ARIES for SEEA-EEA for rapid accounts generation

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UNEP

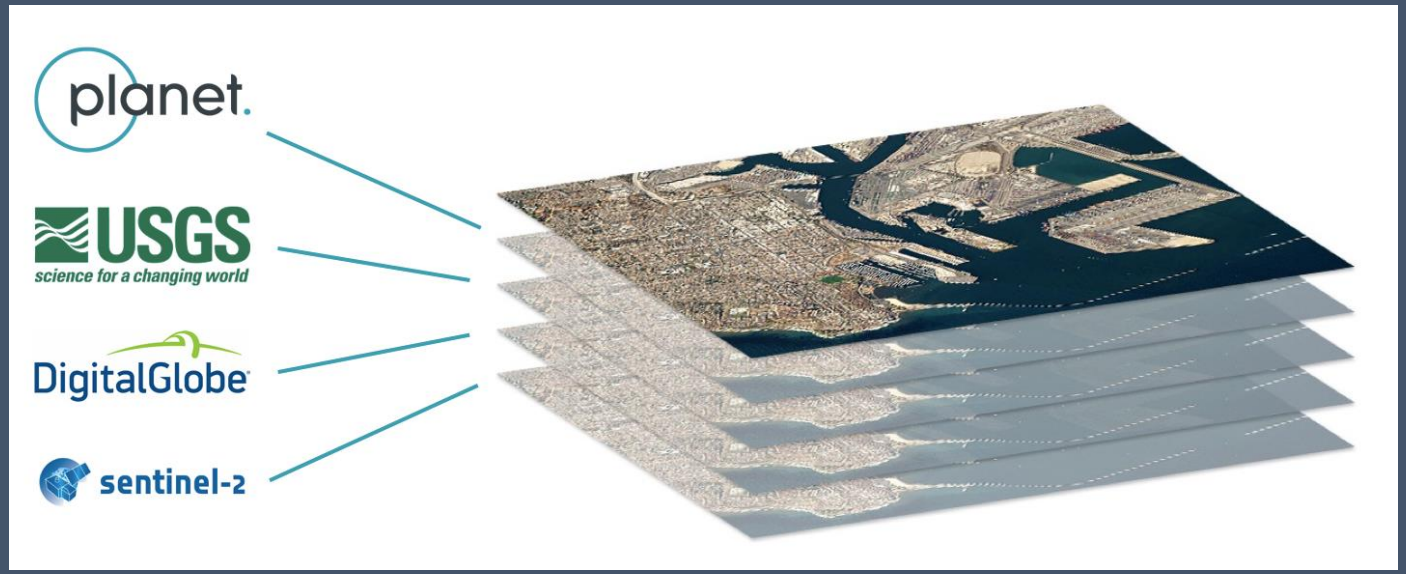
USGS science for a changing world

bc3 BASQUE CENTRE FOR CLIMATE CHANGE Klima Aldaketa Ikergai Sustainability, that's it!

EXCELENCIA MARÍA DE MAEZTU

Open data & models state of the art

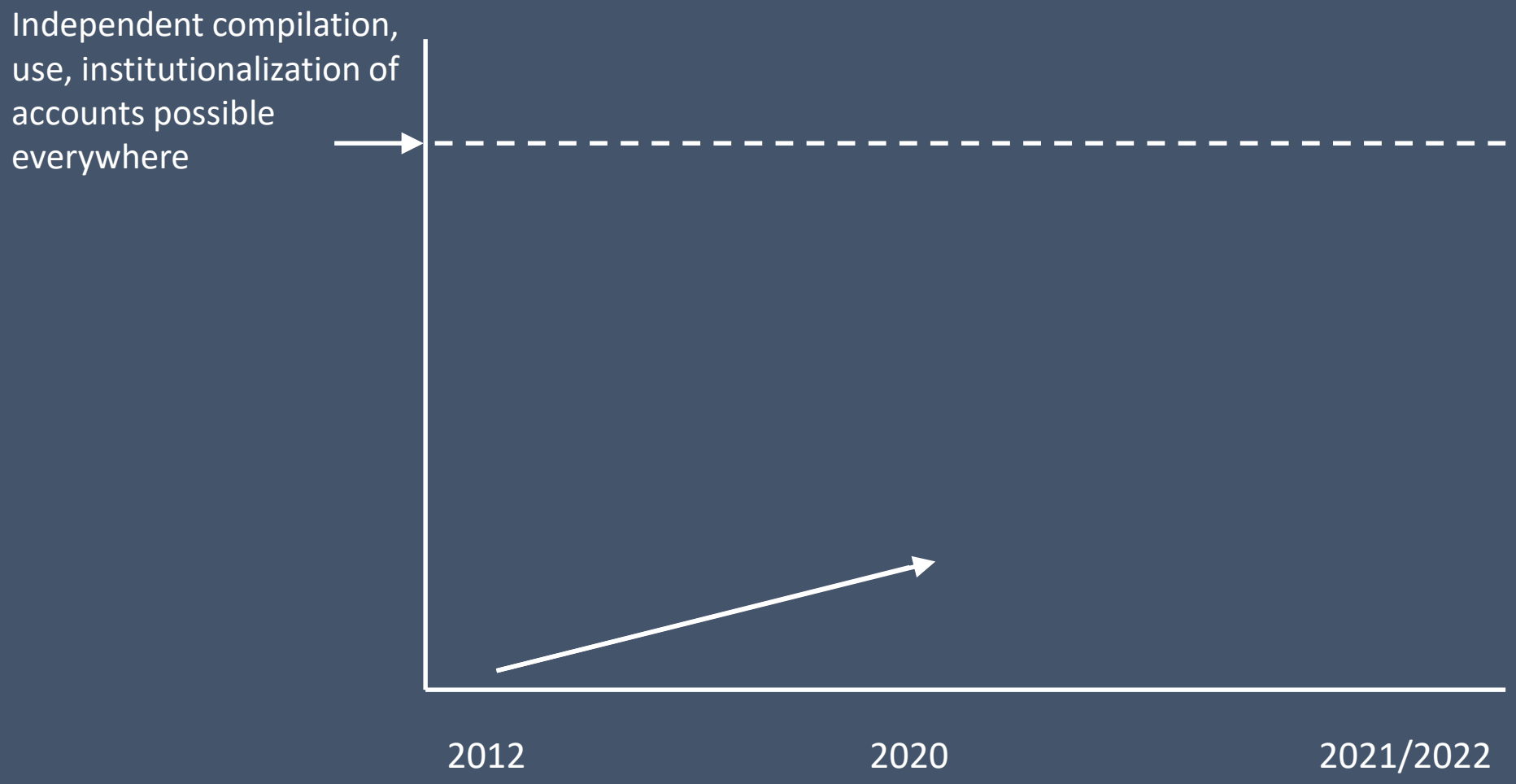
- “Analysis ready data”
- Model/algorithm libraries
- Not good enough: need *accounts-ready data*



