003*	*Yes*	*Do and Bennett*

									(2005)
1464	*Nursery service*	*2243.47*	*USD/ha/yr*	*Value per annum*	*USA*	*FI / PF*	*2003*	*Yes*	*Johnston et al (2002)*
1465	*Nursery service*	*836.66*	*USD/ha/yr*	*Value per annum*	*Fiji Islands*	*DMP*	*2003*	*Yes*	*Lal (1990)*
1466	*Nursery service*	*941.25*	*USD/ha/yr*	*Value per annum*	*Vietnam*	*FI / PF*	*2003*	*Yes*	*Levine and Mindedal (1998)*
1467	*Nursery service*	*5846.52*	*USD/ha/yr*	*Value per annum*	*Australia*	*DMP*	*2003*	*Yes*	*Morton (1990)*
1468	*Nursery service*	*59644.90*	*USD/ha/yr*	*Value per annum*	*Philippines*	*DMP*	*2003*	*Yes*	*Nickerson (1999)*
17	**Protection of gene pool (Conservation)**								
88	Biodiversity protection	1,054.00	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Tong et al. (2007)
268	Biodiversity protection	19	USD/ha/yr	Value per annum	Philippines	BT	1992	Yes	Samonte-Tan et al. (2007)
361	Biodiversity protection	497	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
558	Biodiversity protection	2.6	USD/ha/yr	Value per annum	Sri Lanka	CV	1996	No	Gunawardena and Rowan (2005)
737	Biodiversity protection	2,420.20	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1070	Biodiversity protection	169.14	USD/ha/yr	Value per annum	World	BT	1994	No	Costanza et al. (1997)
1290	Biodiversity protection	24	USD/ha/yr	Value per annum	Malaysia	CV	1999	No	Bann (1999)
1291	Biodiversity protection	7,500.00	USD/ha/yr	Value per annum	Malaysia	CV	1999	Yes	Bann (1999)
1342	Biodiversity protection	69,114.00	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
1349	Biodiversity protection	1,703.27	GBP/ha/yr	Value per annum	UK	BT	2008	No	Everard (2009)
1395	Biodiversity protection	4.28E+07	VND/ha/yr	Value per annum	Vietnam	MC / RC	1999	No	Tri (2000)
1400	Biodiversity protection	723.43	USD/ha/yr	Value per annum (Range)	Micronesia	CV	1996	No	Naylor and Drew (1998)

18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
48	Recreation	1,720.99	LKR/ha/yr	Value per annum	Sri Lanka	TC	2002	Yes	Emerton and Kekulandala (2003)
362	Recreation	64	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
466	Recreation	10.83	USD/ha/yr	Value per annum	USA	TC	1983	No	Costanza et al. (1989)
739	Recreation	5,372.90	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
867	Recreation	14.83	USD/ha/yr	Value per annum	USA	TC	1985	No	Farber and Costanza (1987)
890	Recreation	140.85	USD/ha/yr	Value per annum	USA	BT	1968	No	Gosselink et al. (1974)
915	Recreation	4,034.00	USD/ha/yr	Value per annum (Range)	USA	BT	1993	No	Gren and Soderqvist (1994)
929	Recreation	200	USD/ha/yr	Value per annum	Trinidad and Tobago	BT	1974	No	Hamilton and Snedaker (1984)
1308	Recreation	15.04	USD/ha/yr	Value per annum	Nicaragua	CV	2000	No	Ammour et al. (2000)
1338	Recreation	3.18E+05	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
1347	Recreation	374.61	GBP/ha/yr	Value per annum	UK	BT	2008	No	Everard (2009)
103	Tourism	492.86	USD/ha/yr	Value per annum (Range)	Belize	DMP	2007	Yes	Cooper et al. (2009)
323	Tourism	3	USD/ha/yr	Value per annum	Malaysia	CV	1999	Yes	Bann (1999)
897	Tourism	190	USD/ha/yr	Value per annum	Italy	BT	1993	No	Gren and Soderqvist (1994)
1271	Tourism	154	USD/ha/yr	Value per annum	Philippines	DMP	1999	No	White et al. (2000)
1279	Tourism	423.92	USD/ha/yr	Value per annum	Malaysia	FI / PF	1989	No	Bennett and Reynolds (1993)
1394	Tourism	1.65E+05	VND/ha/yr	Value per annum	Vietnam	TC	1999	Yes	Tri (2000)

814	Hunting / fishing	1,506.96	USD/ha/yr	Value per annum	USA	DMP	1994	No	Bell (1989)
815	Hunting / fishing	110.03	USD/ha/yr	Value per annum	USA	CV	1987	No	Bergstrom et al. (1990)
917	Hunting / fishing	172.97	USD/ha/yr	Value per annum	USA	CV	1972	No	Gupta and Foster (1975)
1063	Hunting / fishing	902.48	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1275	Hunting / fishing	15,989.62	USD/ha/yr	Value per annum	USA	FI / PF	1984	Yes	Bell (1997)
1276	Hunting / fishing	2,424.00	USD/ha/yr	Value per annum	USA	FI / PF	1984	Yes	Bell (1997)
1469	Hunting / fishing	*39.36*	*USD/ha/yr*	*Value per annum*	*USA*	*CV*	*2007*	*Yes*	*Farber (1996)*
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
70	Various	344	USD/ha/yr	Value per annum	Cambodia	AC	2002	No	Emerton (ed) (2005)
898	Various	240	USD/ha/yr	Value per annum	Sweden	BT	1993	No	Gren and Soderqvist (1994)
899	Various	86	USD/ha/yr	Value per annum	Indonesia	BT	1993	No	Gren and Soderqvist (1994)
1296	Various	860	USD/ha/yr	Value per annum (Range)	Sweden	BT	1993	No	Gren and Soderqvist (1994)
24	**Other**								
	no values found								
25	**Total Economic Value**								

341	TEV	5,734.00	EUR/ha/yr	Value per annum	Europe	BT	2003	No	Brander et al. (2008)
342	TEV	4,112.00	EUR/ha/yr	Value per annum	Europe	BT	2003	No	Brander et al. (2008)
343	TEV	5,475.00	EUR/ha/yr	Value per annum	Europe	BT	2003	No	Brander et al. (2008)
364	TEV	15,147.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
467	TEV	23,976.83	USD/ha/yr	Value per annum (Range)	USA	TEV	1983	No	Costanza et al. (1989)
553	TEV	1,088.00	USD/ha/yr	Value per annum	Sri Lanka	TEV	1996	No	Gunawardena and Rowan (2005)
658	TEV	27,400.00	USD/ha	Net Present Value	Thailand	TEV	2001	No	Sathirathai and Barbier (2001)
659	TEV	35,700.00	USD/ha	Net Present Value	Thailand	TEV	2001	No	Sathirathai and Barbier (2001)
679	TEV	3,047.00	USD/ha/yr	Value per annum (Range)	World	TEV	1996	No	Spaninks and Van Beukering (1997)
741	TEV	60,709.10	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2008)
910	TEV	712	USD/ha/yr	TEV	Trinidad and Tobago	BT	1993	No	Gren and Soderqvist (1994)
911	TEV	2,217.00	USD/ha/yr	TEV	Puerto Rico	BT	1993	No	Gren and Soderqvist (1994)
931	TEV	500	USD/ha/yr	Value per annum	Trinidad and Tobago	BT	1974	No	Hamilton and Snedaker (1984)
932	TEV	1,550.00	USD/ha/yr	Value per annum	Puerto Rico	BT	1973	No	Hamilton and Snedaker (1984)
933	TEV	1,100.00	USD/ha/yr	Value per annum (Range)	Fiji Islands	BT	1976	No	Hamilton and Snedaker (1984)
1064	TEV	22,635.91	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1246	TEV	17,963.64	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1298	TEV	6,471.50	USD/ha/yr	TEV	USA	BT	1993	No	Gren and Soderqvist (1994)
1299	TEV	592	USD/ha/yr	TEV	Europe	BT	1993	No	Gren and Soderqvist (1994)

1300	TEV	123	USD/ha/yr	TEV	Asia	BT	1993	No	Gren and Soderqvist (1994)
1367	TEV	1.80E+07	GBP	Present Value	UK	BT	2007	No	Defra (2007)
1399	TEV	533.29	USD/ha/yr	Value per annum (Range)	Micronesia	TEV	1996	No	Naylor and Drew (1998)
26	**Provision of durable/sustainable Energy**								
	no values found								
27	**Cultural values combined or unspecified**								
363	Cultural values [unspecified]	445	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
1337	Cultural values [unspecified]	2,511.00	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
28	**Provisioning values combined or unspecified**								
657	Provisioning values [unspecified]	3,513.53	THB/ha/yr	Value per annum	Thailand	DMP	1995	No	Sathiratai (1998)
901	Provisioning values [unspecified]	1,972.50	USD/ha/yr	Value per annum (Range)	Thailand	BT	1993	No	Gren and Soderqvist (1994)
1297	Provisioning values [unspecified]	66.6	USD/ha/yr	TEV	USA	BT	1993	No	Gren and Soderqvist (1994)
29	**Regulating values combined or unspecified**								
1331	Regulating [unspecified]	2.53E+05	GBP/yr	Value per annum	UK	BT	2000	No	Everard (2009)
30	**Supporting values combined or unspecified**								
	no values found								

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II.5 ES-Values of Inland wetlands

Table II.5 Monetary values per service for Inland wetlands

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
57	Fish	2	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)
134	Fish	51	USD/ha/yr	Value per annum	Zambia	BT	1995	Yes	Seyam et al. (2001)
534	Fish	925	USD/ha/yr	Value per annum (Range)	Uganda	DMP	2005	Yes	Emerton et al. (1998)
545	Fish	1,133	USD/ha/yr	Value per annum (Range)	Laos	DMP	2003	No	Gerrard (2004)
956	Fish	43	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Kumari (1996)
1116	Fish	335,000	Riel/ha/yr	TEV	Cambodia	DMP	2005	No	Chong (2005)
1142	Fish	22,331	UGX/ha/yr	Value per annum	Uganda	DMP	2001	No	Karanja et al. (2001)
1148	Fish	533	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1166	Fish	6	USD/ha/yr	Value per annum	Uganda	DMP	2002	No	Schuijt (2002)
1168	Fish	10	USD/ha/yr	Value per annum	Nigeria	DMP	2002	No	Schuijt (2002)
1172	Fish	78	USD/ha/yr	Value per annum	Malawi	DMP	2002	No	Schuijt (2002)
1176	Fish	26	USD/ha/yr	Value per annum	Southern Africa	DMP	2002	No	Schuijt (2002)
1182	Fish	9	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Turpie et al. (1999)
1187	Fish	5	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1192	Fish	15	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1222	Fish	10	EUR/ha/yr	Value per annum	Cameroon	DMP	2002	No	Loth (ed) (2004)
56	Meat	2	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)

1155	Meat	6	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1175	Meat	3	USD/ha/yr	Value per annum	Malawi	DMP	2002	No	Schuijt (2002)
1177	Meat	24	USD/ha/yr	Value per annum	Southern Africa	DMP	2002	No	Schuijt (2002)
1181	Meat	6	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Turpie et al. (1999)
1183	Meat	0	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Turpie et al. (1999)
1186	Meat	9	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1188	Meat	1	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1193	Meat	11	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1194	Meat	0	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1223	Meat	18	EUR/ha/yr	Value per annum	Cameroon	FI / PF	2002	No	Loth (ed) (2004)
52	Plants / vegetable food	263	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)
135	Plants / vegetable food	128	USD/ha/yr	Value per annum	Zambia	BT	1994	Yes	Seyam et al. (2001)
531	Plants / vegetable food	940	USD/ha/yr	Value per annum	Uganda	DMP	2005	Yes	Emerton et al. (1998)
1127	Plants / vegetable food	67,068	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1154	Plants / vegetable food	330	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1163	Plants / vegetable food	1	USD/ha/yr	Value per annum	Botswana	DMP	2003	No	Mmopelwa et al. (2009)
1170	Plants / vegetable food	0	USD/ha/yr	Value per annum	Nigeria	DMP	2002	No	Schuijt (2002)
1190	Plants / vegetable food	0	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1196	Plants / vegetable food	2	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
83	NTFPs [food only!]	7,397	CNY/ha/yr	Value per annum	China	DMP	2004	Yes	Tong et al. (2007)

906	NTFPs [food only!]	290	USD/ha/yr	Value per annum	Czech Republic	BT	1993	Yes	Gren and Soderqvist (1994)
1156	NTFPs [food only!]	88	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
157	Food [unspecified]	53	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
810	Food [unspecified]	12	USD/ha/yr	Value per annum	Africa	DMP	1994	Yes	Barbier et al. (1991)
1067	Food [unspecified]	51	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1071	Food [unspecified]	1,051	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1078	Food [unspecified]	47	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
2	**(Fresh) water supply**								
1118	Drinking water	335,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1145	Drinking water	46,317	UGX/ha/yr	Value per annum	Uganda	RC	2001	Yes	Karanja et al. (2001)
1117	Water Other	335,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1125	Irrigation water [unnatural]	134,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1143	Irrigation water [unnatural]	725,000	UGX/ha/yr	Value per annum	Uganda	RC	2001	No	Karanja et al. (2001)
149	Water [unspecified]	1,977	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
392	Water [unspecified]	3,815	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
402	Water [unspecified]	4,747	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
662	Water [unspecified]	45	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)

918	Water [unspecified]	128,000	USD/ha/yr	Value per annum	USA	DMP	1972	No	Gupta and Foster (1975)
1031	Water [unspecified]	249,000	USD/ha/yr	Value per annum	USA	AC	1981	No	Thibodeau and Ostro (1981)
1083	Water [unspecified]	7,600	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1174	Water [unspecified]	2	USD/ha/yr	Value per annum	Malawi	DMP	2002	No	Schuijt (2002)
1205	Water [unspecified]	5,200,000	USD	Net Present Value	Zambia	RC	1999	Yes	Turpie et al. (1999)
1208	Water [unspecified]	500,000	USD	Net Present Value	Southern Africa	RC	1999	No	Turpie et al. (1999)
1213	Water [unspecified]	7,500,000	USD	Net Present Value	Southern Africa	RC	1999	No	Turpie et al. (1999)
1225	Water [unspecified]	0	EUR/ha/yr	Value per annum	Cameroon	MC / RC	2002	No	Loth (ed) (2004)
1327	Water [unspecified]	180,000	MNT/ha/yr	Value per annum	Mongolia	FI / PF	2009	No	Emerton et al. (2009)
1350	Water [unspecified]	400	GBP/yr	Value per annum	UK	AC	2010	No	Everard and Jevons (2010)
1470	*Water [unspecified]*	*39*	*USD/ha/yr*	*Value per annum*	*Sweden*	*RC*	*2007*	*Yes*	*Folke (2001)*
1471	*Water [unspecified]*	*3*	*USD/ha/yr*	*Value per annum*	*Bangladesh*	*FI / PF*	*2007*	*Yes*	*Islam and Braden (2006)*
3	**Provisioning of Raw material**								
529	Fibers	10	USD/ha/yr	Value per annum	Uganda	DMP	1998	Yes	Emerton and Muramira (1999)
532	Fibers	2,295	USD/ha/yr	Value per annum (Range)	Uganda	DMP	2005	Yes	Emerton et al. (1998)
1131	Fibers	1,400	DKK/ha/yr	Value per annum	Denmark	DMP	2000	No	Dubgaard et al. (2002)
1151	Fibers	349	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al.

									(2008)
1159	Fibers	29	USD/ha/yr	Value per annum	Botswana	DMP	2003	No	Mmopelwa et al. (2009)
1160	Fibers	11	USD/ha/yr	Value per annum	Botswana	DMP	2003	No	Mmopelwa et al. (2009)
1161	Fibers	0	USD/ha/yr	Value per annum	Botswana	DMP	2003	No	Mmopelwa et al. (2009)
1164	Fibers	18	USD/ha/yr	Value per annum	Uganda	DMP	2002	No	Schuijt (2002)
1173	Fibers	0	USD/ha/yr	Value per annum	Malawi	DMP	2002	No	Schuijt (2002)
1184	Fibers	1	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Turpie et al. (1999)
1189	Fibers	3	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1195	Fibers	14	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
1224	Fibers	2	EUR/ha/yr	Value per annum	Cameroon	DMP	2002	No	Loth (ed) (2004)
1150	Timber	221	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
55	Fuel wood and charcoal	33	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)
663	Fuel wood and charcoal	14	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
811	Fuel wood and charcoal	6	USD/ha/yr	Value per annum	Africa	DMP	1994	Yes	Barbier et al. (1991)
1121	Fuel wood and charcoal	201,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1149	Fuel wood and charcoal	979	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1162	Fuel wood and charcoal	2	USD/ha/yr	Value per annum	Botswana	DMP	2003	No	Mmopelwa et al. (2009)
1169	Fuel wood and charcoal	5	USD/ha/yr	Value per annum	Nigeria	DMP	2002	No	Schuijt (2002)
137	Fodder	10	USD/ha/yr	Value per annum	Zambia	BT	1982	Yes	Seyam et al. (2001)
53	Other Raw	65	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)
118	Other Raw	1	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)

1072	Other Raw	336	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1141	Other Raw	101,000	UGX/ha/yr	Value per annum	Uganda	DMP	2001	No	Karanja et al. (2001)
1171	Other Raw	0	USD/ha/yr	Value per annum	Nigeria	DMP	2002	No	Schuijt (2002)
158	Raw materials [unspecified]	75	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
664	Raw materials [unspecified]	45	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
957	Raw materials [unspecified]	13	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Kumari (1996)
1068	Raw materials [unspecified]	105	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1079	Raw materials [unspecified]	60	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1437	*Raw materials [unspecified]*	*184*	*USD/ha/yr*	*Value per annum*	*Austria*	*DMP*	*2007*	*Yes*	*Kosz et al (1992)*
533	Sand, rock, gravel	2,120	USD/ha/yr	Value per annum	Uganda	DMP	2005	Yes	Emerton et al. (1998)
1120	Sand, rock, gravel	201,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1158	Sand, rock, gravel	66	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1165	Sand, rock, gravel	33	USD/ha/yr	Value per annum	Uganda	DMP	2002	No	Schuijt (2002)
1185	Sand, rock, gravel	0	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Turpie et al. (1999)
1197	Sand, rock, gravel	1	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)

1153	Dyes, oils, cosmeitcs (Natural raw material for)	20	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1157	Dyes, oils, cosmeitcs (Natural raw material for)	9	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
4	**Provision of genetic resources**								
159	Genetic resources [unspecified]	8	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
5	**Provisioning of medical resources**								
140	Biochemicals	66	USD/ha/yr	Value per annum	Zambia	BT	1994	Yes	Seyam et al. (2001)
1126	Biochemicals	134,000	Riel/ha/yr	TEV	Cambodia	TEV	2005	No	Chong (2005)
1152	Biochemicals	365	TZS/ha/yr	Value per annum	Tanzania	DMP	2007	No	Kasthala et al. (2008)
1180	Biochemicals	1	USD/ha/yr	Value per annum	Southern Africa	BT	2002	No	Schuijt (2002)
567	Bioprospecting	0	USD/ha/yr	Value per annum	Uganda	DMP	1995	No	Phillips (ed) (1998)
6	**Provisioning of ornamental resources**								
54	Decorations / Handicrafts	66	USD/ha/yr	Value per annum	South Africa	DMP	2006	Yes	Adekola et al. (2008)
7	**Influence on air quality**								
	no values found								
8	**Climate regulation**								
39	C-sequestration	0	CAD/ha	TEV	Canada	BT	2002	No	Anielski and Wilson (2005)
40	C-sequestration	5	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
130	C-sequestration	15	USD/ha/yr	Value per annum	Tanzania	BT	2000	Yes	Turpie (2000)
952	C-sequestration	265	USD/ha/yr	Value per annum	Malaysia	AC	1994	Yes	Kumari (1996)

1207	C-sequestration	27,000,000	USD	Net Present Value	Zambia	MC / RC	1999	No	Turpie et al. (1999)
1211	C-sequestration	11,000,000	USD	Net Present Value	Southern Africa	MC / RC	1999	No	Turpie et al. (1999)
1215	C-sequestration	8,000,000	USD	Net Present Value	Southern Africa	MC / RC	1999	No	Turpie et al. (1999)
1352	C-sequestration	240	GBP/yr	Value per annum	UK	BT	2007	No	Everard and Jevons (2010)
146	Climate regulation [unspecified]	45	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
389	Climate regulation [unspecified]	311	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
145	Gas regulation	67	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
9	**Moderation of extreme events**								
1069	Storm protection	2,685	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
37	Flood prevention	571	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
41	Flood prevention	926	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
165	Flood prevention	712	USD/ha/yr	Value per annum	New Zealand	AC	2007	Yes	Dep. of Cons. (2007)
522	Flood prevention	1,750	USD/ha/yr	Value per annum	Sri Lanka	MC / RC	2003	Yes	Emerton and Bos (2004)
546	Flood prevention	1,421	USD/ha/yr	Value per annum	Laos	AC	2003	No	Gerrard (2004)
665	Flood prevention	464	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
919	Flood prevention	3,677	USD/ha/yr	Value per annum	USA	AC	1972	No	Gupta and Foster (1975)
1032	Flood prevention	82,459	USD/ha/yr	Value per annum	USA	AC	1981	No	Thibodeau and

1076	Flood prevention	7,240	USD/ha/yr	Value per annum	World	BT	1994	No	Ostro (1981) Costanza et al. (1997)
1082	Flood prevention	3,341	USD/ha/yr	Value per annum	USA	AC	1994	Yes	Costanza et al. (1997)
1132	Flood prevention	103	DKK/ha/yr	Value per annum	Denmark	AC	1998	No	Dubgaard et al. (2002)
1204	Flood prevention	400,000	USD	Net Present Value	Zambia	AC	1999	No	Turpie et al. (1999)
1212	Flood prevention	2,700,000	USD	Net Present Value	Southern Africa	AC	1999	No	Turpie et al. (1999)
147	Prevention of extreme events [unspecified]	1,747	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
390	Prevention of extreme events [unspecified]	9,037	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
401	Prevention of extreme events [unspecified]	217	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
10	**Regulation of water flows**								
51	Natural irrigation	413	NGN/ha/yr	Value per annum	Nigeria	FI / PF	2000	Yes	Acharya and Barbier (2000)
148	Water regulation [unspecified]	379	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
391	Water regulation [unspecified]	7,378	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
1471	*River discharge*	*9,369*	*USD/ha/yr*	*Value per annum*	*UK*	*AC*	*2007*	*Yes*	*UK Environment Agency (1999)*
1473	*River discharge*	*8,484*	*USD/ha/yr*	*Value per annum*	*USA*	*RC*	*2007*	*Yes*	*Leschine et al. (1997)*
11	**Waste treatment / water purification**								

80	Water purification	2,000	USD/ha/yr	Value per annum	Uganda	RC	1999	Yes	Emerton (ed) (2005)
81	Water purification	3,500	USD/ha/yr	Value per annum	Uganda	MC / RC	1999	Yes	Emerton (ed) (2005)
253	Water purification	354	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
393	Water purification	2,071	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
530	Water purification	3,407	USD/ha/yr	Value per annum (Range)	Uganda	DMP	2005	Yes	Emerton et al. (1998)
547	Water purification	36	USD/ha/yr	Value per annum	Laos	RC	2003	No	Gerrard (2004)
549	Water purification	50	EUR/ha/yr	Value per annum	Europe	BT	1995	Yes	Gren et al. (1995)
597	Water purification	8,068	EUR/ha/yr	Value per annum	Germany	AC	2000	No	Meyerhoff and Dehnhardt (2004)
666	Water purification	288	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
905	Water purification	256	USD/ha/yr	Value per annum	Austria	BT	1993	Yes	Gren and Soderqvist (1994)
1130	Water purification	2,727	DKK/ha	Present Value	Denmark	RC	1998	No	Dubgaard et al. (2002)
1146	Water purification	13,028	UGX/ha/yr	Value per annum	Uganda	RC	2001	No	Karanja et al. (2001)
1167	Water purification	1,830	USD/ha/yr	Value per annum (Range)	Uganda	RC	2002	No	Schuijt (2002)
1206	Water purification	11,300,000	USD	Net Present Value	Zambia	RC	1999	No	Turpie et al. (1999)
1210	Water purification	1,600,000	USD	Net Present Value	Southern Africa	RC	1999	No	Turpie et al. (1999)
1214	Water purification	18,400,000	USD	Net Present Value	Southern Africa	RC	1999	No	Turpie et al. (1999)

153	Waste treatment [unspecified]	505	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
953	Waste treatment [unspecified]	30	USD/ha/yr	Value per annum	Malaysia	FI / PF	1994	Yes	Kumari (1996)
972	Waste treatment [unspecified]	324	USD/ha/yr	Value per annum	USA	CV	1994	Yes	Lant and Roberts (1990)
1033	Waste treatment [unspecified]	41,909	USD/ha/yr	Value per annum	USA	RC	1981	No	Thibodeau and Ostro (1981)
1066	Waste treatment [unspecified]	293	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1077	Waste treatment [unspecified]	1,659	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1084	Waste treatment [unspecified]	3,024	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
12	**Erosion prevention**								
150	Erosion prevention	63	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
1209	Erosion prevention	8,900,000	USD	Net Present Value	Southern Africa	AC	1999	No	Turpie et al. (1999)
1353	Erosion prevention	600	GBP/yr	Value per annum	UK	BT	2010	No	Everard and Jevons (2010)
1353	Erosion prevention	600	GBP/yr	Value per annum	UK	BT	2010	No	Everard and Jevons (2010)
13	**Nutrient cycling and maintenance of soil fertility**								
551	Deposition of nutrients	212	EUR/ha/yr	Value per annum	Europe	BT	1995	Yes	Gren et al. (1995)
1144	Deposition of nutrients	9,688	EUR/ha/yr	Value per annum	Uganda	RC	2001	No	Karanja et al. (2001)
1474	*Deposition of nutrients*	*4,588*	*USD/ha/yr*	*Value per annum*	*Sweden*	*RC*	*2007*	*Yes*	*Bystrom (2000)*
151	Soil formation	22	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)

