Overview of application and analyses on connected values of ecosystem services, plans and next steps

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„Challenges of valuation of nature“, ISTAT seminar

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Why develop and carry out analyses on values connected to ecosystem services?

Why ecosystem services' values matter in official statistics:

1

In general

- Monetary values are often expected
- Ecosystem services link ecology and the economy and inform decisions
- Monetary values require careful interpretation and transparency, but are not part of the SEEA EA standard yet
- Clear narratives are needed for policy and practical use

2

=> There is a need to:

- Clarify the semantics of values
- Bring together multiple value perspectives into a coherent system
- Support informed use of the values for policy and stakeholders
- Make ecological foundations more explicit in the interpretation of monetary values

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Where this work comes from — framework and partners

International frameworks

UN Statistics Division
SEEA EA international statistical standard.

UN London Group on Environmental-Economic Accounting
Work requested by London Group at its 30th meeting (Washington, 2024) and further specified at 31th meeting (Tallinn, 2025).
Work was presented to and reviewed by the UN London Group

Eurostat
Scope of the ecosystem services:

EU Regulation 691/2011 on environmental-economic accounts
Work is supported by Eurostat grants 2024-EE-EGD and 2025-EE-SUSTAINABILITY

Also presented at Ecosystem Services Partnership (ESP) Conferences

Who does the experimental work

National statistical offices
Statistics Estonia (Kaia Oras, Katlin Aun, Grete Luukas)
Statistics Netherlands / CBS (Sjoerd Schenau)
Istat / Italian National Statistics (Aldo Femia), national contributions

Estonian academic partners
University of Tartu: prof. Aveliina Helm
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Tallinn Univ. of Technology: prof. Ullas Ehrlich, Aija Kosk, Aljona Karlõševa

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System of Environmental Economic Accounting

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Oras et al „Empirical insights into the multiple economic values of ecosystems: applications and reflections “, 2025

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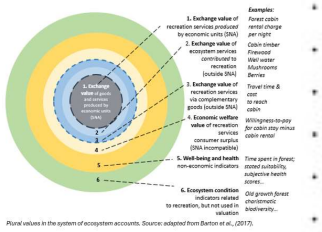
Bringing together values from different perspectives



Plural values in the system of ecosystem accounts. Source: adapted from Barton et al., (2017).

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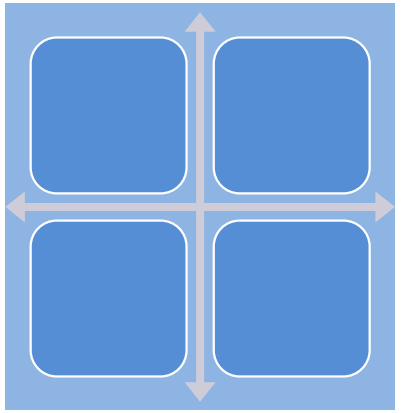
Monetary values on ecosystems...

...representing the whole range of actual transactions, embodied values, assets at risk, rents, opportunities…

…are allocated to the multi-layered matrix of monetary values connected/related to ecosystem services



…based on ecosystem service status (exist/does not exist) and monetary values status/scenarios

The reference scheme for the treatment of multiple economic values connected to ecosystems

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights	Rent of the land, directly observable prices applied to actually traded volumes, observed value of actually observed transactions in tradable permits	X
		Ecosystem services are potentially traded as private usage rights	Directly observable prices applied to potentially for sale permits of using the ES	
		ES is used for producing other goods or services	Resource rent, residual value, hedonic pricing	
		Other (outside or inside of SEEA-EA, within SEEA CF, other satelllie accounts or SNA)	Travel cost method, effective carbon rates	
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		Abatement and substitution costs, averting behaviour
		ES restoration as economic activity*		Restoration costs
		Marketisation of the ES (with or without perfect price discrimination)	Prices applied to quantities of ES not actually traded or tradable under current institutional arrangements WTP for maintaining ES	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		Social cost of lacking ES, expected damages

*-Femia AM, Capriolo A (2022) Beyond valuation. Monetary aggregates for the SEEA-EA. The Italian proposal. One Ecosystem 7: e84689. https://doi.org/10.3897/oneeco.7.e84689

Estonian figures

Dutch figures

Further possible connected values

Ecosystem servces
Crop provision
Wood provision
Pollination
Global climate regulation
Local climate regulation
Air filtration
Nature-based tourism

