Guidance document for the ESVD Value Transfer Tool

This purpose of this guidance document is to elaborate and explain the Ecosystem Services Valuation Database (ESVD) Value Transfer Tool (VTT), found on esvd.net. The document will first give a general introduction to value transfer functions after which it will elaborate on the VTT and how to use it. Furthermore, the document will touch upon the use and misuse of the VTT and it will end with some examples of best practices to spark your interest and possible use of the tool.

1. Introduction to value transfer functions

Any type of value transfer involves estimating the value of ecosystem services through the use of value data and information from bio-physical and socio-economic parameters from other similar ecosystems and populations of beneficiaries. It involves transferring the results of existing primary valuation studies for other ecosystems ("study sites") to ecosystems that are of current policy interest ("policy sites"). Value transfer is also known as benefit transfer but since the values that are transferred may be costs as well as benefits, the term value transfer is more generally applicable.

Value transfer can be beneficial to use over primary valuation studies because primary valuation studies are often time-consuming, more expensive, require local expertise and are often conducted on a local scale. Value transfer functions, when executed correctly, can be cheaper, less time-consuming and can be executed on different scales, while still accounting for local variation via the inclusion of various biophysical and socio-economic context variables.

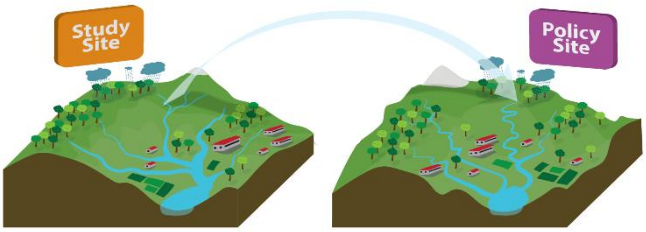

Figure 1: A value transfer function is used to create better and more accurate estimations of monetary values of ecosystem services of a policy site, using monetary valuation data from a study site.

In short, value transfer methodologies use existing value information from a 'study site' to estimate the value of a new 'policy site' (see figure 1).

There are several value transfer methodologies, such as unit transfer, adjusted unit transfer, value function transfer and, used in the VTT, meta-analytic value transfer. Meta-analytic value transfers (see figure 2) use multiple valuation studies (in this case via the ESVD) to estimate a function that relates the monetary value to

- Beneficiaries (e.g. income, population)
- Study sites (e.g. extent, condition, scarcity)
- Valuation methods (e.g. CV, CE, HP, ….)

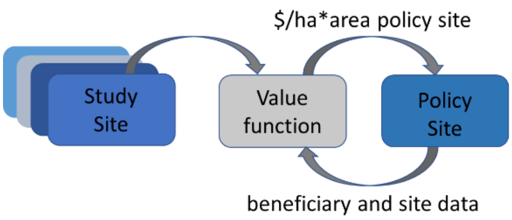

Figure 2: Visualization of a meta-analytic value transfer function.

Context characteristics of the policy site are plugged into the value function to estimate a site specific value using both the ESVD and other relevant context variables.

A regression analysis then provides a monetary value for an ecosystem service for a policy site.

2. The ESVD Value Transfer Tool

The ESVD VTT can be used to estimate ecosystem service values that reflect policy site characteristics as entered by the user. Currently this tool is available for a limited set of ecosystems related to tropical forests and agricultural ecosystems and will be expanded to include other ecosystems in the near future.

2.1 Why the Value Transfer Tool

The ESVD currently contains over 10,000 value records covering all ecosystem services and biomes. This collection of information, although large, is however not readily usable for conducting simple value transfers to inform policy making or to do research for two reasons:

1. The data is not globally representative of ecosystem service values but instead represents the availability of study results in the literature, which is determined by past research funding and interests. It is therefore difficult to use simple summaries of global data from the ESVD as representative of "average" ecosystem service values in specific contexts.
2. Ecosystem service values are inherently highly spatially variable and influenced by site and context characteristics that determine the supply and demand for ecosystem services. Direct application of summary values from the ESVD in value transfers are therefore likely to result substantial transfer errors (over or under estimation of values).

To tackle this and to allow for better and more specific (local) estimations, we developed the VTT. Value transfer functions and the VTT specifically have an enormous potential to effectively and precisely estimate ecosystem services values in combination with other data sources, but they should be used with caution.

