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MEASURING CLIMATE CHANGE

THE ECONOMIC AND FINANCIAL DIMENSIONS

The potential of the System of Environmental Economic Accounting to inform climate policy

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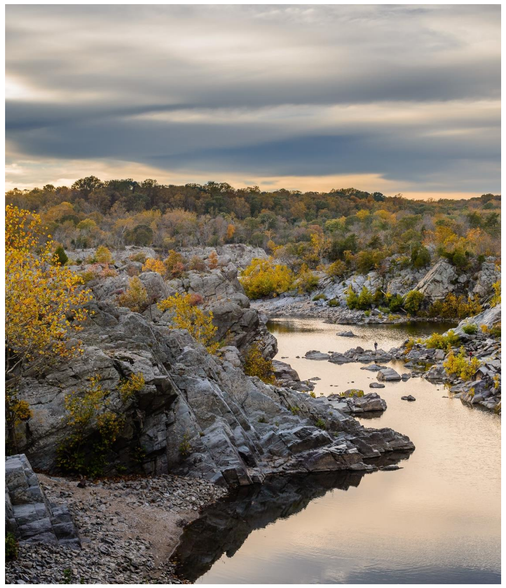
Outline

- SEEA Ecosystem Accounting (SEEA EA)
- Climate regulation service
- Tool: ARIES for SEEA
- Country example
- Conclusions

The need for environmental economic accounts

- Our economic well-being crucially depends on nature.
- But headline indicators like GDP or the unemployment rate do not capture these vital contributions.
- As a result, decision makers don't have access to key information necessary to effectively pursue and track sustainable development.
- The System of Environmental Economic Accounts (SEEA) fills that gap.
- SEEA integrates information on the economy and the environment showing their interrelationship complementing the System of National Accounts



Two sides of the SEEA

Measures environmental assets and individual resources and how the economy used them

Timber

Water

Fish

Soil

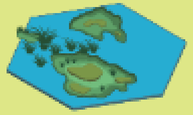
Minerals

Measures ecosystems and the services they provide to economic and human activity

Forests

Rivers

Coral reef



Wetlands

Asset & Resources + Ecosystems = SEEA

Relevant SEEA accounts

- SEEA Central Framework:
  - > Air emission accounts -> GHG emissions by economic activities
  - > Env. taxes / subsidies -> e.g. fossil fuel subsidies
  - > Env. protection expenditure accounts -> cost of mitigation / adaptation policies
- SEEA Ecosystem Accounting
  - > Extent account
  - > Carbon account – stock account in physical unit (stocks and changes therein; comprehensive)
  - > Ecosystem services account
  - > Condition account

Carbon account – ton CO2e

	Geocarbon					Biocarbon			Carbon in the economy			Carbon in the oceans	Carbon in the atmosphere	Total
	Oil	Gas	Coal	Limestone and marl	Other	Terrestrial	Freshwaters and saline wetlands	Marine	Inventories	Fixed assets, consumer durables	Waste	Total	Total	
Opening stock														
Additions to stock														
Unmanaged expansion														
Managed expansion														
Discoveries														
Reclassifications														
Imports														
Reductions in stock														
Unmanaged contraction														
Managed contraction														
Reclassifications														
Exports														
Catastrophic losses														
Net carbon balance														
Closing Stock														

