

System of
Environmental
Economic
Accounting

Measuring climate regulation services using ARIES for SEEA Explorer

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United Nations

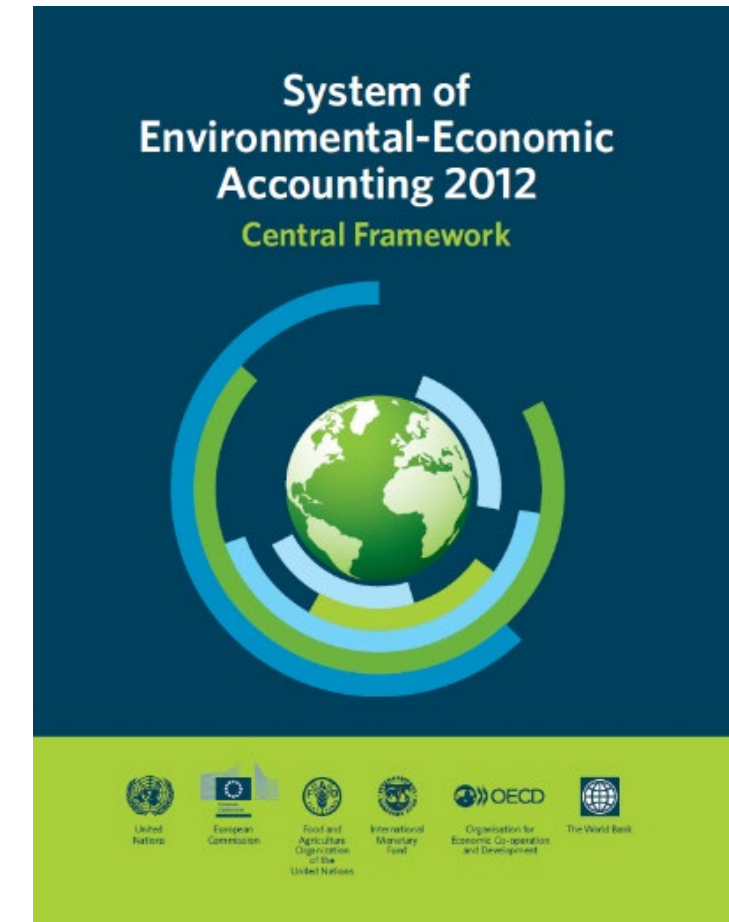
Outline

- Role of SEEA in informing climate policy
- Climate regulation service
- Aries for SEEA
- Brief demonstration
- Interoperability

Context: SEEA and Climate Change

Climate-related uses of the SEEA, include:

- Informing **mitigation strategies** by assessing the role of economic activities and household consumption in generating emissions by economic sector, the value of investments in mitigating technologies, as well as the distribution of carbon credits.
- Informing **adaptation strategies** by tracking expenditures and investments on adaptation by economic sectors or household and analyzing impacts in terms of changes in condition of ecosystems, disasters, and reduced production, for example of crops.
- Providing a comprehensive overview of how much **carbon is stored per ecosystem type** and how this develops over time due to sequestration, deforestation and afforestation, as well as harvesting, forest fires etc.
- Assessing how **climate change impacts** economic activities and households, through the effects it has on ecosystems and the services they provide. The accounts can also be used to assess issues such as land degradation, water shortages and biodiversity.



Global climate regulation service

- Global climate regulation service in SEEA EA considers two components:
 - > carbon retention: the ability of ecosystems to retain the stock of carbon – i.e., ecosystems supply a service through the avoided emission of carbon to the atmosphere
 - > carbon sequestration: the ability of ecosystems to remove carbon from the atmosphere
 - expected to be stored for long periods of time.
 - an appropriate metric is the net ecosystem carbon balance.
- In stable ecosystems, carbon retention will be the primary component while in those ecosystems where there is clear expansion in the stock of carbon, then carbon sequestration may be the focus of measurement.
- Requires compilation of a basic carbon stock account.

