Topics in Sustainable Finance:
CBA and Valuation of Externalities

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Social Cost Benefit Analysis

- **Social Cost Benefit Analysis** (SCBA) s a systematic process used to evaluate the financial, social, and environmental costs and benefits of a project, policy, or investment.

- ***Costs:***

  Direct: Expenses directly related to the project (e.g., labor, materials, equipment).
  Indirect: Secondary expenses (e.g., administrative overhead, support services).
  Intangible Costs: Non-monetary costs like environmental degradation or societal disruption.

- **Benefits:**

  Direct: Tangible gains (e.g., increased revenue, cost savings).
  Indirect: Secondary advantages (e.g., improved health outcomes, reduced risk).
  Intangible Benefits: Difficult-to-quantify gains like enhanced quality of life or ecosystem preservation.

- **Discount Rate:** Used to account for the time value of money, converting future costs and benefits into present value terms. Different between Tangible (market) and Intangible (non-market) Benefits and Costs.

- ***Time Horizon***: T years, Horizon of investment - The period over which costs and benefits are assessed.

Social Cost Benefit Analysis

- **NPV Project = NPV of expected Total Benefit - NPV of expected Total Costs**

$$NPV_0 = NPV_m + NPV_{nm}$$

- **Market** Benefits and Costs (NPV_m):

$$NPV_m = \sum_{t=1}^{T-1} \frac{Profits_t - Cost_t}{(1 + r_m)^t} - Initial\ Cost_0$$

Initial Cost usually refer to the **CAPEX** (Capital Expenditures) of the project/interventions.
Cost usually refers to the **OPEX** (Operating Expenses) of the project/intervention.
Market discount rate – Usually a short-term interest rate for the market, e.g. 1 month Treasury Bill, 1m interbank overnight rate.

Social Cost Benefit Analysis

- **Non-Market** Benefits and Costs (NPV_{nm}):

$$NPV_{nm} = \sum_{t=0}^{T} \frac{MPB_t - MPCos_t}{(1 + r_s)^t}$$

MPB, MPC Marginal Private benefits and Costs for nonmarket goods/ services.

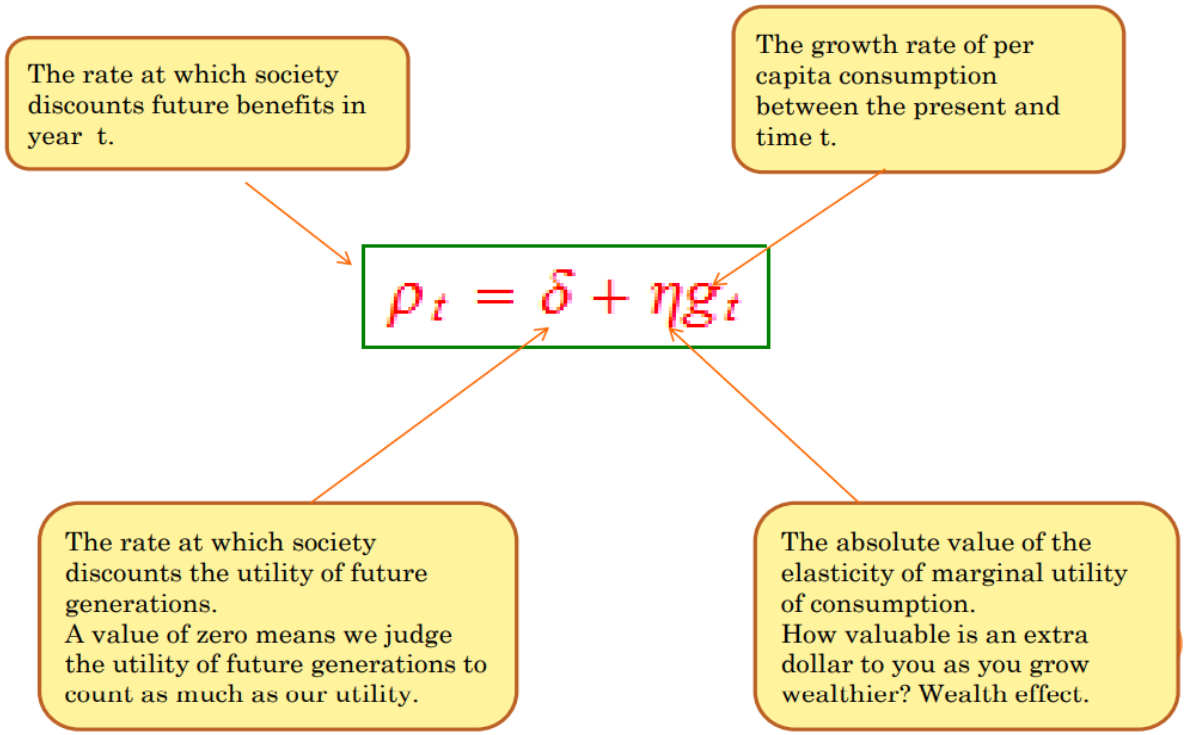
- **DDR: Time Declining Discount Rate** (Koundouri et al, 2008; Tajani et al.,2023)

1. The opportunity cost of capital or the perceived weight of future benefits and costs diminishes as the time horizon extends.

2. **Intergenerational Equity:** Constant rates heavily discount future benefits, undervaluing long-term projects like climate action or biodiversity conservation. A lower rate over time ensures future generations' welfare is better represented.

DDR: Time Declining Discount Rate

Social Rate of Time Preference (SRTP): The Ramsey Formula



- Koundouri et al (2008)

A two regime-switching (RS) model, AR(p) model:

$$r_t = n_k + e_t$$

$$e_t = \sum_{i=1}^{p} \alpha_i^k \, e_{t-i} + \xi_t$$

where:

$\xi_t \sim N(0, \sigma_\kappa^2)$ and k=1,2 for the first, second regime

Social Cost Benefit Analysis – Results -

Criterion	Formula/Concept	Acceptable Outcome
Net Present Value (NPV)	NPV	NPV>0
Benefit-Cost Ratio (BCR)	$BRC = \frac{NPV\ Benefirs}{NPV\ Cost}$	BCR>1: The project provides more benefits than costs.
Internal Rate of Return (IRR)	The discount rate at which NPV=0	IRR>r: The project's rate of return exceeds the social discount rate.
Payback Period	Time required to recover the project's initial costs through benefits.	Shorter payback periods are preferable.

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Integrated Assessment - Linking Financial Performance to Externalities

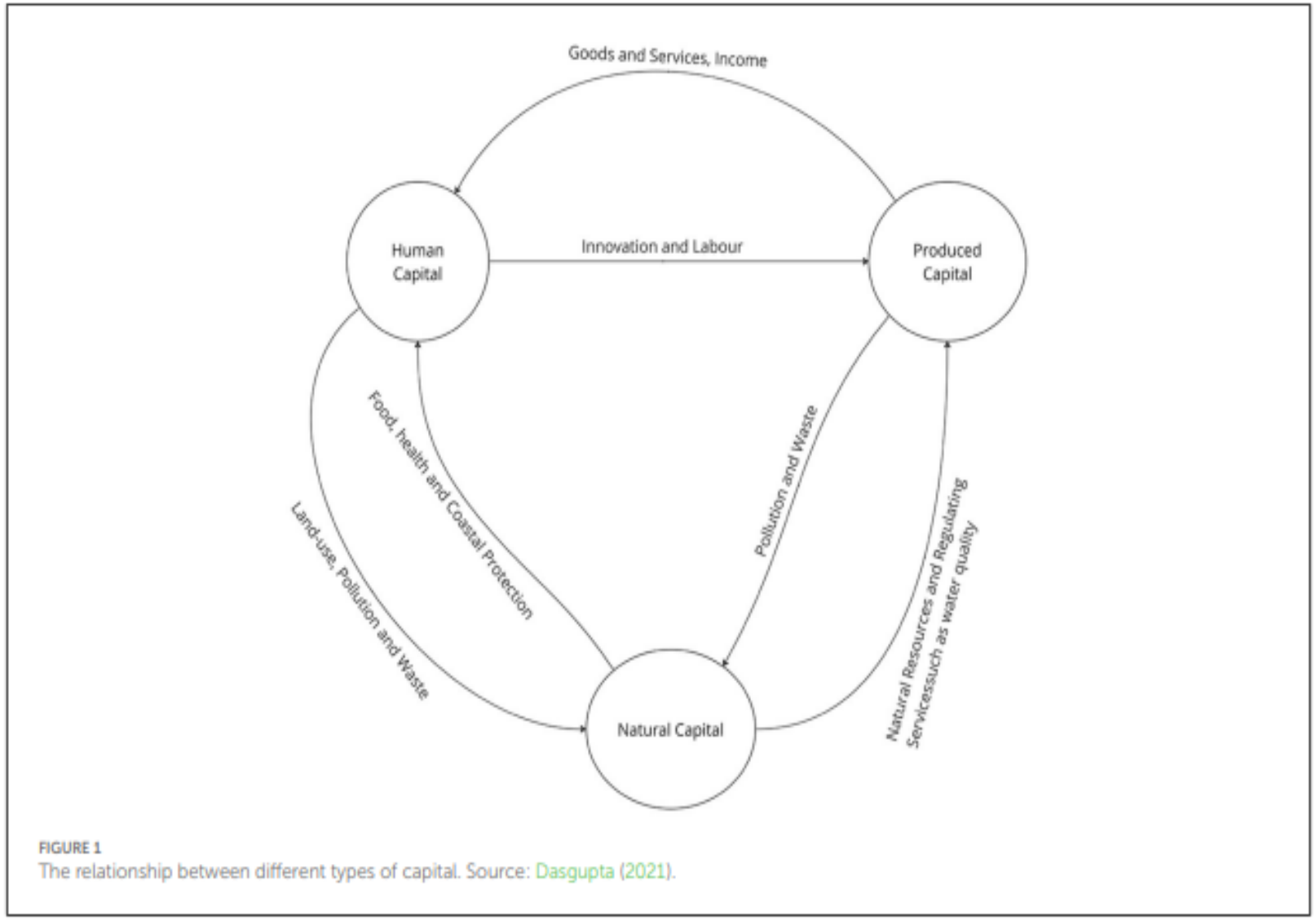

FIGURE 1
The relationship between different types of capital. Source: Dasgupta (2021).

- Natural capital can be considered as a stock in nature that provides a flow of benefits for people and the economy
- Natural, Social, and other forms of externalities are often neglected in economic analyses

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Ecosystem Services (ES)

Provisioning Services
Products Obtained from ecosystems

Food
Fresh Water
Fuelwood
Fiber
Biochemicals
Genetic Resources

Regulating Services
Benefits Obtained from regulation of ecosystem processes

Climate Regulation
Disease Regulation
Water Regulation
Water Purification
Pollination

Cultural Services
Non Material Benefits Obtained from ecosystems

Spiritual and Religious
Recreation and ecotourism
Aesthetic
Inspirational
Educational
Sense of Place
Cultural Heritage

Supporting Services
Services Necessary for the production of all other ecosystem services
Soil Formation Nutrient cycling Primary production

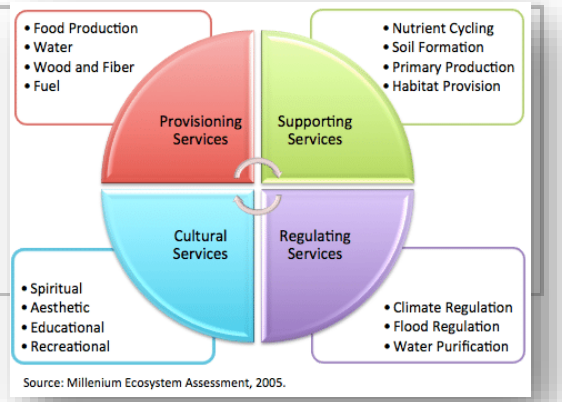
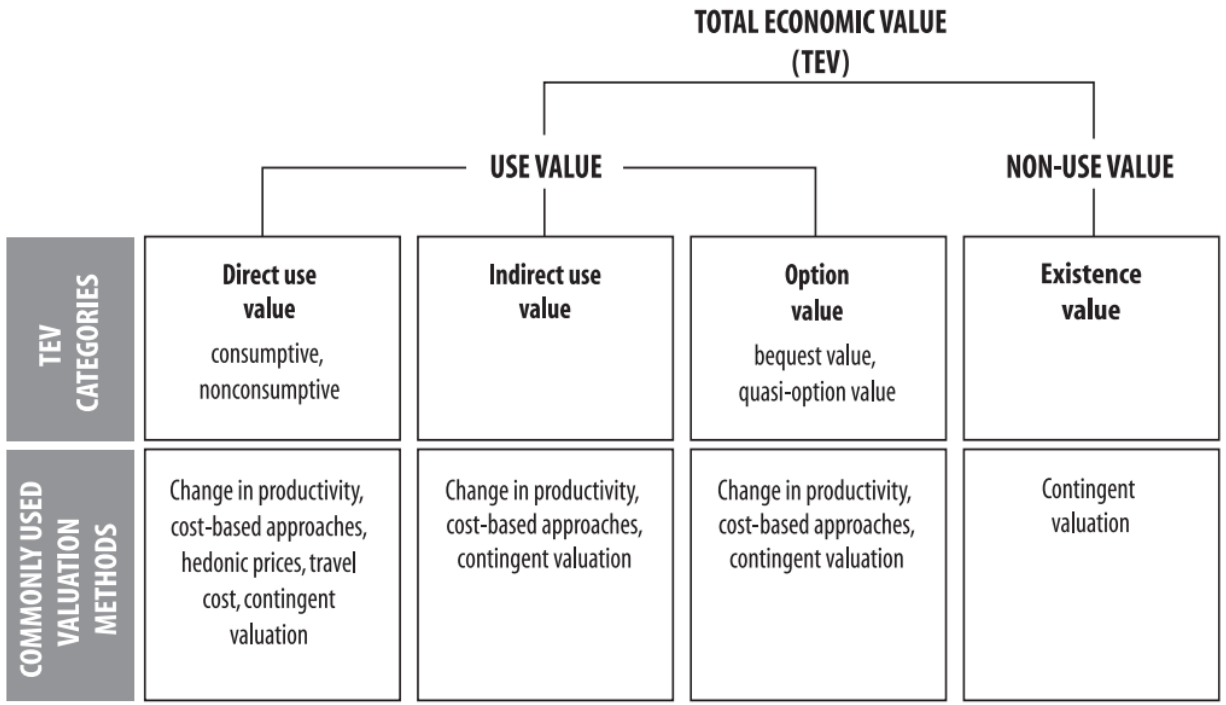


FIGURE 2
Ecosystem services. Source: Millennium Ecological Assessment.

The Total Economic Value Framework



- **Use value includes:**
  - **Direct use value:** Individuals make actual or planned use of an ecosystem service.
    - **Consumptive use** -> the use of resources extracted from the ecosystem (e.g. food, timber)
    - **Non-consumptive use** -> the use of the services without extracting any elements from the ecosystem (e.g. recreation, landscape amenity).
  - **Indirect use value:** individuals benefit from ecosystem services supported by a resource rather than directly using it.
  - **Option value:** the value that people place on having the option to use a resource in the future even if they are not current users
- **Non-use value (passive use):** Is derived from the knowledge that the natural environment is maintained.
  - **Existence value:** derived from the existence of an ecosystem resource, even though an individual has no actual or planned use of it. For example, people are willing to pay for the preservation of whales, through donations, even if they know that they may never actually see a whale.

Non-Market Valuation Methods

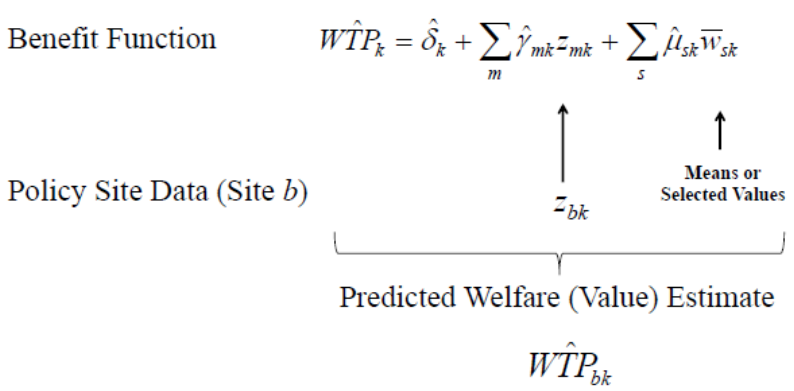
- Environmental and Social Impacts and Intangible Assets often refer to goods and services (natural and social capital) which are not traded in markets or cannot be traded in markets, e.g. no market price is observed.

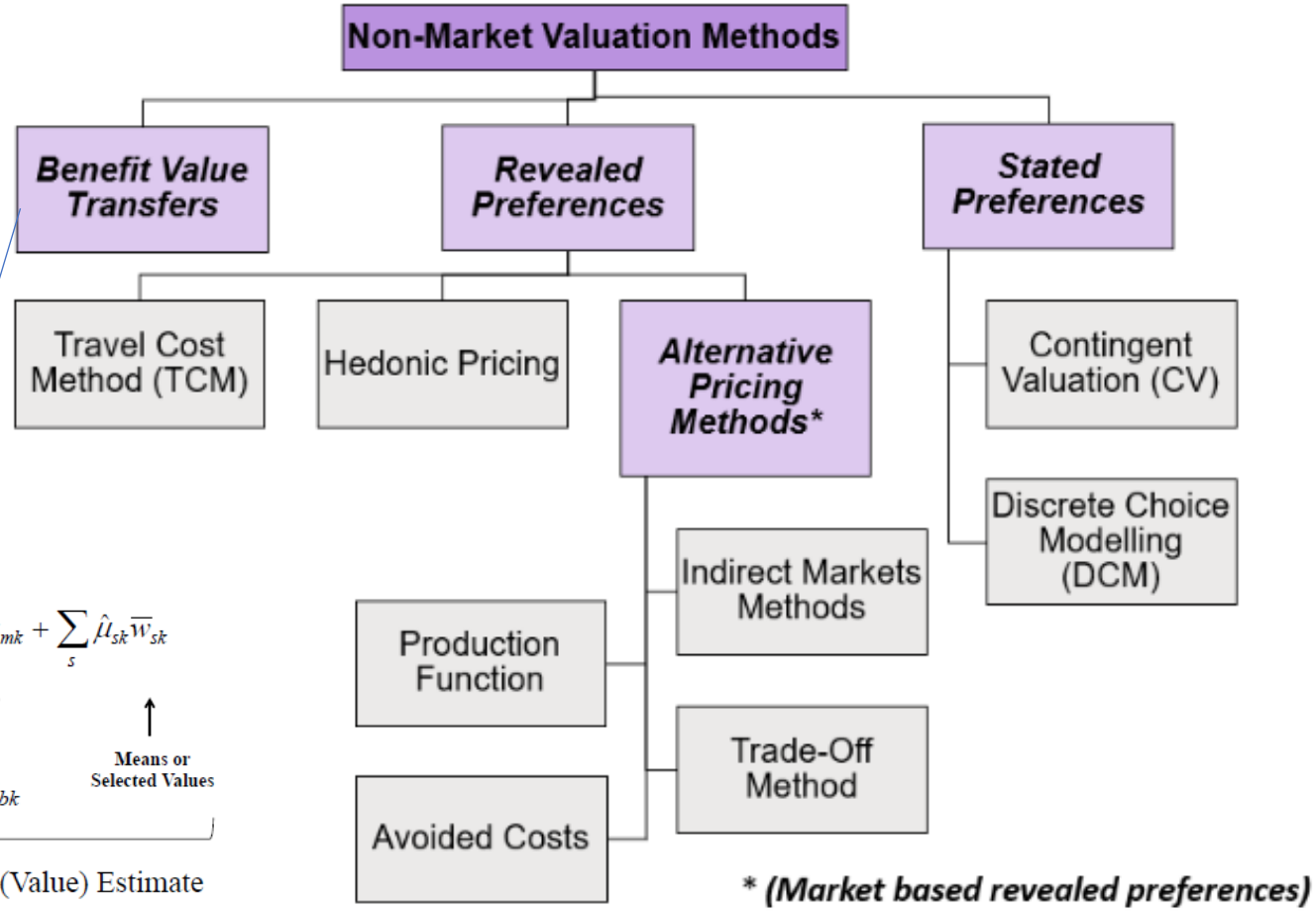
- **Non-market** Valuation Methods are used to evaluate ***intangible impacts***, such as climate abatement, pollution costs or common and public goods.

- Calculate the ***Shadow price*** (direct and indirect use value) for the underlying good or service.

- Several ***Econometric Models*** based on the type of good/service and the economic value to be estimated.

- **Shadow Prices** are also defined as the Willingness to Pay for a non-market good or service.



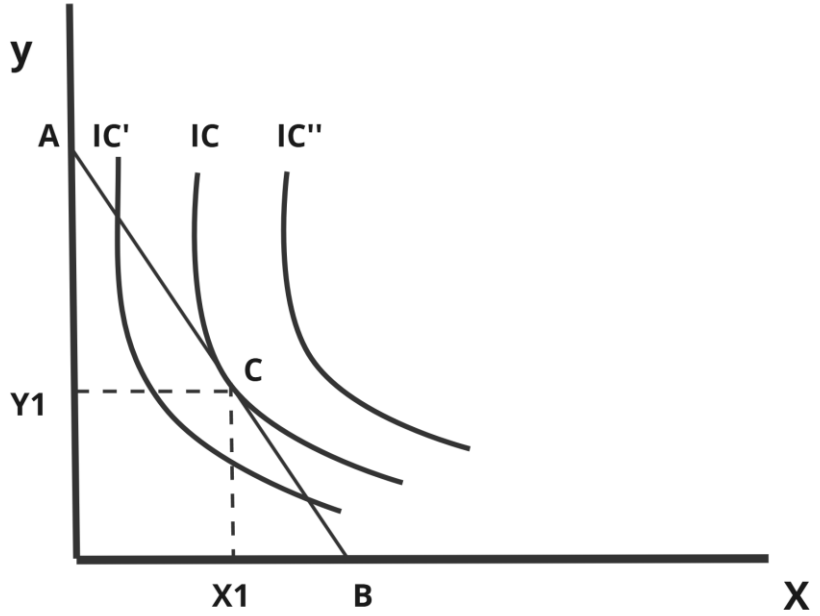


Utility Function and Indifference Curves

- A **Utility Function (U)** for individual, i ,

$$U_i(x, y)$$

assigns a utility value to a combination of goods x and y.



- **Indifference curve (IC)** shows all combinations of goods x and y that provide an equal level of utility $U_i(x, y)$

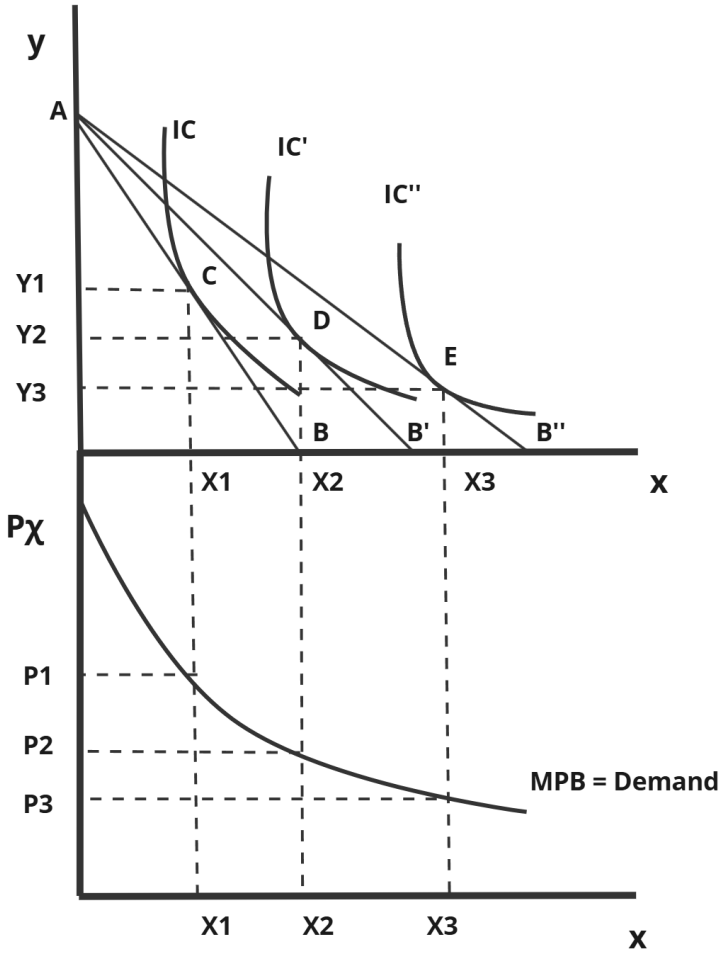
- The **marginal rate of substitution (MRS)** is the slope of the Indifference Curve:

$$MRS_{x,y} = \frac{\frac{\partial U_i(x,y)}{\partial x}}{\frac{\partial U_i(x,y)}{\partial y}}$$

- Individual, i, chooses x, y such as to $\max_{x,y} U_i(x, y)$ subject to $p_x x + p_y y = I$ **(Budget Constraint, AB)**

Point C: $(x_1, y_1) = \arg \max_{x,y} U_i(x, y)$ subject to $p_x x + p_y y = I$

Derivation of Demand Curve



- Ceteris Paribus (p_y *constant*) as p_x decreases $\boldsymbol{p_1 > p_2 > p_3}$
- Budget Constraint shifts from AB to AB' and AB''
- $\arg \max_{x,y} U_i(x,y)$ subject to $p_x x + p_y y = I$, changes from C to D and E with

$$\boldsymbol{x_1 < x_2 < x_3}$$

- The **Demand Curve (D)** reflects the inverse relationship between price and quantity demanded for good x

$$\boldsymbol{p_x = D(x) = MPB(x)}$$

- The demand curve represents the **Marginal Private Benefit (MPB)**. The vertical distance at each quantity shows the price consumers are willing to pay for that unit. Willingness to pay reflects the marginal benefit derived from each unit.