2.2 What the Value Transfer Tool tells us

The monetary values of ecosystem services reflect the importance of nature in a language that we all understand, the language of money. In that light, it is very important to keep in mind that the estimated value provides an indication of the order of magnitude of the ecosystem service value at the study site controlling for a set of relevant explanatory factors. It does not necessarily reflect all relevant determinants of ecosystem service value at the study site and the estimated value may differ from the results of site-specific primary valuation studies. Estimated values should only be used in relevant contexts and validated using a broader set of decision-making tools.

The output of the VTT is in international dollar value using 2020 price levels, similar to the ESVD standardized data. The output can be used to show the current value of a policy site, but it could also highlight the changes in value in scenario analyses.

To give an example of the output of the VTT, see the figure 3 below. A randomly chosen hypothetic scenario gives a value of $811,70 per hectare for all regulating ecosystem services for a tropical and subtropical lowland rainforest policy site. This value means that, given the current dynamics at the 'policy site' represented by the context variables, the combination of all regulating services reflects the value of approximately $800 per hectare. This value should be seen as an order of magnitude, reflecting the importance of ecosystems to humans. If one hectare is lost, $800 of value is lost and vice versa, therefore indicating the importance of this tropical forest in terms of ecosystem services. These $800 reflect a societal value to different types of stakeholders, depending to the context of your policy site. It is therefore also very important and recommended to use other sources and tools in addition to the VTT.

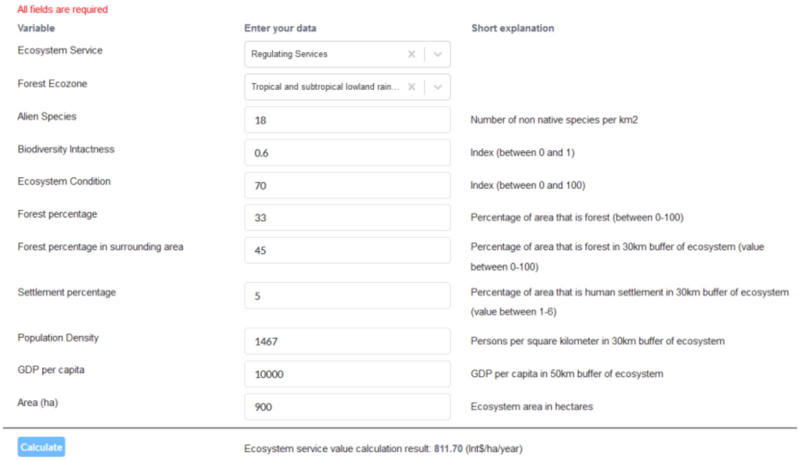

Figure 3: Example of the output of the VTT.

2.3 Who the Value Transfer Tool is for

Theoretically, anybody interested in obtaining and using monetary valuation data of ecosystem services could be using the ESVD VTT. It is used to express the value of ecosystems in monetary terms thereby offering context to the value of various ecosystems. Therefore, this tool could be especially interesting for those working on:

- Public policy makers - In the development of public policy in relation to restoration and conservation, in scenario analyses of impacts of land cover change and in the development of Payment for Ecosystem Services (PES) schemes. It can be used to highlight the benefits of conservation and restoration.

- Private policy makers – New regulations, such as the CSRD in the EU, will require organizations and financial institutions to measure and disclose their impacts on nature. Additionally, companies and financial institutions are becoming aware of the risks of nature loss for their business as many are dependent on nature in some ways (for more information, see this influential DNB report). In both cases, the VTT could be used to practically assess impacts and dependencies on nature via impact and risk assessments.

- Research & academia – The VTT lends itself very well for testing and application in models related to ecosystem services and natural capital. An example of using the ESVD for value transfer functions can be found in the Natural Capital section of the ABC-Map developed by the FAO (see also section 4 below).

All outcomes of the VTT should be used with caution (see section 3 below for more information).

2.4 Step by step guidance of the ESVD VTT

1. Select the biome of interest from the drop-down list.
2. Select the ecosystem service category for which you want to estimate a value.
3. Enter data for each of the variables describing your study site. The units in which each variable is measured are provided under “Short explanation”. The range of feasible values for

each explanatory variable is limited to the range observed for the study sites of the selected biome contained in the ESVD. Further information on the definitions and data sources for the explanatory variables included in the value functions can be found here.
4. In the case that data for an explanatory variable is unavailable for your study site, it is possible to use a default value (select the checkbox on the right). The default value is the mean value for the variable across the study sites of the selected biome contained in the ESVD.
5. All fields are required to estimate an ecosystem service value.
6. Click on the "Calculate" button to estimate a value, which displays in the "Result" box below. Values are reported in International dollars/ha/year at 2020 price levels.