SEEA

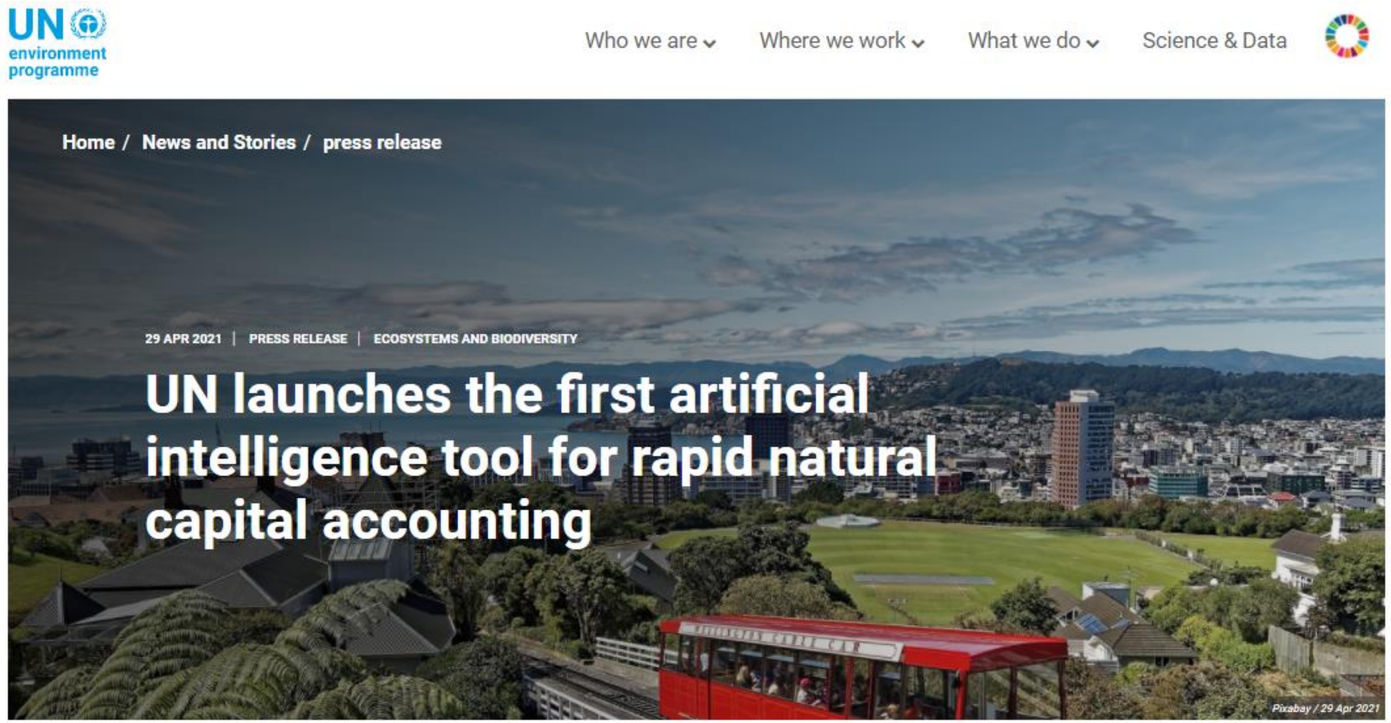
Global climate regulation service

- Long debate during SEEA EA revision process how to frame carbon-related ecosystem services:
  - Net emissions cannot be considered transactions (negative production)
  - Need to provide right incentives, correct policy signals
- 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
- In stable ecosystems, carbon retention will be the primary component while in those ecosystems where there is clear expansion in the stock of carbon, sequestration may be focus of measurement.
- Requires compilation of a basic carbon stock account.

ARIES for SEEA Explorer

- **AR**rtificial **I**ntelligence for **E**nvironment and **S**ustainability
- 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;)
  - AI -> machine reasoning to construct “best available model”
  - Aries has around 150 global data layers, many of them based on EO (e.g. land-cover; elevation; precipitation)
  - Improvement with national data where available
  - Transparent (metadata + download)