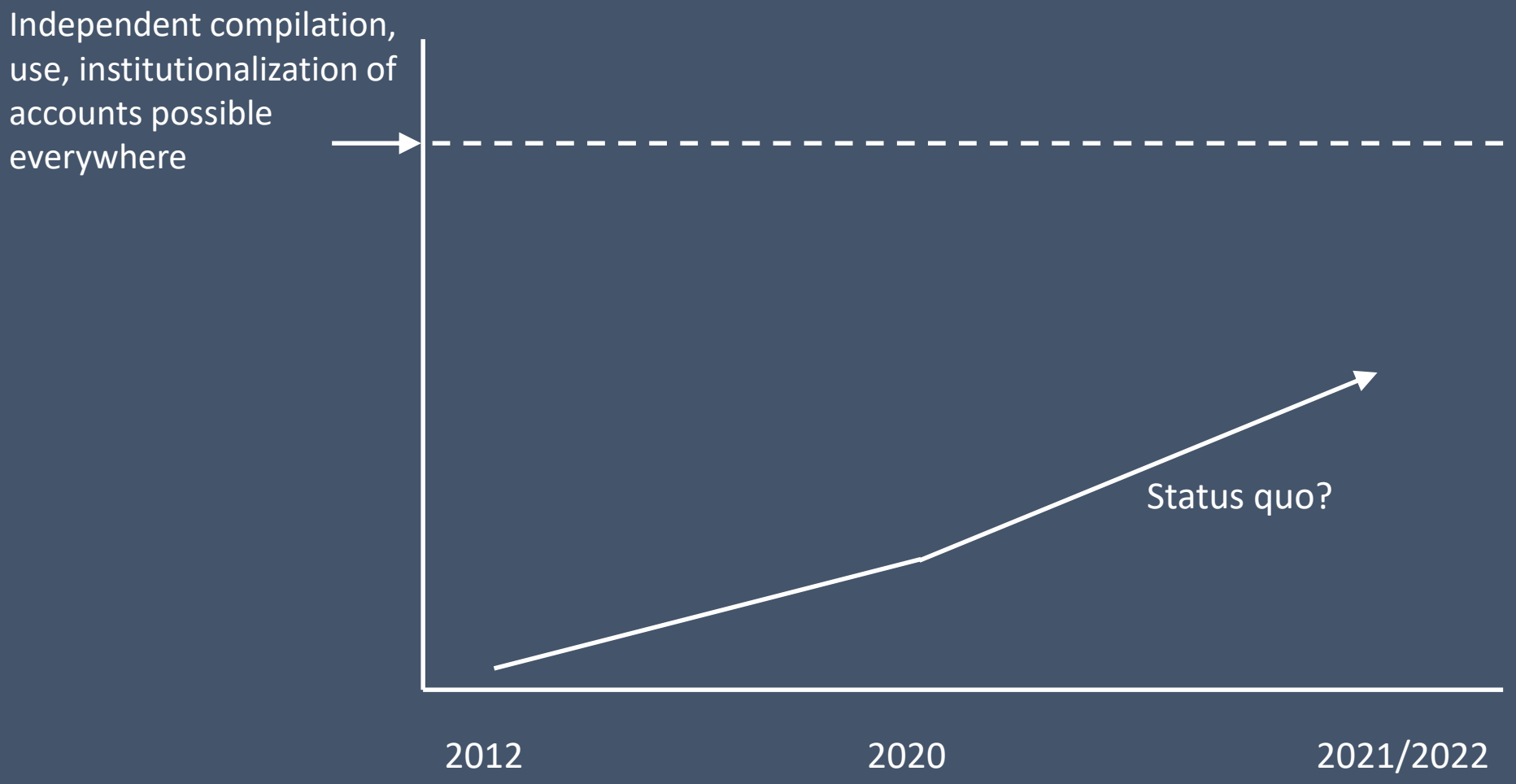
GitHub

Bitbucket

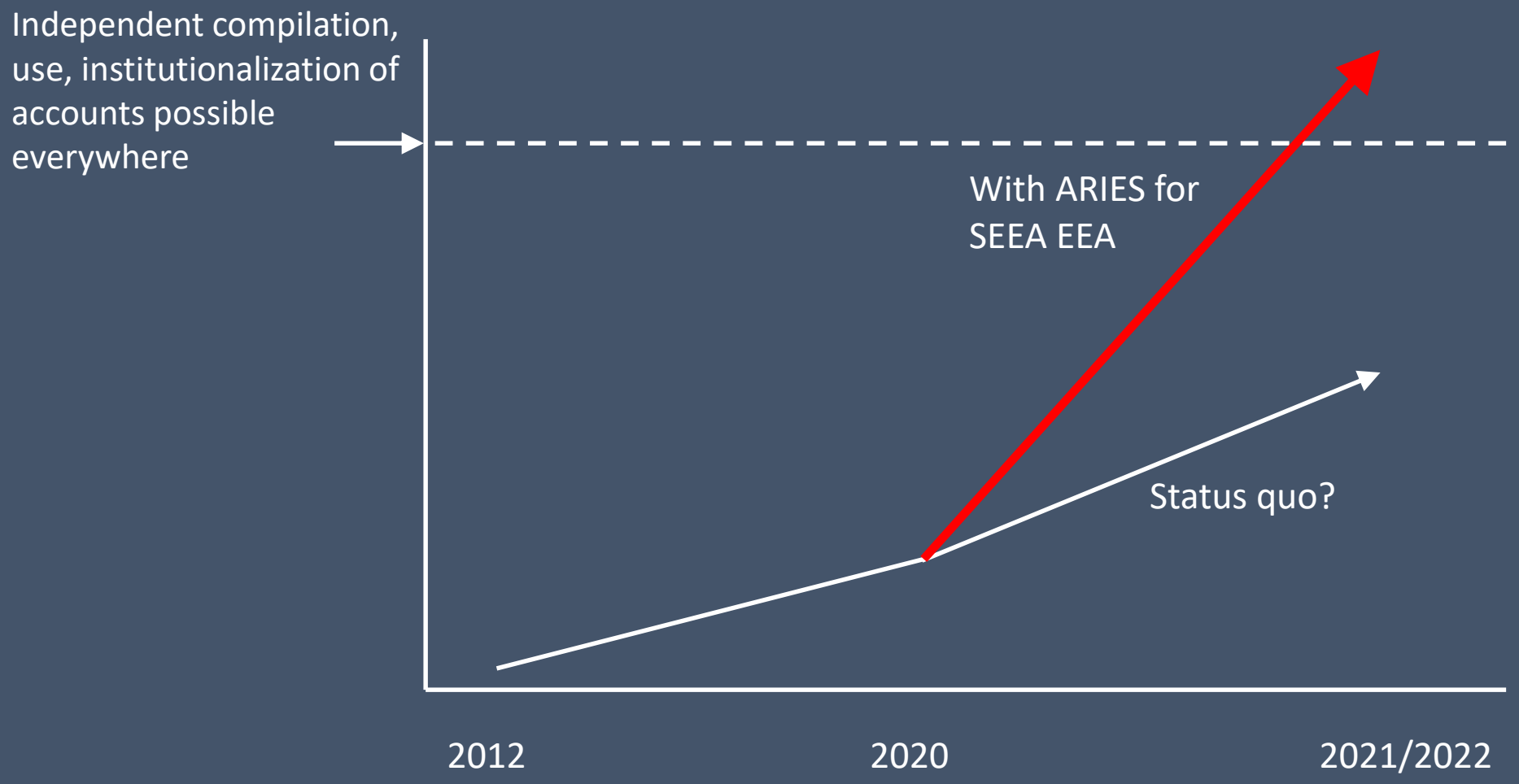
Bending the curve for global ecosystem accounting



