System of Environmental Economic Accounting

Biophysical modeling for ecosystem accounting

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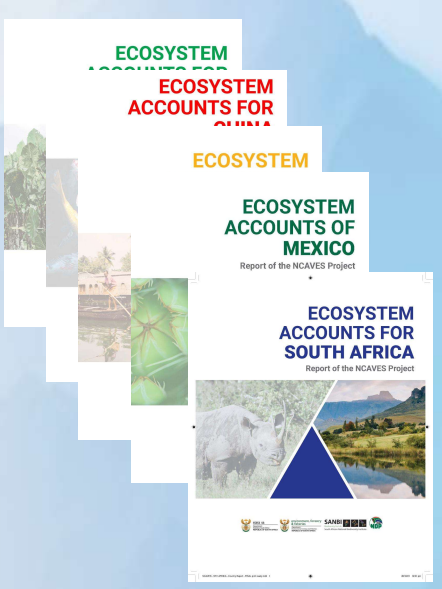
Outline

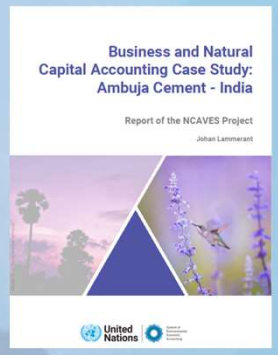
- NCAVES project
- SEEA EA implementation strategy
- Why biophysical modelling
- Guidelines on biophysical modeling for SEEA Ecosystem Accounting
- Future opportunities
- Conclusions

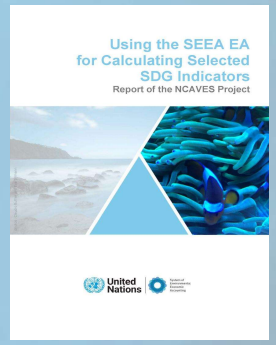
NCAVES project

- Workstream accounts
  - Brazil
  - China
  - India
  - Mexico
  - South Africa
- Workstream - Business Accounting
- Workstream - Communications
- Workstream - Indicators
- Workstream - Guidelines and Methodology
- Workstream - Policy Scenario Analysis

https://seea.un.org/home/Natural-Capital-Accounting-Project







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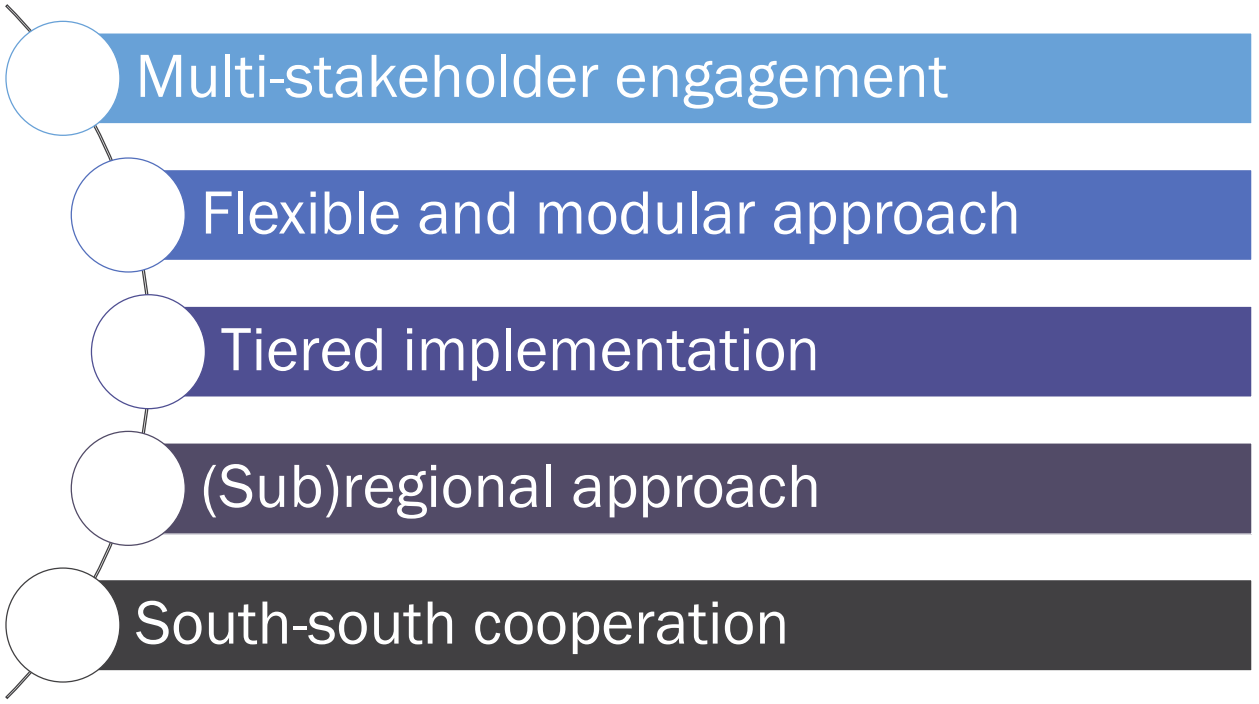
UN environment programme

