ARIES for SEEA-EEA
for rapid accounts generation

Ken Bagstad, Ferdinando Villa,
Stefano Balbi, Alessio Bulckaen
Open data & models state of the art

- “Analysis ready data”
- Model/algorithm libraries
- Not good enough: need accounts-ready data
Bending the curve for global ecosystem accounting

Independent compilation, use, institutionalization of accounts possible everywhere
Bending the curve for global ecosystem accounting

Independent compilation, use, institutionalization of accounts possible everywhere

Status quo?
Bending the curve for global ecosystem accounting

Independent compilation, use, institutionalization of accounts possible everywhere

With ARIES for SEEA EEA

Status quo?
How do we bend the curve?

• Strategic *investment in web-based data & model* reuse & interoperability for SEEA EEA
  • An interoperable, country-supported *global NCA database* that meets modern scientific standards (FAIR)

• *ES models easy enough to use* that developing countries can *truly* master them; real South-South learning becomes possible

• *Training workshops* aim for rapid customization of global models in regional communities of practice (less 1-on-1)
ARIES for SEEA EEA
for rapid, standardized account creation

• Global, customizable models approach enables SEEA EEA compilation anywhere & improvement with local data where available
  • Faster & easier to learn than other biophysical modeling approaches

• Automate production of maps & accounting tables for all accounts

• Support adoption of SEEA EEA as statistical standard by providing a consistent, easy-to-use application enabling ecosystem accounting anywhere on Earth

• First phase April-October 2020
Does ecosystem services modeling always need to be painstakingly slow?
Achieving interoperability

1. *Share data on the web*
   1. Consistent labeling makes it interchangeable
   2. Automate data use by models

2. *Share models on the web*, specify when & where to use each model
   - Models are *global* (run anywhere) yet *highly customizable*

3. Open-source software for stakeholders (modeling & visualization) & modelers (contribute data & models)

4. Fast & transparent (show all data sources & calculations)
   - Can *co-generate/analyze* accounts with stakeholders

https://www.go-fair.org/

http://aries.integratedmodelling.org/?p=1458
A global knowledge network for ecosystem service data & models

• “Global yet customizable” models

• For SEEA EEA, requires:
  • Global data
  • Time series of adequate length (many back to 2000; single-year snapshots less useful)

Martínez-López et al. 2019
ARIES for SEEA EEA: Custom web interface
Ecosystem extent: Modeling IUCN Level 2 Global Ecosystem types

• IUCN GETs are brand new (Keith et al., Feb. 2020)
• No global maps exist yet
• We’ve coded Level 2 terrestrial GETs, wetlands, open water (n = 9) using global data, lookup table, climate cutoffs from Sayre et al. (2020)
• Calculates annual change based with land cover as an input
• Can code Level 3 GETs if we have decision rules & data to allow their coding (from IUCN late 2020?)

Example completed in about a minute
Can also be used to compile SEEA CF land accounts
# Ecosystem condition: Initial accounts for forests

<table>
<thead>
<tr>
<th>SEEA ECT group</th>
<th>SEEA ECT class</th>
<th>Indicators</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic characteristics</td>
<td>Physical state</td>
<td>Drought index</td>
<td><a href="https://crudata.uea.ac.uk/cru/data/drought/#global">https://crudata.uea.ac.uk/cru/data/drought/#global</a>; monthly resolution at 0.5 degrees for 2001-2018</td>
</tr>
<tr>
<td></td>
<td>Chemical state</td>
<td>No known forest-relevant indicators available globally and in time series</td>
<td></td>
</tr>
<tr>
<td>Biotic characteristics</td>
<td>Compositional state</td>
<td>No known multiyear indicators available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Structural state</td>
<td>NDVI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burned area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tree canopy cover</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LAI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Functional state</td>
<td>GPP/NPP</td>
<td></td>
</tr>
<tr>
<td>Land/ seascape characteristics</td>
<td>Landscape level characteristics (e.g., connectivity, fragmentation)</td>
<td>Intact Forest Landscape</td>
<td><a href="https://data.globalforestwatch.org/search?groupIds=577b964b7d8b41b9822d39a7be261bff">https://data.globalforestwatch.org/search?groupIds=577b964b7d8b41b9822d39a7be261bff</a>; available annually for the years 2000, 2013, 2016</td>
</tr>
</tbody>
</table>

Global time series ca. 2000-present  
Challenges: time series data of adequate length, aggregating 8-day to monthly data into yearly totals/averages, etc.
Condition accounts:
Aggregating metrics & reference condition

• Santos et al. (in prep) reference forests as those in protected areas that have remained forested since 1970 (earliest available data)
• Compare forest condition within & outside reference forests, normalize all values. Aggregate using equal weights.
• Earliest current global time series land cover starts in 1992 (CCI)
• Propose Santos et al.’s method for global forest condition accounting

\[ \text{Var\_nor} = \frac{X - \text{min\_ref}}{\text{max\_ref} - \text{min\_ref}} \]
1. Forest NDVI, 2015

2. Forest NDVI in reference areas

3. Forest condition index (quartiles)

Done in minutes through a web browser, using cloud-based data, anywhere on Earth
1 Introduction

1.1 Ecosystem Extent

The Ecosystem Extent Account is the first SEEA-EEA account. It defines the spatial extent of each ecosystem type, showing how ecosystems change over time. Ecosystem types are used in all other accounts, so are fundamental to SEEA-EA.

