Ecosystem Services Valuation Database (ESVD)

Update of global ecosystem service valuation data

Final report (June 2020)

Prepared on behalf of the Department for Environment, Food and Rural Affairs (Defra, UK)

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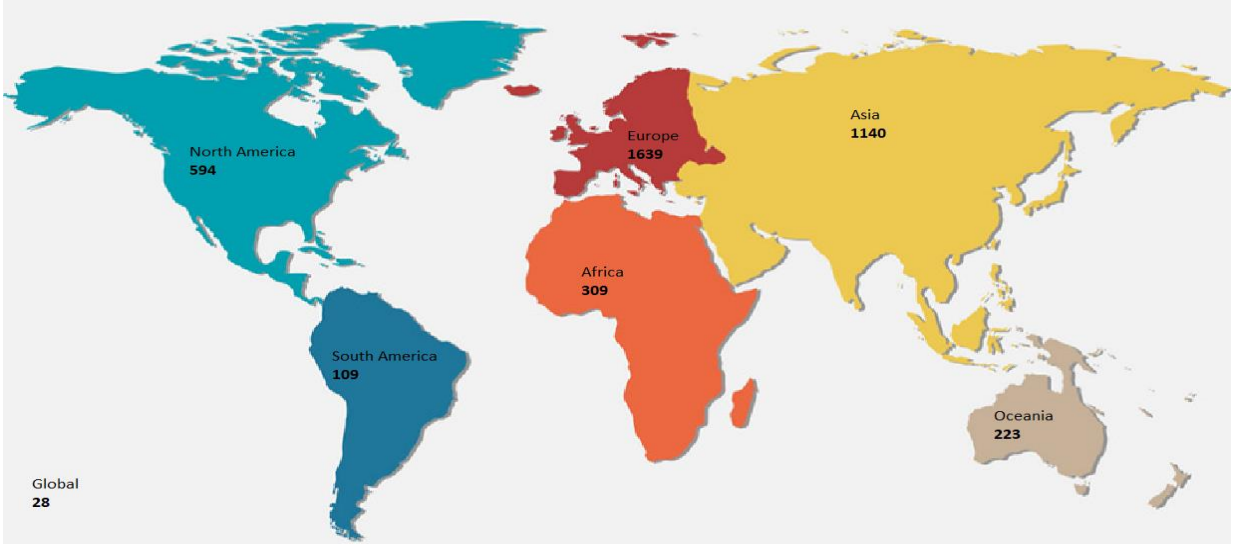

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BRANDER ENVIRONMENTAL ECONOMICS

Preface and acknowledgements

This project was executed between 1 July 2019 and 31 May 2020 with financial support from the Department for Environment, Food and Rural Affairs (Defra), UK.

The project was led by de Rudolf de Groot (FSD) and Luke Brander (BEE). Members of the Project Team with responsibility for coding data were Alistair McVittie, Stefanos Solomonides, Florian Eppink, Matteo Sposato, Luat Do, Andrea Ghermandi, Michael Sinclair and Diane Ingabire.

Many interns contributed to the update of the ESVD by collecting and organising valuation studies, recording bibliographic information and obtaining the geographic coordinates of study sites. We acknowledge the contribution of Martine Feltracco, Yifei Gu, Shan Lan, Zoe Wong, Yuanshan Lin at BEE and Eugene Gakpo Alhassan (repository development & literature search), Brittany Burke, Nicolas Esteban Lara Rodriguez, Nur Rezki Hajar, Shiying Lin (assistance & supporting activities) and Aimilia Paraschou (support UK pilot) at FSD.

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In addition, the following people are currently reviewing data or agreed to do so in the future: Pieter van Beukering, Michael Christie, Evangelia Drakou, Nivedha Elango, Mark Koetse, Sharif Mukul, Ståle Navrud, Paolo Pasquariello, Laura Poikolainen, Mohammed Mofizur Rahman, Mari Saar, Madhu Verma.

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Executive Summary

The Ecosystem Services Valuation Database (ESVD) is a follow-up to the "The Economics of Ecosystems and Biodiversity" (TEEB) database which contained over 1,300 data points from 267 case studies on monetary values of ecosystem services across all biomes. The TEEB database had not been updated since 2010 and naturally many gaps exist across biomes, ecosystems and services.

Recognising the importance of information on spatial ecosystem service values to decision making, the UK Department for Environment, Food and Rural Affairs (Defra) commissioned a project to update the database, which started in July 2019 and ended 31 May 2020.

Before adding new data, the TEEB database structure was updated with additional variables (now 51) including, amongst others, additional information on study site location, size and condition. In addition to the TEEB ecosystem services classification, the values are also linked to CICES V5.1.

The current version of ESVD now contains 4,042 value records (i.e. three times as much as the original TEEB database) based on 693 studies. The number of value estimates that could be standardised to Int.$/ha/year for all relevant beneficiaries at 2020 price level is 2,917. After applying several filters (including leaving out 2,5% of the high and low outliers) we used 2,159 value estimates to calculate mean values per ecosystem service for each biome (Table 7). Note that these summary values are intended for illustration and to identify data gaps. For the purposes of value transfer, users are advised to select value estimates from the database that match the characteristics of their policy site(s) since values are time and context dependent.

During the project we collected over 3,500 new publications raising the number of studies in the repository to 3,783, which is 14x more than the TEEB repository. Within the given time-period, we analysed 693 studies, about 18% of the total number of studies in the repository, leaving 3,090 studies still to be analysed. Extrapolating the average number of value records/study (5.8) this means we have at least another 17.500 values to be entered into the current ESVD. Even without these additional values the current ESVD is to our knowledge the largest database of spatially explicit ecosystem service values.

Something to consider when using the data is that ESVD is currently skewed towards data from the UK (1360 value records, or 36% of the total) with focus on inland wetlands and coastal systems, as agreed with DEFRA.

Another important aspect of this project is the initiation of a systematic review process. 52 experts were invited as external reviewers and 35 agreed to review data. At the time of completing this report, 21 reviewers submitted reviewed data, and with their help approximately 800 value records have been reviewed (about 20% of the total number in ESVD). A further 10% are currently under review, leaving 70% (or about 2,800 value records) still to be externally reviewed.

To ensure the continuous, long-term update and review of the database requires additional funding. Section 5.3 provides an overview of current and potential users, applications and long-term financing possibilities.

1. Introduction

The Ecosystem Services Valuation Database (ESVD) is a follow-up to the data base developed for the TEEB-study on "The Economics of Ecosystems and Biodiversity" (TEEB, 2010, Van der Ploeg and de Groot, 2010). The TEEB database aimed to capture a broad, global, representation of the monetary values of ecosystem services across all biomes (De Groot et al., 2012). The TEEB database was developed and is hosted by the Foundation for Sustainable Development (FSD) and maintained with support of the Ecosystem Services Partnership (ESP). It is the largest available database of spatially explicit monetary valuation estimates (i.e. value unit/per ha) and prior to this update contained over 1,300 data points from 267 case studies. The database has not been updated since 2010 and naturally gaps exist across biomes, ecosystems and services.

Recognising the usefulness of information on spatial ecosystem service values to decision making and the need for more comprehensive and up-to-date data, the UK Department for Environment, Food and Rural Affairs (Defra) has commissioned a project to update the database, starting in July 2019.

The objective of this project is to update the data with the results of research currently omitted, particularly from research conducted since 2010, and to upgrade the current TEEB database structure with additional information on ecosystem condition and other variables. In addition, the aim is to develop a long-term review system supported by an online submission and retrieval system. This new database is referred to as Ecosystem Services Valuation Database (ESVD).

Specifically, the objectives of the work carried out for Defra are to:

1. Provide an update on UK ecosystem service values with a focus on habitats that are relevant for flood risk management (delivered in October 2019, see summary results in Appendix 7).
2. Provide an update of global values to the Ecosystem Service Valuation Database for all biomes and ecosystem services. Ecosystem services and biomes have been prioritised in line with Defra's international priority focus areas (see Chapter 4).
3. Develop and implement a mechanism that ensures the continuous review and update of the database going forward (see Chapter 5).

This report provides the results of the global ecosystem service values update (now over 4000 value records, 3x the original TEEB database) and matrices with standardized average values (in Int.$/ha/y) for all biomes and ecosystem services for the UK (Appendix 7) and global.

Chapter 2 describes the methods that have been used to collect and screen additional valuation studies as well as the ESVD-database structure and standardisation process. Chapter 3 provides a summary of values gathered and gives an overview of the current status of the updated repository in terms of stored literature. As agreed with Defra, priority was given to inland wetlands, coastal systems (including mangroves) and coral reefs for the global update. Section 4 shows the results in terms of standardized values per biome and main ecosystem service type. Section 5 discusses the results and suggestions for future directions.

In addition, the report contains a large number of appendices providing lots of important background information (see Table of Contents for an overview).

2. Methodology

The methodology for study retrieval, data entry and data standardisation is described in detail in a protocol document (Task 3.2, delivered August 2019) and summarised here.

2.1 Study retrieval

The process of collecting new ecosystem service valuation studies to be coded in the ESVD involves three main steps: 1. Identification of potentially relevant studies through multiple channels of literature search; 2. Screening the identified studies according to specified criteria (e.g. valuation in monetary units, valuation of ecosystem service(s), use of primary valuation methods); 3. Storage of studies using a standard file name format in a shared filing structure.

2.1.1 Literature search

The purpose of this step is to obtain a comprehensive collection of studies that estimate the economic value of ecosystem services in monetary terms. The search for additional valuation studies for inclusion in the ESVD utilises multiple sources including:

1. EVRI (Environmental Valuation Reference Inventory, https://www.evri.ca/en). EVRI is a searchable online database of studies on the economic valuation of environmental assets. This database contains records on over 4600 studies that value ecosystems services. Note that EVRI is a database of valuation studies and not value estimates. It is therefore a very useful starting point for identifying studies from which to obtain value data but it does not give spatially explicit monetary valuation estimates (i.e. value unit/per ha).
2. Other valuation literature databases that were consulted included, a.o. ESValues (https://esvalues.org/), GECOSERV (Gulf of Mexico) (http://www.gecoserv.org/) and a list provided by JRC.
3. Traditional online literature tools and libraries including Google Scholar, Scopus, ResearchGate, Mendeley and institutional libraries.
4. Calls for studies have been forwarded to relevant networks and associations of researchers and professionals in the field, such as the Ecosystem Services Partnership and the UK Network for Environmental Economists.
5. Individual contact has been made, by email, with recognised experts in the area of environmental economics and ecosystem valuation, especially with the goal of finding less visible literature (e.g. theses, dissertations, unpublished reports etc).
6. Major reports and studies citing a large number of sources have been used as a lead to track their internal references.
7. Finally, the personal knowledge of the field by the researchers involved in this update project was an essential asset.

2.1.2 Criteria for screening valuation studies

The purpose of this step is to screen the collected studies to ensure that they provide relevant useable data that can be entered into the ESVD. The criteria for identifying screening relevant studies are:

- Publication type. All forms of publication (journal articles, working papers, conference papers, dissertations, theses, NGO reports, other grey literature, etc.).
- Year of value estimate. Studies and value estimates can be for any year (i.e. the update is not limited to studies conducted after 2010).

- Geographic location and scale: Study sites can be at any location or scale (i.e. from small habitat parcels to global biomes).
- Ecosystem/biome: Studies can address any ecosystem type or complexes of multiple ecosystem types, including cultivated areas and urban green and blue infrastructure (see Appendix 6).
- Ecosystem service: Studies can address any ecosystem service or bundles of multiple ecosystem services. Note: we do not include non-renewable (on a human time scale) natural resources (e.g. oil, mineral deposits) and abiotic natural processes (e.g. wind, solar), see Appendix 5 for further details
- Valuation metric: Studies that report values measured in monetary units. Note: to be explored still how qualitative or bio-physical information can be included (see Ch. 5).
- Valuation method: Studies that apply primary valuation methods. Note: in general we do not include estimates using value transfers from other studies. However, in the case of studies that assess multiple ecosystem services using combinations of primary valuation methods and value transfers, some estimates using value transfer have been included in the database. Currently, in the ESVD there are 79 estimates produced with value transfer (2.8% of value records).

The screening of studies on these criteria is constrained by the availability and clarity of information provided in each study. In cases where there is uncertainty regarding whether a study meets all criteria for inclusion in the ESVD, it is included in the repository but not used in this update and can, if necessary, be excluded later in the process (i.e. at the data coding stage).

2.1.3 File name format and filing structure

Collected studies are saved using the file name format: Author – Year - Title. For example:

- Single author: Lal 2003 Economic valuation of mangroves and decision-making in the Pacific.pdf
- Two authors: Glenk and Martin-Ortega 2018 The economics of peatland restoration.pdf
- Multiple authors: De Groot et al 2012 Global estimates of the value of ecosystem services in monetary units.pdf

2.2 Database structure

Compared to the original TEEB database, the structure of the ESVD has been revised to include, amongst others, additional information on study site location, size and condition; ecosystem services (using CICES V5.1 (Haines-Young and Potschin, 2018) in addition to the TEEB classification); and the characteristics of the value estimate (including a description of the change in ecosystem extent or condition that is being valued). The database includes 66 variables that are listed and described in Appendix 3.

2.2.1 Classification of ecosystem services

The database makes use of two of the most widely used ecosystem service classification systems. The TEEB classification (de Groot et al., 2010) presented in Table 1; and the CICES V5.1 classification is presented in Appendix 4. The TEEB classification has been slightly modified to include non-use values (existence and bequest values) as a service. Each main service usually includes many sub-services. In total we distinguished 80 sub-services (see Appendix 5).

Table 1: *Classification of ecosystem services (adapted from de Groot et al., 2010)**

Service Group	ES Code	Ecosystem Service
Provisioning	1	Food
	2	Water
	3	Raw materials
	4	Genetic resources
	5	Medicinal resources
	6	Ornamental resources
Regulating	7	Air quality regulation
	8	Climate regulation
	9	Moderation of extreme events
	10	Regulation of water flows
	11	Waste treatment
	12	Erosion prevention
	13	Maintenance of soil fertility
	14	Pollination
	15	Biological control
Habitat	16	Maintenance of species' life cycles (incl. nursery service)
	17	Maintenance of genetic diversity
Cultural	18	Aesthetic information
	19	Opportunities for recreation and tourism
	20	Inspiration for culture, art and design
	21	Spiritual experience
	22	Information for cognitive development
	23	Existence and bequest 'values'

*) *Only difference with the original TEEB list is the addition of Existence and Bequest values as service*

For each value observation in the database it is necessary to record the specific ecosystem service that is being valued. Note that it is possible that a single value observation in a study is estimated/reported for multiple ecosystem services (e.g. CVM studies asking people's WTP to conserve an ecosystem and the services that it provides or, cultural services that can typically be valued as a bundle e.g. recreation and aesthetic values). In such cases, the value observation should be disaggregated across ecosystem services if possible (i.e. split across separate rows in the database); or that all the ecosystem services that are relevant to the individual value observation are recorded.

2.2.2 Valuation Methods

For each value observation in the database it is necessary to record the specific valuation method that has been used. The categorisation of economic valuation methods builds on material developed by the ESMERALDA project (Brander et al., 2018). The list and description of valuation methods are given in Table 2.

***Table 2**: List and description of economic valuation methods (source: Brander et al., 2018)*

Valuation Method	Acronym	Method Description
Choice Modelling (Choice Experiment)	CE	Ask survey respondents to make trade-offs between ecosystem services and other goods or income to elicit willingness to pay
Contingent Valuation	CV	Ask survey respondents to state their willingness to pay for an ecosystem service through surveys
Damage Cost Avoided	DC	Estimated damage avoided due to ecosystem service
Defensive Expenditure	DE	Expenditure on protection of ecosystem services
Group Valuation (Participatory Valuation)	GV	Ask groups of stakeholders to state their willingness to pay for an ecosystem service through group discussion process
Hedonic Pricing	HP	Estimated influence of environmental characteristics on price of marketed goods
Input-Output Modelling	IO	Quantifies interdependencies between economic sectors to measure impacts of changes in one sector to other sectors in the economy. Ecosystems can be seen as distinct sectors.
Market Prices (Gross Revenue)	MP	Prices for ecosystem services that are directly observed in markets
Net Factor Income (Residual Value)	FI	Revenue from sales of ecosystem-related good minus cost of other inputs
Opportunity Cost	OC	The next highest valued use of the resources used to produce an ecosystem service
Production Function	PF	Statistical estimation of production function for a marketed good including an ES input
Public Pricing	PP	Public expenditure or monetary incentives (taxes/subsidies) for ES as an indicator of value
Replacement Cost	RC	Estimated cost of replacing an ES with a man-made service
Restoration Cost	RT	Estimated cost of restoring degraded ecosystems to ensure provision of an ecosystem service
Social Cost of Carbon	SC	Monetary value of damages caused by emitting one tonne of CO_2 in a given year. The social cost of carbon (SCC) therefore also represents the value of damages avoided for a tonne reduction in emissions.
Travel Cost	TC	Estimated demand for ecosystem recreation sites using data on travel costs and visit rates
Value Transfer (Benefits Transfer)	VT	Estimate of the ecosystem service value at a "policy site" using existing information from different "study site(s)".
Other	OT	Other valuation methods

2.3 Value standardisation

Value observations are reported in the literature in a wide variety of currencies, price level years, spatial units (e.g. per hectare, km^2, total ecosystem area etc.), temporal units (e.g. per visit, day, month, year, present value over some time horizon etc.), and beneficiary units (e.g. per visitor, person, household, total number of beneficiaries etc.). To allow comparability and synthesis of value observations it is necessary to standardise estimated values to a common

currency, year of value, spatial unit, temporal unit and beneficiary unit. For the ESVD the standard units are Int.$ (i.e. USD adjusted for differences in purchasing power across countries, see Box 1), per hectare, per year for the total number of beneficiaries. The standardisation process involves five steps to address each of these five dimensions: price level, currency, spatial unit, temporal unit, beneficiary unit.