152	Nutrient cycling	185	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
14	**Pollination**								
154	Pollination [unspecified]	12	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
15	**Biological Control**								
1351	Disease control	108	GBP/yr	Value per annum	UK	BT	2009	No	Everard and Jevons (2010)
155	Biological Control [unspecified]	11	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
16	**Lifecycle maintenance (esp. nursery service)**								
668	Nursery service	201	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
1147	Nursery service	10,500	UGX/ha/yr	Value per annum	Uganda	BT	2000	No	Karanja et al. (2001)
1475	*Nursery service*	*10*	*USD/ha/yr*	*Value per annum*	*Sweden*	*RC*	*2007*	*Yes*	*Folke (2001)*
1476	*Nursery service*	*917*	*UGX/ha/yr*	*Value per annum*	*Laos*	*DMP*	*2007*	*Yes*	*Gerrard (2004)*
17	**Protection of gene pool (Conservation)**								
38	Biodiversity protection	263	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
79	Biodiversity protection	6,642	XOF/ha/yr	Value per annum	Senegal	CV	2003	Yes	Ly et al. (2006)
136	Biodiversity protection	0	USD/ha/yr	Value per annum	Zambia	BT	1994	Yes	Seyam et al. (2001)
138	Biodiversity protection	0	USD/ha/yr	Value per annum	Zambia	BT	1994	Yes	Seyam et al. (2001)
156	Biodiversity protection	106	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)

167	Biodiversity protection	302	USD/ha/yr	Value per annum	New Zealand	DMP	2007	No	Dep. of Cons. (2007)
394	Biodiversity protection	279	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
596	Biodiversity protection	2,812	AUD/ha/yr	Value per annum	Australia	CV	1998	Yes	Mallawaarachchi et al. (2001)
667	Biodiversity protection	214	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
914	Biodiversity protection	34	USD/ha/yr	Value per annum	UK	BT	1993	Yes	Gren and Soderqvist (1994)
955	Biodiversity protection	20	USD/ha/yr	Value per annum	Malaysia	CV	1994	Yes	Kumari (1996)
1085	Biodiversity protection	439	USD/ha/yr	Value per annum	World	BT	1994	No	Costanza et al. (1997)
1122	Biodiversity protection	134,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1123	Biodiversity protection	134,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1124	Biodiversity protection	134,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1128	Biodiversity protection	67,068	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1139	Biodiversity protection	1,207	DKK/ha/yr	Value per annum	Denmark	BT	1994	No	Dubgaard et al. (2002)
1140	Biodiversity protection	12	AUD/ha/yr	Value per annum	Australia	BT	2005	No	Donaghy et al. (2007)
1219	Biodiversity protection	16,700,000	USD	Net Present Value	Southern Africa	CV	1999	No	Turpie et al. (1999)
1220	Biodiversity protection	4,230,000	USD	Net Present Value	Zambia	CV	1999	No	Turpie et al. (1999)
1312	Biodiversity protection	10,700,000	USD	Present Value	France	CV	2001	No	Amigues et al. (2002)

1358	Biodiversity protection	1,618	GBP/yr	Value per annum	UK	MC / RC	2010	No	Everard and Jevons (2010)
1366	Biodiversity protection	54	USD/ha/yr	Value per annum (Range)	UK	CV	2007	No	Luisetti et al. (2008)
18	**Aesthetic information**								
1035	Attractive landscapes	781	USD/ha/yr	Value per annum (Range)	USA	HP	1981	No	Thibodeau and Ostro (1981)
1477	*Attractive landscapes*	*83*	*USD/ha/yr*	*Value per annum*	*USA*	*HP*	*2007*	*Yes*	*Amacher (1989)*
1478	*Attractive landscapes*	*3,906*	*USD/ha/yr*	*Value per annum*	*Australia*	*CV*	*2007*	*Yes*	*Gerrans (1994)*
19	**Opportunities for recreation and tourism**								
395	Recreation	3,474	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
403	Recreation	3,385	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
904	Recreation	1,500	USD/ha/yr	Value per annum	Austria	BT	1993	No	Gren and Soderqvist (1994)
907	Recreation	133	USD/ha/yr	Value per annum	Austria	BT	1993	Yes	Gren and Soderqvist (1994)
908	Recreation	146	USD/ha/yr	Value per annum	Australia	BT	1993	Yes	Gren and Soderqvist (1994)
958	Recreation	6	USD/ha/yr	Value per annum	Malaysia	TC	1994	Yes	Kumari (1996)
973	Recreation	324	USD/ha/yr	Value per annum	USA	CV	1994	Yes	Lant and Roberts (1990)
1034	Recreation	50,200	USD/ha/yr	Value per annum (Range)	USA	BT	1981	No	Thibodeau and Ostro (1981)
1073	Recreation	750	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1080	Recreation	666	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
1129	Recreation	67,068	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)

1138	Recreation	1,818	DKK/ha/yr	Value per annum	Denmark	BT	2000	No	Dubgaard et al. (2002)
1354	Recreation	828	GBP/yr	Value per annum	UK	DMP	2010	No	Everard and Jevons (2010)
160	Tourism	157	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)
1355	Tourism	2,147	GBP/yr	Value per annum	UK	BT	2010	No	Everard and Jevons (2010)
1369	Tourism	5,565	ATS/ha/yr	Value per annum	Austria	BT	1994	No	Kosz (1996)
139	Ecotourism	1	USD/ha/yr	Value per annum	Zambia	BT	1994	Yes	Seyam et al. (2001)
550	Ecotourism	101	EUR/ha/yr	Value per annum	Europe	BT	1995	Yes	Gren et al. (1995)
670	Ecotourism	492	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
1178	Ecotourism	0	USD/ha/yr	Value per annum	Southern Africa	BT	2002	No	Schuijt (2002)
1191	Ecotourism	1	USD/ha/yr	Value per annum	Southern Africa	DMP	1999	No	Turpie et al. (1999)
166	Hunting / fishing	40	USD/ha/yr	Value per annum	New Zealand	DMP	2007	Yes	Dep. of Cons. (2007)
669	Hunting / fishing	374	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
671	Hunting / fishing	123	USD/ha/yr	Value per annum	World	BT	2000	No	Schuyt and Brander (2004)
1134	Hunting / fishing	600	DKK/ha/yr	Value per annum	Denmark	FI / PF	2002	No	Dubgaard et al. (2002)
1135	Hunting / fishing	400	DKK/ha/yr	Value per annum	Denmark	FI / PF	2002	No	Dubgaard et al. (2002)
1136	Hunting / fishing	400	DKKha/yr	Value per annum	Denmark	FI / PF	2002	No	Dubgaard et al. (2002)
1137	Hunting / fishing	18,400	DKK/ha/yr	Value per annum (Range)	Denmark	BT	2000	No	Dubgaard et al. (2002)
20	**Inspiration for culture, art and design**								
161	Cultural use	425	USD/ha/yr	Value per annum	Brazil	BT	1994	Yes	Seidl and Moraes (2000)

1479	*Cultural use*	*793*	*USD/ha/yr*	*Value per annum*	*New Zealand*	*CV*	*2007*	*Yes*	*Kirkland (1988)*
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
63	Various	0	USD/ha/yr	Value per annum	Zambia	DMP	1999	No	Emerton (ed) (2005)
1370	Various	329	ATS/pp/yr	Value per annum	Austria	CV	1994	No	Kosz (1996)
24	**Other**								
	no values found								
25	**Total Economic Value**								
338	TEV	38,598	EUR/ha/yr	Value per annum (Range)	Europe	BT	2003	No	Brander et al. (2008)
339	TEV	4,129	EUR/ha/yr	Value per annum	Europe	BT	2003	No	Brander et al. (2008)
340	TEV	214	EUR/ha/yr	Value per annum	Europe	BT	2003	No	Brander et al. (2008)
347	TEV	28,585	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
400	TEV	8,359	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
552	TEV	374	EUR/ha/yr	Value per annum	Europe	TEV	1995	No	Gren et al. (1995)
912	TEV	123	USD/ha/yr	Value per annum (Range)	Australia	BT	1993	No	Gren and Soderqvist (1994)
913	TEV	6	USD/ha/yr	TEV	Nigeria	BT	1993	No	Gren and Soderqvist (1994)
1036	TEV	425,000	USD/ha/yr	Value per annum (Range)	USA	TEV	1981	No	Thibodeau and Ostro (1981)

1074	TEV	11,687	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1075	TEV	12,658	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1081	TEV	20,098	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1086	TEV	19,563	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1247	TEV	35,208	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1329	TEV	1.37E+12	MNT	Present Value	Mongolia	TEV	2009	No	Emerton et al. (2009)
1359	TEV	8,599	GBP/yr	TEV	UK	TEV	2010	No	Everard and Jevons (2010)
26	**Provision of durable/sustainable Energy**								
	no values found								
27	**Cultural values combined or unspecified**								
397	Cultural values [unspecified]	2,199	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
404	Cultural values [unspecified]	10	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
920	Cultural values [unspecified]	667	USD/ha/yr	Value per annum	USA	CV	1972	No	Gupta and Foster (1975)
1357	Cultural values [unspecified]	1,450	GBP/yr	Value per annum	UK	BT	2009	No	Everard and Jevons (2010)
28	**Provisioning values combined or unspecified**								
548	Provisioning values [unspecified]	61	EUR/ha/yr	Value per annum	Europe	BT	1995	No	Gren et al. (1995)
593	Provisioning values [unspecified]	17,600	USD/ha	Net Present Value	Uganda	DMP	2002	No	Maclean et al. (2003)

1119	Provisioning values [unspecified]	268,000	Riel/ha/yr	TEV	Cambodia	GV	2005	No	Chong (2005)
1328	Provisioning values [unspecified]	56,000	MNT/ha/yr	Value per annum	Mongolia	FI / PF	2009	No	Emerton et al. (2009)
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.6 ES-Values of Fresh water / rivers and lakes

Table II.6 Monetary values per service for fresh water / rivers and lakes

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
90	Fish	2,299.34	INR/ha/yr	Value per annum	India	DMP	1999	Yes	Verma (2001)
1018	Fish	41.00	USD/ha/yr	Value per annum (Range)	World	DMP	1994	Yes	Postel and Carpenter (1997)
726	Food [unspecified]	96.80	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
2	**(Fresh) water supply**								
89	Drinking water	29,816.86	INR/ha/yr	Value per annum	India	AC	1999	No	Verma (2001)
878	Water Other	211.50	USD/ha/yr	Value per annum (Range)	USA	DMP	1994	No	Gibbons (1986)
879	Water Other	333.00	USD/ha/yr	Value per annum (Range)	USA	DMP	1994	No	Gibbons (1986)
880	Water Other	157.00	USD/ha/yr	Value per annum (Range)	Canada	DMP	1994	No	Gibbons (1986)
875	Irrigation water [unnatural]	1,447.50	USD/ha/yr	Value per annum (Range)	USA	DMP	1994	No	Gibbons (1986)
876	Irrigation water [unnatural]	1,358.00	USD/ha/yr	Value per annum	USA	DMP	1994	No	Gibbons (1986)

				(Range)					
877	Irrigation water [unnatural]	367.50	USD/ha/yr	Value per annum (Range)	USA	DMP	1994	No	Gibbons (1986)
396	Water [unspecified]	1,011.00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
729	Water [unspecified]	19,749.10	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
1088	Water [unspecified]	2,117.00	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
3	**Provisioning of Raw material**								
727	Raw materials [unspecified]	9.70	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
4	**Provision of genetic resources**								
	no values found								
5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
	no values found								
8	**Climate regulation**								
732	Climate regulation [unspecified]	445.30	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
9	**Moderation of extreme events**								
	no values found								
10	**Regulation of water flows**								
	no values found								

11	**Waste treatment / water purification**								
91	Water purification	3,886.21	INR/ha/yr	Value per annum	India	AC	1999	Yes	Verma (2001)
736	Water purification	17,619.30	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
881	Waste treatment [unspecified]	665.00	USD/ha/yr	Value per annum (Range)	USA	RC	1994	No	Gibbons (1986)
12	**Erosion prevention**								
	no values found								
13	**Nutrient cycling and maintenance of soil fertility**								
734	Maintenance of soil structure	9.70	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
14	**Pollination**								
	no values found								
15	**Biological Control**								
	no values found								
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
738	Biodiversity protection	2,410.60	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2010)
18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
92	Recreation	15,146.55	INR/ha/yr	Value per annum	India	CV	1999	Yes	Verma (2001)
170	Recreation	765.96	USD/ha/yr	Value per annum (Range)	Kenya	TC	1991	Yes	Navrud and Mungatana (1994)

171	Recreation	398.94	USD/ha/yr	Value per annum	Kenya	CV	1991	Yes	Navrud and Mungatana (1994)
399	Recreation	880.00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
740	Recreation	4,201.50	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
1019	Recreation	230.00	USD/ha/yr	Value per annum (Range)	USA	DMP	1994	Yes	Postel and Carpenter (1997)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
113	Various	1.91	USD/ha/yr	Value per annum (Range)	USA	CV	2000	No	Loomis et al. (2000)
133	Various	28.37	CNY/ha/yr	Value per annum	China	CV	2002	No	Xu et al. (2003)
24	**Other**								
	no values found								
25	**Total Economic Value**								
398	TEV	1,890.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
742	TEV	44,542.00	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2010)
1089	TEV	8,498.09	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)

1248	TEV	15,280.78	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
26	**Provision of durable/sustainable Energy**								
871	Hydro-electricity	4,480.00	USD/ha/yr	Value per annum	USA	DMP	1994	No	Gibbons (1986)
872	Hydro-electricity	1,160.00	USD/ha/yr	Value per annum	USA	DMP	1994	No	Gibbons (1986)
873	Hydro-electricity	3,650.00	USD/ha/yr	Value per annum	USA	DMP	1994	No	Gibbons (1986)
1087	Hydro-electricity	5,445.00	USD/ha/yr	Value per annum (Range)	World	BT	1994	No	Costanza et al. (1997)
27	**Cultural values combined or unspecified**								
	no values found								
28	**Provisioning values combined or unspecified**								
	no values found								
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.7 ES-Values of Tropical forests

Table II.7 Monetary values per service for tropical forests

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
5	Fish	13.2	USD/ha/yr	Value per annum	Indonesia	DMP	2000	Yes	Van Beukering et al. (2003)
603	Meat	15.6	USD/ha	Net Present Value	Paraguay	DMP	2005	No	Naidoo and Ricketts (2006)
228	Plants / vegetable food	2.1	NPR/ha/yr	Value per annum	Nepal	DMP	2003	Yes	Regmi (2003)
12	NTFPs [food only!]	22.74	USD/ha/yr	Value per annum	Indonesia	DMP	1999	Yes	Van Beukering et al. (2003)
17	NTFPs [food only!]	3.7	USD/ha/yr	Value per annum	India	DMP	2000	Yes	Verma (2000)
23	NTFPs [food only!]	9.3	USD/ha/yr	Value per annum	Laos	DMP	2003	Yes	Rosales et al. (2005)
93	NTFPs [food only!]	12.8	USD/ha/yr	Value per annum	Laos	GV	2003	Yes	Rosales et al. (2005)
211	NTFPs [food only!]	1.95	ZAR/ha/yr	Value per annum	South Africa	DMP	2000	Yes	Turpie(2003b)
299	NTFPs [food only!]	330	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
309	NTFPs [food only!]	191.5	USD/ha/yr	Value per annum (Range)	Cambodia	DMP	1996	Yes	Bann (1997)
312	NTFPs [food only!]	2,309.50	USD/ha	Net Present Value	Cambodia	DMP	1996	No	Bann (1997)
419	NTFPs [food only!]	50	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
508	NTFPs [food only!]	0.34	USD/ha/yr	Value per annum	Belize	BT	1994	No	Eade and Moran (1996)
526	NTFPs [food only!]	10.2	USD/ha/yr	Value per annum	Uganda	DMP	1998	Yes	Emerton and Muramira (1999)
584	NTFPs [food only!]	55	USD/ha/yr	Value per annum (Range)	Cameroon	BT	2001	Yes	Lescuyer (2007)
599	NTFPs [food only!]	707.5	USD/ha/yr	Value per annum (Range)	Brazil	DMP	1995	No	Muniz-Miret et al. (1996)

600	NTFPs [food only!]	1,216.00	USD/ha/yr	Value per annum (Range)	Brazil	DMP	1995	No	Muniz-Miret et al. (1996)
745	NTFPs [food only!]	74	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
766	NTFPs [food only!]	75	USD/ha/yr	Value per annum (Range)	South America	BT	2007	Yes	Verweij et al. (2009)
916	NTFPs [food only!]	115.29	USD/ha/yr	Value per annum	Ecuador	DMP	1994	No	Grimes et al. (1994)
1303	NTFPs [food only!]	6.2	GBP/ha/yr	Value per annum	Cameroon	DMP	2000	No	Yaron (2001)
207	Food [unspecified]	0.22	ZAR/ha/yr	Value per annum	South Africa	DMP	2000	Yes	Turpie(2003b)
225	Food [unspecified]	7.1	USD/ha/yr	Value per annum	Bolivia	DMP	1999	Yes	Godoy et al. (2002)
226	Food [unspecified]	7.8	USD/ha/yr	Value per annum	Honduras	DMP	1999	Yes	Godoy et al. (2002)
484	Food [unspecified]	5.64	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
720	Food [unspecified]	96.8	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
882	Food [unspecified]	33.91	USD/ha/yr	Value per annum	Peru	DMP	1994	Yes	Godoy et al. (1993)
962	Food [unspecified]	7.38	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Kumari (1996)
1015	Food [unspecified]	40.13	USD/ha/yr	Value per annum	Peru	DMP	1994	Yes	Pinedo-Vasquez et al. (1992)
1481	*Food [unspecified]*	*8.18*	*USD/ha/yr*	*Value per annum*	*World*	*DMP*	*2007*	*Yes*	*Krutilla (1991)*
1482	*Food [unspecified]*	*104.92*	*USD/ha/yr*	*Value per annum*	*World*	*DMP*	*2007*	*Yes*	*Krutilla (1991)*
2	**(Fresh) water supply**								
4	Water [unspecified]	1.56E+09	USD	Net Present Value	Indonesia	AC	2000	No	Van Beukering et al. (2003)
486	Water [unspecified]	10.15	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
716	Water [unspecified]	3,097.90	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)

961	Water [unspecified]	7.63	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Kumari (1996)
3	**Provisioning of Raw material**								
13	Timber	1.00E+09	USD	Net Present Value	Indonesia	DMP	2000	No	Van Beukering et al. (2003)
15	Timber	9.13	USD/ha/yr	Value per annum	India	DMP	2000	Yes	Verma (2000)
24	Timber	10.5	USD/ha/yr	Value per annum	Laos	DMP	2003	Yes	Rosales et al. (2005)
310	Timber	24	USD/ha/yr	Value per annum	Cambodia	DMP	1996	Yes	Bann (1997)
311	Timber	122	USD/ha/yr	Value per annum	Cambodia	DMP	1996	Yes	Bann (1997)
313	Timber	408	USD/ha	Net Present Value	Cambodia	DMP	1996	No	Bann (1997)
314	Timber	1,697.00	USD/ha	Net Present Value	Cambodia	DMP	1996	No	Bann (1997)
421	Timber	230	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
422	Timber	148	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
582	Timber	56	USD/ha/yr	Value per annum	Cameroon	BT	2001	Yes	Lescuyer (2007)
602	Timber	27.6	USD/ha	Net Present Value	Paraguay	DMP	2005	No	Naidoo and Ricketts (2006)
607	Timber	85,182.00	THB/ha	Net Present Value	Thailand	DMP	1997	No	Niskanen (1998)
744	Timber	307	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
767	Timber	517	USD/ha	Net Present Value	Brazil	BT	2007	No	Verweij et al. (2009)
947	Timber	26	USD/ha/yr	Value per annum	USA	BT	1989	No	Kramer et al. (1992)
1301	Timber	112.5	USD/yr	Value per annum	Venezuela	DMP	1977	No	Farnworth et al. (1983)
1302	Timber	104	GBP/ha	Net Present Value	Cameroon	DMP	2000	No	Yaron (2001)
14	Fuel wood and charcoal	41.74	USD/ha/yr	Value per annum	India	DMP	2000	Yes	Verma (2000)
420	Fuel wood and charcoal	40	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
525	Fuel wood and charcoal	21.2	USD/ha/yr	Value per annum	Uganda	DMP	1998	Yes	Emerton and Muramira (1999)
583	Fuel wood and charcoal	61	USD/ha/yr	Value per annum	Cameroon	BT	2001	Yes	Lescuyer (2007)
1306	Fuel wood and charcoal	16.9	USD/ha/yr	Value per annum (Range)	India	BT	1986	No	Chopra (1993)

16	Fodder	40.43	USD/ha/yr	Value per annum	India	DMP	2000	Yes	Verma (2000)
1307	Fodder	29.2	USD/ha/yr	Value per annum (Range)	India	BT	1983	No	Chopra (1993)
109	Other Raw	0.44	USD/ha/yr	Value per annum	Indonesia	DMP	1999	Yes	Van Beukering et al. (2003)
206	Raw materials [unspecified]	26.03	ZAR/ha/yr	Value per annum	South Africa	DMP	2000	Yes	Turpie(2003b)
496	Raw materials [unspecified]	6.81	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
721	Raw materials [unspecified]	2,517.00	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
823	Raw materials [unspecified]	66.67	USD/ha/yr	Value per annum	India	BT	1990	Yes	Chopra (1993)
883	Raw materials [unspecified]	214.15	USD/ha/yr	Value per annum	Brazil	DMP	1994	Yes	Godoy et al. (1993)
884	Raw materials [unspecified]	1,010.07	USD/ha/yr	Value per annum	India	DMP	1994	Yes	Godoy et al. (1993)
885	Raw materials [unspecified]	115.83	USD/ha/yr	Value per annum	Indonesia	DMP	1994	Yes	Godoy et al. (1993)
886	Raw materials [unspecified]	96.53	USD/ha/yr	Value per annum	Mexico	DMP	1994	Yes	Godoy et al. (1993)
887	Raw materials [unspecified]	99.49	USD/ha/yr	Value per annum	Sri Lanka	CV	1994	Yes	Godoy et al. (1993)
1016	Raw materials [unspecified]	1013.76	USD/ha/yr	Value per annum	Peru	DMP	1994	Yes	Pinedo-Vasquez et al. (1992)
1480	*Raw materials [unspecified]*	*90*	*USD/ha/yr*	*Value per annum*	*World*		*2007*	*Yes*	*Krutilla (1991)*
1483	*Raw materials [unspecified]*	*1805.24*	*USD/ha/yr*	*Value per annum*	*India*	*DMP*	*1994*	*Yes*	*Chomitz and Kumari (1995)*
4	**Provision of genetic resources**								
423	Genetic resources [unspecified]	1,500.00	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)

485	Genetic resources [unspecified]	17.13	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
510	Genetic resources [unspecified]	7	USD/ha/yr	Value per annum	Belize	BT	1994	No	Eade and Moran (1996)
585	Genetic resources [unspecified]	7	USD/ha/yr	Value per annum	Cameroon	BT	2001	Yes	Lescuyer (2007)
888	Genetic resources [unspecified]	112.1	USD/ha/yr	Value per annum	Belize	DMP	1994	Yes	Godoy et al. (1993)
5	**Provisioning of medical resources**								
28	Biochemicals	0.33	USD/ha/yr	Value per annum (Range)	Laos	BT	2003	Yes	Rosales et al. (2005)
869	Biochemicals	1.47E+09	USD/yr	Value per annum	USA	DMP	1979	No	Farnworth et al. (1983)
1304	Biochemicals	2,855.00	GBP/ha	Net Present Value	Cameroon	DMP	2000	No	Yaron (2001)
300	Bioprospecting	6.4	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
468	Bioprospecting	133.05	USD/ha/yr	Value per annum (Range)	World	DMP	2006	Yes	Costello and Ward (2006)
509	Bioprospecting	2,026.50	USD/ha/yr	Value per annum (Range)	Belize	BT	1994	No	Eade and Moran (1996)
559	Bioprospecting	22,646.00	INR/ha/yr	Value per annum	India	CV	2001	Yes	Gundimeda et al. (2006)
565	Bioprospecting	0.38	USD/ha/yr	Value per annum (Range)	Uganda	DMP	1995	No	Phillips (ed) (1998)
604	Bioprospecting	2.2	USD/ha	Net Present Value	Paraguay	BT	2005	No	Naidoo and Ricketts (2006)
675	Bioprospecting	10.1	USD/ha/yr	Value per annum (Range)	World	DMP	1996	Yes	Simpson et al. (1996)
1098	Bioprospecting	954.41	USD/ha/yr	Value per annum	Ecuador	FI / PF	2000	No	Rausser and Small (2000)
1099	Bioprospecting	2,771.97	USD/ha/yr	Value per annum	Sri Lanka	FI / PF	2000	No	Rausser and Small (2000)
1100	Bioprospecting	948.65	USD/ha/yr	Value per annum	New Caledonia	FI / PF	2000	No	Rausser and Small (2000)
1101	Bioprospecting	76.99	USD/ha/yr	Value per annum	Madagascar	FI / PF	2000	No	Rausser and Small (2000)
1102	Bioprospecting	65.85	USD/ha/yr	Value per annum	India	FI / PF	2000	No	Rausser and Small (2000)
1103	Bioprospecting	64.12	USD/ha/yr	Value per annum	Philippines	FI / PF	2000	No	Rausser and Small (2000)
1104	Bioprospecting	24.27	USD/ha/yr	Value per annum	Brazil	FI / PF	2000	No	Rausser and Small (2000)

