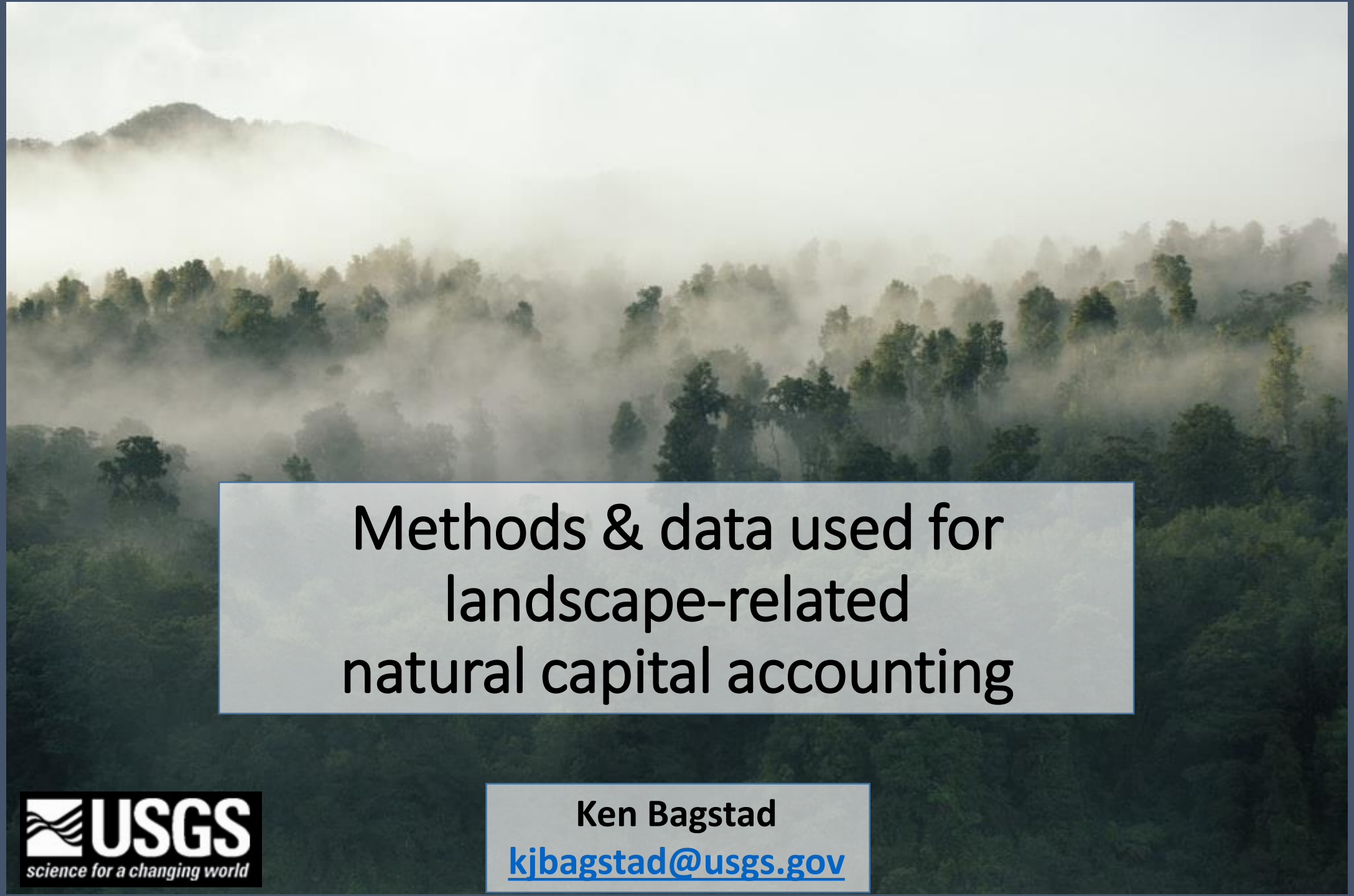

Methods & data used for landscape-related natural capital accounting

USGS science for a changing world

Ken Bagstad
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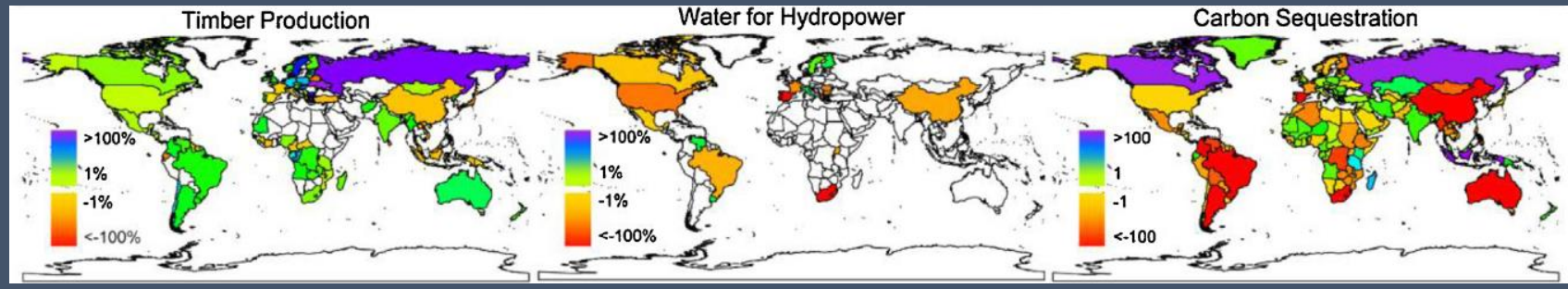
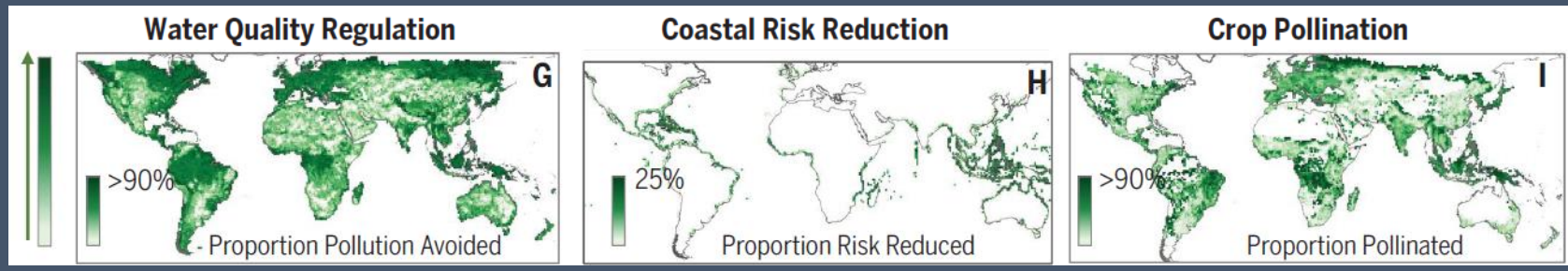
Why biophysical modeling?

- Statistical systems collect data at national & sometimes subnational scales (population, trade, agriculture, fisheries, etc.)
- Most things vary in space; those patterns matter for resource management!