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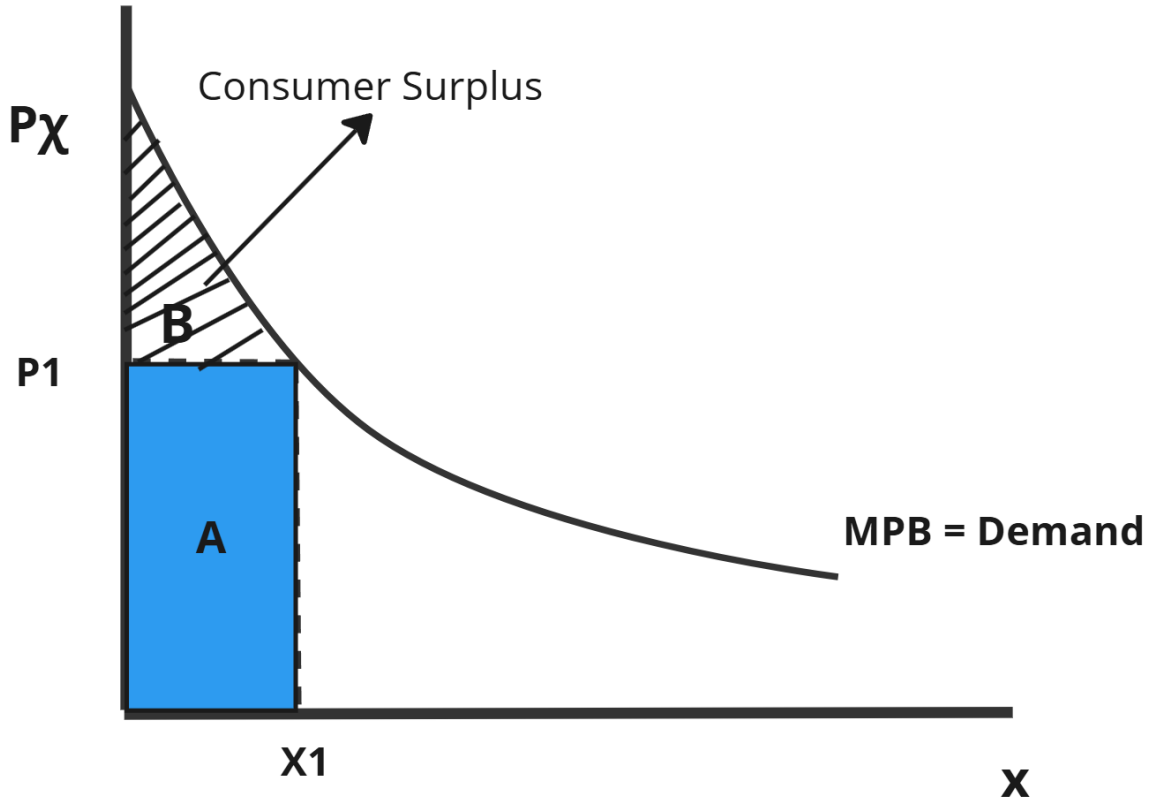
Total Private Benefit



- **Total Private Benefit (TPB)** from the consumption of $\boldsymbol{x_1}$ units of good $\boldsymbol{x}$ is equal to the area below the Demand Curve up until $\boldsymbol{x_1}$ (A+B).

$$TPB(\boldsymbol{x_1}) = \int_0^{\boldsymbol{x_1}} MPB(x)dx$$

- **Consumer Surplus (CS)**:

$$CS(\boldsymbol{x_1}) = \int_0^{\boldsymbol{x_1}} MPB(x)dx - \boldsymbol{p_1 x_1}$$

$$CS(\boldsymbol{x_1}) = \int_0^{\boldsymbol{x_1}} [MPB(x) - \boldsymbol{p_1}]dx$$

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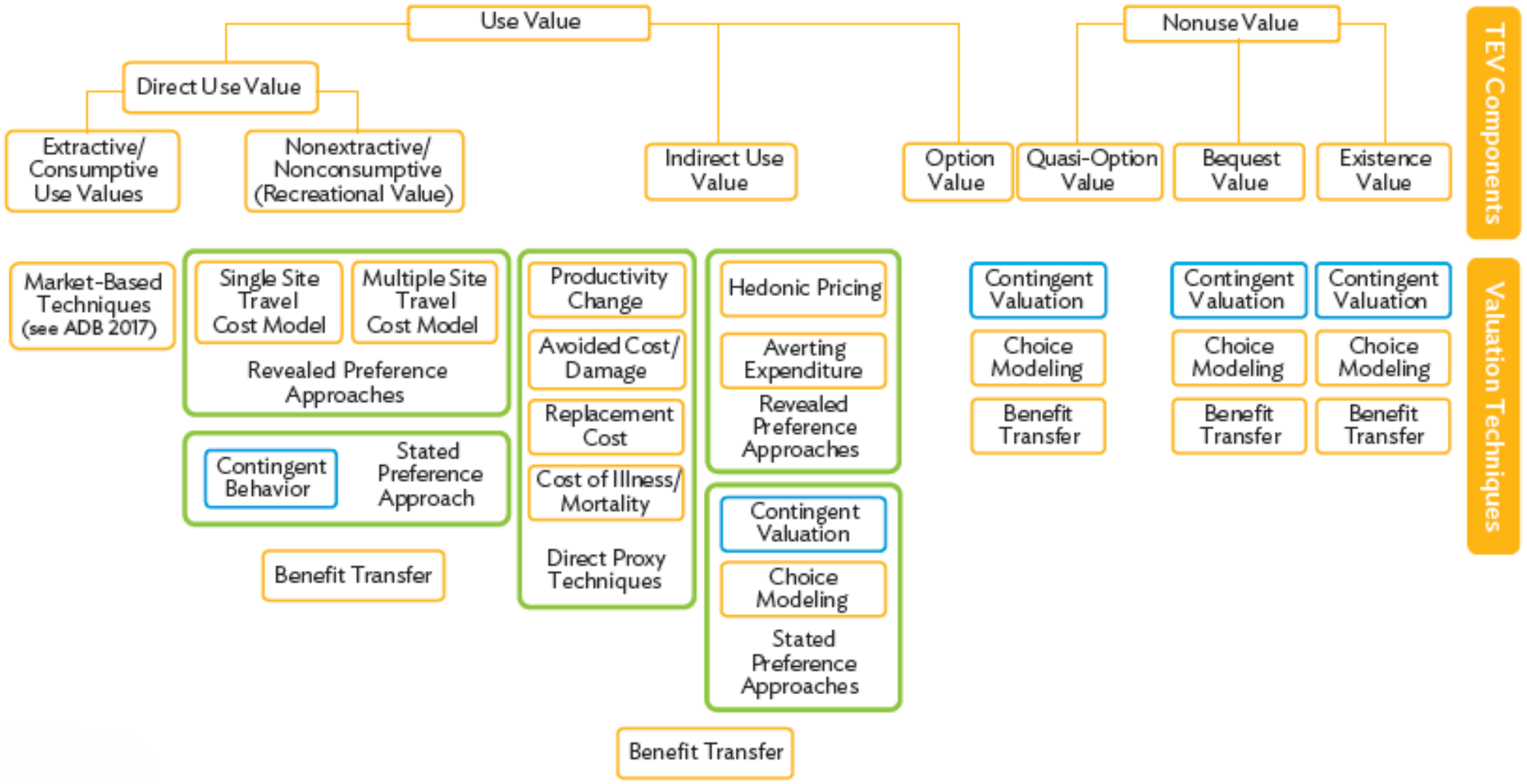
Non-Market Goods and **Economic Valuation Framework**



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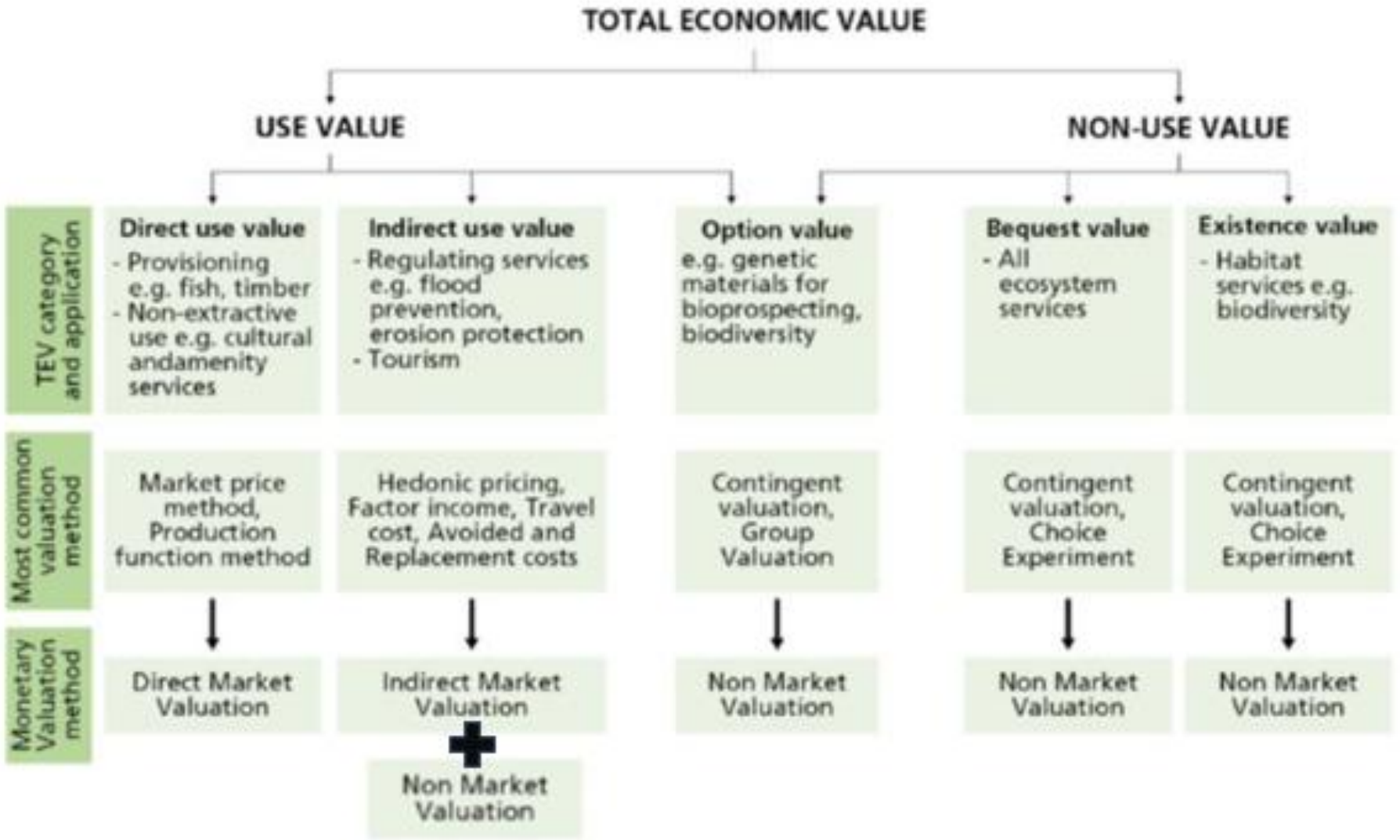
Non-Market Economic Valuation Framework



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Valuation Methods

Valuation method	Element of TEV captured	Ecosystem service(s) valued	Benefits of approach	Limitations of approach
Market prices	Direct and indirect use	Those that contribute to marketed products e.g. timber, fish, genetic information	Market data readily available and robust	Limited to those ecosystem services for which a market exists.
Cost-based approaches	Direct and indirect use	Depends on the existence of relevant markets for the ecosystem service in question. Examples include man-made defences being used as proxy for wetlands storm protection; expenditure on water filtration as proxy for value of water pollution damages.	Market data readily available and robust	Can potentially overestimate actual value
Production function approach	Indirect use	Environmental services that serve as input to market products e.g. effects of air or water quality on agricultural production and forestry output	Market data readily available and robust	Data-intensive and data on changes in services and the impact on production often missing
Hedonic pricing	Direct and indirect use	Ecosystem services that contribute to air quality, visual amenity, landscape, quiet i.e. attributes that can be appreciated by potential buyers	Based on market data, so relatively robust figures	Very data-intensive and limited mainly to services related to property
Travel cost	Direct and indirect use	All ecosystems services that contribute to recreational activities	Based on observed behaviour	Generally limited to recreational benefits. Difficulties arise when trips are made to multiple destinations.
Random utility	Direct and indirect use	All ecosystems services that contribute to recreational activities	Based on observed behaviour	Limited to use values
Contingent valuation	Use and non-use	All ecosystem services	Able to capture use and non-use values	Bias in responses, resource-intensive method, hypothetical nature of the market
Choice modelling	Use and non-use	All ecosystem services	Able to capture use and non-use values	Similar to contingent valuation above

Source: Based on eftec (2006) *Valuing our Natural Environment*

Choice Modelling – Discrete Choice Experiments

- Lancaster's (1966) **Characteristics of Value** theory

  Any good may be described by a bundle of characteristics/attributes and the levels that these may take.

- **Random Utility Model**

The Indirect Utility of the individual, i for the alternative j in the choice set, J, $U_{i,j}$ can be decomposed into:

$$U_{i,j} = V_{i,j}(X_{i,j}) + \varepsilon_{i,j}$$

$V_{i,j}(X_{i,j}) = f(X_{i,j})$ deterministic component, function of a vector of k attributes for the jth alternative: $X_{i,j}$

Usually $f(X_{i,j})$ is assumed linear, so $f(X_{i,j}) = \beta\, X_{i,j}$, where β a vector of k parameters.

$\varepsilon_{i,j}$ stochastic element, which represents unobservable influences on individual choice.

Choice experiments

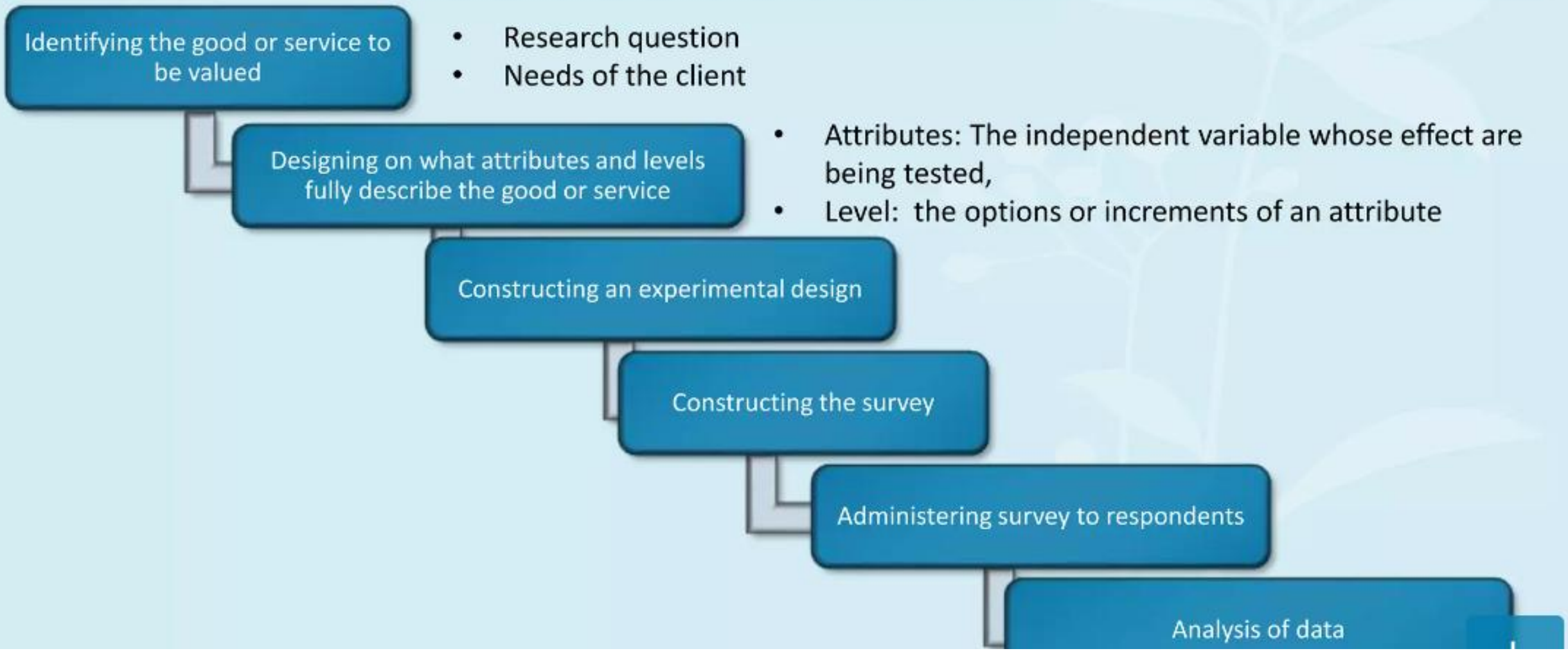
- Initially developed by **Louviere and Hensher (1982) and Louviere and Woodworth (1983)** in the marketing economics and transportation literature.
- It allows researchers to uncover **how individuals value selected attributes** of a program, product or service **by asking them to state their choice** over different **hypothetical alternatives**.
- Each alternative is described by several characteristics, known as **attributes**.
- Can be used for products and services **not traded on a market**, such as for a new product under development and not yet commercially available.
- A monetary value is included as one of the attributes, along with other attributes of importance.
- When individuals make their choice, they implicitly make **trade-offs between the levels of the attributes** in the different alternatives presented in a choice set (Alpizar et al., 2001)
- Choice experiments were inspired by the Lancasterian microeconomic approach (Lancaster, 1966), in which **individuals derive utility from the characteristics of the goods** rather than directly from the goods themselves.

- It has its theoretical foundation in **random utility theory** and relies on the assumptions of economic rationality and utility maximization.
- In stating a preference the individual is assumed to choose the alternative that yields his/her highest individual benefit, known as **utility**. The utility yielded by an alternative is assumed to depend on the utilities associated with its composing attributes and attribute levels.

$$Y_{iq} = X_i b_i + u_{iq}$$

- Y_{iq} is the utility of individual q for the i^{th} alternative and is assumed to be a function of its attributes, X_i is a vector of attributes for the i^{th} alternative accompanied by a set of weights, b_i, that establish the relative contribution of each attribute to the utility associated with the i^{th} alternative.
- Used **to determine the significance of the attributes** that describe the good or service and the extent to which individuals are **willing to trade one attribute for another**.

How to design a choice experiment?



Choice experiment: concept and approach

- CEs are **samples of choice sets or choice scenarios** drawn from the universe of all possible choice sets.
- CE comprises of the following elements-

1) A set of **fixed choice options** that have explicit names.

2) A **set of attributes** that describe potential differences in the choice options.

3) A set of **levels or values assigned to each attribute** of each choice options to represent a range of variation in that attribute appropriate to the research objectives of a particular study.

4) A **sample of subjects** evaluates all or a subset of the choice sets in the total experiment and chooses one of the possible options available to be chosen in each set.

Which of the following wetland management scenarios do you favour? Option A and option B would entail a cost to your household. No payment would be required for "Neither management scenario" option, but the conditions at the wetland would deteriorate to low levels for biodiversity, open water surface area and research and education attributes, and no locals would be re-trained.

Attributes

Levels

	Wetland management Scenario A	Wetland management Scenario B	Neither management
Biodiversity	Low	High	scenario A nor management scenario B:
Open water surface area	Low	Low	
Research and education	High	Low	I prefer NO wetland management
Re-training of locals	50	50	
One-off payment	€ 3	€ 10	
I would prefer: (Please tick as appropriate)	Choice A —	Choice B —	Neither —

Choice Modelling – Discrete Choice Experiments

- The probability that an individual prefers option $g \in J$, to any alternative option $h \in J$, can be expressed as the probability that the utility associated with option g exceeds that associated with all other options

$$\Pr\left[(U_{i,g} > U_{i,h}) \,\forall\, g \neq h\right] = \Pr\left[(V_{i,g} - V_{i,h}) > (\varepsilon_{i,h} - \varepsilon_{i,g})\right]$$

- $\varepsilon_{i,j}$ is independently and identically distributed with an extreme-value (Weibull) distribution:

$$\Pr(\varepsilon_{i,j} \leq t) = \exp(-\exp(-t))$$

- The above distribution of the error term implies that the probability of any particular alternative g being chosen as the most preferred can be expressed in terms of the logistic distribution (multinomial logit model)

$$\Pr\left[(U_{i,g} > U_{i,h}) \,\forall\, g \neq h\right] = \frac{\exp(V_{i,g})}{\sum_{j=1}^{J} \exp(V_{i,g})}$$

Choice Modelling – Discrete Choice Experiments

- Multinomial Logit Model can be estimated by maximum likelihood procedures, with the respective log-likelihood function:

$$\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} y_{i,j} \log \left[\frac{\exp(V_{i,g})}{\sum_{j=1}^{J} \exp(V_{i,g})} \right] (1)$$

Where $y_{i,j} = 1$ if individual, i, chooses option j, and zero otherwise.

- The marginal benefit (Marginal Willingness to pay) for the kth attribute:

$$MWTP_k = -\frac{b_k}{b_c}$$

Where b_k and b_c the maximum likelihood estimates of (1)

- The coefficient b_c gives the marginal utility of income and is the coefficient of the cost attribute.

Estimation of willingness to pay

- After estimating parameters, welfare measures, in the form of marginal willingness to pay (WTP), can be determined by estimating the marginal rate of substitution between the change in the wetland management attribute in question and the marginal utility of income represented by the coefficient of the payment attribute.
- Marginal WTP values, for each of the wetland management attributes estimated using the Wald procedure (Delta method) in LIMDEP 8.0 NLOGIT 3.0.

Table 8 – Marginal WTP for wetland management attributes (€ /respondent

Attributes	CL model	RPL model	RPL model interactions
Biodiversity***	15.62 (13.55–17.69)	15.44 (13.57–17.3)	15.10 (13.10–17.10)
OWSA***	9.86 (7.90–11.82)	10.79 (8.80–12.78)	11.02 (8.94–13.10)
Research and education***	8.69 (6.80–10.58)	9.27 (7.45–11.09)	10.79 (8.76–12.82)
Re-training (per person)***	0.122 (0.078–0.166)	0.129 (0.078–0.18)	0.154 (0.103–0.210)

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005. T-tests s
models (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% signifi

Source: Birol E. et al, 2006

Derive Aggregate Demand

- The **Marginal Private Benefit (MPB)** is the aggregate of all individuals' **Marginal Willingness to Pay (MWTP)** values for an incremental improvement in the attribute. It represents the Demand for attribute k.

$$\text{MPB}_k = MWTP_k N$$

- The **Marginal Private Benefit (MPB)** derived above can be used as input to Social Cost Benefit analysis in the presence of non-market goods.

- Total Private Benefits can be calculated as in the market goods case

Economic Valuation of Ecosystem Services (ES) in the Black Sea

- Black Sea is threatened by biodiversity loss, waste, and algal blooms
- **EU Policy Framework: Marine Strategy Framework Directive (MSFD)** & **Common Fisheries Policy (CFP)** aim to protect **MPAs** while promoting sustainable economic activities
- Policies support **local well-being and health** alongside marine conservation
- BRIDGE-BS aims to develop predictive tools and capabilities necessary to understand and predict the impacts of climate-driven and anthropogenic multi-stressors on the services stemming from Black Sea ecosystems
- BRIDGE-BS is structured around “three” interconnected nodes: Service Dynamics, Blue Growth Incubators and Empowered Citizens
- **Key Ecosystem Services:** Focus on **Provisioning (fisheries), Cultural (tourism), and Regulation services** based on stakeholder insights

Economic Valuation of Ecosystem Services (ES) in the Black Sea: Methods

•**Study Scope:** Conducted in **Turkey, Romania, and Georgia** with **375 respondents** using a **Choice Experiment (CE)** to assess **WTP** for environmental improvements

•**Three Hypothetical Scenarios:**

1. **Scenario A:** Full inclusion of all activities (recreational fishing, anchoring, recreation)
2. **Scenario B:** Excludes recreational fishing
3. **Scenario C:** Excludes both recreational fishing and anchoring

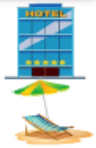
•**Environmental Attributes Assessed:** fish population status, marine litter presence, beach conditions, MPA zoning, and carbon sequestration (Zostera Seagrass).

•Five attributes are (i) the status of edible and charismatic fish being either in “good” or “under pressure” status, (ii) the existence of marine litter, (iii) the condition of the beach either being “occupied” or “natural”, (iv) the MPA zoning with four activities (e.g., anchoring, professional fishing, recreational fishing, and recreational activities), and (v) carbon sequestration at low, medium, or high levels linked to Zostera Seagrass.