2.3.1 Price level standardisation

Value estimates from primary valuation studies are reported at the general price level for a particular year, usually (but not always) the year in which the study was conducted. For example, a valuation study conducted in 2010 is likely to report values in the price level in that year. Inflation, however, causes general price levels in an economy to rise over time so that any given amount of money is worth less, in terms of the goods and services that it can purchase, over time. In order to compare value observations that were estimated in different years it is necessary to standardise values to a common price level year (i.e. accounting for differences in prices levels over time). The selected base year for price levels in the ESVD is 2020.

This standardisation can be made using available domestic price indices or GDP deflators that measure the annual rate of price change in an economy. GDP deflators were obtained from the World Bank World Development Indicators.[1]

The formula for the price level standardisation is:

$$V_{2020} = V_t (D_{2020} / D_t)$$

where:

V_{2020} = value observation at 2020 price level

V_t = value observation at study year price level

D_{2020} = GDP deflator index for the base year 2020

D_t = GDP deflator index for the study year

2.3.2 Currency standardisation

Value observations for ecosystem services may be reported in any currency. Primary valuation studies generally report values in the currency of the country in which the study site is located, or in US dollars (particularly if the results are intended for an international audience), or possibly in a third currency. To compare and synthesise value observations it is necessary to convert all values to the same currency. The selected common currency for the ESVD is the International dollar (Int$), which represents the value of the US dollar in the United States in terms of purchasing power. Converting other currencies to Int$ involves using purchasing power parity adjusted exchange rates (see explanation in Box 1), which are available from the World Bank World Development Indicators.

The formula for this adjustment is:

$$V_{Int\$} = V_{LC} \times FX_{PPP}$$

where:

$V_{in\$}$ = value observation in Int$

V_{LC} = value observation in local currency

FX_{PPP} = purchasing power parity adjusted exchange rate between the local currency and the USD

[1] http://datatopics.worldbank.org/world-development-indicators/

In cases where a value observation has already been converted into a second currency (often USD) using a standard market exchange rate, it is necessary to adjust this reported value to reflect differences in purchasing power. This involves converting the value reported in USD back into the local currency using the market exchange rate (ideally the rate that was used by the analyst for the primary study) and then converting it into Int$ using a PPP adjusted exchange rate.

Box 1: Purchasing Power Parity explained

Purchasing power parity exchange rates are used in order to control for differences in general price levels between countries. General prices for goods and services vary across countries (as well as over time) reflecting differences in the costs of production and demand. Prices for goods and services will tend to be higher where the cost of production and/or demand is higher.

Differences in the general level of prices between countries are measured using price indices, which compare prices for a representative basket of consumer goods in each country. When comparing across countries with different price levels, a given amount of money income will be able to purchase more goods and services in a country with a lower general price level than in a country with a higher general price level. For example, someone earning USD 1,000 in Turkey would be able to buy more goods and services than someone earning USD 1,000 in the United States because prices are generally 33% higher in the United States. In other words, the purchasing power of money, in terms of the goods and services that it can buy, differs across countries.

Differences in purchasing power have implications for comparing values for ecosystem services across countries. Differences in purchasing power mean that a dollar in one country is not equivalent, in terms of the goods and services that it represents, to a dollar in another country. A dollar is effectively worth more in a country with a low general price level than in a country with a high price level. This means that it is not valid to directly compare values between countries with different price levels – since the same amount of money represents a different quantity of goods and services and therefore welfare for the consumer. Since we want to measure and compare welfare derived from ecosystem services, it is necessary to make adjustments to observed values to reflect differences in price levels. In other words, it is necessary to reflect "real" money values in terms of the goods and services that can be bought rather than "nominal" money values.

Controlling for differences in price levels between countries can be thought of as the equivalent to controlling for changes in price level in a single country over time due to inflation.

2.3.1 Spatial unit standardisation

Value observations can be reported for different spatial dimensions of the ecosystem that provides the service, primarily either per unit area of the ecosystem (e.g. value/hectare of forest), per unit length of the ecosystem (e.g. value/km of river or shoreline) or for the total spatial extent of the ecosystem.

Values that are reported per unit of area can use multiple different areal units (e.g. m^2, hectares, km^2, acres etc.). In order to compare and synthesise value observations it is necessary to standardise values to the same spatial units. The selected common unit of area for the ESVD is one hectare since this was used in previous versions of the ESVD and also widely used in other value databases and publications. Converting values reported in other areal units involves multiplying them by an appropriate conversion factor (see Table 3).

***Table 3**: Conversion factors for areal units to hectares*

Areal Unit	Conversion factor to hectares
Square feet	107,640
Square metres	10,000
Acres	2.471
Square kilometres	0.01
Square miles	0.003861

Values that are reported per unit of length of the ecosystem can use multiple different units (e.g. feet, meters, kilometres, miles etc.). In order to compare and synthesise value observations it is necessary to standardise values to the same unit of length. The selected common unit of length for the ESVD is one kilometre since this is used in previous versions of the ESVD and also widely used in other value databases and publications. Converting values reported in other units of length involves multiplying them by an appropriate conversion factor (see Table 4).

***Table 4**: Conversion factors for units of length to kilometres*

Areal Unit	Conversion factor to hectares
Feet	3,280.8
Metres	1,000
Miles	0.6214

Values that are reported for the total spatial extent of the ecosystem need to be converted to per hectare terms by dividing by the ecosystem area (in hectares).

2.3.2 Temporal unit standardisation

Value observations can be reported for multiple different periods of time (e.g. per visit, day, week, month, year, or a period of multiple years). In order to compare and synthesise value observations it is necessary to standardise values to the same unit of time. The selected common unit of time for the ESVD is one year since this is used in previous versions of the ESVD and also widely used in other value databases and publications.

Values reported as present values over a specified period of time period should be converted to annual values using the discount rates quoted in the study. If no discount rate is quoted an appropriate local discount rate should be identified, e.g. through an online search.

2.3.3 Beneficiary standardisation

Value observations can be reported for multiple different units of beneficiary (e.g. per visitor, person, household, or for the total number of beneficiaries of the ecosystem service). In order to compare and synthesise value observations it is necessary to standardise values to the same specification of beneficiary. The selected common specification for the ESVD is the total population of beneficiaries. This can also be described as the 'market size' or 'economic constituency' for the ecosystem service in question.

For value observations reported per visitor it is necessary to multiple by the total number of visitors, which would ideally be reported in the study. Similarly, for value observations reported per person or per household it is necessary to multiple by the total number of people

or households that benefit from the ecosystem service, which again would ideally be reported in the study. In cases where the study does not report the relevant number of beneficiaries over which to aggregate, secondary sources may be used.

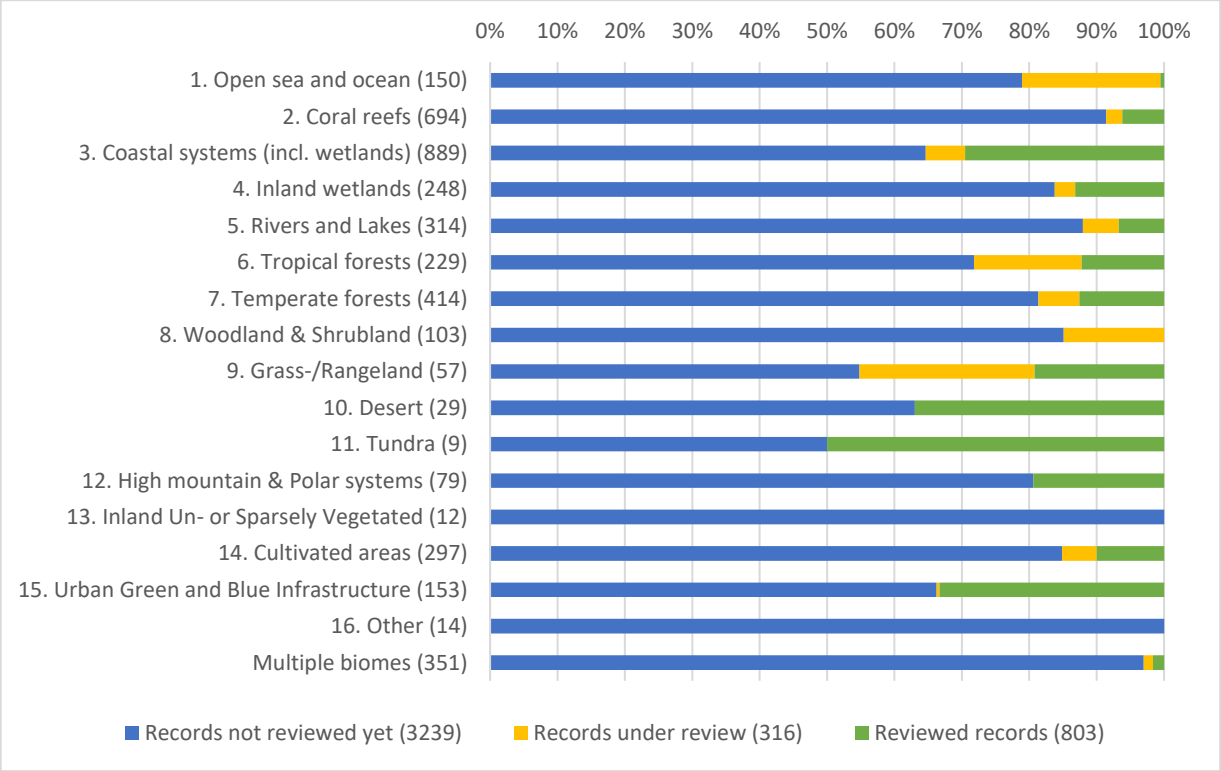
2.4 Data review procedure

A review procedure for the data entered into the ESVD has been established. This procedure followed the following steps:

1. Experts in the field of ecosystem service valuation were invited to act as external reviewers. Currently 52 experts have been invited and 35 have agreed to review data.
2. Reviewers are asked to specify the biomes for which they would prefer to review data.
3. Each reviewer is sent an Excel file with a sub-set of coded ESVD data (20-40 value estimates), a guide to the review process (see Appendix 10) and access to the online repository of valuation studies.
4. Reviewers return reviewed data with suggested corrections and additional value estimates (if relevant) to be incorporated into the ESVD. The reviewer name and data of review is recorded for each relevant value estimate in the ESVD.

At the time of completing this report, 21 reviewers submitted reviewed data, and with their help approximately 800 value records have been reviewed (about 20% of the total number in ESVD). A further 10% are currently under review, leaving 70% (or about 2,800 value records) still to be externally reviewed (see Figure 1, and Chapter 5: Future directions).

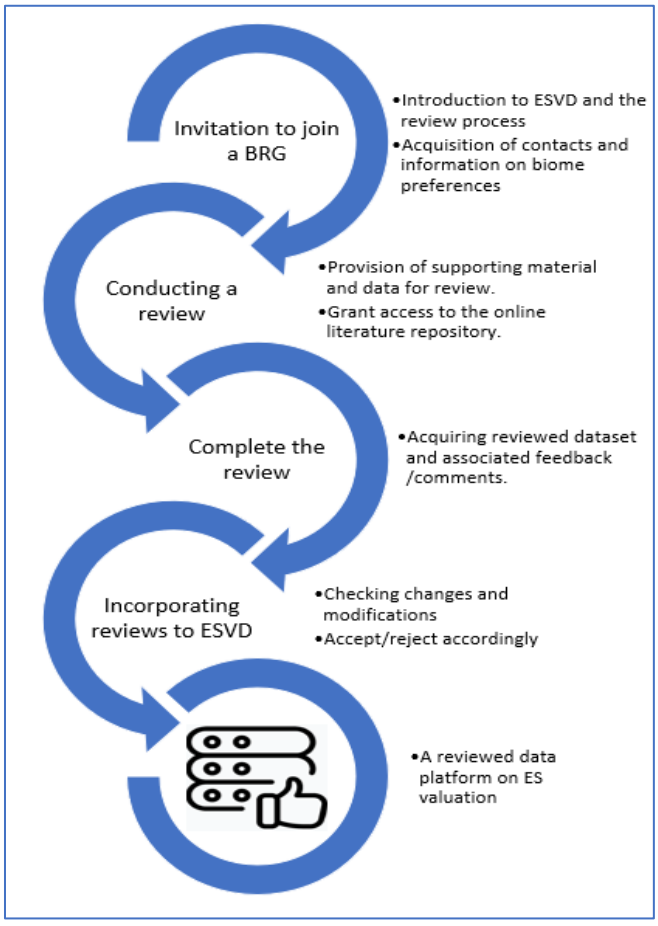
Figure 1 *Summary of value records per biome (4042 total) and review status*



For reviewing the data (but looking also ahead into the future of ESVD, see Ch 5) we are forming 'Biome Review Groups' (BRG). The aim is to create groups of experts, specialised in different biomes, to review data according to their expertise. To invite potential reviewers, we created an invitation letter, with some information about the project, and a sign up list which we sent to selected people and also announced in the monthly ESP Newsletter (see Appendix 9 for further information about the reviewer invitation process). Although participation is on a voluntary basis, the response rate was very high and people are still signing up which is promising in view of our plans to continue updating the data base in the future (see Ch 5).

To handle the input from dozens (and eventually hundreds) of reviewers implies the need for a standardised review process (see Figure 2). To that end, we developed a detailed set of instructions to help reviewers navigate through the process. The 'Guide for ESVD Data Review' (Appendix 10) provides all the information that is needed to perform the review. This includes sections on how to interpret the database fields, how to access the repository and retrieve corresponding studies as well as to when/how they need to do modifications in the data.

Figure 2 *The ESVD review process*



Once a reviewer had agreed to join a BRG, then he/she would receive a set of the following three items: 1: The Guide for ESVD Data Review, 2: A subset from the data to be reviewed, 3: An invitation to the online drive repository for retrieving the literature that corresponds to the data sent for review.

Considering the large size of the current ESVD, we decided to send small batches of roughly 20 records according to the biome (or geographic) preferences of each reviewer. This seemed to work well because most reviewers completed the review process within a reasonable timeframe and some indicated willingness to review a second batch.

To treat the feedback in a structured and standardised way we used a 3-file format approach:

1. Excel file **sent**: this is the file with the initial data sent for review.
2. Excel file **reviewed**: this refers to the file that includes the feedback/comments and changes made by the reviewers after they had completed the review.
3. Excel file **checked**: this file includes all the decisions made about modifications on individual records and indicates whether a change has been accepted or rejected.

Using this approach allows us to be clear on how we treat the feedback acquired as we can always go back to each individual modification and explain why/when we accept a change or not. With repeated similar iterations (and with recruitment of more reviewers), we aim to gradually review all the data we have now and data that will be added in the future.

3. Global ecosystem service values: overview of collected records

3.1 Studies collected in the literature repository

During the first round of data collection for updating the database, 3783 valuation studies have been collected (Figure 3). Compared to the TEEB database, this is a 14-fold increase in the number of studies (note that only a fraction of that literature has been analysed, see 3.2). This is partially attributable to the increasing rate of valuation publications in the last decade but also to the improved study retrieval methodology developed for this update (Appendix 2). The revised search methodology enabled for better screening of literature repositories and the acquisition of a significant number of studies through the combination of multiple relevant search terms. However, as the number of relevant publications is expected to continue expanding, it may be necessary to revise the retrieval methodology. This process involves expanding the list of search terms with new key words and trying different combinations in a way that can capture future developments in the related literature.