Karp et al. 2015

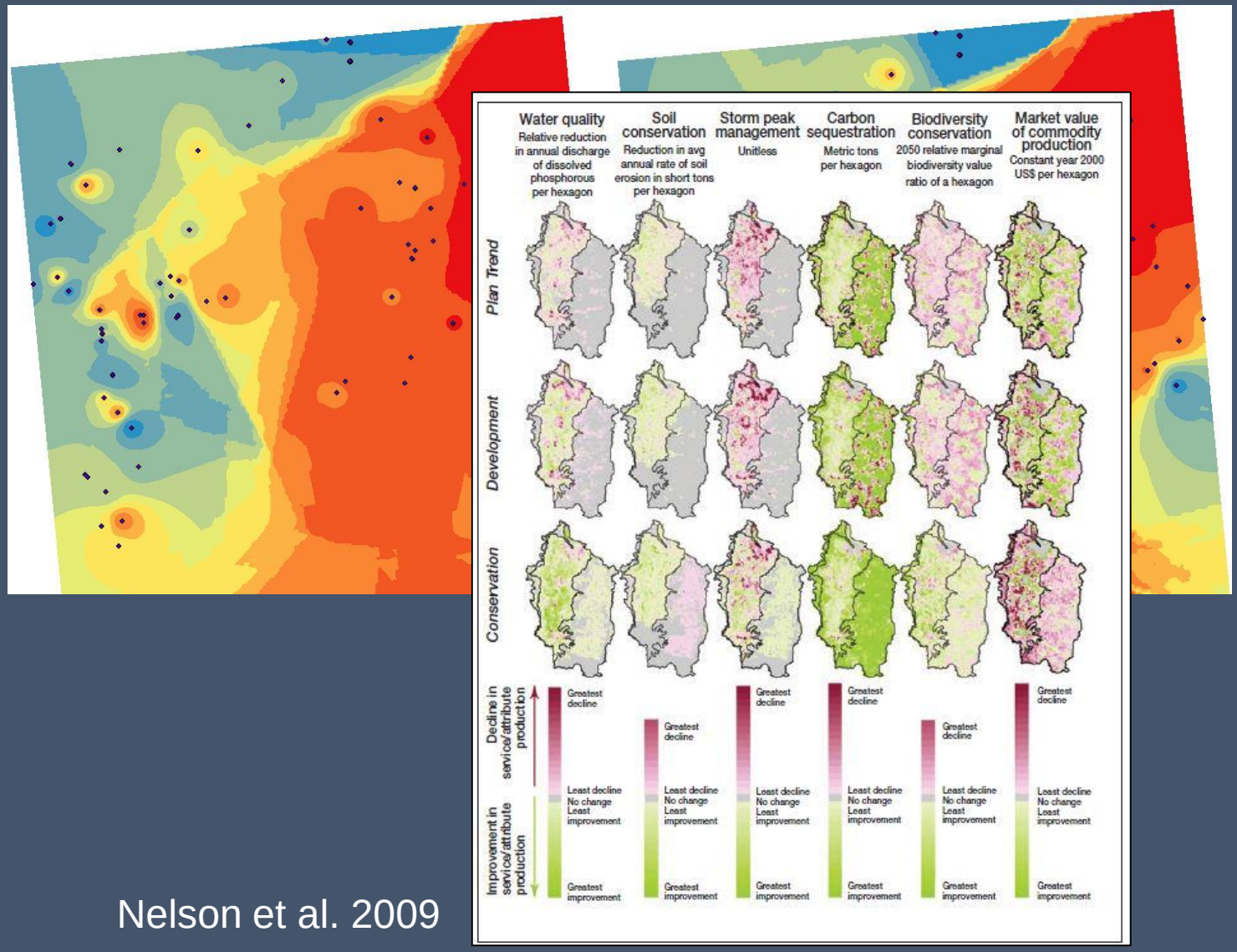


Chaplin-Kramer et al. 2019

What does biophysical modeling enable?