Economic Valuation of Ecosystem Services (ES) in the Black Sea: Methods

- WTP & Price Levels: Four price options (10€, 20€, 40€, 80€) with the maximum WTP recorded at 37.50€ and minimum at 0€ (Status Quo choice)
- calculate the mean WTP per responder **per price (10€, 20€, 40€ and 80€ respectively)** for each Pilot Site separately and for the full sample, as well as the mean WTP per responder per scenario (Scenario A, Scenario B and Scenario C respectively) for each Pilot Site separately and for the full sample.

Table 4: Questionnaire Choice Experiment Card Attributes Elements

Icon:	Explanation:
	Under Pressure
	Good Status
	Edible Fish: fish stock suitable for human consumption
	Charismatic Fish: Marine species charismatic of the Black Sea ecosystem and biodiversity (not fished)
	Coast with Marine Litter: solid litter polluting the beach and the sea
	Coast without Marine Litter:
	Unoccupied Beach (Natural): each and its surroundings preserved from any human activities' construction, free access
	Occupied Beach: *the level of beach occupation of each pilot site leading to coastal development by including umbrella and other economic activities such as hotels, restaurants, bars, cafeterias, etc and may require paying access (Dhaher and Hagui, 2022).*

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Economic Valuation of Ecosystem Services (ES) in the Black Sea: Methods

Table 1: Descriptive Statistics

	Georgia			*Romania*			*Turkey*			*All Pilot Sites*		
	Scenario A	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*
Mean	27.39	26.69	28.39	22.85	22.93	23.00	25.74	26.59	25.81	25.11	25.17	25.50
Median	35.00	35.00	37.50	30.00	35.00	35.00	36.25	35.00	37.50	35.00	35.00	37.50
Maximum	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Std. Deviation	13.24	13.5	13.49	15.8	16.38	16.41	13.95	14.45	14.85	14.60	15.04	15.22
Skewness	-0.94	-0.83	-1.05	-0.39	-0.44	-0.43	-0.65	-0.88	-0.68	-0.64	-0.70	-0.69
Kurtosis	2.30	2.12	2.49	1.37	1.35	1.34	1.81	2.05	1.69	1.72	1.74	1.71
Jarque - Bera	19.86	17.54	21.31	20.30	21.89	21.60	14.02	18.09	16.19	51.22	55.35	56.22
Prob. (JB)	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Obs.	118	118	118	149	149	149	108	108	108	375	375	375

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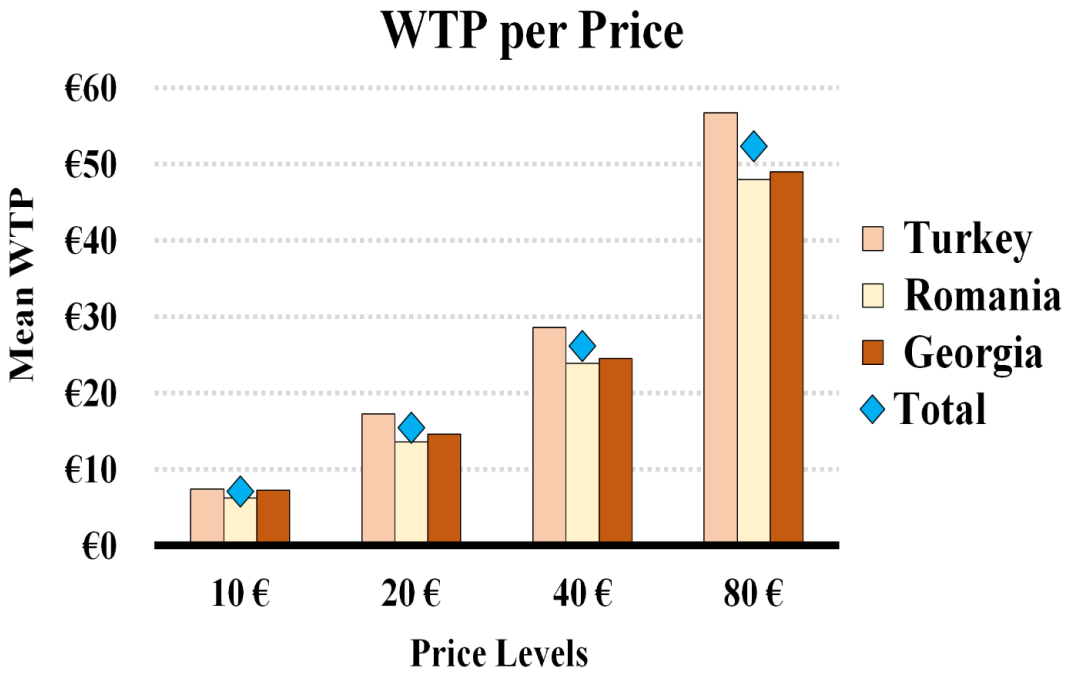
Economic Valuation of Ecosystem Services (ES) in the Black Sea: Results

- **Highest WTP 10 € Price Point:** Turkey (7.37€), Georgia (7.23€), Romania (6.26€)
- **20€ Price Point:** Mean WTP (15.43€), highest in Turkey (17.29€)
- **40€ Price Point:** Mean WTP (26.2€), highest in Turkey (28.59€)
- **80€ Price Point:** Mean WTP (52.34€), Turkey leads (56.72€)

Cross Tabulation Test:

- **Income, gender,** and **age** don't significantly affect WTP
- **Marital status, education** has significant impact in WTP in Romania, but **not i**n Turkey and Georgia
- **Employment status** is significant in WTP in Romania and Georgia, but **not** in Turkey

- **Highest** WTP for **Scenario C (25.51€)** (excludes amateur fishing & anchoring).



AE4RIA
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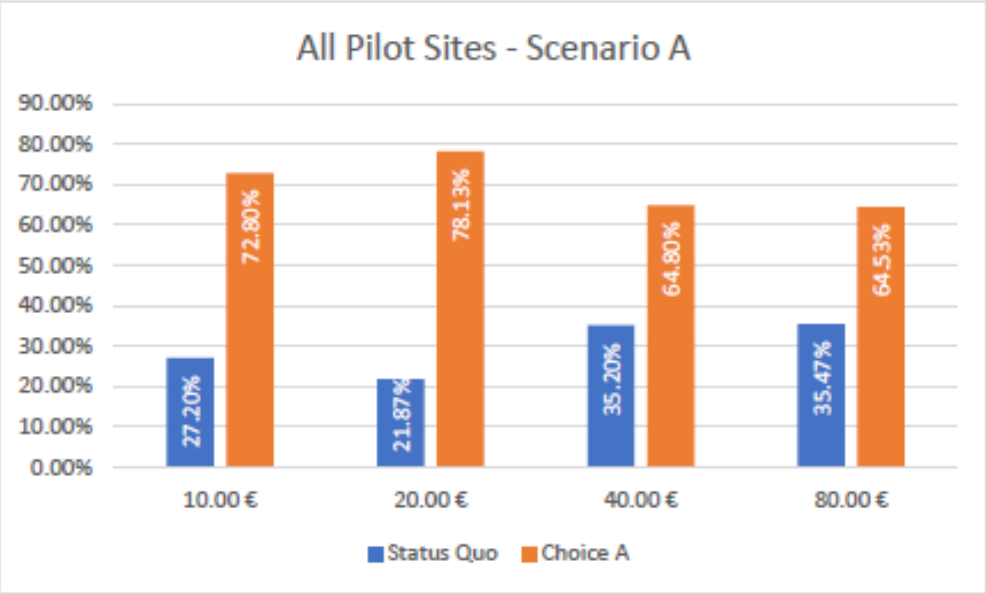
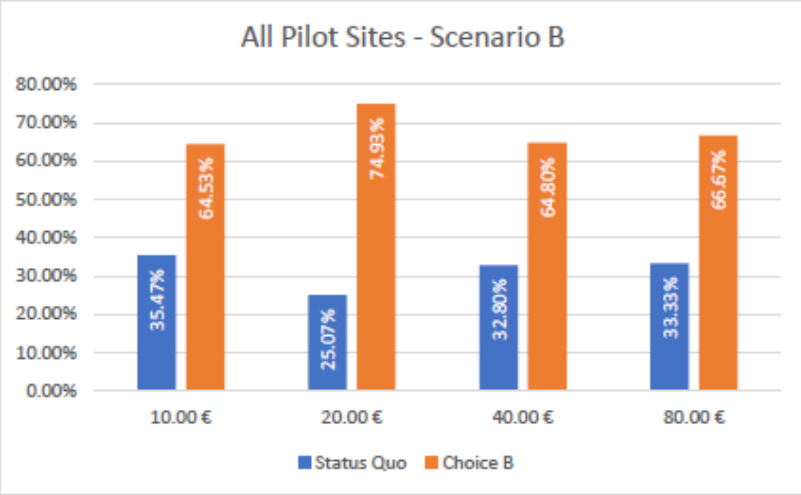
Economic Valuation of Ecosystem Services (ES) in the Black Sea: Methods





- Scenario A is characterized by the Full Inclusion of the MPA Zoning
- Scenario B is characterized by the exclusion of the Amateur Fishing option

- vast majority of the responders are willing to pay the proposed price to improve the current situation and move a step forward to the improvement of species status and/or marine litter status as well as the beach occupation which leads to coastal and as a result economic development.

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AE4RIA
Alliance of Excellence for Research and Innovation on Aephoria

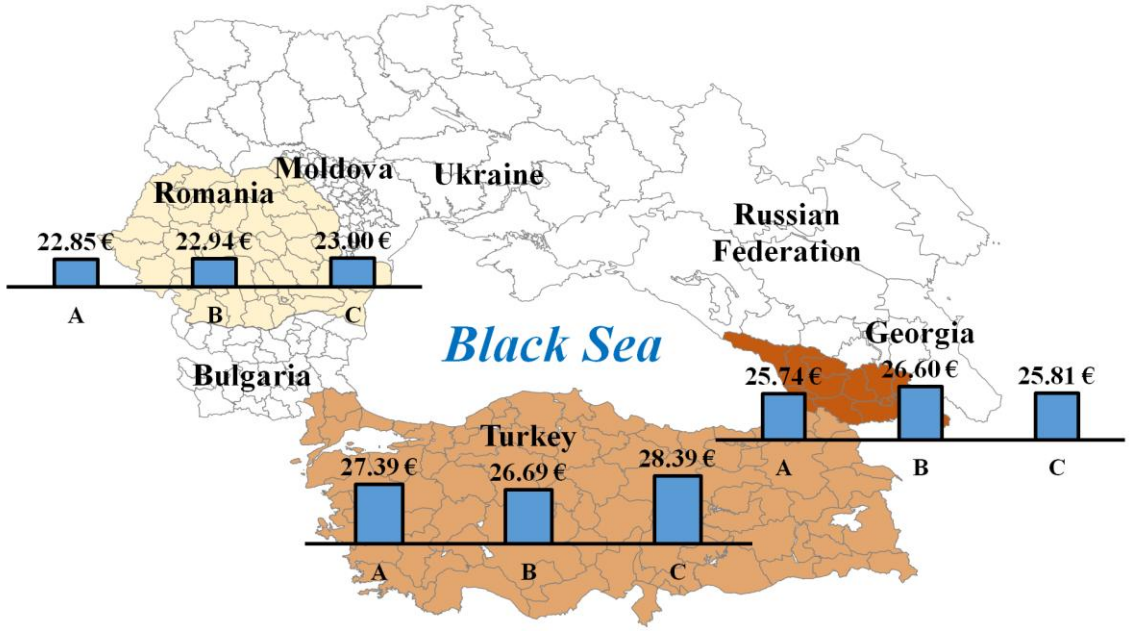
Economic Valuation of Ecosystem Services (ES) in the Black Sea: Impact

- Respondents favor higher payments for stricter measures against **overfishing and marine litter**

- **Turkey:** Highest WTP for **Scenario C (28.39€)**, showing strong support for **coastal protection and species conservation**

- **Georgia:** Prefers **Scenario B (26.60€)** over stricter measures, indicating a focus on **recreational fishing restrictions**

- **Romania:** Highest WTP for **Scenario C (23€)**, likely due to concerns about **species protection, waste management, and carbon sequestration**



Economic Valuation of Ecosystem Services (ES) in the Black Sea: Management

- **Highest WTP** Observed in **Turkey** (7.37€–56.72€), Georgia (7.23€–49.04€), Romania (6.26€–47.96€)
- **Need for Public Support for Environmental Protection:** opportunities for sustainable tourism (marine biodiversity) & eco-friendly fisheries
- **Scenario C (WTP: 25.51€)** received the **highest** support, indicating preference for stronger marine habitat protection
- **Marine Protection Strategies:** Establish **MPAs** to restrict fishing/anchoring, safeguard biodiversity, and deploy **tech solutions** (e.g., satellite & drone monitoring)
- **Regional Cooperation:** Develop an **umbrella policy** for the Black Sea, aligning conservation strategies, fishing quotas, and enforcement mechanisms across Turkey, Georgia, and Romania
- **Education campaigns and public engagement** are key for policy success

Economic Valuation of Ecosystem Services (ES) in the Black Sea: Policy

1. **Education & Awareness:** European policies should promote environmental sensitivity through educational campaigns, linking to sustainable tourism
2. **Maritime Spatial Planning:** Integrated coastal zone management can help mitigate marine litter and other negative externalities
3. **Ecosystem-Based Management:** Nature- and technology-based solutions can drive blue growth and protect marine ecosystem services
4. **Sustainable Fisheries:** Essential for preserving local species, preventing biodiversity loss, and controlling invasive species

Meta-Regression Analysis: Motivation and Introduction

- “Meta-analysis refers to the **statistical** analysis of a **large collection** of results from individual studies for the purpose of **integrating** the findings. It connotes a **rigorous alternative** to the casual, narrative discussions of research studies that typify our attempt to make sense of the rapidly expanding research literature.”

  Glass (1976)

Practical Applications of Meta-Analysis

- Meta-analysis is often discussed in terms of its relevance for understanding the scholarly literature.
- Results can (at least in concept) inform decisions in the real world, but sometimes impacts are indirect or unclear.
  - Example—Do minimum wages affect employment?
  - MRA results challenge common wisdom.
- MRA can also provide direct inputs for policy analysis. Here, the effect is more clear.
- Multiple examples are found in environmental economics.
  - VSL is a good example. This is frequently used as a direct input in benefit-cost analysis (BCA).

Non Market Valuation

- MRA is commonly used to provide estimates of non-market values for use within BCA and other types of policy analysis.
- Non-market valuation provides estimates of economic value for environmental goods and services that are not exchanged in markets.
  - Ecosystem service values are often non-market values.
  - Common examples include the value of improved air quality, water quality, fish stocks, wildlife stocks and many others.
  - These values are often measured using estimates of willingness to pay (WTP), reflecting Hicksian compensating surplus or variation.

Example—Non-Market Value of Recreational Fishing

- What is the true value of recreational fishing to an angler (a recreational fisherman)?
- How much more would an angler be willing to pay (in time and travel costs) to go fishing at a site where he expects to catch one more fish compared to current sites?
- The angler cannot directly "buy" improved fishing quality.
- There is no market, so this is a non-market value.
- But, the observed tradeoff between time/travel and additional catch reveals an economic value.
- This value can be estimated by analyzing fishing behavior.

- Johnston et al. (2006): Mean willingness to pay per fish caught.

Marginal Value per Fish, by Region and Species							
Species	California	North Atlantic	Mid-Atlantic	South Atlantic	Gulf of Mexico	Great Lakes	Inland
big game	$12.32	$6.19	$5.95	$13.57	$13.26		
small game	$6.38	$5.22	$5.19	$5.03	$4.95		$4.71
flatfish	$8.57	$5.24	$4.94	$4.93	$4.82		
other saltwater	$2.60	$2.62	$2.56	$2.50	$2.44		$2.54
salmon	$13.67					$11.66	$13.88
steelhead	$11.25					$12.57	$11.42
musky						$61.37	$64.71
walleye/pike						$3.61	$3.60
bass						$7.52	$7.92
panfish			$0.93	$0.93		$1.17	$0.93
rainbow trout						$7.38	$2.84
other trout						$8.29	$2.48
generic freshwater						$5.46	$1.96
generic saltwater	$2.73	$2.64	$2.85	$2.51	$3.22		$2.79

Environmental Benefit Transfer

- The time and money required for high quality primary valuation research has led to the common use of *benefit transfer* to estimate values for policy analysis.
- Benefit transfer uses results from prior research at one or more study sites to predict value estimates at other policy sites for which value estimates are unavailable.
- Benefit transfer involves transfer errors, but is often the only option to estimate non-market benefits or costs for environmental policy analysis.
- Benefit transfer is a nearly universal component of large-scale BCA in the US, EU and other countries (Johnston et al. 2015).

MRM Models - Benefit Functions

- Benefit functions (used for benefit transfer) can be
  - transferred directly from one prior study, or
  - estimated using information from many prior studies in the literature.
- Meta-regression models (MRMs) are often used to estimate these benefit functions.
- Use of MRMs enables benefit functions that are more flexible and generally applicable than benefit functions taken from a single published study.

MRM Models - Benefit Functions

- The dependent variable in a benefit transfer MRM is a comparable measure of economic value drawn from similar studies addressing the same good at many different sites.
  - Most often mean willingness to pay (WTP) from revealed or stated preference valuation studies.
- Independent variables characterize site, resource, population and methodological attributes hypothesized to explain variation in value.
- The goal is a statistical benefit function able to predict economic values at sites where no primary valuation studies have been conducted.

Transferred Value Estimate or Benefit Function

$$Value_A = f(X_A, \beta_A)$$

Study Site A
(Economic Value Measured Here by Prior Primary Research)

Policy Site B
(Value Estimate Required for BCA)

Valuing Estuarine Resource Services
Using Economic and Ecological Models:
The Peconic Estuary System Study

$$Transfer\ Value = f(X_B, \beta_A)$$

Observed Conditions at Policy Site B

Non-Market Valuation MRM

Primary Study a

$$Y_a = \alpha_a + \sum_j \beta_{aj} x_{aj} + \varepsilon_a$$

Behavioral Measure (e.g., trips)

Primary Study Calculates

$$WTP_{ak} = \beta_{ak} / \beta_{a\_cost}$$

MRM

$$\begin{bmatrix} WTP_{1k} \\ WTP_{2k} \\ \cdots \\ WTP_{Ak} \end{bmatrix} = \delta_k + \sum_m \gamma_{mk} \begin{bmatrix} z_{1mk} \\ z_{2mk} \\ \cdots \\ z_{Amk} \end{bmatrix} + \sum_s \mu_{sk} \begin{bmatrix} w_{1sk} \\ w_{2sk} \\ \cdots \\ w_{Ask} \end{bmatrix} + \varepsilon_k$$

WTP from Multiple Studies (1…A)

Policy, Site, Population & Resource Variables

Methodological Variables

Non-Market Valuation MRM - Predictions

Benefit Function

$$\hat{WTP}_k = \hat{\delta}_k + \sum_m \hat{\gamma}_{mk} z_{mk} + \sum_s \hat{\mu}_{sk} \overline{w}_{sk}$$

Policy Site Data (Site b)

z_{bk}

Means or Selected Values

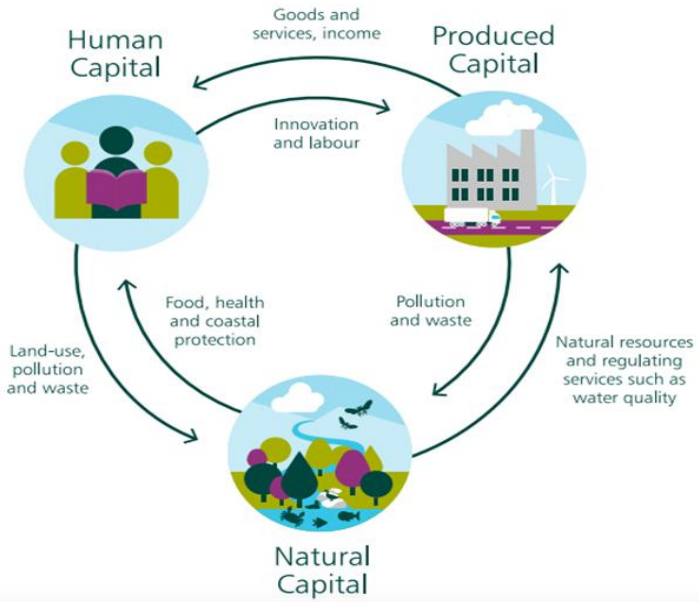
Predicted Welfare (Value) Estimate

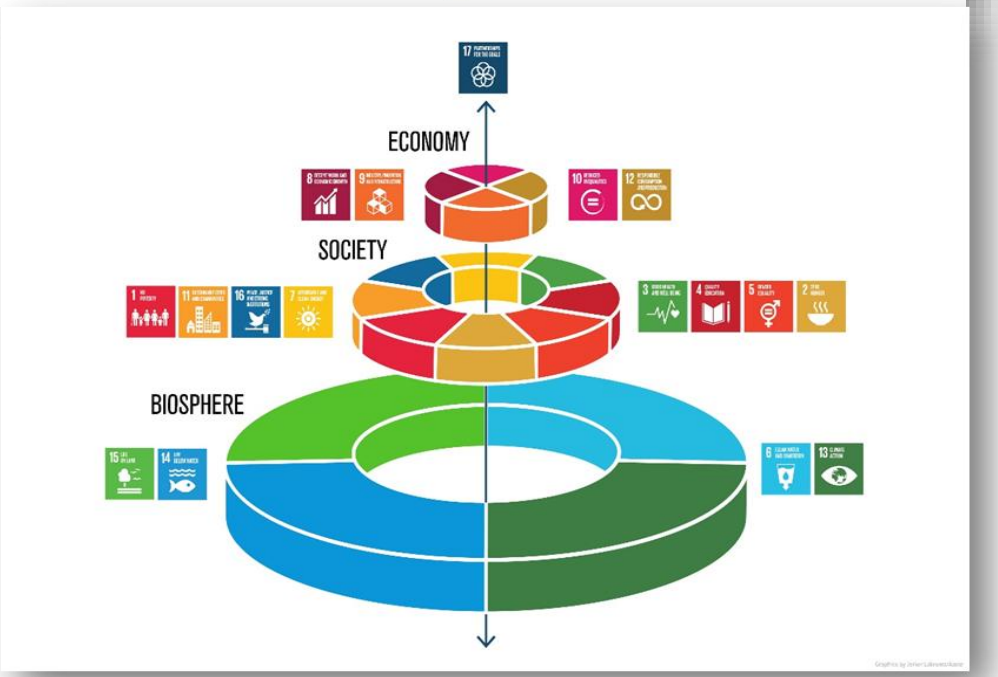
$$\hat{WTP}_{bk}$$

MRMs of Environmental Value

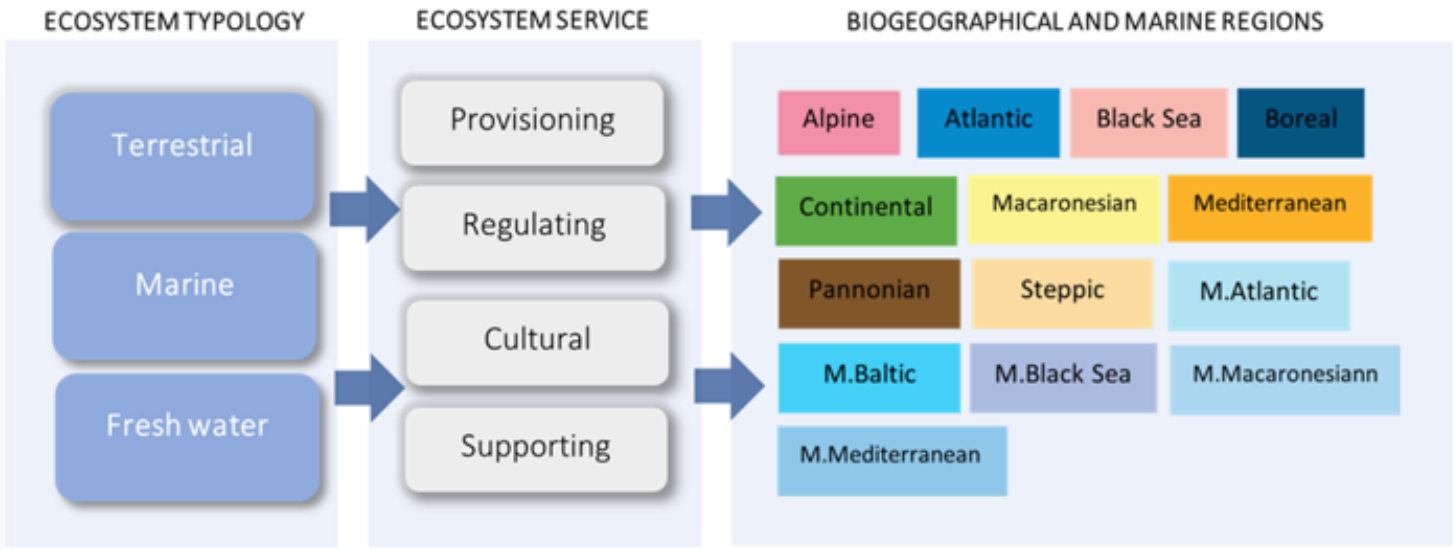
- There roughly 200 published MRMs in the environmental economics literature (Nelson and Kennedy 2009; Johnston et al. 2015). Examples include MRMs on the value of:
  - Water quality (Johnston et al. 2005, 2016; Johnston and Thomassin 2010; Poe et al. 2001; Van Houtven et al. 2007).
  - Wetlands (Brouwer et al. 1999; Woodward and Wui 2001; Ghermandi and Nunes 2013; Brander et al. 2012).
  - Coral reefs (Brander et al. 2007; Londoño and Johnston 2012).
  - Outdoor recreation (Bateman and Jones 2003; Johnston et al. 2006; Rosenberger and Loomis 2000a,b; Moeltner et al. 2007; Moeltner and Rosenberger 2008, 2014; Stapler and Johnston 2009).