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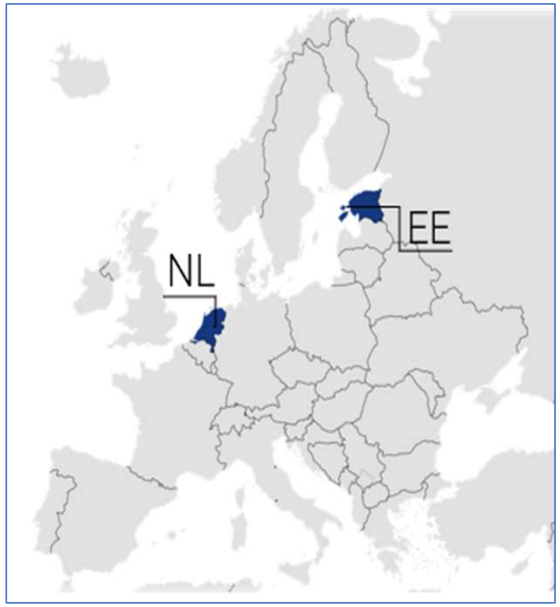
Empirical work: collaborative methodological mapping of the ecosystem services related valuation methods

Scope:

- Ecosystem services: EU regulation on environmental economic accounts
- Methods: existing practices in Estonia and the Netherlands.



	EE	NL
Area, km²	45 339	41 850
Popula-tion	1.35 million	17.6 million
GDP	41 billion EUR	1 trillion EUR
GDP per capita	30 400 EUR	61 600 EUR

Oras et al „Empirical insights into the multiple economic values of ecosystems: applications and reflections “, 2025

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Dutch figures

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Crop provision: market values and the hidden contribution of ecosystems

			Ecosystem service in scenorio	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	ES traded as a right of private usage (observed transactions volumes)	**100** (land rent, use rights on assets)	X
			590 (land rent, use rights on assets)	
		ES potentially traded as a right of private usage (observed prices applied to stocks)		
		ES is used for producing other goods or service	**14.9** (resource rent of NACE A.1 agriculture activity)	
			959 (resource rent NACE A.1 agriculture activity)	
		Other (outside or inside of SEEA-EA, within SEEA CF, other satelllie accounts or SNA)	**300** (crops, final product)	
			4 769 (crops, final product)	
			agricultural subsidies (organic farmic, general support scheme, etc)	
	"would appear" (does not exist in reality, does in the scenario)	Avoiding the need of the ES as economic activity		
		ES restoration as economic activity		**1 500** (replacement of soil, NPV 3% DR, 50 years, total soil asset value 41 300).
		Marketisation of the ES	**1.4** (WTP for maintaining supply of agricultural production)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		

Unit: million euros, data refer for 2022 or last available year

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Further possible connected values

Ecosystem servces

- Crop provision
- Wood provision
- Pollination
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- Local climate regulation
- Air filtration
- Nature-based tourism

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Wood provision: market values and ecosystem contributions reflected in them

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	ES traded as a right of private usage (observed transactions volumes)		X
		ES potentially traded as a right of private usage (observed prices applied to stocks)	Timber asset value **20 639** Net income (NPV) (a) **3 900** (land value) (a)	
		ES is used for producing other goods or services	**86** (Land value annuity method - rent on land only) **171** (residual value, resource rent of forest activity A02) **20** (residual value of forest activity A02)	
		Other (outside or inside of SEEA-EA, within SEEA CF, other satellite accounts or SNA)	**762** Harvest at stumpage prices **565** Net increment from FAWS plus removals from OWL and FNAWS in stumpage prices **99** harvest (timber felled /per year and in stumpage prices) **1,5** (reforestration subsidy 2022)	
	"would appear" (does not exist in reality, does in the scenario)	Avoiding the need of the ES as economic activity		
		ES restoration as economic activity		
		Marketisation of the ES		
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		

Unit: million euros, data refer for 2022 or last available year

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Pollination: from weak market signals to strong economic dependency