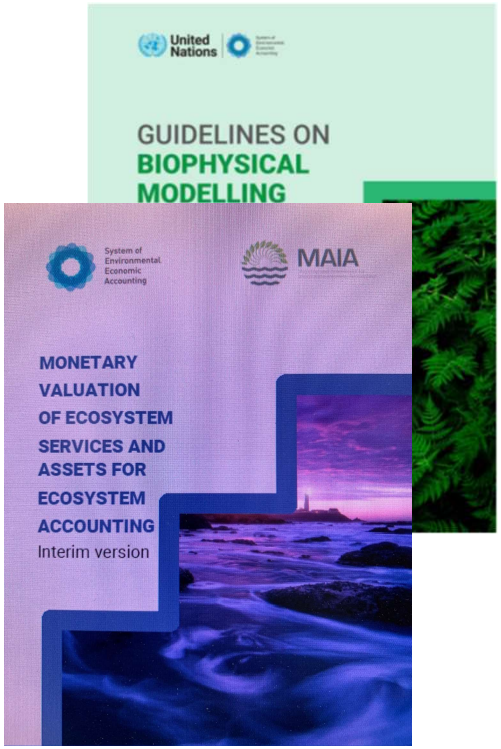
Funded by the European Union

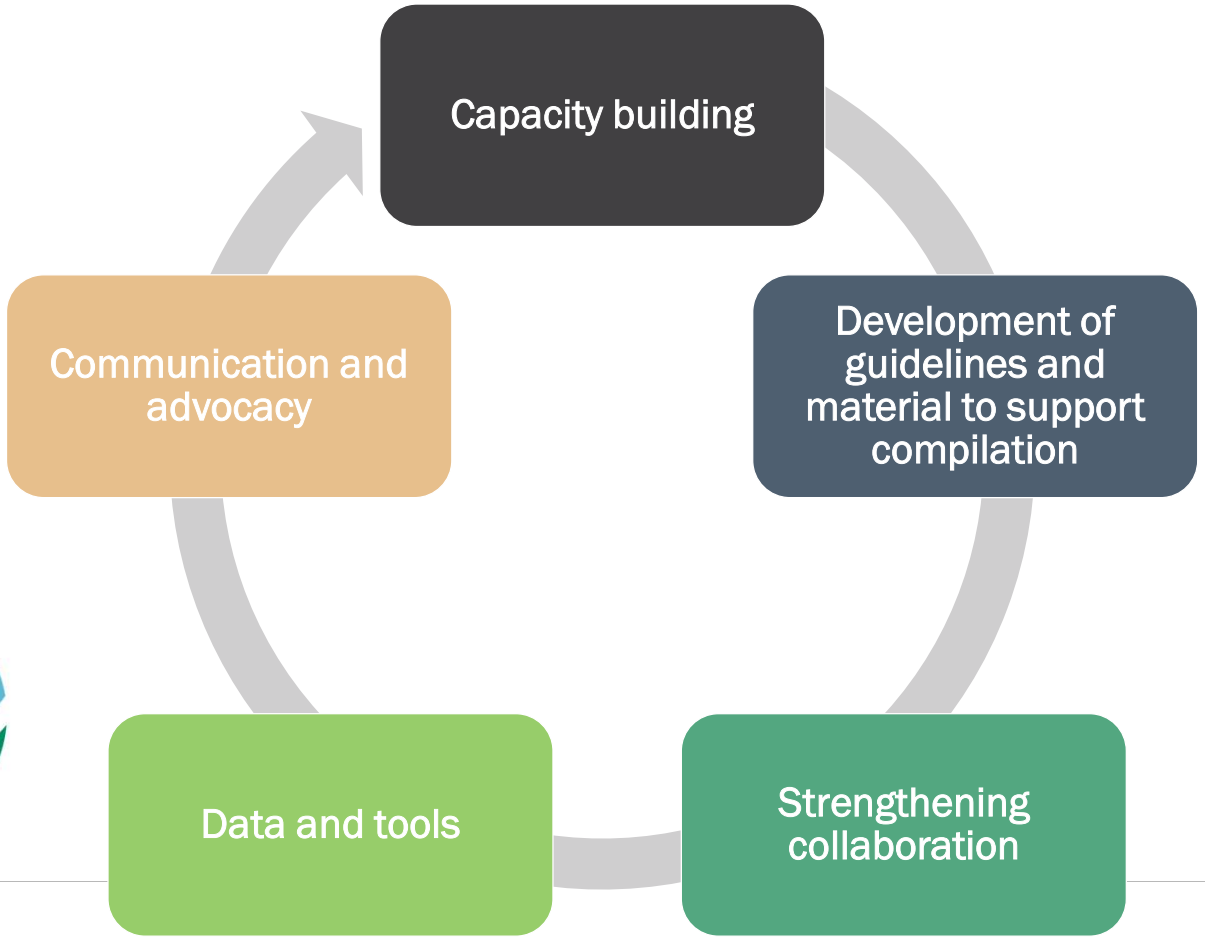
SEEA EA Global Implementation Strategy

- **Overall objective:** scale up the uptake of the SEEA Ecosystem Accounting
- **Suggested target:** at least 60 countries implement at least one account of the SEEA EA by 2025
- Approach and main principles



Activities in support of the implementation





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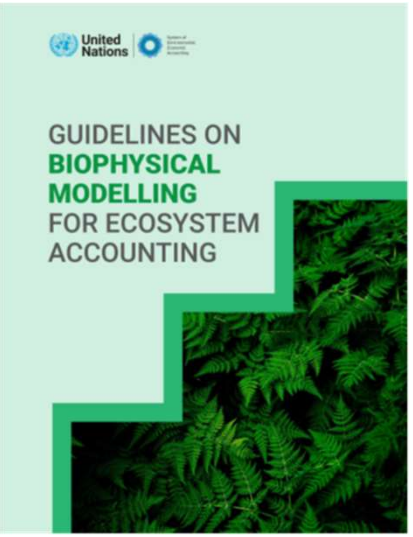
Why do we need biophysical modelling?

- Ecosystem accounting **ambitious in bridging statistical + geospatial domain**
  - > Requires maps with spatial cover of ecosystem types, condition variables, and ecosystem services flows
- Why need modelling?
  - > For some services or condition indicators, data are only available for specific locations -> Spatialize tabular data (e.g. visitors, or water quality)
  - > Several ecosystem accounting concepts (e.g. certain services) require a model
  - > Integration: data from various sources and scales need to combined
- Biophysical modelling may be necessary, it can never replace data collection processes:
  - > Earth observation data sets need ground-truthing
  - > Models rely on in situ data (adjust model setup / calibration)

Biophysical guidelines (1/3)