Integrating Ecosystem Valuation to Decision Making





- Valuation Platform of European Ecosystem Services
- 4 Types of Ecosystem Services: Provisioning, Regulating, Cultural, Supporting
- 6 Biogeographical and Marine Regions
- Total Economic Value = Use Value + Non-use value



MAES Typology for ecosystem classification

Millennium Ecosystem Assessment, 2005

Habitats Directive (92/43/EEC), Art.17.

Meta Regression Value Transfer Method

- **Step 1.1**: IDENTIFICATION of the full range of ecosystem services in each **biogeographical region**
  - Mapping of different ecosystems
  - Establishment of the geographical area of reference

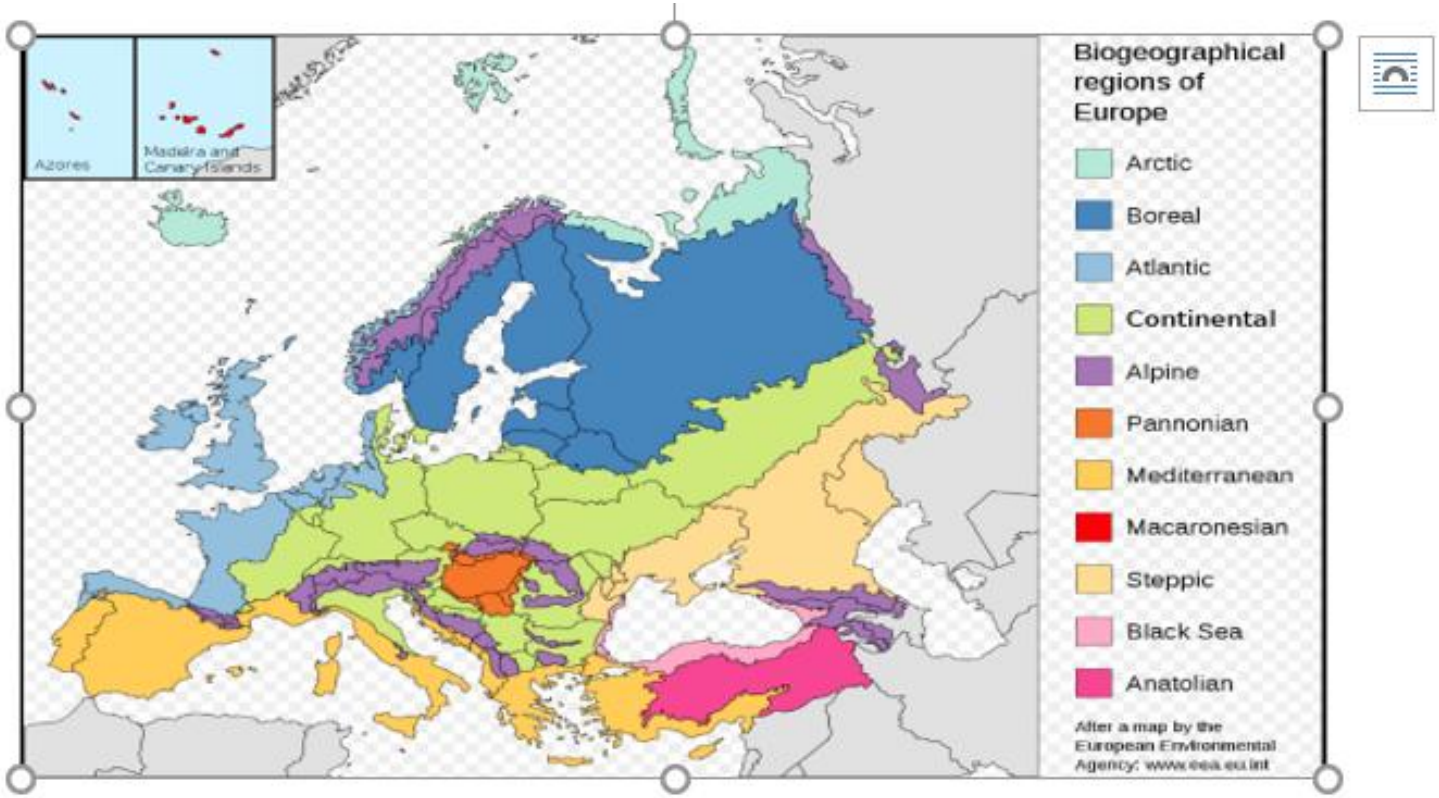


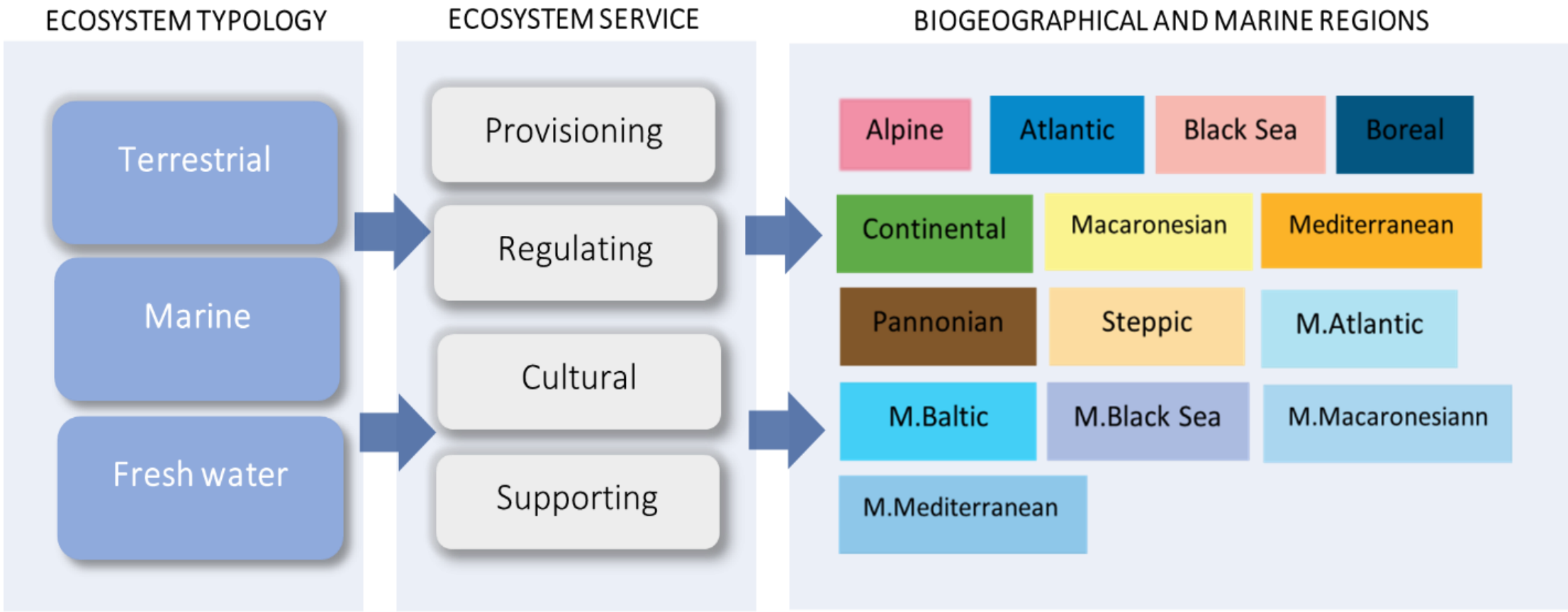
Figure 20 European Bio Geographical Regions

- **Step 1.2**: Gather a vast sample of valuations from primary studies

  Using data from literature databases (EVRI, ESVD)

- **Step 1.3**: Estimate the Benefit Transfer value Function

Mapping of Ecosystems Typology to Services across Biogeographical regions



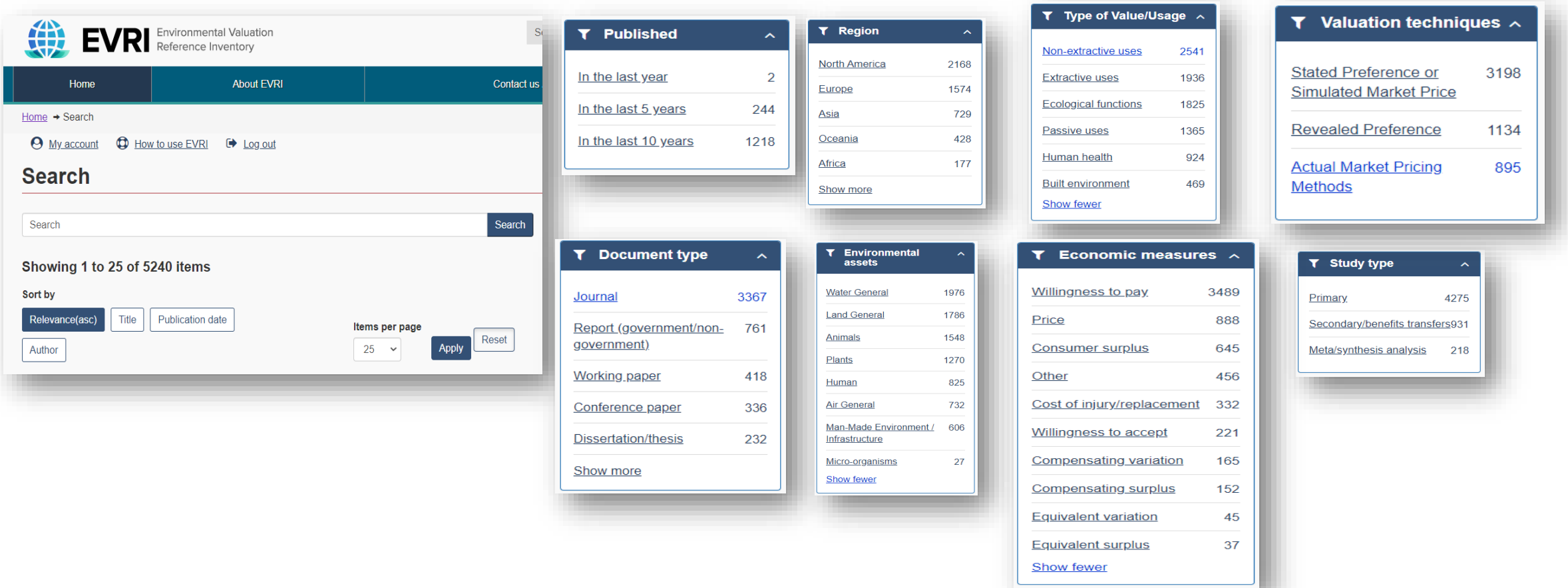
MAES Typology for ecosystem classification

Millennium Ecosystem Assessment, 2005

Habitats Directive (92/43/EEC), Art.17.

Step 1.2: Collecting the Meta Data

- ✓ Literature review aimed at identifying the value of ecosystems in specific EU countries.
- ✓ EVRI and ESDV databaseS is used – An open–access repository with many filtering options.
- ✓ Primary literature related to ecosystem services valuation from 2012 to 2022 has been selected. Studies have been selected according to the ecosystem typology and the ecosystem services valued, and by the bio-geographical area in which the study has been conducted.



- Development of the metadata is the most difficult component of meta-analysis, and can be subject to unseen errors.
- No statistical method can fully overcome bias caused by a poorly conceptualized research question, ambiguous definition of effect sizes, or incomplete/erroneous coding.
- Transparency in literature search and coding is critical.
- Data inspection and summary, including formal testing for heterogeneity, is a critical initial step.
- Beware of naïve interpretations of weighted averages (FEE and REE)—WLS is almost always more informative.
- Heterogeneity is always found—leading to multiple MRA.

Meta Data

Table 1 Descriptive Statistics

Variable	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
WTP	76.8	12.9	165.7	0.0	93000.0	23.4	64.4	1404.6
ES Terrestrial	0.521	0.039	0.501	0.000	0.000	1.000	1.000	1.000
ES Marine	0.394	0.038	0.490	0.000	0.000	0.000	1.000	1.000
ES Fresh Water	0.085	0.022	0.280	0.000	0.000	0.000	0.000	1.000
Cultural	0.588	0.038	0.494	0.000	0.000	1.000	1.000	1.000
Provisioning	0.267	0.035	0.444	0.000	0.000	0.000	1.000	1.000
Supporting	0.436	0.039	0.497	0.000	0.000	0.000	1.000	1.000
Regulating	0.327	0.037	0.471	0.000	0.000	0.000	1.000	1.000
SD Interview	0.665	0.037	0.474	0.000	0.000	1.000	1.000	1.000
SD Questionnaire online	0.329	0.037	0.471	0.000	0.000	0.000	1.000	1.000
SD Secondary data	0.050	0.017	0.218	0.000	0.000	0.000	0.000	1.000
CE	0.461	0.039	0.500	0.000	0.000	0.000	1.000	1.000
CVM	0.400	0.038	0.491	0.000	0.000	0.000	1.000	1.000
REVEALED	0.139	0.027	0.347	0.000	0.000	0.000	0.000	1.000
Alpine	0.133	0.027	0.341	0.000	0.000	0.000	0.000	1.000
Atlantic	0.236	0.033	0.426	0.000	0.000	0.000	0.000	1.000
Boreal	0.139	0.027	0.347	0.000	0.000	0.000	0.000	1.000
Continental	0.212	0.032	0.410	0.000	0.000	0.000	0.000	1.000
Macaronesian	0.006	0.006	0.078	0.000	0.000	0.000	0.000	1.000
Mediterranean	0.279	0.035	0.450	0.000	0.000	0.000	1.000	1.000
Steppic	0.006	0.006	0.078	0.000	0.000	0.000	0.000	1.000
Marine Atlantic	0.176	0.030	0.382	0.000	0.000	0.000	0.000	1.000
Marine Black Sea	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine Baltic	0.042	0.016	0.202	0.000	0.000	0.000	0.000	1.000
AGE	44.221	0.624	6.301	28.620	40.088	43.000	49.350	58.000
INCOME	27969	1210	15160	2398	18267	24512	35371	104030
GENDER	0.489	0.009	0.087	0.170	0.463	0.510	0.540	0.640
EDUC	0.554	0.178	2113.000	0.104	0.265	0.360	0.460	25.400

Policy, Site, Population & Resource Variables

Methodological Variables

MRM Estimation – Benefit Transfer

- **MRM:** $\mathbf{WTP_i = \beta' X_i + \varepsilon_i}$ **(Weighted Least Squares)**
- Newey West Standard Error in parenthesis
- Bold denotes 5% statistical significance
- Model Selection – Minimizes BIC

	All Ecosystems	Terrestrial	Marine & Fresh Water
ALPINE	**148.94**	**105.93**	43.01
	[0.020]	[0.041]	[0.279]
ATLANTIC	**-86.23**	-21.91	**-64.32**
	[0.084]	[0.487]	[0.091]
BOREAL	-82.96	19.39	**-102.34**
	[0.286]	[0.748]	[0.040]
CONTINENTAL	-48.36	-7.07	-41.29
	[0.162]	[0.817]	[0.269]
MEDITERRANEAN.	**-91.73**	**-54.37**	-37.36
	[0.057]	[0.069]	[0.344]
MARINE_ATLANTIC	**-74.40**	**-62.46**	-11.95
	[0.106]	[0.059]	[0.779]
PROVISIONING	**59.32**	25.77	33.55
	[0.075]	[0.292]	[0.259]
REGULATING	**53.19**	12.98	**40.21**
	[0.224]	[0.541]	[0.214]
SUPPORTING	**42.70**	13.46	29.24
	[0.117]	[0.599]	[0.312]
SD_QUESTIONNAIRE	-42.09	**-50.20**	8.11
	[0.351]	[0.118]	[0.803]
AGE	**3.77**	**1.14**	**2.64**
	[0.007]	[0.127]	[0.023]
EDUCATION	**-5.20**	-0.60	-4.60
	[0.187]	[0.853]	[0.387]
CHOICE_EXPERIMENT	**-79.15**	-0.52	**-78.63**
	[0.157]	[0.983]	[0.126]
CONTINGENT_VALUATION	-60.07	10.78	**-70.84**
	[0.297]	[0.704]	[0.161]
R-squared	0.32	0.27	0.18
Adjusted R-squared	0.20	0.15	0.04
F-statistic	**87.90**	**75.71**	**1.96**
	[0.000]	[0.000]	[0.0229]
MWTP	**80.53**	**38.42**	**42.10**

MRM - Benefit Transfer – Ecosystem Services / Regions

$$\hat{WTP}_k = \hat{\delta}_k + \sum_m \hat{\gamma}_{mk} z_{mk} + \sum_s \hat{\mu}_{sk} \overline{w}_{sk}$$

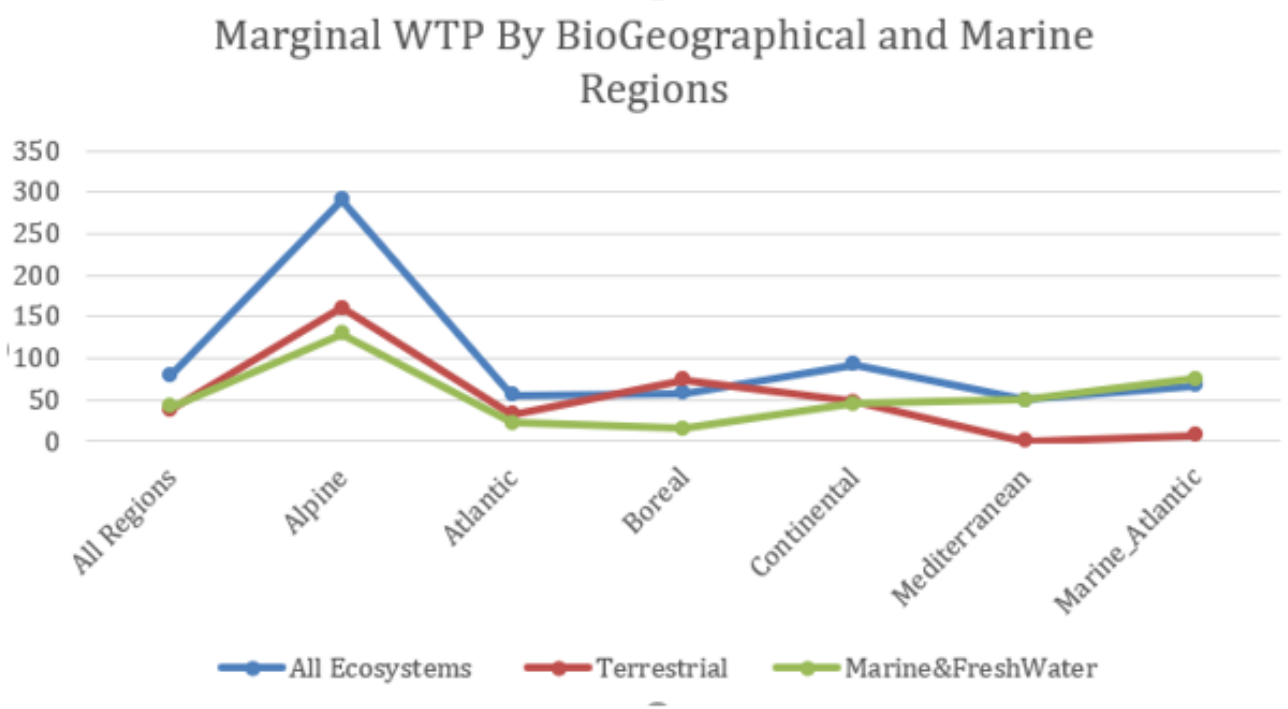


Figure 19 Annual Marginal WTP by Biogeographical Region

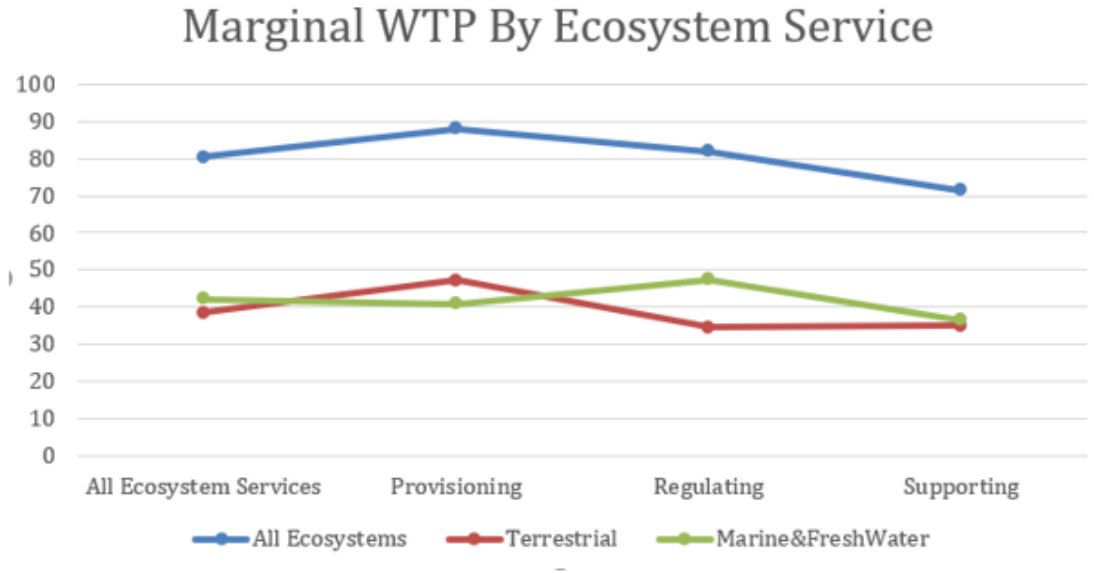


Figure 18 Annual Marginal WTP by Ecosystem Service

- **Higher WTP estimates for Alpine Region**
- WTP for Marine and Freshwater Ecosystems Higher for **Mediterranean and Marine Regions** , and WTP for Terrestrial Ecosystems higher for **Alpine** and **Boreal**
- **Regulating** Service more important for Marine and Freshwater Ecosystem and **Provisioning** for Terrestrial

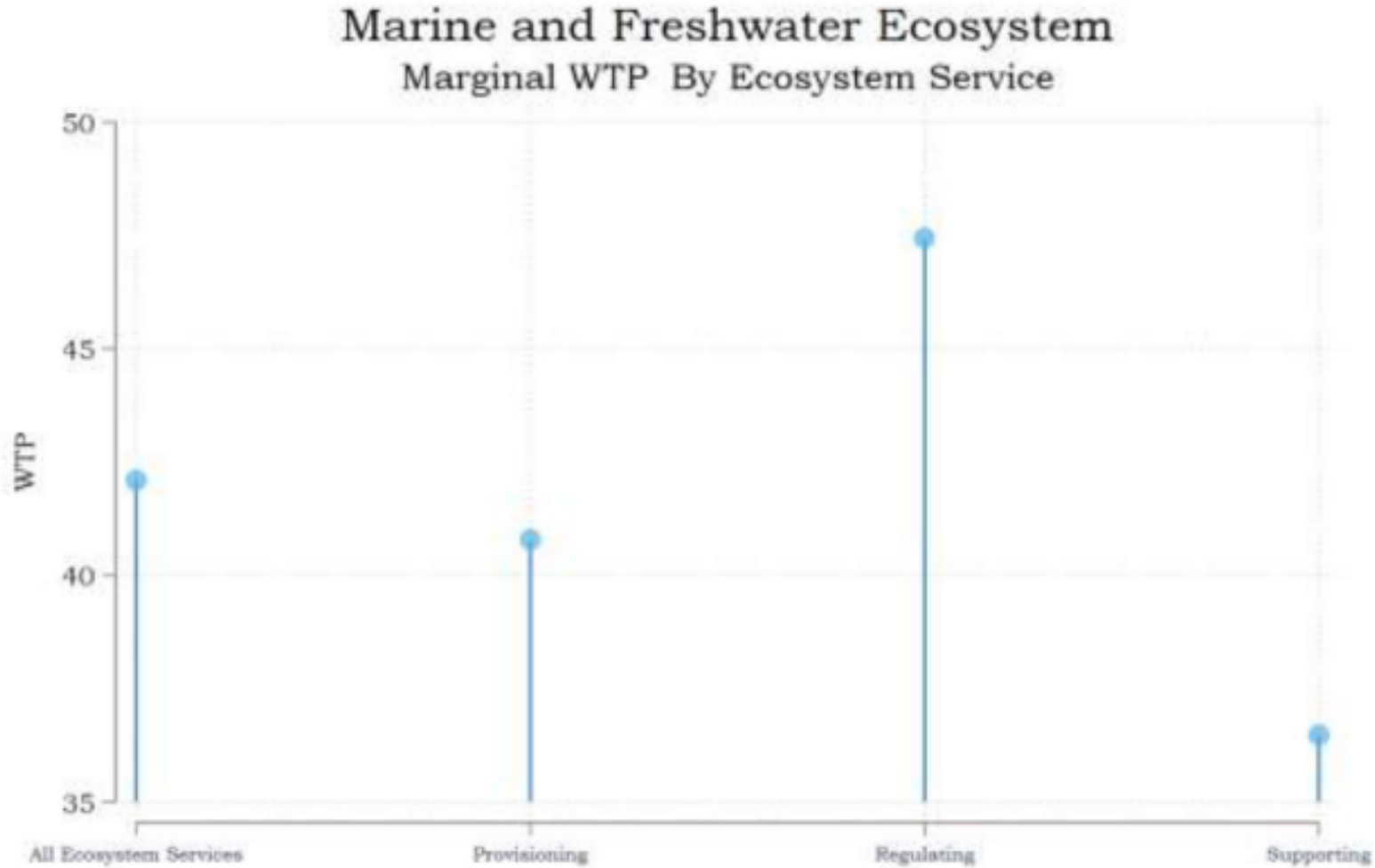


FIGURE 5
Marine and freshwater ecosystem—Annual Marginal WTP by ecosystem service. Source: authors' calculations.

