Watershed-scale environmental-economic accounting

Bridging SEEA-CF and SEEA-EA in a data-scarce developing country

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Argument in one slide

The gap

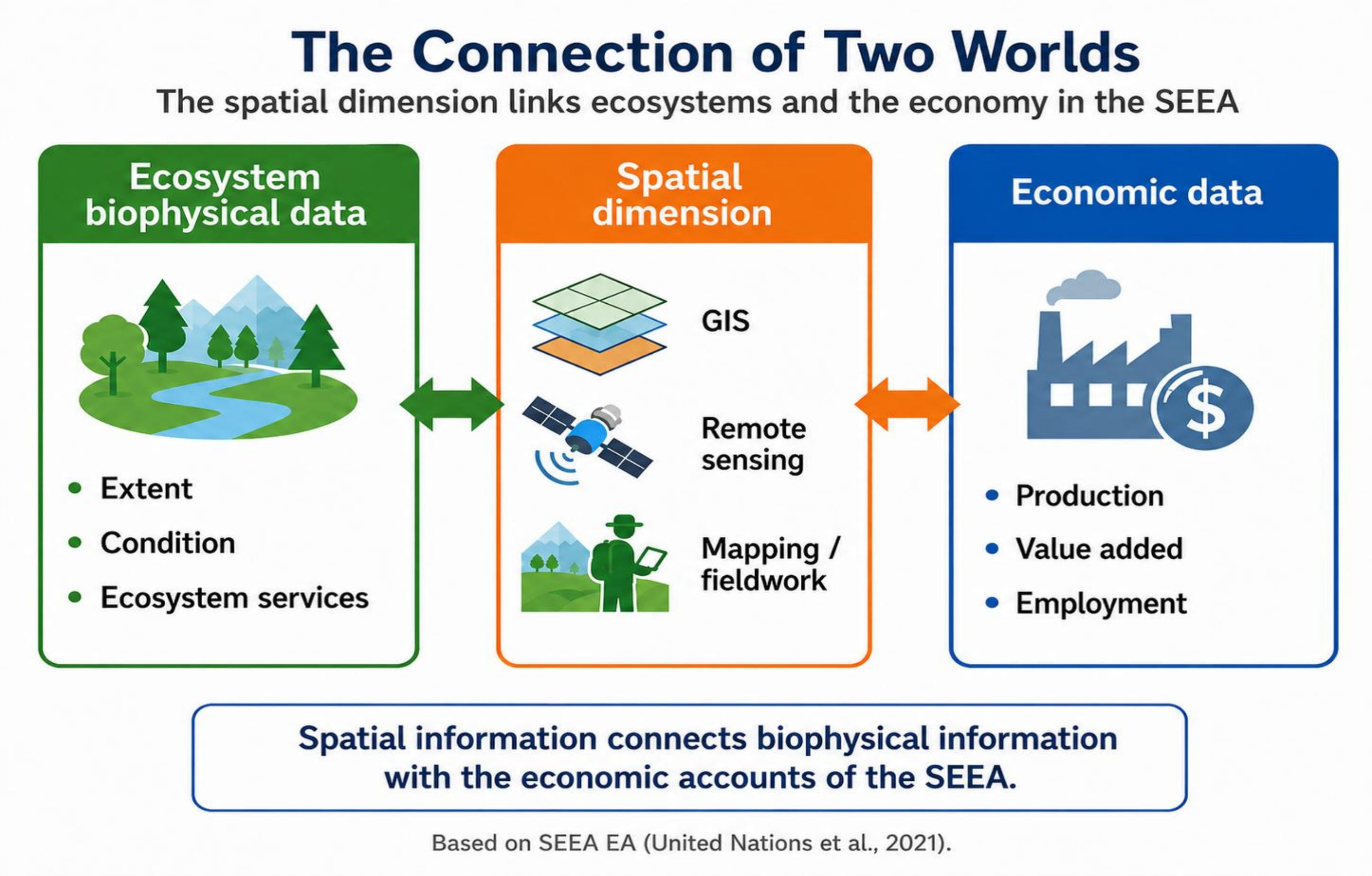
Economic accounts are national and sectoral. Ecosystem services are spatial and ecological. The missing piece is a common territorial unit.

The approach

Combine SNA and Supply and Use Table data with land use, nighttime lights, and InVEST ecosystem-service models at basin scale.

The output

Spatially explicit economic activity, ecosystem accounting areas, and water-use indicators by industry and territory.



Spatial information is the bridge between the ecological and economic sides of the SEEA.

What are we missing?

The central problem is not whether we can measure ecology or the economy. It is whether both can be organized at a spatial scale that allows them to be read together.