- Why developed?
  - > Diverse models and tools have proliferated over the past decade and are constantly evolving but not developed specifically for accounting purposes
  - > But many produce results can be used directly in SEEA EA or produce results that can be modified for use in SEEA EA.
- Audience:
  - > Ecosystem accounts compilers + managers
  - > Assumes familiarity with SEEA Ecosystem Accounting but does not assume knowledge of biophysical modelling
- Process:
  - > Under auspices of UNCEEA
  - > Global consultation in 2021 + Adopted by UN Statistical Commission



Biophysical guidelines (2/3)

1. Introduction
2. Process guidance for agencies
3. Modeling for ecosystem accounts
4. Modeling for extent accounts
5. Modeling for condition accounts
6. Modeling for ecosystem service accounts
7. Data quality
8. Future of biophysical modeling

Annexes

1. Global data sources + data portals
2. Modelling techniques
3. Cartography essentials
4. Literature list (16 pages)

NB: Living document: see for latest tables:

https://seea.un.org/ecosystem-accounting/biophysical-modelling

Biophysical guidelines (3/3)

- Tiered approach
  - > recognizes countries are in different circumstances (data availability + expertise)
  - > may differ per ES
  - > progress over time
- Decision trees to facilitate choices

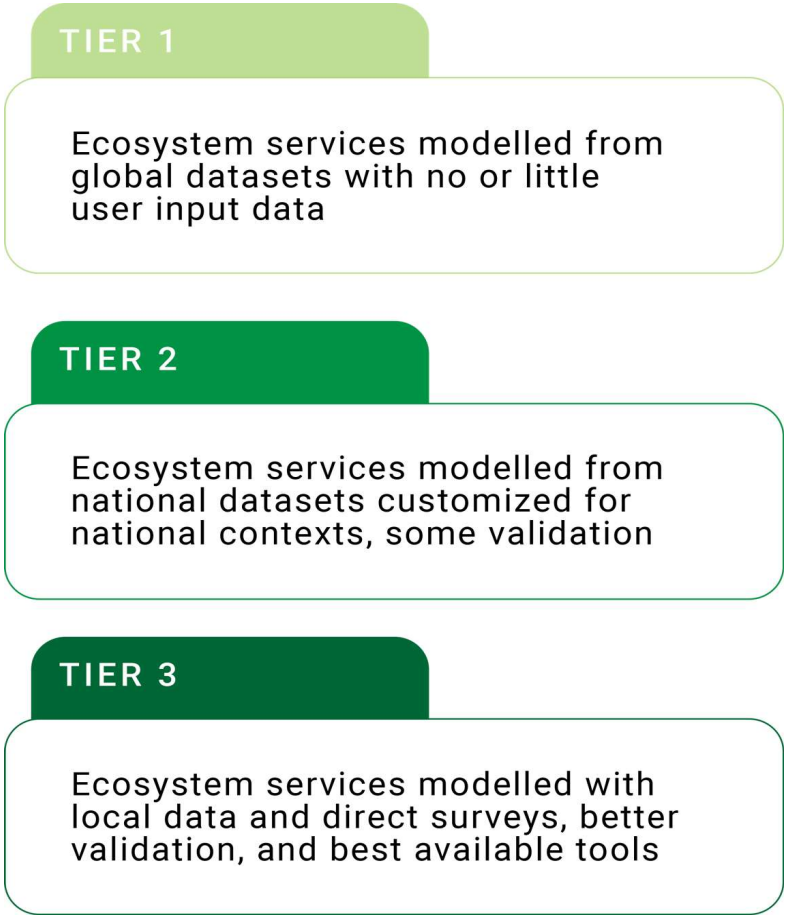


Figure 2: *Tiered approach*

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Modelling techniques

Model technique	Definition	Data needs	Efforts