1105	Bioprospecting	7.75	USD/ha/yr	Value per annum	South America	FI / PF	2000	No	Rausser and Small (2000)
1106	Bioprospecting	35.14	USD/ha/yr	Value per annum	Tanzania	FI / PF	2000	No	Rausser and Small (2000)
1108	Bioprospecting	5.39	USD/ha/yr	Value per annum	Malaysia	FI / PF	2000	No	Rausser and Small (2000)
1110	Bioprospecting	25.61	USD/ha/yr	Value per annum	Cote d'Ivore	FI / PF	2000	No	Rausser and Small (2000)
1111	Bioprospecting	1.35	USD/ha/yr	Value per annum	Malaysia	FI / PF	2000	No	Rausser and Small (2000)
1112	Bioprospecting	1.63	USD/ha/yr	Value per annum	Southern Asia	FI / PF	2000	No	Rausser and Small (2000)
1113	Bioprospecting	0.83	USD/ha/yr	Value per annum	Colombia	FI / PF	2000	No	Rausser and Small (2000)
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
487	Capturing fine dust	16.2	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
700	Capturing fine dust	3,388.30	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
8	**Climate regulation**								
10	C-sequestration	1.27E+08	USD	Net Present Value	Indonesia	AC	2000	No	Van Beukering et al. (2003)
29	C-sequestration	1,284.00	USD/ha/yr	Value per annum	Laos	BT	2003	No	Rosales et al. (2005)
301	C-sequestration	100	USD/ha/yr	Value per annum (Range)	Mexico	BT	1989	Yes	Adger et al. (1994)
315	C-sequestration	6.9	USD/ha	Net Present Value	Cambodia	BT	1996	No	Bann (1997)
527	C-sequestration	42	USD/ha/yr	Value per annum	Uganda	DMP	1998	Yes	Emerton and Muramira (1999)
586	C-sequestration	155.35	USD/ha/yr	Value per annum (Range)	Cameroon	BT	2001	Yes	Lescuyer (2007)
605	C-sequestration	378	USD/ha	Net Present Value	Paraguay	AC	2005	No	Naidoo and Ricketts (2006)
608	C-sequestration	19,758.00	THB/ha	Net Present Value	Thailand	DMP	1997	No	Niskanen (1998)
612	C-sequestration	2,830.00	USD/ha	Net Present Value	World	DMP	2000	No	Pearce (2001)
613	C-sequestration	1,940.00	USD/ha	Net Present Value	World	DMP	2000	No	Pearce (2001)

614	C-sequestration	1,150.00	USD/ha	Net Present Value	World	DMP	2000	No	Pearce (2001)
615	C-sequestration	790	USD/ha	Net Present Value	World	DMP	2000	No	Pearce (2001)
616	C-sequestration	630	USD/ha	Net Present Value	World	DMP	2000	No	Pearce (2001)
768	C-sequestration	85	USD/ha/yr	Value per annum (Range)	Brazil	BT	2007	Yes	Verweij et al. (2009)
769	C-sequestration	5,375.00	USD/ha	Capital / stock value	Brazil	BT	2007	No	Verweij et al. (2009)
804	C-sequestration	56	USD/ha/yr	Value per annum	Mexico	BT	1989	No	Adger et al. (1994)
946	C-sequestration	600	USD/ha	Value per annum (Range)	World	BT	1989	No	Kramer et al. (1992)
1305	C-sequestration	1,400.00	GBP/ha	Net Present Value	Cameroon	AC	2000	No	Yaron (2001)
424	Climate regulation [unspecified]	1,280.00	USD/ha	Net Present Value	World	BT	2001	No	CBD (2001)
715	Climate regulation [unspecified]	2,613.90	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
746	Climate regulation [unspecified]	153	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
959	Climate regulation [unspecified]	260.28	USD/ha/yr	Value per annum	Malaysia	AC	1994	Yes	Kumari (1996)
1484	*Climate regulation [unspecified]*	*760.56*	*USD/ha/yr*	*Value per annum*	*Malaysia*	*DMP*	*2007*	*Yes*	*Krutilla (1991)*
20	Microclimate regulation	8.5	USD/ha/yr	Value per annum	India	BT	2000	Yes	Verma (2000)
488	Gas regulation	15.96	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
9	**Moderation of extreme events**								
6	Flood prevention	1.41E+09	USD	Net Present Value	Indonesia	AC	2002	No	Van Beukering et al. (2003)
25	Flood prevention	92.3	USD/ha/yr	Value per annum	Laos	AC	2003	Yes	Rosales et al. (2005)
512	Flood prevention	23	USD/ha/yr	Value per annum	Belize	BT	1994	No	Eade and Moran (1996)
747	Flood prevention	4	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
800	Flood prevention	84.8	GBP/ha	Net Present Value	Cameroon	DMP	2000	No	Yaron (2001)

1371	Flood prevention	1.27E+05	USD	Net Present Value	Madagascar	AC	1995	No	Kramer et al. (1997)
11	Fire Prevention	3.73E+08	USD	Net Present Value	Indonesia	AC	2000	No	Van Beukering et al. (2003)
772	Fire Prevention	6	USD/ha/yr	Value per annum	Brazil	BT	1997	Yes	Verweij et al. (2009)
493	Prevention of extreme events [unspecified]	12.91	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
10	**Regulation of water flows**								
230	Water regulation [unspecified]	27.3	USD/ha/yr	Value per annum	Mexico	PES	2008	Yes	Perrot-Maître and Davis (2001)
489	Water regulation [unspecified]	2.58	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
805	Water regulation [unspecified]	0.14	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
960	Water regulation [unspecified]	16.91	USD/ha/yr	Value per annum	Malaysia	FI / PF	1994	Yes	Kumari (1996)
11	**Waste treatment / water purification**								
302	Water purification	0.24	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
316	Water purification	76	USD/ha	Net Present Value	Cambodia	DMP	1996	No	Bann (1997)
425	Water purification	432.5	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
491	Water purification	13.61	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
571	Water purification	1,022.00	USD/ha/yr	Value per annum	USA	RC	2000	No	Kaiser and Roumaset (2002)
587	Water purification	162	USD/ha/yr	Value per annum (Range)	Cameroon	BT	2001	Yes	Lescuyer (2007)
718	Water purification	1,268.20	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
497	Soil detoxification	11.97	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
12	**Erosion prevention**								
7	Erosion prevention	900	USD/ha/yr	Value per annum	Indonesia	AC	2000	Yes	Van Beukering et al. (2003)

26	Erosion prevention	2.97	USD/ha/yr	Value per annum	Laos	AC	2003	Yes	Rosales et al. (2005)
306	Erosion prevention	30	USD/ha/yr	Value per annum	Guatemala	TEV	2000	Yes	Ammour et al. (2000)
490	Erosion prevention	17.13	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
511	Erosion prevention	1,699.00	USD/ha/yr	Value per annum	Belize	BT	1994	No	Eade and Moran (1996)
528	Erosion prevention	89.5	USD/ha/yr	Value per annum	Uganda	RC	1998	Yes	Emerton and Muramira (1999)
609	Erosion prevention	1,967.00	THB/ha	Net Present Value	Thailand	RC	1997	No	Niskanen (1998)
748	Erosion prevention	238	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
770	Erosion prevention	238	USD/ha/yr	Value per annum	Brazil	BT	2007	Yes	Verweij et al. (2009)
821	Erosion prevention	83.9	USD/ha/yr	Value per annum (Range)	India	BT	1990	Yes	Chopra (1993)
836	Erosion prevention	57.67	USD/ha/yr	Value per annum	Philippines	AC	1994	No	Cruz et al. (1988)
1485	*Erosion prevention*	*15.66*	*USD/ha/yr*	*Value per annum*	*Ecuador*	*AC*	*2007*	*Yes*	*Chomitz and Kumari (1995)*
1486	*Erosion prevention*	*213.49*	*USD/ha/yr*	*Value per annum*	*Philippines*	*AC*	*2007*	*Yes*	*Chomitz and Kumari (1995)*
1487	*Erosion prevention*	*1536.58*	*USD/ha/yr*	*Value per annum*	*Philippines*	*FI / PF*	*2007*	*Yes*	*Dixon and Hodgson (1988)*
13	**Nutrient cycling and maintenance of soil fertility**								
717	Maintenance of soil structure	3,775.60	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
498	Soil formation	2.35	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)

499	Nutrient cycling	9.16	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
822	Nutrient cycling	3.53	USD/ha/yr	Value per annum	India	BT	1969	No	Chopra (1993)
1309	Nutrient cycling	18.6	USD/ha/yr	Value per annum	Guatemala	AC	2000	No	Ammour et al. (2000)
14	**Pollination**								
624	Pollination of crops	46	USD/ha/yr	Value per annum	Indonesia	DMP	2001	No	Priess et al. (2007)
627	Pollination of crops	128.58	USD/ha/yr	Value per annum	Costa Rica	DMP	2003	No	Ricketts et al. (2004)
771	Pollination of crops	49	USD/ha/yr	Value per annum	Ecuador	BT	2007	Yes	Verweij et al. (2009)
212	Pollination [unspecified]	81.5	ZAR/ha/yr	Value per annum	South Africa	FI / PF	2000	Yes	Turpie(2003b)
500	Pollination [unspecified]	8.45	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
15	**Biological Control**								
492	Biological Control [unspecified]	14.84	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
16	**Lifecycle maintenance (esp. nursery service)**								
501	Refugia for migratory and resident species	20.19	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
17	**Protection of gene pool (Conservation)**								
9	Biodiversity protection	2.74E+08	USD	Net Present Value	Indonesia	BT	2000	No	Van Beukering et al. (2003)
22	Biodiversity protection	435	USD/ha/yr	Value per annum	India	BT	2000	Yes	Verma (2000)
27	Biodiversity protection	0.07	USD/ha/yr	Value per annum	Laos	DMP	2003	No	Rosales et al. (2005)
208	Biodiversity protection	21.5	ZAR/ha/yr	Value per annum	South Africa	CV	2000	Yes	Turpie(2003b)

303	Biodiversity protection	5.22	USD/ha/yr	Value per annum (Range)	Mexico	BT	1989	Yes	Adger et al. (1994)
317	Biodiversity protection	511	USD/ha	Net Present Value	Cambodia	BT	1996	No	Bann (1997)
426	Biodiversity protection	7	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
427	Biodiversity protection	4,400.00	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
502	Biodiversity protection	23.24	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
503	Biodiversity protection	7.75	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
513	Biodiversity protection	6.4	USD/ha/yr	Value per annum	Belize	BT	1994	No	Eade and Moran (1996)
563	Biodiversity protection	48	USD/ha/yr	Value per annum	Brazil	CV	2000	No	Horton et al. (2003)
578	Biodiversity protection	29.04	USD/ha/yr	Value per annum	World	GV	2000	No	Kramer et al. (1995)
588	Biodiversity protection	25.5	USD/ha/yr	Value per annum (Range)	Cameroon	BT	2001	Yes	Lescuyer (2007)
590	Biodiversity protection	3	USD/ha/yr	Value per annum	Cameroon	BT	2001	Yes	Lescuyer (2007)
595	Biodiversity protection	18	AUD/ha/yr	Value per annum	Australia	CV	1998	Yes	Mallawaarachchi et al. (2001)
606	Biodiversity protection	25	USD/ha	Net Present Value	Paraguay	BT	2005	No	Naidoo and Ricketts (2006)
719	Biodiversity protection	3,156.00	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
749	Biodiversity protection	194	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
773	Biodiversity protection	18	USD/ha/yr	Value per annum (Range)	Brazil	BT	2007	Yes	Verweij et al. (2009)

1313	Biodiversity protection	0.6	USD/ha/yr	Value per annum (Range)	Bolivia	BT	2004	No	Asquith et al. (2008)
1314	Biodiversity protection	2.25	USD/ha/yr	Value per annum (Range)	Bolivia	PES	2007	No	Asquith et al. (2008)
1315	Biodiversity protection	14.42	USD/ha	WTP/pp or WTP/hh	Bolivia	PES	2007	No	Asquith et al. (2008)
1316	Biodiversity protection	1.08	USD/ha/yr	Value per annum	Bolivia	PES	2007	No	Asquith et al. (2008)
1373	Biodiversity protection	45	USD/ha/yr	Value per annum	Costa Rica	PES	2004	No	Pagiola et al. (2004)
18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
8	Recreation	2.89E+08	USD	Net Present Value	Indonesia	DMP	2000	No	Van Beukering et al. (2003)
304	Recreation	6.21	USD/ha/yr	Value per annum	Mexico	BT	1989	No	Adger et al. (1994)
428	Recreation	236	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
429	Recreation	770	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
430	Recreation	1,000.00	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
494	Recreation	5.9	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	Yes	Curtis (2004)
535	Recreation	1.78	USD/ha/yr	Value per annum	Kenya	CV	1998	No	Emerton (1998b)
589	Recreation	19	USD/ha/yr	Value per annum	Cameroon	BT	2001	Yes	Lescuyer (2007)
594	Recreation	318	USD/visitor/yr	Value per annum (Range)	Madagascar	TC	1993	No	Maille and Mendelsohn (1993)
601	Recreation	0.98	USD/ha/yr	Value per annum (Range)	Uganda	CV	2001	Yes	Naidoo and Adamowicz (2005)
673	Recreation	1,627.50	USD/ha/yr	Value per annum (Range)	Costa Rica	CV	2000	No	Shultz et al (1998)
722	Recreation	1,239.20	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
743	Recreation	55	USD/ha/yr	Value per annum (Range)	Costa Rica	TC	1991	No	Tobias and Mendelsohn (1991)

750	Recreation	37	USD/ha/yr	Value per annum	Brazil	BT	1993	Yes	Torras (2000)
817	Recreation	2.84E+08	USD/yr	Value per annum	Kenya	TC	1994	No	Brown and Henry (1993)
824	Recreation	0.77	USD/ha/yr	Value per annum (Range)	India	BT	1994	Yes	Chopra (1993)
862	Recreation	246.1	USD/ha/yr	Value per annum	Costa Rica	CV	1994	Yes	Echeverria et al. (1995)
863	Recreation	661.62	USD/ha/yr	Value per annum	Ecuador	HP	1994	Yes	Edwards (1991)
948	Recreation	6.00E+06	USD/yr	Value per annum	Thailand	BT	1980	Yes	Kramer et al. (1992)
949	Recreation	9,412.00	USD/yr	Value per annum	USA	BT	1984	Yes	Kramer et al. (1992)
963	Recreation	14.5	USD/ha/yr	Value per annum	Malaysia	DMP	1994	Yes	Kumari (1996)
305	Tourism	0.62	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
560	Tourism	1,354.00	INR/ha/yr	Value per annum	India	DMP	2001	Yes	Gundimeda et al. (2006)
579	Tourism	17.57	USD/ha/yr	Value per annum (Range)	Madagascar	CV	2000	No	Kramer et al. (1995)
18	Ecotourism	391.3	USD/ha/yr	Value per annum	India	BT	2000	Yes	Verma (2000)
774	Ecotourism	6.65	USD/ha/yr	Value per annum	Ecuador	BT	2007	Yes	Verweij et al. (2009)
1488	*Tourism*	*122.3*	*USD/ha/yr*	*Value per annum*	*Costa Rica*	*TC*	*2007*	*Yes*	*Krutilla (1991)*
1489	*Tourism*	*209.21*	*USD/ha/yr*	*Value per annum*	*Kenya*	*TC*	*2007*	*Yes*	*Krutilla (1991)*
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
60	Various	24,077.67	INR/ha/yr	Value per annum	India	CV	1995	No	Hadker et al. (1997)
24	**Other**								
	no values found								
25	**Total Economic Value**								
495	TEV	234.47	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	No	Curtis (2004)

723	TEV	21,152.80	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2008)
751	TEV	1,175.00	USD/ha/yr	Value per annum	Brazil	BT	1993	No	Torras (2000)
801	TEV	2,329.00	GBP/ha	Net Present Value	Cameroon	DMP	2000	No	Yaron (2001)
964	TEV	220	USD/ha/yr	TEV	World	TEV	1995	No	Lampietti and Dixon (1995)
1090	TEV	2,613.39	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1243	TEV	3,608.91	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
26	**Provision of durable/sustainable Energy**								
111	Hydro-electricity	0.01	USD/ha/yr	Value per annum (Range)	Laos	DMP	2003	No	Rosales et al. (2005)
112	Hydro-electricity	907	USD/ha/yr	Value per annum (Range)	Laos	DMP	2003	No	Rosales et al. (2005)
27	**Cultural values combined or unspecified**								
504	Cultural values [unspecified]	12.68	AUD/ha/yr	Value per annum (Range)	Australia	DMP	2002	No	Curtis (2004)
28	**Provisioning values combined or unspecified**								
	no values found								
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.8 ES-Values of Temperate and boreal forests

Table II.8 Monetary values per service for Temperate and boreal forests

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
34	NTFPs [food only!]	0.33	CAD/ha/yr	Value per annum	Canada	DMP	2002	Yes	Anielski and Wilson (2005)
287	NTFPs [food only!]	330	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
293	NTFPs [food only!]	330	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
178	Food [unspecified]	0.91	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
1490	*Food [unspecified]*	*72*	*USD/ha/yr*	*Value per annum*	*World*	*CV*	*2007*	*Yes*	*Krutilla (1991)*
2	**(Fresh) water supply**								
33	Drinking water	0.08	CAD/ha/yr	Value per annum	Canada	DMP	2002	Yes	Anielski and Wilson (2005)
176	Water [unspecified]	1.67	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
367	Water [unspecified]	403	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
610	Water [unspecified]	223.6	USD/ha/yr	Value per annum	Chile	DMP	2005	No	Nunez et al. (2006)
795	Water [unspecified]	934.52	CNY/ha/yr	Value per annum	China	RC	1998	No	Xue and Tisdell (2001)
1320	Water [unspecified]	99.72	USD/ha/yr	Value per annum	Portugal	DMP	2006	No	Cruz and Benedicto (2009)
3	**Provisioning of Raw material**								
30	Timber	61.41	CAD/ha/yr	Value per annum	Canada	DMP	2002	Yes	Anielski and Wilson (2005)
197	Timber	2.79	WST/ha/yr	Value per annum	Samoa	DMP	2000	Yes	Mohd-Shahwahid (2001)
1491	*Timber*	*36.08*	*USD/ha/yr*	*Value per annum*	*World*	*DMP*	*2007*	*Yes*	*Sharma (1992)*
198	Other Raw	2.51	WST/ha/yr	Value per annum	Samoa	DMP	2000	Yes	Mohd-Shahwahid (2001)

179	Raw materials [unspecified]	9.39	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
4	**Provision of genetic resources**								
177	Genetic resources [unspecified]	4.84	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
374	Genetic resources [unspecified]	20	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
5	**Provisioning of medical resources**								
288	Bioprospecting	6.4	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
294	Bioprospecting	6.4	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
641	Air quality regulation [unspecified]	700	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
8	**Climate regulation**								
31	C-sequestration	3,227.00	CAD/ha/yr	Value per annum	Canada	RC	2002	No	Anielski and Wilson (2005)
32	C-sequestration	7.03	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
248	C-sequestration	3,402.00	CAD/ha	NPV	Canada	BT	2002	No	Anielski and Wilson (2005)
249	C-sequestration	10,989.00	CAD/ha	NPV	Canada	BT	2002	No	Anielski and Wilson (2005)
250	C-sequestration	8,212.00	CAD/ha	NPV	Canada	BT	2002	No	Anielski and Wilson (2005)
251	C-sequestration	3.27	CAD/ha/yr	Value per annum	Canada	DMP	2002	Yes	Anielski and Wilson (2005)
252	C-sequestration	23.96	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
289	C-sequestration	103	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
295	C-sequestration	20	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
794	C-sequestration	1,724.23	CNY/ha/yr	Value per annum	China	MC / RC	1998	No	Xue and Tisdell (2001)
1096	C-sequestration	1,500.00	CAD/ha	NPV	Canada	DMP	2002	No	Anielski and Wilson (2005)
172	Climate regulation [unspecified]	13.32	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)

366	Climate regulation [unspecified]	133	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
434	Climate regulation [unspecified]	245	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
804	Climate regulation [unspecified]	56	USD/ha/yr	Value per annum	Mexico	AC	1994	Yes	Adger et al. (1994)
797	Gas regulation	91.27	CNY/ha/yr	Value per annum	China	RC	1998	No	Xue and Tisdell (2001)
9	**Moderation of extreme events**								
173	Prevention of extreme events [unspecified]	0.3	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
10	**Regulation of water flows**								
174	Water regulation [unspecified]	3.78	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
805	Water regulation [unspecified]	0.14	USD/ha/yr	Value per annum	Mexico	AC	1994	Yes	Adger et al. (1994)
11	**Waste treatment / water purification**								
62	Water purification	85	AUD/ha/yr	Value per annum	Australia	PES	1999	Yes	Perrot-Maître and Davis (2001)
290	Water purification	0.04	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
296	Water purification	0.04	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
370	Water purification	109	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
431	Water purification	19.5	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
1326	Water purification	18.22	USD/ha/yr	Value per annum	Portugal	RC	2006	No	Cruz and Benedicto (2009)
12	**Erosion prevention**								
175	Erosion prevention	1.25	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
368	Erosion prevention	122	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
796	Erosion	13.17	CNY/ha/yr	Value per annum	China	AC	1998	No	Xue and Tisdell (2001)

	prevention								
13	**Nutrient cycling and maintenance of soil fertility**								
798	Deposition of nutrients	259.69	CNY/ha/yr	Value per annum	China	DMP	1998	No	Xue and Tisdell (2001)
369	Soil formation	12	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
14	**Pollination**								
371	Pollination [unspecified]	400	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
15	**Biological Control**								
1362	Seed dispersal	41,000.00	SEK/ha	Present Value	Sweden	RC	2005	No	Hougner et al. (2006)
35	Pest control	22.32	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
372	Biological Control [unspecified]	5	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
36	Biodiversity protection	0.05	CAD/ha/yr	Value per annum	Canada	BT	2002	Yes	Anielski and Wilson (2005)
291	Biodiversity protection	5.22	USD/ha/yr	Value per annum (Range)	Mexico	BT	1989	Yes	Adger et al. (1994)
297	Biodiversity protection	5.22	USD/ha/yr	Value per annum (Range)	Mexico	BT	1989	Yes	Adger et al. (1994)
373	Biodiversity protection	2,281.00	USD/ha/yr	Value per annum	Spain	BT	2004	Yes	Brenner-Guillermo (2007)
432	Biodiversity protection	28.5	USD/ha/yr	Value per annum (Range)	World	BT	2001	Yes	CBD (2001)
435	Biodiversity protection	70	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
572	Biodiversity protection	325.66	EUR/ha/yr	Value per annum	Finland	CV	2000	No	Kniivila et al. (2002)

574	Biodiversity protection	260	USD/ha/yr	Value per annum	China	CV	2003	No	Kontoleon and Swanson (2003)
591	Biodiversity protection	4,400.00	USD/ha/yr	Value per annum	USA	CV	2000	No	Loomis and Ekstrand (1998)
617	Biodiversity protection	23.07	USD/ha/yr	Value per annum	USA	BT	2006	No	Phillips et al. (2008)
674	Biodiversity protection	0	USD/ha/yr/hh	Value per annum (Range)	Finland	CV	1999	No	Siikamäki and Layton (2007)
757	Biodiversity protection	22.27	USD/ha/yr	Value per annum	South Africa	CV	2001	Yes	Turpie (2003)
779	Biodiversity protection	37.84	USD/ha/yr	Value per annum (Range)	USA	CV	1980	No	Walsh et al. (1984)
18	**Aesthetic information**								
1324	Attractive landscapes	650	USD	Marginal	Portugal	CV	2006	No	Cruz and Benedicto (2009)
19	**Opportunities for recreation and tourism**								
180	Recreation	2.12	WST/ha/yr	Value per annum	Samoa	CV	2000	Yes	Mohd-Shahwahid (2001)
329	Recreation	3.83E+05	ITL/ha/yr	Value per annum (Range)	Italy	TC	1994	No	Bellu and Cistulli (1997)
336	Recreation	65	SEK/ha/yr	Value per annum	Sweden	CV	2006	No	Bostedt and Mattsson (2006)
375	Recreation	301	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
433	Recreation	80	USD/ha/yr	Value per annum	World	BT	2001	Yes	CBD (2001)
507	Recreation	1,000.00	DKK/ha/yr	Value per annum	Denmark	CV	1995	No	Dubgaard (1998)
573	Recreation	2.5	EUR/ha/yr	Value per annum	Finland	CV	2000	No	Kniivila et al. (2002)
618	Recreation	11.18	USD/ha/yr	Value per annum	USA	DMP	2006	No	Phillips et al. (2008)
660	Recreation	5.16E+05	GBP/ha/yr	Value per annum	Ireland	CV	2000	No	Scarpa et al. (2000)
661	Recreation	1.58E+06	GBP/ha/yr	Value per annum	Ireland	CV	2000	No	Scarpa et al. (2000)
763	Recreation	7,570.00	EUR/ha/yr	Value per annum	Netherlands	CV	2002	No	Van der Heide (2005)
803	Recreation	4,373.00	EUR/ha/yr	Value per annum (Range)	Denmark	BT	1997	No	Zandersen et al. (2005)
806	Recreation	6.21	USD/ha/yr	Value per annum	Mexico	BT	1989	No	Adger et al. (1994)

292	Tourism	0.62	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
298	Tourism	0.62	USD/ha/yr	Value per annum	Mexico	BT	1989	Yes	Adger et al. (1994)
807	Tourism	0.62	USD/ha/yr	Value per annum	Mexico	BT	1989	No	Adger et al. (1994)
1322	Tourism	2.72	USD/ha/yr	Value per annum	Portugal	BT	2006	No	Cruz and Benedicto (2009)
1321	Ecotourism	9.58	USD/ha/yr	Value per annum	Portugal	TC	2006	No	Cruz and Benedicto (2009)
	no values found								
20	**Inspiration for culture, art and design**								
181	Cultural use	0.15	WST/ha/yr	Value per annum	Samoa	BT	2000	Yes	Mohd-Shahwahid (2001)
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
1310	Science / Research	0.01	USD/ha/yr	Value per annum	USA	BT	2006	No	Phillips et al. (2008)
1323	Education	0.49	USD/ha/yr	Value per annum	Portugal	TC	2006	No	Cruz and Benedicto (2009)
23	**Various ecosystem services**								
	no values found								
24	**Other**								
	no values found								
25	**Total Economic Value**								
213	TEV	1.77E+05	KZT/ha/yr	Value per annum	Kazakhstan	TEV	2004	No	Tyrtyshny (2005)
229	TEV	290.77	USD/ha/yr	Value per annum	Tanzania	TEV	2000	No	IRG (2000)
351	TEV	3,789.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
799	TEV	3,053.07	CNY/ha/yr	TEV	China	TEV	1998	No	Xue and Tisdell (2001)
1091	TEV	302.33	USD/ha/yr	Value per annum (Range)	World	TEV	1994	No	Costanza et al. (1997)
1244	TEV	543.04	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1311	TEV	82.72	USD/ha/yr	Value per annum	USA	TEV	2006	No	Phillips et al. (2008)
1364	TEV	302	USD/ha/yr	Value per annum	USA	BT	1997	No	Kreuter et al. (2001)
26	**Provision of durable/sustainable Energy**								
	no values found								
27	**Cultural values combined or unspecified**								