2.5 Context variables used in the value functions

Various context variables were used in the development of the ESVD VTT, for more information on their units and background, see here.

Forest value transfer (9 context variables):

1. Alien species (Number of non native species per km2)
2. Biodiversity intactness (Index (between 0 and 1)
3. Ecosystem condition Index (between 0 and 100)
4. Forest percentage (Percentage of area that is forest)
5. Forest percentage in surrounding area (Percentage of area that is forest in 30km buffer of ecosystem)
6. Settlement percentage (in 30km buffer of ecosystem)
7. Population Density (Persons per square kilometer in 30km buffer of ecosystem)
8. GDP per capita (GDP per capita in 50km buffer of ecosystem)
9. Area (Ecosystem area in hectares)

Agricultural value transfer (13 context variables):

1. Fragmentation (in Km2)
2. Human appropriation of net primary productivity (Millions of kg of carbon per square meter
3. Population density (Persons per square kilometer in 30km buffer of ecosystem
4. Ecosystem area in hectares
5. Ecosystem condition (Index between 0 and 100)
6. Biodiversity Intactness (Index between 0 and 1)
7. Human modification index (Index between 0 and 1)
8. Net Primary Productivity (in kg*C/m^2)
9. Alien Species (Number of non native species per km2)
10. Night time light (nano Watt/cm2/sr)
11. Population mean age (years)
12. GDP per capita
13. GDP per capita in 50km buffer of ecosystem
14. Percentage of protected Area

Some specific observations related to the ESVD VTT:

- Tropical forest value transfer: Value transfers only for overarching categories of ecosystem services, namely for provisioning, regulating and cultural ecosystem services, can be created.

- Agricultural value transfer: Value transfers for all ecosystem services (TEEB classification) can be created
- The variables in the VTT are not confounding, meaning that the various independent variables do not influence each other and therefore influence the outcome.
- Generally, extreme input for the various variables could provide very high or very low outcomes in terms of monetary values.
- Output: the larger the size of the forest (both in terms of area in hectares and forest percentage variables), the lower the monetary value and vice versa. This results from the fact that larger areas have lower per marginal unit value because of their abundancy. Vice versa, because of scarcity, smaller forests usually provide large monetary values.
- Limited Scope: While VTTs can provide useful estimates of the economic value of ecosystem services, they may not capture the full range of ecosystem benefits or externalities, leading to an incomplete understanding of the overall value of ecosystems.
- The VTT relies on and is bounded by the data from valuation studies in the ESVD. This means that minimum and maximum values used as input in the VTT variables cannot exceed the minimum and maximum values from valuation studies in the ESVD. Therefore, this may not accurately represent the unique characteristics of ecosystems in the study site of interest.

3. Responsible use of the Value Transfer Tool

The VTT is a specialized tool and requires specific knowledge of using value transfer functions, both in terms of data as well as in terms of explaining outcomes and variation in the outcomes. For collaboration and commercial use regarding the use of value transfers for decision making and research, please get in touch via esvd@fsd.nl.

In no event will the Foundation for Sustainable Development, their affiliates, agents or collaborators be liable for any damages; including without limitation, direct or indirect, special or incidental, moral or consequential, arising in connection with your use of the ESVD VTT.

4. Example application for the FAO-ABC map

For the purposes of illustrating the potential of using meta-analytic value transfer for estimating spatially variable ES values, we conduct a global value transfer exercise to estimate the economic values of regulating services provided by wetlands in agricultural areas. The first step in this exercise is the selection of wetland "policy sites" to which values are transferred. A GIS was used to select wetland sites that are located in cultivated/agricultural areas using a spatial selection of all centroids of the wetlands in the Global Lakes and Wetlands Database (Lehner and Döll, 2004) that are within a distance of 5 km of a cultivated/agricultural area of at least 5 km^2 in size. Cultivated/agricultural areas are defined by the land cover classes 13, 16, 17 and 18 from the Global Land Cover 2000 database (EC-JRC, 2004). This results in a selection of approximately 36% of all wetland sites in the database. The number and area of selected wetland sites by world region[1] are given in the second and third columns of Table 3. The selection of wetlands is considered conservative and represents a lower bound estimation of the number and area of wetlands in agricultural landscapes. Given the coarse resolution of the global wetlands data, small wetland patches (<1km^2) within agricultural landscapes are not included in the analysis. GIS is subsequently used to quantify the spatial variables that are

[1] We use the 24 World regions defined for the IMAGE-GLOBIO model (Netherlands Environmental Protection Agency, 2010).

included in the value function for each selected wetland "policy site". These variables are wetland size, abundance of other wetlands, population, and gross cell product per capita; the latter three variables are measured for a 50km radius of the centroid of each wetland site.