Figure 3 *Number of publications per year in the ESVD repository (total 3.783)*

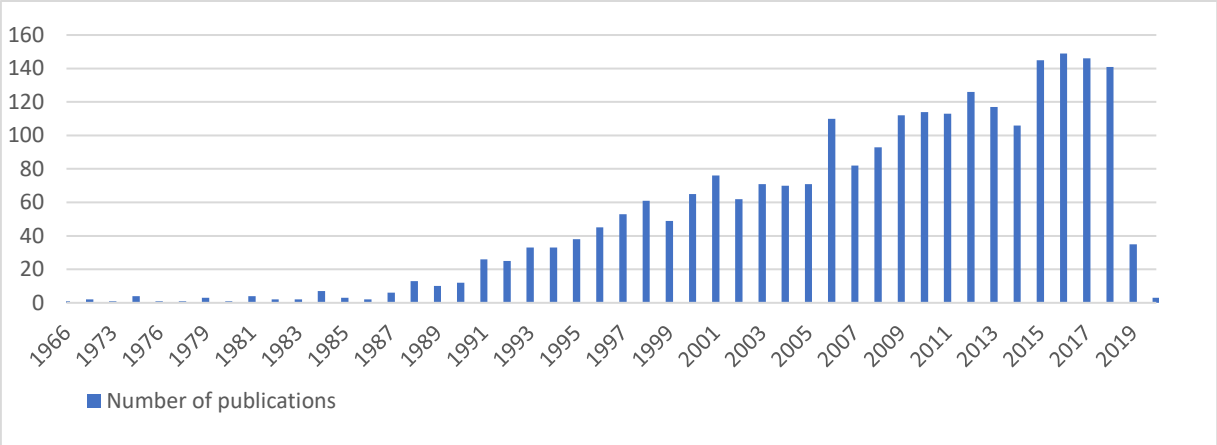
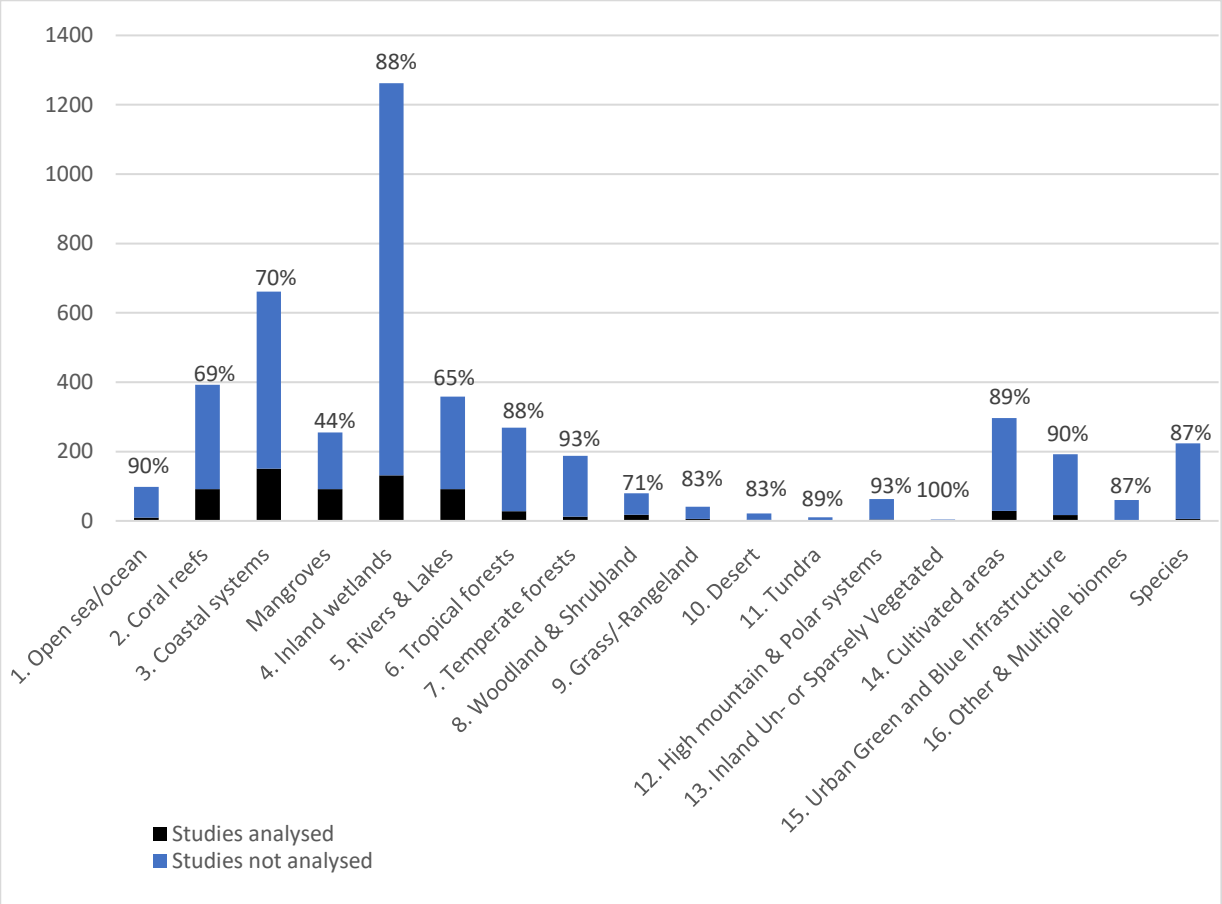


Figure 4 illustrates the number of stored studies per biome. The biome with the most studies in the literature is Inland Wetlands with 1,131 studies. Other biomes with large numbers of valuation studies are Coastal systems (510), Coral reefs (301), Cultivated areas (268)and Rivers & Lakes (266) Some biomes, however, appear to be currently unrepresented in the economic valuation literature. For example, very few studies have been found for Tundra (9) followed by Inland Un- or Sparsely vegetated systems (4) and Desert (18). Although our literature collection is not considered exhaustive, it is quite extensive and continues to grow. Therefore, it can be seen as a proxy indication of existing trends in ecosystem services valuation research in terms of biome focus and identifying research gaps and needs.

3.2 Studies included in the database

Figure 5 shows the number of studies that have been analysed (693) compared to the total number of collected studies in the repository (3783). Thus, so far approximately 18% have been analysed and the number of studies that still needs to be analysed is 3090.

Figure 4 *Total number of collected studies per biome and number of studies analysed*



3.3 Summary of value records

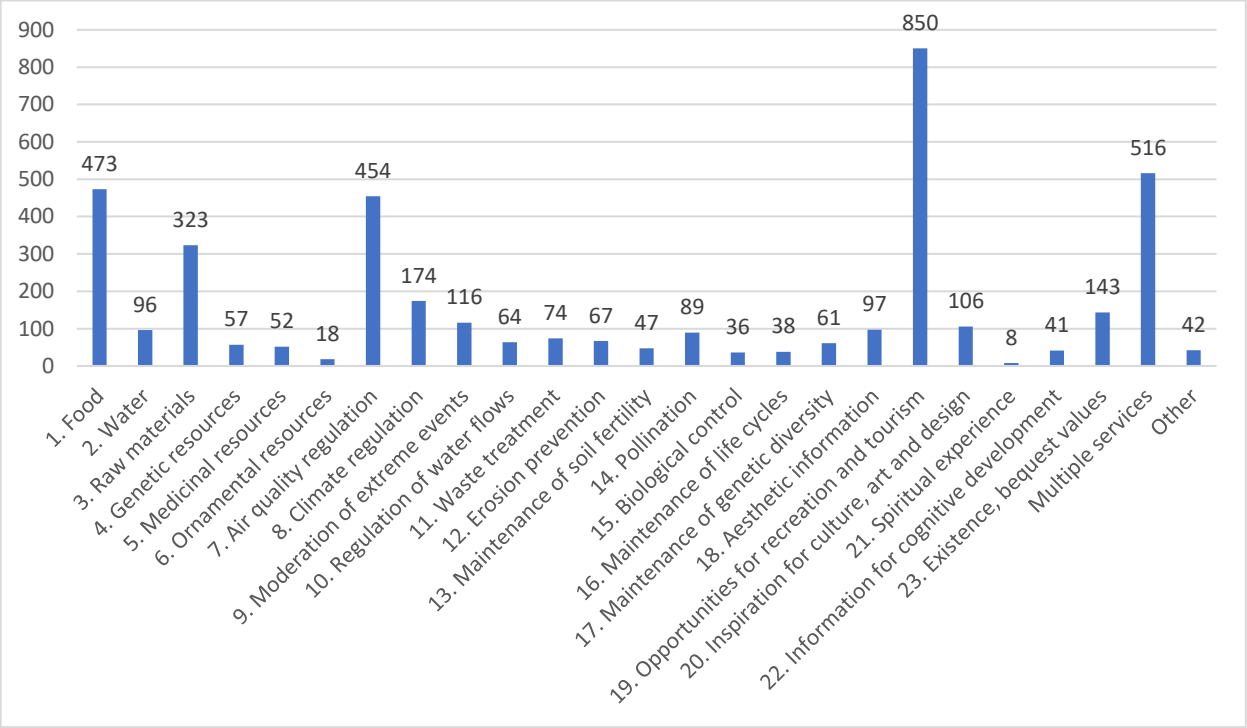
The updated ESVD currently contains 4042 value estimates for ecosystem services from 693 valuation studies. Thus, on average each study provides 5.8 value estimates. With 3.090 studies still to be analysed this means the total number of value records could quickly grow by another 17.900 records (5.8 x 3090).

In this section, a summary of the value records included in the database is provided and presented below in terms of related biomes, services, valuation method, geographic origin and year of the value points collected so far.

3.3.1 Value records per service

Figure 5 presents the cumulative total number of value records per service (using the revised TEEB ecosystem service classification framework). In the current dataset, the most assessed ecosystem service is "Opportunities for recreation & tourism" with 850 value estimates recorded followed by "Multiple ES (bundled)" with 516 value records, Food (473) and Air quality regulation (454). These numbers are expected to change as more studies are analysed. Such overviews can indicate trends in the economic valuation research in terms of services assessed and identify knowledge gaps.

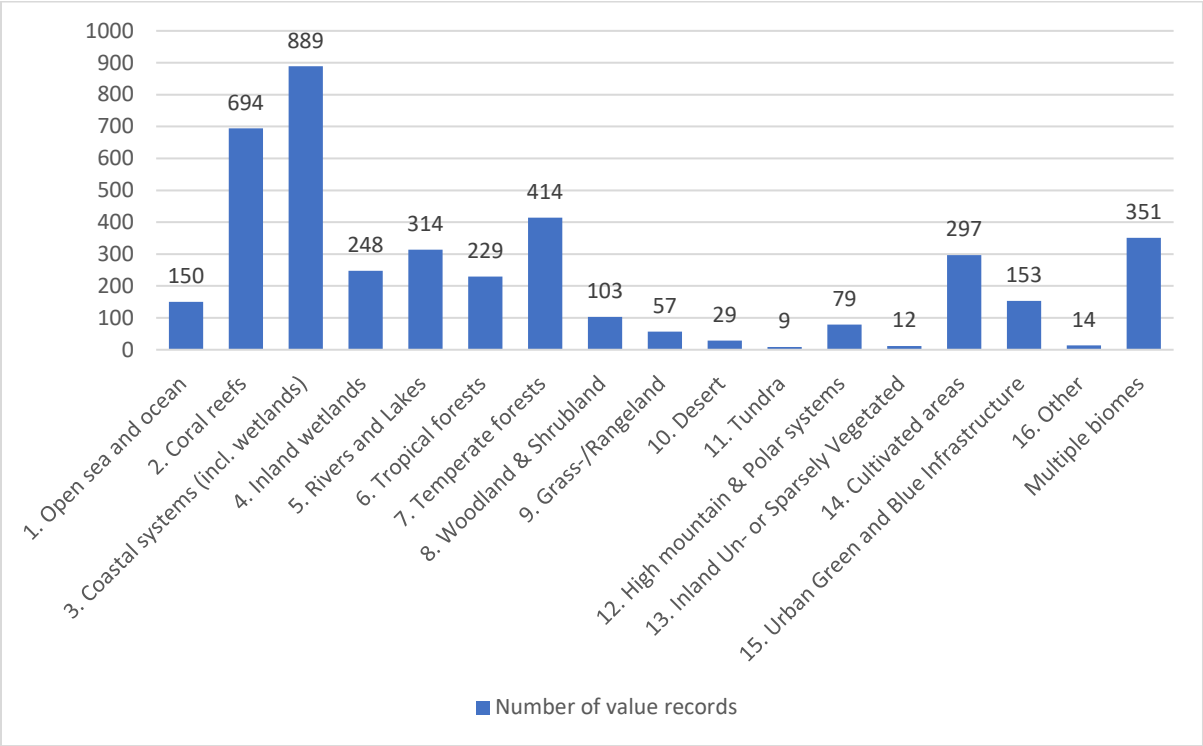
Figure 5 *Number of value estimates per service (total: 4.042).*



3.3.2 Value records per biome

Figure 6 presents the cumulative total number of value records in the current dataset per biome (using the revised biome classification framework).

Figure 6. *Number of value estimates per Biome (total: 4.042).*

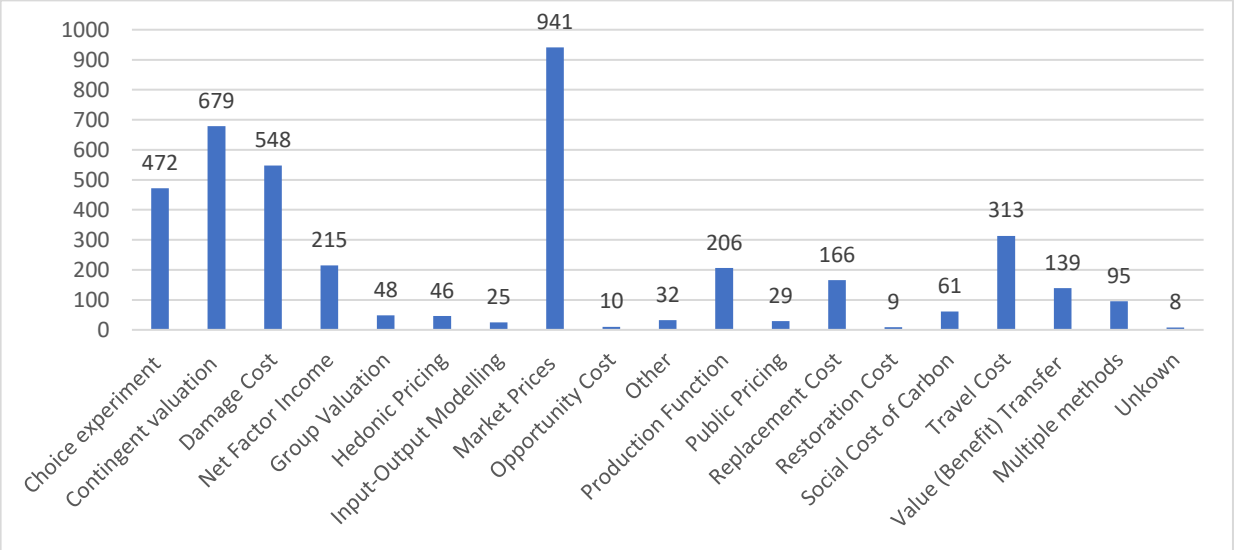


It is important to mention that the numbers per biome are not representative for the distribution on the repository but have been influenced by two main factors. Firstly, the focus given on specific biomes (tropical forests, coral reefs & coastal systems) during this first update at request of Defra. Due to this focus, we have managed to collect quite a significant number of values for these biomes (fig. 6) A second factor is that the data from the UK pilot, which was finished earlier (see Appendix 7) have been inserted in the global database which resulted in a substantial increase in the number of estimates for biomes such as Temperate forests (414), Rivers and Lakes (314), and Cultivated areas (297).

3.3.3 Value records per method

Figure 7 presents the total number of value estimates recorded per valuation method used. The most frequently used method used based on the current dataset is Market Prices. Almost 25% (941) of the value estimates recorded were derived using this method. This would be no surprise, as it could be argued that it is probably the most frequently used method in ES valuation literature in general. A significant amount of records where produced using Choice Experiments (CE) (472), Contingent Valuation (CV) (679) and Travel Cost (313) methods, which relates to the fact that many of these estimates were for recreation and other cultural services. One out of six value points in the database was estimated using Damage Cost (679). This can be attributed to the focus given during this update to coastal systems, particularly in relation to the flood control service, which is often valued using DC.

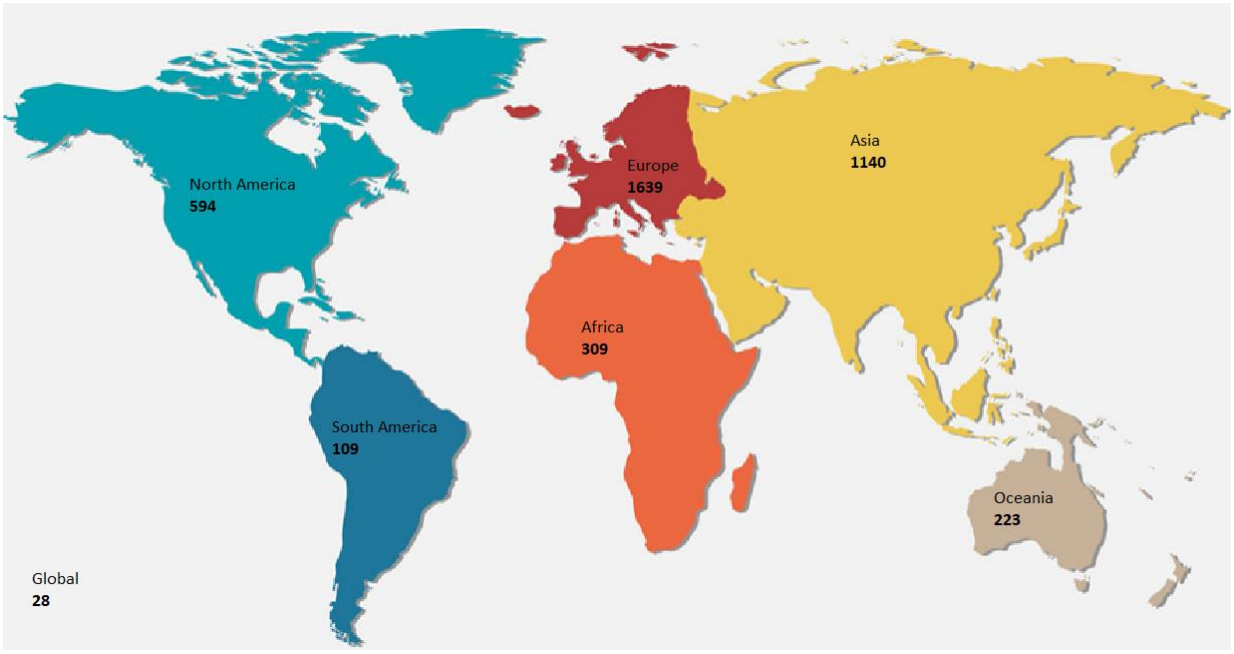
Figure 7 *Number of value estimates per valuation method*



3.3.4 Value records per geographic location and year

Figure 8 presents the total number of value records per geographic location (continent). Not surprisingly, most of the values are from Europe, which is also skewed by the UK pilot data.