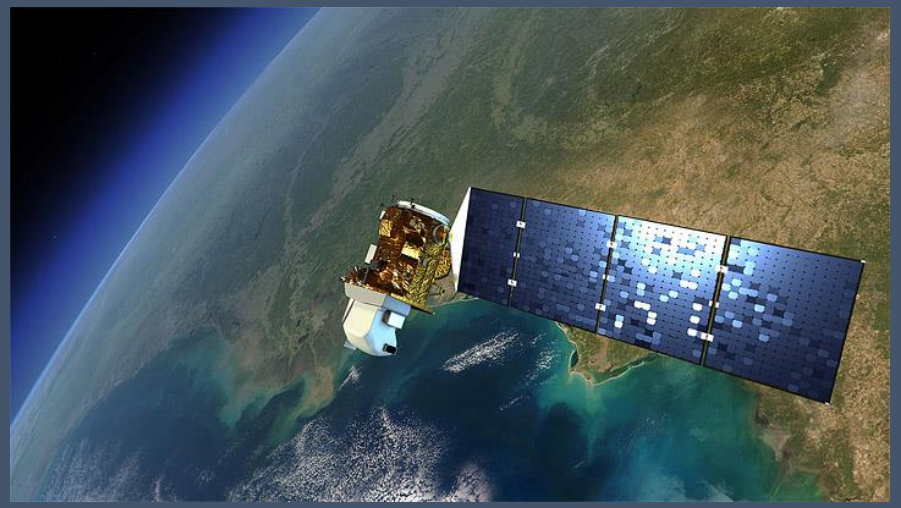
- *Interpolation* – across space & time

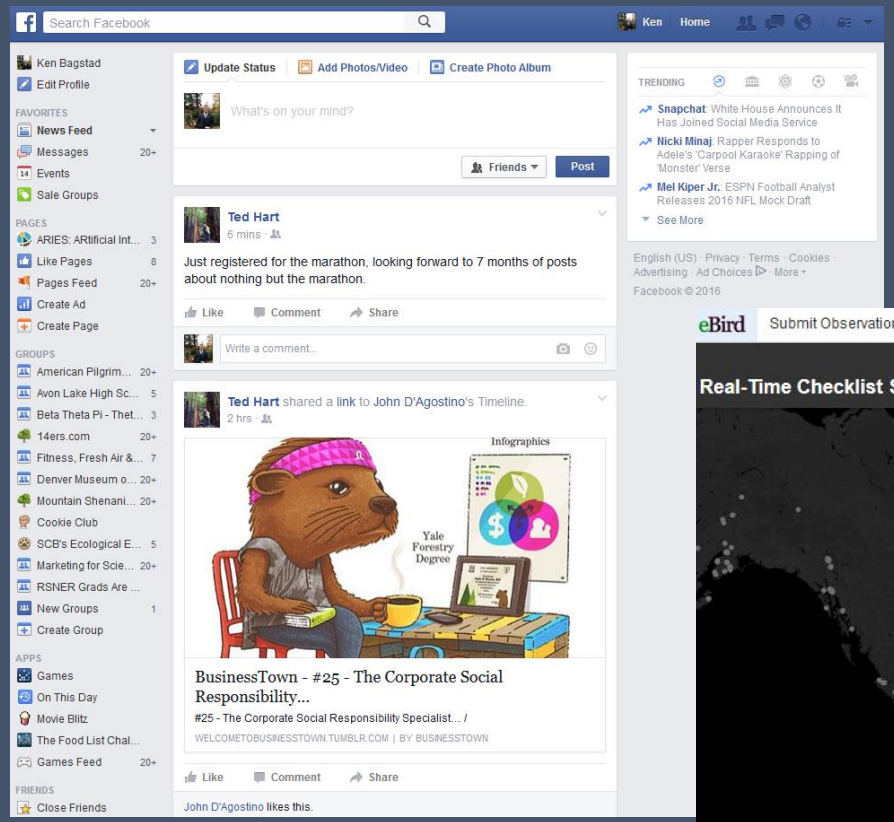
- Modeling future scenarios

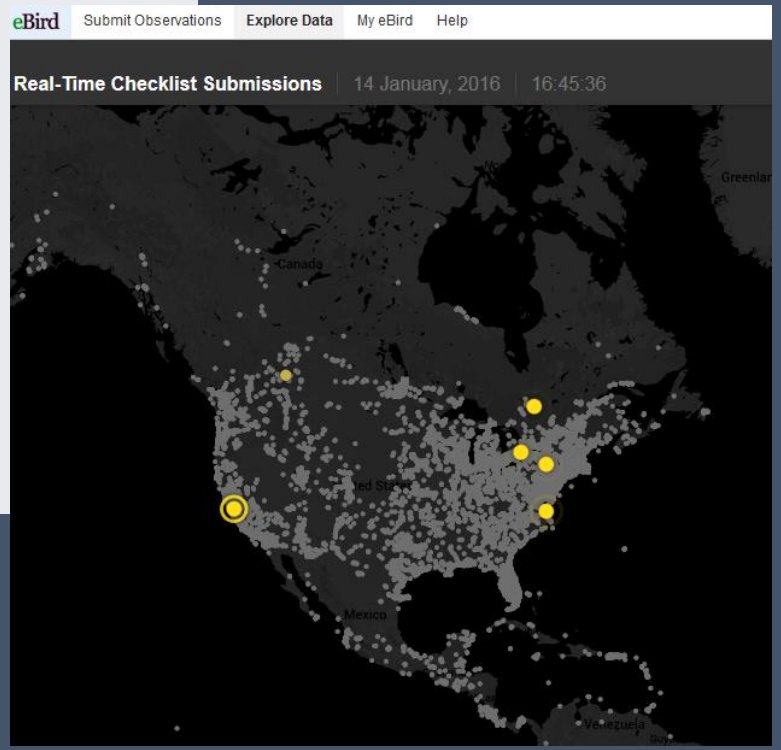


Nelson et al. 2009

Living in a golden age of data







Turning raw data into natural capital accounts is slow, painstaking work

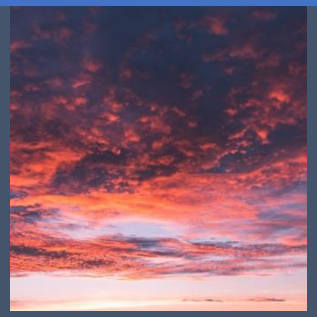
Requires collaboration of many experts

Satellite remote sensing

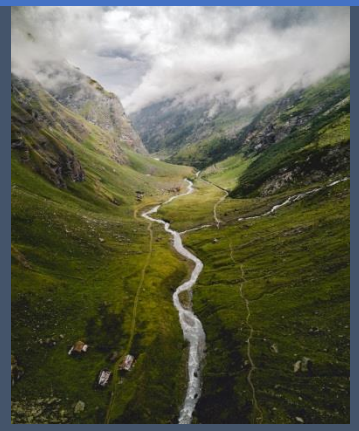
Soil science

Oceanography

This is before you get to the GIS modelers, accountants & economists!

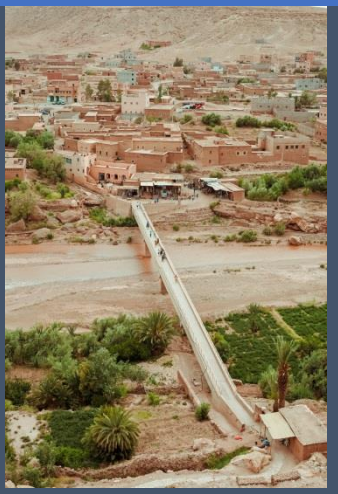


Atmospheric science



Hydrology

Ecology



Demography

1. All models are a simplification of reality

2. There are many different types of models

The modeler must make choices:

1. What is the purpose of my model?
   - What details do I need, what can I leave out?
2. How well do I understand my system & what's driving it?
3. Which data are available?
4. How much expertise is available?
5. How much time do I have?