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



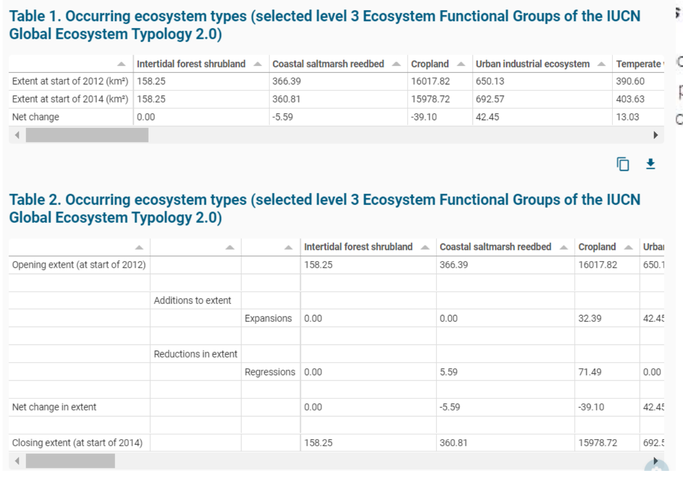
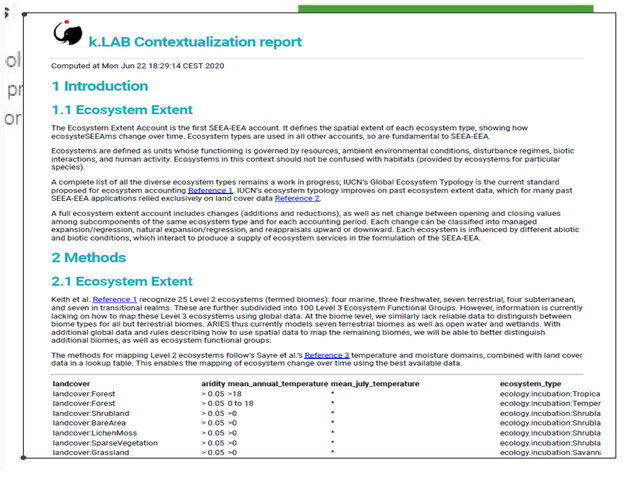


Table 1. Occurring ecosystem types (selected level 3 Ecosystem Functional Groups of the IUCN Global Ecosystem Typology 2.0)

	Intertidal forest shrubland	Coastal saltmarsh reedbed	Cropland	Urban industrial ecosystem	Temperate
Extent at start of 2012 (km²)	158.25	366.39	16017.82	650.13	390.60
Extent at start of 2014 (km²)	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	Urbar
Opening extent (at start of 2012)			158.25	366.39	16017.82	650.1
	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	692.5



k.LAB Contextualization report

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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 ecosysteSEEAms 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's 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:Shrubla
landcover:BareArea	> 0.05	>0	*	ecology.incubation:Shrubla
landcover:LichenMoss	> 0.05	>0	*	ecology.incubation:Shrubla
landcover:SparseVegetation	> 0.05	>0	*	ecology.incubation:Shrubla
landcover:Grassland	> 0.05	>0	*	ecology.incubation:Savann

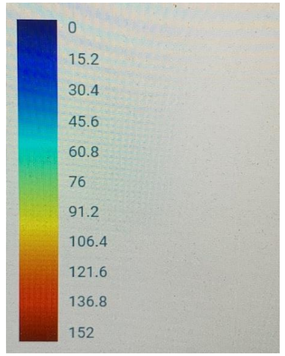
Current ARIES for SEEA content: Global climate regulation

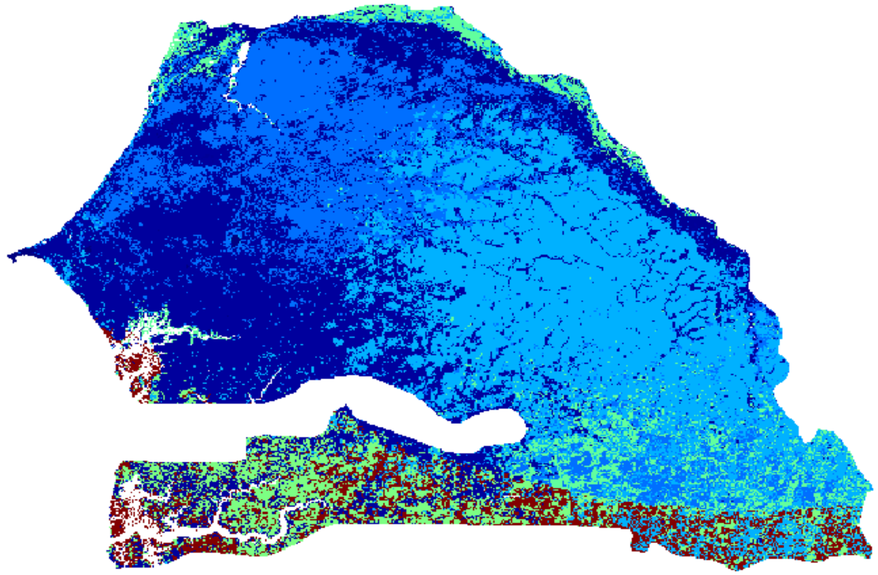
Methods	Data
Tier 1 Intergovernmental Panel on Climate Change (IPCC) approach: Aboveground & belowground vegetation carbon storage quantified using a multilayer lookup table[1].	Land cover, ecofloristic region, continent, presence of frontier forests (proxy for forest degradation), recent occurrence of fires, soil carbon storage.
Outputs	**Next Steps**
Estimated carbon stored in aboveground & belowground vegetation, plus the upper 2 m of soil. Results priced using Social Cost of Carbon.	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