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights		X
		Ecosystem services are potentially traded as private usage rights		
		ES is used for producing other goods or services		
		Other (outside or inside of SEEA-EA, within SEEA CF, other satellite accounts or SNA)	0.57 (payment for ecosystem services, subsidy on establishing fields that are attractive for foraging to pollinators)	
			256 €/ha (restoration subsidy), if applied to actually benefitting areas	
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		Hand pollination/designated pollination by domesticated bee species (substitution cost - averting behaviour)
		ES restoration as economic activity*		256 €/ha (restoration cost), if applied to areas providing the service
		Marketisation of the ES	3.3 (WTP for enabling pollination and honey collection)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		62.4 (production change - dependency rate)
				134 (production change - dependency rate)

Unit: million euros, data refer for 2022 or last available year

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Global climate regulation: market flows, monetisation and risk-based values

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights	**249** (Directly observed volume of actual transactions in tradable permits)	X
		Ecosystem services are traded as potentially private usage rights	Directly observable prices applied to the existing stock of tradable permits held by economic units	
		ES is used for producing other goods or services		
		Other (outside or inside of SEEA-EA, within SEEA CF, other satellite accounts or SNA)	Effective carbon rate payments, total	
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		Abatement cost **1 681 788** (C stock)
				Efficient carbon rate - averting behaviour **184** (C sequestration)
		ES restoration as economic activity		Cost of planting and raising trees
		Marketisation of the ES	Directly observable prices (EU ETS price) **1 259 582** of which: **1 259 427** stock, **154** sequestration	
			Contingent valuation (WTP for maintaining ecosyst. C capture) **13** (sequestration)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged (=other negative changes in value=) because of the lack of the ES		Social cost of carbon (cost of having C in atmosphere) **2 514 829** (C stock)
				Social cost of carbon **36.3 – 185.7** (C sequestration)

Unit: million euros, data refer for 2022 or last available year

The matrix in a simple form: one selected value per one ecosystem service "global climate regulation"

	Ecosystem service EXISTS	Ecosystem service DISAPPEARS (hypothesis)
Value OBSERVABLE	**Global climate regulation** **€ 249 M** Volume of actual transactions in tradeable permits *Real transaction.*	X
Value APPEARS/ DISAPPEARS	**Global climate regulation** **€ 154 M** ETS (Emission Trading System) prices x sequestrated amount of C *Monetization of ecosystem services.*	**Global climate regulation** **€2.5 trillion** Unit social cost of carbon (623 EUR/t of C) applied to C stock values (4 035 M tons C) *A warning signal, the projected cost of damages avoided by keeping carbon in ecosystems*

What is missing… next steps

UN London Group on environmental economic accounting and contributing experts acknowledged the importance of the mapping of the values and urged to:

1 **Develope further the semantics and links to national accounts**

… and widen the scope to:

2 **Input-Output (IO) analysis**

To follow 'who directly uses nature' and 'who ultimately depends on nature' — across the full supply chain..

3 **Socio-ecological characterization of services**

A standardized profile per service describing the ecological and social conditions under which a service is delivered — making monetary values interpretable.

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Input-Output analyses: beyond the first user

How important are ecosystems to the economy — not just for the first user, but across the entire supply chain?

Standard ecosystem accounts…

…identify who directly uses an ecosystem service. But the economic value flows far beyond the first user.

Input-output analysis lets us follow

Traces how the direct dependency from ecosystem service of certain production or consumption activities propagates through the economy — downstream from suppliers and upstream from final consumers.

This is one missing link

Between 'who directly uses nature' and 'who ultimately depends on nature' — across the full supply chain.

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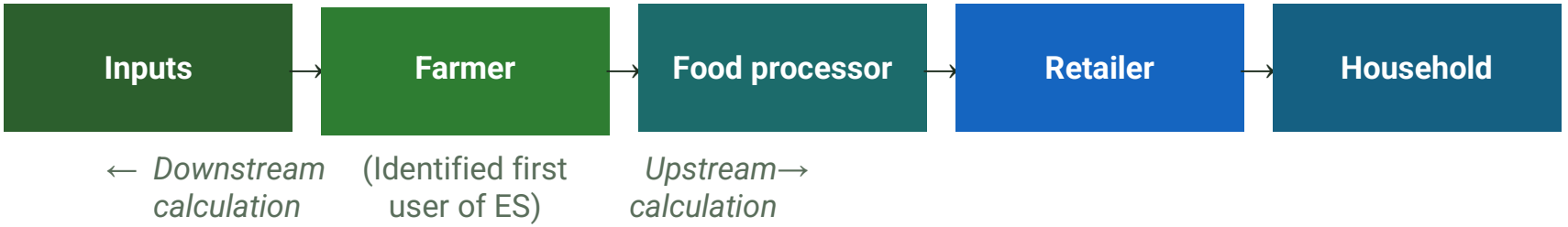
C. Rozendal, S. Schenau, „Structural analysis ecosystem accounting“ Report Eurostat Grant 2023, European Commission

Input-Output analyses: following the benefit and/or value beyond the first user

Standard ecosystem accounts identify who directly uses an ecosystem service.
But the economic value flows far beyond the first user.