Choices point toward which models to use

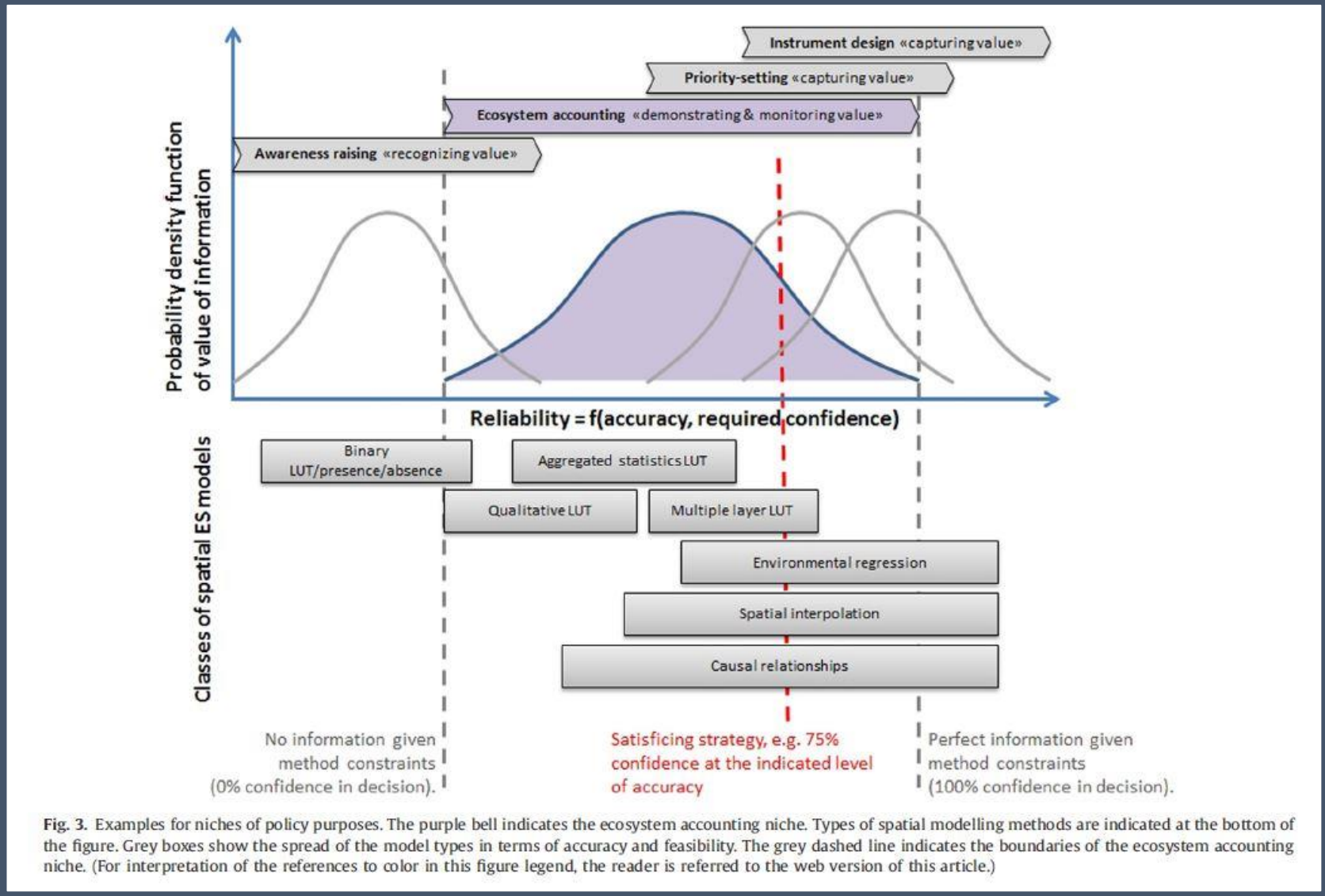


Fig. 3. Examples for niches of policy purposes. The purple bell indicates the ecosystem accounting niche. Types of spatial modelling methods are indicated at the bottom of the figure. Grey boxes show the spread of the model types in terms of accuracy and feasibility. The grey dashed line indicates the boundaries of the ecosystem accounting niche. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