Bending the curve for global ecosystem accounting



Bending the curve for global ecosystem accounting



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

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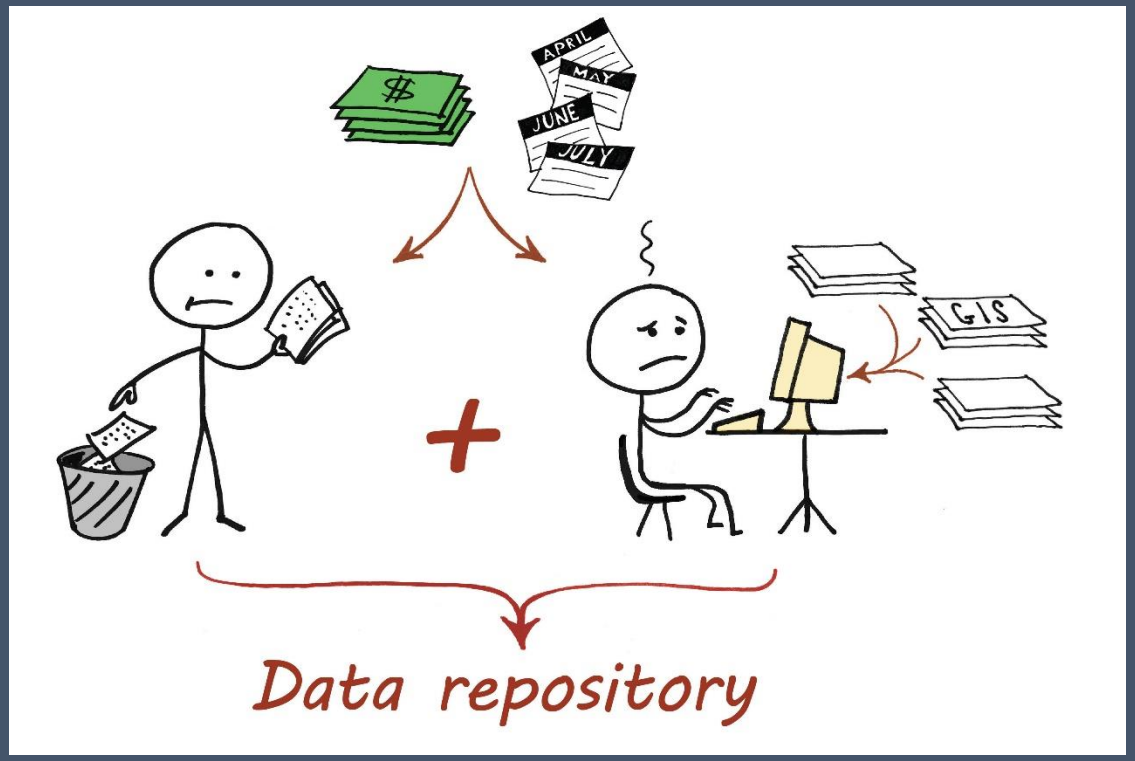
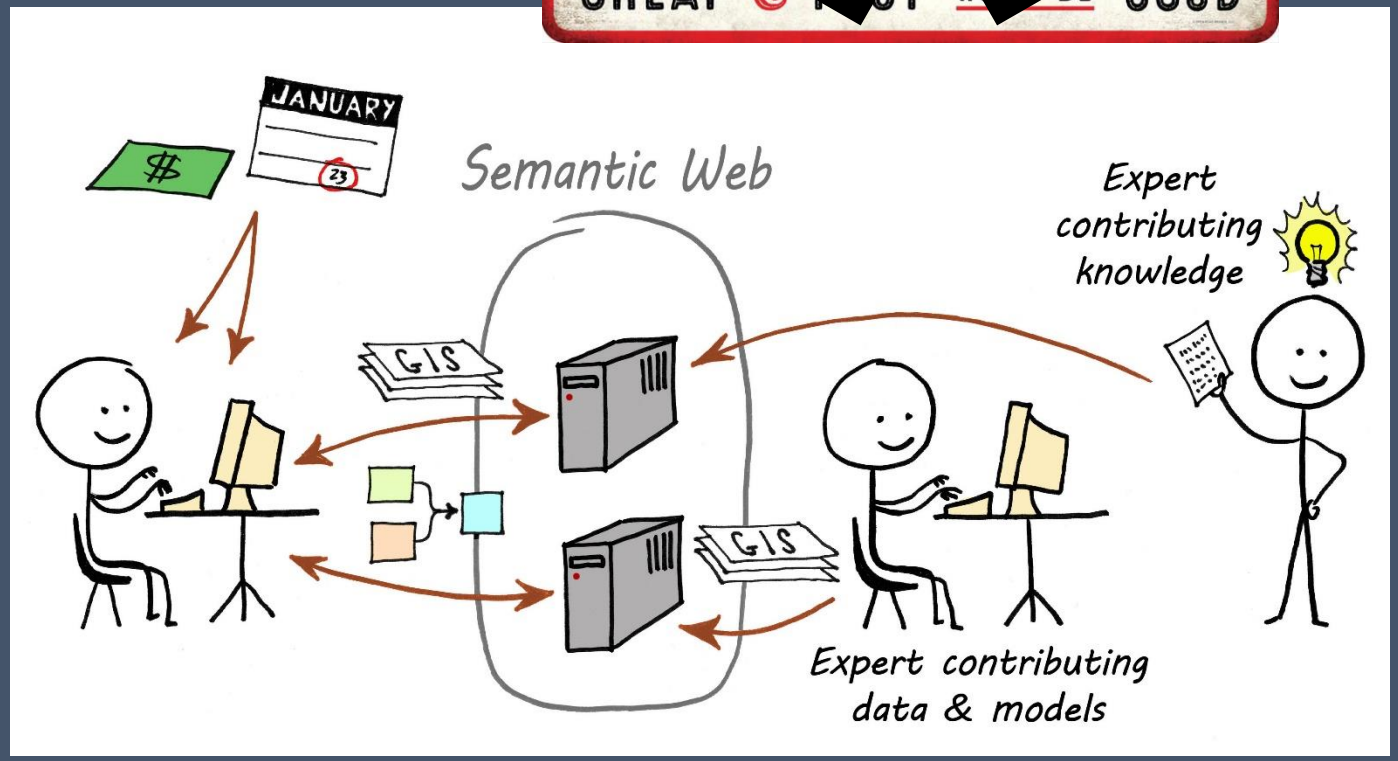
Does ecosystem services modeling always need to be painstakingly slow?