376	Cultural values [unspecified]	2	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
1017	Cultural values [unspecified]	4.35	USD/ha/yr	Value per annum	USA	CV	1994	No	Pope and Jones (1990)
28	**Provisioning values combined or unspecified**								
	no values found								
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.9 ES-Values of Woodlands

Table II.9 Monetary values per service for Woodlands

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
123	Meat	0.1	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
120	Plants / vegetable food	0.65	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
631	Plants / vegetable food	322.06	PEN/ha/yr	Value per annum	Peru	DMP	2006	Yes	Rodriguez et al. (2006)
2	**(Fresh) water supply**								
	no values found								
3	**Provisioning of Raw material**								
122	Timber	9.85	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
469	Timber	67.5	EUR/ha/yr	Value per annum (Range)	Southern Europe	DMP	2001	No	Croitoru (2007)
121	Fuel wood and charcoal	2.38	USD/ha/yr	Value per annum	Tanzania	DMP	2000	Yes	Turpie (2000)
470	Fuel wood and charcoal	28	EUR/ha/yr	Value per annum (Range)	Southern Europe	DMP	2001	No	Croitoru (2007)
519	Fuel wood and charcoal	1,166.69	ERN/ha/yr	Value per annum	Eritrea	DMP	1997	Yes	Emerton and Asrat (1998)
536	Fuel wood and charcoal	18,528.57	DJF/ha/yr	Value per annum	Djibouti	DMP	1998	Yes	Emerton (1998)

633	Fuel wood and charcoal	188.97	PEN/ha/yr	Value per annum	Peru	DMP	2006	Yes	Rodriguez et al. (2006)
471	Fodder	37	EUR/ha/yr	Value per annum (Range)	Southern Europe	DMP	2001	No	Croitoru (2007)
632	Fodder	235.58	PEN/ha/yr	Value per annum	Peru	RC	2006	Yes	Rodriguez et al. (2006)
630	Other Raw	690.2	PEN/ha/yr	Value per annum	Peru	DMP	2006	Yes	Rodriguez et al. (2006)
480	Raw materials [unspecified]	39	EUR/ha/yr	Value per annum	Various	BT	2005	No	Croitoru (2007b)
481	Raw materials [unspecified]	41	EUR/ha/yr	Value per annum	Southern Europe	BT	2005	No	Croitoru (2007b)
482	Raw materials [unspecified]	54	EUR/ha/yr	Value per annum	Northern Africa	BT	2005	No	Croitoru (2007b)
483	Raw materials [unspecified]	20	EUR/ha/yr	Value per annum	Western Asia	BT	2005	No	Croitoru (2007b)
640	Raw materials [unspecified]	500	EUR/ha/yr	Value per annum	Europe	DMP	2006	Yes	LNV (2006)
4	**Provision of genetic resources**								
	no values found								
5	**Provisioning of medical resources**								
1107	Bioprospecting	1.85	USD/ha/yr	Value per annum	South Africa	FI / PF	2000	No	Rausser and Small (2000)
1109	Bioprospecting	2.56	USD/ha/yr	Value per annum	Australia	FI / PF	2000	No	Rausser and Small (2000)
1114	Bioprospecting	1.31	USD/ha/yr	Value per annum	Chile	FI / PF	2000	No	Rausser and Small (2000)
1115	Bioprospecting	0	USD/ha/yr	Value per annum	USA	FI / PF	2000	No	Rausser and Small (2000)
6	**Provisioning of ornamental resources**								

634	Decorations / Handicrafts	39.71	PEN/ha/yr	Value per annum	Peru	DMP	2006	Yes	Rodriguez et al. (2006)
7	**Influence on air quality**								
642	Air quality regulation [unspecified]	70	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
8	**Climate regulation**								
472	C-sequestration	12	EUR/ha/yr	Value per annum (Range)	Southern Europe	BT	2001	No	Croitoru (2007)
537	C-sequestration	472.71	DJF/ha/yr	Value per annum	Djibouti	DMP	1998	Yes	Emerton (1998)
643	Climate regulation [unspecified]	336.6	EUR/ha/yr	Value per annum	Europe	CV	2006	Yes	LNV (2006)
9	**Moderation of extreme events**								
	no values found								
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
473	Water purification	76.5	EUR/ha/yr	Value per annum (Range)	Southern Europe	RC	2001	No	Croitoru (2007)
645	Water purification	609.4	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
646	Water purification	170	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
647	Water purification	33.79	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
648	Water purification	0.18	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
12	**Erosion prevention**								
644	Erosion prevention	42.75	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
1413	Erosion prevention	16	PEN/ha/yr	Value per annum	Peru	CV	2006	No	Rodriguez et al. (2006)
13	**Nutrient cycling and maintenance of soil fertility**								
	no values found								

14	**Pollination**								
	no values found								
15	**Biological Control**								
	no values found								
16	**Lifecycle maintenance (esp. nursery service)**								
628	Nursery service	1,589.85	PEN/ha/yr	Value per annum	Peru	RC	2006	Yes	Rodriguez et al. (2006)
17	**Protection of gene pool (Conservation)**								
474	Biodiversity protection	30.5	EUR/ha/yr	Value per annum (Range)	Southern Europe	BT	2001	No	Croitoru (2007)
755	Biodiversity protection	0.46	USD/ha/yr	Value per annum	South Africa	CV	2001	Yes	Turpie (2003)
1097	Biodiversity protection	3.68	AUD/hh	WTP/pp or WTP/hh	Australia	CV	1997	No	Blamey et al. (2000)
18	**Aesthetic information**								
541	Attractive landscapes	3,312.00	USD/ha/yr	Value per annum (Range)	Israel	CV	2003	Yes	Fleischer and Tsur (2004)
19	**Opportunities for recreation and tourism**								
475	Recreation	86	EUR/ha/yr	Value per annum (Range)	Southern Europe	CV	2001	No	Croitoru (2007)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
119	Various	0.9	USD/ha/yr	Value per annum	Tanzania	DMP	2000	No	Turpie (2000)
24	**Other**								

	no values found								
25	**Total Economic Value**								
476	TEV	110.5	EUR/ha/yr	TEV	Southern Europe	TEV	2001	No	Croitoru (2007)
477	TEV	173	EUR/ha/yr	TEV	Southern Europe	TEV	2001	No	Croitoru (2007)
478	TEV	70	EUR/ha/yr	TEV	Northern Africa	TEV	2001	No	Croitoru (2007)
479	TEV	48	EUR/ha/yr	TEV	Western Asia	TEV	2001	No	Croitoru (2007)
26	**Provision of durable/sustainable Energy**								
	no values found								
27	**Cultural values combined or unspecified**								
	no values found								
28	**Provisioning values combined or unspecified**								
629	Provisioning values [unspecified]	1,476.52	PEN/ha/yr	Value per annum	Peru	DMP	2006	No	Rodriguez et al. (2006)
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.10 ES-Values of Grasslands

Table II.10 Monetary values per service for Grasslands

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
776	Plants / vegetable food	157	USD/ha/yr	Value per annum	South America	BT	2003	No	Viglizzo and Frank (2006)
778	Plants / vegetable food	90.5	USD/ha/yr	Value per annum (Range)	South America	BT	2003	No	Viglizzo and Frank (2006)
308	Food [unspecified]	3.67	BWP/ha/yr	Value per annum	Botswana	DMP	1990	Yes	Arntzen (1998)
326	Food [unspecified]	12,826.99	BWP/ha	NPV	Botswana	DMP	1991	No	Barnes (2002)
684	Food [unspecified]	290.4	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1438	Food [unspecified]	57.04	USD/ha/yr	Value per annum	USA	DMP	1995	Yes	US Dept. of Commerce
2	**(Fresh) water supply**								
74	Drinking water	500	NZD/ha/yr	Value per annum	New Zealand	AC	2006	Yes	Butcher Partners Limited (2006)
75	Drinking water	909.09	NZD/ha/yr	Value per annum	New Zealand	AC	2006	Yes	Butcher Partners Limited (2006)
76	Irrigation water [unnatural]	545.45	NZD/ha/yr	Value per annum	New Zealand	DMP	2006	Yes	Butcher Partners Limited (2006)
686	Water [unspecified]	774.5	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
3	**Provisioning of Raw material**								
635	Raw materials [unspecified]	27	EUR/ha/yr	Value per annum	Netherlands	DMP	2006	Yes	LNV (2006)
685	Raw materials [unspecified]	48.4	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)

543	Biomass fuels	7.95E+07	USD/ha/yr	Value per annum (Range)	Israel	CV	2005	No	Fleischer and Sternberg (2006)
4	**Provision of genetic resources**								
1011	Genetic resources [unspecified]	0.01	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Perrings (1995)
5	**Provisioning of medical resources**								
564	Bioprospecting	0.2	USD/ha/yr	Value per annum	Uganda	BT	1995	No	Phillips (ed) (1998)
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
687	Capturing fine dust	774.5	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
8	**Climate regulation**								
622	C-sequestration	610.98	USD/ha/yr	Annualized NPV	Philippines	DMP	2001	Yes	Predo (2003)
655	C-sequestration	280	USD/ha/yr	Value per annum (Range)	World	DMP	1997	Yes	Sala and Paruelo (1997)
1024	C-sequestration	1.2	USD/ha/yr	Value per annum	USA	BT	1995	No	Sala and Paruelo (1997)
377	Climate regulation [unspecified]	7	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
636	Climate regulation [unspecified]	99	EUR/ha/yr	Value per annum	World	CV	2006	Yes	LNV (2006)
688	Climate regulation [unspecified]	871.3	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
1025	Gas regulation	0.05	USD/ha/yr	Value per annum	USA	AC	1997	No	Sala and Paruelo (1997)
1026	Gas regulation	0.6	USD/ha/yr	Value per annum	USA	AC	1997	No	Sala and Paruelo (1997)
1092	Gas regulation	6.58	USD/ha/yr	Value per annum	World	DMP	1994	Yes	Costanza et al. (1997)
9	**Moderation of extreme events**								
	no values found								
10	**Regulation of water flows**								
378	Water regulation [unspecified]	5	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)

11	**Waste treatment / water purification**								
381	Water purification	109	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
638	Water purification	121	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
639	Water purification	11.05	EUR/ha/yr	Value per annum	Europe	AC	2006	Yes	LNV (2006)
690	Water purification	1,268.20	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
12	**Erosion prevention**								
379	Erosion prevention	37	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
637	Erosion prevention	42.75	EUR/ha/yr	Value per annum	Belgium	AC	2006	Yes	LNV (2006)
1027	Erosion prevention	100	USD/ha/yr	Value per annum	USA	BT	1992	No	Sala and Paruelo (1997)
1492	*Erosion prevention*	*37.82*	*USD/ha/yr*	*Value per annum*	*USA*	*DMP*	*2007*	*Yes*	*Barrow (1991)*
13	**Nutrient cycling and maintenance of soil fertility**								
689	Maintenance of soil structure	1,887.80	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
380	Soil formation	7	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
14	**Pollination**								
382	Pollination [unspecified]	32	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
15	**Biological Control**								
383	Biological Control [unspecified]	30	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
691	Biodiversity protection	1,055.20	CNY/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
754	Biodiversity protection	0.05	USD/ha/yr	Value per annum	South Africa	CV	2001	Yes	Turpie (2003)
756	Biodiversity protection	0.01	USD/ha/yr	Value per annum	South Africa	CV	2001	Yes	Turpie (2003)
18	**Aesthetic information**								

816	Attractive landscapes	16.87	USD/month	Value per annum (Range)	USA	HP	1982	No	Brookshire et al. (1982)
19	**Opportunities for recreation and tourism**								
327	Ecotourism	51	BWP/ha	NPV	Botswana	DMP	1991	No	Barnes (2002)
835	Recreation	38.7	USD/ha/yr	Value per annum	China	BT	2004	Yes	Li et al. (2008)
835	Ecotourism	0.8	USD/ha/yr	Value per annum	South Africa	CV	1994	Yes	Cowling et al. (1997)
991	Recreation	0.44	USD/ha/yr	Value per annum	Africa	CV	1994	Yes	Pearce and Moran (1994)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
	no values found								
24	**Other**								
	no values found								
25	**Total Economic Value**								
349	TEV	230	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
693	TEV	7,009.00	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2008)
775	TEV	181	USD/ha/yr	TEV	South America	BT	2003	No	Viglizzo and Frank (2006)
777	TEV	2,954.00	USD/ha/yr	TEV	South America	BT	2003	No	Viglizzo and Frank (2006)
1093	TEV	232.31	USD/ha/yr	Value per annum	World	TEV	1994	No	Costanza et al. (1997)
1245	TEV	417.17	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1363	TEV	232	USD/ha/yr	Value per annum	USA	BT	1997	No	Kreuter et al. (2001)
26	**Provision of durable/sustainable Energy**								
77	Hydro-electricity	1,386.36	NZD/ha/yr	Value per annum	New Zealand	DMP	2006	No	Butcher Partners Limited (2006)
27	**Cultural values combined or unspecified**								
	no values found								

28	**Provisioning values combined or unspecified**								
620	Provisioning values [unspecified]	1.14	USD/ha/yr	Annualized NPV	Philippines	DMP	2001	No	Predo (2003)
621	Provisioning values [unspecified]	1,209.28	USD/ha/yr	Annualized NPV	Philippines	DMP	2001	No	Predo (2003)
29	**Regulating values combined or unspecified**								
	no values found								
30	**Supporting values combined or unspecified**								
	no values found								

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II.11 ES-Values of Desert and Semi-Desert

Table II.11 Monetary values per service for Desert and Semi-Desert

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
	no values found								
2	**(Fresh) water supply**								
	no values found								
3	**Provisioning of Raw material**								
169	Fuel wood and charcoal	0.38	USD/ha/yr	Value per annum	Kenya	DMP	2007	No	Barrow and Mogaka (2007)
168	Fodder	160.00	USD/ha/yr	Value per annum	Kenya	DMP	2007	No	Barrow and Mogaka (2007)
4	**Provision of genetic resources**								
	no values found								
5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
	no values found								
25	**Total Economic Value**								
626	TEV	258.00	USD/ha/yr	Value per annum (Range)	USA	CV	1993	No	Richer (1995)

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II.12 ES-Values of Cultivated Lands

Table II.12 Monetary values per service for Cultivated Lands (Plantations, crop lands, pastures, orchards etc)

This 'biome' was not in the scope of the original study but because a considerable number of estimates was found it was decided to publish them in this paragraph.

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
203	Fish	1,516.00	USD/ha/yr	Value per annum	El Salvador	DMP	1997	No	Turner et al. (2003)
256	Fish	1.48	USD/ha/yr	Value per annum	Australia	DMP	2006	No	Access Economics (2008)
127	Plants / vegetable food	62.81	USD/ha/yr	Value per annum	Tanzania	DMP	2000	No	Turpie (2000)
224	Plants / vegetable food	667.00	USD/ha/yr	Value per annum	South Africa	DMP	1996	No	High and Shackleton (2000)
540	Plants / vegetable food	7,425.50	USD/ha/yr	Value per annum (Range)	Israel	DMP	2003	No	Fleischer and Tsur (2004)
542	Plants / vegetable food	3,842.07	USD/ha/yr	Value per annum	Israel	DMP	2003	No	Fleischer and Tsur (2004)
204	Food [unspecified]	3.00	USD/ha/yr	Value per annum	El Salvador	DMP	1997	No	Turner et al. (2003)
694	Food [unspecified]	193.60	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
696	Food [unspecified]	968.10	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
2	**(Fresh) water supply**								
698	Water [unspecified]	1,936.20	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
699	Water [unspecified]	580.90	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
3	**Provisioning of Raw material**								
227	Fodder	0.07	NPR/ha/yr	Value per annum	Nepal	DMP	2003	No	Regmi (2003)
1283	Fodder	3.69E+05	DJF/ha/yr	Value per annum	Djibouti	DMP	1998	No	Emerton (1998)

695	Raw materials [unspecified]	1,282.70	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
697	Raw materials [unspecified]	96.80	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
4	**Provision of genetic resources**								
	no values found								
5	**Provisioning of medical resources**								
	no values found								
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
701	Capturing fine dust	2,081.40	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
702	Capturing fine dust	484.00	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
8	**Climate regulation**								
623	C-sequestration	1,695.80	USD/ha/yr	Annualized NPV	Philippines	DMP	2001	No	Predo (2003)
703	Climate regulation [unspecified]	1,742.60	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
704	Climate regulation [unspecified]	861.60	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
9	**Moderation of extreme events**								
	no values found								
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
61	Water purification	230.00	USD/ha/yr	Value per annum	France	PES	1999	No	Perrot-Maître and Davis (2001)
707	Water purification	1,268.20	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
708	Water purification	1,587.70	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
12	**Erosion prevention**								
1012	Erosion prevention	106.25	USD/ha/yr	Value per annum	USA	RC	1992	No	Pimentel et al. (1995)

1014	Erosion prevention	40.00	USD/ha/yr	Value per annum	USA	MC / RC	1992	No	Pimentel et al. (1995)
1286	Erosion prevention	21,700.00	DJF/ha/yr	Value per annum	Djibouti	AC	1998	No	Emerton (1998)
13	**Nutrient cycling and maintenance of soil fertility**								
705	Maintenance of soil structure	2,831.70	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
706	Maintenance of soil structure	1,413.40	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
1013	Maintenance of soil structure	168.75	USD/ha/yr	Value per annum	USA	RC	1992	No	Pimentel et al. (1995)
14	**Pollination**								
385	Pollination [unspecified]	20.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
15	**Biological Control**								
386	Biological Control [unspecified]	30.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
387	Biodiversity protection	2,053.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
709	Biodiversity protection	2,105.60	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
710	Biodiversity protection	687.30	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
1372	Biodiversity protection	1,450.00	USD	Net Present Value	Nicaragua	PES	2004	No	Pagiola et al. (2004)
18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
388	Recreation	37.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)

711	Recreation	638.90	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
712	Recreation	9.70	CNY/ha/yr	Value per annum	China	BT	2004	No	Li et al. (2010)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
	no values found								
24	**Other**								
	no values found								
25	**Total Economic Value**								
350	TEV	2,140.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
713	TEV	14,080.90	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2010)
714	TEV	6,689.50	CNY/ha/yr	Value per annum	China	TEV	2004	No	Li et al. (2010)
802	TEV	1,400.80	GBP/ha	Net Present Value	Cameroon	DMP	2000	No	Yaron (2001)
1249	TEV	165.43	AUD/ha/yr	Value per annum	Australia	TEV	2005	No	Blackwell (2006)
1365	TEV	92.00	USD/ha/yr	Value per annum	USA	BT	1997	No	Kreuter et al. (2001)

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II.13 ES-Values of Urban areas

Table II.13 Monetary values per service for Urban areas

This 'biome' was not in the scope of the original study but because a considerable number of estimates were found for the none planned biomes as well it was decided to publish them in this paragraph.

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
8	**Climate regulation**								
353	Climate regulation [unspecified]	830.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
10	**Regulation of water flows**								
355	Water regulation [unspecified]	15.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
19	**Opportunities for recreation and tourism**								
354	Recreation	5,266.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)
25	**Total Economic Value**								
352	TEV	6,111.00	USD/ha/yr	Value per annum	Spain	BT	2004	No	Brenner-Guillermo (2007)

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II.14 ES-Values of Multiple ecosystems

Table II.14 Monetary values per service form case studies with Multiple ecosystem types

This 'biome' was not in the scope of the original study but because a considerable number of estimates were found for the none planned biomes as well it was decided to publish them in this paragraph.

ID	SERVICE	Value	Unit	Value type	Country / Region	Valuation method	Year of validation	Used for TEEB?	Reference
1	**Food provisioning**								
64	Fish	257.76	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
116	Fish	41.78	USD/ha/yr	Value per annum	Tanzania	DMP	2000	No	Turpie (2000)
142	Fish	830.60	USD/ha/yr	Value per annum	Thailand	CV	2002	No	Seenprachawong (2002)
232	Fish	4,157.69	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
67	Plants / vegetable food	1.13	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
68	Plants / vegetable food	0.84	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
69	Plants / vegetable food	0.01	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
236	NTFPs [food only!]	19.23	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
1284	Food [unspecified]	5,100.00	DJF/ha/yr	Value per annum	Djibouti	DMP	1998	No	Emerton (1998)
2	**(Fresh) water supply**								
	no values found								
3	**Provisioning of Raw material**								
237	Fibers	115.38	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
65	Fuel wood and charcoal	5.34	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
233	Fuel wood and charcoal	1,103.85	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
163	Other Raw	0.03	USD/ha/yr	Value per annum	Tanzania	DMP	2000	No	Turpie (2000)
235	Other Raw	30.77	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
4	**Provision of genetic resources**								

	no values found								
5	**Provisioning of medical resources**								
66	Biochemicals	0.51	USD/ha/yr	Value per annum	Cambodia	DMP	2002	No	Emerton (ed) (2005)
6	**Provisioning of ornamental resources**								
	no values found								
7	**Influence on air quality**								
	no values found								
8	**Climate regulation**								
1282	C-sequestration	46.60	ERN/ha/yr	Value per annum	Eritrea	AC	1997	No	Emerton and Asrat (1998)
9	**Moderation of extreme events**								
	no values found								
10	**Regulation of water flows**								
	no values found								
11	**Waste treatment / water purification**								
	no values found								
12	**Erosion prevention**								
1281	Erosion prevention	760.15	ERN/ha/yr	Value per annum	Eritrea	RC	1997	No	Emerton and Asrat (1998)
13	**Nutrient cycling and maintenance of soil fertility**								
128	Deposition of nutrients	64.66	USD/ha/yr	Value per annum	Tanzania	FI / PF	2000	No	Turpie (2000)
14	**Pollination**								
	no values found								
15	**Biological Control**								
	no values found								
16	**Lifecycle maintenance (esp. nursery service)**								
	no values found								
17	**Protection of gene pool (Conservation)**								
141	Biodiversity protection	1,788.99	USD/ha/yr	Value per annum	Thailand	CV	2002	No	Seenprachawong (2002)

144	Biodiversity protection	191.68	USD/ha/yr	Value per annum	Thailand	CV	2002	No	Seenprachawong (2002)
246	Biodiversity protection	100.00	USD/ha/yr	Value per annum	Jamaica	BT	2000	No	Cesar and Chong (2004)
18	**Aesthetic information**								
	no values found								
19	**Opportunities for recreation and tourism**								
42	Recreation	18.60	CAD/ha/yr	Value per annum	Canada	BT	2002	No	Anielski and Wilson (2005)
210	Tourism	1,037.09	ZAR/ha/yr	Value per annum	South Africa	DMP	2000	No	Turpie(2003b)
214	Tourism	0.09	USD/ha/yr	Value per annum	Indonesia	DMP	1995	No	Walpole et al. (2001)
215	Tourism	2.03	USD/ha/yr	Value per annum	Indonesia	CV	1995	No	Walpole et al. (2001)
231	Tourism	3,603.85	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
234	Hunting / fishing	876.92	UGX/ha/yr	Value per annum	Uganda	DMP	1997	No	Emerton (1999)
20	**Inspiration for culture, art and design**								
	no values found								
21	**Spiritual experience**								
	no values found								
22	**Information for cognitive development (education and science)**								
	no values found								
23	**Various ecosystem services**								
82	Multiple	8,845.48	USD/ha/yr	Value per annum (Range)	USA	TEV	2004	No	Corzine and Jackson (2007)
24	**Other**								
	no values found								
25	**Total Economic Value**								
566	TEV	332.40	USD/ha/yr	Net Present Value	Uganda	TEV	1995	No	Phillips (ed) (1998)

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Appendix III - Summary of analysis of estimates per biome

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Introduction

In this Appendix the main results of the analysis of monetary ecosystem services values collected for the TEEB-study are briefly presented and discussed for the 11 main biomes/ecosystems, with special attention to Coral reefs and Tropical forests, as sub-biomes (ecosystems) under marine systems and forests, respectively.
The Desert and Tundra biomes are not included because there was too little data found on their services and values in this stage of the TEEB study. Also, cultivated land and urban areas are not included here because the main purpose of the TEEB study is to analyse the costs of biodiversity loss and cultivated land and urban areas, principally, do not add to biodiversity at the global scale and in fact are an important cause for the loss of biodiversity[1]

The following 11 sections are organised as follows:
1) Each biome-section starts with a brief description of the main ecosystem-types included in that biome, the total surface area and a brief "status" statement (i.e. how much is still more or less natural/intact (see also Table 1, in Chapter 1) and issues of sustainability and potential use.
2) Monetary Value: for each biome, the data presented in Appendix II is summarised in a table with the following layout.
3) Brief discussion of the economically most important services, including quality aspects of values found, discussion of methods used and the influence of determining factors (e.g. socio-economic context) when available.
4) For each biome a box is added with an example of a *"best practice"* study for that particular biome that has applied the Total Economic Value framework (or similar) that (i) represents the state-of-the-art and (ii) does not rely heavily upon benefits transfer (BT).