Artificial Intelligence for Environment & Sustainability (ARIES)

- What is ARIES?
 - ARIES is a modelling technology, rather than a model(s), or specific program/application
 - Uses k.Lab software (knowledge)
 - It is an artificial intelligent modeler, based on machine reasoning



- It defines a variety of data, models and the relationships between them using consistent and uniform terms (semantics / ontology).
- ARIES technology uses artificial intelligence to determine the “most appropriate” data and model for your request (setting a context)

ARIES for SEEA: Rapid, standardized environmental-economic accounting

- Global, customizable models approach enables SEEA EA compilation anywhere & improvement with local data where available
 - Fast & easy to learn
- Automate production of maps & tabular output
- Infrastructure for the community to share & reuse interoperable data & models

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

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29 APR 2021 | PRESS RELEASE | ECOSYSTEMS AND BIODIVERSITY

UN launches the first artificial intelligence tool for rapid natural capital accounting

Table 1. Occurring ecosystem types (selected level 3 Ecosystem Functional Groups of the IUCN Global Ecosystem Typology 2.0)

	Intertidal forest shrubland	Coastal saltmarsh reedbed	Cropland	Urban industrial ecosystem	Temperate
Extent at start of 2012 (km ²)	158.25	366.39	16017.82	650.13	390.60
Extent at start of 2014 (km ²)	158.25	360.81	15978.72	692.57	403.63
Net change	0.00	-5.59	-39.10	42.45	13.03

Table 2. Occurring ecosystem types (selected level 3 Ecosystem Functional Groups of the IUCN Global Ecosystem Typology 2.0)

	Intertidal forest shrubland	Coastal saltmarsh reedbed	Cropland	Urban
Opening extent (at start of 2012)	158.25	366.39	16017.82	650.13
Additions to extent				
Expansions	0.00	0.00	32.39	42.45
Reductions in extent				
Regressions	0.00	5.59	71.49	0.00
Net change in extent	0.00	-5.59	-39.10	42.45
Closing extent (at start of 2014)	158.25	360.81	15978.72	692.57

k.LAB Contextualization report

Computed at Mon Jun 22 18:29:14 CEST 2020

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-EEA.

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, which for many past SEEA-EEA 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 reappraisals 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 (termed biomes): four marine, three freshwater, seven terrestrial, four subterranean, and seven in transitional realms. These are further subdivided into 100 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. ARIES 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 the Sayre 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.

landcover	aridity	mean_annual_temperature	mean_july_temperature	ecosystem_type
landcover:Forest	> 0.05	> 18	*	ecology:incubation:Tropica
landcover:Forest	> 0.05	0 to 18	*	ecology:incubation:Temper
landcover:Shrubland	> 0.05	> 0	*	ecology:incubation:Shrubia
landcover:BareArea	> 0.05	> 0	*	ecology:incubation:Shrubia
landcover:LichenMoss	> 0.05	> 0	*	ecology:incubation:Shrubia
landcover:SparseVegetation	> 0.05	> 0	*	ecology:incubation:Shrubia
landcover:Grassland	> 0.05	> 0	*	ecology:incubation:Savanna

Interfaces for nontechnical & technical users

ARIES for SEEA Explorer
The SEEA Ecosystem Accounting standard on the ARIES platform. A collaboration between UNSD, UNEP and BC3. Powered by k.LAB semantic web technology.