Example: Senegal

- ARIES for SEEA: carbon storage
  - > Disaggregation by Ecosystem Type
  - > Time series: 1995-2015
- Retention modelling :
  - > Social cost of carbon (Nordhaus (2017).
  - > Annualizes costs
  - > Costs assumed to increase 3% per year
  - > Results:
    - 11,1 billion USD, > 60% of GDP.
- Sequestration modelling:
  - > Result:
    - about 2 % of GDP
- **Climate regulation highly important service !**





Million tons carbon	Intertidal forest shrubland	Coastal saltmarsh reedbed	Cropland	Urban industrial ecosystem	Tropical subtropical savanna	Seasonally dry tropical shrubland	Rocky pavement lavaflow scree	Tropical subtropical lowland rainforest	Tropical subtropical dry forest thicket	Other desert semidesert	Episodic arid floodplain	Tropical flooded forest peat forest	**Total**
Quantity at start of 1995 (tons C storage)	106	32	703	4	11	759	1	2	598	383	37	4	2,640
Quantity at start of 2015 (tons C storage)	106	33	714	7	11	710	0	1	651	377	37	4	2,652
Net change	**0**	**1**	**11**	**3**	**0**	**-49**	**0**	**-1**	**53**	**-6**	**0**	**0**	**12**

SEEA

Atmosphere as asset

- The SEEA EA:
  - considers the bottom part of the troposphere as part of the ecosystem asset.
  - extended balance sheet integrates SNA and SEEA asset classification -> includes an entree for "atmospheric systems"
  - treatment of the atmosphere as an asset placed on to the SEEA research agenda.
- Atmosphere should be considered an environmental asset:
  - atmosphere clearly provides services (such as protection against UV radiation)
  - but - sink function for CO2 is counterintuitive
  - possibility to account for atmospheric degradation (modified from A. Vanoli's "unpaid ecological costs") as a **new type of liability**
  - recognition of atmosphere as an asset will have implications for SNA treatment of emission permits (currently discussed as part of SNA revision)

Relevance of SEEA EA for climate policies

- Nationally Determined Contributions / Monitoring of GHG emissions
  - > Carbon account can provide underpinning of Land Use, Land Use Change and Forestry (LULUCF) - reporting
  - > Discussion on (un)managed land necessary – all land considered managed?
- Reducing emissions from deforestation and degradation (REDD+)
  - > Distinctions in SEEA between ecosystem conversion and degradation conceptually similar to afforestation / deforestation and degradation in IPCC
  - > Tension between land cover and land use perspectives on forests
- Carbon Markets
  - > SEEA EA makes carbon related services visible, both in physical as well as monetary units.
  - > Allows to assess trade-offs
  - > Potential to inform Carbon Border Adjustment mechanisms

Conclusions

- Various SEEA CF accounts can inform range of climate policies
- Ecosystem accounting: new standard which integrates climate and nature aspects with the economy
- ARIES for SEEA allows to rapidly generate a set of basic accounts including for carbon
- Such data has potential to inform policies such as NDCs, REDD+ and carbon markets

- Further info:
  - https://seea.un.org/content/aries-for-seea
  - https://aries.integratedmodelling.org/

THANK YOU

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