In the biome summary tables the analysis of ecosystem service values per biome are shown. Per ecosystem service several descriptive statistics have been calculated. For every ecosystem service the table shows the number of used estimates, the mean, the standard deviation of the mean, the median, the minimum value and the maximum value. For the calculation of the totals, only the values of those ecosystem services have been used for which more than 1 estimate was selected from the TEEB Valuation Database (Van der Ploeg et al 2010, URL: www.es-partnership.org; direct link to the database: www.fsd.nl/esp/77979/5/0/30). For ecosystem services for which only one value was found these are shown separately in the last two columns of the tables. On the basis of these tables the main summary table in chapter 4.2 has been made, which shows the results per biome but does not provide the details per ecosystem service.
The TEEB Valuation Database contains 1310 estimates, of which 582 were used for the calculations of the total values per biome. Not all estimates met our criteria for selection or could be converted into the required unit (Int.$/ha/yr)[2]. The data gathering and selection methodology is described in more detail in chapter 3 of this report.

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[1] Although there is some evidence that some species in urban areas are subject to evolutionary processes and are beginning to develop into "urban sub-species", this speciation-process does not weigh up against the rate at which we are losing "wild" species.

[2] The international dollar, or the Geary-Khamis dollar, is a hypothetical unit of currency that is used to standardize monetary values across countries by correcting to the same purchasing power that the U.S. dollar had in the United States at a given point in time. Figures expressed in international dollars cannot be converted

For all used estimates the units have been standardized into Int.$/ha/yr (2007 value). The methods of standardization are specified in paragraph 3.4. More details of all Individual values in the database are shown in Appendix II.

Notes:
In the Tables the following variables are shown:
- ***No. of estimates*** : Number of estimates used for the calculation of the mean, standard deviation of mean, median, minimum and maximum value. For those ecosystem services for which no values have been selected from the database it is indicated whether the service is not applicable to this biome on theoretical grounds (=***NA***) or if the service can in principle be provided by that biome but no appropriate values were found or could not be included in the database yet for time or technical reasons (= open cells).
- ***Mean*** (Int.$/ha/y): Per ecosystem service only the selected values have been used to calculate the mean.
- ***St. dev of mean*** (Int.$/ha/y): The standard deviation of the values to the mean has been calculated to indicate the variation amongst the values found.
- ***Median*** (Int.$/ha/y): In order to provide more insight in the variation amongst the used values the Median is show as well.
- ***Minimum value*** (Int.$/ha/y) : The minimum value of the used values per ecosystem service.
- ***Maximum* Value** (Int.$/ha/y) : The maximum value of the used value per ecosystem service.
- ***No. of Single estimates* :** Number of ecosystem services for which only one value was selected for the analysis (= single estimates)
- ***Single estimates*** (Int.$/ha/y): the value of the respective Single value
***- Total values* :** There are several totals shown in the tables. The main total is the TEV, which is the sum of the mean values per ecosystem service. In addition the number of used estimates per ecosystem service has been summed up, as well as the median, minimum and the maximum values.

to another country's currency using current market exchange rates; instead they must be converted using the country's PPP (purchasing power parity) exchange rate. 1 Int.$ = 1 USD

III.1 – Monetary value of ecosystem services provided by Open Oceans

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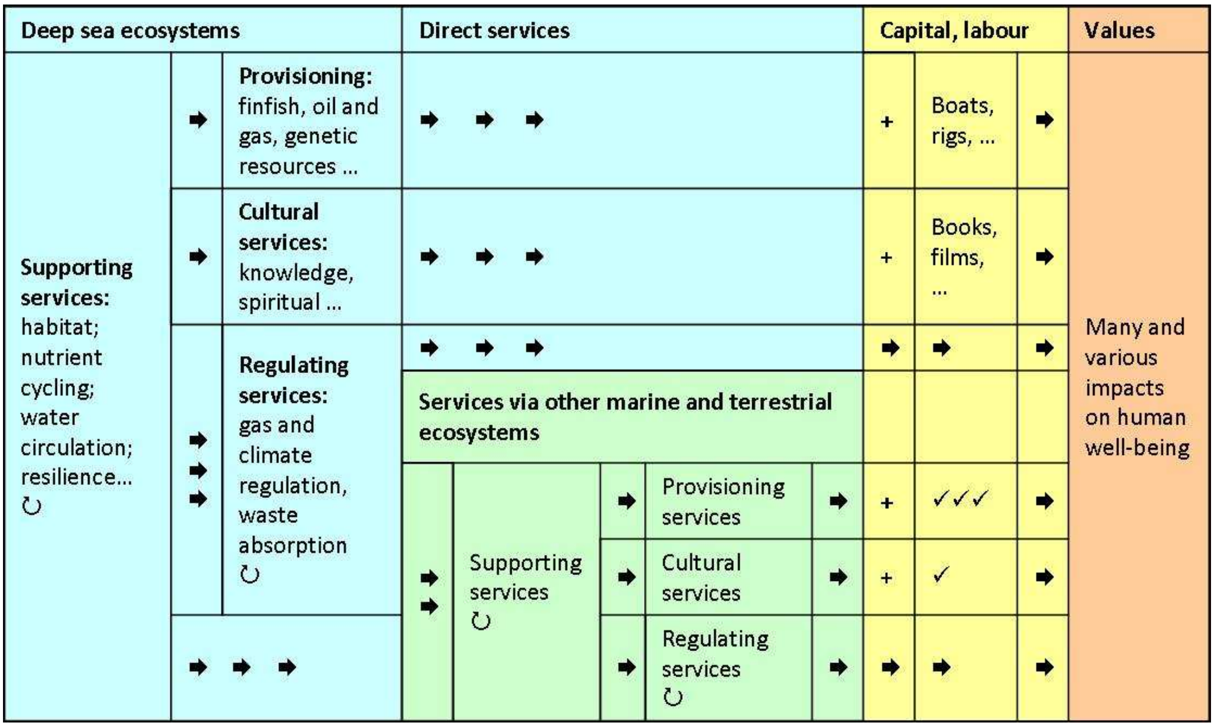
1) Brief "status" description of the Open Ocean Biome

The open ocean, called the pelagic zone, is the largest area of the marine ecosystem. Excluded from this biome-section are shelf sea, coral reefs, ocean islands and atolls which are included in other sections (III.2 – III.4).

The deep sea (water and sea floor below 200 m – Martinez, 2007)) is relatively unstudied, though it forms 90% of the biosphere. There is little or no light, but life is surprisingly abundant and highly diverse. Deep sea ecosystems play key roles in a wide range of functions, goods and services. They are highly valuable, even infinitely valuable, in the sense of supporting crucial biogeochemical processes and cycles that support much of life on Earth as we know it (see Figure III.1).

Figure III. 1: ***Deep sea ecosystem services and human well-being (****



****) Armstrong et al., 2010 "Ecosystem Goods and Services of the Deep Sea" (www.eu-hermione.net)***

Halpern et al. (2008) paint a somber picture of anthropogenic damages occurring in marine ecosystems, with many being subject to complex cumulative anthropogenic impacts.

Many services from marine ecosystems are being degraded and used unsustainably: over fishing, destructive harvesting methods, eutrophication and pollution, coastal development, effects of El Niño and global warming and the introduction of exotic species have caused significant damage and pose a serious threat to marine biodiversity (UNEP 2006, Halpern et al 2008).

From the current literature in the database it was difficult to ascertain whether values pertain to sustainable use or not, but if in doubt, the lower-bound values were used.

2) Monetary value of Open Ocean services

As Table III.1 shows, the total monetary value of the potential sustainable use of all services of open oceans combined varies between 13 and 84 Int.$/ha/year, with a mean value of about 49 Int.$/ha/y (2007-values), based on 6 original value-points.

In spite of their importance to human wellbeing, as described above, there is a great paucity of original, empirical studies on ocean services.

Also relatively little is known about how these vital ecosystem services may respond to growing threats and pressures arising through global environmental change and direct use of deep-sea resources, and we are as yet not able to make reliable assessments of the values arising through changes in these processes. This is true even for provisioning services such as deep-sea fisheries, because though we may know levels of harvests, we do not know where these are sustainable, and where they are in effect “mining” out slow-growing, slow reproducing stocks which are typical in the deep. For cultural services, we need better information on how humans relate to, and value, the services. For the regulating and supporting services, we need better scientific understanding of the determinants of rates of processes and functions providing services, and the threats posed by human activity. Especially supporting services are vital, and can not be ignored when valuing ecosystems, as the deep sea to a large degree supplies supporting services to other parts of the ocean and to all life on our planet. In many cases there are substantial uncertainties in economic valuation, though in some cases generally accepted values can be derived, notably for carbon capture and storage. (Armstrong et al., 2010)

Possible reasons for the limited number of data points we have for this biome are presented below:

1. Direct use value of open oceans is mainly associated with provisioning services (e.g. fisheries catch data) and some cultural services such as leisure and recreation (whale watching, arctic excursions, birding) but data on the non-extractive use of open oceans (e.g. role in bio-geochemical cycling and climate regulation is much more limited than terrestrial/coastal ecosystems).

2. Many services are not applicable for the marine biome (e.g. erosion prevention and pollination).

3. Whereas there is a policy rationale for commissioning a valuation study to determine whether a particular terrestrial/coastal ecosystem ought to be conserved or converted to an alternative land use, the same does not apply for open oceans: in most cases there is no feasible conversion of open oceans to an alternative biome-type.

*Table III.1 – Summary of Monetary value of services provided by the Marine Biome (in Int. $/ha/year-2007 values) (**

	Open Oceans	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
	TOTAL: 49 Int. $/ha/year (n = 6)	**6**	**49**	**50**	**49**	**13**	**84**	***4***	***9***
	PROVISIONING SERVICES	**2**	**15**	**9**	**15**	**8**	**22**	***1***	***0.1***
1	Food	2	15	9	15	8	22		
2	Water								
3	Raw materials	*1*						*1*	*0.1*
4	Genetic resources								
5	Medicinal resources								
6	Ornamental resources	NA							
	REGULATING SERVICES	**4**	**34**	**41**	**34**	**5**	**62**	***1***	***7***
7	Influence on air quality		?						
8	Climate regulation	2	30	36	30	4	55		
9	Moderation of extreme events	NA							
10	Regulation of water flows	NA							
11	Waste treatment / water purification								
12	Erosion prevention	NA							
13	Maintenance of soil fertility /nutrient cycling	*1*						*1*	*7*
14	Pollination	NA							
15	Biological control	2	4	5	4	1	7		
	HABITAT SERVICES	**0**	**0**	**0**	**0**	**0**	**0**	***1***	***2***
16	Lifecycle maintenance (esp. nursery service)								
17	Maintenance of genetic diversity (gene pool prot.)	*1*						*1*	*2*
	CULTURAL SERVICES	**0**	**0**	**0**	**0**	**0**	**0**	***1***	***1***
18	Aesthetic information								
19	Opportunities for recreation and tourism	*1*						*1*	*1*
20	Inspiration for culture, art and design								
21	Spiritual experience								
22	Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources

As a result of these factors (amongst others), the number of reliable values found thus far is quite small (n = 6). Furthermore, the values that have been collected in the review process are not only limited in number but also subject to a high level of uncertainty vis-à-vis extrapolation of values. The study by Hussain et al. (2010) discussed in Box 1 below shows that the benefits derived vary markedly across different marine landscapes-types, all of which *together* constitute the 'open oceans' biome.

3) Brief discussion of the economically most important services.

Bearing in mind the many difficulties and constraints regarding the economic analysis of open oceans, the three economically most important services are climate regulation, food provisioning and nutrient cycling. Definitions specific to marine ecosystems follow Beaumont et al. (2008).

a) *Climate regulation*

The ocean regulates the global balance of the Earth's climate. It exchanges with the atmosphere large quantities of heat, water, gases, particles and momentum. It is an important part of the global redistribution of heat from the tropics to the polar regions therein keeping our planet habitable. The surface of the ocean plays a critical role in the global carbon cycle. Approximately one quarter of the carbon dioxide emitted to the atmosphere from the burning of fossil fuels, deforestation, and other human activities are absorbed by the ocean. In the absence of this service by the oceans, the atmospheric level of CO2 would be significantly higher than at present and the effects of global climate change more marked (Secretariat of the Convention on Biological Diversity, 2009).

b) *Food*

It may be surprising that the ecosystem service of food provisioning (fish *etc)* totals only 15 US$/ha/yr and this may be an over-estimate in that the data are based on direct market value as opposed to the economic rent. On the other hand, fishing in the coastal zone and continental shelf is not included in this value (see III.3 on Coastal Systems). Further, all values included in the TEEB study are, as much as possible, based on sustainable use levels and most ocean fish stocks suffer globally from over-use (UNEP 2006, Sumaila 2006)

c) *Nutrient cycling*

Nutrient cycling is defined here as the (i) storage, (ii) cycling and (iii) maintenance of availability of nutrients as mediated by living marine organisms. This function is critical in marine ecosystems in (for instance) the mitigation of excessive nutrient loading which can lead to algal blooms. In essence a break-down in nutrient cycling would imply marine ecosystem collapse and so the estimate should be treated with caution, i.e. it is only meaningful at the margin.

d) Other services

The services considered above are the ones for which (i) data sources are acceptable with regard to the screening criteria, and (ii) where it is *not entirely unreasonable* to consider a per hectare estimation. It remains the case that, for each of these services, a per hectare estimation remains both crude and indeed perhaps inappropriate as a metric.

There are various other services for which an estimate was available but which have not been included in the summary table (see Appendix II for details). These are given below.

- ✓ *Raw materials*. UNEP (2007) provides an estimate using direct market pricing of the value of oil and gas extraction based on the global value of these resources.
- ✓ *Medicinal resources*. Arico and Salpin (2005) provide an estimate for the benefit (in 2000 US$) to the entire pharmaceutical industry of marine species for anti-cancer agents, marine bio-technology (100 billion $US/year) and sea sponge treatment of herpes.
- ✓ *Tourism* this ecosystem service mainly relates to cruises, eco-tourism (whale watching, arctic excursions and birding) and visiting marine parks. These activities are concentrated in relatively small areas and large parts of the oceans are not suitable for these activities.

4) Example of a "best-practice" study on the TEV of a particular case study

Although the study included in Box 1 does not meet the second selection criterion (i.e. "should not rely heavily on Benefit Transfer") it was selected in part due to the paucity of extant studies for this biome, as discussed in this section. Other reasons for its selection are (i) it had a direct input on policy using the Ecosystem Approach, (ii) there was an associated like-for-like assessment of costs, and (iii) it deals directly with an issue that is a feature of marine ecosystems valuation, *viz*. benefits being expressed in aggregate terms.

Box 1 - TEV of Marine Conservation Zones (MCZs) in UK

Hussain et al. (2010) pertains to the UK Marine and Coastal Access Bill (2009)3 and specifically the establishment of a network of marine protected areas, termed Marine Conservation Zones (MCZs) in UK legislation. The benefit assessment was commissioned in order to provide an evidence base for this legislation and to meet Impact Assessment guidance. Two sets of management regimes (with varying degrees of exclusion/reduced anthropogenic impact) were assessed in the context of three network scenarios describing the proposed location of MCZ sites. The main methodological challenges were (i) the lack of appropriate primary valuation studies for BT and (ii) the way that estimates were framed in these studies, viz. in aggregate terms. Aggregate values for different ESSs pertaining to UK temperate marine ecosystems are presented in Beaumont et al. (2008) which forms a basis for the values used in Hussain et al. (2010).

The methodology developed had to account for the following constraints: (i) the impact of MCZ designation would vary across the different ecosystem services (ESSs); and (ii) within any single ESS, the impacts would vary across different landscape types. The methodology thus scored the impact of designation for each individual ESS/each landscape. This scoring was relative to the benchmark, i.e. how much provisioning of the particular ESS/landscape combination would occur without MCZ designation?

Since the only estimates (where available) were for 2007-equivalent provisioning, this had to be used as the benchmark. Two elements were scored: (i) the extent to which MCZs would impact on

[3] http://www.publications.parliament.uk/pa/jt200708/jtselect/jtmarine/159/15902.htm

provisioning, measured as a percentage change relative to 2007 provisioning; and (ii) when this change in provisioning would likely occur – the impact trajectory. The latter meets the requirement for a consistent discount rate to be applied (in this case 3.5%) for both costs and benefits in Impact Assessment. As well as assigning this score for each ESS/landscape, the methodology had to account for how important one hectare of a particular landscape is relative to other landscapes for that ESS. Marine ecologists determined four categories based on combinations of (i) spatial extent, (ii) proximity to coastline, (iii) average per hectare provisioning

Once this methodology had been applied, the aggregate benefit estimates for each of the three propose MCZ networks/two management regimes were calculated. The present value (using the 3.5% discount rate) ranged from around £11.0-£23.5 billion. Applying sensitivity analysis reduced this range from around £6.4 to £15.1 billion. 'Gas and climate regulation' accounted for the bulk of this expected benefit (around 70%) with 'nutrient cycling' and 'leisure and recreation' around 10% each. The assessment of the costs of the MCZ networks was assessed in 2007. Secondary data and literature were assessed and interviews carried out with affected industries (fisheries, telecommunications, oil and gas extraction etc.); the cost estimate ranged from £0.4-£1.2 billion, implying a worst-case benefit-cost ratio of five.

The implications of this research are significant: (i) it is possible to apply (to a limited extent) an Ecosystem Approach to the marine biome; (ii) values were found for only seven of the 11 ESSs and yet even these alone derived a significant benefit-cost ratio. The lobbies linked to the exploitation of marine ecosystems are highly organised and well resourced; this kind of research and evidence-based justification for conservation is thus important.

III.2 – Monetary value of ecosystem services provided by coral reefs

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1) Brief "status" description of coral reefs

Coral reefs are highly productive, diverse and attractive ecosystems producing a wide range of valuable goods and services. These goods and services include recreational opportunities for diving, snorkeling and viewing (direct use values); coastal protection and habitat/nursery functions for commercial and recreational fisheries (indirect use values); and the welfare associated with the existence of diverse natural ecosystems (preservation values).

In addition to their economic importance, coral reefs play essential roles in maintaining food-webs and biochemical balance in the marine and coastal environment. They are also very important to the livelihood and cultural identity of millions of people living in coastal communities (Wilkinson 2002, Moore and Best 2001, Martinez et al 2007).

In spite (and probably because) of their enormous ecological, economic and cultural importance, coral reefs are one of the most threatened ecosystems. Major threats are inland and marine pollution (sediment, nutrient and pollutant flows), overexploitation, destructive fishing and tourism practices, climate change, acidification of the oceans, diseases and plagues, coral bleaching, decreasing poor water quality, removal of coastal (mangrove) forests and poor land use practices (Wilkinson 2002, Moore and Best 2001, Bryant et al 1998).

2) Monetary value of Coral Reefs

As Table III.2 shows, the total monetary value of the potential sustainable use of all services of coral reefs combined varies between 2.214 and 1.195.592 Int.$/ha/year, with a mean value of about 105.126 Int.$/ha/y (2007-values), based on 96 original value-points.

As can been seen in Table III.2, there are considerable ranges in the original values on which the ecosystem service averages are based. For example, values for tourism and recreation varied from less than one dollar to more than one million per hectare per year.

The wide range of actual (and potential) uses of the reefs at different locations (or countries) makes the use of mean-values for benefit transfer, or extrapolation to the global level very difficult.

When interpreting the data, it should be realised that many services were not included yet in the analysis due to lack of information, and some very high values included in Appendix II were left out of the calculation (i.e. for genetic resources and erosion prevention) because they were based on only 1 study.

Table III.2 - ***Summary of Monetary value of services provided by the Coral Reefs (in Int. $/ha/year-2007 values) (****

	Coral reefs	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
	TOTAL: 105.126 Int.$/ha/year (n = 96)	**96**	**105.126**	**280.205**	**18.327**	**2.214**	**1.195.592**	***5***	***206.881***
	PROVISIONING SERVICES	**32**	**3.981**	**7.761**	**346**	**6**	**20.892**	***1***	***20.078***
1	Food	22	393	186	53	0	3.752		
2	(Fresh) water supply	NA							
3	Raw materials	5	3.360	7.509	1	0	16.792		
4	Genetic resources	*1*						*1*	*20.078*
5	Medicinal resources								
6	Ornamental resources	5	228	66	292	6	348		
	REGULATING SERVICES	**15**	**6.190**	**2.693**	**1.112**	**7**	**33.633**	***3***	***186.796***
7	Influence on air quality								
8	Climate regulation	*1*						*1*	*627*
9	Moderation of extreme events	13	6.149	2.657	1.071	2	33.556		
10	Regulation of water flows	NA							
11	Waste treatment / water purification	2	41	36	41	5	77		
12	Erosion prevention	*1*						*1*	*186.168*
13	Nutrient cycling and maintenance of soil fertility								
14	Pollination	NA							
15	Biological control	*1*						*1*	*1*
	HABITAT SERVICES	**9**	**11.697**	**7.461**	**1.196**	**0**	**56.137**	***0***	***0***
16	Lifecycle maintenance (esp. nursery service)	?							
17	Gene pool protection (conservation)	9	11.697	7.461	1.196	0	56.137		
	CULTURAL SERVICES	**40**	**83.258**	**262.290**	**15.673**	**2.201**	**1.084.930**	***1***	***7***
18	Aesthetic information	2	14.759	17.760	14.759	2.201	27.317		
19	Opportunities for recreation and tourism	32	68.453	244.472	883	0	1.057.492		
20	Inspiration for culture, art and design	2	0,03	0,05	0,03	0,00	0,07		
21	Spiritual experience	*1*						*1*	*7*
22	Information for cognitive development	4	46	58	31	0	121		

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources

3) Brief discussion of the economically most important services.

The main economically important services according to this analysis are tourism and recreation, genetic diversity, and moderation of extreme events. Erosion prevention and genetic resources have high average values but these are based on only one value estimate each – we therefore focus here on coral reef ecosystem services for which there is a reasonable amount of reliable information.

a) Recreation

Because healthy coral reefs are highly valued as a tourist attribute, this biome can potentially play an important role in recreational activities. This value manifests itself both directly, in terms of diving and snorkeling activities, and indirectly by supporting the tropical and natural image of a tourist destination. With more than 50 studies reporting recreational values for coral reefs, this ecosystem services is one of the best documented services in the coral reef valuation literature. A meta-analysis on the recreational value of coral reefs by Brander et al. 2008 indicated that the average recreational value of coral reefs is US$ 3.726 per hectare/year ranging between $ 0,25 and $ 57.470 per hectare. In terms of valuation methods, the contingent valuation method (CVM) has been the most widely used method for assessing coral reef recreational values. Strong examples of recreational value studies include Carr and Mendelsohn (2003) for the Great Barrier Reef (Australia), Wielgus et al. (2003) for the reefs in Eilat (Israel), and Parson and Thur (2007) for the Bonaire National Marine Park and van Beukering et al (2007) in Guam.

b) Maintenance of genetic diversity

This service relates to the importance of ecosystems to maintain biological, and genetic diversity through natural selection and evolutionary processes. Coral reefs are highly diverse ecosystems and people around the world appreciate coral reefs highly for the sole reason of its existence value. With more than 26 data points from around 15 studies, this so-called non-use value is also well researched. The annual mean value, based on the 8 moth reliable figures is close to Int.$12,000 per hectare. Similar to recreational services, existence values are mostly estimated through CVM or choice experiments. Influential examples of studies include Peatchy (1998), Spash et al. (2000) and Samonte-Tan et al 2007.

c) Moderation of extreme events

Because coral reefs absorb much of the incoming wave energy, they function as natural breakwaters and help to protect the shoreline from erosion and property damage. For example, measurements showed that up to 77% of the force of waves in Nicaragua is eliminated by discontinuous coral reefs (UN-Oceans, 2002). In other words, without the wave buffering and sand production roles of coral reefs, rates of coastal erosion and beach loss (and associated economic damage) would be significantly higher (Mullane and Sukzuki, 1997). The valuation of the coastal protection service of coral reefs has only recently been picked up by researchers and therefore only few examples exist on the valuation of coastal protection services provided by coral reef ecosystems. Van Beukering et al. (2005 and 2006) estimated the value of the protective function of reefs in Guam and Saipan, respectively, Burke et al. (2008) estimated this service for Tobago and St. Lucia and recently Van Beukering et al. (2010) estimated similar services for the reefs of Bermuda. The average value of coral reefs of the moderation service of extreme events is estimated at US$6,149 per hectare/year. It should be realized that the coastal protection value varies widely depending on specific characteristics of the location of the coral reef (e.g. exposure level to storms, elevation, population density).

4) Example of a "best-practice" study on the TEV of a particular case study

Box 2 - The Total Economic Value of the coral reefs of Hawaii ***(Cesar and van Beukering 2004)***

Hawaii's coral reef ecosystems provide many goods and services to coastal populations, such as fisheries and tourism. Besides, they form a unique natural ecosystem, with an important biodiversity value as well as scientific and educational value. Also, coral reefs form a natural protection against wave erosion. Without even attempting to measure their intrinsic value, this paper shows that coral reefs, if properly managed, contribute enormously to the welfare of Hawaii through a variety of quantifiable benefits. Net benefits of the State's 166,000 hectares of reef area of the Main Hawaiian Islands are estimated at US$360 million a year for Hawaii's economy (Cesar and van Beukering 2004).

Table 1: Annual benefits of the Hawaiian coral reefs

Types of value	units	Value
Recreational value	Million$/year	304
Amenity (real estate) value	Million$/year	40
Research value	Million$/year	17
Fishery value	Million$/year	2.5
Total annual benefits	Million$/year	363.5

Source: Cesar and van Beukering 2004, p.240.

To assess the spatial variation of economic values of the Hawaiian reefs, the overall values are also expressed on a 'per area' basis (Cesar et al. 2002). Three case study sites were considered in particular. The most valuable site in Hawaii, and perhaps even in the world, is Hanauma Bay (Oahu) which was an extremely high intensity of recreational use. Reefs at Hanauma are ecologically average for Hawaiian standards, yet are more than 125 times more valuable (US$92 per m^2) than the more ecologically diverse reefs at the Kona Coast (US$0.73 per m^2). This demonstrates that economic values can differ dramatically from ecological values or researchers' preferences.