Status quo



Linked, web-based collaborative modeling

Achieving *interoperability*

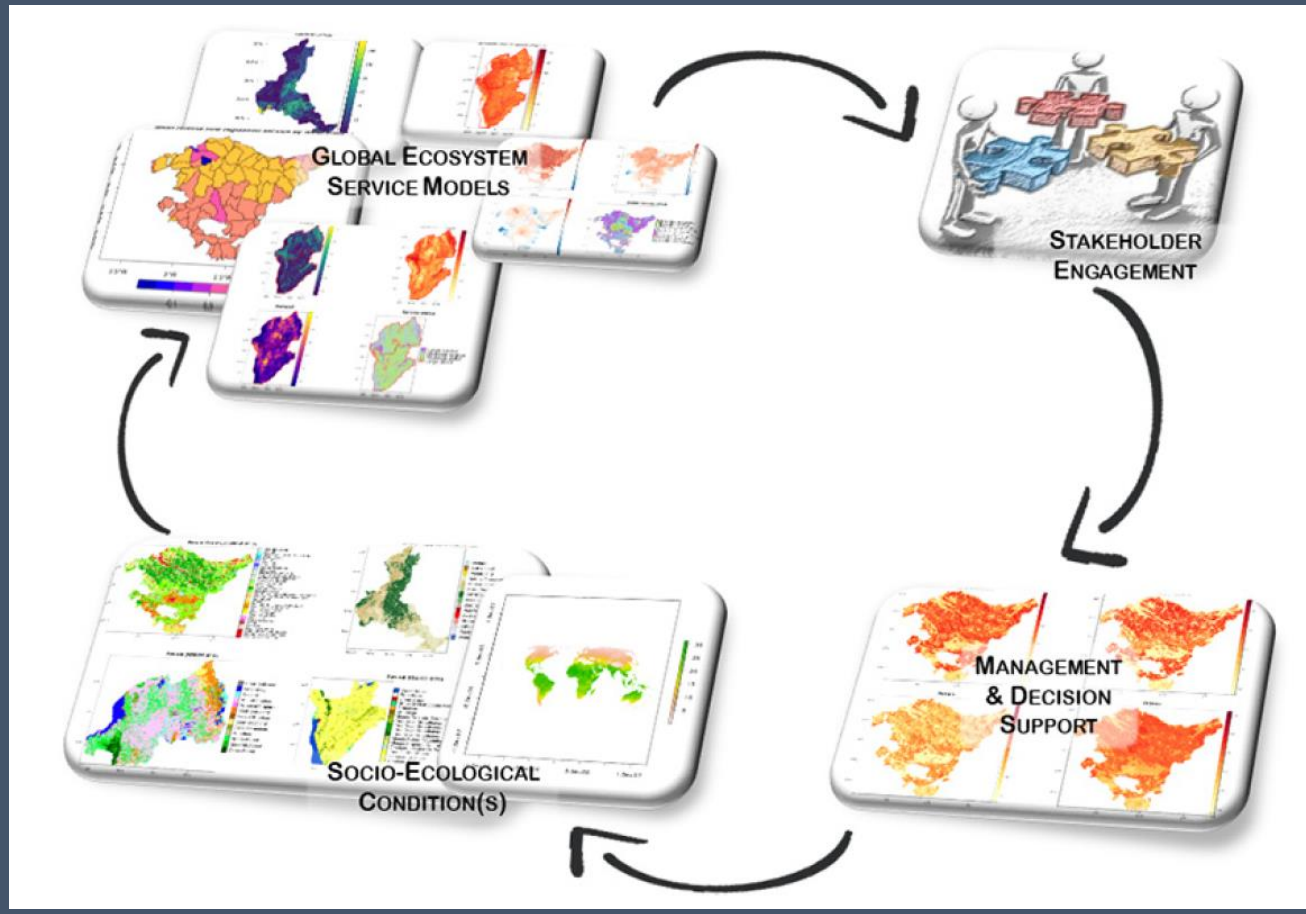
1. *Share data on the web*
   1. Consistent labeling makes it interchangeable
   2. Automate data use by models
2. *Share models on the web*, specify when & where to use each model
   - Models are *global* (run anywhere) yet *highly customizable*
3. Open-source software for stakeholders (modeling & visualization) & 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

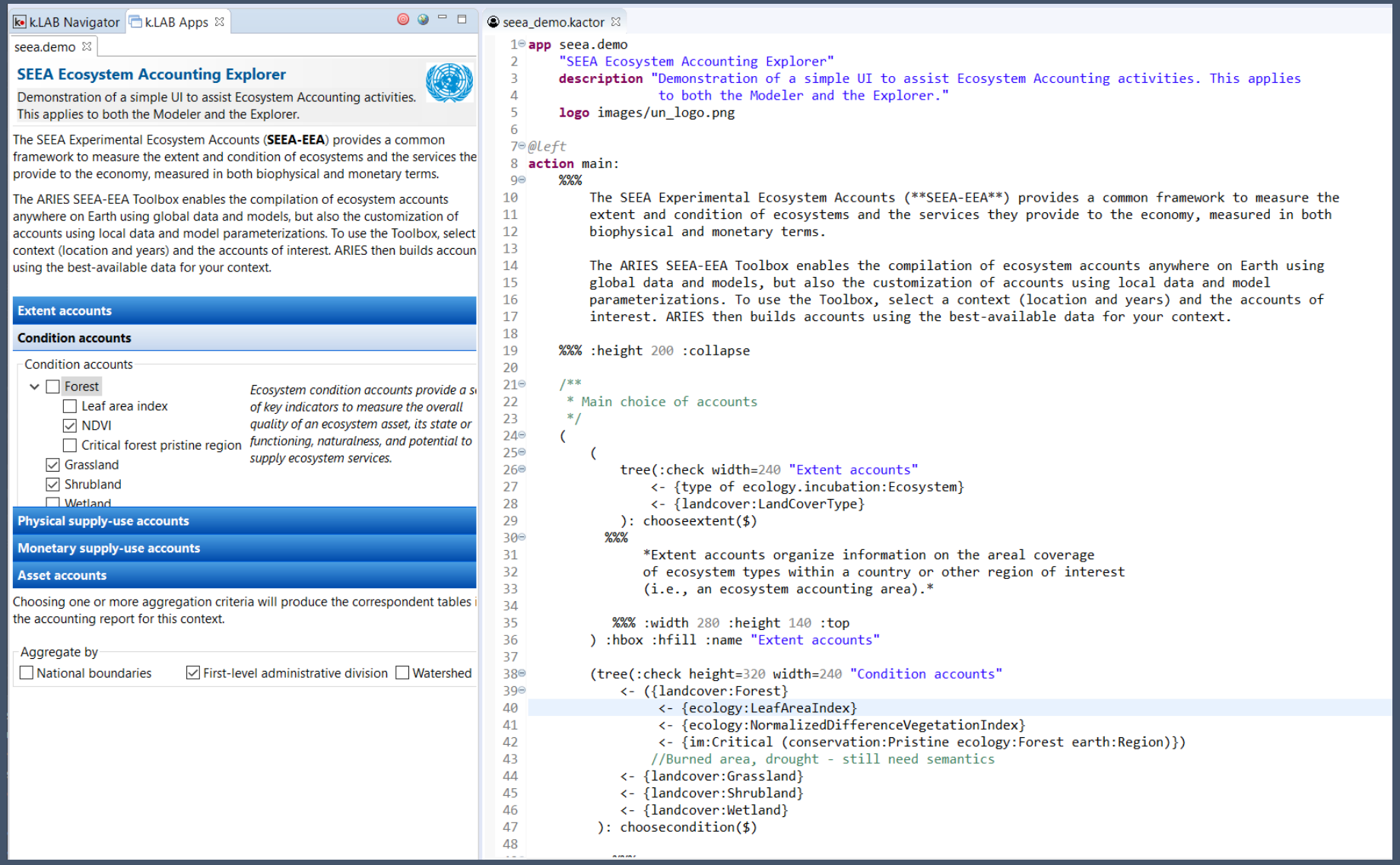
A *global knowledge network* for ecosystem service data & models