ECOlogy

We measure ecosystem extent, condition, and service capacity. But these flows are generated and experienced in specific places.

The spatial dimension

GIS, remote sensing, land-use mapping, and field information provide the common geography needed to connect both systems.

ECOnomy

The SNA measures production, value added, and employment by sector. These data are powerful but usually not organized by ecological boundaries.

Working proposition: use watersheds and empirically derived Ecosystem Accounting Areas to bridge both sides.

1. Spatialize the economy

Use the System of National Accounts as the economic backbone, then disaggregate value added to watershed

Agriculture

Allocate value added using land-use classes and the national Supply and Use Table.

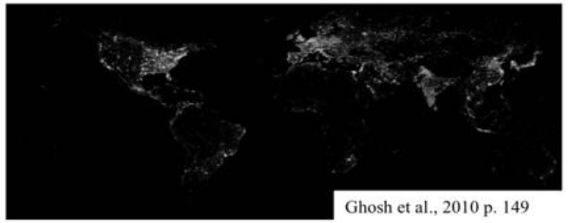
Non-agriculture

Use VIIRS nighttime lights as the spatial proxy for non-agricultural activity.

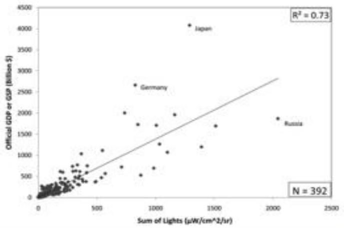
Output

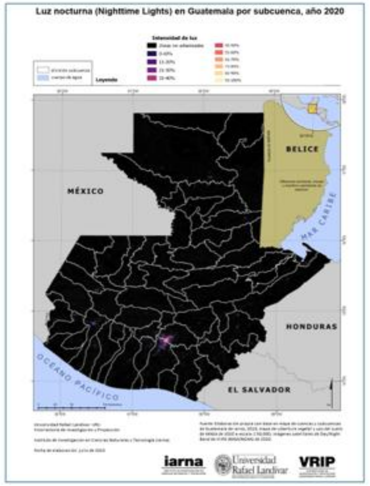
GDP by territory with the same ISIC/CPC logic used in the national accounts.

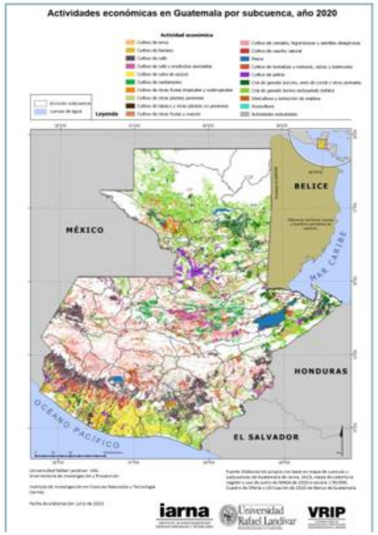
GDP estimation by watershed using nighttime light imagery (Ghosh et al., 2010) and land uses.



Ghosh et al., 2010 p. 149







Urbanized land use and industrial activities

Surveys and administrative data

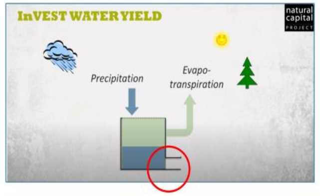
Agricultural land uses and activities

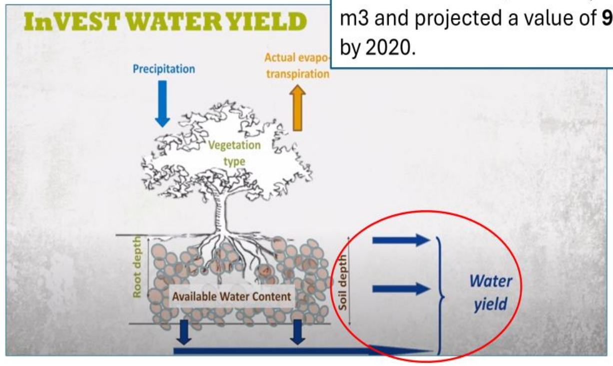
Reyes, Goyzueta, Castañeda et al. (2026), Research Square. https://doi.org/10.21203/rs.3.rs-9452018/v1

2. Measure water-related ecosystem services

InVEST provides a standardized way to model water yield and sediment dynamics for all 62 river basins using the same reference year.