Look-up Table	Specific values for an ecosystem service or condition variable are attributed to every pixel in a certain class, usually a land cover, land use, or ecosystem type class.	Limited	Easy
Spatial interpolation	Creates surfaces from measured points	Moderate	Moderate
Geostatistical models	Statistical algorithms predict the value of un-sampled pixels based on nearby pixel values in combination with other characteristics of the pixel.	Moderate	Moderate
Statistical models	Values of pixels are assigned based on a set of underlying variables. The relation between the value and the independent variables is developed with a regression analysis.	Moderate	Moderate
Dynamic systems (such as process-based models)	Dynamic systems modelling uses sets of differential equations to describe responses of a dynamical system to all possible inputs and initial conditions. The equations include a set of state (level) and flow (rate) variables in order to capture the state of the ecosystem, including relevant inputs, throughputs and outputs, over time. Most process-based models are examples of dynamic systems models that predict ecosystem services supply or other variables based on a mathematical representation of one or several of the processes describing the functioning of the ecosystem.	High	High
Machine learning	A type of artificial intelligence. Machine learning uses training data to build algorithms to make predictions without explicit programming.	High	Moderate

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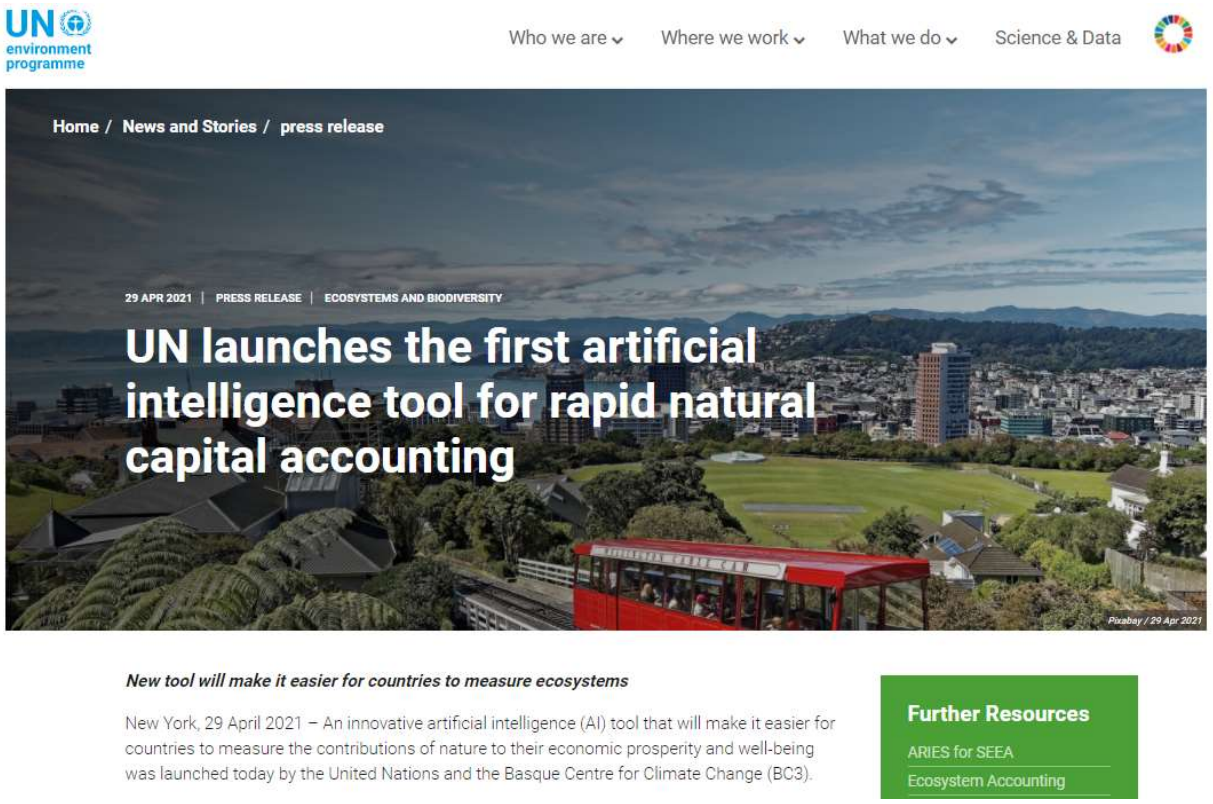
Overview of platforms with potential use in SEEA EA

