

Results of an Econometric Model of the TEEB Database

Introduction

TEEB (The Economics of Ecosystems and Biodiversity) is an international organisation created in 2007 at the initiative of the G8+5¹ to investigate the benefits of biodiversity and the costs of ecosystem loss or degradation. Starting in 2010, it developed the Ecosystem Services Valuation Database that now comprises over 4,000 ecosystem service values (data points) estimated at different scales (municipality, province, country, region or world). The TEEB database was updated in December 2020; its values are now drawn from approximately 690 case studies published between 1973 and 2020. The database distinguishes 23 ecosystem services for over 16 ecosystem types. To provide for greater comparability, TEEB analyses each study and standardises the original monetary values of the case studies by multiplying or dividing into US dollars per hectare per year. This standardisation process, however, introduces a bias, as the value of services provided by an ecosystem is not necessarily proportional to its surface area. After reprocessing, and eliminating observations for which data was missing, the meta-analysis reported here was conducted on the basis of 2,944 values from 365 case studies.

A cross-sectional regression of the value (US dollars per hectare per year) of ecosystems (Y , in logarithm) is run on ecosystem type (biome) (B , 10 categories) and type of service (SE , 16 categories), controlling for other variables that may explain differences between observations, namely the methodological approach (M , 3 categories) and the continent of the case study (C , 6 categories).

$$\text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \beta_2 SE_{ie} + \beta_3 M_{ie} + \beta_4 C_{ie} + \varepsilon_{ie}$$

where i represents an observation and e a case study.

Estimating the coefficients of the four models

The following table presents the estimations of the parameters of the regression in four different configurations:

- Model 1 with one explanatory variable: Biome.
- Model 2 with 2 variables: Biome, Type of service.
- Model 3 with 3 variables: Biome, Type of service, Methodological approach.
- Model 4 with 4 variables: Biome, Type of service, Methodological approach, Geography.

¹ The G8+5 group was composed of the heads of government of the G8 countries (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States), plus the five major emerging countries (Brazil, China, India, Mexico and South Africa).

Variable	Log (Value of ecosystem service)			
	(1)	(2)	(3)	(4)
Biome: Temperate forests	2.22*** (0.76)	3.01*** (0.94)	3.03*** (0.94)	3.29*** (0.83)
Biome: High mountains	0.84 (0.76)	1.77** (0.86)	1.83** (0.84)	2.05*** (0.78)
Biome: Coastal	1.97*** (0.74)	2.51*** (0.82)	2.72*** (0.76)	2.24*** (0.62)
Biome: Open sea/ocean	1.64** (0.80)	1.98** (0.87)	2.14*** (0.83)	1.72** (0.69)
Biome: Rivers and lakes	2.29*** (0.81)	2.59*** (0.86)	2.85*** (0.79)	2.34*** (0.68)
Biome: Urban areas	3.88*** (1.32)	4.66*** (1.29)	4.63*** (1.33)	4.92*** (1.23)
Biome: Tropical forests	-0.99 (1.03)	0.34 (0.75)	0.34 (0.73)	-0.28 (0.60)
Biome: Grassland and woodland	-0.51 (0.83)	0.32 (0.84)	0.42 (0.87)	0.20 (0.85)
Biome: Wetlands	0.48 (0.74)	1.19 (0.84)	1.37 (0.82)	1.27 (0.69)
SE: Food		1.08*** (0.42)	1.17*** (0.37)	1.23*** (0.34)
SE: Water		2.23*** (0.43)	2.14*** (0.45)	1.95*** (0.48)
Provisioning SE: Information for cognitive development		0.12 (0.68)	0.05 (0.74)	0.27 (0.73)
SE: Medicinal resources		-0.99 (1.30)	-0.71 (1.24)	-0.80 (1.25)
SE: Genetic resources		0.61 (1.05)	0.58 (1.05)	1.09 (0.93)
SE: Pollination		3.01*** (1.13)	3.29*** (1.03)	3.77*** (0.95)
SE: Moderation of extreme events		1.49** (0.62)	1.06 (0.69)	1.18** (0.60)
SE: Erosion prevention		2.55*** (0.64)	2.18*** (0.71)	1.99*** (0.66)
Regulating SE: Biological control		2.15 (1.56)	2.15 (1.47)	2.12 (1.50)
SE: Waste treatment		1.75** (0.77)	1.27 (0.81)	1.35 (0.69)
SE: Air quality regulation		0.75 (0.95)	0.22 (0.96)	0.46 (0.83)
SE: Climate regulation		0.69 (0.54)	0.42 (0.56)	0.53 (0.48)
SE: Regulation of water flows		0.77 (0.76)	0.70 (0.80)	0.88 (0.68)
SE: Opportunities for recreation and tourism		1.28*** (0.49)	1.37*** (0.51)	1.65*** (0.43)
SE: Spiritual experience		-1.99** (1.01)	-1.92** (0.96)	-2.34** (1.09)
Cultural SE: Aesthetic information		0.51 (0.72)	0.65 (0.71)	0.56 (0.64)
SE: Existence and bequest values		0.810 (0.764)	0.93 (0.82)	0.80 (0.77)
SE: Inspiration for culture, art and design		0.571 (0.639)	0.66 (0.60)	1.01 (0.52)
SE: Ornamental resources		-2.09 (1.09)	-1.92 (1.07)	-1.65 (1.05)
SE: Maintenance of genetic diversity		2.51*** (0.796)	2.50*** (0.79)	2.60*** (0.84)
Habitat SE: Maintenance of life cycles		1.10 (0.82)	1.12 (0.80)	0.96 (0.82)
SE: Maintenance of soil fertility		0.16 (0.77)	-0.28 (0.81)	-0.13 (0.68)
M: Cost-based approach			0.80 (0.49)	0.85** (0.41)
M: Preference-based approach			0.01 (0.43)	0.36 (0.41)
Continent: Asia				1.29*** (0.38)
Continent: Africa				0.16 (0.63)
Continent: North America				0.91 (0.57)
Continent: Oceania				0.38 (0.45)
Continent: South America				1.50 (0.87)
Observations	2,381	2,381	2,381	2,381
Adjusted R ²	0.14	0.19	0.19	0.21
Residual Std. Error	2.73 (df = 2370)	2.66 (df = 2347)	2.65 (df = 2345)	2.62 (df = 2340)
F Statistic	3.84*** (df = 10; 2370)	64.17*** (df = 33; 2347)	63.15*** (df = 35; 2345)	68.98*** (df = 40; 2340)