Ecosystems are defined as units whose functioning is governed by resources, ambient environmental conditions, disturbance regimes, biotic interactions, and human activity. Ecosystems in this context should not be confused with habitats (provided by ecosystems for particular species).

A complete list of all the diverse ecosystem types remains a work in progress. IUCN's Global Ecosystem Typology is the current standard proposed for ecosystem accounting. Reference 1. IUCN's ecosystem typology improves on past ecosystem extent data, for which many past SEEA-EA applications relied exclusively on land cover data Reference 2.

A full ecosystem extent account includes changes (additions and reductions), as well as net change between opening and closing values among subcomponents of the same ecosystem type and for each accounting period. Each change can be classified into managed expansion/regression, natural expansion/regression, and reassignments upward or downward. Each ecosystem is influenced by different abiotic and biotic conditions, which interact to produce a supply of ecosystem services in the formulation of the SEEA EEA.

2 Methods

2.1 Ecosystem Extent

Keith et al. Reference 1 recognize 25 Level 2 ecosystems (terrestrial biomes): four marine, three freshwater, seven terrestrial, four subterranean, and seven in transitional realms. These are further subdivided into Level 3 ecosystem functional groups. However, information is currently lacking on how to map these Level 3 ecosystems using global data. At the biome level, we similarly lack reliable data to distinguish between biome types for all but terrestrial biomes. ARISE thus currently models seven terrestrial biomes as well as open water and wetlands. With additional global data and rules describing how to use spatial data to map the remaining biomes, we will be able to better distinguish additional biomes, as well as ecosystem functional groups.

The methods for mapping Level 2 ecosystems follow Siare et al.s Reference 3 temperature and moisture domains, combined with land cover data in a lookup table. This enables the mapping of ecosystem change over time using the best available data.
Replacing global data with national/local

• Happens automatically when datasets are annotated the same:
  • E.g., a national-scale 10 m DEM replaces global 90 m data when both are stored on the cloud & annotated as “elevation in m”
  • Categorical data like land cover are more complex, need to be given consistent names (e.g., “open water” = “water bodies”)

• Substituting custom data not yet possible from the web interface; requires use of a more advanced Modeler interface that comes with the software
  • We’ll provide written & video documentation for this by fall
Stay tuned for additional features (Summer/Fall 2020)

• Automatic compilation of accounting tables
• NCAVES country examples
• Guidance on model customization with national data
Multiple modeling platforms can assist with SEEA EEA

Good data & model interoperability practices can benefit all modeling platforms
Discussion/Feedback on:

• General approach
• Approach to ecosystem extent
  • IUCN Level 2 GET with potential to map Level 3 given appropriate global data & rules for how to map
• Approach to ecosystem condition
  • Selected forest ecosystem condition indicators
  • Measuring reference state

Learn more and get started (functionality will evolve quickly this summer/fall):
https://www.integratedmodelling.org/get_started
- Code for ecosystem extent (IUCN Level 2 GETs)

```javascript
define IUCN_GLOBAL_ECOSYSTEMS as {{
    landcover: Forest | aridity > 0.05 | mean_annual_temperature > 18 | mean_july_temperature | ecosystem_type
    Landcover: Forest | > 0.05 | > 18 | * | ecology.incubation:TropicalSubtropicalForest
    Landcover: Forest | > 0.05 | 0 to 18 | * | ecology.incubation:TemperateBorealForestWoodland
    Landcover: Shrubland | > 0.05 | > 0 | * | ecology.incubation:ShrublandShrubbyWoodland
    Landcover: BareArea | > 0.05 | > 0 | * | ecology.incubation:ShrublandShrubbyWoodland
    Landcover: LichenMoss | > 0.05 | > 0 | * | ecology.incubation:ShrublandShrubbyWoodland
    Landcover: SparseVegetation | > 0.05 | > 0 | * | ecology.incubation:ShrublandShrubbyWoodland
    Landcover: Grassland | > 0.05 | > 0 | * | ecology.incubation:SavannaGrassland
    Landcover: TransitionalWoodlandScrub | > 0.05 | > 0 | * | ecology.incubation:SavannaGrassland
    Landcover: ScrubHerbaceousVegetation | < 0.05 | > 0 | * | ecology.incubation:DesertSemidesert
    Landcover: SeminaturalOpenSpace | < 0.05 | > 0 | * | ecology.incubation:DesertSemidesert
    Landcover: ScrubHerbaceousVegetation | * | < 0 | < 10 | ecology.incubation:PolarAlpine
    Landcover: SeminaturalOpenSpace | * | < 0 | < 10 | ecology.incubation:PolarAlpine
    Landcover: GlacierAndPerpetualSnow | * | * | * | ecology.incubation:PolarAlpine
    Landcover: ArtificialSurface | * | * | * | ecology.incubation:IntensiveLandUseSystem
    Landcover: AgriculturalVegetation | * | * | * | ecology.incubation:IntensiveLandUseSystem
    Landcover: Wetland | * | * | * | ecology.incubation:Wetland
    Landcover: WaterBody | * | * | * | ecology.incubation:Aquatic
}};
```
Infrastructure for FAIR, AI-supported scientific modeling

https://www.goi-fair.org/fair-principles/

http://www.integratedmodelling.org