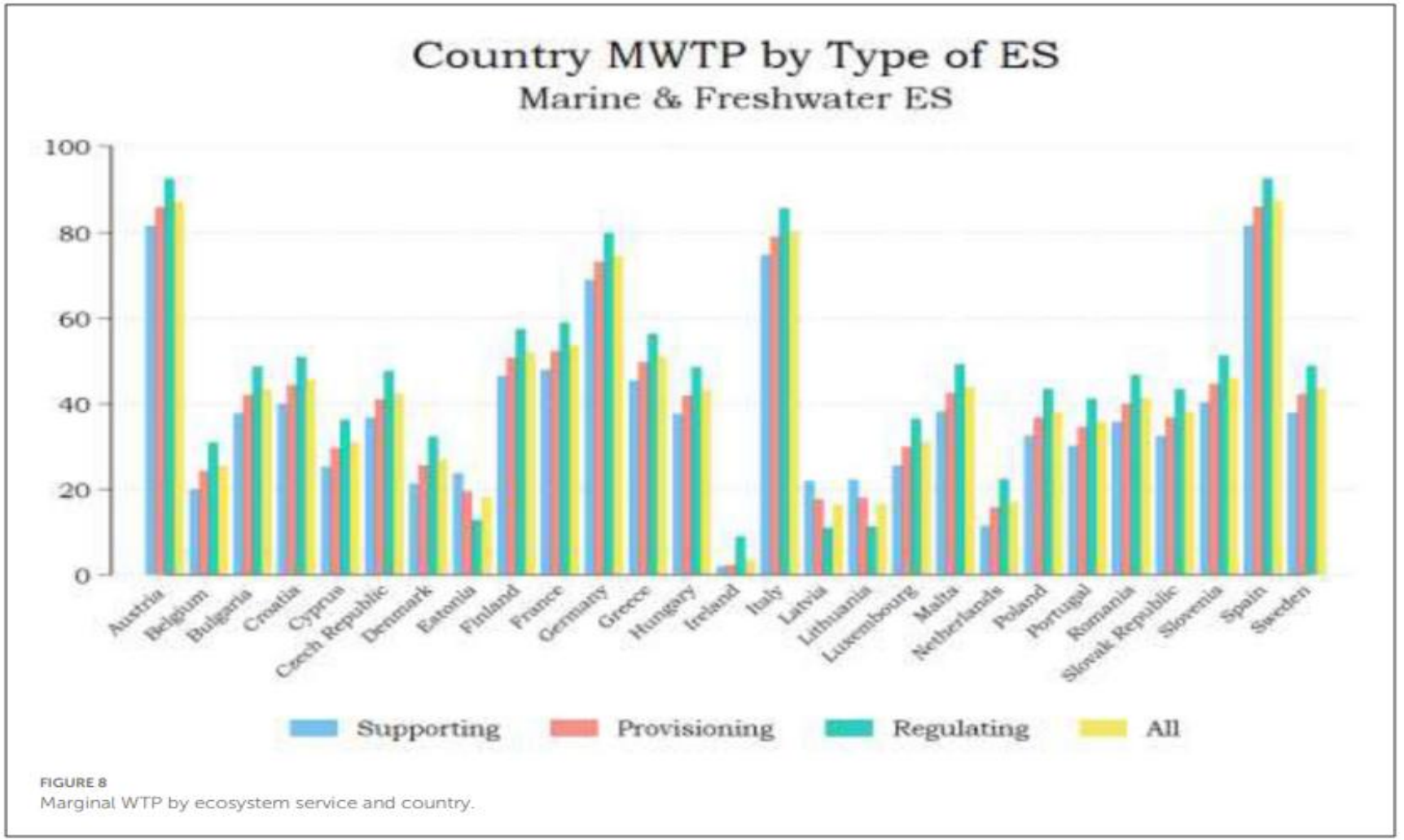
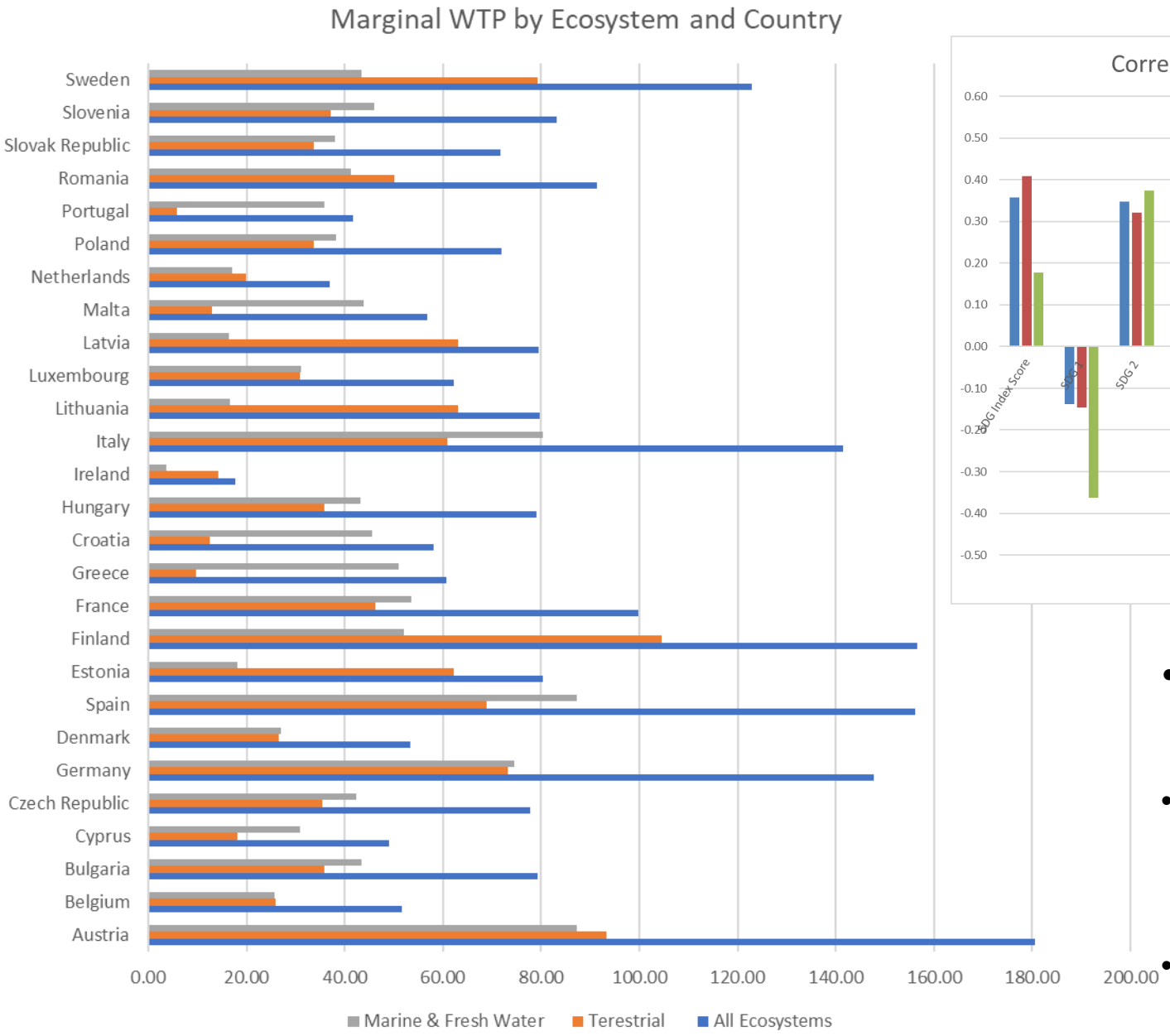


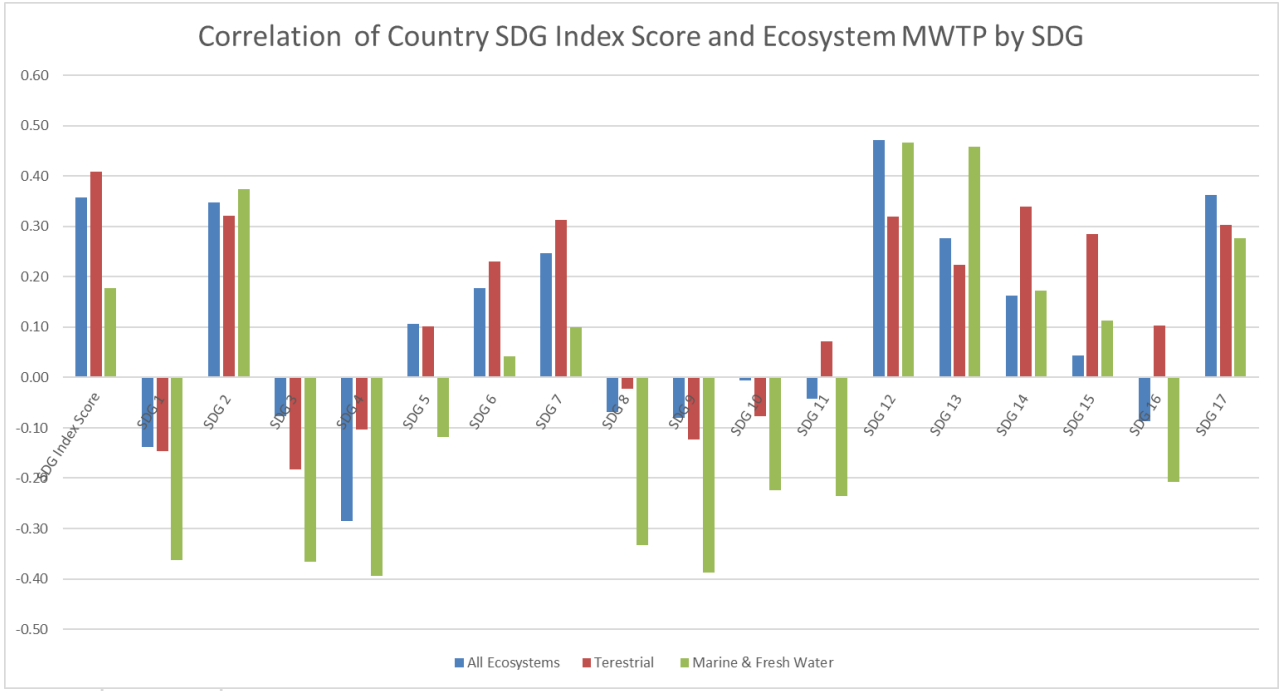
FIGURE 8
Marginal WTP by ecosystem service and country.

- For 63% of European countries (17 out of 27), the willingness to pay for the improvement of the marine and freshwater ecosystem is high and exceeds estimates for terrestrial ecosystems (Sachs et al., 2022).

- For most of the EU28 Countries the Regulating ecosystem services are valued higher (46.15 euro on average) than Provisioning or Supporting, while Provisioning is valued higher than Supporting (40.97 and 37.77 euro on average, respectively).

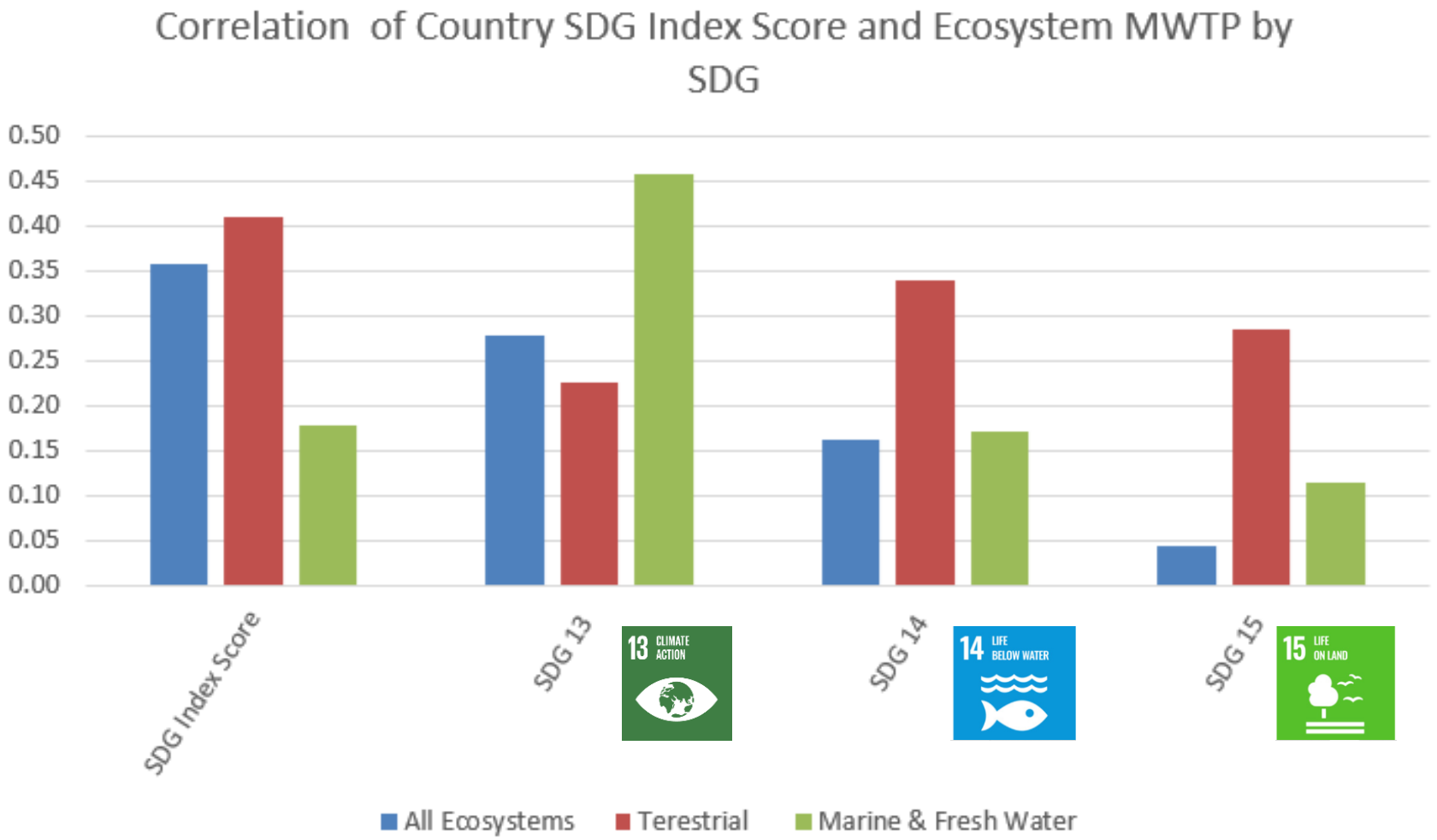
National MWTP – All Ecosystems





- Positive Correlation Implies a higher MWTP for SDGs with a high level of implementation.
- **People's preferences are in the same direction with the intentions of government to make the transformations necessary to achieve SDGs.**
- MWTP is high for a transformation that is **needed.**

Link to SDGs 13, 14 & 15



- **Positive Correlation between MWTP and SDGs performance – Integrating the Value of Capital in Investment and Policy Decisions**
- Terrestrial Ecosystem
  Higher Correlation to **SDG 15**
- Marine and Fresh Water
  Higher Correlation to **SDG 13 and 14**

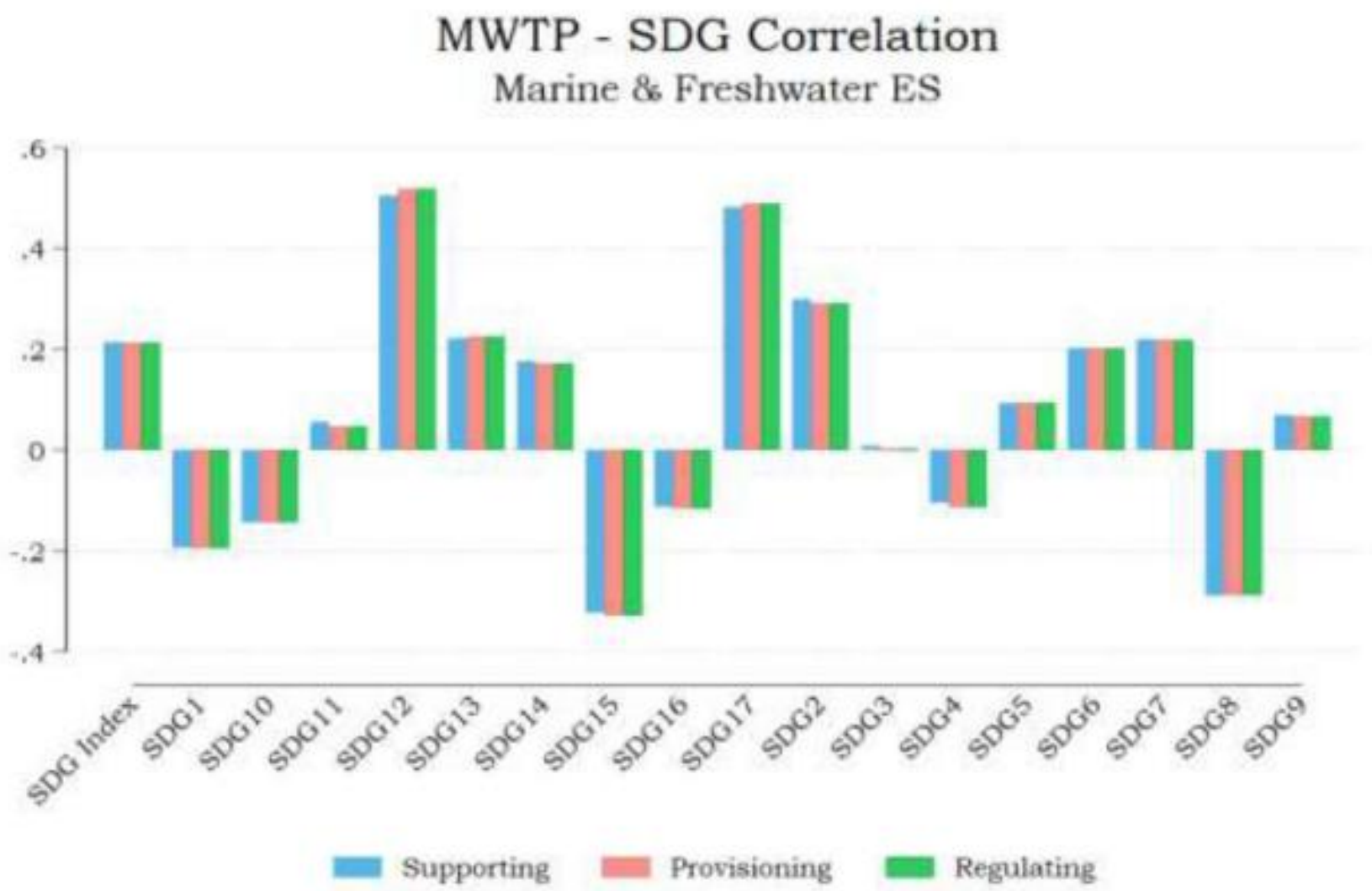
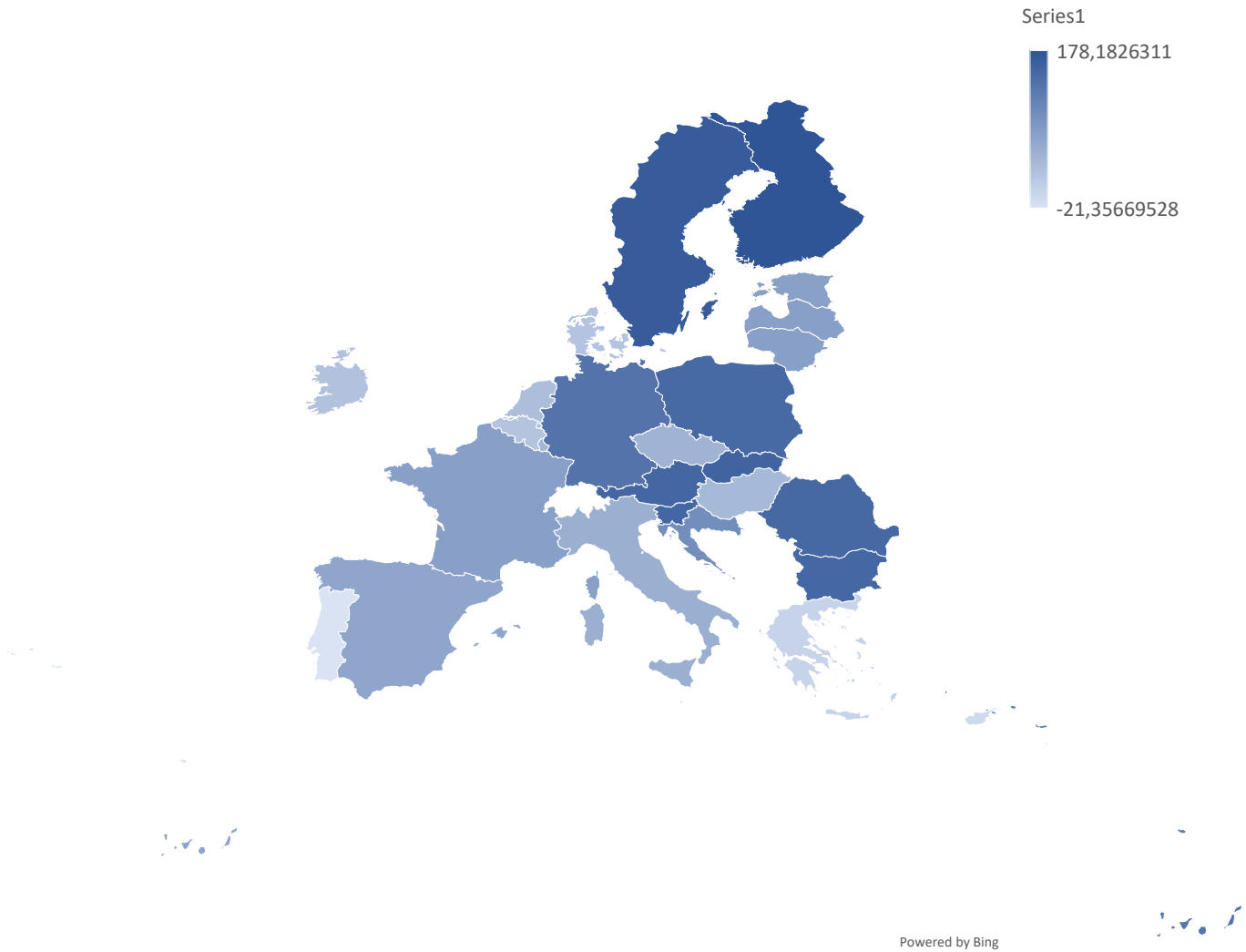
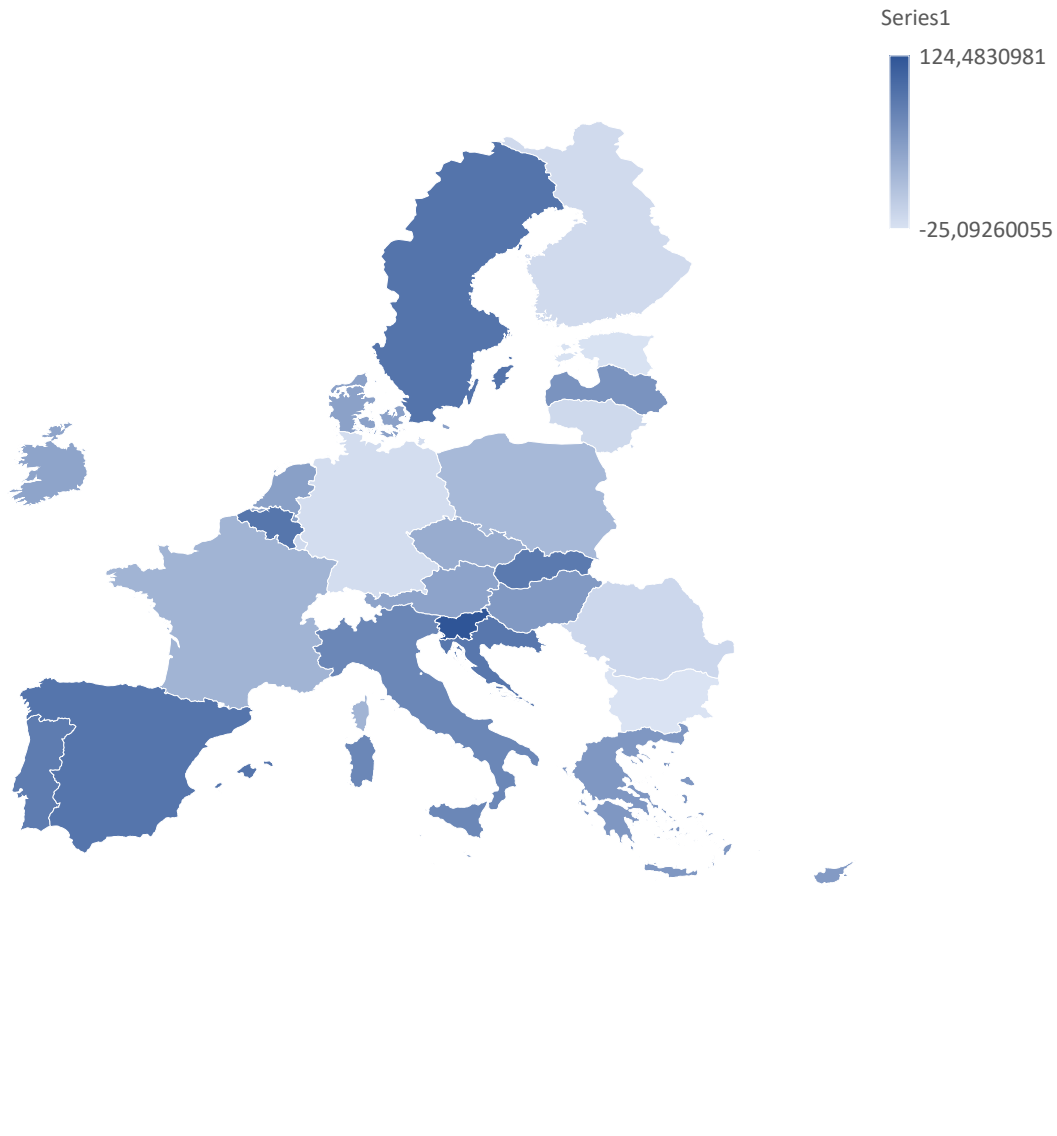


FIGURE 9
Cross sectional correlation of UNSDSN Index Scores and ecosystem service's MWTP, by SDG. Source: authors' calculations.