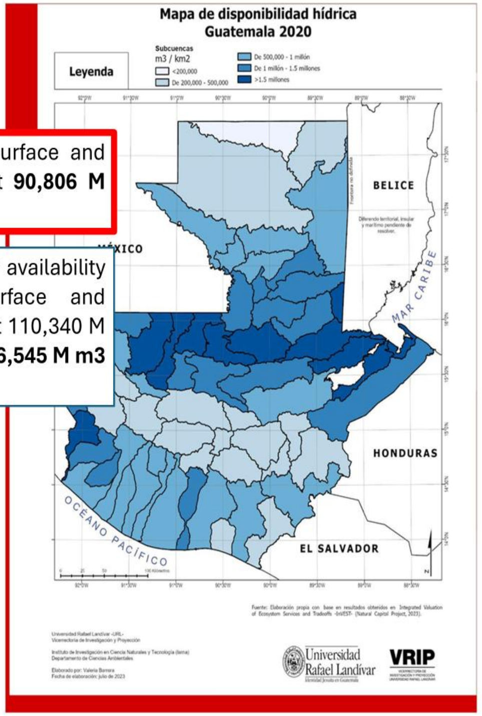
InVEST *water yield model* (Sharp et al., 2016)





-Runoff water (surface, subsurface and base flow) was estimated at **90,806 M m3.**

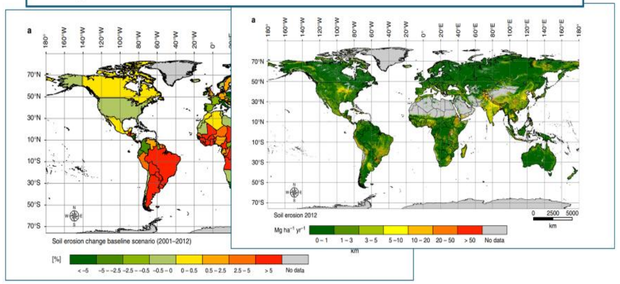
-Iarna (2013) estimated water availability (groundwater recharge, surface and subsurface runoff, and soil) at 110,340 M m3 and projected a value of **96,545 M m3** by 2020.



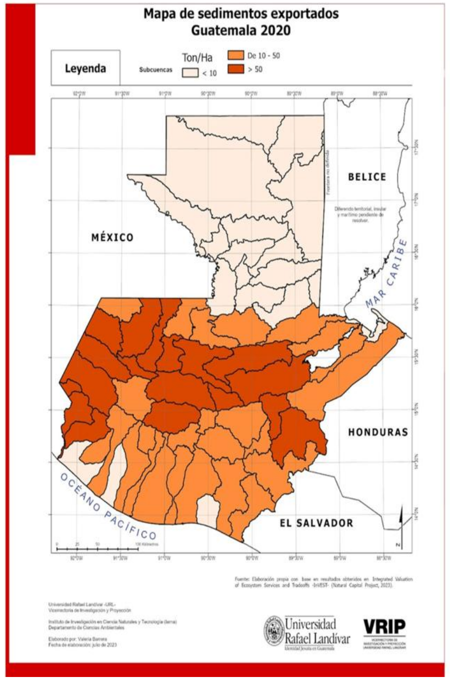
InVEST *Sediment retention model* (Sharp et al., 2016)

-Sedimentation exported was estimated at **343 M T** in 2020.
-Sedimentation avoided was estimated at 3,810 M tons.

- Iarna (2009) estimated potential erosion at **263 M ton/year.**
-During the period 2001-2012, Guatemala was one of the countries with the highest erosion potential (Borrelli et al., 2013).



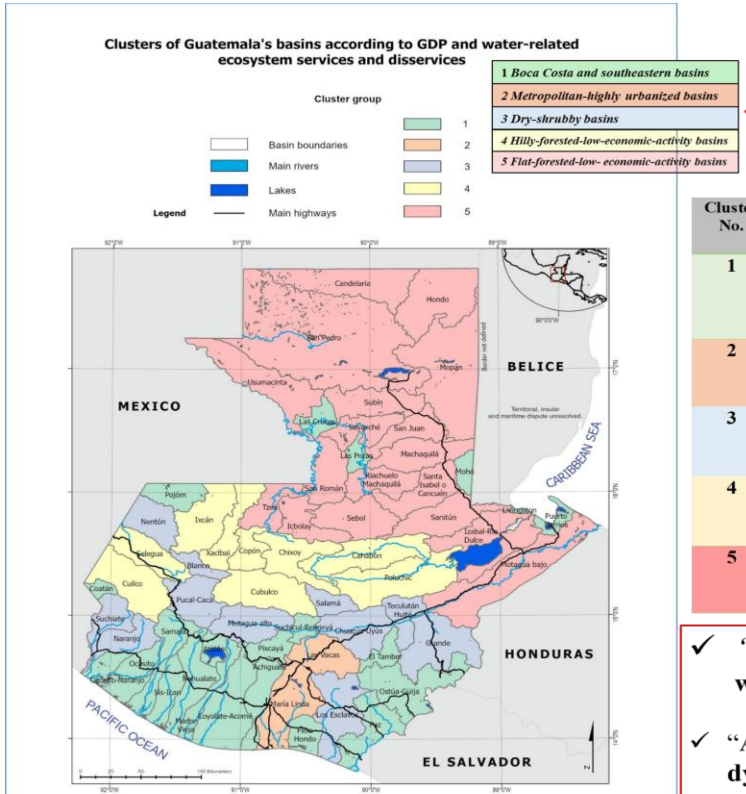
(Borrelli et al., 2013 p.3 y p.5).