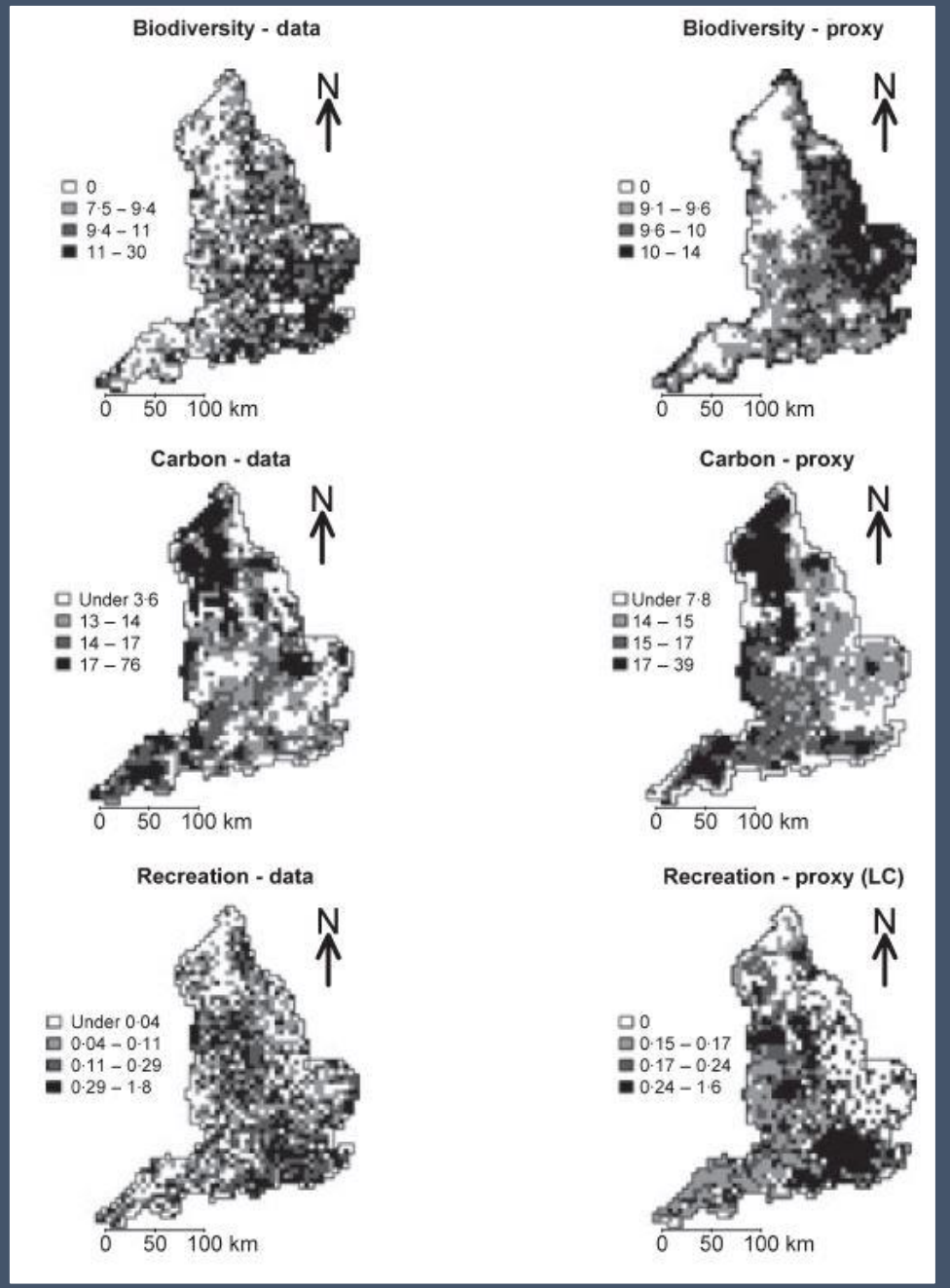
Schröter et al. 2015

Choosing which model to use

A good model:

- Incorporates local data & knowledge
- Represents physical & social processes & their drivers