Modelling platform	Primary goal of platform	Coverage
ARIES (Villa et al., 2014)	ARIES (Artificial Intelligence for Ecosystem Services). Provides easy access to data and models through a web-based explorer and using Artificial Intelligence to simplify model selection, promoting transparent reuse of data and models in accordance with the FAIR principles.	Extent, Condition, Ecosystem Services
Data4Nature	Data4Nature (formerly known as EnSym - Environmental Systems Modelling Platform) is a decision support tool that is designed to answer questions about where organizations should invest in their natural resources. Data4Nature is specifically designed with SEEA EA in mind.	Extent, Ecosystem Services
ESTIMAP (Zulian et al., 2018)	ESTIMAP (Ecosystem Services Mapping tool) is a collection of models for mapping ecosystem services in a multi scale perspective (it can be applied at different scales) (Zulian et. al 2018).	Ecosystem Services
InVEST (Sharp et al., 2018)	A compilation of open-source models for mapping and valuing ecosystem services. InVEST is the flagship tool of the Natural Capital Project and has been the most widely used ecosystem service modelling tool globally.	Ecosystem Services, Condition
i-Tree	i-Tree is a tool developed by the USDA Forest Service with capabilities of modelling ecosystem services related to trees, particularly in urban settings (i.e. air filtration, carbon storage urban heat island mitigation, and rainfall interception and infiltration).	Ecosystem Services (forest related)
Nature Braid (Jackson et al., 2013)	The Nature Braid (formerly LUCI/Polyscape) provides a suite of high spatial resolution ecosystem services models designed to improve decision-making around restoration and land management. The Nature Braid is particularly well suited for mapping soil, water and chemical transport processes at high resolution.	Extent, Condition, Ecosystem Services (hydrological, soil)

ARIES for SEEA Explorer

- ARrtificial Intelligence for Environment and Sustainability
- Application on Aries platform (by Basque Centre for Climate Change):
  - Uses global data and models to generate a basic set of ecosystem accounts
  - Enables compilation anywhere on earth (country; watershed;)
- Why?
  - Need for a computational platform
  - Lowering barriers to compiling ecosystem accounts for countries
  - Make it easier to collaborate (share data and develop models)
  - Facilitate deriving indicators (using solid basis in accounts)



https://seea.un.org/content/aries-for-seea

Example 'Tiered' approach: carbon

- Follows Tiers specified by the IPCC Guidelines. Tiers increase with better stratification of land cover and nationally applicable coefficients thereby increasing in accuracy
- Tier 1: IPCC stock-difference method with default IPCC emission factors and parameters
  - > InVEST's carbon storage and sequestration model; single-layer look-up table.
  - > ARIES for SEEA: IPCC Tier 1 approach following specifications of Ruesch and Gibbs (2008). Multi-dimensional look-up table + burned land
- Tier 2: Same methodology but country specific factors and parameters.
- Tier 3: Tailor-made models (e.g. information on forest age, class, production system, soil parameters, integrating data sources from various types of monitoring

Future opportunities

- Developed an interoperability strategy for SEEA Accounting that specifies roles & responsibilities of data providers; modelers; institutions
- Move towards (semantic) interoperability of data and models. For instance:
  - > Custodians of data sets (global and national) to share data through APIs / nodes;
  - > Interconnect data through semantics / classifications
- Working towards future data becoming Account Ready

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https://seea.un.org/sites/seea.un.org/files/interoperability_strategy_draft.pdf

Conclusions

- There is no ‘one size fits all’; choice of approach, model, tools, will depend on country specific circumstances
- Oftentimes we need a combination of techniques, models (platforms)
- Tiers allow for a growth model of accounts compilation
- Biophysical modelling may be necessary, it can never replace data collection processes
- Vision based on interoperability of data and models

THANK YOU

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