Figure 8 *Number of value records per continent (total 4042)*

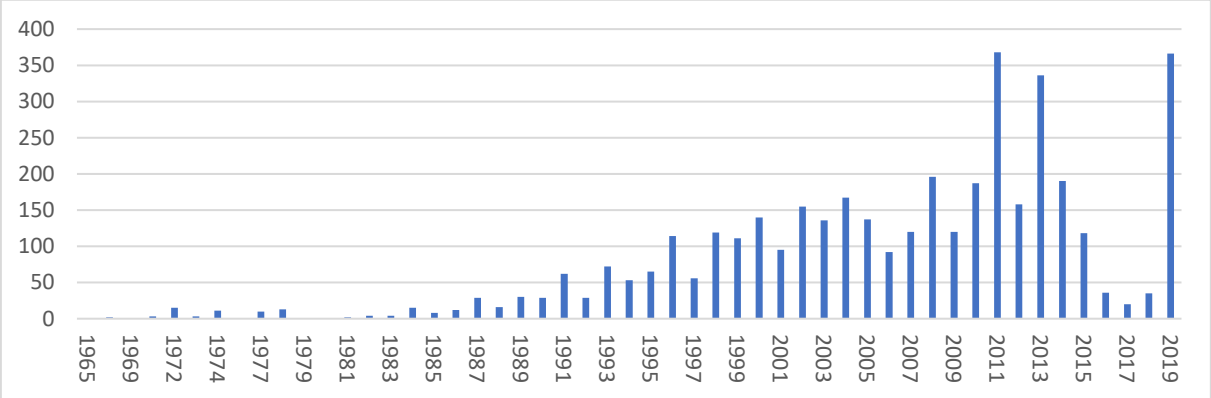


The majority of value records in the current dataset are from the United Kingdom (1360) which were collected during the creation of the UK pilot update. Not taking into consideration the UK values, the geographic distribution of the records can be explained by the current project focus. More specifically, countries in the Indo-Pacific region with tropical forests, mangroves and coral reefs have significant amounts of value estimates. Examples include, Indonesia

(156), China and India (143), Australia (116), Philippines (98), Malaysia (96), Sri Lanka and Thailand (87). In addition, a lot of the value records in the database originate from the United States of America (388).

Finally, Figure 9 shows the total number of value records per year. The year in which most estimates were produced is 2019 (366).

Figure 9 *Number of value records per year*



*Note: numbers refer to the year in which values were estimated (not the year in which the study was published -e.g. using the field 'Value year' and not the 'Year of publication').

4. Results

Here we provide a summary of the value estimates contained in the ESVD. To do so, we apply a number of filters to the data to allow making a summary (Table 6) and comparison of values. The total number of value estimates included in the database is 4,042. Here we restrict the summary to only estimates that could be standardised to a common set of units in terms of area (hectares), time (annual) and beneficiaries (all relevant beneficiaries). The number of value estimates with sufficient information on the areal, temporal and beneficiary dimensions that could be standardised to Int. Dollar/ha/year for all relevant beneficiaries at 2020 price level is 2,917 (72%).
We further restrict the data used in this summary by excluding:

- Estimates derived using value transfer (136)
- Estimates for bundles of ecosystem services because these could not be meaningfully disaggregated by ecosystem service (515)
- Estimates for study sites that cover multiple biomes because these could not be meaningfully disaggregated by biome (351)
- Highest 2.5% of value estimates to reduce the effect of potentially spurious outliers
- Lowest 2.5% of value estimates to reduce the effect of potentially spurious outliers

This leaves 2,159 value estimates (53% of the total in the database) that are summarised in the following tables.

Note that this summary of values is for illustrative purposes only to provide an impression of the order of magnitude of the values obtained from the literature and to identify data gaps. It

is not advised to use these summary statistics for value transfers since they reflect the underlying ecological and socio-economic contexts of diverse (but not necessarily representative) study sites. For the purposes of value transfer, users are advised to access the ESVD to find original values most closely related to their policy case or to use value functions that allow the prediction of values that reflect site specific characteristics.

Mean and median standardised values for each ecosystem service are summarised in Table 5. Some ecosystem services are more studied than others with over 446 value estimates for air quality regulation (albeit largely obtained from a single study – Eftec and CEH, 2019) and 435 value estimates for recreation and tourism. Whereas for others there is relatively limited information (e.g. spiritual experiences and ornamental resources). The ecosystem services with the highest mean values per unit area are maintenance of genetic diversity (6,629 Int$/ha/year), waste treatment (6,552 Int$/ha/year) and recreation and tourism (4,248 Int$/ha/year).

Table 5*. Total number, mean and median standardised values per ecosystem service (Int$/hectare/year; 2020 price levels*)

Ecosystem Service	N	Mean	S.D.	Median
Food	293	3,953	13,528	226
Water	53	3,865	11,413	360
Raw materials	177	2,366	11,220	27
Genetic resources	8	344	861	56
Medicinal resources	40	4	9	1
Ornamental resources	3	5	7	1
Air quality regulation	446	4,226	8,887	912
Climate regulation	120	1,196	4,317	172
Moderation of extreme events	74	4,095	11,561	262
Regulation of water flows	47	1,785	7,007	73
Waste treatment	50	6,552	18,567	250
Erosion prevention	36	3,852	6,272	1,137
Maintenance of soil fertility	35	4,199	15,281	22
Pollination	42	2,595	9,390	71
Biological control	32	2,184	9,175	443
Maintenance of life cycles of migratory species	16	958	1,187	506
Maintenance of genetic diversity	23	6,629	15,429	1,778
Aesthetic information	37	2,174	8,839	153
Opportunities for recreation and tourism	435	4,248	10,431	542
Inspiration for culture, art and design	75	359	1,526	60
Spiritual experience	2	38	54	38
Information for cognitive development	32	3,731	15,258	98
Existence and bequest values	65	3,408	9,031	263
Total	2,159	3,465	10,477	264

Table 6 shows the mean values per service for each biome (Int$/hectare/year; 2020 price levels). Note that the standardised values included in this table were winsorized per ecosystem service in order to avoid including spurious outlier values (i.e. the top and bottom 2.5% of values per service were truncated from the distribution before computing mean values). Again, we caution that this summary is primarily to explore the magnitude of values obtained from the literature and to identify knowledge/data gaps.

Here we draw some observations from this summary:

1. Gaps in the data are due to a variety of reasons:
    a. Some biomes do not provide or are not important sources of some ecosystem services (e.g. water provisioning or air quality regulation from coral reefs). Such gaps are therefore expected and do not require additional research.
    b. Some ecosystem services are commonly valued within a bundle of multiple services and so it is not possible to disaggregate and report values for each service individually. For example, this is the case for recreation/tourism and aesthetic enjoyment derived from urban green-blue ecosystems. The ESVD does contain values for these services from this biome but only valued jointly. This presents a challenge for producing summary values but does not necessarily represent a gap in knowledge for supporting decision making.
    c. Some ecosystem service value estimates cannot be standardised in per unit area terms for the purposes of producing a summary of the value data. For example, the absence of a summary value for existence and bequest values for rivers and lakes is primarily due to the fact that the area of rivers and lakes is often not available (and not necessarily a useful measure of the scale of the resource). The ESVD does contain value estimates for this service from this biome but not measured per unit of area.
    d. Some ecosystem services have not been widely researched and the ESVD currently contains a limited number or no value estimates for these services in most biomes. This is the case for pollination, biological control and spiritual experience. These gaps represent potentially important knowledge gaps that should be filled through future research efforts.
    e. In some cases, the area information in studies assessing pollination relates the value to the 'cultivated area' (which is the service-benefitting area) and not to the area that actually provides the service. Similarly, the additional value to crop production by pollination would be multiplied by the total cultivated area to give a total estimate. Thus, this value can be seen as the added value/ha/yr provided by pollination services to cultivated areas (and not the value of pollination services provided by cultivated areas).
    f. Some biomes have not been widely researched and the ESVD currently contains a limited number or no value estimates for them. This is the case for desert and tundra. These gaps represent potentially important knowledge gaps that should be filled through future research efforts.

g. Valuation studies have been conducted for specific ecosystem services and biomes but the results have not yet been entered in the ESVD. Although the process of updating the ESVD attempted to be as comprehensive as possible, it is very likely that some gaps simply require filling with existing available studies. With over 17,500 value records still to be entered into the ESVD this will be the case for many ecosystem services and biomes.

2. Some ecosystem services for specific biomes have unexpectedly high values. For example, the mean value for the waste treatment service provided by coral reefs is 61,013 Int$/ha/year. A closer look at the data underlying this summary value reveals that there are relatively few estimates for this service from coral reefs and that the high mean value is attributable to a single study for a small but intensively used study site. The same applies for example for the value of recreation and tourism in Tropical forests (52,789 Int$/ha/year) which came from studies on frequently visited locations with stable visitor flow and is certainly not representative for the entire tropical forest biome. This does not imply that the estimated value from the study is incorrect but highlights that the data in the ESVD is not necessarily globally representative. This emphasises the need for caution in using these summary values for value transfers and the need to use value estimates that match the characteristics of policy sites.

3. Most of the data from the original TEEB database has been included in ESVD, albeit after additional screening which resulted in some values to be discarded for the moment. Comparing the TEV of the biomes as presented in Table 6 with those from the TEEB database, published by de Groot et al. (2012), shows considerable differences: although coral reefs consistently score highest, in the TEEB-database they are followed by mangroves and (other) coastal systems, in ESVD by tropical forests and rivers & lakes. These differences highlight once more that average TEV-values at the biome level must only be used as indication of the relative economic importance and further expansion of the ESVD is urgently needed to fill the gaps to allow for more context specific estimates of the full welfare-effect, preferably broken down further to the ecosystem and habitat level. However, taking the average of both databases shows consistently six biomes with the highest values: coral reefs, mangroves, tropical forests, other coastal systems, rivers & lakes and inland wetlands (all with TEV's of at least 35,000 int$/ha /year), followed by urban green & blue infrastructure.

Table 6. Mean standardised values per ecosystem service biome (Int$/hectare/year; 2020 price levels)

	Open sea/ Ocean	Coral reefs	Coastal systems	Man-groves	Inland wetlands	Rivers and lakes	Tropical forests	Temp-erate forests	Wood-land and shrubland	Grass-land	Desert	Tundra	High mountain & Polar systems	Inland Un-or Sparsely Vegetated	Cultivated areas	Urban green-blue
Food	43	6,231	9,892	6,717	6,030	2,288	602	4	8				2,448	12	510	
Water			5,172	10,496	1,934	9,198	47,869			313		1	58		604	
Raw materials	9		44	4,454	1,682	92	11,739	33	1	637			377	12	6	
Genetic resources	9		11		60		16									
Medicinal resources							3		1							
Ornamental resources													5			
Air quality regulation			15	1,323	34		309	1,593	7	8		1			10	9,416
Climate regulation	69		262	1,698	150	251	658	481	89	73		812	190	17	10	1,722
Moderation of extreme events		15,312	12,730	16,960	13,320	18	108	6					419		993	
Regulation of water flows			104	2,285	3,638	4,221	442	68	71	43				29	17	620
Waste treatment	28,190	61,013	36,556	4,079	2,043	50,760	12								40	
Erosion prevention		22,158	55	3,998			604	6							173	
Maintenance of soil fertility			4,019	5,576		6,189	42	117					160		34	
Pollination							877								1,498	
Biological control						142	14								621	
Maintenance of life cycles of migratory species			375	1,658	1,886	803	19									
Maintenance of genetic diversity			165	6,645	3,427	17,987	7									
Aesthetic information		1,200	268	334	49	2,276		35	38					23	395	
Opportunities for recreation and tourism	2,473	14,057	7,694	4,366	2,660	13,633	52,789	281	124	92		3	167	96	3,101	
Inspiration for culture, art and design		244	145	3,890	114	310	5	196	214	284				56	16	
Spiritual experience					1	76										
Information for cognitive development		90	5,683	1,429	120	116		147	214	147		1		92		
Existence and bequest values	2	38,255	972	2,146	11,498		2,960	2,416	2							
Sum	30,794	158,560	84,163	78,052	48,647	108,361	119,076	5,383	769	1,597		818	3,822	337	8,026	11,759

5. Discussion and Future directions

The Defra commissioned update of the ESVD enable substantial progress with adding new data (now 4,042 value records versus 1,310 in the 2012 database) and set up an effective data retrieval and review procedure. The ESVD is now, to our knowledge, the largest global database of ecosystem service values.

This chapter provides a discussion on some of the main challenges of developing the ESVD (5.1), a roadmap and opportunities for the future development (5.2), as well as some examples of (potential) users, applications and long-term financing possibilities (5.3)

5.1 Discussion

Due to the very large number of new primary valuation studies conducted and published in the past ten years, we were only able to enter data into the ESVD for approximately 18% (693 studies) of the total number of valuation studies (3783) retrieved and saved in the literature repository. We therefore had to be selective by focussing on 1. UK valuation studies initially; 2. biomes that are of particular interest to Defra (i.e. tropical biomes relevant to climate finance projects); 3. Providing coverage of all ecosystem services and biomes where possible. There remains considerable work to be done to enter data for all available ecosystem service valuation studies.

Approximately 20% of all the value records (4,042) in the ESVD have been externally reviewed, a further 10% is currently under review and the remaining 70% are pending review (see Figure 1). The review status of each value record is indicated in the database so that users are aware of the different 'confidence' levels of the value records. The review is an ongoing process (see 5.2) so the number of peer reviewed value records will steadily increase over time.

The summary tables in Chapter 4 are only intended for illustrative purposes and it is not advised to use them directly for value transfer and project appraisal at specific policy sites. The summary values reflect the context and characteristics of the underlying study sites, which are not necessarily globally representative of each ecosystem service or biome and highly unlikely to be representative of specific policy sites. Moreover, the uneven distribution of the number of value records across biomes and ecosystem services makes the average values for some more reliable than others. Users are advised to access the ESVD to find original values most closely related to their policy case or to use value functions that allow the prediction of values that reflect site specific characteristics.

5.2 Future directions

The ESVD is, to our knowledge, the most comprehensive global database of spatially explicit ecosystem service values but there remains scope for further development in several directions. Here we identify some of the potential tasks and activities to further develop the ESVD.

1. **Continue reviewing current data**: we still have over 3,000 value records already in the database that need to be externally reviewed before the data is put in the public domain.

For the current Defra commissioned update we developed a systematic review procedure (see Appendices 9 and 10) but further streamlining the functionality of the review process is needed considering the scale of the task ahead. The high response rate to our call for reviewers during this first update is a promising sign that there is much interest in continuing this process (see also Chapter 2.4 and Appendix 9)

2. **Continue adding new studies to the repository**: new studies are appearing on a daily basis; with the current ESVD Project Team we have a great knowledge base to continue screening and adding new data. In addition, we are in the process of expanding the involvement of the Ecosystem Services Partnership (www.es-partnership.org) by setting up a Task Force have created a 'landing page' (https://www.es-partnership.org/esvd-draft2/) with information regarding the ESVD and ways to collaborate.

3. **Start a process to regularly publish** in international journals (e.g. 'Ecosystem Services') both to share and disseminate the data and provide incentives for data-providers and reviewers to participate in updating the ESVD. Here too, the Ecosystem Services Partnership (www.es-partnership.org) will play a central role. ESP is the largest global membership-based organization on ecosystem service with many working groups on related topics (e.g. ES Classification, ES Quantification Indicators, ES Valuation methods (monetary and non-monetary) and many others). ESP members meet on a regular basis during regional and world conferences to bring the science, policy and practice in this field forward. The Task Force mentioned under point 2 would thus be part of an active global community ensuring high-level input, feedback and outreach.

4. **Develop a web user interface:** to facilitate 1, 2 and 3 and handle the huge number of studies, an interactive web-interface is considered essential to support and streamline data retrieval, review and exchange. We also envision the development of the option for users to visualize the data in maps, tables or graphs, depending on the availability of data and the access rights of the user. It is envisaged that users can select valuation data based on a combination of multiple fields including country, biome type, ecosystem type, valuation method, ecosystem service and author.

5. **Estimate value functions for transferring/scaling up values** across diverse "policy" sites. The ESVD provides a promising basis for the estimation of value functions that can be used for value transfer and scaling up values across diverse policy sites. A value function is an equation that relates the value of an ecosystem service to the characteristics of the ecosystem (e.g. size, type, condition) and the beneficiaries of the ecosystem service (e.g. population, income), which can be applied to predict the value of ecosystem services at multiple policy sites with diverse characteristics. The data in the ESVD could potentially be pooled and used to estimate value functions for specific ecosystem services or biomes. Since such a "meta-analytic" value function is estimated from the results of multiple studies it is able to represent and control for wide variation in the characteristics of

ecosystems, beneficiaries and also methodological aspects of the primary valuation studies.[2]

6. **Discuss the need and possibilities to revise existing variables**. Before embarking on adding more value records the typology of ecosystem services and classification of biomes, ecosystems and habitats should be revisited one more time to make sure it is long-term future-proof. During this update-process we noticed the current typology of especially subservices, and of ecosystems and habitats is still not ideal. Before we continue entering more data it is quite crucial to resolve this issue now as soon as possible.

7. **Discuss needs and possibilities to include additional variables**. The current data structure includes a large number of variables (66) covering the characteristics of the study site, ecosystem service, beneficiaries and methodology. Additional variables could be considered including: a) the welfare concept that is measured (e.g. consumer surplus, exchange value etc.), which would facilitate the selection of data for specific purposes (e.g. use in System of Environmental Economic Accounts (SEEA) applications); b) measures of precision or dispersion (e.g. confidence intervals, standard errors, value ranges); and c) measures of study quality (quantitative and/or qualitative indicators).