Water yield	Sediment exported	Sediment avoided
≈ 90.8 billion m³ in 2020.	≈ 343 million tonnes.	≈ 3.81 billion tonnes.

3. Connect ECOlogy and ECOnomy

A factor analysis and Ward cluster analysis combine economic output with water-related ecosystem services to delineate analytical accounting areas.



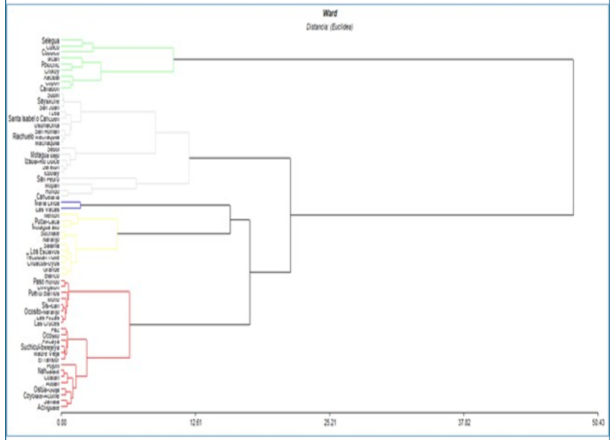
Pinillos et al., 2025

Agrupación de cuencas de Guatemala en función del PIB y servicios ecosistémicos hidrológicos

Cluster No.	Number of basins	Slope percentage (F1) and variability	Main land use and land cover (F2)	Average GDP (F3) and % of national share	Average proportion of urban area
1	22	• 28.8% • High variability (Max. 48.3- Min.2.93%)	1. Annual crops (16%) pastures (15%), 2. Forest 15% 3. Low shrub 13%	• US$14,729 M • 19%	• 3%
2	2	• 32.3% • Low variability (Max. 36.0% - Min. 32.3%)	1. Coffee plantations 18% 2. Low shrub vegetation 17% 3. Pastures 13%	• US$47,168 M • 61%	• 12%
3	11	• 37.6% • Medium variability (Max. 45.8 - Min 33.1%)	1. Low shrub vegetation 25% Forest 20% Annual crops 19%	• US$6,464 M • 8%	• 2%
4	9	• 43.4% • Medium (Max. 49.2% - Min. 38.3%)	1. Forest 34% 2. Annual crops 20% 3. Low shrub vegetation 16%	• US$4,848 M • 6%	• 0.8%
5	18	• 18.6% • High variability (Max. 35.0 – Min. 3.13%)	1. Forest 29% 2. Pastures 27% 3. Flooded areas 14%	• US$4,385 M • 6%	• 0.6%

- ✓ **"The ecosystem accounting area (EAA) is the geographical territory for which an ecosystem account is compiled**." (UNCEEA, 2021; p.47).
- ✓ "Areas defined **as socio-ecological systems integrate ecosystem functions and dynamics as well as human activities** and the range of interactions of these components." (UN et al., 2014; p.28).

Cluster analysis of basins based on ecological and economic data



All estimations per basin (n=62) for the year 2020.

Output

Five Ecosystem Accounting Areas derived from 62 basins.

The accounting areas reveal a spatial mismatch

The metropolitan cluster concentrates economic activity, while forested clusters provide a disproportionate share of water-related ecosystem services.

Metropolitan EAA

2 basins
61% of national GDP
12% average urban area

Forested upland EAA

9 basins
6% of national GDP
34% forest cover

Forested lowland EAA

18 basins
6% of national GDP
29% forest cover

The implication is straightforward. National aggregates hide where economic dependence and ecosystem-service supply actually coincide or diverge.