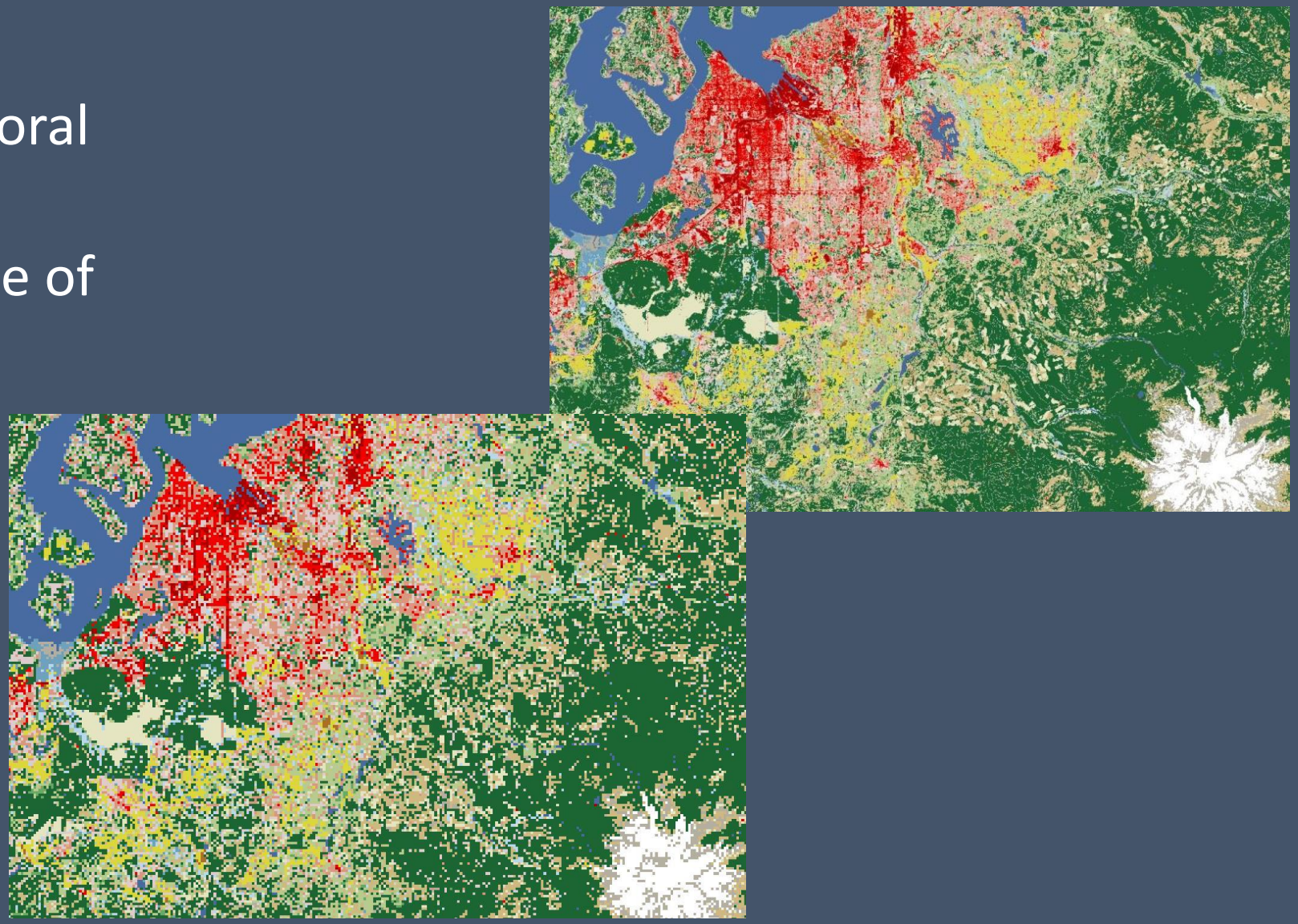
"…land cover based proxies provide a poor fit to primary data…"



Eigenbrod et al. 2010

A good model:

- Has good spatiotemporal resolution
- But not at the expense of accuracy!