The second step in the value transfer exercise is to estimate site specific unit values (Int$ per hectare/year) for each wetland "policy site" by substituting site specific variables into the meta-analytic value function given in Table 1.[2] Unit values are subsequently multiplied by the area of each wetland site to provide an estimate of the total annual value of regulating services provided by each wetland. Summary statistics for wetland values (mean unit values and total values) are presented in columns 4 and 5 of Table 1. In order to represent the uncertainty associated with these estimated values, we compute the lower and upper 95% prediction interval values following the method proposed by Osbourne (2000) – columns 6 and 7 in Table 1. The prediction intervals are large and emphasise the need to treat transferred values with caution.

Table 1. Estimated values for wetland regulating services in agricultural landscapes

Region	Number of wetland sites	Area (ha; millions)	Mean unit value (Int/ha/yr)[1]	Total value (Int/yr; millions)	Lower 95% CI (Int/yr; millions)	Upper 95% CI (Int/yr; millions)
Canada	3,560	8	223	261	231	375
USA	1,528	59	1,490	1,809	1,334	6,125
Mexico	259	0	2,599	197	156	263
Cent. America & Carib.	463	1	2,505	381	300	486
Brazil	1,402	59	810	1,370	436	6,629
Rest of South America	1,733	20	1,283	1,059	602	2,100
North Africa	1,524	3	1,126	905	806	1,012
West Africa	8,719	32	911	4,533	3,989	5,105
East Africa	2,430	8	983	1,812	1,563	2,063
Southern Africa	1,585	13	1,029	1,512	1,037	2,081
Western Europe	696	2	2,353	661	550	869
Central Europe	40	1	1,743	114	8	477
Turkey	28	0	5,289	105	30	325
Ukraine Region	84	2	2,089	261	61	1,003

[2] The variable for wetland type is set to represent natural wetlands. The variables indicating the provision of each regulating service are set to represent the average level of provision observed in the "study site" wetlands underlying the meta-analysis. We treat the three regulating services as non-overlapping and non-mutually exclusive so that it is reasonable to sum their values within an individual wetland ecosystem.

STANs	3,292	6	752	789	721	893
Russia & Caucasus	13,197	37	297	1,641	1,426	1,901
Middle East	5,501	8	914	2,001	1,839	2,164
South Asia	1,529	2	5,956	2,252	2,071	2,451
Korea Region	32	0.32	4,205	231	53	822
China Region	2,742	7	1,502	2,061	1,714	2,457
South East Asia	506	8	2,856	1,338	662	2,528
Indonesia	530	17	676	896	388	2,215
Japan	48	0.10	5,817	193	123	284
Oceania	1,124	1	512	134	124	146
Antarctica	42	0.04	24	1	0	1
World	52,594	294	978	26,514	20,223	44,773

[1] Mean wetland values per hectare are computed for each region across wetland sites without weighting by wetland area.

Considering the mean unit values for each region, it is apparent that there is considerable spatial variation in the value of regulating services from wetlands. Mean unit values are estimated to be low in countries that have sparsely populated agricultural areas and have relatively abundant stocks of wetlands (e.g. Canada and Russia), and are high in countries that are densely populated and have relatively few wetlands (e.g. Japan). These results again highlight the potential inaccuracy of using fixed unit values to assess ecosystems located in very different bio-physical and socio-economic contexts. The global mean unit value would be a very poor predictor of regional mean unit values, which in turn is likely to be a poor predictor of values for individual wetlands within that region.

Discussion

The proposed approach for using meta-analytic value functions to estimate ecosystem service values accounting for spatial variation in site and context characteristics is shown to be feasible and justified. Given the substantial spatial variation in the value of ecosystem services, there is good reason to invest in developing the necessary data and methods to enable meta-analytic value transfers that can account for local scale determinants of supply and demand.

The approach is illustrated in this document and can be developed and tested in further applications. There are several avenues for developing the approach:

1. Estimate value functions for other biomes/ecosystems for which there is sufficient data in the ESVD (e.g. forests, agricultural systems, coastal ecosystems);

2. Estimate value functions for a broader set of ecosystem services, either individually or in combination to represent bundles of services.