8. **Develop tailor-made user guides for specific user groups**: Many organisations and individuals regularly contact us regarding the use of the 2010 database and there is clearly a high demand for a reliable and easy-to-use database with spatially explicit data on ES values (see 5.3).

9. **Develop a database of non-monetary valuation results:** there are many other ways than monetary valuation to quantify the importance people place on ecosystems, or nature, and the benefits they provide. Several groups within the ES-Partnership are working on the development of a typology of non-monetary 'valuation' indicators and it would be interesting to explore the potential for a database of non-monetary valuation results.

10. **Establish functional links with ES quantification databases:** often a big bottleneck in valuation studies is not so much the (monetary/economic) valuation itself, but getting the underlying biophysical data right, e.g. to determine actual or potential sustainable use levels. It would be worthwhile to explore possibilities to link ESVD with such databases)

To realise all these action points will require substantial additional funding which can be provided on a 'tailor-made' basis: depending on the needs and interest, 'sponsors' can choose to provide financial support for a specific task, that also can be used by (see 5.3)

5.3 (Potential) users, applications and long-term financing possibilities.

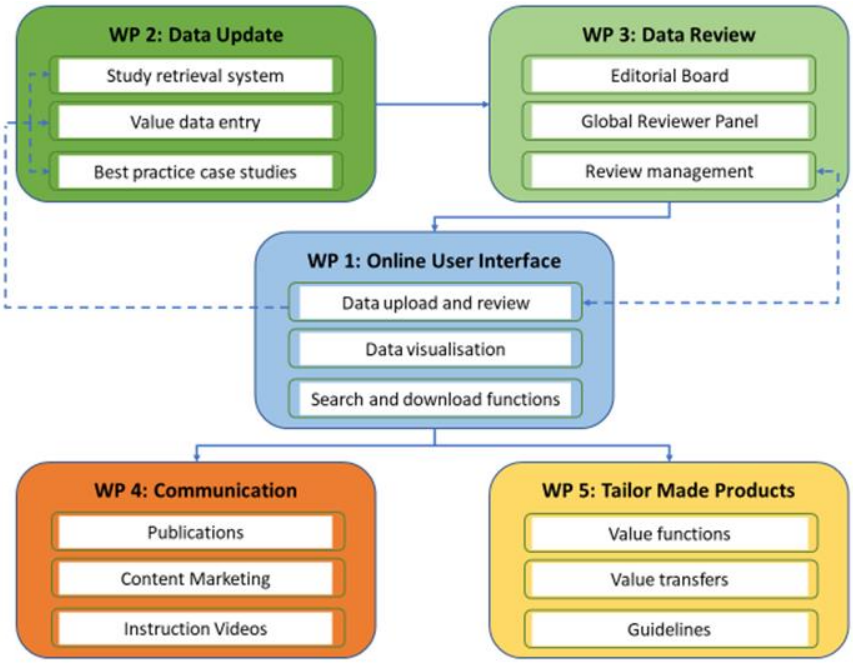
Currently we are in contact with several 'parties' including Environment & Climate Change Canada (to make an update of the national valuation of ecosystem goods and services), with the Government of Costa Rica to use the ESVD for improving their PES program, with UNEP

[2] See Brander et al (2012) for an example estimation and application of a value function for mangrove ecosystem service values.

and UN Statistics Division to develop SEEA compatible values and value functions, with FAO and the Agence Française de Développement (AFD) to integrate ecosystem service values into the B-INTACT tool, and with financial institutions in the Netherlands to explore how ESVD can be used to analyse the 'true' costs and benefits of their investments.

We recently developed a 'Proposition' for the long-term development and maintenance, and thus financing, of the ESVD with five Work Packages (see Fig. 10).

Figure 10 *The five Work Packages needed to update and maintain the ESVD*



Funding could be provided in various ways:

a) Sponsoring by governmental organisations like Defra, National Ministries, EU , etc. or NGO's (IUCN, WWF, etc.) who have a national/public interest to have access to reliable data on ES-values. Support could be for further development of specific aspects of ESVD (see Fig 10) but could also be for establishing working-relations with related initiatives and platforms, like the FAO B-INTACT tool, EVRI, IPBES, OPPLA etc.).

b) Payments by specific users (e.g. specific requests for data from for example government agencies, consultants, business or the financial sector). They often need a specific sub-set of data which they can search for on the public ESVD (which only contains peer-reviewed data) or approach us to get access to the full data-set (which includes also not-yet-peer-reviewed data and is continuously expanded) and search for the required data. This would be made available for an appropriate user fee (if so desired we could think of an annual subscription fee so the user receives the annually updated version of the database at a reduced fee).

c) Payments for assignments for specific applications: to assist with research- and advise in a particular case study context, develop and provide trainings and other applications. For example, we can conduct pilot studies and develop tailor made information (e.g. meta-analytic value functions for the purposes of estimating context specific ecosystem service

values) or guidelines on how to use the database in a specific context (e.g. for assessing effects of nature conservation, cost-benefit analysis of land use change and restoration, business externalities, natural capital accounting and national conservation strategies). The 'ESVD team' could dedicate staff-time to these assignments and/or engage members of the ES-Partnership.

d) Donations: some people or organisations might wish to support this effort by unconditional donations, or have a particular interest in supporting the improvement of valuation-data on a specific biome or service.

These are some first ideas and comments and further suggestions for securing long-term funding for updating and maintaining the ESVD are very welcome.

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Appendix 1: Overview of TEEB 2010 database

The TEEB database contained in total 1310 data points (original ecosystem service values) from 290 case study locations and 267 publications (v.d. Ploeg & de Groot, 2010)

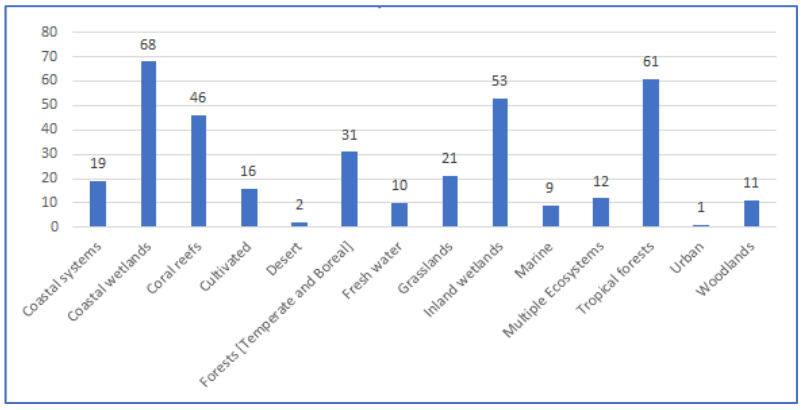


Fig.1 *Studies per biome in TEEB database*

The data was organised by 12 main biome types and 22 main services (plus 8 additional service groups that were difficult to put explicitly under one of the existing service types). Note that some of the biome types were split further and presented separately because of different ecological and socio-economic context (e.g. coastal systems and coastal wetlands). Figure 1 shows the total number of monetary values per biome in the original TEEB database. Figure 2 gives an overview of the total number of value estimates per service (from 30 services categories). Figure 3 shows the total number of recorded studies per biome (note that a study may have assessed more than 1 biome).

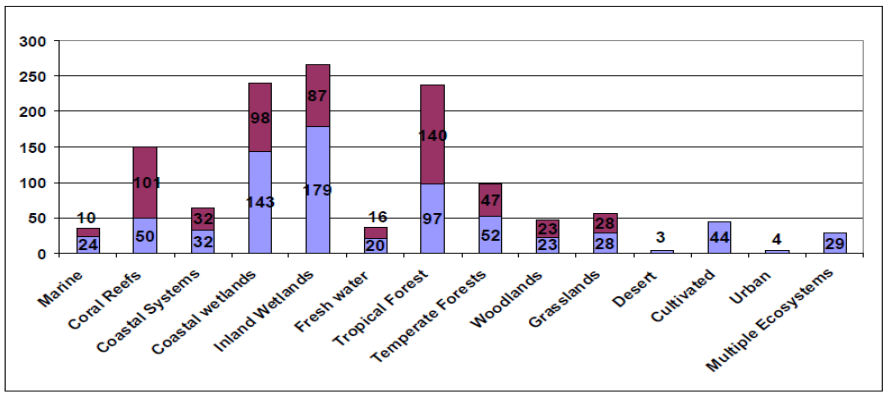


*Figure 2: Value Column totals show the total number of value records **per biome in** the TEEB database, in red are the value records that have been used for the published analysis (De Groot et al., 2010a)*

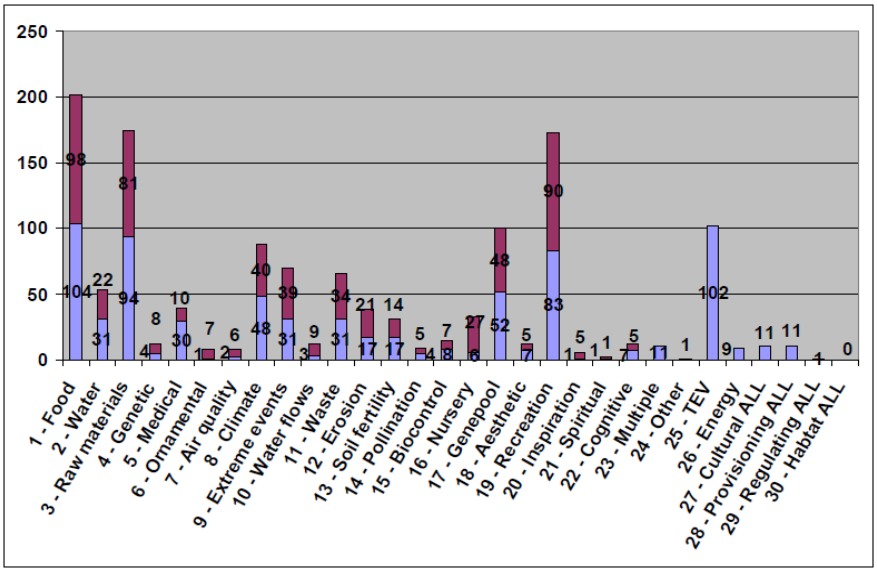


*Figure 3: Value Column totals show the total number of value records **per service** in the TEEB database, in red are the value records that have been used for the published analysis (De Groot et al., 2010a)*

Appendix 2: Search terms

In the searchable databases, potentially relevant valuation studies have been identified using combinations of search terms (depending on the functionality of search options):

1. Biomes/ecosystems/habitats
    - Coral reefs
    - Forests
    - Grasslands
    - Wetlands
    - Woodlands
    - Natural capital
    - ….
2. Ecosystem services
    - Fisheries
    - Carbon sequestration
    - Recreation
    - Biodiversity
    - Nature's contribution to people
    - Ecosystem service
    - ….
3. Valuation methods
    - Contingent valuation
    - Market prices
    - Hedonic pricing
    - Replacement cost
    - ….
4. Value terms
    - Willingness to pay
    - Producer surplus
    - Consumer surplus
    - Total Economic Value
    - Net present value
    - Benefit
    - ….

Appendix 3: List and description of variables included in the ESVD

Category	Variable Name	Description
	ValueID	Unique ID number for each value observation. A value observation is a single monetary estimate for an ecosystem service (or bundle of services) from a specified ecosystem (or complex of ecosystems) derived using a specified valuation method (or multiple methods). Each row in the database describes a single value observation.
	StudyID	Unique ID number for each valuation study. A valuation study is specific publication that reports value observations. Note that multiple valuation studies can potentially report the same value observations. Each study still receives a unique ID but duplication of reported value observations should be recorded in the Notes column.
Biome and Ecosystem	Biome	The biome(s) that is the subject of the value observation. Note that multiple biomes is possible. See "Biomes and Ecosystems" worksheet for classifications
	Biome code	See "Biomes and Ecosystems" worksheet for codes
	Biome 1	The first biome type that is the subject of the value observation
	Biome 2	The second biome type that is the subject of the value observation
	Biome 3	The third biome type that is the subject of the value observation
	Ecosystem	The ecosystem(s) that is the subject of the valuation observation. Note that multiple ecosystems is possible. See "Biomes and Ecosystems" worksheet for classifications
	Ecosystem code	See "Biomes and Ecosystems" worksheet for codes
	Ecosystem 1	The first ecosystem type that is the subject of the value observation
	Ecosystem 2	The second ecosystem type that is the subject of the value observation
	Ecosystem 3	The third ecosystem type that is the subject of the value observation
	Ecosystem 4	The fourth ecosystem type that is the subject of the value observation
	Ecosystem 5	The fifth ecosystem type that is the subject of the value observation
	Ecosystem 6	The sixth ecosystem type that is the subject of the value observation
	Ecosystem 7	The seventh ecosystem type that is the subject of the value observation
	Ecosystem (text description from study)	Description of the ecosystem (or complex of ecosystems) that is the subject of the valuation study. The text description can be taken directly from the valuation study

Category	Variable Name	Description
Ecosystem Service	Ecosystem Service (text description from study)	Text description of the ecosystem service (or bundle of ecosystem services) that is the subject of the valuation study. The text description can be taken directly from the valuation study
	TEEB Ecosystem Service	The TEEB ecosystem service(s) that are the subject of the value observation. See "TEEB Services" worksheet. Note - be careful NOT to include "." in the code
	TEEB ES Subservice	The TEEB ecosystem sub-service(s) that are the subject of the value observation. See "TEEB Services" worksheet. Note - be careful NOT to include "." in the code
	TEEB ES 1	The first TEEB ecosystem service that is the subject of the value observation
	TEEB ES 2	The second TEEB ecosystem service that is the subject of the value observation
	TEEB ES 3	The third TEEB ecosystem service that is the subject of the value observation
	TEEB ES 4	The fourth TEEB ecosystem service that is the subject of the value observation
	TEEB ES 5	The fifth TEEB ecosystem service that is the subject of the value observation
	TEEB ES 6	The sixth TEEB ecosystem service that is the subject of the value observation
	TEEB ES 7	The seventh TEEB ecosystem service that is the subject of the value observation
	TEEB ES 8	The eigth TEEB ecosystem service that is the subject of the value observation
	TEEB ES 9	The ninth TEEB ecosystem service that is the subject of the value observation
	TEEB ES 10	The tenth TEEB ecosystem service that is the subject of the value observation
	CICES V5.1 Code	The CICES V5.1 code(s) for the ecosystem service(s) that are the subject of the value observation. See "CICES V5.1" worksheet. Only include "biotic" ecosystem services, i.e. NOT "abiotic" services.
Study Site	Country	The country(ies) that is the subject of the value observation. For continental or global scale study sites, leave blank
	Country ISO Code	The 3-letter ISO codes(s) for the country(ies) or territory(ies) that is the subject of the value observation. See "Country ISO" worksheet for codes. For study sites that cover multiple countries and/or territories, record the codes for all. For continental or global scale study sites, leave blank
	Country 1	The name of the first country containing the study site
	Country 2	The name of the second country containing the study site
	Country 3	The name of the third country containing the study site
	Country 4	The name of the fourth country containing the study site
	Continent ISO Code	The 2-letter ISO codes(s) for the continent(s) that is the subject of the value observation. See "Country ISO" worksheet for codes. For global studies enter "GL"

Category	Variable Name	Description
	Scale of study site	Text description of the scale of the study site (e.g. local, sub-national, national, multi-country, continental, global). Note that this variable records the scale over which the service producing ecosystem is measured and not the scale of the constituency of beneficiaries (e.g. the area from which beneficiaries are sampled). Also note that the “scale of study site” and “site area” variables are related but different (e.g. it is possible to have a national scale study site but for the total area of the valued ecosystem to be small if it is scarce).
	Scale code	Five category indicator for the scale of the study site: 1 Local; 2 Sub-national; 3 National; 4 Multi-country; 5 Global
	Location Name	Name of the study site location. In the case that the study site does not have a specific name, provide a text description of the location (preferably taken from the study)
	Protected Status Code	Three level indicator of protected status: 0. No protection; 1. Partially Protected; 2. Protected. See "Protection Status" worksheet
	Site Area	The areal extent of the ecosystem that is the subject of the valuation study. This should be a numeric value only. The units of area are specified in the next column. The area of the ecosystem may not be relevant to rivers, shorelines etc.
	Site Area Spatial Unit	The units of area (e.g. hectare, km2, acre) in which the area of the ecosystem is measured
	Site Area in Hectares	The areal extent of the study site in hectares
	Site Length	The length of the ecosystem that is the subject of the valuation study. This should be a numeric value only. The units of length are specified in the next column. The length of the ecosystem is mostly relevant to rivers, shorelines etc.
	Site Length Spatial Unit	The units of length (e.g. meters, kilometers, feet, miles) in which the length of the ecosystem is measured
	Site Length in KM	The length of the study site in kilometers
	Site Condition (text description from study)	Text description of the condition of the ecosystem that is the subject of the valuation study
	Site Condition Code	Three category indicator of the ecosystem condition: 0. Highly degraded (or intensively managed); 1. Intermediate; 2. Well-functioning (or extensively managed)
	Latitude	Latitude of the study site in decimal degrees
	Longitude	Longitude of the study site in decimal degrees. Note - be careful to include the "-" if the location is in the Western hemisphere.