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



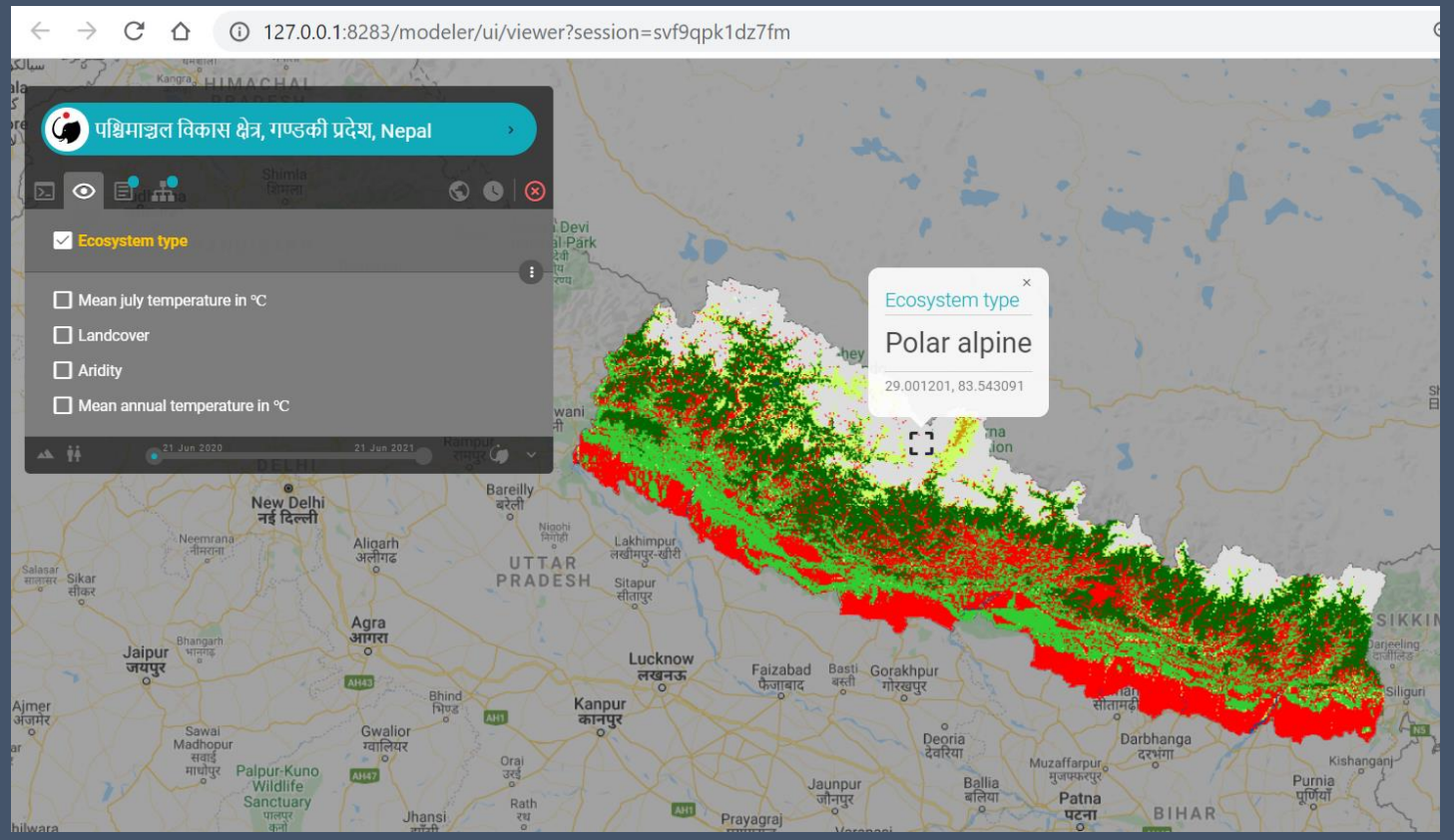
Martínez-López et al. 2019

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

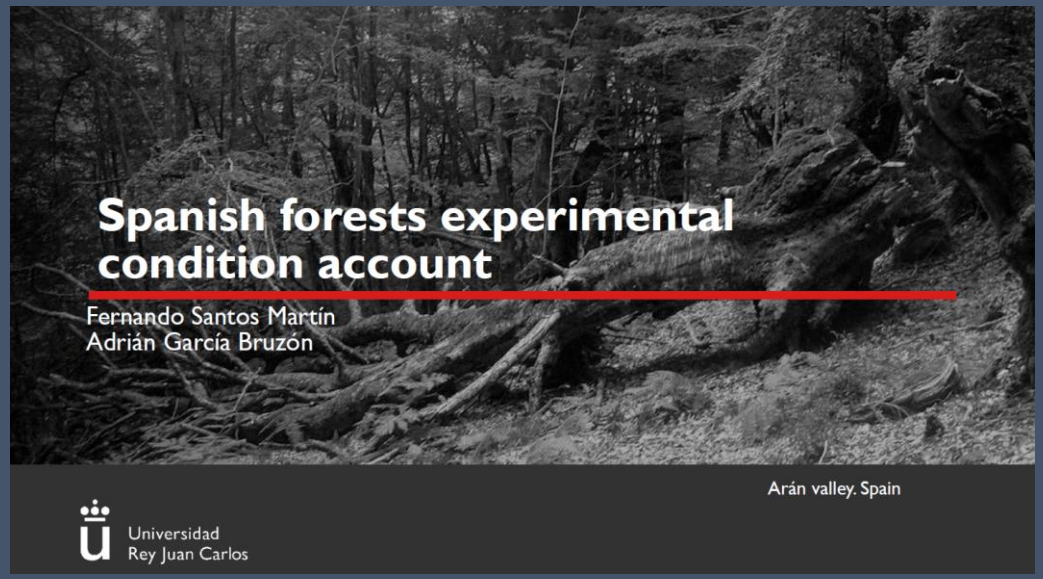
SEEA ECT group	SEEA ECT class	Indicators	Notes
Abiotic characteristics	Physical state	Drought index	https://crudata.uea.ac.uk/cru/data/drought/#global; monthly resolution at 0.5 degrees for 2001-2018
	Chemical state	No known forest-relevant indicators available globally and in time series	
Biotic characteristics	Compositional state	No known multiyear indicators available	
	Structural state	NDVI Burned area Tree canopy cover LAI	NDVI: MODIS monthly 1 km data, 2000-2018 Burned area: MODIS monthly 500 m data, 2000-2018 Tree canopy: Hansen, annual data, 2000-2018 LAI: MODIS 8-day 500 m, 2000-2018
	Functional state	GPP/NPP	MODIS monthly 1 km data
Land/ seascape characteristics	Landscape level characteristics (e.g., connectivity, fragmentation)	Intact Forest Landscape	https://data.globalforestwatch.org/search?groupIds=577b964b7d8b41b9822d39a7be261bff; available annually for the years 2000, 2013, 2016