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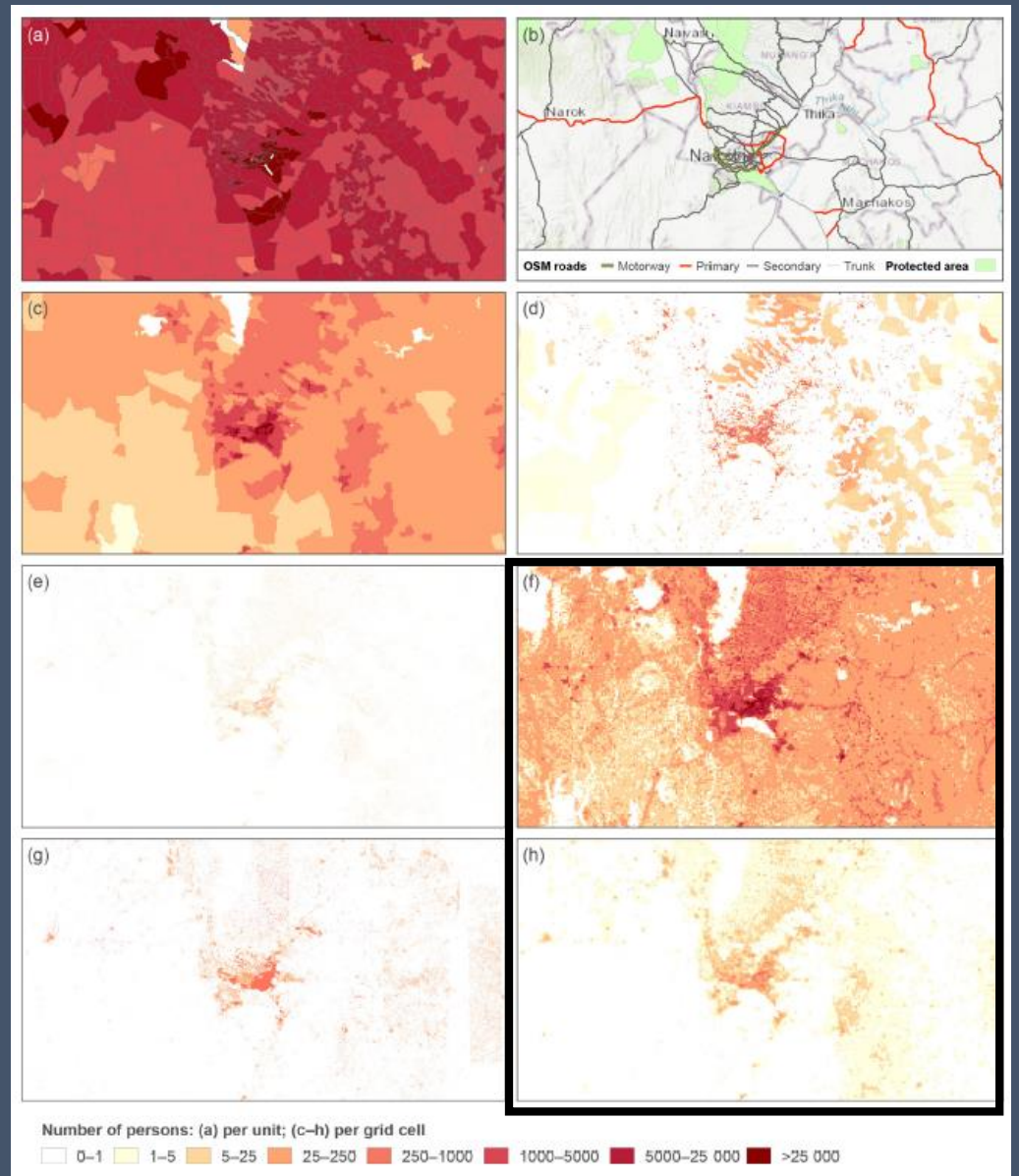
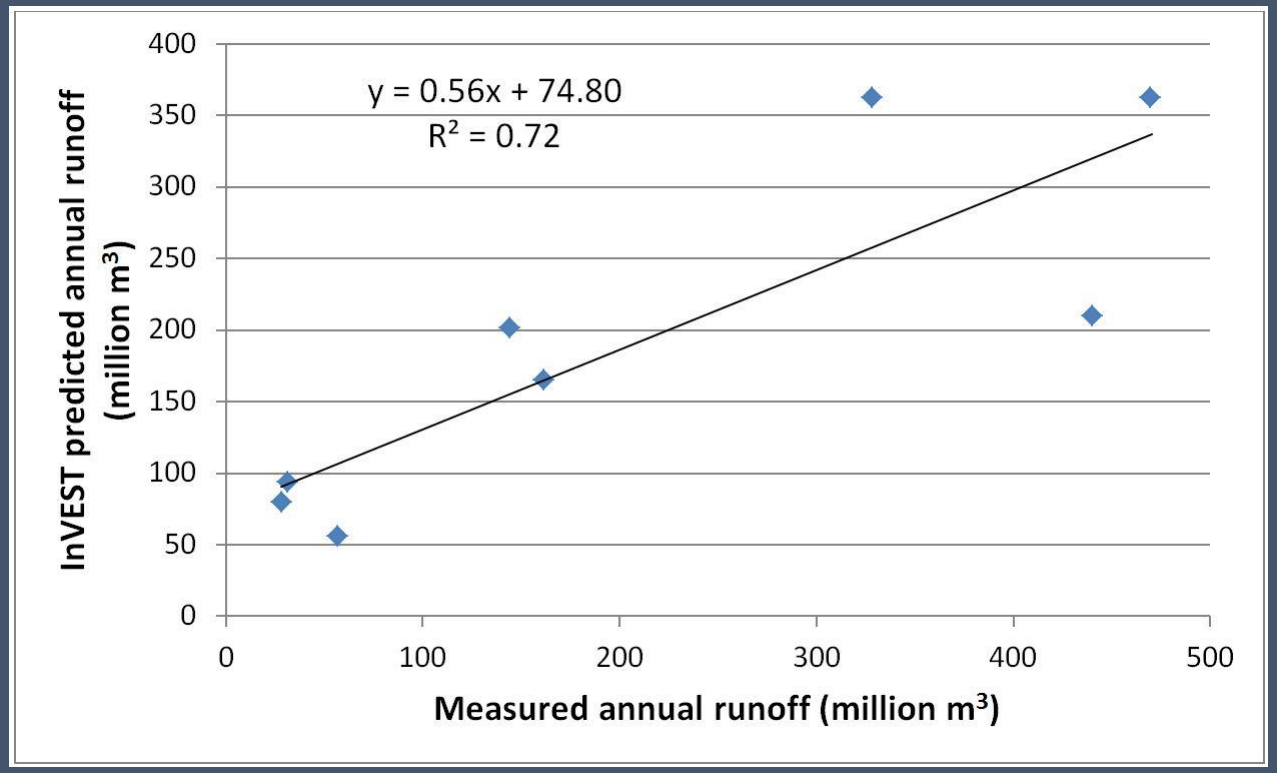