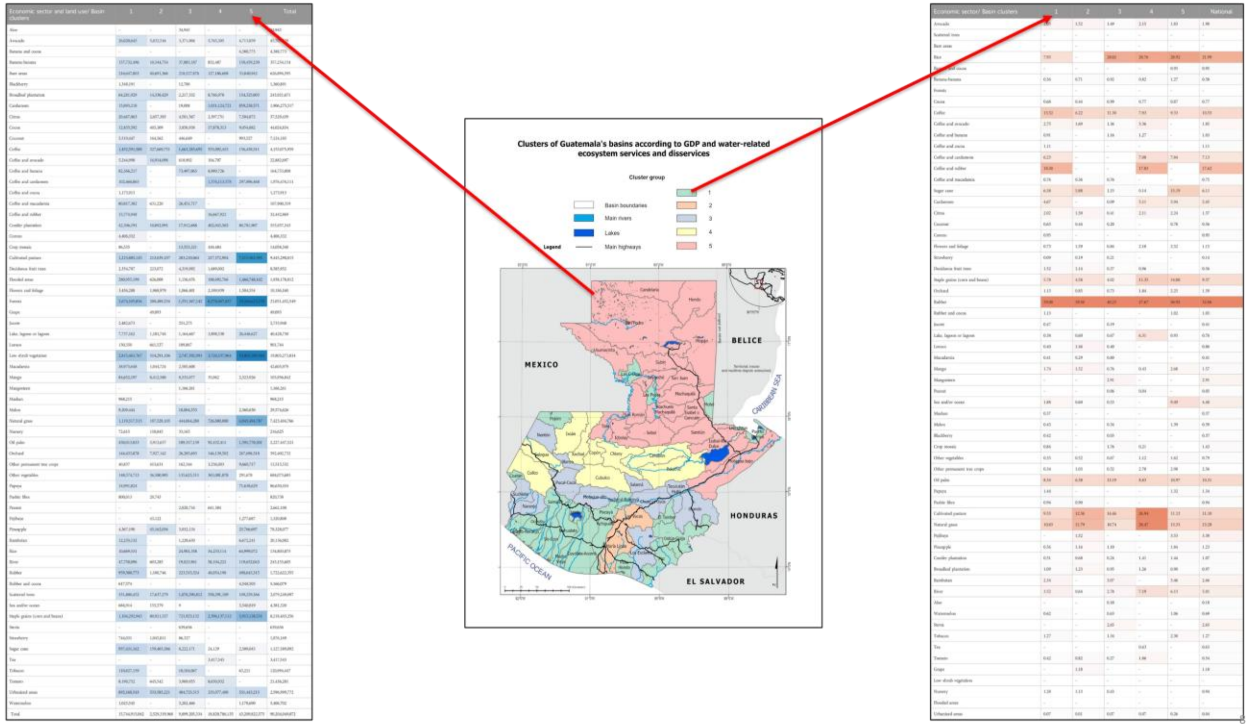
Accounting units make those territorial differences visible and comparable.

Water use by industry and accounting area

The next step is to assign water-related flows to the same sector classifications used in the economic accounts.

Suministro de agua en términos físicos (m³) por tipo de cuenca y uso de suelo-actividad económica

Índice de intensidad del uso del agua por tipo de cuenca y uso de suelo-actividad económica



Supply and use

Water supply and water use can be organized by ISIC/CPC and by accounting area.

Intensity

Water-use intensity links physical water flows to economic value added.

Policy use

The resulting indicators identify sectors and territories with stronger dependence on water services.

What does this add?

A common spatial unit

Watersheds and statistically derived accounting areas allow SEEA-CF and SEEA-EA information to be read on the same geography.

A common classification

The SNA and Supply and Use Table provide the industry structure needed to connect environmental flows to economic activity.

A practical pathway

The approach relies mainly on datasets and statistical operations that many countries already maintain.

Connecting ECOlogy and ECOnomy at basin scale changes the question from "how much natural capital do we have?" to "where does the economy depend on it, and which sectors are exposed?"

This makes the accounts more useful for territorial planning, investment prioritization, and risk assessment.

Potential institutional and research agenda

Institutional agenda

- Official publication of SEEA-CF accounts
- Presentation and peer review through the London Group
- Start implementation of SEEA-EA accounts
- Expand environmental-economic modeling

Research agenda

- Urban accounting and urban-rural interfaces
- Health and natural capital accounting
- Valuation of natural capital and ecosystem services
- Continued experimentation with territorial accounts

A possible collaboration agenda is to move from one-off analytical exercises toward repeatable statistical production that connects the SNA, SEEA-CF, and SEEA-EA.

Subject to institutional decisions, funding, and partnerships.

Thank you!

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