Global time series ca. 2000-present

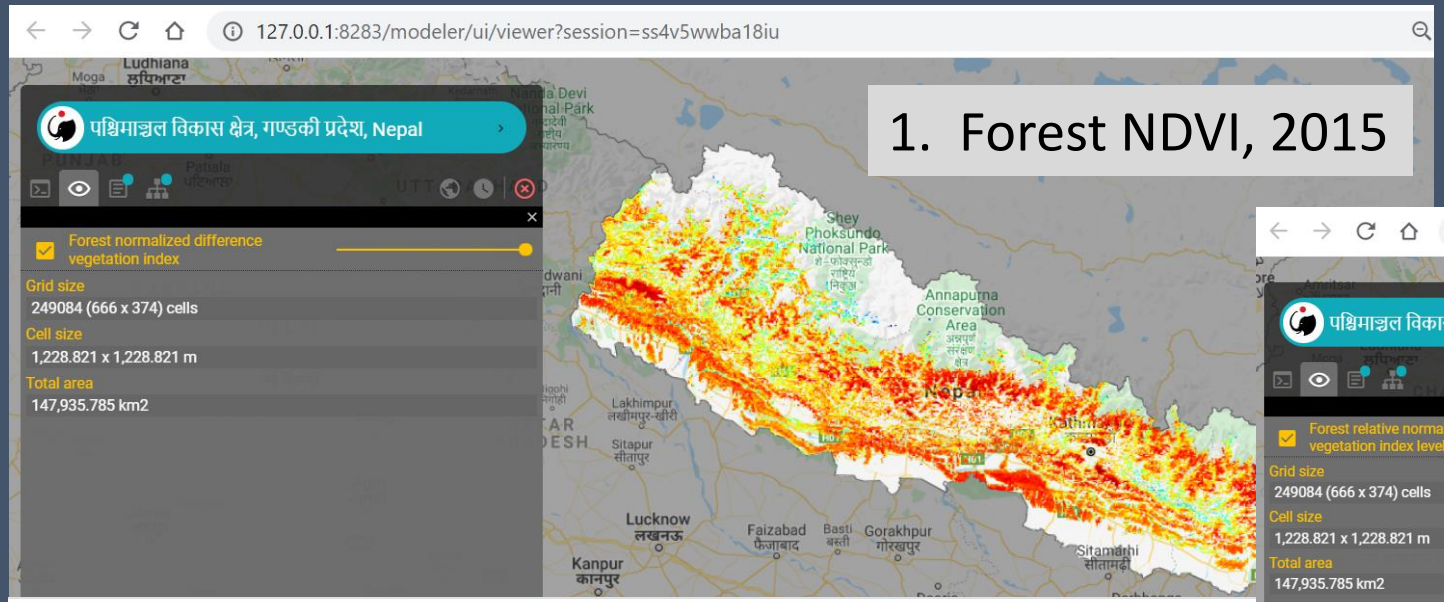
Challenges: time series data of adequate length, aggregating 8-day to monthly data into yearly totals/averages, etc.

Condition accounts: Aggregating metrics & reference condition

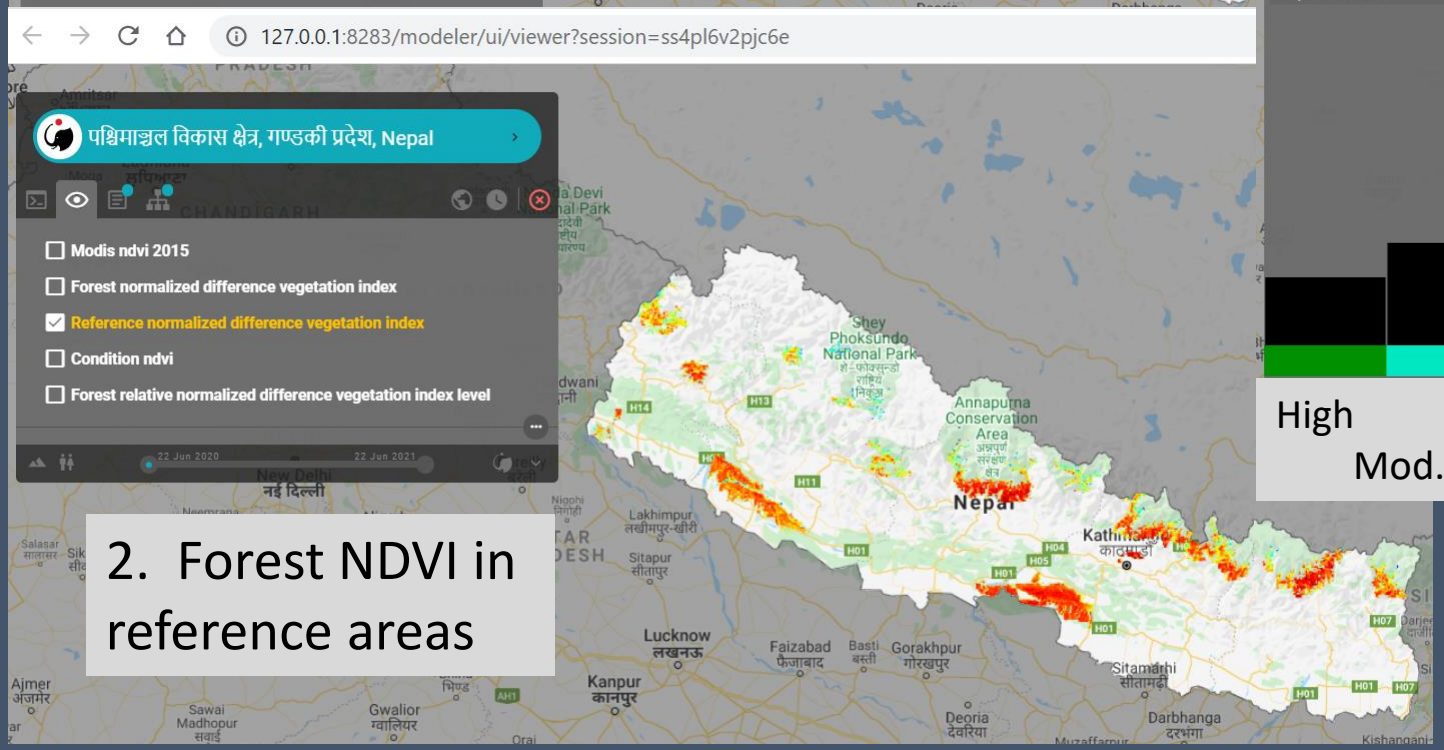
- Santos et al. (in prep) reference forests as those in protected areas that have remained forested since 1970 (earliest available data)
- Compare forest condition within & outside reference forests, normalize all values. Aggregate using equal weights.
- Earliest current global time series land cover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



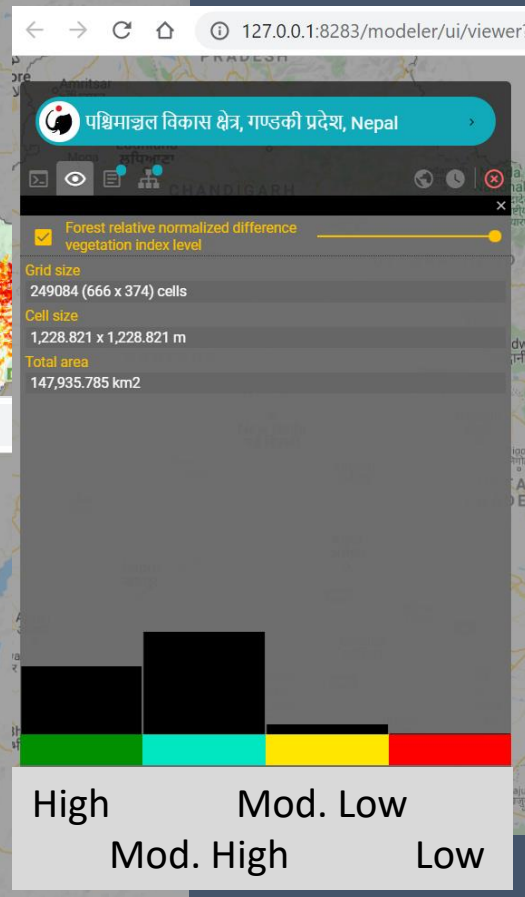
$$Var\downarrow nor = X - min\downarrow ref \; / max\downarrow ref \; - min\downarrow ref$$