III.3 – Monetary value of ecosystem services provided by Coastal systems

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1) Brief "status" description of the coastal systems.

Coastal biomes are found around continental margins throughout the world. In this study, coastal biomes refer to several distinct ecosystems such as sea-grass fields, shallow seas of continental shelves, estuaries, and shores (rocky and beaches), which are found in the terrestrial near-shore as well as the intertidal zones—where ocean meets land, from the shore to the 200m bathymetric line with open oceans.

These ecosystems play an important role in providing fish, shellfish, and seaweed, in stabilizing sediments, sequestering carbon, and in nutrient cycling. In addition, they are an important nursery and foraging habitat (Silvestri and Kershaw, 2010). Their value to humans is therefore significant. The abundance of resources there has been historically and prehistorically fundamentally important for the evolution of the human race and the livelihoods, recreation and spiritual well-being of many millions of people (Burke et al., 2000).

2) Monetary value of coastal systems

As Table III.3 shows, the total monetary value of the potential sustainable use of all services of coastal systems combined varies between 2.143 and 79.580 Int.$/ha/year, with a mean value of about 22.000 Int.$/ha/y (2007-values), based on 27 original value-points.

This value is substantially higher than the value found for coastal systems in Costanza et al. (1997) (4,052 US$/ha/yr) which could be explained, among other things, by the heterogeneity of this biome (beaches, for example, were not included in the Costanza study), as well as by the new data generated since 1994. In addition it should be realised, as has been mentioned in various places in this chapter, that monetary values are highly time and context dependent which is particularly relevant for coastal habitats (Shuang et al., in press, Nuñes et al., 2009).

Although the estimated mean values, and value-ranges are informative of the significance of services in these selected coastal biomes, it has to be interpreted with the caveat that any careful assessment of service values for the purpose of supporting decision-making processes should be taken with a landscape perspective, which would likely entail inclusion of a mosaic of biomes that are not listed as 'coastal biomes' in this exercise, such as tidal wetlands and mangroves, among others. Ideally, it should also involve an exercise on the relevance of these services to local livelihoods and human well-being. This is especially relevant in coastal areas which are subject to extensive human impact and degradation.

Table III.3 – ***Summary of Monetary value of services provided by the*** **Coastal systems** ***(in Int. $/ha/year-2007 values) (****

Coastal systems	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 27.948 Int.$/ha/year (n = 27)	**27**	**27.948**	**34.629**	**27.845**	**2.143**	**79.580**	***5***	***77.798***
PROVISIONING SERVICES	**16**	**783**	**2.149**	**59**	**1**	**7.549**	***1***	***1.453***
1 Food	12	773	2.135	55	1	7.517		
2 Water	*1*						*1*	*1.453*
3 Raw materials	4	10	15	4	0	32		
4 Genetic resources								
5 Medicinal resources								
6 Ornamental resources								
REGULATING SERVICES	**3**	**19.979**	**15.588**	**27.421**	**2.065**	**30.451**	***2***	***76.144***
7 Influence on air quality								
8 Climate regulation								
9 Moderation of extreme events	*1*						*1*	*76.088*
10 Regulation of water flows								
11 Waste treatment / water purification								
12 Erosion prevention								
13 Maintenance of soil fertility /nutrient cycling	3	19.979	15.588	27.421	2.065	30.451		
14 Pollination								
15 Biological control	*1*						*1*	*56*
HABITAT SERVICES	**2**	**120**	**62**	**120**	**77**	**164**	***1***	***164***
16 Lifecycle maintenance (esp. nursery service)	2	120	62	120	77	164		
17 Maintenance of genetic diversity (gene pool prot.)	*1*						*1*	*164*
CULTURAL SERVICES	**6**	**7.065**	**16.830**	**245**	**0**	**41.416**	***1***	***37***
18 Aesthetic information	*1*							
19 Opportunities for recreation and tourism	6	7.065	16.830	245	0	41.416		
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development	*1*						*1*	*37*

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

3) Brief discussion of the economically most important services.

Based on this preliminary analysis, the three main, economically important services are: 'moderation of extreme events, nutrient cycling & waste treatment and tourism and recreation. It should be noted that service-performance is quite different for the included ecosystems: tourism is mainly found on the beaches and water purification is mainly provided by estuaries. Further literature research, and original studies are therefore necessary to make them more robust.

1) Moderation of extreme events

Coastal biomes minimize the impact of storms by reducing wind action and mitigating the impacts of waves and currents. By doing so, they help to prevent coastal erosion as well as the negative impacts of extreme weather events, such as storms and flooding along coastal areas, which can result in the destruction of shoreline structures, and ultimately the loss of life during major storms in near-shore areas. This service is of great relevance given that human populations around the world are concentrated along the coast—it is estimated that one-third of the world's population lives in coastal communities (Barbier et al., 2008).

It is therefore not surprising that this service was found to have such a significant economic value. According to Burke et al. (2000), as coastal settlements expand and put more people and property at risk, the economic and human costs of coastal storm damage are growing.

Climate change risk: related to this service is the degree to which coastal systems can buffer against climate change events, specifically for the more vulnerable and impoverished coastal populations. This will be particularly important with climate change effects, such as sea level rise and potential increase in intensity, severity and frequency of coastal storms (Kennedy et al., 2002). For example, while the values of these services in protecting against property damage of more developing areas can be significant and reasonably estimated with damage-avoided cost methodologies, in other areas undergoing less development the significance of these services could be better assessed in the context of expected mortality rates.

2) Nutrient cycling and waste treatment

Nutrient cycling refers to processes through which chemical elements, such as carbon, nitrogen, oxygen, phosphorus, and sulphur move through the Earth's biotic and abiotic systems. This is a life supporting service and a crucial process which underpins all other ecosystem services (MA, 2005). In coastal biomes, and marsh-estuarine systems in particular, nutrient-rich effluents are trapped by tidal circulation patterns, and assimilated in the productive biological systems (Gosselink et al., 1974). Such systems have an immense capacity to buffer nutrient changes and to absorb nutrient loading from terrestrial inputs such as those associated with urban areas and the runoff from cultivated land areas.

The high value found for nutrient cycling, the second highest after moderation of extreme events, is indicative of the significance of this service for humans. Indeed, excessive nutrient loading can have serious effects such as eutrophication, which will eventually lead to loss in water quality or the development of dead zones (hypoxic areas where aquatic life is no longer supported). This is the case of the Gulf of Mexico dead zone, for example—an estimated 6,000 square miles in the gulf coast of North America, caused by excessive fertilizer and nutrient-rich sediment runoff. The ecological and economic implications of such zones are severe; they have far-reaching effects on marine life and threaten commercial and recreational fisheries that in the Gulf of Mexico alone are estimated to generate annual revenues of about US$2.8 billion (NOAA, 2009).

3) Tourism and recreation

The volume of coastal tourism and recreation has substantially increased worldwide over the past decades. Coastal tourism has become a primary contributor to the GDP of a number of countries and to the well-being of large coastal populations. In Europe, for instance, coastal tourism is a leading economic sector in the Mediterranean region both in terms of revenues and occupation. According to Eurostat statistics (http://ec.europa.eu/eurostat), in Spain, 83% of the 53.5 million tourists in 2006 visited either one of the four Mediterranean coastal regions or the Canary Islands—1.5 million people were employed in the coastal tourism sector. In addition, the development of coastal tourism is currently a key economic development strategy for various developing counties.

In assessing the impact of coastal tourism and recreational activities on human well-being, one must take into account that a substantial component of the welfare generated by many recreational activities is not reflected in market transactions, and remains, therefore, out of the scope of market-based analyses. Among such activities are both consumptive uses (e.g., hunting, fishing, and shell fishing) and non-consumptive uses (e.g., swimming, sun-bathing, boating, wind-surfing, bird watching, snorkelling, and diving). Aggregating such non-market values and scaling them up at administrative levels may lead to substantial economic figures (Nunes et al, 2009, Brander et al, 2010).

4) Example of a "best-practice" study on the TEV of a coastal area

Box 3 Valuing the services provided by the Peconic Estuary System, USA

Source: Johnston, R. J., T. A. Grigalunas, J. J. Opaluch, M. Mazzotta, and J. Diamantedes. 2002. Valuing estuarine resource services using economic and ecological models: The Peconic Estuary system. *Coastal Management* 30(1): 47-65.

This study looks at the wide range of ecosystem services provided by the Peconic estuary system, NY, USA, with twofold objectives. On the one hand, it aims at informing local coastal policies by assessing the economic impacts of ecological management strategies for the reservation or restoration of the estuary. On the other hand, it discusses various non-market valuation methodologies to identify the most appropriate approaches for different types of services, and the highlights the issues arising in the integration of the findings of different methods in a total economic value.

The coastal region valued is at the East End of Long Island and comprises a system of bays, islands, watershed lands, and coastal communities. It includes a wide range of coastal resources, including fisheries, beaches, parks, open space, and wildlife habitat, which are under threat from localized water pollution and loss of coastal habitats due to land conversion by development activities.

The study integrates the results of four economic studies:
A hedonic pricing study examines the value of environmental amenities such as **open space and attractive views** on the market price of property in the coastal town of Southold. In the 374

investigated parcels of land, the preservation of nearby open space is found to increase property values on average by 12.8%, while dense development and proximity to highways and agricultural land have negative impacts ranging from 13.3 to 16.7%.

A travel-cost study investigates the value of recreational activities such as **swimming, boating, fishing, and bird and wildlife viewing** taking place in the estuary. Based on 1,354 completed surveys, the study estimated the consumer surplus that recreationists received, i.e., the value above the cost of their recreational trip. Aggregating individual consumer surplus estimates over the whole population or recreationists reveals values equal to 12.1 M$/year for swimming, 18.0 M$/year for boating, 23.7 M$/year for recreational fishing, and 27.3 M$/year for bird and wildlife watching.

A productivity function study assesses the value of eelgrass, sand/mud bottoms, and inter-tidal salt marshes as a **nursery habitat for fish, shellfish and birds**. The study simulates the biological functions of the ecosystems to assess the marginal per acre value of productivity in terms of gains in commercial value for fish and shellfish, bird-watching, and waterfowl hunting. Estimated yearly values per acre are $67 for inter-tidal mud flats, $338 for salt marsh, and $1,065 for eelgrass.

Finally, a contingent choice study investigates the willingness-to-pay of local residents for the preservation and restoration of key ecosystems in the Peconic estuary. Although the value estimates elicited partly overlap with the results of the other three methods, this study adds the additional dimension of **non-use and existence values** to the picture of the total economic value of the estuary. The highest values are found for the preservation of farmland ($6,398-9,979 acre/year), eelgrasses ($6,003-8,186 acre/year), and wetlands ($4,863-6,560 acre/year). Lower values are for undeveloped land ($1,203-2,080 acre/year) and shellfish areas ($2,724-4,555 acre/year).

Some useful general lessons for the valuation of the total economic value of coastal ecosystems can be drawn. First, a single valuation method can hardly capture the complexity of the interactions between different types of land uses and services in coastal areas. Consider the case of farmland in the discussed study. Although hedonic pricing indicates negative *use values* of farmland, the contingent choice experiment shows that the willingness-to-pay of residents for farmland is high, suggesting that *non-use values* may play an important role in determining the total value of such land use.

Second, even when budget and time limitations allow for the implementation of different valuation methodologies, one must consider that integration of their findings is not straightforward. In the present study, simply summing up the values determined with hedonic pricing and the travel cost methods would lead to double-counting benefits, since property values will likely also reflect the opportunities for recreation available in the neighbourhood. Similarly, the values elicited by the production function will partly reflect the opportunities for bird-watching and waterfowl hunting that high productivity entails.

III.4 – Monetary value of ecosystem services provided by Coastal wetlands

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1) Brief "status" description of coastal wetlands

The coastal wetlands biome includes two main types of ecosystem, tidal marshes and mangroves. The coverage of this section is weighted towards mangrove ecosystems although the available valuation literature on tidal marshes is also presented.

Mangroves are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics and occur both in estuaries and along open coastlines and dominate three quarters of tropical coastlines. Mangroves are characterized by high biological productivity and consequently are of high importance to the nutrient budget of adjacent coastal waters. They also maintain water quality by extracting nutrients from potentially eutrophic situations and by increasing the limited availability of saline and anaerobic sediments to sequester or detoxify pollutants. Mangroves are recognised to provide a wide range of ecosystem services, including support to local and commercial fisheries; coastal protection and storm buffering; climate regulation; erosion control; provision of timber, thatch, medicinal plants and other materials; opportunities for recreational fishing, hunting and also non-consumptive recreation activities; and provide habitat for animal and plant species (Cooper et al., 2009, Emerton, 2005).

Despite the many benefits provided by mangroves, in many parts of the world they are under intense pressure from competing land uses (esp. aquaculture and urban development) and excessive extraction of materials. Mangroves also experience degradation resulting from excessive harvesting of materials (e.g. firewood collection, charcoal production and wood chipping). In addition, mangrove functioning is threatened by a number of sources of pollution, including solid waste, rubbish disposal, oil spillage, and other chemicals.

Many mangrove resources are harvested for subsistence purposes (e.g., firewood, Nipa palm (*Nypa fruticans*) leaves for home construction, vines for handicrafts, fish and shell fish for food). Local communities located in, or near, mangrove areas may be almost entirely dependent on mangroves for their livelihood. The loss or degradation of mangroves can therefore have a dramatic negative effect on the well-being of mangrove dependent communities.

2) Monetary value of coastal wetlands

As Table III.4 shows, the total monetary value of the potential sustainable use of all services of coastal wetlands combined varies between 1.995 and 213.752 Int.$/ha/year, with a mean value of about 47.542 Int.$/ha/y (2007-values), based on 96 original value-points.

Table III.4 – ***Summary of Monetary value of services provided by*** **Coastal wetlands *(in Int. $/ha/year-2007 values) (****

Coastal wetlands	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 47.542 Int. $/ha/year (n = 96)	**96**	**47.542**	**50.605**	**11.276**	**1.995**	**213.752**	***2***	***960***
PROVISIONING SERVICES	**35**	**1.982**	**1.729**	**606**	**44**	**6.692**	***0***	***0***
1 Food	12	167	295	68	0	1.003		
2 Water	3	1.588	1.332	483	41	4.240		
3 Raw materials	18	208	86	36	1	1.414		
4 Genetic resources								
5 Medicinal resources	2	19	16	19	2	35		
6 Ornamental resources								
REGULATING SERVICES	**26**	**38.537**	**30.641**	**9.560**	**1.914**	**135.361**	***2***	***960***
7 Influence on air quality	*1*						*1*	*492*
8 Climate regulation	6	947	756	107	2	4.677		
9 Moderation of extreme events	13	3.294	892	2.387	4	9.729		
10 Regulation of water flows								
11 Waste treatment / water purification	4	33.966	28.781	6.926	1.811	120.200		
12 Erosion prevention	3	330	212	140	97	755		
13 Maintenance of soil fertility /nutrient cycling	*1*						*1*	*468*
14 Pollination								
15 Biological control								
HABITAT SERVICES	**25**	**6.339**	**17.295**	**853**	**27**	**68.795**	***0***	***0***
16 Lifecycle maintenance (esp. nursery service)	21	3.800	12.880	362	2	59.645		
17 Maintenance of genetic diversity (gene pool prot.)	4	2.539	4.416	491	25	9.150		
CULTURAL SERVICES	**10**	**684**	**939**	**257**	**10**	**2.904**	***0***	***0***
18 Aesthetic information								
19 Opportunities for recreation and tourism	10	684	939	257	10	2904		
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

3) Brief discussion of the economically most important services.

The three main economically important services derived from coastal wetlands, as shown in Table III.4 are: water purification and waste water treatment, moderation of extreme events and nursery service, which supports commercial fisheries elsewhere.

1) Water purification

Water purification and waste water treatment is a highly valuable service provided by coastal wetlands. There are, however, relatively few studies that have attempted to value this ecosystem service from mangroves and tidal marshes. We review 4 studies, 3 for tidal marshes and one for mangroves. The average estimated value for this service is just under 34,000 USD/ha/year, with a median value just under 7,000 USD/ha/year, and a range of values 1,800 – 120,200 USD/ha/year. The highest value estimate is from a study by Gosselink et al. (1974) on the value of waste water treatment by tidal marshes in 5 US mid-Atlantic estuaries (Delaware, Potomac, James, East River, Hudson) using the replacement cost valuation approach. This value is a particularly high estimate due to the socio-economic context of the ecosystem sites that are valued in this study and due to the valuation method applied. The replacement cost approach is prone to over estimating ecosystem service values.

2) Moderating extreme events

The value of coastal wetlands in moderating extreme events has received a considerable amount of attention in the economic valuation literature, particularly since the 2004 Indian ocean tsunami and hurricane Katrina in the Gulf of Mexico in 2005. The importance and value of coastal wetlands in moderating extreme weather events is likely to increase over time due to climate change. We review 13 studies that estimate the value of storm or flood protection by coastal wetlands. The average value of this service is 3,300 USD/ha/year, with a median value of 900 USD/ha/year. The range of estimated values is 4-9,700 USD/ha/year. An example of a methodologically sound valuation of storm protection provided by mangroves is a study by Naylor and Drew (1998). This study examines the economic value of storm protection and other ecosystem services provided by mangroves in Kosrae, Micronesia using the contingent valuation method. The combined value of storm protection, erosion control and materials from the mangrove is estimated to be 1,965 USD/ha/year.

3) Nursery service

A large number of valuation studies provide estimates of the economic value of the nursery service provided by coastal wetlands. Our review includes 33 studies that address this ecosystem service, the majority of which are for mangroves. The mean value for nursery services is just under 2,800 USD/ha/year. The estimated values do, however, cover a wide range with the minimum estimate being 2 USD/ha/year and the maximum just under 60,000 USD/ha/year. The median value is 424 USD/ha/year, indicating that the distribution of values is skewed with a large number of relatively low values and a few estimates of high values. A good example of a valuation study that estimates the value of the nursery service provided by mangroves, amongst other services, is a study by Sathirathai (1998). This study uses the production function valuation method to estimate the value of mangroves as an input into commercial off-shore demersal and shellfish fisheries in Surat Thani, South Thailand. The estimated value of this service is 608 USD/ha/year.

4) Example of a "best-practice" study on the TEV of a coastal wetland

Box 4 The Total Economic Value of the Muthurajawela Wetland, Sri Lanka (*Emerton and Kekulandala, 2003)*

The Muthurajawela Marsh covers an area of 3,068 hectares, and is located near Colombo, the capital of Sri Lanka. It forms a coastal wetland together with the Negombo Lagoon. It is rich in biodiversity and in 1996 part of the wetland was declared a Wetland Sanctuary. The pressures facing the Muthurajawela wetland are growing. Major threats are urban, residential, recreational, agricultural and industrial developments; over-harvesting of wetland species; and pollution from industrial and domestic wastes. As a result, the wetland has been seriously degraded.

The economic values of ecosystem services and total economic value of the Muthurajawela wetland are presented in Table 3. This study uses direct market prices to estimate direct use values such as fishing, firewood, agricultural production, recreation and also the support service to downstream fishereis. The replacement cost method is used to value indirect use values including wastewater treatment, freshwater supplies and flood attenuation.

Table III.4b: Economic Value of the Muthurajawela Wetland, Sri Lanka

Economic Benefit	**Economic Value per year (converted to 2003 US$)**
Flood attenuation	5,033,800
Industrial wastewater treatment	1,682,841
Agricultural production	314,049
Support to downstream fisheries	207,361
Firewood	82,530
Fishing	64,904
Leisure and recreation	54,743
Domestic sewage treatment	44,790
Freshwater supplies for local populations	39,191
Carbon sequestration	8,087
TOTAL ECONOMIC VALUE	**7,532,297**

III.5 – Monetary value of ecosystem services provided by Inland wetlands

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1) Brief "status" description of Inland Wetlands.

This biome-type includes (freshwater) floodplains, swamps / marshes and peat lands. It explicitly does not include coastal wetlands and rivers and lakes, which are addressed in sections III.4 and III.6 respectively.

The diversity in ecosystem services that wetlands provide makes them incredibly valuable ecosystems. For example, they have a very high ecological value, providing the water and primary productivity upon which countless species of plants and animals depend. Wetlands support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. It has been estimated that freshwater wetlands hold more than 40% of the world's species and 12% of all animal species.

2) Monetary value of inland wetlands

As Table III.5 shows, the total monetary value of the potential sustainable use of all services of inland wetlands combined varies between 980 and 44.977 Int.$/ha/year, with a mean value of about 14.750 Int.$/ha/y (2007-values), based on 81 original value-points.

3) Brief discussion of the economically most important services.

With 86 values, inland wetlands represent one of the more extensively studied biomes with regard to ecosystem service valuation. In spite of this, there is limited value information for many ecosystem services provided by this biome. For three ecosystem services there are no available value estimates and for six we only have one value estimate.

The three main, economically important services according to evidence presented in Table III.5 are: regulation of water flows, aesthetic enjoyment, and moderation of extreme events.

1) Regulation of water flows

The mean value of the regulation of water flows by freshwater wetlands is estimated to be just under 4,700 USD/ha/year based on four valuation studies. Again the range of values is large, with the lowest value estimate being 14 USD/ha/year and the highest just under 9,400 USD/ha/year. The median value of this service is just above 4,600 USD/ha/year. The valuation methods used to value this ecosystem service from inland wetlands include net factor income, avoided costs and replacement cost (e.g. Leschine et al., 1997).

Table III.5 – ***Summary of Monetary value of services provided by the Inland wetlands (in Int. $/ha/year-2007 values) (****

Inland wetlands	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 14,752 Int. $/ha/year (n = 81)	**81**	**15.752**	**15.925**	**9.860**	**981**	**44.977**	***6***	***282***
PROVISIONING SERVICES	**29**	**2.740**	**3.636**	**370**	**5**	**10.090**	***3***	***167***
1 Food	12	709	937	235	3	2.301		
2 Water	6	1.598	2.441	88	1	5.359		
3 Raw materials	11	433	258	47	1	2.430		
4 Genetic resources	*1*						*1*	*11*
5 Medicinal resources	*1*						*1*	*88*
6 Ornamental resources	*1*						*1*	*68*
REGULATING SERVICES	**29**	**8.941**	**8.345**	**6.134**	**318**	**23.018**	***3***	***115***
7 Influence on air quality								
8 Climate regulation	5	104	64	60	4	351		
9 Moderation of extreme events	7	1.569	559	816	237	4.430		
10 Regulation of water flows	4	4.660	4.948	4.630	14	9.369		
11 Waste treatment / water purification	9	1.356	548	430	40	4.280		
12 Erosion prevention	*1*						*1*	*84*
13 Maintenance of soil fertility /nutrient cycling	4	1.252	2.226	199	22	4.588		
14 Pollination	*1*						*1*	*16*
15 Biological control	*1*						*1*	*15*
HABITAT SERVICES	**10**	**852**	**1.521**	**504**	**10**	**3.471**	***0***	***0***
16 Lifecycle maintenance (esp. nursery service)	2	463	641	463	10	917		
17 Maintenance of genetic diversity (gene pool prot.)	8	389	880	41	0	2.554		
CULTURAL SERVICES	**13**	**3.218**	**2.423**	**2.852**	**648**	**8.399**	***0***	***0***
18 Aesthetic information	2	1.994	1.911	1.994	83	3.906		
19 Opportunities for recreation and tourism	9	546	397	180	1	3.700		
20 Inspiration for culture, art and design	2	678	115	678	564	793		
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

2) Aesthetic enjoyment,

The mean value of aesthetic enjoyment provided by freshwater wetlands is estimated to be 1,994 USD/ha/year. This estimate however is only based on the results of two valuation studies, which produce widely differing value estimates (83 and 3,906 USD/ha/year respectively). The lower value is produced by a study of freshwater marshes at lake St Clair in Michigan, USA (Amacher et al., 1989). This study uses the hedonic pricing method to estimate the aesthetic amenity value of wetlands. The higher value is produced by a study of the Jandacot wetlands in Western Australia using the contingent valuation method (Gerrans, 1994).

3) Moderation of extreme events.

The moderation of extreme events by freshwater wetlands, which is principally the attenuation of flood waters, has an estimated average value of 1,569 USD/ha/year with a median value of 816 USD/ha/year. These values are based on information from 7 studies that have used either replacement cost (Emerton and Bos, 2004) or avoided cost (Department of Conservation, 2007) valuation methods. A number of the value estimates included in the TEEB database for this ecosystem service are from benefit transfers (e.g. Anielski and Wilson, 2005).

4) Example of a "best-practice" study on the TEV of inland wetlands

Box 5. Three examples of best-practice studies for TEV of inland wetlands in New Zealand, the US and Greece.

a) Economic value of Whangamarino wetland, North Island, New Zealand (Kirkland, 1988)

Whangamarino wetland is the second largest peat bog and swamp complex on North Island, New Zealand. It is the most important breeding area in New Zealand for *Botaurus poiciloptilus* and a habitat for wintering birds and a diverse invertebrate fauna. The wetland covers and area of 10,320 hectares and supports a commercial fishery, cattle grazing, recreational activities. Estimated use and non-use values for Whangamarino are presented in Table III.4b. These value estimates are estimated using the contingent valuation method.

Table III.5b - Economic Value of Whangamarino wetland, New Zealand

Economic Benefit	Economic Value per year (converted to 2003 US$)
Non-use preservation	7,247,117
Recreation	2,022,720
Commercial fishing	10,518
Flood control	601,037
TOTAL	**9,881,392**

b) Economic value of the Charles River Basin wetlands, Massachusetts, US (Thibodeau and Ostro, 1981)

The Charles River Basin wetlands in Massachusetts consist of 3,455 hectares of freshwater marsh and wooded swamp. This is 75% of all the wetlands in Boston's major watershed. The benefits derived from these wetlands include flood control, amenity values, pollution reduction, water supply and recreational opportunities. Estimates of economic values derived from these wetlands are presented in Table III.4c. Value estimates are obtained using a variety of valuation methods including hedonic pricing, replacement costs, and market prices.

