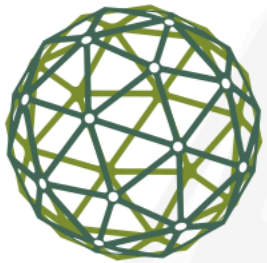

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Local to global continuum for the modelling of ecosystem services

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Modelling of ecosystem services

Using geospatial information, big data and global datasets

Let’s start from the end… users

The importance of end users

1. Ecosystem Services as transdisciplinary science
2. Model users are not necessarily the model developers
3. Need to make scientific products more FAIR
4. Tension with the complexity of the science needed to model complex socio-ecological systems

And a unifying end… use

End use: Beyond GDP

- Reporting under the Kunming-Montreal Global Biodiversity Framework (GBF) of the Convention on Biological Diversity (CBD): B1 indicators
- Natura Capital Accounting (NCA)
- SEEA-EA: an integrated and comprehensive statistical framework (UN SC 2021)
- Gross Ecosystem Product (GEP)
- *SEEA and GEP could be useful complementary measures (but stronger theoretical foundations and greater methodological rigor is needed for GEP)*

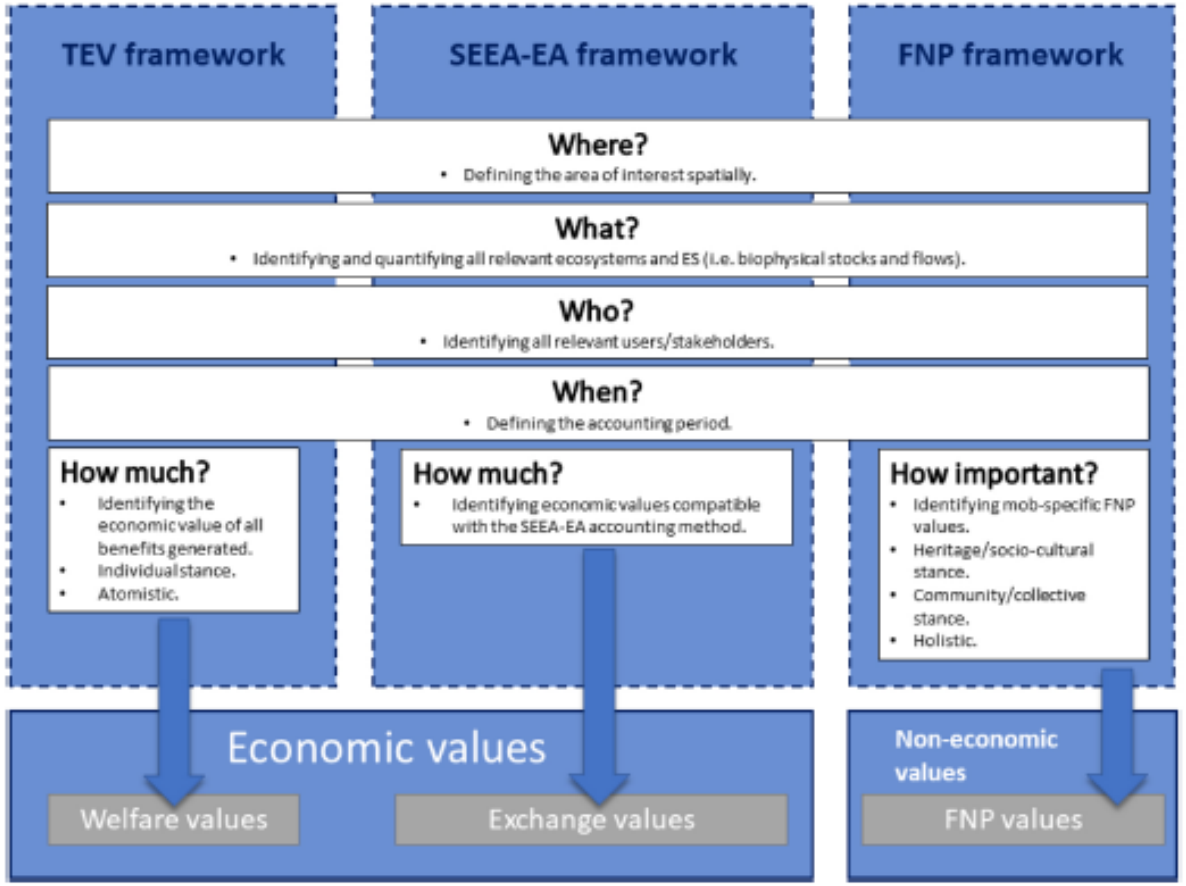


Fig. 4. Stepwise ecosystem accounting process following the extended SEEA-EA methodology.