Category	Variable Name	Description
Valuation	Valuation Method	The 2-letter code for the method used obtain the value observation. See "Methods" worksheet for list of valuation methods, explanations and 2-letter code
	Valuation method 1	The first valuation method used to obtain the value observation (2-letter code)
	Valuation method 2	The second valuation method used to obtain the value observation (2-letter code)
	Valuation method 3	The third valuation method used to obtain the value observation (2-letter code)
	Valued Change (text description from study)	Text description of the change in ecosystem service, extent of ecosystem, or change in condition that is valued in the study
	Value	The monetary value as reported in the study (i.e. in the reported currency, spatial unit, temporal unit etc.)
	Currency ISO Code	ISO currency code. See "Currency ISO" worksheet
	Value Year	The year in which the value observation was estimated. This is generally earlier than the year of publication and indicated by the year in which data underlying the valuation was collected. If the year of data collection is not available, assume that it is two years before the year of publication.
	Spatial Unit	The spatial unit in which the value observation is reported (e.g. hectare, km2, acre, total area, meter, kilometer, mile, total length). It is important to record whether the reported value is per unit area (e.g. USD/ha) or for the total area of the ecosystem
	Temporal Unit	The temporal unit for which the value observation is reported (e.g. visit, day, month, year, or present value over multiple years)
	Present Value Years	The number of years over which a present value is computed. This is only relevant if the temporal unit is "present value"
	Present Value Discount Rate	The discount rate used to compute a present value. This is only relevant if the temporal unit is "present value"
	Beneficiary Unit	The beneficiary unit for which the value observation is reported (e.g. visitor, person, household, or total number of beneficiaries).
	Number of beneficiaries	The number of beneficiaries that benefit from the ecosystem service. This might be reported as the number of visitors, population, or number of households over which a value estimate is extrapolated to obtain a total value of the service. This is NOT the sample size or number of beneficiaries surveyed.
	Type of beneficiary	Text description of the type of beneficiary of the service (e.g. visitors, residents, non-users, tourists etc.)
	Int$ per hectare per year	The monetary value of the ecosystem service standardised to International dollars per hectare per year for all beneficiaries; 2020 price level

Category	Variable Name	Description
Bibliographic details	Authors	Author names
	Year Publication	The year in which the valuation study was published
	Title	The title of the valuation publication
	Reference	Full reference for the valuation study
Data management	Notes	Comments regarding the value observation here (e.g. missing data, unclear results, unclear methodology, potential duplication with other observations etc.)
	Secondary data sources	Sources of any secondary data used here (e.g. for ecosystem area, length, protection status etc.)
	Coded by	Name of researcher who entered the data
	Coded date	Date on which the data was entered
	Reviewed by	Name of reviewer
	Reviewed date	Date on which the data was reviewed

Appendix 4: Common International Classification of Ecosystem Services (CICES) V5.1

source: Haines-Young and Potschin, 2018

Section	Division	Group	Code
Provisioning (Biotic)	Biomass	Cultivated terrestrial plants for nutrition, materials or energy	1.1.1
Provisioning (Biotic)	Biomass	Cultivated aquatic plants for nutrition, materials or energy	1.1.2
Provisioning (Biotic)	Biomass	Reared animals for nutrition, materials or energy	1.1.3
Provisioning (Biotic)	Biomass	Reared aquatic animals for nutrition, materials or energy	1.1.4
Provisioning (Biotic)	Biomass	Wild plants (terrestrial and aquatic) for nutrition, materials or energy	1.1.5
Provisioning (Biotic)	Biomass	Wild animals (terrestrial and aquatic) for nutrition, materials or energy	1.1.6
Provisioning (Biotic)	Genetic material from all biota (including seed, spore or gamete production)	Genetic material from plants, algae or fungi	2.1.1
Provisioning (Biotic)	Genetic material from all biota (including seed, spore or gamete production)	Genetic material from animals	2.1.2
Provisioning (Biotic)	Genetic material from all biota (including seed, spore or gamete production)	Genetic material from organisms	2.1.3
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	4.2.1
Provisioning (Abiotic)	Water	Ground water for used for nutrition, materials or energy	4.2.2
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	2.1.1
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of nuisances of anthropogenic origin	2.1.2
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	2.2.1
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	2.2.2
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Pest and disease control	2.2.3
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of soil quality	2.2.4
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Water conditions	2.2.5
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Atmospheric composition and conditions	2.2.6
Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Physical and experiential interactions with natural environment	3.1.1

Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Intellectual and representative interactions with natural environment	3.1.2
Cultural (Biotic)	Indirect, remote, often indoor interactions with living systems that do not require presence in the environmental setting	Spiritual, symbolic and other interactions with natural environment	3.2.1
Cultural (Biotic)	Indirect, remote, often indoor interactions with living systems that do not require presence in the environmental setting	Other biotic characteristics that have a non-use value	3.2.2

Appendix 5: Revised TEEB service classification

TEEB classification of ecosystem services and sub-services (adapted from de Groot et al. 2010)

	Ecosystem Service	ES Code	Ecosystem Sub-Service	ESS Code
Provisioning	Food	1	Fish	11
			Meat	12
			Plants / vegetable food	13
			NTFPs [food only!]	14
			Food [unspecified]	15
			Other	16
	Water	2	Drinking water	21
			Industrial water	22
			Water Other	23
			Irrigation water [unnatural]	25
			Water [unspecified]	26
	Raw materials	3	Fibers	31
			Timber	32
			Fuel wood and charcoal	33
			Fodder	34
			Fertiliser	35
			Other Raw	36
			Raw materials [unspecified]	37
			Sand, rock, gravel	38
			Biomass fuels	39
	Genetic resources	4	Plant genetic resources	41
			Animal genetic resources	42
			Genetic resources [unspecified]	43
	Medicinal resources	5	Biochemicals	51
			Models	52
			Test-organisms	53
			Bioprospecting	54
	Ornamental resources	6	Decorative Plants	61
			Fashion	62
			Decorations / Handicrafts	63
			Pets and captive animanls	64
Regulating	Air quality regulation	7	Capturing fine dust	71
			Air quality regulation [unspecified]	72
			UVb-protection	73
	Climate regulation	8	C-sequestration	81
			MDS-production	82
			Climate regulation [unspecified]	83
			Microclimate regulation	84
			Gas regulation	85
	Moderation of extreme events	9	Storm protection	91
			Flood prevention	92
			Fire Prevention	93

			Prevention of extreme events [unspecified]	94
	Regulation of water flows	10	Drainage	101
			River discharge	102
			Natural irrigation	103
			Water regulation [unspecified]	104
	Waste treatment	11	Water purification	111
			Soil detoxification	112
			Abatement of noise	113
			Waste treatment [unspecified]	114
	Erosion prevention	12	Erosion prevention	121
	Maintenance of soil fertility	13	Maintenance of soil structure	131
			Deposition of nutrients	132
			Soil formation	133
			Nutrient cycling	134
	Pollination	14	Pollination of crops	141
			Pollination of wild plants	142
			Pollination [unspecified]	143
	Biological control	15	Seed dispersal	151
			Pest control	152
			Disease control	153
			Biological Control [unspecified]	154
Habitat	Maintenance of life cycles	16	Nursery service	161
			Refugia for migratory and resident species	162
	Maintenance of genetic diversity	17	Biodiversity protection	171
Cultural	Aesthetic information	18	Attractive landscapes	181
	Opportunities for recreation and tourism	19	Recreation	191
			Tourism	192
			Ecotourism	193
			Hunting / fishing	194
	Inspiration for culture, art and design	20	Artistic inspiration	201
			Cultural use	202
			Inspiration [unspecified]	203
	Spiritual experience	21	Spiritual / Religious use	211
	Information for cognitive development	22	Science / Research	221
			Education	222
			Cognitive [unspecified]	223
	Existence, bequest values	23	Existence value	231
			Bequest value	232

Appendix 6: Revised TEEB biome classification

Biomes and Ecosystems	Code
Open sea/ocean	**1**
Shelf sea / neritic zone	1,1
Deep sea / Abyssal zone	1,2
Pelagic zone (up to 200 m deep)	1,3
Other (sea/ocean)	1,4
Coral reefs	**2**
Barrier reefs	2,1
Atolls	2,2
Fringing reefs	2,3
Patch reefs	2,4
Other (coral reefs)	2,5
Coastal systems (incl wetlands)	**3**
Sand dunes, beaches, rocky shores	3,1
Tidal marshes	3,2
Salt marshes	3,3
Mangroves	3,4
Lagoons	3,5
Estuaries	3,6
Unvegetated sediment	3,7
Shellfish reefs	3,8
Seagrass beds	3,9
Kelp forests	3,11
Other (coastal systems)	3,12
Inland wetlands	**4**
Swamps, marshes	4,1
Peatland, Non-forested	4,2
Peatland, Forested	4,3
Peatland, Tropical	4,4
Peatland, Boreal	4,5
Wetlands, Forested (on alluvial soils)	4,6
Wetlands, Groundwater-dependent	4,7
Floodplains	4,8
Other (inland wetlands)	4,9
Rivers and lakes	**5**
Rivers	5,1
Lakes, freshwater	5,2
Lakes, saltwater	5,3
Human made water bodies	5,4
Other (rivers and lakes)	5,5
Tropical forests	**6**
Tropical rain forest	6,1
Tropical dry forest	6,2
Tropical cloud forests	6,3
Other (tropical forests)	6,4
Temperate forests	**7**
Temperate rain or evergreen forest	7,1
Temperate deciduous forest	7,2

Boreal/coniferous forest ('Taiga')	7,3
Other (temperate forests)	7,4
Woodland & Shrubland	**8**
Tropical wood-& shrublands	8,1
Mediterranean wood-& shrubland	8,2
Temperate wood-& shrubland	8,3
Heathland	8,4
Other (woodland and shrubland)	8,5
Grass-/Rangeland	**9**
Savanna	9,1
Tropical grasslands	9,2
Temperate grasslands	9,3
Steppe (dry, cold grassland)	9,4
Other (grassland)	9,5
Desert	**10**
True desert (sand/rock/salt)	10,1
Semi-desert	10,2
Other (desert)	10,3
Tundra	**11**
Alpine Tundra	11,1
Arctic Tundra	11,2
Other (tundra)	11,3
High mountain & Polar systems	**12**
High Mountain - forest	12,1
High Mountain - grassland	12,2
High Mountain - snow and ice	12,3
Polar	12,4
Other (high mountains and polar)	12,5
Inland Un- or Sparsely Vegetated	**13**
Underground systems	13,1
Inland rock formations	13,2
Other (inland un- or sparsely vegetated)	13,3
Cultivated areas	**14**
Cropland (arable land)	14,1
Pastures	14,2
Orchards/agro-forestry	14,3
Plantations	14,4
Rice paddies, etc	14,5
Aquaculture	14,6
Small landscape elements	14,7
Other (cultivated areas)	14,8
Urban Green and Blue Infrastructure	**15**
Urban Parks & Forests	15,1
Lawns, sports fields, golf courses	15,2
Urban lakes, ponds, wetlands	15,3
Cultivated areas	15,4
(Street) Trees & Shrubs	15,5
Other (urban green-blue)	15,6
Other	**16**

Appendix 7: Summary results of UK pilot report (Task 2.2)

This appendix provides a summary of the pilot update of the ESVD with UK valuation studies. The full results of the UK update can be found in Brander et al (2019). The process of updating the ESVD started with a focus on the UK since the UK Department for Environment, Food and Rural Affairs (Defra) commissioned the project. The initial focus on the UK provided the opportunity to develop, test and adapt procedures and data structure for the global update. The UK update of the ESVD contains 1,328 value estimates for ecosystem services from 142 valuation studies. Tables A7.1-7.3 summarise UK values by biome, UK habitat type and ecosystem service. Note that values are reported in British pounds (GBP).

Table A7.1. Summary of ecosystem service values per ecosystem service

(GBP/hectare/year; 2020 price levels)

Ecosystem	N	Mean	S.D.	Median
Food	29	421	2,226	1
Water	7	561	1,261	24
Raw materials	37	116	597	5
Genetic resources	5	795	1,077	13
Air quality regulation	427	2,366	4,821	557
Climate regulation	66	478	2,092	78
Moderation of extreme events	11	7,673	11,101	3,883
Regulation of water flows	36	96	158	41
Waste treatment	7	8	18	1
Erosion prevention	2	5,538	6,840	5,538
Maintenance of soil fertility	17	3,097	10,502	4
Biological control	1	128	-	128
Maintenance of life cycles	1	15	-	15
Aesthetic information	20	88	333	16
Recreation and tourism	215	12,857	81,744	288
Inspiration for culture, art and design	68	99	149	39
Information for cognitive development	15	98	39	89
Existence and bequest values	6	1,647	760	1,723
Provisioning services (unspecified)	11	3	2	3
Regulating services (unspecified)	1	48	.	48
Cultural services (unspecified)	5	77	110	3
Total	987	4,055	38,559	175

Table A7.2. Summary of ecosystem service values per ecosystem service and biome (GBP/hectare/year; 2020 price levels)

	Open sea/ocean	Coastal systems (incl. wetlands)	Inland wetlands	Rivers and lakes	Temperate forests	Woodland and shrubland	Grassland	Inland Un- or Sparsely Vegetated	Cultivated areas	Urban green-blue	All biomes
Food	22.95	0.74	2,005.61		3.02	0.64		8.81	6.79		420.93
Water	6.74		1,930.68		24.34				11.74		561.10
Raw materials		56.81	612.61		25.49	2.61		8.81	2.07		115.85
Genetic resources	6.68	1,031.77	952.36								794.99
Air quality regulation		11.02			864.44	5.56	6.94		5.92	7,194.19	2,365.97
Climate regulation	44.10	54.15	147.35	29.48	289.60	68.06	55.56	13.22	3.76	2,410.52	477.73
Moderation of extreme events	1.89	18,500.30	8,741.01		4.59				889.15		7,672.53
Regulation of water flows		79.86	89.10	33.28	51.87	54.00	40.53	22.03	5.74	476.67	95.72
Waste treatment			47.62						1.38		7.98
Erosion prevention			5,538.32								5,538.32
Maintenance of soil fertility	21,478.00		4,806.76						5.66		3,096.65
Biological control			128.20								128.20
Maintenance of life cycles		14.62									14.62
Aesthetic information		25.93	6.49		27.08	29.12		17.63	159.41		87.77
Recreation and tourism	15,236.52	7,782.26	1,100.77	24,317.64	214.59	1,106.67	34.67	73.50	342.75		12,856.67
Inspiration for culture		111.10	86.94	236.79	149.96	163.31	217.15	43.20	11.07		99.15
Cognitive development		64.53	92.15	88.92	112.47	163.82	112.37	70.30			97.83
Existence and bequest values					1,647.33						1,647.33
Provisioning (unspecified)		2.24	2.23	3.80	3.34	5.64	3.74				3.30
Regulating (unspecified)			47.56								47.56
Cultural (unspecified)	1.95		95.23								76.57
All ecosystem services	14,144.67	4,878.46	988.31	20,685.72	760.28	176.00	77.99	35.19	54.82	6,561.08	4,055.18

Table A7.3. Summary of ecosystem service values per ecosystem service and UK habitat (GBP/hectare/year; 2020 price levels)

	Coastal-Marine	Farmland	Inland wetlands	Freshwater	Mountains moorland heath	Semi-natural grassland	Urban	Woodland-Forest	All habitats
Food	17.40	6.79	2,005.61		3.37			3.02	420.93
Water	6.74	11.74	1,930.68					24.34	561.10
Raw materials	56.81	2.07	612.61		4.68			25.49	115.85
Genetic resources	690.07		952.36						794.99
Air quality regulation	11.02	5.92			5.56	6.94	7,194.19	864.44	2,365.97
Climate regulation	52.14	3.76	147.35	29.48	54.35	55.56	2,410.52	289.60	477.73
Moderation of extreme events	13,875.70	889.15	8,741.01					4.59	7,672.53
Regulation of water flows	79.86	5.74	89.10	33.28	46.01	40.53	476.67	51.87	95.72
Waste treatment		1.38	47.62						7.98
Erosion prevention			5,538.32						5,538.32
Maintenance of soil fertility	21,478.00	5.66	4,806.76						3,096.65
Biological control			128.20						128.20
Maintenance of life cycles	14.62								14.62
Aesthetic information	25.93	159.41	6.49		25.29			27.08	87.77
Recreation and tourism	12,970.02	342.75	1,100.77	24,317.64	848.37	34.67		214.59	12,856.67
Inspiration for culture	111.10	11.07	86.94	236.79	115.27	217.15		149.96	99.15
Cognitive development	64.53		92.15	88.92	117.06	112.37		112.47	97.83
Existence and bequest values								1,647.33	1,647.33
Provisioning (unspecified)	2.24		2.23	3.80	5.64	3.74		3.34	3.30
Regulating (unspecified)			47.56						47.56
Cultural (unspecified)	1.95		95.23						76.57
All ecosystem services	10,213.55	54.82	988.31	20,685.72	136.29	77.99	6,561.08	760.28	4,055.18

Appendix 8: Repository of best practice studies (Task 3.4)

This appendix gives a selection of ' best practice' studies with examples of a mix of different biomes, ecosystem services and valuation methods

Barbier, E. B. (2007). Valuing ecosystem services as productive inputs. Economic policy, 22(49), 178-229.

Biome: Coastal Systems
Ecosystem: Mangroves
Location: All coastal mangroves, Thailand.
Ecosystem Service(s) Assessed: Flood prevention; Hunting / fishing.
Valuation Method(s): Production Function; Avoided Damage Costs.

Abstract: This paper explores two methods for valuing ecosystems by valuing the services that they yield to various categories of user and that are not directly valued in the market and illustrates the usefulness of these methods with an application to the valuation of mangrove ecosystems in Thailand. The first method is known as the production function approach and relies on the fact that ecosystems may be inputs into the production of other goods or services that are themselves marketed, such as fisheries. I discuss issues that arise in measuring the input into fisheries, particularly those due to the fact that the fishery stock is changing over time, and the shadow value of the ecosystem consists in its contribution to the maintenance of the stock as well as its contribution to current output. The second method is known as the expected damage approach and is used to value the services of storm protection in terms of the reduction in expected future storm damage that the ecosystem can provide. These two methods are shown to yield very different valuations of ecosystems from those that would be derived by the methods typically used in cost-benefit analyses. I argue that they represent a significant improvement on current practice.