Table III.5c - Economic Value of Charles River Basin wetlands, Massachusetts, US

Economic Benefit	Economic Value per year (converted to 2003 US$)
Flood damage prevention	39,986,788
Amenity value of living close to the wetland	216,463
Pollution reduction	24,634,150
Recreational value: Small game hunting, waterfowl hunting	23,771,954
Recreational value: Trout fishing, Warm water fishing	6,877,696
TOTAL	**95,487,051**

c) Economic value of the Zazari-Cheimaditida wetland, Greece (Ragkos et al., 2006)

The Zazari–Cheimaditida catchment is situated in North-West Greece. The total area of the wetland ecosystem is 11,400 ha and includes areas of forest, rangelands and farmland. The ecosystem is included in Natura2000 network. More than 150 plant species have been reported in the area, while local fauna is also of great importance, especially endangered bird species such as the Dalmatin Pelican, Ferriginous Duck, Lesser Kestrel and Montagu's Harrier. Environmental degradation of the wetland ecosystem is visible as meadows have been reduced, open water surface has diminished, the area reed bed is constantly expanding and water quality has been reduced. Agrochemical use in the region is moderate but water extraction for irrigation is heavy and is steadily increasing. These conditions adversely affect natural habitats and commercial fish populations.

The economic value of five ecosystem services have been valued using a dichotomous choice contingent valuation survey of local households in face-to-face interviews. The ecosystem services valued are groundwater recharge (infiltration and percolation of detained floodwater into an aquifer), floodwater retention (detention and storage of waters from overbank flooding and/or slope runoff), sediment retention (net retention of sediments, which maintains water quality), nutrient export (removal and/or transformation of excess nutrients, which reduces eutrophication), and food web support (relates to harvest of biomass, recreational activities, and biodiversity). The estimate values are presented in Table III.4d.

Table III.5c - Economic Value of the Zazari-Cheimaditida wetland, Greece

Economic Benefit	Economic Value in US$/ha/year (2003)
Groundwater recharge	13,470
Floodwater retention	13,230
Sediment retention	12,740
Nutrient export	13,801
Food web support	12,490

III.6 – Monetary value of ecosystem services provided by Rivers and Lakes

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1) Brief "status" description of the "lakes & rivers" biome.

This biome-type includes freshwater rivers and lakes. Saline lakes, and wetlands and floodplains are not included in this biome (see coastal and inland wetlands). The total surface area is estimated at 6,713,000 square km, holding approximately 105,000 cubic km of freshwater.

Lakes and rivers are of critical importance to human well-being through the supply of freshwater for human consumption. Lakes and rivers are also important sources of provisioning (food and water supply) and cultural (recreation and tourism) services. They also provide a regulating service through the treatment of waste and purification of water. The critical nature of freshwater resources makes rivers and lakes especially vulnerable to degradation. Yet despite this, there appears to be a paucity of ecosystem service values.

Lakes and rivers have a long history of modification, regulation and diversion to supply drinking water and irrigation water for food production. In a global study, Nilsson et al (2005) report that over half of the 292 large river systems assessed (account for 60% of global water discharge) are fragmented by dams.

Fresh water systems are also threatened by diffuse pollution of organic material from agricultural systems (nitrates, phosphates). Point source pollution of organic and heavy metals also threatens many freshwater resources.

2) Monetary value of lakes and rivers

As Table III.6 shows, the total monetary value of the potential sustainable use of all services of rivers and lakes combined varies between 1.700 and 13.500 Int.$/ha/year, with a mean value of about 7.400 Int.$/ha/y (2007-values), based on 12 original value-points. Of these, the freshwater supply and water purification ecosystem services seem to most important although recreation and tourism values are relatively more common but of considerably lower value.

*Table III.6 – Summary of Monetary value of services provided by the Rivers and Lakes Biome (in Int. $/ha/year-2007 values) (**

Rivers and Lakes	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 7.433 Int. $/ha/year (n = 12)	**12**	**7.433**	**7.420**	**7.290**	**1.779**	**13.488**	***4***	***812***
PROVISIONING SERVICES	**5**	**3.455**	**3.228**	**3.420**	**1.169**	**5.776**	***1***	***3***
1 Food	3	94	90	59	27	196		
2 Water	2	3.361	3.139	3.361	1.141	5.580		
3 Raw materials	*1*						*1*	*3*
4 Genetic resources								
5 Medicinal resources								
6 Ornamental resources								
REGULATING SERVICES	**2**	**2.642**	**3.304**	**2.642**	**305**	**4.978**	***2***	***129***
7 Influence on air quality								
8 Climate regulation	*1*						*1*	*126*
9 Moderation of extreme events	NA							
10 Regulation of water flows								
11 Waste treatment / water purification	2	2.642	3.304	2.642	305	4.978		
12 Erosion prevention	NA							
13 Maintenance of soil fertility /nutrient cycling	*1*						*1*	*3*
14 Pollination	NA							
15 Biological control	NA							
HABITAT SERVICES	**0**	**0**	**0**	**0**	**0**	**0**	***1***	***681***
16 Lifecycle maintenance (esp. nursery service)								
17 Maintenance of genetic diversity (gene pool prot.)	*1*						*1*	*681*
CULTURAL SERVICES	**5**	**1.337**	**888**	**1.228**	**305**	**2.733**	***0***	***0***
18 Aesthetic information								
19 Opportunities for recreation and tourism	5	1.337	888	1.228	305	2.733		
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources

3) Brief discussion of the economically most important services

Fresh water systems provide several crucial services with considerable economic value: fresh water fisheries, maintenance of nutrient flows, treatment of pollution (BOD), water supply (irrigation, industrial and residential), hydropower, water-based recreation and navigation.

The three main, economically important services are: 'water supply', 'waste treatment/water purification' and 'tourism'. It should be noted that hydropower (and other natural sources of sustainable energy production) and navigation are not considered as ecosystem services in the TEEB study and therefore not included in our analysis of ecosystem service benefits (De Groot et al 2010a and De Groot et al 2010b).

1) Water supply

The supply of freshwater from lakes and rivers is critical to human survival. The primary value of water held by rivers and lakes is ascertained through markets. The market price of water is highly variable, depending on the final use of the water, and is only available as a volumetric measure. For example, bottled water for human consumption sells at the equivalent of approximately 3 million US$/ML assuming US$ 1.50 for a 500ml bottle. Annual licenses to extract irrigation water for food production have recently traded in Australia's water market at up to 2,000 US$/ML. However, mature markets for irrigation water are rare and in many countries irrigation water is extracted for no cost. Converting these volumetric values into areal values is possible using the total global volume and area of rivers and lakes, but the result is a range of very values (31,000 US$/ha to 47 million US$/ha).

2) Water purification

The water purification service provided by lakes and rivers is through the process of filtration and absorption by the soil particles and living organisms within the freshwater system. Water pollutants are removed as water moves through wetland areas, forests, and riparian zones. An often-quoted example (e.g. Heal, 2000) is that of the New York State water authorities avoiding a US$ 6-8 billion expenditure on a water treatment facility in New York City by spending US$ 1 billion to restore the watershed that provided the City's drinking water. The freshwater system, including interconnected wetlands and surrounding forests, naturally purified the water at a much cheaper cost than the engineering alternative.

The values used for the Table are based on two studies, one using benefit transfer (Li et al, 2010) and the other using avoided cost (Verma, 2001).

3) Recreation and tourism

Freshwater bodies are attractive locations for recreation and tourism, with many activities often undertaken along rivers and within lakes. Popular activities include water sports (skiing, swimming, rowing), recreational pursuits (boating, camping, fishing), tourism and general amenity. Methods used to value these services are typically based on travel cost, contingent valuation or market prices. We have drawn from four different studies for this service, making it the richest set of data for this biome.

4) Example of a "best-practice" study on the TEV of lakes and rivers

Box 6. - TEV of the River Murray, Australia

The 2,700 km River Murray is Australia's longest freshwater river system and has been heavily modified and developed. Water from the River Murray is used for human consumption, and industrial and agricultural production. The River Murray channel and interconnected wetlands are important habitat for a large diversity of species and many locations along the river are recognised as internationally significant under the Ramsar Convention. The major ecosystem services provided by the river include freshwater for human consumption, recreation and tourism, aesthetics, agricultural production, and fishing. Over development and extraction of water for consumption and production purposes, exacerbated by recent drought, has compromised the ecological health or the river system. In 2007-08, the lack of inflows resulted in near-zero allocations to many irrigators who extract water from the River Murray and its upstream tributaries.

The annual economic values of major ecosystem services provided by the River Murray is listed in Table X. Values are drawn from several sources. Food produced from irrigation water diverted from the River Murray and the tourism and recreation services along the river account for the bulk of economic value. Other smaller but important values are the avoided damages provided by a freshwater system with low salt content, and the maintenance of sufficient environmental flows to maintain riverine species habitat.

III.6b - Total economic value of ecosystem services provided by the River Murray, Australia (2007 $AUD/Year)

Ecosystem Service	**Valuation Method**	**Source**	**Total Value ($m)**
Recreation and tourism	Market Prices	Howard, 2008	2,97
Food production	Market Prices	Australian Bureau of Statistics, 2008	1,600*
Water Quantity (environmental flows)	Contingent Valuation	Bennett, 2008	80
Water Quality (no salinity)	Avoided Cost	Connor, 2008	18
Total Economic Value			**4,668**

**An estimate for the River Murray water only. Total value of irrigated agriculture in Murray-Darling River Basin is $4,600m. Water drawn from the River Murray for irrigation is approximately a third of the total water drawn from the Basin, suggesting the river's water accounts for a third of irrigated agriculture value.*

For other examples of good TEV-studies, see Thomas et al., (1991)

III.7 – Monetary value of ecosystem services provided by Tropical Forests

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1) Brief "status" description of the tropical forest biome

The Tropical Forests biome includes various types of forests, eg. moist- or rainforests, deciduous/semi-deciduous broadleaf forest and tropical mountain forests. The total surface area of remaining tropical forests is, depending on the source, estimated to be around 9.149 million km2 (Braat et al., 2008) and 17.900 million km2 (Secretariat of the Convention on Biological Diversity, 2001). Wilson (1992) has suggested that half of all known species reside in tropical forests, and WCMC (1992) conjectures that the majority of yet-to-be-discovered species are in tropical areas. Braat et al. (2008) estimate that 76% of tropical forests are still intact (see TEEB D0 Chapter 1 (De Groot et al 2010b)).

Tropical forests provide a wide variety of goods and services: they regulate or influence the climate on the local and global level, temper extreme weather events, regulate the hydrological cycle, stabilize watersheds and water flows, prevent erosion, and provide a source of animal and plant genetic information. They also contribute directly by providing many resources like, food, water, timber, other raw materials, NTF-product and opportunities for recreation (SCBD 2001, Markandya et al (2008), Mendelsohn and Balick (1995), MEA (2005)).

It is estimated that, on average, between 50,000 and 120,000 km2 of Tropical forests are lost each year (Achard et al, 2002; FAO Forest Resource Assessment, 2000). More recent evidence suggests the rates of deforestation are increasing, particularly in tropical Asia and the Brazilian Amazon (Fearnside and Barbosa, 2004; Hansen and DeFries, 2004). The majority of these losses are a direct consequence of human-induced activities including: subsistence activities, oil extraction, logging, mining, fires, war, commercial agriculture, cattle ranching, hydroelectric projects, pollution, hunting and poaching, the collection of fuel wood and building material, and road construction. Further, many of these extractive processes are not sustainable, and often result in the long-term loss of important ecosystem services, which in turn will affect people's welfare both at the local level (e.g. soil erosion and fertility) and the international level (e.g. climate regulation).

2) Monetary value of tropical forests

As Table III.7 shows, the total monetary value of the potential sustainable use of all services of tropical forests combined varies between 100 and 23.222 Int.$/ha/year, with a mean value of about 5.100 Int.$/ha/y (2007-values), based on 139 original value-points.

Although much care must be taken when extrapolating and aggregating these values some interesting comparisons can be made: Van Beukering et al. (2003) calculated an average value of 400-900 US$ /ha/year for the Leuser National Park on Sumatra, Indonesia (see Box 7) Torras (2000) calculated for the Amazonian forest values between 1,175 US$/ha/y (1994 values) and 1,445 US$/ha/yr (2000-values); Costanza et al (2007) came at an average of 2,007 US$/ha/yr (1994 value),

*Table III.7 – Summary of Monetary value of services provided by the Tropical Forests Biome (in Int. $/ha/year-2007 values) (**

Tropical forests	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 5.088 Int. $/ha/year (n = 139)	**139**	**5,088**	**8,303**	**1,912**	**91**	**23,222**	***2***	***29***
PROVISIONING SERVICES	**62**	**1,886**	**3,320**	**412**	**26**	**9,384**	***0***	***0***
1 Food	24	121	250	41	0	1,204		
2 Water	3	300	498	16	8	875		
3 Raw materials	26	568	927	227	2	3,723		
4 Genetic resources	4	506	865	105	14	1,799		
5 Medicinal resources	5	392	779	23	1	1,782		
6 Ornamental resources								
REGULATING SERVICES	**43**	**2,180**	**3,087**	**1,272**	**57**	**7,135**	***1***	***12***
7 Influence on air quality	2	485	667	485	13	957		
8 Climate regulation	10	358	295	328	13	761		
9 Moderation of extreme events	4	92	165	10	8	340		
10 Regulation of water flows	4	19	19	19	2	36		
11 Waste treatment / water purification	6	261	294	185	0	665		
12 Erosion prevention	11	562	985	210	11	3,211		
13 Maintenance of soil fertility /nutrient cycling	3	359	613	8	2	1,067		
14 Pollination	3	45	48	28	7	99		
15 Biological control	*1*						*1*	*12*
HABITAT SERVICES	**13**	**649**	**1,469**	**19**	**6**	**5,277**	***1***	***17***
16 Lifecycle maintenance (esp. nursery service)	*1*						*1*	*17*
17 Maintenance of genetic diversity (gene pool prot.)	13	649	1,469	19	6	5,277		
CULTURAL SERVICES	**21**	**373**	**427**	**209**	**2**	**1,426**	***0***	***0***
18 Aesthetic information								
19 Opportunities for recreation and tourism	21	373	427	209	2	1,426		
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

and values from the COPI-study (Brink et al 2009), range between 3,528 – 4,381 US$/yr/ha (2007; PPP adjusted).

3) Brief discussion of the economically most important services.

The economically most important services are erosion prevention, maintenance of genetic diversity, raw materials (esp. timber), closely followed by genetic resources, influence on air quality and climate regulation

The value for prevention of soil erosion ranges between 11 and 3,211 int. $/ha/y (2007 values) based on eleven studies that generally measure the avoided costs or the replacement costs. The studies tend to be linked to areas of the forest that is at the inter-face with human activity. Although the per ha values can be aggregated to the whole area of the forest, it is likely that the risk of soil erosion, and thus the value in terms of avoided costs, would be greatest where people are exploiting the forest.

4) Example of a "best-practice" study on the TEV of a Tropical Forest

Box.7 Economic valuation of the Leuser National Park on Sumatra, Indonesia.
van Beukering, Cesar, Janssen (2003) Ecological Economics 44, 43 – 62.

One of the best examples of an evaluation of the total economic value of tropical forests is the research undertaken by van Beukering et al (2003) which aimed to evaluate the TEV of the ecosystem services associated with the 25,000 km^2 Leuser rainforest and buffer zone, and evaluate the consequences of deforestation on the delivery of these services.

Despite its protected status, about 20% of Leuser National Park has been lost or degraded due to logging, exploitation of non-timber forest products (NTFP), illegal poaching, unsustainable tourism, and conversion to crop plantations. The consequence of this is that there has been a reduction in the forest area (ultimately leading to the development of wastelands), increased soil erosion (reducing agricultural productivity), reduced water retention (leading to increased frequency and intensity of floods and droughts), and reduced pollination and pest control (reducing agricultural productivity). To address these issues, the study examines three possible future scenarios for Leuser: a *deforestation* scenario (i.e. the current trend in logging and exploitation of NTFP continues); a *conservation* scenario (i.e. logging of primary and secondary forest cease, and eco-tourism is developed); and a *selective use* scenario (i.e. logging of primary forest is substantially reduced and logged forests are replanted + some eco-tourism development).

Eleven services were identified as being important for the appraisal of the three scenarios: water supply, fishery, flood and drought prevention, agriculture and plantations, hydro-electricity, tourism, biodiversity, carbon sequestration, fire prevention, NTFP, and Timber. The economic value of the impacts has been assessed using a wide range of economic techniques, including production functions, market prices and contingent valuation. The important message here is the fact that no single valuation method is capable of evaluation all the benefits streams; different valuation methods are suited to evaluate different impacts.

Following the approach described above, the authors estimate that the total economic value of Leuser National Park (for the period 2000 – 2030) is 9,538m US$ for the *Conservation* scenario, 9,100m US$ for the *Selective use* scenario and 6,958m US$ for the *Deforestation* scenario (see Table III.7b).

Table III.7b: Distribution of benefits to the different sectors (in million US$)

	Deforestation		Conservation		Selective Use	
	Value	Proportion (%)	Value	Proportion (%)	Value	Proportion (%)
Water Supply	699	10	2419	25	2005	22
Fisheries	557	8	659	7	674	7
Flood prevention	1223	18	1591	17	1396	15
Agriculture	2499	36	1642	17	1016	11
Hydro-power	252	4	898	9	696	8
Tourism	171	2	828	9	407	4
Biodiversity	56	1	492	5	92	1
Carbon sequestration	53	1	200	2	125	1
Fire prevention	30	0	715	7	643	7
NTFP	235	3	94	1	1222	13
Timber	1184	17	0	0	825	9
Total	**6958**	**100**	**9538**	**100**	**9100**	**100**

Note: for the period 2000-2030, at a discount rate of 4%. Source: Van Beukering et al (2010)

Finally, it is worth highlighting some key factors that made this an exemplar case study of the value of tropical forests. First, the authors utilized the knowledge and experience of local, regional and national stakeholders at all stages of the research. This is important as it helps to better define the impacts. Second, the use of the 'impact pathway' is important to help identify what they key impacts are. Finally, the research utilized a wide range of valuation methods to assess the impacts.

III.8 – Monetary value of ecosystem services provided by Temperate Forests

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1) Brief "status" description of Temperate and Boreal Forests.

This biome-type includes temperate deciduous forest, temperate broadleaf and mixed forests, temperate coniferous forest, temperate rainforest, and boreal forest

2) Monetary value of non-tropical forests

As Table III.8 shows, the total monetary value of the potential sustainable use of all services of temperate and boreal forests combined varies between 30 and 4.850 Int.$/ha/year, with a mean value of about 1.260 Int.$/ha/y (2007-values), based on 40 original value-points.

3) Brief discussion of the economically most important services.

The three economically most important services are influence on air quality, food provisioning and pollination

4) Example of a "best-practice" study on the TEV of a specific case study

Box 8 Example of TEV case study: Economic valuation of Mediterranean forests (Croitoru, 2007)

Mediterranean forests provide a wide array of benefits; however, most of them are poorly recognized. This study attempted to value comprehensively all forest benefits in Mediterranean countries. Its objective is to arrive at a rough order of magnitude of total forest value in each country and in the Mediterranean region as a whole, and of the composition of this value, using available data. Forest benefits are identified based on a common framework and valued using a range of methods. The novelty of this study arises from undertaking it on a large scale, within a structured framework that allows for estimates to be aggregated within countries and compared across countries. The study covered 18 countries, divided into: Southern countries: Morocco, Algeria, Tunisia and Egypt; Eastern countries: Palestine, Israel, Lebanon, Syria, Turkey and Cyprus; Northern countries: Greece, Albania, Croatia, Slovenia, Italy, France, Spain and Portugal.

Continued on page 37

*Table III.8 – Summary of Monetary value of services provided by the Temperate and other Forests Biome (in Int. $/ha/year-2007 values) (**

Temperate Forest	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 1.261 Int. $/ha/year (n = 40)	**40**	**1.261**	**2.123**	**200**	**30**	**4.863**	***7***	***1.281***
PROVISIONING SERVICES	**15**	**692**	**933**	**103**	**25**	**1.736**	***1***	***3***
1 Food	5	496	647	72	0	1.204		
2 Water	3	152	262	1	0	455		
3 Raw materials	5	20	24	7	2	54		
4 Genetic resources	*1*						*1*	*3*
5 Medicinal resources	2	23	0	23	23	23		
6 Ornamental resources								
REGULATING SERVICES	**14**	**145**	**184**	**60**	**3**	**456**	***5***	***1.277***
7 Influence on air quality	*1*						*1*	*805*
8 Climate regulation	8	118	146	47	3	376		
9 Moderation of extreme events	*1*						*1*	*0*
10 Regulation of water flows	2	1	2	1	0	3		
11 Waste treatment / water purification	4	25	36	12	0	77		
12 Erosion prevention	*1*						*1*	*1*
13 Maintenance of soil fertility /nutrient cycling								
14 Pollination	*1*						*1*	*452*
15 Biological control	*1*						*1*	*20*
HABITAT SERVICES	**7**	**399**	**960**	**34**	**0**	**2.575**	***0***	***0***
16 Lifecycle maintenance (esp. nursery service)								
17 Maintenance of genetic diversity (gene pool prot.)	7	399	960	34	0	2.575		
CULTURAL SERVICES	**4**	**25**	**47**	**2**	**1**	**96**	***1***	***0***
18 Aesthetic information								
19 Opportunities for recreation and tourism	4	25	47	2	1	96		
20 Inspiration for culture, art and design	*1*						*1*	*0*
21 Spiritual experience								
22 Information for cognitive development								

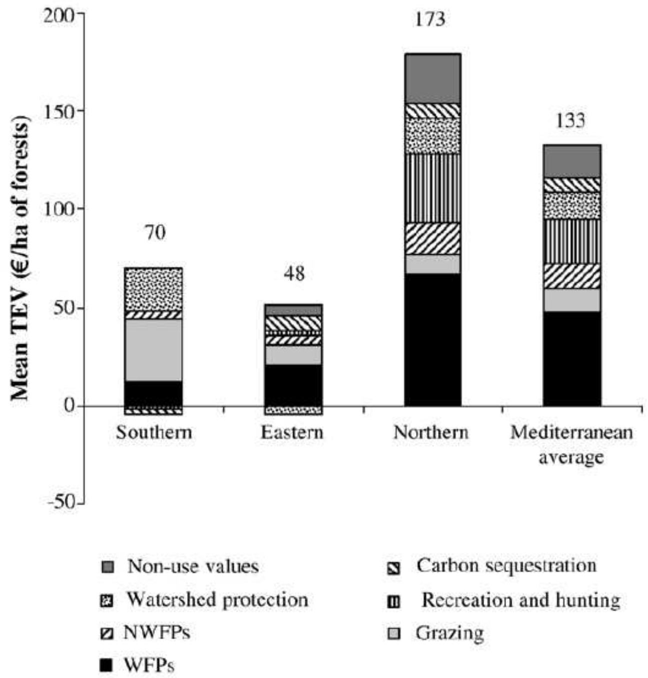
*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

4) Example of a "best-practice" study on the TEV of a specific case study

Box 8 (continued)

The average TEV of Mediterranean forests is about €133/ha. The average TEV in northern countries (about €173/ha) is higher than that in the southern (about €70/ha) and eastern countries (about €48/ha). In per capita terms, forests provide annual benefits of over €50 to the Mediterranean people. Average benefits are higher in northern countries (over €70 per capita) and lower in southern (under €7 per capita) and eastern countries (under €11 per capita). The large difference between the estimates for northern and those for southern and eastern countries is due in part to the much larger extension of forest area relative to population in the north, as well as to their relatively higher quality, thanks to more favourable climatic conditions and lower levels of degradation. To some extent, it is also due to the greater degree of underestimation of benefits in southern and eastern countries. The figure III.8b shows the average estimates of forest benefits at Mediterranean and sub-Mediterranean levels.

Figure III.8 – Mean Total Economic Value of three types of Mediterranean forests in Euro/ha (source: (Croitoru, 2007))



The study shows that Wood Forest Products (WFPs) such as timber account for only a small portion of total forest benefits. Watershed protection benefits are often much more important. In the southern and eastern Mediterranean, grazing dominates. Recreation is already very important in the northern Mediterranean and its importance is likely to grow throughout the region. This multifunctionality needs to be explicitly recognized and incorporated into forest policy.

Another good TEV-study was done on Chilean Temperate rainforests by Nahuelhual et al., 2007.

III.9 – Monetary value of ecosystem services provided by Woodlands

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1) Brief "status" description of the woodland-biome.

The "woodland-biome" includes a large range of vegetation types including woodlands, savannas, shrub lands, scrublands and chaparral interleaved with one another in mosaic landscape patterns distributed along the western coasts of North and South America, areas around the Mediterranean Sea, South Africa, and Australia, jointly representing about 5% of the planets surface.

Woodlands are important for the wellbeing of many millions around the world in many ways and market institutions are being put in placed to promote the flow of woodland products to the final consumers. Depending on the local institutional arrangements (property rights and access to the resource) this can lead to significant social gains (e.g. increased income for the resource owners, and enhanced trading) but also to serious sustainability issues (e.g. over exploitation of the woodland). The commercialisation of Marula fruit (*Sclerocarya birrea*) is a case in point. This woodland product brings a suite of opportunities for rural development, but also a number of challenges and threats – commercialisation of Marula products takes many forms, from household level trade in Marula beer to international liquor markets (Wynberg et al, 2002).

2) On the monetary value of woodlands

As Table III.9 shows, the total monetary value of the potential sustainable use of all services of woodlands varies between 16 and 1.950 Int.$/ha/year, with a mean value of about 800 Int.$/ha/y (2007-values), based on 17 original value-points.

3) Brief discussion of the economically most important services.