IO analysis calculates how much of the value which is dependent on original ecosystem service is carried forward at each step — both toward:

- final consumers (upstream)
- back toward supplying sectors (downstream).

C. Rozendal, S. Schenau, „Structural analysis ecosystem accounting“ Report Eurostat Grant 2023, European Commission

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What the potential results show

Dependency of the economy on ecosystem services:

Main dependent activities:

Which economic sectors depend directly and indirectly on ecosystem service(s).

Degradation effects:

How degradation of ecosystem services affects national economic sectors, households, investments, and exports.

Dependency indicators:

Indicators reflecting dependencies — for example exports, household final consumption.

*Example (Netherlands): For crop provisioning, 74% of ecosystem benefit reaches domestic final consumers; 26% is embodied in exported services.**

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C. Rozendal, S. Schenau, „Structural analysis ecosystem accounting“ Report Eurostat Grant 2023, European Commission

Limitations

The structural analysis shows how much different sectors depend directly and indirectly on ecosystem services.

It does NOT show what happens when ecosystem condition deteriorates:

Missing link: condition → service supply
Difficult to incorporate regulative services

Identifying which condition indicators drive changes in ecosystem service levels remains qualitative at this stage.

→ **What is the logical next step? Linking condition indicators to service supply models.**

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Socio-ecological perspective: the missing piece in the puzzle

SOCIO-ECOLOGICAL CHARACTERISATION „CONTEXT BOX“

What it would be?

A standardised profile — one per ecosystem service — **summarising the ecological and social conditions and dependencies** under which a service is delivered.

It will tells us:

- which ecosystem characteristics support the service;
- how vulnerable ecosystem service is to pressures;
- whether ecosystem service can be realistically restored or substituted;
- how confident we can be in the data and outcomes.

It is a step that makes monetary values interpretable.

Inspiration: IPBES (2018). Conceptualisation: Helm, Femia, et al.

What does it involve?

Science-based sketch of ecosystem functioning

A concise description of what ecological functions and processes underpin the service.

⚠ Vulnerability profile of the service

Thresholds, resilience limits, and conditions under which the service provision could decline or collapse.

Basis for interpreting connected monetary values

Helps decision-makers judge whether a number is a market signal or an ecological risk warning.

It does not produce new numbers but helps to understand what do they mean.

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Socio-ecological characterisation: one box per ecosystem service

1 Main ecosystem dependencies

e.g. habitat extent and condition, landscape configuration, absence of negative drivers

2 Ecosystem resilience

e.g. vulnerability of pollinators to pesticides. Impact of negative drivers. Lower collapse threshold → less resilient ecosystem

3 Ecosystem processes/functions supporting the service

e.g. dependence on interactions (pollination), water regime, soil processes

4 Critical ecological thresholds

Where identified. E.g. habitat loss below XX% → collapse of service

5 Irreversibility & restorability

e.g. carbon stored in peatlands: recovery takes centuries/millennia → very low replaceability

6 Data quality & confidence class

High / Medium / Low · Brief justification (model-based, observed, perception-based)

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Example: Ecological context box — Pollination

1 Main dependencies

Species-rich (native) flowering vegetation. Diversity and availability of important pollinator habitats (food source and nesting sites). Presence of habitat corridors and lack of barriers for connectivity. Low pollution load.

2 Ecosystem resilience

Low resistance to pesticides, monocultures, climate extremes, landscape simplification. Resilience increases with diverse grasslands and mosaic landscapes. Low collapse threshold — fragile system.

3 Ecosystem functions

Wild pollinator habitat (bumblebees, solitary bees, flies, butterflies). Pesticide-free forage diversity. Landscape cohesion ensuring population survival.

4 Critical thresholds

Natural habitat below ~20–30% → stable pollination not provided.
Fragmentation reduces mobility non-linearly.
Spatial limitations for effective service provision.