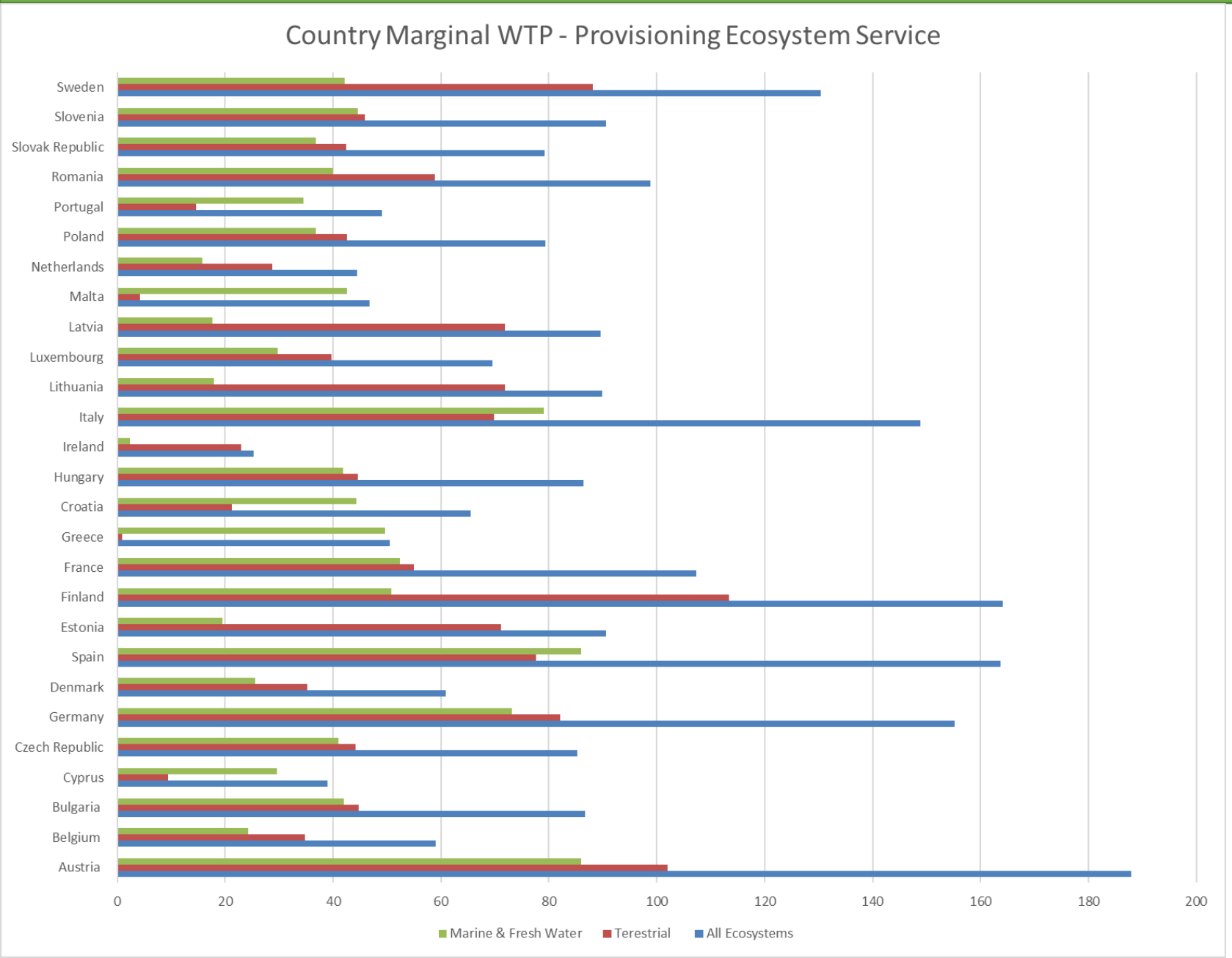
Terestrial Ecosystem



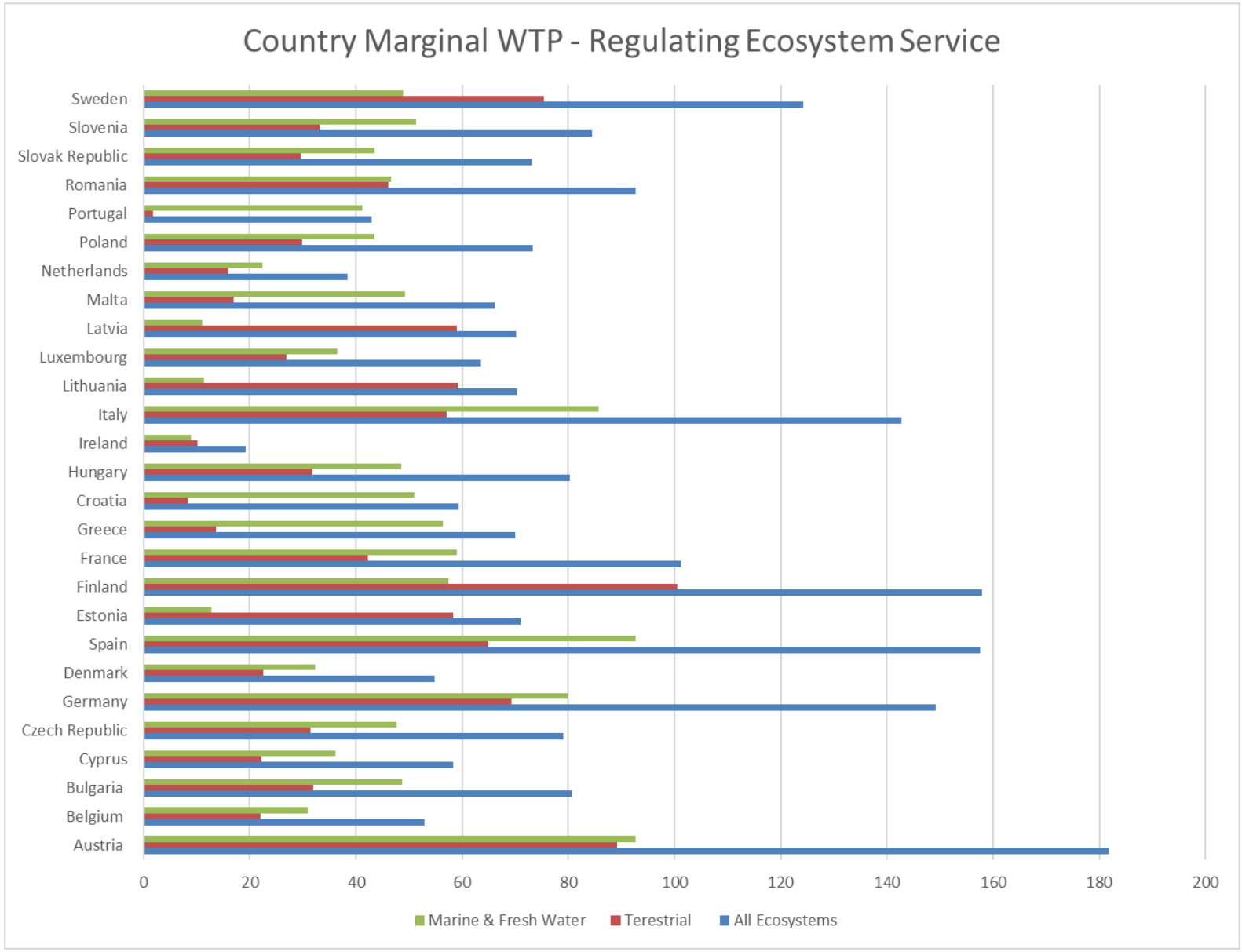
Marine Ecosystem



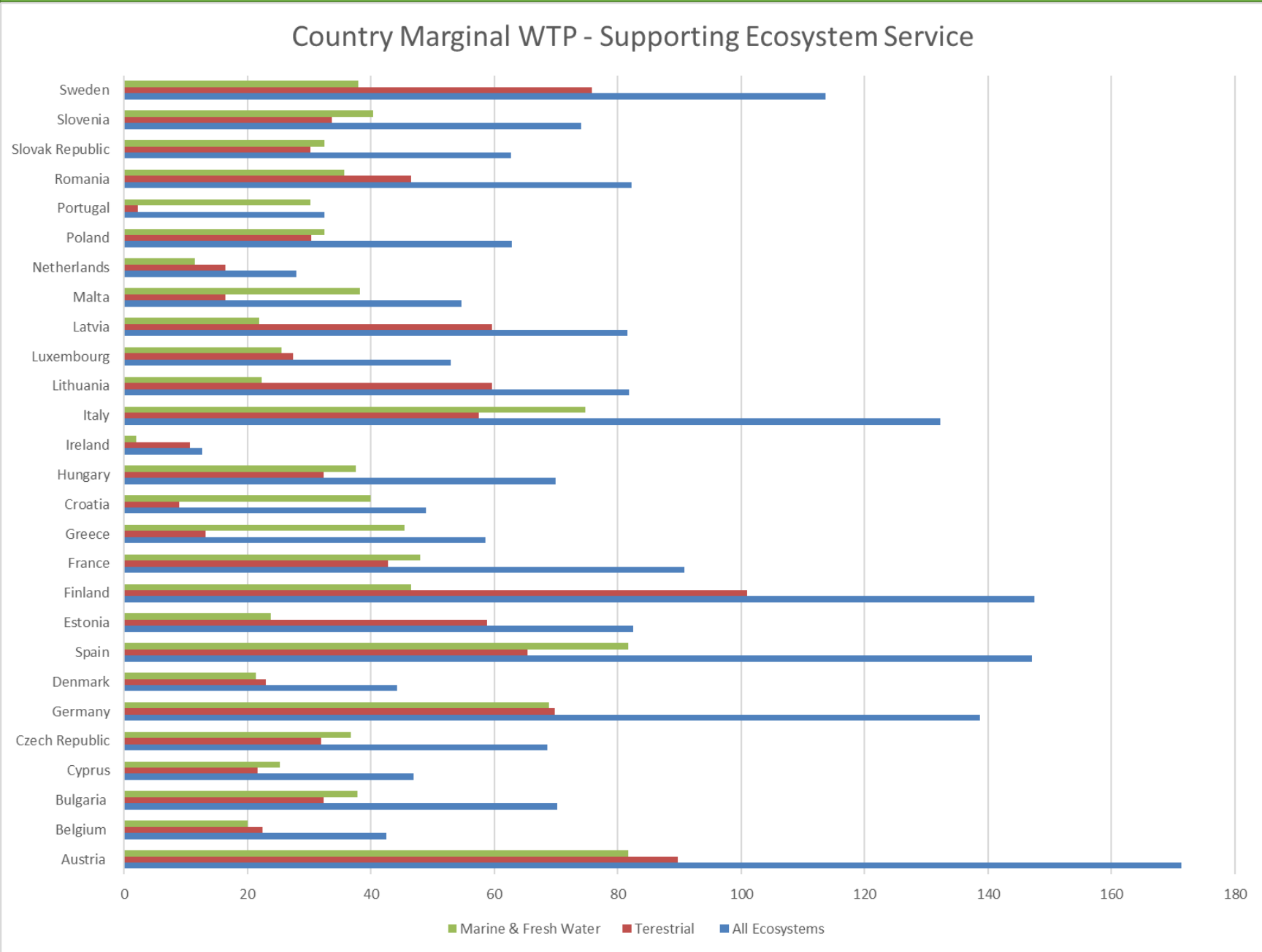
Provisioning Ecosystem Service



Regulating Ecosystem Service



Supporting Ecosystem Service



How Accurate Is Benefit Transfer?

- Like many economic phenomena, true WTP can never be observed, only estimated.
- Benefit transfer is only conducted when a primary study has not been conducted.
- Accuracy in actual situations is not known.
- But, if a primary valuation study *has been* conducted for a site, we can compare the value estimated using benefit transfer to the value estimated by the primary study.
  - This is called convergent validity testing.
  - Used to evaluate "how accurate" benefit transfer might be in actual policy uses.

Testing MRM Benefit Transfer

- To evaluate the out-of-sample accuracy of BT forecasts from the MRM (inversely related to transfer error), we apply an iterative leave-one-out convergent validity test.
  - Begin with metadata of n=1…N observations.
  - Omit n^{th} observation from the metadata.
  - Estimate MRM using the remaining N-1 observations.
  - Steps 2 and 3 iterated for each n=1…N observation, resulting in a vector of N unique sets of MRM parameter estimates, each corresponding to the omission of the nth observation.
  - For each iteration, results are used to forecast WTP for the nth omitted observation, resulting in N out-of-sample forecasts.
  - Evaluate transfer error for each iteration.

Convergent Validity Test Results

	Mean Absolute Value Error ($)	Std. Dev.	Mean Absolute Value Error (%)	Std. Dev. (%)
Model Accuracy Measures	$3.03	$4.09	**68.23%**	133.45%

- On average, one expects a mean (absolute value) error of approximately 68%, when the model is used for benefit transfer in actual situations (forecasting out of sample).
- This is a common magnitude of error for MRM benefit transfers.
- If greater accuracy is needed, primary valuation studies should be conducted.

- Our Results have a 25% which is considered acceptable

MSFD Ecosystem Services (ES)- Valuation for Cyprus Under MSFD Article 8

Table 8. MSFD and MEA mapping.

MSFD Subject	MSFD Theme	MSFD Sub-theme	MSFD Label: Features and elements	MSFD Code	Link to MEA (2005)
Ecosystem services	-		All ecosystem services	EcosysServAll	Provisioning - Regulating - Cultural
	Nutrition	Biomass	All ecosystem services related to nutrition	EcosysServNutrAll	Provisioning
			Wild plants, algae and their outputs	EcosysServNutrSeafoodAlgae	Provisioning
			Wild animals and their outputs	EcosysServNutrSeafoodAnimals	Provisioning
			Algal seafood from aquaculture	EcosysServNutrAquacAlgae	Provisioning
			Animals from in-situ aquaculture	EcosysServNutrAquacAnimals	Provisioning
	Materials	Biomass	All ecosystem services related to provision of materials	EcosysServMatAll	Provisioning
			Fibres and other materials from plants, algae and animals for direct use or processing	EcosysServMatRaw	Provisioning
			Materials from plants, algae and animals for agricultural use	EcosysServMatAlgaeAnimalsForAquac	Provisioning
			Genetic materials from all biotas (*)	EcosysServMatGenetic	Provisioning
	Energy	Biomass-based energy sources	All ecosystem services related to provision of energy	EcosysServEnerAll	Provisioning
			Plant-based resources	EcosysServEnerPlants	Provisioning
			Animal-based resources	EcosysServEnerAnimals	Provisioning
		-	All ecosystem services related to mediation of waste, toxics and other	EcosysServWasteAll	Regulating

- The ***MSFD*** and the ***MEA*** use slightly different approaches to classify ecosystem services.
- ***MSFD*** focuses more on the ecological status of the services, while on the other hand the MEA focuses on assessing how ecosystems contribute to human well-being/welfare.
- We performed a Mapping/link between the two frameworks.

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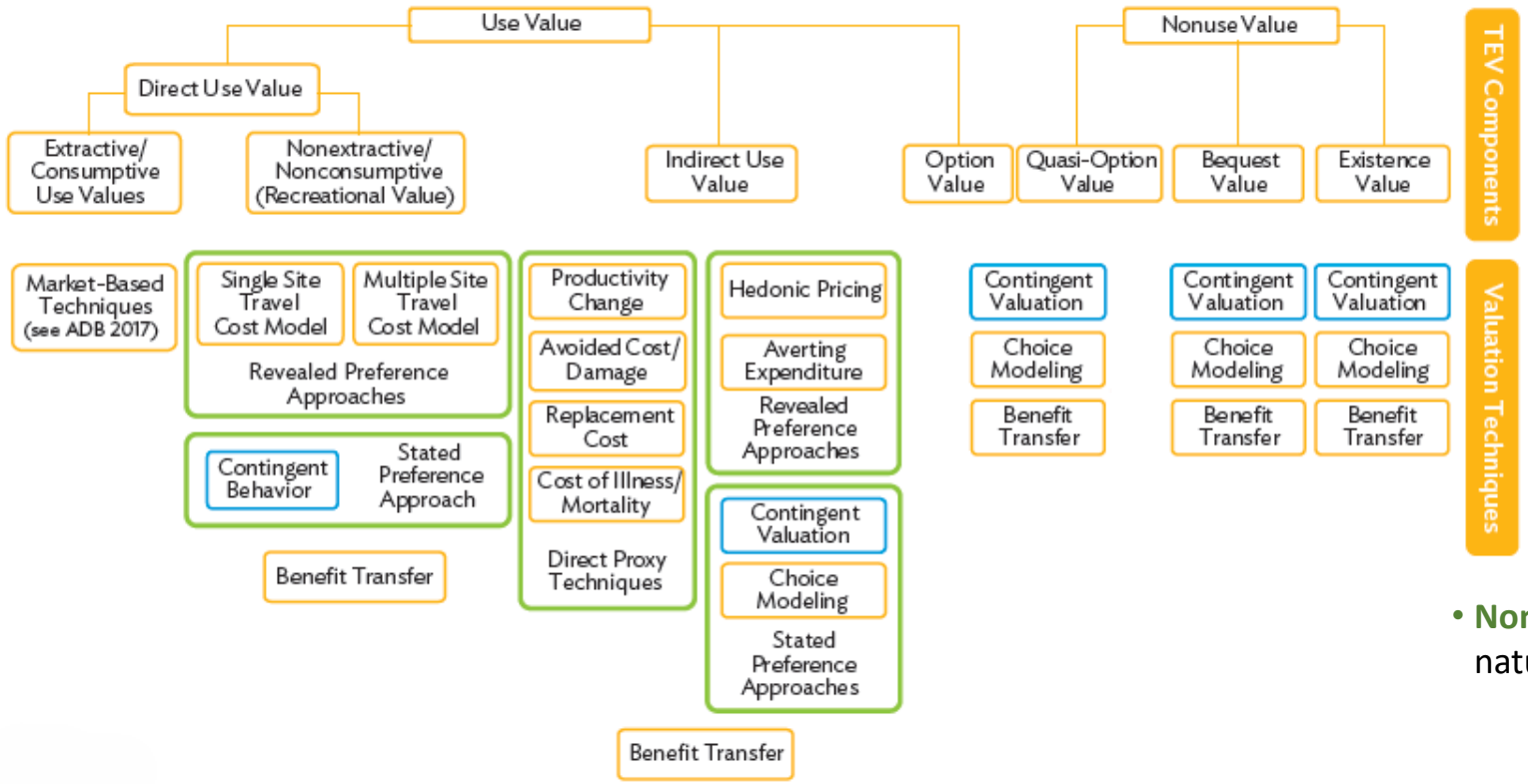
The Total Economic Value Framework



- **Use value includes:**
  - **Direct use value:** Individuals make actual or planned use of an ecosystem service.
    - **Consumptive use** -> the use of resources extracted from the ecosystem (e.g. food, timber)
    - **Non-consumptive use** -> the use of the services without extracting any elements from the ecosystem (e.g. recreation, landscape amenity).
  - **Indirect use value:** individuals benefit from ecosystem services supported by a resource rather than directly using it.
  - **Option value:** the value that people place on having the option to use a resource in the future even if they are not current users
- **Non-use value (passive use):** Is derived from the knowledge that the natural environment is maintained.
  - **Existence value:** derived from the existence of an ecosystem resource, even though an individual has no actual or planned use of it. For example, people are willing to pay for the preservation of whales, through donations, even if they know that they may never actually see a whale.

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Meta Regression – Benefit Transfer Value Function Method

- For ***Provisioning, Supporting and Regulating*** Services we use the benefit value transfer models estimated in Koundouri et al., 2023.

- For ***Cultural Services*** we use the models estimated in Koundouri et al., 2024.

Primary Study a

$$Y_a = \alpha_a + \sum_j \beta_{aj} x_{aj} + \varepsilon_a$$

Behavioral Measure (e.g., trips)

Primary Study Calculates

$$WTP_{ak} = \beta_{ak} / \beta_{a\_cost}$$

WTP from Multiple Studies (1…A)

Policy, Site, Population & Resource Variables

Methodological Variables

MRM

$$\begin{bmatrix} WTP_{1k} \\ WTP_{2k} \\ \dots \end{bmatrix} = \delta_k + \sum_m \gamma_{mk} \begin{bmatrix} z_{1mk} \\ z_{2mk} \\ \dots \end{bmatrix} + \sum_s \mu_{sk} \begin{bmatrix} w_{1sk} \\ w_{2sk} \\ \dots \end{bmatrix} + \varepsilon_k$$

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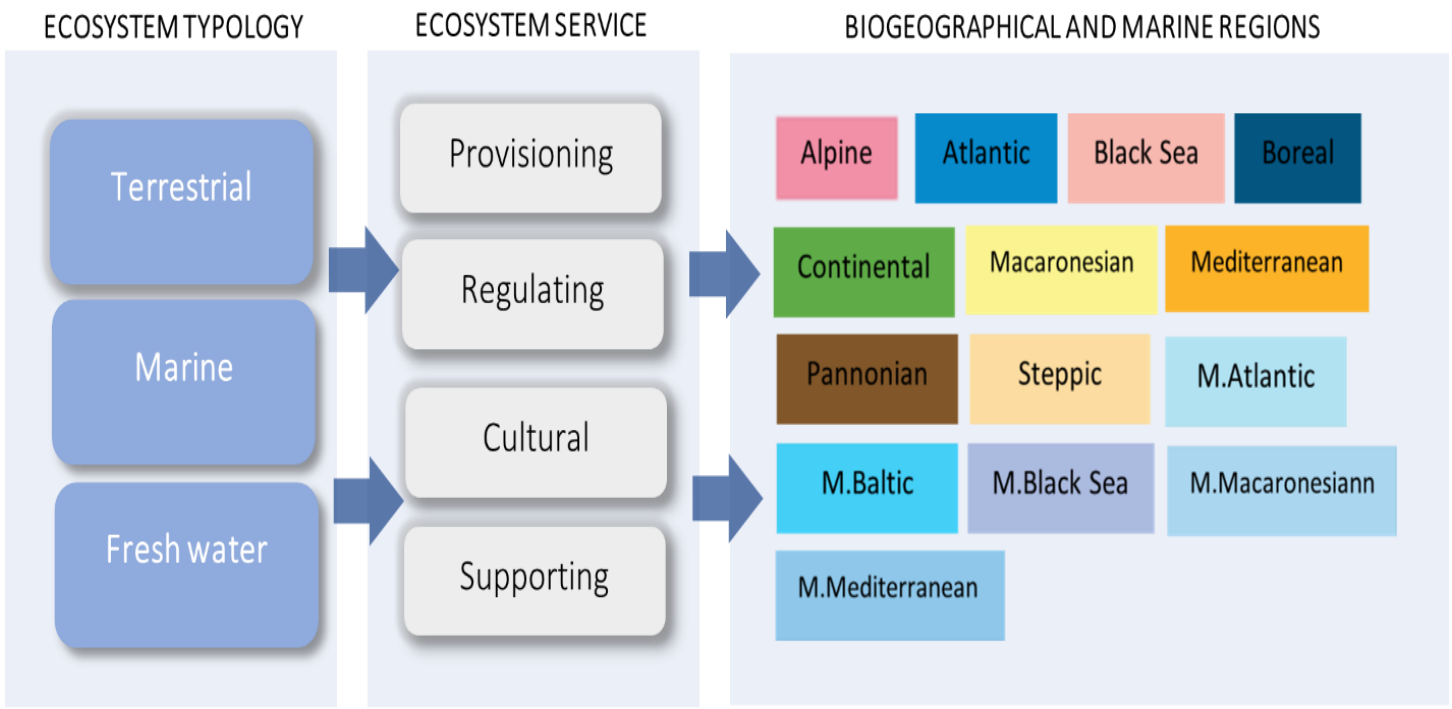
Koundouri et al, 2023 Methodology



MAES Typology for ecosystem classification

Millennium Ecosystem Assessment, 2005

Habitats Directive (92/43/EEC), Art.17.