De Valck et al. 2023. Marine Policy

A wish list based on our experience:

1. Flexibly incorporate the best knowledge available
   - From global public datasets to user provided data
2. Rescale smartly across spatial and temporal scales
   - From local to global and vice versa
3. Open, transparent and well documented models
   - Simple and modular model coding with mandatory encapsulated documentation
   - Individually documented modelling components and computational workflows that collect and process this information
4. Data and Models are alive on the web
   - Not only static datasets served as web services
   - But also computational workflows (e.g. making of account ready…)
   - Have DOI, peer reviewed, with metadata like in Zenodo, etc.

An example of distributed architecture

ARIES-OpenEO-UDP/UDF catalog
(public repository to access INCA functionality & advanced OpenEO functionality)

Access via k.LAB client API in UDF

OpenEO adapter

Data and Processing Engine

data pre-processing

models & methods

k.LAB
Knowledge Integrated Modelling
SEEA

Access via k.LAB client API

Semantic front-end

https://esa-people-ea.org/en

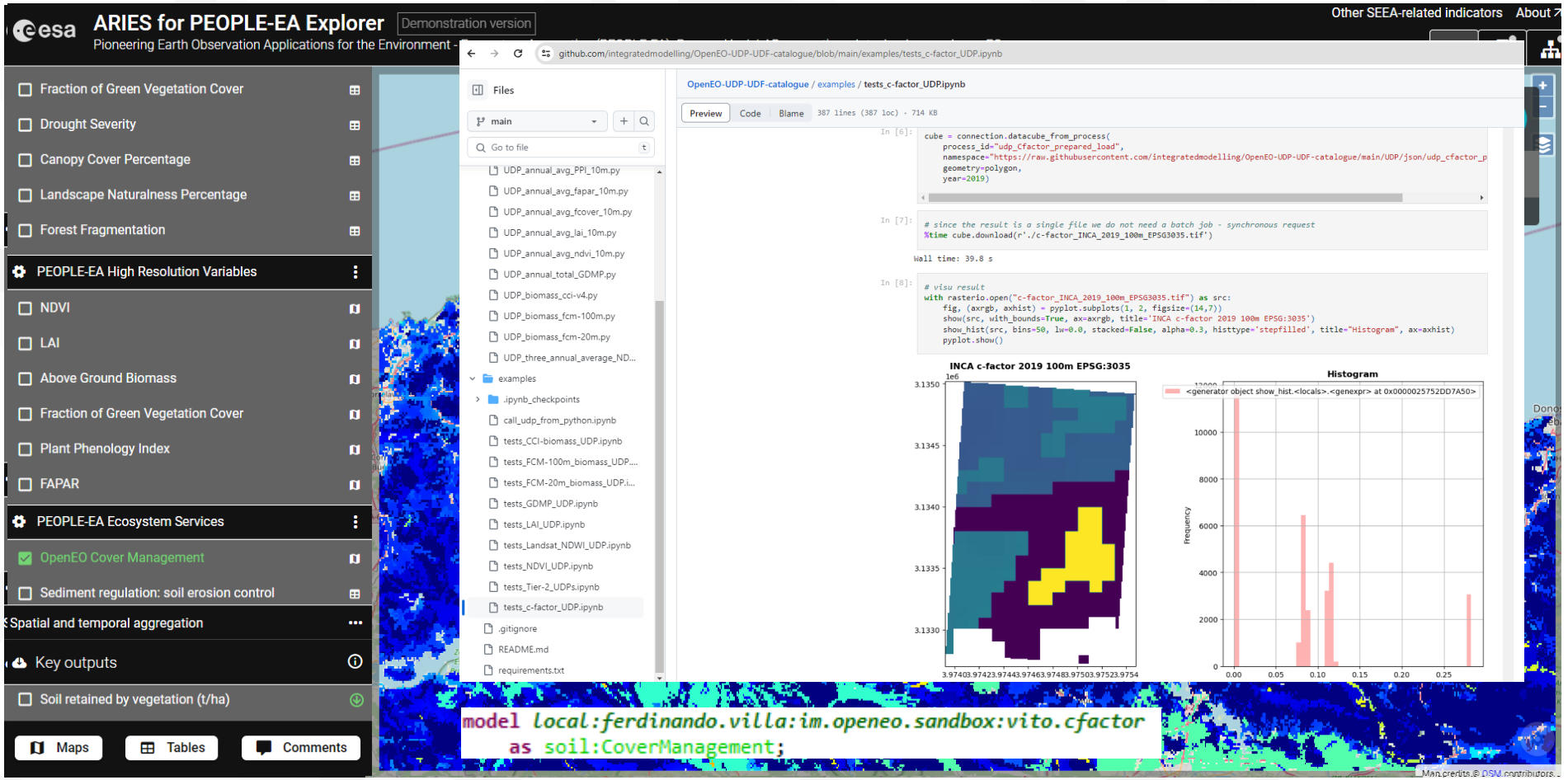
NCA standard for EU

Behind the curtains

1. EO retrieval and processing
   - ESA Sentinel L2A, e.g. NDWI
   - NASA Landsat 7, 8, 9, e.g. LAI, FAPAR
2. Distributed system with two different computational architectures:
   - OpenEO - Terrascope
   - ARIES for SEEA Sector Hub of the UNGP – k.LAB tech
     - Link to online data services, including OGC-compliant and STAC catalogues
3. Open Source and openly documented
   - Online open repositories
4. Models are integrated and composed with distributed building blocks
   - An example: erosion/sediment retention modelling

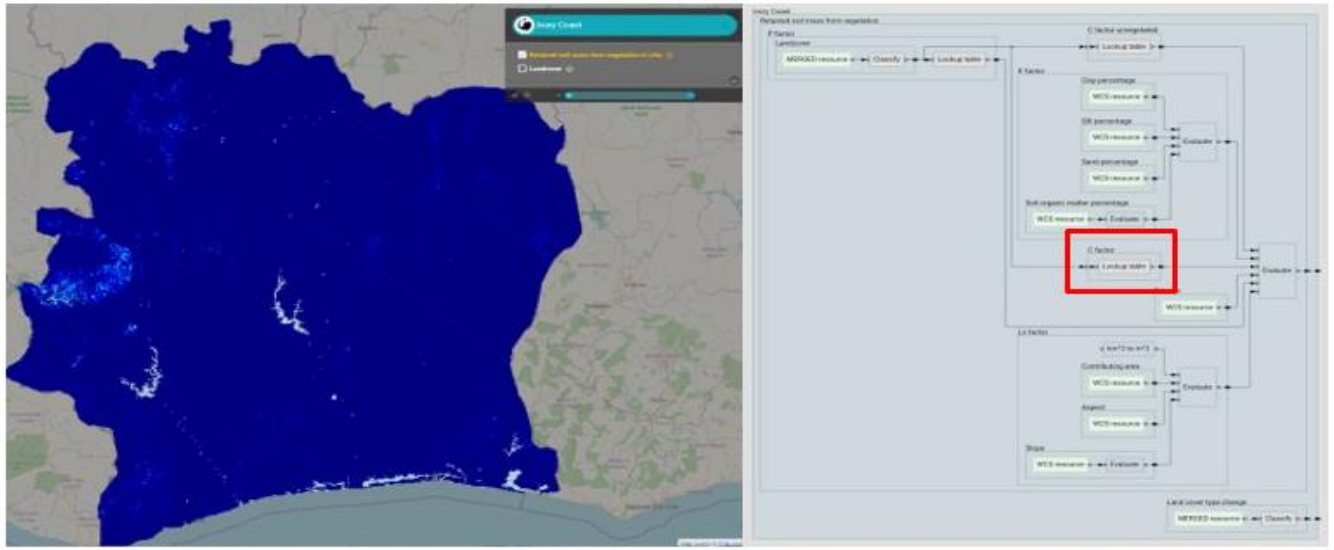
Task: quantify sediment retention attributable to vegetation in tons/ha*year

- Demo application served online at: https://peopleea.integratedmodelling.org/modeler/?app=aries.peopleea.en
- Point and click UI
- All the complexities are kept under the hood
- All the black boxes are made transparent
- Video: https://www.youtube.com/watch?v=fvChjWO5IN8
- Documentation: https://confluence.integratedmodelling.org/display/AFP