5 Irreversibility

Recovery uncertain once populations decline below critical levels.
Recovery nearly impossible after extinction of species.
Manual pollination economically unrealistic at scale.

6 Data & confidence

MEDIUM. Modelled from spatial crop + habitat data (Wageningen method adapted). Pollinator habitat mapping incomplete; yield data reliable.

Valuation implication: Low market price ≠ low ecological importance. Values signal dependency and risk of loss — not substitutability.

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From characterisation to valuation: what would the box say

The ecological profile constrains which monetary values are valid in certain context. Three contrasting services:

Pollination	Global climate regulation	Nature-based tourism
Profile Low substitutability · threshold-like collapse · medium confidence	**Profile** Very long recovery · ETS market exists, social component underestimated · various social cost estimates	**Profile** Moderate resilience · direct user relationship · clear spending
✓ Valid values Dependency-based · risk-of-loss estimates	**✓ Valid values** ETS permit transactions · avoided damage (social cost)	**✓ Valid values** Expenditure-based market values · WTP adds welfare dimension
⚠ Caution Replacement cost NOT realistic — needs clear understanding on assumptions	**⚠ Caution** Stock vs annual flow (sequestration) values tell different story.	**⚠ Caution** Double-counting risk if recreation and tourism overlap

The ecological context box does not produce new numbers. It determines which numbers are trustworthy in certain context — and what they actually mean.

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Way forward in 2026

Develope further plural/connected values framework: **semantics, indicators, links to national accounts and typology.**

Try out input-output analysis for ecosystem services like timber, crop and nature tourism, which would help to follow 'who directly uses service' and '**who ultimately depends on it**' — across the full supply chain.

Populating socio-ecological perspective under which a service is delivered for selected ecosystem services.

Next presentations:

IARIW conference, August 2026
UN London Group, September 2026
ESP 2027 (?)

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Thank you!

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Dutch figures

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Local climate regulation: the importance of green infrastructure

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights		
		Ecosystem services are potentially traded as private usage rights		
		ES is used for producing other goods or services	3-10% higher real estate prices (hedonic pricing)	
		Other (outside or inside of SEEA-EA, within SEEA CF, other satelllie accounts or SNA)		
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		Cooling, shading by artificial means (substitution cost - averting behaviour)
		Ecosystem service restoration as economic activity*		
		Marketisation of the ecosystem service	1.7 (WTP for preservation and maintenance of urban green spaces that provide microclimate regulation)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		Avoided health damage costs

Unit: million euros, data refer for 2022 or last available year

Estonian figures

Dutch figures

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Air filtration: avoiding health costs

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights		
		The ES is appropriated and potentially traded as a right to use on its own		
		ES is used for producing other goods or services		
		Other (outside or inside of SEEA-EA, within SEEA CF, other satelllie accounts or SNA)		
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		
		ES restoration as economic activity		
		Marketisation of the ES	**5** (WTP)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		**1,3** (Avoided health cost, value transfer)
				167 avoided health cost

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Nature-based tourism: economic resources allocated to enjoying nature

			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does not exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	The ES is appropriated and actually traded as a right to use on its own		
		The ES is appropriated and potentially traded as a right to use on its own		
		ES is used for producing other goods or services		
		Other (outside or inside of SEEA-EA, within SEEA CF, other satellite accounts or SNA)	**576** (travel costs, accommodation costs, other costs)	
			3 390 (travel costs, accommodation costs, other costs), of which **1 150** (travel cost)	
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		
		ES restoration as economic activity		Restoration of the ecosystem regarding attractive characteristics for recreation
		Marketisation of the ES	**157** (alternative use of time)	
			25 (WTP for maintaining the infrastructure necessary for recreation in nature)	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		

Unit: million euros, data refer for 2022 or last available year

Why input-output analyses matters for policy

Ecosystem degradation does not only affect farmers:

Food supply chain competitiveness

Affects the competitiveness of the entire food supply chain, export revenues, and sectors supplying farmers with inputs.

Structural economic dependency

Reframes ecosystem services from an environmental concern into a structural economic dependency.

Cross-domain policy

Industrial policy, trade strategy, business risk assessment — not only environmental ministries and researchers.

C. Rozendal, S. Schenau, „Structural analysis ecosystem accounting“ Report Eurostat Grant 2023, European Commission

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