The three economically most important services are raw materials, water purification and climate regulation; below some of the values found for the 4 main service categories are briefly discussed.

a) Provisioning services, esp. raw materials

Provisioning services are well reported in the literature like Food and Raw Materials because the flow of these services and their contribution to people's wellbeing are relatively easy to quantify. However, a clear understanding of the use of the harvested biomass is required to avoid miss calculations. For example, there is evidence indicating that in woodland areas of Southern Africa, biomass is collected from the field to be used as firewood or for construction purposes; however after several years of use, the construction wood is recycled to be used as firewood (Goebel et al. 2000). Woodlands contribution to household income might be high as in some areas of the Peruvian Andes where goods collected from Opuntia scrublands represent as much as 36% of the total household income, which is very close to the income obtained from agriculture (Rodriguez et al., 2006).

*Table III.9 – Summary of Monetary value of services provided by the Woodlands Biome (in Int. $/ha/year-2007 values) (**

Woodlands	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 792 Int. $/ha/year (n = 17)	**17**	**792**	**958**	**573**	**16**	**1,950**	***6***	***5,066***
PROVISIONING SERVICES	**11**	**360**	**368**	**258**	**7**	**862**	***1***	***25***
1 Food	3	68	117	2	0	203		
2 Water								
3 Raw materials	8	292	251	256	7	659		
4 Genetic resources								
5 Medicinal resources								
6 Ornamental resources	*1*						*1*	25
REGULATING SERVICES	**6**	**432**	**590**	**315**	**9**	**1,088**	***2***	***130***
7 Influence on air quality	*1*						*1*	*80*
8 Climate regulation	2	198	267	198	9	387		
9 Moderation of extreme events								
10 Regulation of water flows								
11 Waste treatment / water purification	4	234	323	117	0	701		
12 Erosion prevention	*1*						*1*	*49*
13 Maintenance of soil fertility /nutrient cycling								
14 Pollination								
15 Biological control								
HABITAT SERVICES	**0**	**0**	**0**	**0**	**0**	**0**	***2***	***1,005***
16 Lifecycle maintenance (esp. nursery service)	*1*						*1*	*1,003*
17 Maintenance of genetic diversity (gene pool prot.)	*1*						*1*	*1*
CULTURAL SERVICES	**0**	**0**	**0**	**0**	**0**	**0**	***1***	***3,907***
18 Aesthetic information	*1*						*1*	*3,907*
19 Opportunities for recreation and tourism								
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

However, attention should be paid to the differences in the use and consumption patterns of the woodlands products between poor and better-off households. For example, poorer households in Zimbabwe value the woodlands for a variety of subsistence and marketed products representing about 25% of their income, while richer households value woodlands more for grazing resources and only derive 8% of their income from that ecosystem.

b) Regulating services

Woodland provide a large range of regulatory ecosystem services, however it is important to consider that not all the woodlands provide the same type of services to society. For example, there is evidence supporting that Australian woodlands assist in salinity control by reducing local water recharge, avoiding a rising water table that transports the salts in the soil to the root area of the crops. However, not all the woodlands are located in regions with salinity problems and even in those regions, the value of salinity control might significantly vary since it is influenced by the hydrology of the system, the location of the trees and the value of the agricultural production.

c) Habitat values

For example Opuntia scrublands are host of cochineal insects, a very important source of natural dyes. In Ayacucho, these insect are collected from the scrubland for commercial purposes. The value of the nursery and refugium service of the scrubland was quantified based on the costs avoided by peasants if the Opuntia plants should be infested by hand, representing a figure of 1590 PEN/ha/year, exceeding the value of all the goods collected from the same ecosystem (Rodriguez et al., 2006).

d) Cultural and spiritual values

Finally, some services provided by woodlands, like cultural and sacred values, are hard to quantify in monetary terms or incommensurable but they are certainly important for local people. For example, in a participatory exercise in the Woodlands of Zimbabwe, the findings of Campbell et al. 1997 indicate that Cultural and Sacred values might account as much as 29% of the total value of the system, but there was no attempt to monetize those values. Hassan et al. 2002 estimated that the social and cultural values of woodlands as providers of raw material for traditional and religious customs might be between SZL 12000 and SZL 20520 per year for men and SZL 40000 per year for females.

4) Example of a "best-practice" study on the TEV of a woodland

Box 9 Example of TEV case study: Goods and services from Opuntia Scrublands in Ayacucho, Peru *(Rodriguez et al., 2006)*

Opuntia scrublands, one of the most important Andean socio-ecosystems in terms of the social and ecological functions that they provide. They perform a major role protecting slopes against erosion, improving the soil properties and providing a variety of products employed in the human diet, and in animal feeding, as well as cochineal insects, a highly value source of dyes.

The ecosystem goods and services provided by Opuntia scrublands are very diverse with regard to the structures and functions involved in their supply, in their level of integration to diverse markets, and with regard to their contribution to human wellbeing.

Rodriguez et al. 2006 contributed to the estimation of the use value of Opuntia scrublands to local communities in Ayacucho by initially exploring the ‘cultural domain’ of Opuntia in order to identify the ecosystem goods and services recognized by the Andean communities. Then, the local perception of the internal relationships among the goods and services provided by the scrubland was estimated, as well as the relationships between the Opuntia scrubland and-other environmental and socio-economic systems existent in the region. The authors presented empirical estimates of the values of the goods and services provided by the Opuntia scrubland and their contribution to household income

Table III.9b - Goods and services from Opuntia Scrublands in Ayacucho, Peru (Source: Rodriguez et al., 2006)

Goods and services from Opuntia Scrublands	**Average value US$/ha/year**
Production Function	
Cochineal production	216
Fruit production	101
Fodder production	73
Fuel production	59
Ornamental production	12
Total Production Function	**461**
Habitat Function	
Cochineal infestation for dye production	**497**
Regulation Function	
Erosion control	**5**
Habitat Function	
Not quantified in monetary terms. Many lyrics of Pumpin music, a traditional genre in Ayacucho are inspired by the Opuntia. Lyrics represent advices, rules and norms for the sustainable use of the goods and services provided by Opuntia scrublands	**NA**

III.10 – Monetary value of ecosystem services provided by Grasslands

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1) Brief description and status of the grassland biome.

Grasslands occur in a wide variety of environments. They include tropical grasslands (savannas), temperate grasslands (including the European and Central Asian steppe and North American prairie), boreal grasslands (tundra's) and mountainous grasslands (such as the Latin American Paramo highlands). The largest continuous stretch of tropical grassland is the North African Sahel, that stretches from Senegal to the Horn of Africa.

As all ecosystems, grasslands provide a wide variety of ecosystem services. The large variation in the specific characteristics of grasslands means that the specific services provided vary very widely between individual grassland ecosystems. However, one provisioning service stands out as a key service provided in almost all grasslands: providing feed for livestock keeping (Walker & Noy-Meir, 1982; Walker & Abel, 2002). Other services provided by grasslands include carbon sequestration, biodiversity conservation, watershed regulation and the provision of opportunities for recreation and tourism. Table III.10 provides an indication of the economic value of grassland ecosystems. Given the wide variety of grassland types, their biophysical characteristics, management regimes, and socio-economic context, these values should not be used for interpolation to specific grassland ecosystems.

2) On the monetary value of grasslands

As Table III.10 shows, the total monetary value of the potential sustainable use of all services of grasslands varies between 290 and 3.000 Int.$/ha/year, with a mean value of about 1.200 Int.$/ha/y (2007-values), based on 25 original value-points.

*Table III.10 – Summary of Monetary value of services provided by the Grasslands Biome (in Int. $/ha/year-2007 values) (**

Grasslands	No. of estimates	Mean Value (Int.$/ha/y)	St. dev of mean (Int.$/ha/y)	Median Value (Int.$/ha/y)	Minimum Value (Int.$/ha/y)	Maximum Value (Int.$/ha/y)	No. of Single estimates	Single estimates (Int.$/ha/y)
TOTAL: 1.244 Int. $/ha/year (n = 25)	**25**	**1.244**	**1.255**	**874**	**297**	**3.091**	***3***	***752***
PROVISIONING SERVICES	**9**	**454**	**217**	**444**	**237**	**715**	***1***	***0***
1 Food	3	54	43	76	4	82		
2 Water	4	378	161	346	219	602		
3 Raw materials	2	22	12	22	14	31		
4 Genetic resources	*1*						*1*	*0*
5 Medicinal resources								
6 Ornamental resources								
REGULATING SERVICES	**10**	**686**	**860**	**428**	**60**	**2.067**	***2***	***752***
7 Influence on air quality	*1*						*1*	*219*
8 Climate regulation	5	473	679	246	9	1.661		
9 Moderation of extreme events	NA							
10 Regulation of water flows	NA							
11 Waste treatment / water purification	3	170	175	139	13	358		
12 Erosion prevention	2	43	7	43	38	47		
13 Maintenance of soil fertility /nutrient cycling	*1*						*1*	*533*
14 Pollination								
15 Biological control								
HABITAT SERVICES	**3**	**99**	**172**	**0**	**0**	**298**	***0***	***0***
16 Lifecycle maintenance (esp. nursery service)								
17 Maintenance of genetic diversity (gene pool prot.)	3	99	172	0	0	298		
CULTURAL SERVICES	**3**	**4**	**6**	**2**	**0**	**11**	***0***	***0***
18 Aesthetic information								
19 Opportunities for recreation and tourism	3	4	6	2	0	11		
20 Inspiration for culture, art and design								
21 Spiritual experience								
22 Information for cognitive development								

*) Values which are based on only one study (shown in italics), have not been used for the calculation of the total average. **NA** = service is not applicable to this ecosystem; **Blank cell** = no data found yet but service is (probably) applicable. See Appendix II for a detailed overview of the original values and their sources.

3) Brief discussion of the economically most important services.

This section discusses five key ecosystem services provided by grasslands: (i) livestock keeping; (ii) carbon sequestration; (iii) biodiversity conservation; (iv) provision of wood and other raw materials, and (v) tourism and recreation. Other ecosystem services provided by grasslands, as indicated in Table III.10 include for example hunting and watershed regulation. These services can be of high importance for specific grasslands, but are not further discussed in this section.

1) Livestock keeping

In most grasslands, livestock is the main source of local income, making this service critical to the livelihood of local communities. The major grazing systems include confined grazing, transhumance and pastoralism, and animals kept include cattle, goats, sheep, camels and reindeer. Income is derived from the sale of animals (meat and/or hides), and milk. The productivity, on a per hectare basis, is often low. For instance, in the western Sahel (Ferlo, Senegal), Hein and Weikard (2008) find a net annual income from grazing of only around US$ 1/ha/year. The overall economic value of this service is nevertheless high, given the very large surface area where grazing is the key source of income, and the general lack of alternative employment opportunities in these areas.

2) Carbon storage and sequestration

Many grasslands contain significant stocks of carbon, in particular below-ground. For example, average above ground soil carbon in Chinese temperate grasslands (steppe) is around 10 tonnes per ha and average below ground soil carbon is around 120 tonnes per ha (Ni, 2002). Carbon stocks develop as a function of vegetation dynamics, temperature and soil moisture levels. The level of accumulation of carbon varies widely between types of grasslands, with low temperature and flooded grasslands having the highest rates of carbon accumulation and other grasslands having virtually no accumulation.

3) Biodiversity conservation (habitat service)

Biodiversity is a function of the grassland type, the occurrence of native grass and forb species, and the presence and density of grazers and species higher up in the food web depending on these grazers. In all grassland types, biodiversity varies widely as a function of population pressures and past and present human management but biodiversity may be particularly high in the protected grasslands of Eastern and Southern Africa.

4) Provision of wood and other raw materials

In addition to grazing, another provisioning service is the supply of a broad range of products and materials from grassland species. These products may be provided by herbaceous species or, more commonly, by the shrub and tree species present in the grassland. Local people may engage in, for instance, the collection of material for use as biofuels, collection of wood for construction purposes, and production/collection of NTFPs. An example of a NTFP particular for tropical rangelands is Arabic gum, a resin of the tree *Acacia senegalensis*, which is collected commercially in the Sahel.

5) Tourism and recreation

The most prominent type of tourism in grasslands is related to spotting game and wildlife, in particular in Eastern and Southern Africa. Grasslands are highly popular for 'safari's' because of the high diversity of large animals and the high likelihood of seeing them due to the openness of the terrain. For some countries, tourism related to grassland biodiversity is a very important source of income. For example, the World Development Indicators database indicates that the receipts from international tourism in Kenya in 2005 amount to US$ 969 million, making it the country's 2nd largest economic sector after agriculture.

4) Example of a "best-practice" study on the TEV of a grassland ecosystem

Box 10 Example of TEV case study: Goods and services from Maloti–Drakensberg mountain range in southern Africa *(Blignaut et al., 2010, Mander et al., 2010)*

An example of a best-practice study is an elaborate hydrological-ecological-economic study undertaken to analyse ecosystem rehabilitation options in the Maloti–Drakensberg mountain range in southern Africa (Blignaut et al., 2010, Mander et al., 2010). The study targeted a fire-prone grassland ecosystem, in a mountain range that is South Africa's most strategic source of fresh water. While occupying less than 5% of South Africa's surface area, it produces 25% of the country's runoff through rivers, major dams, and national and international inter-basin transfers. The specific objective of the study was to analyse the financial and economic viability of restoration of five catchments in the Maloti-Drakensberg range in South Africa, considering the costs of restoration and the benefits of enhanced watershed regulation, carbon sequestration and sediment retention services. The results are listed in Table III.10b on the next page.

The study shows that the PV of the benefits of the examined watershed services ranges from R116 to R220/ha/yr over the project period. The PV of the cost (both restoration and management), however, ranges from R21 to R88/ha/yr resulting in an NPV of R87 to R153/ha/yr, which translates to BCA ratios of between 2.5 and 5.6. The study concluded that the benefits of introducing improved management practices exceeds cost in low to medium degraded areas, but not in heavily degraded ones. The economic return on the water (base flow) produced by such a system of improved land use management, however, far exceeds that of conventional (construction-based) water development programmes and offers meaningful economic and market development opportunities in the study area.

Continued in next page

Table III.10b The difference in ecosystem services supply before and after restoration in five catchments in [dryland areas] in South Africa *

	Unit	Upper-Thukela Grasslands biome	Upper-Mzimvubu Grasslands biome	Krom Fynbos biome	Kouga Fynbos biome	Baviaans Sub-tropical thicket biome
Changes in watershed services						
Change in base-flow	m3/yr	12,869,204	3,936,842	20,028,219	15,861,808	5,649,308
Sediment reduction	m3/yr	1,256,252	4,920,958	91,522	112,693	44,571
Carbon dioxide sequestration	t/yr	133,618	337,718	155,053	288,703	359,4
Financial and economic analysis of changes in watershed services following restoration (1,2						
PV of base flow	R./ha/yr	20.12 (3	8.06 (3	53.74	17.85	9.63
PV of carbon	R./ha/yr	74.78	89.15	71.54	55.82	105.23
PV of sediment reduction	R./ha/yr	31.58	60.58	2.54	1.31	0.79
PV of all other services (4	R./ha/yr	62.00	62.00	12.38	41.48	64.14
PV of total services	R./ha/yr	188.47	219.78	140.20	116.46	179.78
PV of cost of intervention (5	R./ha/yr	36.01	88.60	53.21	21.63	48.01
NPV of intervention (6	R./ha/yr	152.46	131.18	86.99	95.82	131.77
Benefit-Cost Ratio	ratio	5.2	2.5	2.6	5.6	3.7
Average net return per ha: unsust. land use	R/ha/y	70-90	70-90	35-80	35-80	35-80

****) sources: Blignaut et al., 2010., Mander et al., 2010***

Notes:

1 - Taken over 30 years at a social discount rate of 4%.

2 - In South African Rand (R7,5 : 1$ and R10,50 : 1 Euro).

3 - Taken only for the dry winter months.

4 - Value of all other quantifiable services for which a market exist, such as tourism, sustainable agriculture, etc.

5 - Intervention implies the cost of restoration and the ensuing annual management action(s) after restoration.

6 - Difference between the benefits and the costs.

Another interesting study was done by Fernandez-Nunez, et al. (2007) on an economic evaluation of land use alternatives between forest, grassland and silvopastoral systems.

III.11 – Monetary value of ecosystem services provided by Grasslands

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1) Brief description of the polar & high mountain biome.

The definition of polar and high mountain biomes used here deviates slightly from that used in the Millennium Ecosystem Assessment (2005). In particular, we define this biome in terms of its cryosphere (Kotlyakov 2009). Thus, Arctic/Antarctic regions are defined as the area within the 10°C isotherm based on the warmest month of the year (see maps produced by the Scott Polar Research Institute in Cambridge UK: Stonehouse, 1990). Based on this definition, Polar regions include all the Arctic seas and much of the Southern Ocean, the tundra/permafrost zone to the tree line, areas where there is long term snow cover (especially in the Arctic), and sub/marine zones in the Southern/Arctic oceans. This definition corresponds well with the WWF Arctic ecoregions (www.panda.org), the Udvardy (1975) and Clark and Dingwall (1985) biogeographical provinces for Antarctica.

Similar criteria could be applied to high mountains extrapolating from the altitudinal maps produced by Messerli and Ives at the UNU. So, for example, high mountain regions could be defined as those areas higher than the 1000masl mean line.

The MA gives the share of terrestrial space of polar and high mountains as 31% (MA 2005 Synthesis volume p31 Table 1.1). Our revised definition would put the cryosphere proportion nearer 50% of terrestrial space (at maximum seasonal extension). Thus, our definition would include 20% from the MA marine system (10% area for both the Southern and Arctic oceans).

The cryosphere is currently encountering many problems particularly in times of rapid climate change, especially due to warming and melting. There is currently a lack of data on the value of ecosystem services associated with the cryosphere, however, recent activities through the International Polar Year (Kaiser 2010) will help to start highlighting the importance of these services and the potential threat to their continued delivery. Further work is however needed to measure the value of these services.

2) On the monetary value of polar & high mountain systems

As Christie et al. (2005) note, there is currently very little quantification of the monetary value of services provided by polar and high mountain systems. This situation may change later this year when the 2000+ papers of the International Polar Year (IPY) are presented at the Oslo Polar Science Congress in June 2010 and at the IPY "Knowledge to Action" meeting in Montreal in 2012. The lack of monetary valuation research, however, should not be interpreted to infer the polar and high mountain areas to do deliver important services. Indeed, it is clear that these cryospheres are of paramount importance in terms of global ecosystem services. For example, the Pew Report on Arctic melting (Goodstein et al., 2010) estimates that the loss of Arctic snow, ice and permafrost currently costs the world US$61 billion to US$371 billion (See Box 10 for further details), as well as what Sagoff (2008) calls moral values. The most important services are briefly discussed below.

3) Brief discussion of the economically most important services.

1) Freshwater Storage

Approximately 80% of the planet's freshwater (ID 2) is locked up in the ice caps (Pitt, 1996; Gabler, 2008). The possible future break up and melting of these ice caps (for example West Antarctic ice sheet) along with melting of mountain glaciers (Zemp and van Woerden, 2008) would result is a rise in sea level (potentially up to several metres) which would have significant global costs associated with the protection or 'drowning' the some of the world's major cities (Mac Cracken, 2008; Overpeck and Weiss, 2009).

A significant proportion of the world's population depends on the meltwater of high mountain glaciers. Climate change threatens the existence of these glaciers, which in turn could have significant local and global consequences. For example, the meltwater of glaciers in the Himalayas and on the Tibetan plateau sustain the major rivers of India and China and is used for irrigation of wheat and rice fields. Given that India and China are the world leading wheat are rice producers, projected melting of the glaciers presents a significant threat to local and global food security (Brown, 2009).

2) Climate Regulation

The Southern Ocean and the Arctic Permafrost / tundra are both major greenhouse carbon sinks. However, global warming is likely to convert the Arctic permafrost/tundra into a net source of GHG (including methane) (McGuire et al, 2000). The polar regions also have a significant role in reducing climate change through the albedo effect, i.e. they reflect the sun's light back into space (MA 2005 v1 p859). Prizborski (2010) also suggest that the recent calving of the 2,545 km2 Mertz glacier tongue iceberg may disrupt ocean currents worldwide by blocking the flow of bottom water.

3) Fishing

It is estimated that the Southern Oceans contribute around one sixth of the global fish take (Knock, 1992) and that this resource may become increasingly important as other areas are fished out. However, legal protection of these marine resources is fragile (Constable et al, 2000). For example, the Commission for the Conservation of Antarctic Marine Living Resources suggests that 80 – 90% of the take of the rare Patagonian toothfish was illegal (MA 2005 p 487).

4) Raw Materials

Raw materials (ID 3) are very valuable too in the cryosphere (eg Howard, 2010; Emmerson, 2010; Orrega, 2009) and becoming a major area for international conflict. The Arctic is said to contain more than a quarter of the world's hydrocarbons (Auslaug 2008) and is widely presumed to be a future flashpoint as nations compete. The Antarctic Treaty System (ATS) currently prohibits exploitation of raw materials and creates the world's largest protected and demilitarized area reserved "for peace and science": however, the ATS expires in 2041 and its replacement is uncertain. Even now there is conflict over resources. The Australians and New Zealanders are currently taking the Japanese to court over abuses of the whaling moratorium. The British and Argentineans are involving warships as oil drilling is explored in the Falkalands/Malvinas, whilst even old friends like Canada and the USA are at daggers drawn over the NW passage"

5) Habitat service

The apparently dead and frozen waste of the cryosphere has been called species poor but evidence is accumulating not only of life in the extreme cold (including suspended animation), but also of vibrant hot spots (e.g. in the polynyas, sea leads, extensive sub glacial lakes or on the seamounts, around the volcanic vents). The IPY archive will contain faunal census material though we have some estimates for some species (e.g. Shirihai (2007) for Antarctica, CAFF (2001) and Ervin (2010) in the Arctic) whilst the international circum Antarctic census of marine life will be a benchmark in the Southern Ocean (Stoddart 2009). In biomass terms the primary productivity of the Southern Ocean is enormous: Van der Zwaag (1986) estimates that it is more than fifty times that of the North Sea in terms of grams of carbon per m^2 per annum. The NPP figures in the MA Synthesis Table (op cit) are very low for the polar biome especially and may need revisiting after IPY.

6) Cultural services and Tourism

Current there is little information on the aesthetic, recreational, inspirational, spiritual, cognitive etc values (ID 18-22) of the cryosphere, and innovative methods such as those highlighted by Christie (2005) will be needed to calculate these types of calculate values. For example, Samson and Pitt (2000) explore the passive use values of the cryosphere including the role it plays in what has been called the noosphere: the realm of ideas which embraces all cultural activities. Pitt (2010) have explored how iconic cryosphere species score in terms of internet hits: penguins top the poll. High mountains contain the most sacred and holy sites of humanity.

The cryosphere is also an important tourism resource. Snyder and Stonehouse (2007) project that in 2010 there will be 1.5 million visitors to the Arctic, 80, 000 Antarctic, 10 million to the Alps and many more in other high mountains.

4) Example of a "best-practice" study on the TEV of a polar and high mountain biome

Box 11 . Cost of Lost Climate Regulation Services Due to Changes in the Arctic Cryosphere.

Goodstein, E, E. Euskirchen and H. Huntington (2010) An Initial Estimate of the Cost of Lost Climate Regulation Services Due to Changes in the Arctic Cryosphere. The Pew Environmental Group: Washington DC

The Arctic cryosphere plays an essential role in regulating the global climate. For example, the reflective surfaces of ice and snow have a cooling (Albedo) effect, while permafrost traps vast quantities of methane and other forms of carbon. As the Arctic melts as a result of global warming, these critical, climate-stabilizing ecosystem services are being lost. This paper provides a first attempt to monetize the cost of some of those lost services.

The approach used to estimate the costs of Arctic melting is to first calculate the added emissions of CO2 equivalents (CO2e) due to climate-induced changes in Arctic sea ice, snow cover, and methane emissions for the period 2010 to 2100. These CO2e are then multiplied by three different estimates of the social cost of carbon.

Sea-Ice Albedo Declines: Arctic sea-ice helps to stabilise the climate by reflecting the sun's energy back into space: the albedo effect. Global warming is reducing the area of Arctic summer sea-ice, and it is predicted that summer sea-ice could disappear in the Arctic by the year 2050. The sea-ice will be replaced by darker surfaces, which absorb more heat. By 2100, the loss of sea-ice (and the resulting decline in the albedo effect) is expected to result in the absorption of an additional 0.8 - 1.6 Wm^{-2} into the atmosphere radiation budget. This is equivalent to an annual impact of between 900 to 1,800 MT CO_2e.

Snow-Cover Albedo Declines: Similarly, climate change is expected to reduce the duration of snow cover by 4.4 days per decade or a 44 day decrease in the length of the snow season by 2100. This translates into an increase in atmospheric heating of 4.3W m^{-2} per decade across the pan-Arctic (Euskirchen et al., 2009). This is equivalent to an annual impact of between 1,600 to 2,600 MT CO_2e.

Increased Methane Emissions from Thawing Permafrost: It is expected that future global warming will continue to degrade the Arctic permafrost, which in turn will release between 0.5 and 1.0 Tg methane per year (equivalent to 2,100 to 3,400 MT CO_2e.

Based on these assessments, the authors show that the current impact of global warming on these three processes are 3,000MT CO_2e per annum (equivalent to 42% of current total US emissions of GHGs). By 2050, this impact will increase to between 3,700 to 5,000 MT CO_2e, and then to 4,700 to 7,800 MT CO_2e by 2100.

The cumulative global costs resulting from the thawing of the Arctic was then estimated by multiplying the additional CO_2e emissions by the social cost of carbon (SCC). Three different estimates of the SCC are used in the analysis: EPA/NHTSA ($22/T CO2e); EPA 3 ($46/T CO2e) and Stern ($140 / T CO2e).

Based on the above approach, the authors illustrate that observed changes in the albedo effect of the Arctic sea-ice and snow-cover and increased methane releases from thawing permafrost, are already generating large economic costs at an estimated rate of $61 billion - $371 billion annually. With future declines in albedo and increases in methane releases both being likely, the cumulative cost impact over the next 90 years could reach between $4.85 trillion to $91.2 trillion. Finally, the authors note that the above estimate only includes three impacts of global warming in the Arctic, and importantly they do not address a possible worst-case scenario where global warming triggers massive releases of methane-hydrates from Arctic soils and ocean-beds.

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