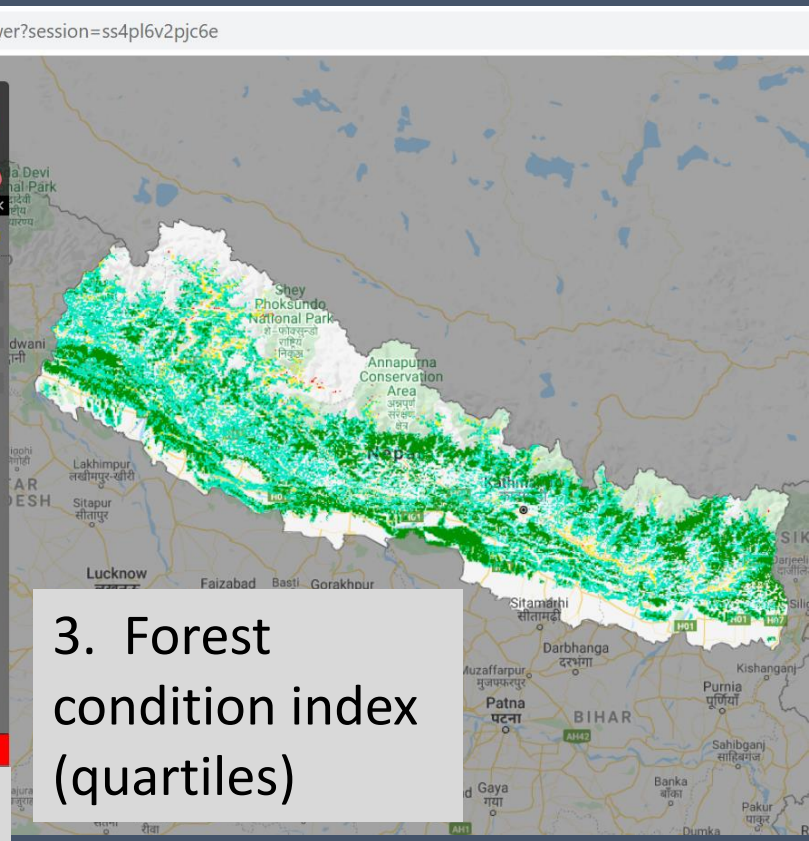


1. Forest NDVI, 2015



2. Forest NDVI in reference areas

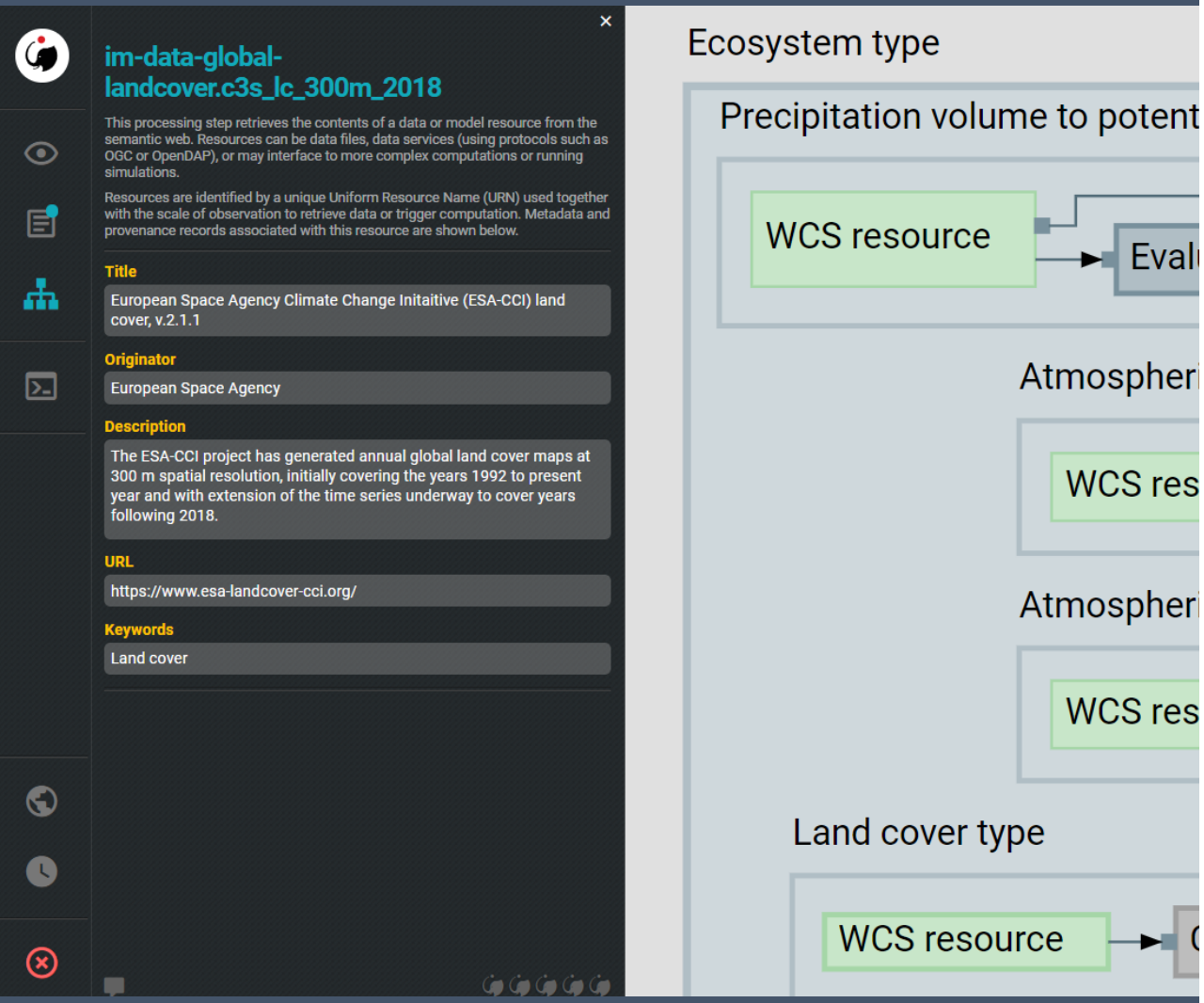




3. Forest condition index (quartiles)

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

Transparent data assembly & reporting



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 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:Savanna