Context: where, when
Dominican Republic
Map boundaries: 610.0 m
Years: 2012 To 2014
Study setup
Extent accounts
Extent account: net balance
Extent account: additions and reductions
Ecosystem type: change matrix
Land account: net balance
Land account: additions and reductions
Land cover type: change matrix
Spatial and temporal aggregation
Key SEEA EA outputs
Land cover type
Ecosystem type - IUCN GET 2.0 Level 3

Dominican Republic
Ecosystem type
Grid size: 274955 (635 x 433) cells
Cell size: 619.487 x 619.821 m
Temporal transitions: Sat Dec 31 17:00:00 MST 2011
Total area: 48,187.364 km²

Maps Tables Comments

```
namespace data.usa.geography;  
  
@index  
model each Local:kbagstad:im.data.usa:census_state_boundaries  
as policy:State earth:Region;  
  
model Local:kbagstad:im.data.usa:ecosheds_dem  
as geography:Elevation in m named ecosheds_dem  
over space (urn='local:kbagstad:im.data.usa:boundary_ecosheds');  
  
model Local:kbagstad:im.data.usa:ecosheds_slope  
as geography:Slope in degree_angle named ecosheds_slope  
over space (urn='local:kbagstad:im.data.usa:boundary_ecosheds');  
  
//model wcs(service = "http://epqs2.er.usgs.gov/ms/mapserv?MAP=ELEV&")  
// named elevation_3dep  
// as measure geography:Elevation in m  
// with metadata {dc:originator "3DEP 1/3 arc-second WCS" //ca. 10 m US DEM  
// dc:url "http://ned.usgs.gov/"  
// im:reliability 90  
// im:distribution "public"};  
  
observe earth:Region named co_headwaters_blm  
over space (  
urn= 'local:kbagstad:im.data.usa:blm_co_headwaters_final',  
id= '100'
```

workspace - im.data.usa/src/data/usa/geography.kim - k.Modeler
File Edit Navigate Search Project Run Window Help
k.LAB Navigator
Resource editor
geography.kim hydrology.kim landcover.kim ecology.kim climate.kim
k.LAB Runtime
User kbagstad logged in
Version: Memory: Up:
Session events
By task artifact Report level Info
System Log
Report level Info
exception while checking offline node
Layer ARIES_usa_rusle_r_factor was not found in service
Layer ARIES_usa_soil_depth_STATSGC was not found in service
Layer CL_slope was not found in service
Writable Insert 12:60:397

Access & run scientific models in minutes through a web browser, using cloud-based data, anywhere on Earth

Contribute & semantically annotate new data & model resources for reuse by scientific community & public

Current ARIES for SEEA content: Ecosystem extent

Methods

Currently maps **29 ecosystem types** (primarily terrestrial & wetland) based on IUCN GET 2.0 methods¹.

Outputs

Net change, additions & reductions, change matrix for ecosystems & land cover types

Data

Lookup table to model **IUCN EFGs**, based on: **temperature, landform, elevation, aridity, land cover**², ca. 1992-2019

Next Steps

Expand to more ecosystem types (especially freshwater/marine), though conceptual/data challenges remain; collaborate more closely with IUCN GET team

1: Keith, D. et al. 2020. IUCN Global Ecosystem Typology 2.0. IUCN: Gland, Switzerland. - **2: Using thresholds from Sayre, R., et al. 2020.** An assessment of the representation of ecosystems in global protected areas using new maps of World Climate Regions and World Ecosystems. Global Ecology and Conservation 21:e00860.

Current ARIES for SEEA content: Ecosystem condition

Methods

Identifies forest ecosystem condition with 6 indicators adapting **Santos' aggregation methods**¹: Consulted virtually with J. Maes, F. Santos and colleagues

Outputs

Ecosystem variable, indicator, index accounts for user-selected indicators

Data

Drought index, LAI, NDVI, NPP, forest fragmentation, burned area. Adapted from original temporal resolution to yearly values (e.g., mean, maximum), ca. 2000-2019

Next Steps

Expand to additional ecosystem types/condition metrics (e.g., collaboration with South Africa on grassland condition)
Customizable weighting to reflect local ETs' characteristic

¹: Santos Martin, F. & Garcia Bruzon, A. In prep. Spanish forests experimental condition account. Universidad Rey Juan Carlos: Madrid.