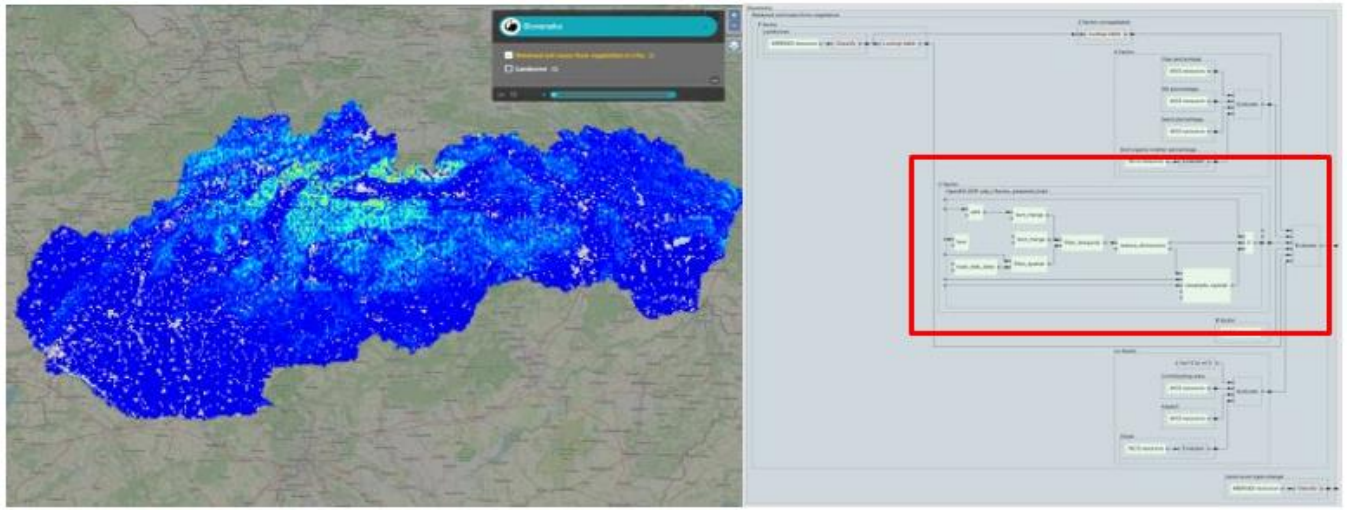


Smart resources prioritization

- When computed in *Côte D'Ivoire*, the model uses the **default C-factor calculation**, based on a lookup table driven by land cover type.



- When the same query is made in *Slovakia*, ARIES realizes that **OpenEO C-factor** provides a more specific and higher-resolution C-factor model (aligned with the INCA methodology endorsed in EU)



ES models availability

- Globally customizable ecosystem services models in ARIES (Martínez-López et al. 2019, Science of Total Environment)
- Other usual suspects: InVEST, ESTIMAP (JRC), etc.: however, a limited model set used: : e.g. sediment, pollination, recreation, carbon storage.

- Based on the SEEA EA ecosystem services reference list (Table 6.3), the summary table presents candidate models, data sources, and SEEA-compatible valuation methods for all ecosystem services.

- Reviewing Table 25 of the Guidelines on Biophysical Modeling for SEEA EA, we include open-source models available in ARIES, ESTIMAP, and InVEST, as well as a wide variety of additional ecosystem service-specific models, and national ecosystem accounts in countries where a wide range of ecosystem services have been included in the accounts, e.g., *the Netherlands, South Africa, and U.K.*

- **33 models vs. the current 9/10 most established and used**

Prioritization criteria

1. **ES assessment criteria:**
   a. Existing models
   b. Data needs
   c. Valuation (in monetary terms)

2. **Ecosystem Serviceshed:** need to select the appropriate spatial and temporal context for the analysis

3. **Calibration:** need to use actual measurements to parameterize methods

Ecosystem Service	Potential models
2.14 Nursery population & habitat maintenance services	Fish larva dispersal models, e.g., here
3. Cultural Services	
3.1 Recreation-related services (Serviceshed, Calibration)	Nature-based tourism (disaggregation of tourism statistics), e.g., NL ecosystem accounts
	ES shed contextualization (work in progress by BC3 complexity modeling group)
	Routing based models of recreation (i.e., INCA/ESTIMAP, ARIES)
vices	Old ARIES viewshed models
	National land accounts
3.3 Education, scientific, & research services	We are unaware of examples at the needed scale to support SEEA EA

Final considerations

- It's time to build and maintain a common knowledge base on **ES and beyond**
  - Good practices, Standards, Datasets, Algorithms, Protocols, Platform APIs

- This is precondition for deep integration and interoperability
  - From "open science" to "deep(ly integrated) science"
  - Resources live online independent of their semantic orchestration
  - Distributed and autonomously produced scientific products can be peer reviewed and maintained on the web, especially geospatial and EO products.
  - Serve multiple purposes: ES, GEP, SEEA-EA, Biodiversity monitoring, etc.

#Integration: Bridging communities, data & models for intercomparison and reuse

#MakeNatureCount: Global understanding of the role of nature for better policies

#ScienceBased: Scientific foundation for [illegible] and uptake

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Thank you

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