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

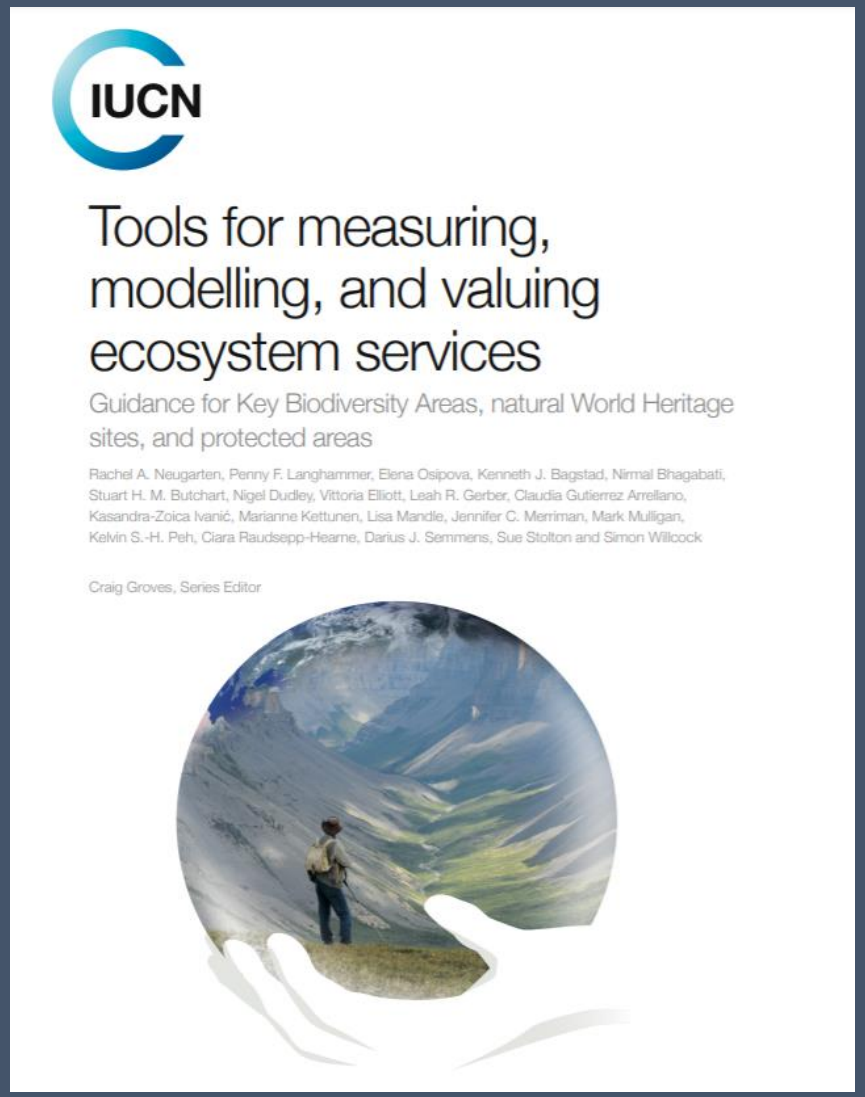


Table 3. Purpose of measuring, modelling or valuing ES of KBAs, natural World Heritage sites, and protected areas, and tools that might be applied. ✓ = can potentially be used; ✓✓ = can potentially be used and there are case studies available. For case studies, see Annexes II and IV.

Reasons for measuring ES provided by sites	ARIES	C$N	EST	InVEST	MIMES	PA-BAT	SolVES	TESSA	WW
Public/policy support									
Provide additional evidence and justification for the importance of conserving a particular site	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓
Foster local awareness of the ES provided by a particular site	✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓
Build support for the conservation of multiple sites through increased understanding of their wide range of benefits	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Link ES contributed by all sites in a country to international or national sustainability goals and national policies (e.g. SDGs)	✓	✓✓		✓✓	✓	✓✓			✓✓
Site management									
Establish the baseline of ES provided by a site to enable monitoring of changes and support management planning	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

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)

```
define IUCN_GLOBAL_ECOSYSTEMS as {{
          landcover                                | aridity   | mean_annual_temperature   | 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

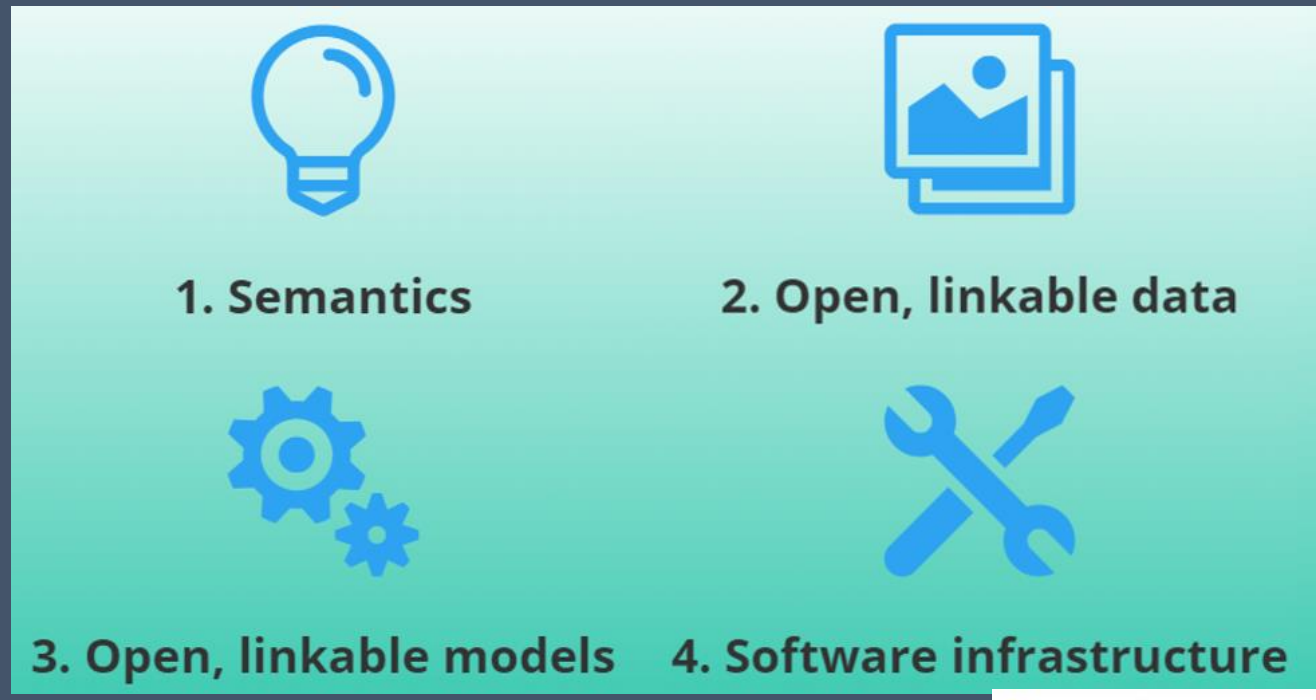
Box 2 | The FAIR Guiding Principles

To be Findable:
F1. (meta)data are assigned a globally unique and persistent identifier
F2. data are described with rich metadata (defined by R1 below)
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:
A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

To be Interoperable:
I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (meta)data use vocabularies that follow FAIR principles
I3. (meta)data include qualified references to other (meta)data

To be Reusable:
R1. meta(data) are richly described with a plurality of accurate and relevant attributes
R1.1. (meta)data are released with a clear and accessible data usage license
R1.2. (meta)data are associated with detailed provenance
R1.3. (meta)data meet domain-relevant community standards



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