Standard errors are clustered by the reference study.

*p<0.1; **p<0.05; ***p<0.01

$$(1) \text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \varepsilon_{ie}$$

$$(2) \text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \beta_2 SE_{ie} + \varepsilon_{ie}$$

$$(3) \text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \beta_2 SE_{ie} + \beta_3 M_{ie} + \varepsilon_{ie}$$

$$(4) \text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \beta_2 SE_{ie} + \beta_3 M_{ie} + \beta_4 C_{ie} + \varepsilon_{ie}$$

Reference modalities for categories:

- Biomes (B): Cultivated areas
- Ecosystem services (SE): Raw materials
- Method (M): Production-based approach
- Continent: Europe

Estimating the coefficients for the modalities of the categorical variables “Biome” and “Type of ecosystem service”

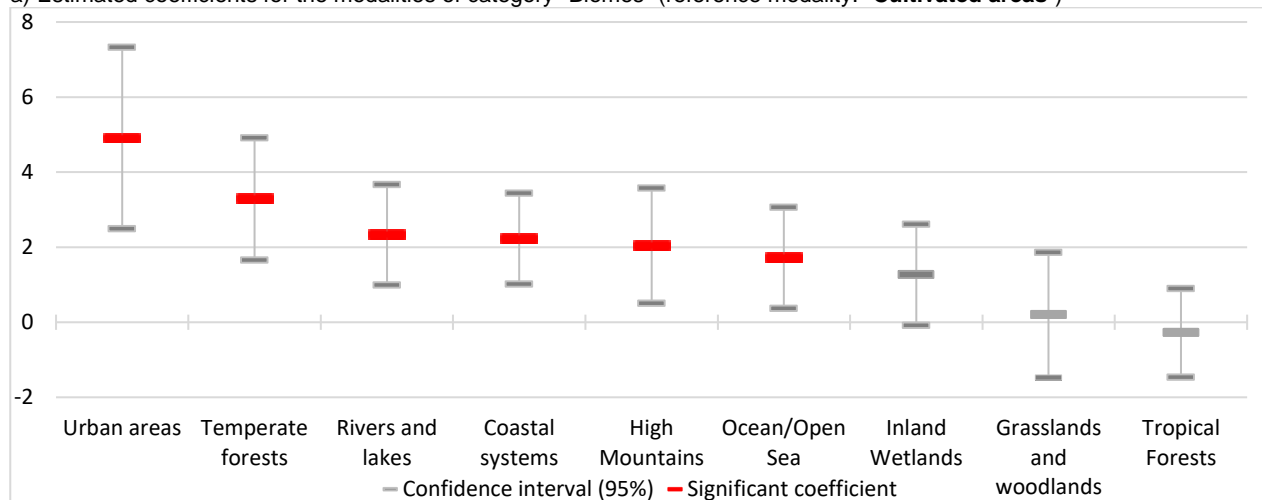
The following charts represent, on the vertical axis, the **estimators of the beta coefficients** (β) associated with the various modalities (horizontal axis) of the four categorical variables, B (biomes), SE (ecosystem services), M (method), and C (continent) of the following model: (4) $\text{Log}(Y_{ie}) = \beta_0 + \beta_1 B_{ie} + \beta_2 SE_{ie} + \beta_3 M_{ie} + \beta_4 C_{ie} + \varepsilon_{ie}$ where i represents an observation and e a study.