Current ARIES for SEEA content: Ecosystem services supply & use tables

Ecosystem Services and Accounts:

	Physical	Monetary
1. Crop provisioning (ecosystem contribution)	✓	✓
2. Crop pollination (insect pollinators contribution)	✓	✓
3. Global climate regulation services (carbon storage)	✓	✓
4. Soil erosion control services (physical only)	✓	-
5. Nature-based tourism (non-domestic)	✓	✓

Current ARIES for SEEA content: Global climate regulation

Methods

Tier 1 IPCC approach: Aboveground & belowground vegetation carbon storage quantified using a multilayer lookup table¹.

Outputs

Estimated carbon stored in aboveground & belowground vegetation, plus the upper 2 m of soil. Results priced using Social Cost of Carbon (SCC).

Data

Land cover, ecofloristic region (FAO classification), continent, presence of frontier forests (proxy for forest degradation), recent occurrence of fires, soil carbon storage.

Next Steps

Incorporate newer & more regional carbon storage estimates, as well as models more sophisticated than lookup tables.

¹: Ruesch, A., & H.K. Gibbs. 2008. New IPCC Tier-1 Global Biomass Carbon Map for the Year 2000. Available online from the Carbon Dioxide Information Analysis Center [<http://cdiac.ornl.gov>], Oak Ridge National Laboratory, Oak Ridge, Tennessee

ARIES for SEEA: Audiences

1. Countries with **very limited data & experience** (create accounts using common global data)
2. Countries with **national data wanting to customize accounts** (create accounts using national data & models)
3. Countries with **sophisticated modeling capacity** (contribute their data & models to global SEEA EA community)

Current focus has been on group 1; increasing focus on groups 2 & 3 in near future.

Results: demonstration

- Kyrgystan: carbon storage
 - > Disaggregation by IUCN EFGs
 - > Time series: 2012-2014
- Allows to compute both components of global climate regulation service:
 - > Sequestration (net balance)
 - > Retention (for opening and closing stocks)

<i>(million tC)</i>	<i>Cropland</i>	<i>Urban industrial ecosystem</i>	<i>Polar tundra desert</i>	<i>Polar alpine rocky outcrop</i>	<i>Alpine grassland shrubland</i>	<i>Ice sheet glacier permanent snowfie</i>	<i>Temperate woodland</i>	<i>Temperate subhumid grassland</i>	<i>Rocky pavement lavaflow scree</i>	<i>Cool temperate heathland</i>	<i>Seasonally dry temperate heath shrub</i>	<i>Boreal temperate montane forest w</i>	<i>Temperate forest</i>	<i>Other desert semidesert</i>	<i>Cool desert semidesert</i>	<i>Total</i>
Quantity at start of 2012 (tons C storage)	1747	11	55	453	2299	39	1	54	301	1190	3	122	264	32	66	6636
Quantity at start of 2014 (tons C storage)	1738	11	56	457	2311	39	1	54	299	1183	3	122	263	31	66	6635
Net change	-9	1	0	4	12	0	0	0	-2	-6	0	0	-1	0	0	-1

The importance of interoperability

- Interoperable data:
 - > Interoperable is broader than mere open (downloadable) data.
 - > The idea is to share the data through APIs using SDMX etc.
 - > Global data can be complemented by reviewed national data sets, all interconnected through common classifications and definitions (semantics/ontology)
- Data storage:
 - > Ecosystem accounting requires large data sets which are costly to store -> better have one custodian that shares the data, that updates when new data are available.
- Interoperable models:
 - > In ES modelling many platform and models exist.
 - > Interoperable allows re-using each other model(s) components; coefficients etc. -> re-use of scientific knowledge.

SEEA Interoperability strategy

1. Current state of interoperability & vision for the future
2. Roles & responsibilities (data providers, modelers, institutions incl. NSOs)
3. Implementing the strategy (pilot testing, engaging key stakeholders, governance, training/capacity building)

2021

**AN INTEROPERABILITY
STRATEGY FOR THE
NEXT GENERATION OF
SEEA ACCOUNTING**



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

THANK YOU

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