Table 4. Valuation of storm protection service, Thailand, 1996–2004 (US$)

Valuation approach	Average annual mangrove loss	
	FAO (18.0 km^2)[a]	Thailand (3.44 km^2)[b]
Replacement cost method:[c]		
Annual welfare loss	25 504 821	4 869 720
Net present value (10% discount rate)	146 882 870	28 044 836
Net present value (12% discount rate)	135 896 056	25 947 087
Net present value (15% discount rate)	121 698 392	23 236 280
Expected damage function approach:		
Annual welfare loss	3 382 169 (2 341 686–5 797 339)	645 769 (447 106–1 106 905)
Net present value (10% discount rate)	19 477 994 (13 485 827–33 387 014)	3 718 998 (2 574 894–6 374 694)
Net present value (12% discount rate)	18 021 043 (12 477 089–30 889 671)	3 440 818 (2 382 292–5 897 868)
Net present value (15% discount rate)	16 138 305 (11 173 553–27 662 490)	3 081 340 (2 133 404–5 281 692)

Notes: Figures in parentheses represent upper and lower bound welfare estimates based on the 95% confidence interval for the estimated coefficients in the model (see Section A3 in the appendix).
[a] FAO estimates from FAO (2003). 2000 and 2004 data are estimated from 1990–2000 annual average mangrove loss of 18.0 km^2.
[b] Thailand estimates from various Royal Thailand Forestry Department sources reported in Aksornkoae and Tokrisna (2004). 2000 and 2004 data are estimated from 1993–96 annual average mangrove loss of 3.44 km^2
[c] Re-calculated based on Sathirathai and Barbier (2001).
Sources: Author's calculations.

Summary of results: Replacement cost value to calculate the annual and net present value welfare losses associated with the two mangrove deforestation estimates for Thailand over 1996–2004.

Bateman, I. J., & Langford, I. H. (1997). Non-users' willingness to pay for a National Park: an application and critique of the contingent valuation method. Regional studies, 31(6), 571-582.

Biome: Rivers and lakes.
Ecosystem: Rivers ; Lakes and freshwaters
Location: Norfolk Broads, United Kingdom.
Ecosystem Service(s) Assessed: Recreation; Inspiration.
Valuation Method(s): Contingent Valuation.

Abstract: A great deal of the ongoing academic debate concerning the contingent valuation (CV) method has focused upon whether or not the method is suitable for assessing non-use values. This paper presents results from a study examining non-users' values for preserving the Norfolk Broads, a wetland area of recognized international importance, from the threat of saline flooding. Discussion of results centers upon the validity of the CV method for eliciting unbiased estimates of non-use value. A graphical representation of findings from a variety of studies is presented to suggest that such results are logically ordered across goods and valuation scenarios. However, as the paper concludes, logicality and validity are not necessarily synonymous.

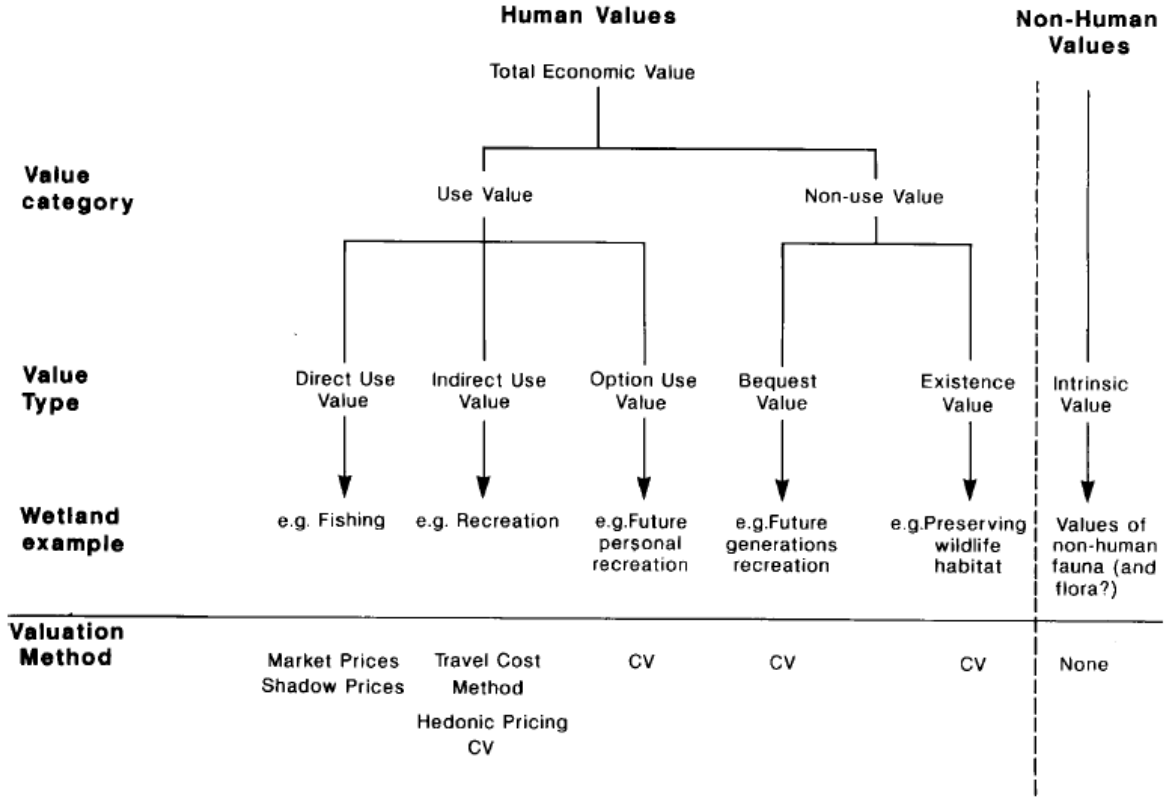
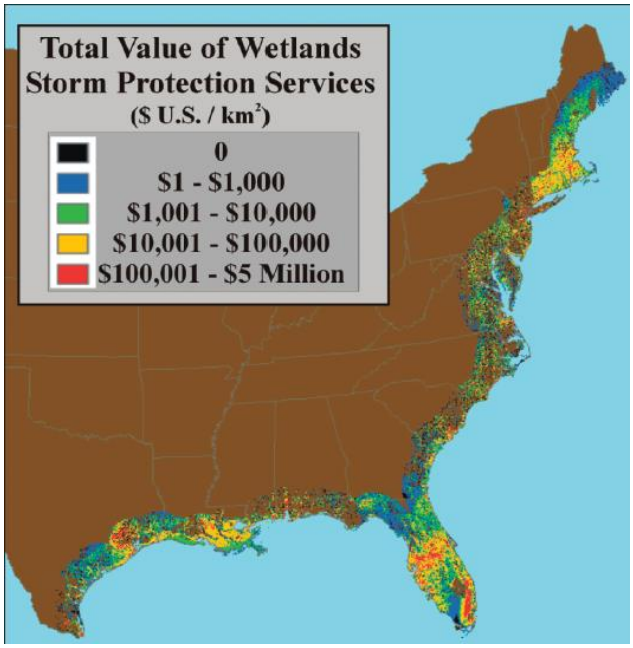


Fig. 1. The total economic value of a wetland
Source: Draws upon PEARCE and TURNER, 1990; BARBIER, 1991; and TURNER 1991.

Costanza, R., Pérez-Maqueo, O., Martinez, M. L., Sutton, P., Anderson, S. J., & Mulder, K. (2008). The value of coastal wetlands for hurricane protection. *AMBIO: A Journal of the Human Environment*, *37*(4), 241-248.

Biome: Coastal Systems.
Ecosystem: Coastal Wetlands.
Location: Louisiana; United States of America.
Ecosystem Service(s) Assessed: Strom Protection.
Valuation Method(s): Damage Cost Avoided

Abstract: Coastal wetlands reduce the damaging effects of hurricanes on coastal communities. A regression model using 34 major US hurricanes since 1980 with the natural log of damage per unit gross domestic product in the hurricane swath as the dependent variable and the natural logs of wind speed and wetland area in the swath as the independent variables was highly significant and explained 60% of the variation in relative damages. A loss of 1 ha of wetland in the model corresponded to an average USD 33 000 (median 1⁄4 USD 5000) increase in storm damage from specific storms. Using this relationship and taking into account the annual probability of hits by hurricanes of varying intensities, we mapped the annual value of coastal wetlands by 1km 3 1km pixel and by state. The annual value ranged from USD 250 to USD 51 000 ha1 yr1, with a mean of USD 8240 ha1 yr1 (median 1⁄4 USD 3230 ha1 yr1) significantly larger than previous estimates. Coastal wetlands in the US were estimated to currently provide USD 23.2 billion yr1 in storm protection services. Coastal wetlands function as valuable, self-maintaining ''horizontal levees'' for storm protection, and also provide a host of other ecosystem services that vertical levees do not. Their restoration and preservation is an extremely cost-effective strategy for society.



Map of total value of coastal wetlands for storm protection by 1 km x 1 km pixel. It shows wetlands of particularly high storm protection value density at the intersection of high storm probability, high coastal GDP, and high wetland area.

Van Beukering, P. J., Cesar, H. S., & Janssen, M. A. (2003). Economic valuation of the Leuser national park on Sumatra, Indonesia. *Ecological economics*, *44*(1), 43-62.

Biome: Tropical forests.
Ecosystem: Tropical rain forest
Location: Leuser National Park on Sumatra, Indonesia.
Ecosystem Service(s) Assessed: Fisheries. NTFPs (food), Water, Bioprospecting, C-sequestration, Flood prevention, Fire prevention, Erosion prevention, Biodiversity protection, Ecotourism.
Valuation Method(s): Market Prices (Gross Revenue), Damage Cost Avoided, Value Transfer (Benefits Transfer), Contingent Valuation.

Abstract: The Leuser Ecosystem in Northern Sumatra is officially protected by its status as an Indonesian national park. Nevertheless, it remains under severe threat of deforestation. Rainforest destruction has already caused a decline in ecological functions and services. Besides, it is affecting numerous economic activities in and around the Leuser National Park. The objectives of this study are twofold: firstly, to determine the total economic value (TEV) of the Leuser Ecosystem through a systems dynamic model. And secondly, to evaluate the economic consequences of deforestation versus conservation, disaggregating the economic value for the main stakeholders and regions involved. Using a dynamic simulation model, economic valuation is applied to evaluate the TEV of the Leuser National Park over the period 2000/2030. Three scenarios are considered: 'conservation', 'deforestation' and, 'selective use'. The results are presented in terms of (1) the type of benefits, (2) the allocation of these benefits among stakeholders, and (3) the regional distribution of benefits. The economic benefits considered include: water supply, fisheries, flood and drought prevention, agriculture and plantations, hydro-electricity, tourism, biodiversity, carbon sequestration, fire prevention, non-timber forest products, and timber. The stakeholders include: local community members, the local government, the logging and plantation industry, the national government, and the international community. The regions considered cover the 11 districts involved in the management of the Leuser Ecosystem. With a 4% discount rate, the accumulated TEV for the ecosystem over the 30-year period is: US $7.0 billion under the 'deforestation scenario', US $9.5 billion under the 'conservation scenario' and US $9.1 billion under the 'selective utilisation scenario'. The main contributors in the conservation and selective use scenarios are water supply, flood prevention, tourism and agriculture. Timber revenues play an important role in the deforestation scenario. Compared to deforestation, conservation of the Leuser Ecosystem benefits all categories of stakeholders, except for the elite logging and plantation industry.

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%.

Summary of results.

Brander L., Tai B., Crossman N. and Hong Yeo B. (2018). Natural Capital Valuation using primary data research methods in Baleh, Sarawak Heart of Borneo Project. WWF-Malaysia Project Report.

Biome: Tropical forests.
Ecosystem: Tropical rain forest
Location: Baleh watershed & Rajang river basin; Malaysia.
Ecosystem Service(s) Assessed: Food, Drinking water, Raw materials, C-sequestration, Flood prevention, Hunting / fishing, Recreation, Tourism, Ecotourism, Artistic inspiration, Cultural use, Existence value, Bequest value, Erosion prevention, Maintenance of soil structure.
Valuation Method(s): Contingent Valuation, Damage Cost Avoided, Choice Modelling (Discrete Choice Experiment; Conjoint Analysis), Market Prices (Gross Revenue).

Abstract: The purpose of this Final Report is to present the results and policy recommendations from study. It expands on the Interim Report, which provided a description of the policy and institutional context of the study with a view to developing policy recommendations; the development of alternative future land use scenarios that underlie the economic valuation of ecosystem services; the spatial modelling of ecosystem services; the implementation of primary data collection 7 through three surveys; and the preliminary results of those surveys. This Final Report builds on the Interim report to present the results of the bio-physical models of ecosystem service provision; the economic valuation results; and develops policy recommendations. In order to produce a comprehensive assessment of the economic value of ecosystem services from the Baleh watershed, the area of interest is defined from the headwaters of the Baleh River at the Indonesia-Malaysia border to the main stem and mouth of the Rajang River. The assessment will examine ecosystem services produced by natural capital within the Baleh watershed and examine the values of those services to beneficiaries both within the Baleh watershed and in the downstream portion of the Rajang River (and further afield if relevant).

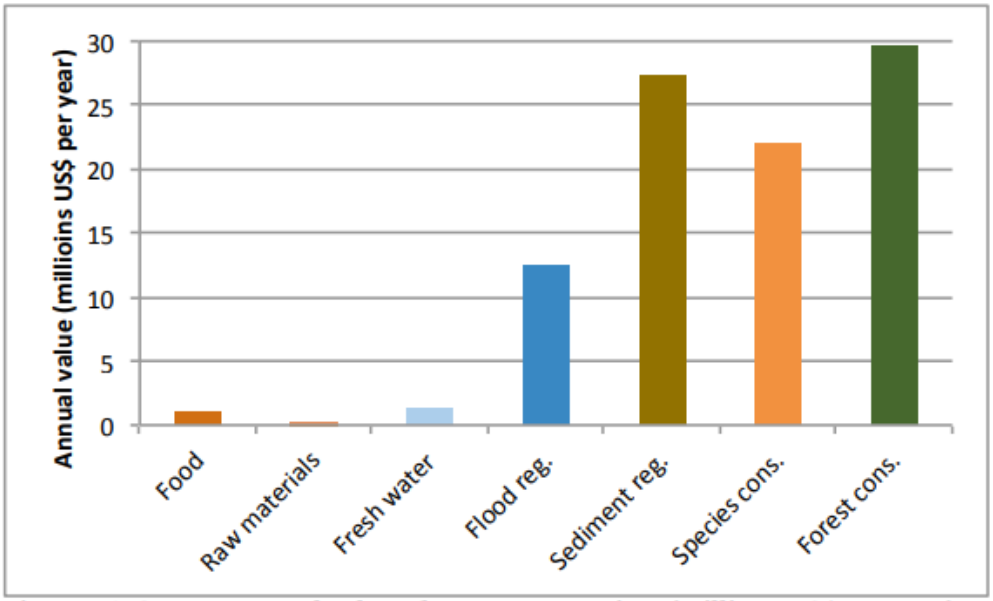


Figure 56. Current annual value of ecosystem services (millions US$ per year)

Appendix 9: Forming Biome Review Groups

To develop and implement a mechanism that ensures the continuous, long-term review and update of the database we started with the formation of so-called 'Biome Review Groups' (BRG). These are experts, specialised in different biomes, to handle the input from dozens (and eventually hundreds) of reviewers.

Towards this purpose, we employed a couple of ways to inform about and invite experts to our initiative through personal communication to known experts and by taking advantage of our access to the ESP network for contacting potential reviewers. We used the outreach of ESP on social media with special posts about ESVD. In addition, we created announcements about ESVD in our monthly newsletters and posted related material on the website (https://www.es-partnership.org/).

Many of the reviewers were able to complete their reviews within the timeframe of this update and their feedback was included in the delivered dataset. The feedback from reviewers that was not returned early enough, will be incorporated gradually in the main dataset.

The current response from the ESP network has been the result of only a few months towards the end of the project. With appropriate follow up actions we are positive that we will be able to establish a robust data reviewing system with experts from around the globe specialised in the different biomes. Relevant actions may include further content creation and calls for collaboration as well as improved guide versions and explanatory material. The role that the ESP network has to play in this is catalytic. As part of our efforts towards this purpose, we are in the process of establishing a Task Force and created a 'landing page' (https://www.es-partnership.org/esvd-draft2/) with information regarding the ESVD and ways to collaborate. Following up on these actions and improving the Data Review process of the ESVD has a high priority in the future directions of the project because the benefits of are manifold:

- ✓ Puts in place a global network of specialist scientists and practitioners that will be actively involved and be part of the ESVD.
- ✓ Improves data quality and strengthens data credibility.
- ✓ Ensures a scientifically robust and transparent data platform.
- ✓ Helps towards mainstreaming our analytical framework in the ES valuation field.
- ✓ Increases popularity and reach of the initiative to the respective professional networks of reviewers from around the world. That could potentially bring more collaborators and organisations that focus on similar topics.