For each modality, the beta coefficient (β) represents, *ceteris paribus*, the difference in the value of the ecosystem service relative to a **reference modality for each categorical variable**. The reference modalities are: biomes (B) - *cultivated areas*; ecosystem services (SE) - *raw materials*; method (M) - *production-based approach*; and continent (C) - *Europe*.

As the dependent variable (value of the ecosystem service) is expressed in log form, the beta coefficients (β) represented below should be interpreted as a **difference of ($\beta * 100$)% between the mean value of the ecosystem service of the modality examined, and the value of the reference modality**. All things being equal (that is, assuming ecosystem services, methods and continents are the same), the value of the services provided by “temperate forests”, for instance, is on average three times greater (329%) than the value of services provided by “cultivated areas”.

The confidence interval, represented by the upper and lower boundaries (in grey), provides information on the **reliability of the beta estimate**. They can be interpreted by saying that the coefficient associated with each modality falls in the interval between the two boundaries at the 95% confidence level. To take one example, the coefficient for “temperate forests” falls in the interval between 1.7 and 4.9 at the 95% confidence level. When the boundaries of a confidence interval are not strictly negative or positive (graphically, when the vertical segment representing the confidence interval intersects the zero horizontal axis), the coefficient cannot be considered significant (as in the case of “grasslands and woodlands²” below).

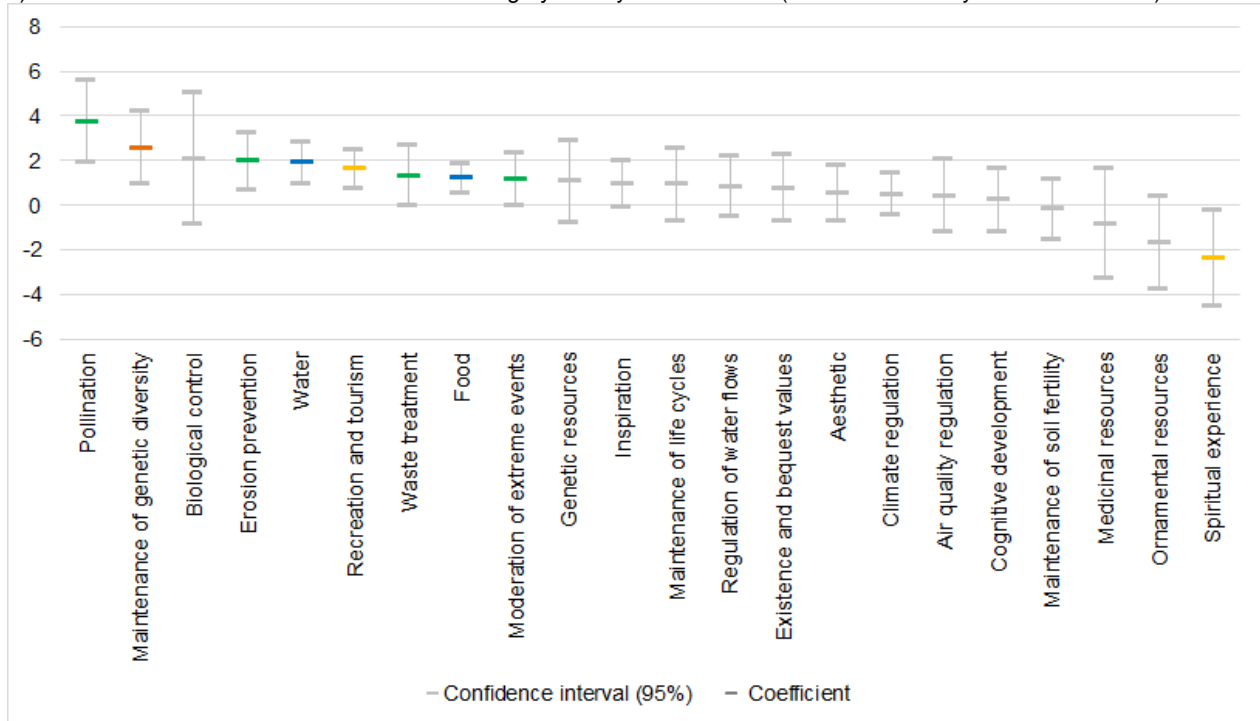
a) Estimated coefficients for the modalities of category “Biomes” (reference modality: “Cultivated areas”)³



² Woodland & Shrubland and Grass-/Rangeland.

³ Coefficients estimated for Model 4; their value is found in the last column of the table.

b) Estimated coefficients for the modalities of category “Ecosystem services” (reference modality: “Raw materials”)⁴



Significant coefficients are shown in colour.

Colour code for environmental service category: **provisioning**, **regulating**, **cultural**, **habitat**.

⁴ Coefficients estimated for Model 4; their value is found in the last column of the table.