- ✓ Primary literature related to ecosystem services valuation in Europe from 2012 to 2022, covers 5000+ papers from EVRI and **ESDV** databases. Studies have been selected according to the ecosystem typology and the ecosystem services valued, and by the **bio-geographical** area in which the study has been conducted.

- ✓ An extend set of Policy, Site, Population & Resource and Socio-economics Variables were included to account for various aspects of heterogeneity among the underlying sites.

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Meta Data

Table 1 Descriptive Statistics

Variable	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
WTP	76.8	12.9	165.7	0.0	93000.0	23.4	64.4	1404.6
ES Terrestrial	0.521	0.039	0.501	0.000	0.000	1.000	1.000	1.000
ES Marine	0.394	0.038	0.490	0.000	0.000	0.000	1.000	1.000
ES Fresh Water	0.085	0.022	0.280	0.000	0.000	0.000	0.000	1.000
Cultural	0.588	0.038	0.494	0.000	0.000	1.000	1.000	1.000
Provisioning	0.267	0.035	0.444	0.000	0.000	0.000	1.000	1.000
Supporting	0.436	0.039	0.497	0.000	0.000	0.000	1.000	1.000
Regulating	0.327	0.037	0.471	0.000	0.000	0.000	1.000	1.000
SD Interview	0.665	0.037	0.474	0.000	0.000	1.000	1.000	1.000
SD Questionnaire online	0.329	0.037	0.471	0.000	0.000	0.000	1.000	1.000
SD Secondary data	0.050	0.017	0.218	0.000	0.000	0.000	0.000	1.000
CE	0.461	0.039	0.500	0.000	0.000	0.000	1.000	1.000
CVM	0.400	0.038	0.491	0.000	0.000	0.000	1.000	1.000
REVEALED	0.139	0.027	0.347	0.000	0.000	0.000	0.000	1.000
Alpine	0.133	0.027	0.341	0.000	0.000	0.000	0.000	1.000
Atlantic	0.236	0.033	0.426	0.000	0.000	0.000	0.000	1.000
Boreal	0.139	0.027	0.347	0.000	0.000	0.000	0.000	1.000
Continental	0.212	0.032	0.410	0.000	0.000	0.000	0.000	1.000
Macaronesian	0.006	0.006	0.078	0.000	0.000	0.000	0.000	1.000
Mediterranean	0.279	0.035	0.450	0.000	0.000	0.000	1.000	1.000
Steppic	0.006	0.006	0.078	0.000	0.000	0.000	0.000	1.000
Marine Atlantic	0.176	0.030	0.382	0.000	0.000	0.000	0.000	1.000
Marine Black Sea	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marine Baltic	0.042	0.016	0.202	0.000	0.000	0.000	0.000	1.000
AGE	44.221	0.624	6.301	28.620	40.088	43.000	49.350	58.000
INCOME	27969	1210	15160	2398	18267	24512	35371	104030
GENDER	0.489	0.009	0.087	0.170	0.463	0.510	0.540	0.640
EDUC	0.554	0.178	2113.000	0.104	0.265	0.360	0.460	25.400

Policy, Site, Population & Resource Variables

Methodological Variables

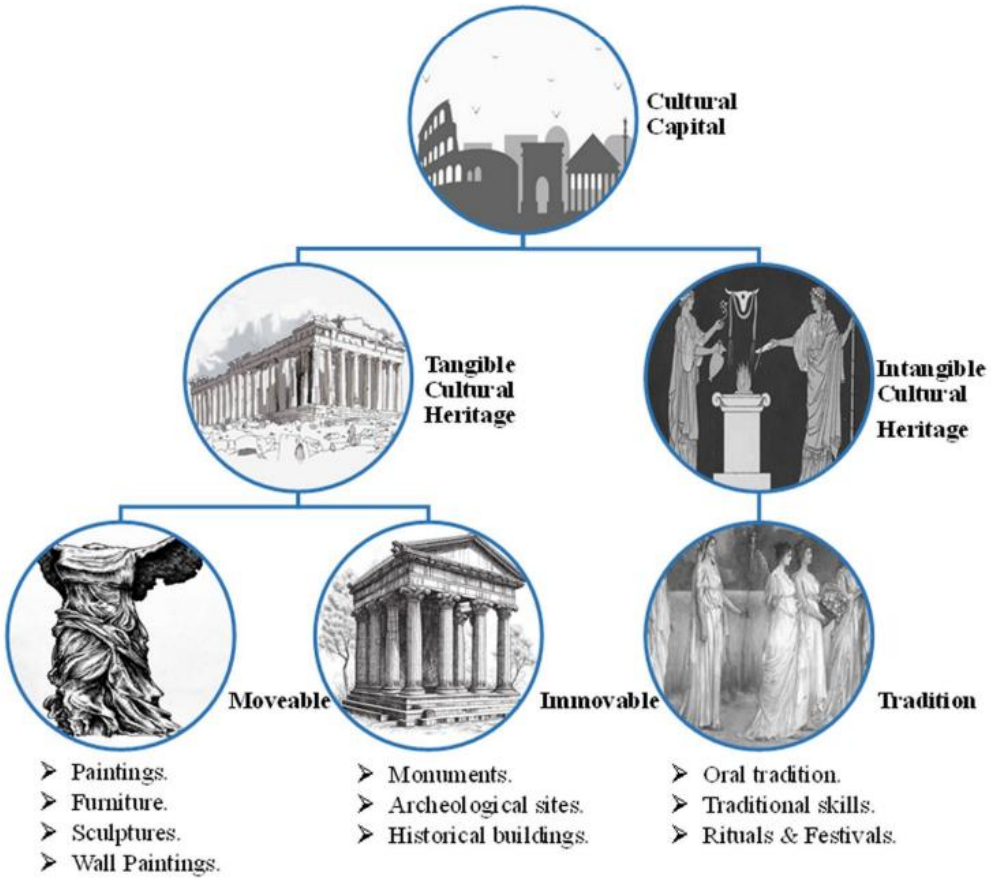
MRM Estimation – Benefit Transfer Models

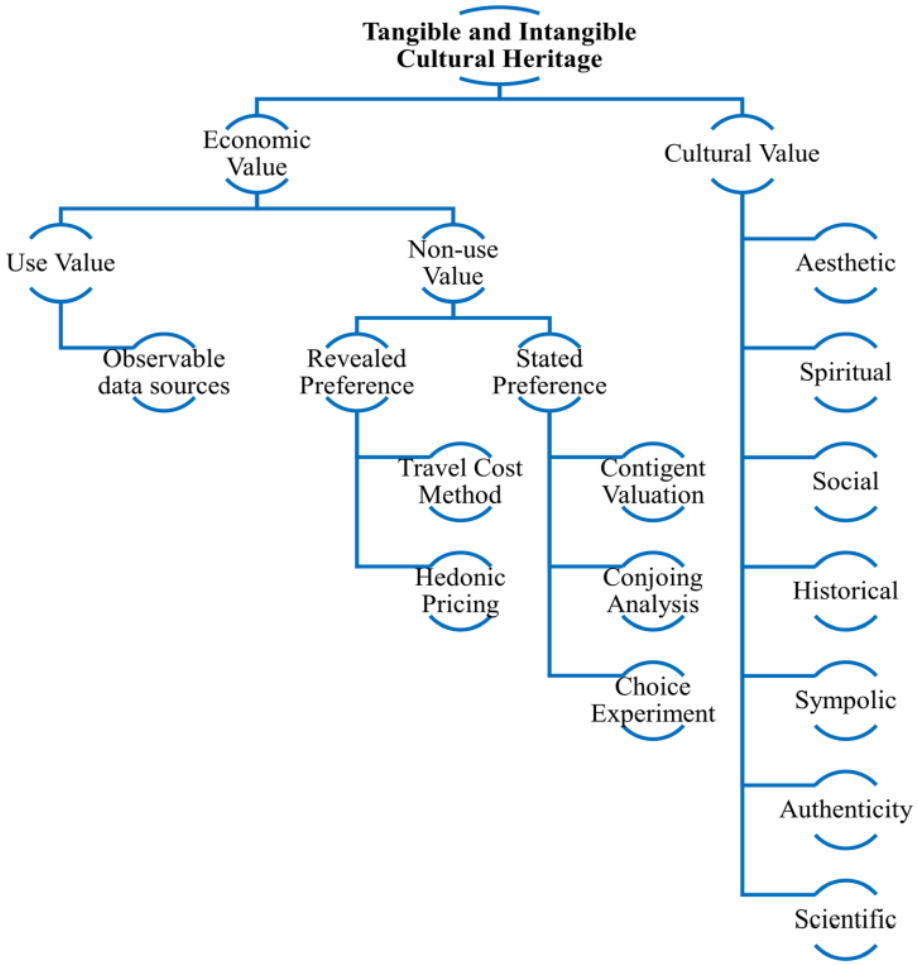
- **MRM:** $\mathbf{WTP_i = \beta' X_i + \varepsilon_i}$ **(Weighted Least Squares)**
- Newey West Standard Error in parenthesis
- Bold denotes 5% statistical significance
- Model Selection – Minimizes BIC

	All Ecosystems	Terrestrial	Marine & Fresh Water
ALPINE	**148.94**	**105.93**	43.01
	[0.020]	[0.041]	[0.279]
ATLANTIC	**-86.23**	-21.91	**-64.32**
	[0.084]	[0.487]	[0.091]
BOREAL	-82.96	19.39	**-102.34**
	[0.286]	[0.748]	[0.040]
CONTINENTAL	-48.36	-7.07	-41.29
	[0.162]	[0.817]	[0.269]
MEDITERRANEAN.	**-91.73**	**-54.37**	-37.36
	[0.057]	[0.069]	[0.344]
MARINE_ATLANTIC	**-74.40**	**-62.46**	-11.95
	[0.106]	[0.059]	[0.779]
PROVISIONING	**59.32**	25.77	33.55
	[0.075]	[0.292]	[0.259]
REGULATING	**53.19**	12.98	**40.21**
	[0.224]	[0.541]	[0.214]
SUPPORTING	**42.70**	13.46	29.24
	[0.117]	[0.599]	[0.312]
SD_QUESTIONNAIRE	-42.09	**-50.20**	8.11
	[0.351]	[0.118]	[0.803]
AGE	**3.77**	**1.14**	**2.64**
	[0.007]	[0.127]	[0.023]
EDUCATION	**-5.20**	-0.60	-4.60
	[0.187]	[0.853]	[0.387]
CHOICE_EXPERIMENT	**-79.15**	-0.52	**-78.63**
	[0.157]	[0.983]	[0.126]
CONTINGENT_VALUATION	-60.07	10.78	**-70.84**
	[0.297]	[0.704]	[0.161]
R-squared	0.32	0.27	0.18
Adjusted R-squared	0.20	0.15	0.04
F-statistic	**87.90**	**75.71**	**1.96**
	[0.000]	[0.000]	[0.0229]
MWTP	**80.53**	**38.42**	**42.10**

Koundouri et al, 2024 Methodology

Fig. 1 Tangible and intangible aspects of cultural capital. Source: Authors' elaboration inspired by UNESCO [3]





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MRM Estimation – Benefit Transfer Models

Variables	European Countries (n = 51)	Non-European countries (n = 55)
Gender	6.0392 [0.3536]	
Income	− 1.0532 [0.1177]	− 0.2460 [0.0586]
Education	8.0032 [0.0074]	− 10.4789 [0.2434]
Age		1.4511 [0.1288]
Cultural value		
CV_Aesthetic	− 63.5646 [0.0018]	17.8077 [0.4664]
CV_Authenticity		32.9540 [0.2798]
CV_Spiritual	− 50.0845 [0.0252]	− 40.7892 [0.2342]
CV_Symbolic		32.3384 [0.2036]
CV_Social		38.0880 [0.2361]
Cultural heritage goods & services		
Intangible goods	114.3066 [0.0114]	164.1822 [0.0238]
Intangible social habits	− 50.5228 [0.0582]	− 177.9597 [0.0551]
Intangible traditional skills	− 57.2029 [0.0512]	147.2847 [0.0164]
Intangible oral tradition		− 168.7514 [0.0034]
Tangible archaeological	− 78.6118 [0.0017]	
Tangible historical buildings	73.5298 [0.0083]	
Tangible paintings	− 77.8216 [0.0077]	
Diagnostic tests		
R-square	0.4064	0.5127
ARCH effect test	0.0128 [0.9099]	0.1259 [0.7226]
Heteroskedasticity Glejser	14.1405 [0.2253]	21.54 [0.0430]
HeteroskedasticityHarvey	14.8782 [0.1881]	21.5420 [0.0430]
Heteroskedasticity White	9.6655 [0.5607]	14.878 [0.1881]
Total WTP (in EUR)	37.6	60.12

$$WTP_i = \alpha + \sum_{i=1}^{I} \beta_i Q_i + \sum_{i=1}^{I} \gamma_i X_i + \sum_{i=1}^{I} \delta_i M_i + \varepsilon_i$$

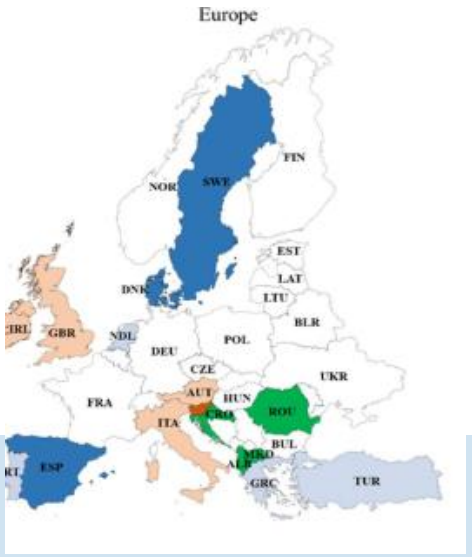
α is the intercept

β, γ, *and* δ represent the parameters to be estimated as slopes of the specifications:

quality-quantity variables (Q)

socioeconomic variables and area characteristics (X),

methodological variables (M)



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Benefit Transfer Models- Specifications for Cyprus

Table 9. Ecosystem Services - Benefit Transfer Functions and Specifications for Cyprus

Model Parameters Marine Ecosystem (Koundouri et al., 2022)		Specification Provisioning	Specification Regulating	Specification Supporting	Model Parameters European Cultural (Koundouri et al., 2023)		Specification Cultural
Alpine	43.01	0.00	0.00	0.00	Gender	60.30	0.47
Atlantic	-64.32	0.00	0.00	0.00	Income	0.00	35.69
Boreal	-102.34	0.00	0.00	0.00	Education	80.21	0.57
Continental	-41.29	0.00	0.00	0.00	CV_Aesthetic	-63.55	0.52
Mediterranean	-37.36	1.00	1.00	1.00	CV_Spiritual	-50.18	0.14
Marine_Atlantic	-11.95	0.18	0.18	0.18	Intabgible Goods	114.46	0.56
Provisioning	33.55	1.00	0.00	0.00	Intagible Social Habits	-50.59	0.28
Regulating	40.21	0.00	1.00	0.00	Intangible Traditional Skills	-57.22	0.46
Supporting	29.24	0.00	0.00	1.00	Tangible Archaeological	-78.35	0.12
sd_questionnaire	8.11	0.33	0.33	0.33	Tangible Historical Building	73.68	0.36
age	2.64	37.90	37.90	37.90	Tangible Paintings	-77.88	0.10
education	-4.60	0.57	0.57	0.57			
choice_experiment	-78.63	0.46	0.46	0.46			
contingent_valuation	-70.84	0.40	0.40	0.40			

- The most recent socioeconomic data such as the mean population age, the share of population with tertiary education, the average annual disposable household income, the number of Households and the gender balance were obtained by the National statistical agency of Cyprus (CY-Stat)

MSFD Cyprus

Table 98. MSFD Cyprus - Levels and Monetary Value of ecosystem services.

MSFD Ecosystem Services		MEA Ecosystem Services Link			Levels			Million Euros Per Year
Code	Description	Cult-ural	Provisi-oning	Regu-lating	Status 10 years ago	Status today	Short Description of change in the status	
1. EcosysServ All	All ecosystem services	x	x	x	Good status	Good status	Given that the majority of the ES are in Good condition we consider the All-Ecosystem Services category to be in Good	49.929
1.1 EcosysServ NutrAll	All ecosystem services related to nutrition		x		Moderate status	Moderate status	We consider the ES to be in Moderate Condition as the ES on Aquaculture is in Good and ES on fisheries Under Pressure. We consider that Aquaculture products compensate inadequacies in the Fisheries ES	
1.1.1 EcosysServ NutrSeafoodAnimals	Wild animals and their outputs		x		Under pressure	Under pressure	Fisheries Stocks were and continue to be Under Pressure Therefore based on Expert Judgment, we consider them to be at a Moderate Status.	
1.1.2 EcosysServ NutrAquacAnimals	Animals from in-situ aquaculture		x		Good status	Good status	The Cypriot Aquaculture Sector, according to the Multiannual National Strategic Aquaculture Plan 2021 – 2030 (DFMR 2021), composes more than 80% of the total quantity of Cyprus fishing production and is considered the 3rd most important exported product in value of the Primary Agriculture Sector (DFMR, 2021). Based on DFMR production and mariculture environmental monitoring data, the ES regarding the in-situ aquaculture is considered to be in Good status.	9.963
1.2 EcosysServ MatAll	All ecosystem services related to provision of materials		x			Good status	Category only includes EcosysServMatGenetic	
1.2.1 EcosysServ MatGenetic	Genetic materials from all biota		x			Good status	Genetic studies 10 years age are considered as non-existent or rather low in number. In the last years there has been an increasing trend into carrying out surveys, among others, aiming to investigate the	

- By implementing the Benefit transfer functions for Cyprus, the monetary value of Ecosystem services can be calculated, which can be used to assess the cost of their degradation.

- The total value of ecosystem services corresponds to €50 million per Year, where ***€33,019*** million refer to **Cultural services**, and **€9,9 and €6,9** million to **provisioning and regulating** accordingly. All services are classified as of Good Status, except “Wild animals and their outputs” which is Under Pressure, while the status of all ecosystem services had remained stable during the last 10 years.

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MSFD Cyprus-Provisioning

Table 2 MSFD Ecosystem Services List		MEA Ecosystem Services Link			LEVELS			Euros Per Year
Code	Description	Cultural	Provisioning	Regulating	Status 10 years ago	Status today	Short Description of change in the status	
1. EcosysServAll	All ecosystem services	x	x	x	Good status	Good status	Given that the majority of the ES are in Good condision we consider the All Ecosystem Services category to be in Good	€ 49.929.216,93
1.1 EcosysServNutrAll	All ecosystem services related to nutrition		x		Moderate status	Moderate status	We consider the ES to be in Moderate Condition as the ES on Aquaculture is in Good and ES on fisheries under Pressure. We consider that Aquaculture products compensates inadequacies in the Fisheries ES	
1.1.1 EcosysServNutrSeafoodAnimals	Wild animals and their outputs		x		Under pressure	Under pressure	Fisheries Stocks were and continue to be Under Pressure Therefore bases on Expert Judgment, we consider them to be at moderate status.	
1.1.2 EcosysServNutrAquacAnimals	Animals from in-situ aquaculture		x		Good status	Good status	The Cypriot aquaculture sector, according to the Multiannual National Strategic Aquaculture Plan 2021 – 2030 (DFMR 2021), composes more than 80% of the total quantity of Cyprus fishing production and is considered the 3rd most important exported product in value of the Primary Agriculture Sector (DFMR, 2021). Based on DFMR production and mariculture environmental monitoring data, the ES regarding the in-situ aquaculture is considered to be in GOOD status	€ 9.963.301,25
1.2 EcosysServMatAll	All ecosystem services related to provision of materials		x			Good status	Category only includes EcosysServMatGenetic	
1.2.1 EcosysServMatGenetic	Genetic materials from all biota		x			Good status	Genetic studies 10 years before are considered as non-existant or rather low. In the last years there has been an increasing trend into carrying out surveys, among others, aiming to investigate the connectivity of the N2Ks etc. by examining the DNA, eDNA analyses etc. covering inmportant aspects of the biodiversity conservation	

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MSFD Cyprus - Regulating

Table 2 MSFD Ecosystem Services List		MEA Ecosystem Services Link			LEVELS			Euros Per Year
Code	Description	Cultural	Provisioning	Regulating	Status 10 years ago	Status today	Short Description of change in the status	
2.1 EcosysServWasteAll	All ecosystem services related to mediation of waste, toxics and other nuisances			x	Good status	Good status	As in All 3 components the Status is good	€ 6.946.249,18
2.1.1 EcosysServWasteSmellVisImpacts	Mediation of smell/visual impacts			x	Good status	Good status	No events have been reported by the public regarding smell/visual problems. Therefore based on Expert Judgment, we consider this to be and remain in Good Status	
2.1.2 EcosysServWasteRemovalByOrgan	Filtration/sequestration/storage/ accumulation by micro-organisms, algae, plants, and animals			x	Good status	Good status	The chemical and biological condition was assessed through the indicators addressed by the Descriptors 5 and 8 and it generally found to be in Good Condition. Therefore based on Expert Judgment, we consider this to be and remain in Good Status	
2.1.3 EcosysServWasteRemovalByEcosys	Filtration/sequestration/storage/ accumulation by ecosystems			x	Good status	Good status	The chemical and biolofical condition was assessed through the indicators addressed by the Descriptors 5 and 8 and it generally found to be in Good Condition. Therefore based on Expert Judgment, we consider this to be and remain in Good Status	
2.2 EcosysServMainCondAll	All ecosystem services related to maintenance of physical, chemical and biological conditions			x	Good status	Good status	Category includes only EcosysServMainCondChem	
2.2.1 EcosysServMainCondChem	Chemical condition of salt waters			x	Good status	Good status	The chemical condition was assessed through the Indicators addressed by the Descriptors 5 and 8 and it generally found to be in Good Condition	

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MSFD Cyprus - Cultural

Table 2 MSFD Ecosystem Services List		MEA Ecosystem Services Link			LEVELS			Euros Per Year
Code	Description	Cultural	Provisioning	Regulating	Status 10 years ago	Status today	Short Description of change in the status	
3.1 EcosysServInteracPhyAll	All ecosystem services underpinning physical and intellectual interactions	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.1.1 EcosysServInteracPhyRecreat1	Experiential use of plants, animals and land-/seascapes in different environmental settings	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.1.2 EcosysServInteracPhyRecreat2	Physical use of land-/seascapes in different environmental settings	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.1.3 EcosysServInteracPhyScientif	Scientific	x			Good status	Good status	In the last decate there has been an increasing trend and interest in carrying our Scientific Research. Therefore based on Expert Judgment, we consider this to be and remain in Good Status	
3.1.4 EcosysServInteracPhyEducat	Educational	x			Good status	Good status	In the last decate there has been an increasing trend and interest in carrying our Scientific Research. Therefore based on Expert Judgment, we consider this to be and remain in Good Status	
3.1.5 EcosysServInteracPhyCultur	Heritage, cultural	x			Good status	Good status	The marine enviornment based on expert Judgment, was and continues to be in Good status, providing entertainment. Increasing trend	€ 33.019.666,49
3.1.6 EcosysServInteracPhyEntert	Entertainment	x			Good status	Good status	The marine enviornment based on expert Judgment, was and continues to be in Good status, providing entertainment to people. For Cyprus continues to rank on the 1st example Bathing Waters are continuesly	
3.1.7 EcosysServInteracPhyAesthe	Aesthetic	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.2 EcosysServInteracSpiAll	All ecosystem services underpinning spiritual, symbolic and other interactions	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.2.1 EcosysServInteracSpiSymb	Symbolic	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.2.2 EcosysServInteracSpiExis	Existence	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	
3.2.3 EcosysServInteracSpiBequ	Bequest	x			Good status	Good status	Based on Expert Judgment, we consider this to be and remain in Good Status	