Appendix 10: Guide for reviewing the updated Ecosystem Services Valuation Database

Below is the text that was sent to people who agreed to review value records from the ESVD

Thank you for agreeing to participate in the data reviewing process of the Ecosystem Services Valuation Database! This document will help you and guide you through the procedure. For the reviewing process, three basic items are essential:

1. The Guide for data reviewing (= this document) which contains an explanation of the dataset and detailed instructions for data reviewing (please read carefully before starting review).
2. An Excel file (dataset) that contains the value observations (+metadata) that you will be reviewing based on the biome preference(s) you have indicated. The file also contains complementary information in separate sheets that will help you navigate through the data. You will receive this file together with the invitation-email
3. Access to the online repository of valuation studies from which the data has been coded. An invitation to the online repository will be sent in a separate email message.

(1) The dataset (Excel file)

This section of the Guide explains the structure of the Excel file you have received. The Excel file contains 10 worksheets; the first (ESVD2020) contains the data to be reviewed and the remaining nine contain supporting information for coding/understanding the data. Each worksheet is explained in more detail here:

1. **ESVD2020:** Includes the value observations and related metadata to be reviewed. Each row records one value observation (note that multiple value observations/rows may be derived from the same valuation study). Each column records information on a specific variable/data field. Note: values are kept in their original ' form' (currency, spatial unit etc.)
2. **Variables:** Explanation of all the data fields in ESVD2020.
3. **Biomes and ecosystems:** The biome and ecosystem classification and codes used in the database. The classification is based on a mix of existing classifications, primarily TEEB (2010), MA (2005), Costanza et al (1997) which in turn was based on classifications from US Geol. Survey, IUCN, WWF, UNEP and FAO + UK-NEA). ➔ Related data field(s): *Biome, Biome code, Ecosystem, Ecosystem code*.
4. **TEEB Services:** The ecosystem service classification and codes used in the database. Adapted from the TEEB (2010) classification. ➔ Related data field(s): *TEEB Ecosystem Service, TEEB ES Subservice*
5. **CICES V5.1:** The CICES ecosystem service classification (version 5.1; biotic services only).[3] Source: Haines-Young, R. and M.B. Potschin (2018): Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. ➔ Related data field(s): *CICES V5.1 Code.*
6. **Protection Status:** 3-level numeric classification used to describe the level of protection of the assessed site (0 = no protection; 1 = partially protected; 2 = protected) ➔Related data field(s): *Protection status.*

[3] The database includes both the TEEB and CICES classifications to give users flexibility regarding the classification system they want to use.

7. **Valuation methods:** List of economic valuation methods and 2-letter acronyms (source: Brander, L.M., van Beukering P., Balzan, M., Broekx, S., Liekens, I., Marta-Pedroso, C., Szkop, Z., Vause, J., Maes, J., Santos-Martin F. and Potschin-Young M. (2018). Report on economic mapping and assessment methods for ecosystem services. Deliverable D3.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007). ➔ Related data field(s) *Valuation method*.

8. **Country ISO:** A list of the ISO Alpha-3 Country Codes for UN states and territories and Alpha-2 Continent Codes (source: https://www.iso.org/publication/PUB500001.html; https://www.un.org/Depts/Cartographic/english/geoinfo/geoname.pdf). ➔Related data field(s): *Continent ISO Code, Country, Country ISO Code.*

9. **Currency ISO:** A list of the ISO 4217 Currency Codes (source: https://www.iso.org/iso-4217-currency-codes.html) ➔Related data field(s): *Currency ISO Code.*

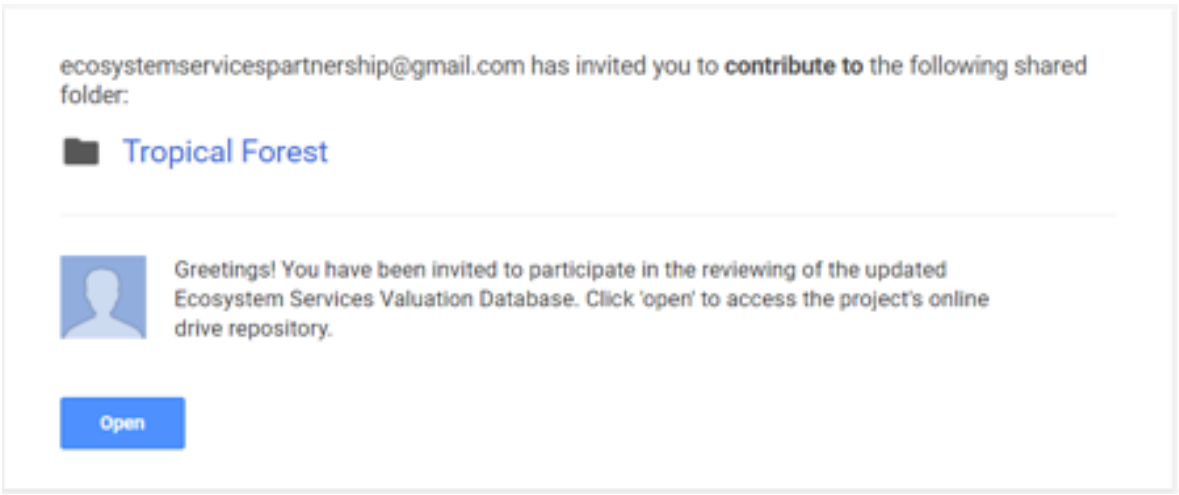
10. **Condition:** 3-level numeric classification used to describe the condition of the assessed site (0 = highly degraded; 1 = intermediate; 2 = well functioning) . ➔Related data field(s): *Site condition code.*

(2) Instructions for data reviewing

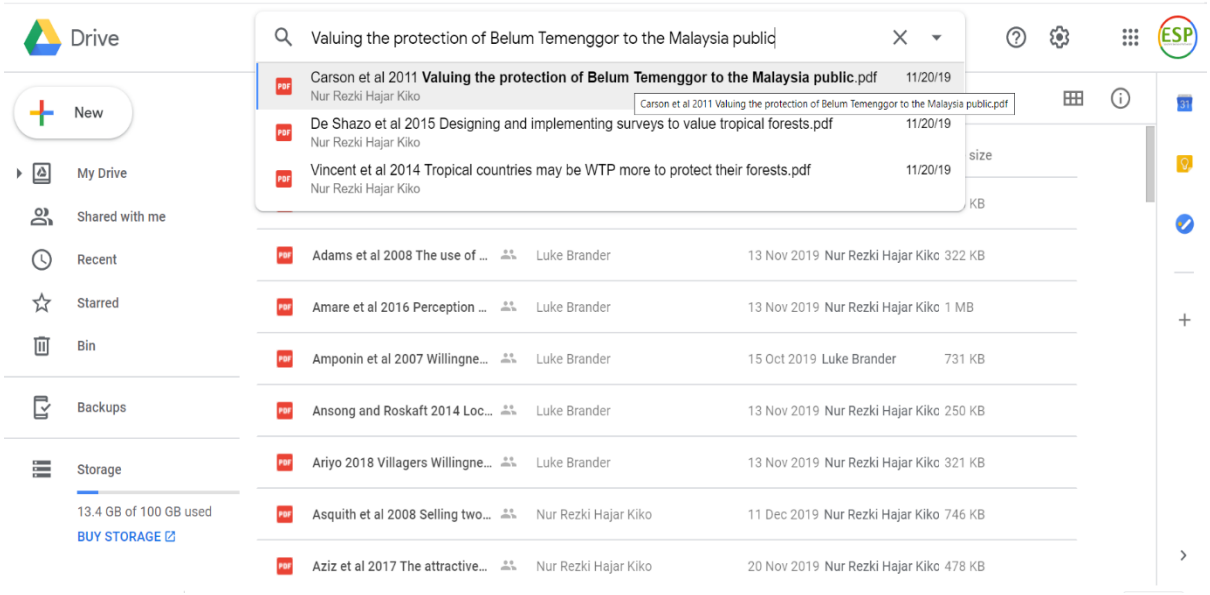
This section of the Guide provides detailed instructions on how to perform the data review. As with any database of study results, the ESVD potentially contains errors due to simple typos/entry mistakes and due to misinterpretation of the underlying study. It is the Reviewers' job to identify and correct such mistakes. The review process involves the following steps:

1. Open the dataset (Excel file) and select the ESVD2020 worksheet containing the data to be reviewed. We suggest starting with the first observation (row) and working systematically through.

2. Open the repository folder containing the valuation studies from which the data is derived. You will have received an invitation to the project's repository that will grant you access to the studies underlying the data. An example invitation to the tropical forest valuation studies folder looks like this:



3. Open the relevant valuation study. Once you have opened the folder, you can search and find the appropriate paper. Bibliographic information in the dataset can be used to search for the paper in the repository.



4. Read the study and check the information recorded in the ESVD2020. The key variables to check are:
    a. The monetary value (Data field *Value*). This is the monetary value as reported in the study in the original currency, spatial unit, temporal unit etc.). Note that value observations will be standardised later to a common set of units (e.g. int.$/ha/y) but that the data entered here should be **as reported in the study**.
    b. The spatial unit in which the value observation is reported (i.e. is it a value per hectare, km2, acre, total ecosystem area, meter, kilometre, mile, total ecosystem length?). Data field *Spatial Unit*
    c. The temporal unit for which the value observation is reported (i.e. is it a value per visit, day, month, year, or present value over multiple years?). Data field *Temporal Unit*
    d. The beneficiary unit in which the value observation is reported (i.e. is it a value per visitor, person, household, or total number of beneficiaries?). Data field *Beneficiary Unit*
    e. The biome(s) that is the subject of the value observation. Note that multiple biomes is possible. See "Biomes and Ecosystems" worksheet for classifications *and codes. Data fields Biome and Biome code*
    f. *The TEEB* ecosystem service(s) that are the subject of the value observation. See "TEEB Services" worksheet. Data field *TEEB Ecosystem Service*
    g. The TEEB ecosystem sub-service(s) that are the subject of the value observation. See "TEEB Services" worksheet. Data field *TEEB ES Subservice*

    In addition to these key variables, Reviewers are welcome to check and correct all other data fields.

5. Please note the field(s) that you have modified by highlighting the individual cell(s) with yellow colour.

Authors	Year Publicatio n	Title	Ecosyste m (text descriptio n from study)	Biome	Biome code	Ecosyste m	Ecosyste m code	Ecosyste m Service (text descriptio n from study)	TEEB Ecosyste m Service	TEEB ES Subservic e	CICES V5.1 Code	Continent ISO Code	Country	Country ISO Code	Scale of study site	Location Name	Protected Status	Site Area	Site Area Spatial Unit	Site Length	Site Length Spatial Unit	Site Condition (text descriptio n from study)
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Rattan sho	1	14	1.1.5.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Bamboo sh	1	14	1.1.5.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Fish	1	11	1.1.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Jungle fowl	1	12	1.1.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Resin	3	36	1.1.5.2	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Lizard	1	12	1.1.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Frog	1	12	1.1.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Snake	1	12	1.1.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Malva nut	1	14	1.1.5.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Fire wood	3	33	1.1.5.3	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Carbon seq	8	81	2.2.6.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Water stor	10	101	2.2.1.3	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Soil erosior	12	121	2.2.1.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr
Kibria et al	2017	The value c	The forest	Tropical for	6	Tropical rai	6,1	Soil fertility	13	134	2.2.4.1	AS	Cambodia	KHM	Local	Veun Sai-Si	2	55639	ha			Due to chr

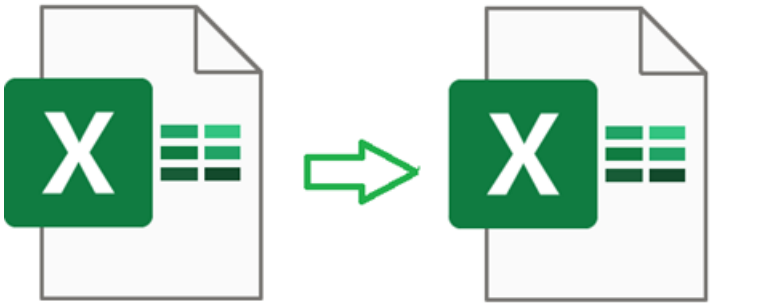
6. Use the field 'Reviewed' towards the end of the ESVD2020 worksheet to indicate whether the record has been reviewed by indicating YES or NO.

Value	Currency ISO Code	Spatial Unit	Temporal Unit	Present Value Years	Present Value Discount Rate	Beneficiar y Unit	Number of beneficiar ies	Type of beneficiar y	Notes	Secondary data sources	Coded by	Coded date	Flag for review	Reference	ValueID 2010	Reviewed
4579	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
30810	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
53325	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
284	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
5688	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
5925	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
2465	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
4148	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
14220	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
45504	USD	total	year			household	35	resident	Data regarding income		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
7870000	USD	total	year			total		global popu	The average net carbo		Stefanos Sc	12/11/2019	YES (check	Kibria, A. S., Behie, A.,		NO
32310000	USD	total	year			total		resident	One commonly adopte		Stefanos Sc	12/11/2019	YES (Replac	Kibria, A. S., Behie, A.,		NO
22210000	USD	total	year			total		resident	One method of estima		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		NO
1000000	USD	total	year			total		resident	The forest also helps t		Stefanos Sc	12/11/2019	YES (TEEB s	Kibria, A. S., Behie, A.,		NO
1050000	USD	total	year			total		resident	The forest also helps t		Stefanos Sc	12/11/2019	YES (TEEB s	Kibria, A. S., Behie, A.,		NO
7420000	USD	total	year			total		resident	The forest also helps t		Stefanos Sc	12/11/2019	YES (TEEB s	Kibria, A. S., Behie, A.,		NO
480000	USD	total	year			total		resident	For this formula data r		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		NO
30000	USD	total	year			total		resident	For this formula data r		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		NO
30000	USD	total	year			total		resident	For this formula data r		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		NO
55670000	USD	total	year			total		resident	For this formula data r		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES
20000	USD	total	year			total		resident	We have fist calculate		Stefanos Sc	12/11/2019		Kibria, A. S., Behie, A.,		YES

7. Please briefly explain why you have changed certain fields using the 'Modification' columns in the last fields of the ESVD2020 worksheet. Do so by first indicating for which field the modification corresponds to, followed by the justification. Doing that will help us understand your rationale for modifying data and ensure that the reviewing process is transparent. Ideally, your reasoning would be traceable in the study (you can use original text from papers to help us find the specific information on which you have modified a data field). If you have corrected more than 4 fields, you can add more 'Modification' columns.

Coded date	Flag for review	Reference	ValueID 2010	Reviewed	Modification 1	Modification 2	Modification 3	Modification 4
12/11/2019		Kibria, A. S., Behie, A.,		YES	**Site area** is incorrect: '*Belum-Temengor, a 300,000-hectare forested region in northern Perak* '	**Number of beneficiaries** is incorrect: '*The sample frame included 2,100 households in 210 enumeration blocks* '		

8. You are all done! You can now send us back the file that contains the reviewed dataset. Please rename the original file name by adding the extension '-reviewed' and your initials at the end.



Thank you for your contribution!

Appendix 11: ESVD User manual

This document is a manual aiming to guide the user of the updated ESVD on how to navigate through the data fields, search and retrieve data. The manual focuses exclusively on the technical use of the current database and does not reflect on any methodological considerations regarding the values and/or interpretation issues. For further information on such aspects, the user should refer to the database **report**.

The current repository is a relational database: a type of database that stores and provides access to data points that are related to one another. All rows in a relational database are records and are identified with a unique (to each) key.

The records are described with various fields that are related to the different aspects of a value estimate (e.g. bibliographic, geographic, ecological etc) – for the full description of the database fields the user should refer to the database **protocol**.

The database utilisation is primarily based on data filtering. This refers to the process of filtering large amounts of data to smaller datasets according to a pre-defined set of filter criteria. Pre-definition of the criteria usually reflects the user's focus/interest in specific areas of information. To filter, click on the 'heading' of each data field and subsequently select all the options that suit your criteria.

For example, let us assume that the user is interested in values related to a particular biome, e.g. Coral reefs. To retrieve this information, the user simply needs to filter the dataset according to Biome, by selecting values only on Coral reefs:

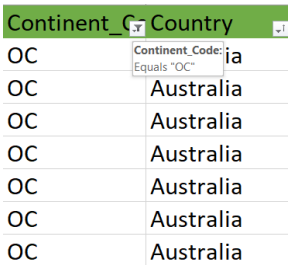
Biome	Biome_Code
Coral reefs	2
Coral reefs	2
Coral reefs	2
Coral reefs	2
Coral reefs	2
Coral reefs	2
Coral reefs	2

After doing that, the system will provide the user with all the data that match this criterion; in this case that would be all records on Coral reefs.

Let us take our hypothetical query on coral reefs a step further and assume that the user is only interested in a specific service and not all values on that biome e.g. in Recreation. Then, the user needs to add an additional filter (on top of the biome filter) that will clear out all values except the ones related to recreation (19 is the ES code for Recreation – for the full lists of biome/service classifications the user should refer to the database **protocol**):

TEEB_ES	TEEB_SubES
19	192
19	191, 192
19	194
19	194
19	191, 192
19	191, 192
19	192

Now, let us assume that the user not only wants values from a specific biome and service but also from a specific region, e.g. is only interested in related values originating from Oceania. The user can then simply apply another filter to the related field (continent code) to match the desired criteria:



Naturally, the more filters are applied, the fewer results will appear due to stricter criteria setting. Users can always use combinations of such criteria, e.g. someone might need results on: *Coral Reefs & Coastal systems (biomes)* ***x*** *Recreation & Coastal protection (services)* ***x*** *Oceania & Asia (continents*). In that case, users would simply have to set the data filters in accordance with their specific interest (e.g. add more selections to the filters). The database will always generate all values that match the pre-defined criteria.

Of course, filters can be applied to any other field that might be important to the user such as valuation method, valuation year, study scale and others.