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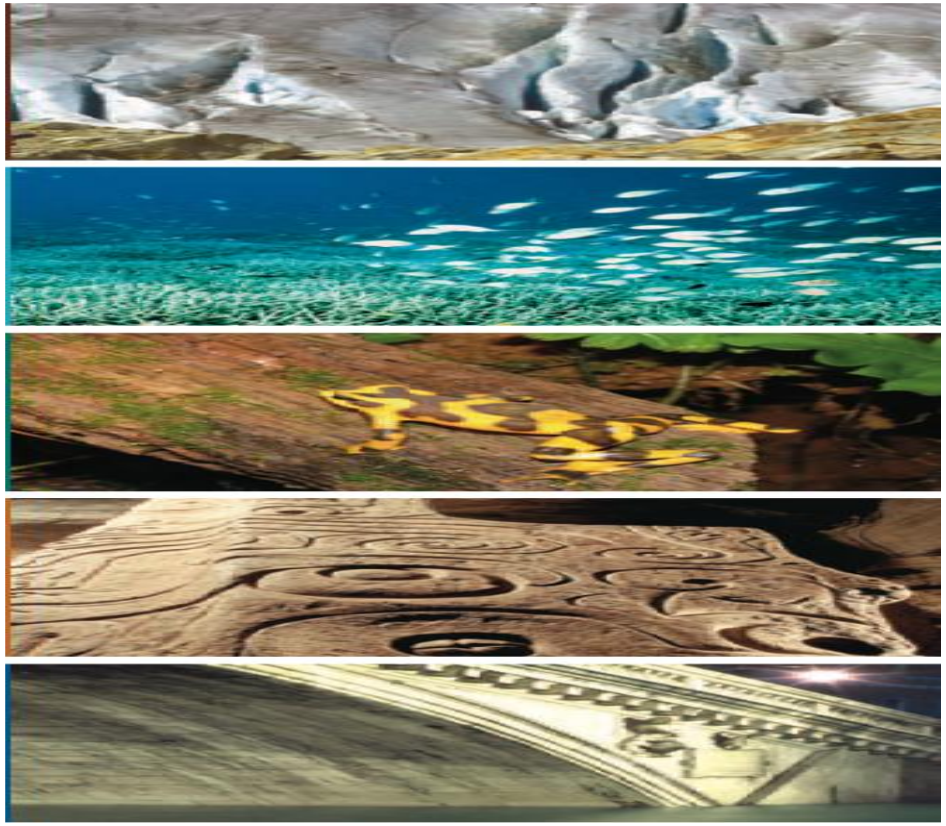


Sustainable Finance

Valuation of Cultural Heritage Services – Benefit Transfer

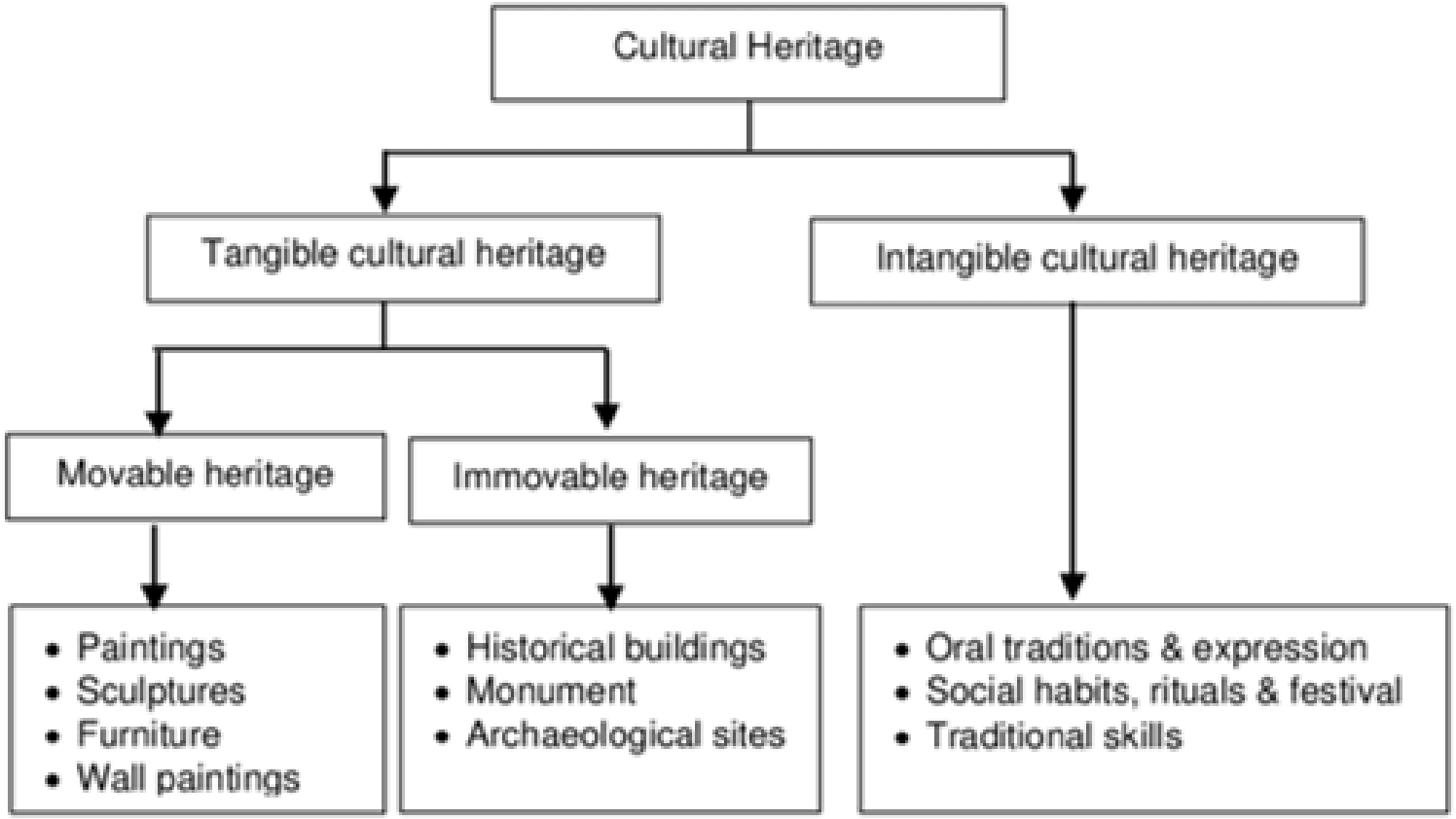
Cultural Heritage and Climate Change

Cultural heritage provides goods and services to society that are non-marketed, hence they have no explicit price, but have value

- Cultural heritage comprises a variety of assets and sites that are often in need of maintenance, repair or refurbishment. Recently, there has been increasing recognition of the need to identify and assess the value of cultural heritage assets in order to guide investments in maintenance and conservation programs.
- World Heritage properties are affected by the impacts of climate change at present and in the future.
- Their preservation requires understanding these impacts to their Outstanding Universal Value and responding to them effectively.
- Cultural heritage CC adaptation:
  - reductions or avoidance of adverse effects from CC
  - exploitation of beneficial management opportunities

Total Economic Value of Cultural Heritage

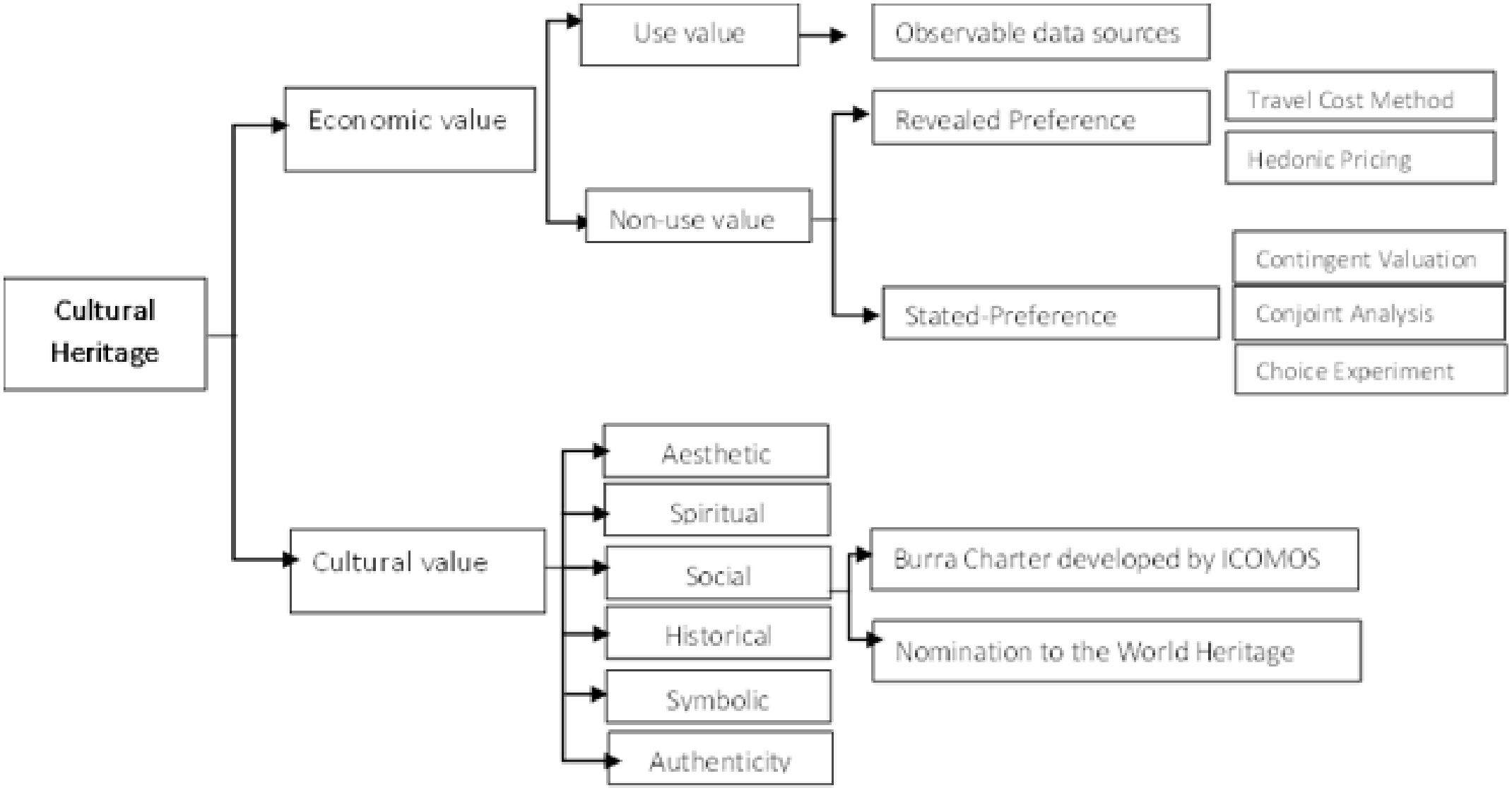
Fig. 1: Cultural Heritage Goods classification



Source UNESCO, 2003

Cultural Heritage - Valuation

Fig. 2: Cultural Heritage: economic and cultural value and valuation methodologies



Cultural Heritage – Meta-Regressions

Step 1: The dataset currently comprises 19 studies published between 2001-2020 and providing valuations for the shadow prices (WTP) of cultural heritage goods at various countries around the world.

Step 2: Meta-Regression Estimation of the value of ecosystem services using Benefit Transfer Method -Estimates economic values by transferring and adjusting existing benefit estimates, from studies already completed for another location.

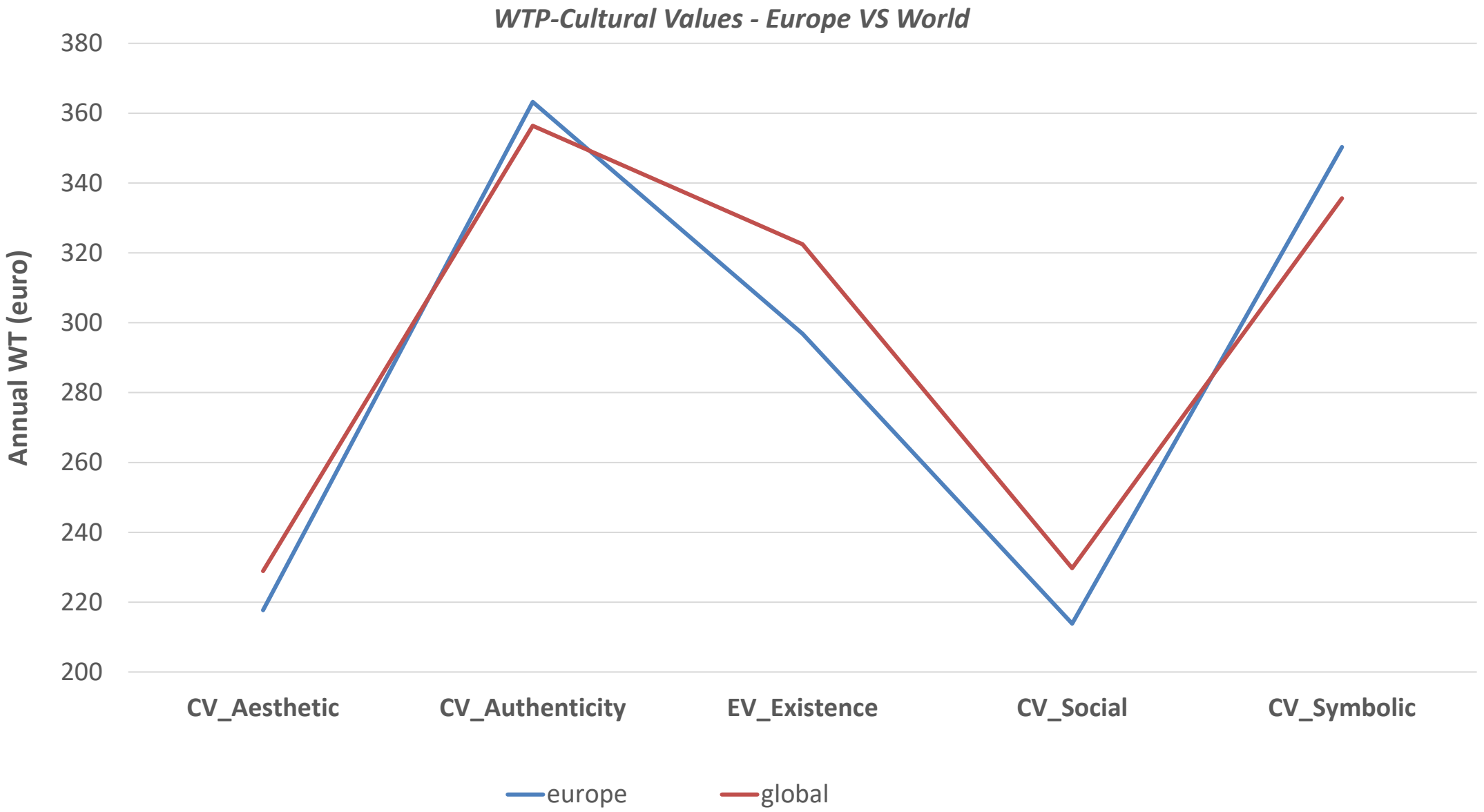
- Annual mean WTP for Cultural Services in Europe is ***46.41euro***
- Annual WTP for Cultural Services at a International level is ***39.78euro***

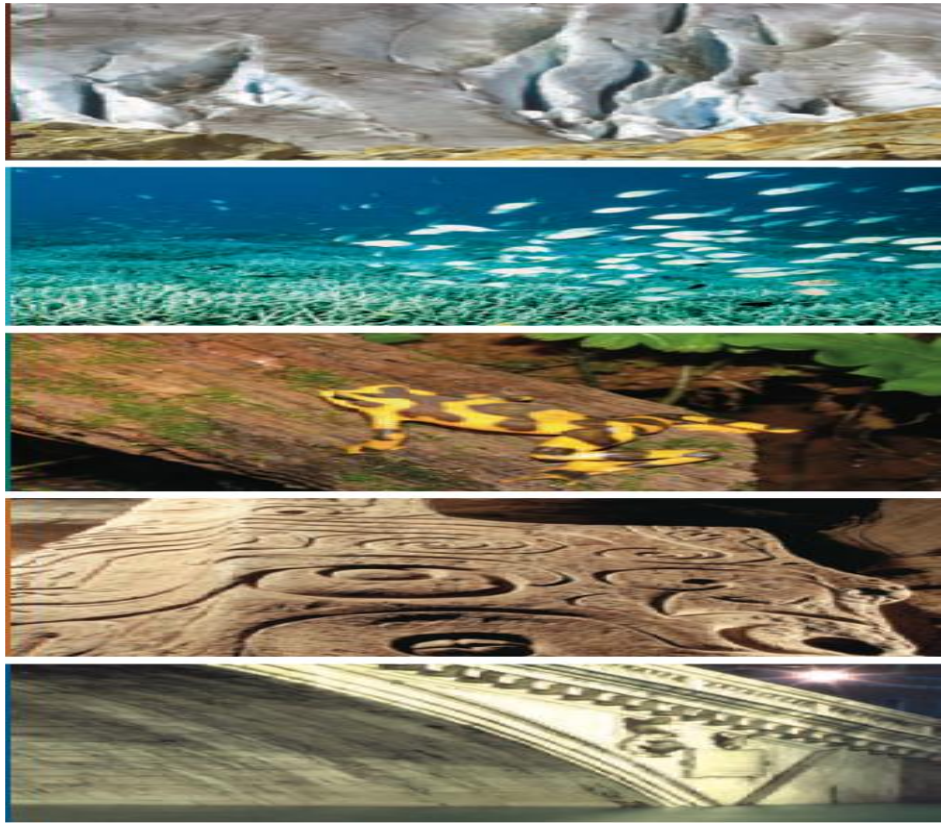
Table1 Cultural Heritage Meta-Regression Results

Variables	**EUROPE**	**GLOBAL**
Age	-5.7679 [0.338]	-2.3361 [0.3822]
Gender	**1184.085*** [0.0641]	**889.32**** [0.0198]
Income	0.002093 [0.3084]	**0.002147*** [0.0943]
CV_Aesthetic	**-179.8042**** [0.0480]	***-172.0732**** [0.0040]
CV_ Authentification	-34.2873 [0.6163]	-44.5934 [0.4121]
CV_Existence	***-100.636*** [0.2249]	**-78.50827*** [0.0941]
CV_Social	**-183.6599*** [0.0697]	**-171.2683***** [0.0041]
CV_Symbolic	-47.18176 [0.4920]	***-65.3534*** [0.2324]
R-square	0.67	0.60
Hetersoskedasticity Glejser test	[0.1177]	[0.4130]
ARCH test	[0.6958]	[0.5559]
Total WTP	**46.41**	**39.78**

P-values in brackets

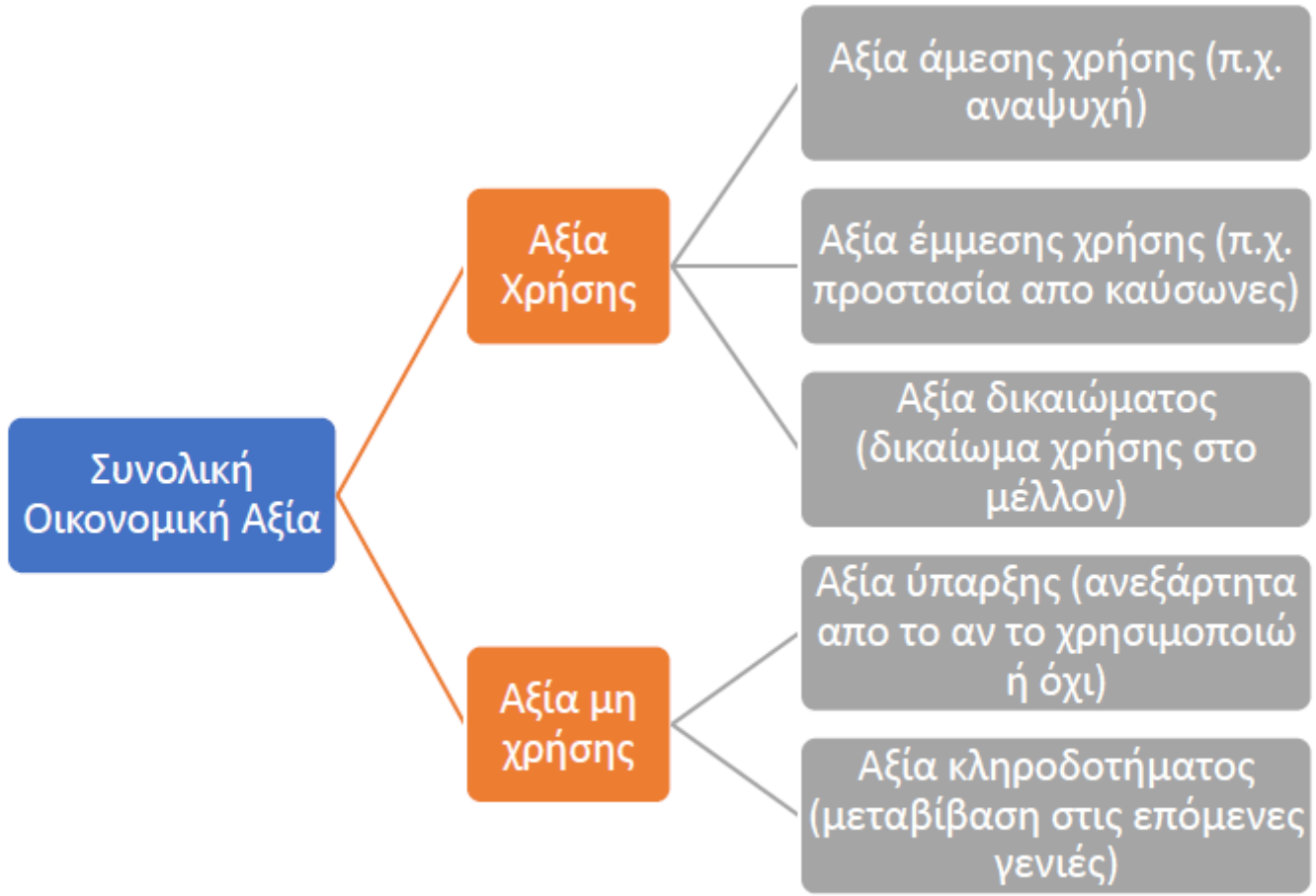
Cultural Heritage Services -WTP





Sustainable Finance

Valuation of Urban Parks in Greece– Benefit Transfer



Εικόνα 4 Απεικόνιση των συστατικών της Συνολικής Οικονομικής Αξίας

Πίνακας 3 – Περιγραφικά στατιστικά δείγματος

	WTP	POP	GEN	AGE	EDU	INCOME	EUROPE	ASIA
Μέσος	21.54	2494080	0.49	35.91	0.5	12782.47	0.36	0.52
Διάμεσος	7.86	1847000	0.49	35.91	0.5	10729.71	0	1
Μέγιστη Τιμή	103.64	8700000	0.6	46	0.84	38579.34	1	1
Ελάχιστη Τιμή	0.1	18000	0.41	23.57	0.15	371.25	0	0
Τυπική Απόκλιση	27.39	2757761	0.04	6.18	0.19	11617.28	0.49	0.51
Λοξότητα[11]	1.61	1.12	0.61	-0.26	0.1	0.63	0.58	-0.08
Κύρτωση[12]	4.69	2.84	4.34	2.58	2.18	2.13	1.34	1.01
Παρατηρήσεις	25	25	25	25	25	25	25	25

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j X_{i,j} + \varepsilon_i \quad (1)$$

Πίνακας 6 Αποτελέσματα Μετα-παλίνδρομης, εξίσωσης (1)

Μεταβλητή	Συντελεστής	Τυπικά Σφάλματα	t-Στατιστική	p value
β0	**-57.68***	29.64	-1.95	0.07
AGE	**2.25****	0.86	2.63	0.02
AGE*(1-ASIA)	**-2.59*****	0.79	-3.27	0.00
EDU	**-57.51****	25.71	-2.24	0.04
EDU*(1-ASIA)	**196.85*****	57.68	3.41	0.00
INCOME	**0.00095****	0.00045	2.13	0.05
POP	**0.0000053****	0.00000	2.49	0.02
R-squared	0.58			
Adjusted R-squared	0.43			
F-statistic	**4.08*****			
p value (F-statistic)	0.0093			
Schwarz criterion (BIC)	9.46			

$$\widehat{WTP} = \hat{\beta}_0 + \sum_{j=1}^{k} \widehat{\beta}_j \widetilde{X_{\iota,j}} \qquad (2)$$

Η εκτίμηση του Willingness to Pay (WtP), σε ετήσια κατά κεφαλήν βάση, προκύπτει από την εκτίμηση της σχέσης 1 του πίνακα 6 και την χρήση των Κοινωνικό-οικονομικών και δημογραφικών χαρακτηριστικά δήμου Αθηναίων ($\widetilde{X_{\iota,j}}$), από την σχέση 2:

$$\widehat{WTP} = 23{,}7 \varepsilon \upsilon \rho \acute{\omega}$$

Που αντιστοιχεί στο κατά κεφαλήν ετήσιο ποσό που είναι πρόθυμοι να πληρώσουν οι Αθηναίοι πολίτες για την διατήρηση του πάρκου Ριζάρη.

References

Koundouri et al, (2022), “Financing the Joint Implementation of Agenda 2030 and the European Green Deal”, 2nd Report of the SDSN Senior Working Group on the European Green Deal, Chapter 3.2, https://egd-report.unsdsn.org/.

Koundouri, P., Anquetil-Deck, C., Becchetti, L., Berthet, E., Borghesi, S., Cavalli, L., Chioatto, E., Cruickshank, E., Devves, S., Dibattista, I., Fusacchia, I., Giovannini, E., Halkos, G., Hansmeyer, C., Landis, C., Mazzarano, M., Papa, C., Patel, K., Plataniotis, A., Salustri, F., Tiwari, M.M., (2023) Transforming Our World: Interdisciplinary Insights on the Sustainable Development Goals, SDSN European Green Deal Senior Working Group

Koundouri P, Halkos G, Landis C, Dellis K, Stratopoulou A, Plataniotis A and Chioatto E (2023) Valuation of marine ecosystems and Sustainable Development Goals. Front. Environ. Econ. 2:1160118. doi: 10.3389/frevc.2023.1160118(*).

Benefit Transfer of Environmental and Resource Values, 2015, Volume 14, ISBN : 978-94-017-9929-4, https://link.springer.com/content/pdf/10.1007/978-94-017-9930-0.pdf

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