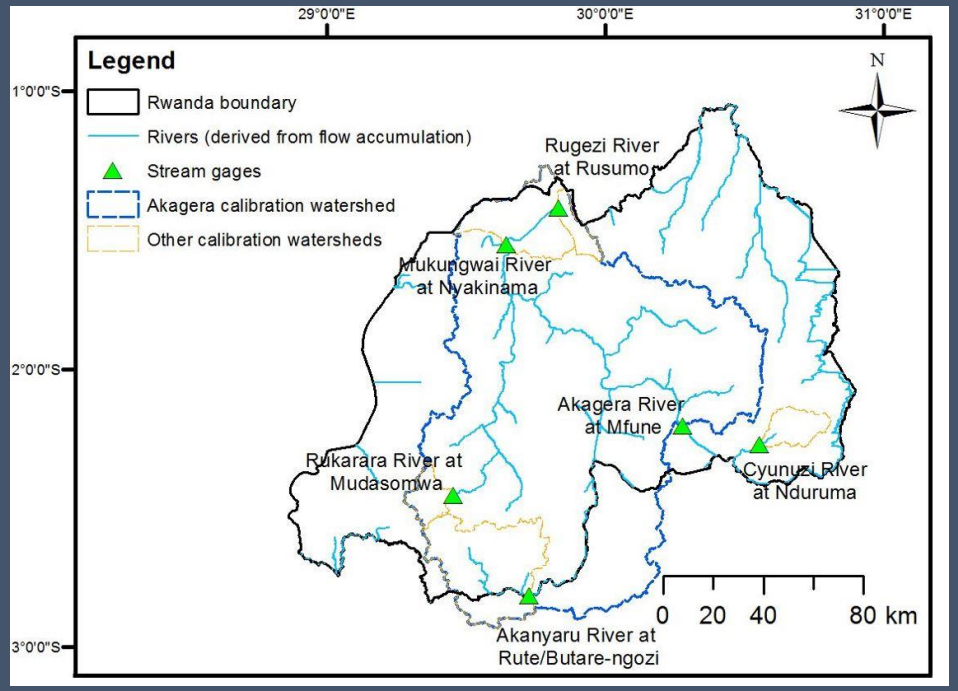
Comparing global models of population density for Nairobi, Kenya (Leyk et al. 2019)

F & H are same resolution, but F more accurate!

A good model:

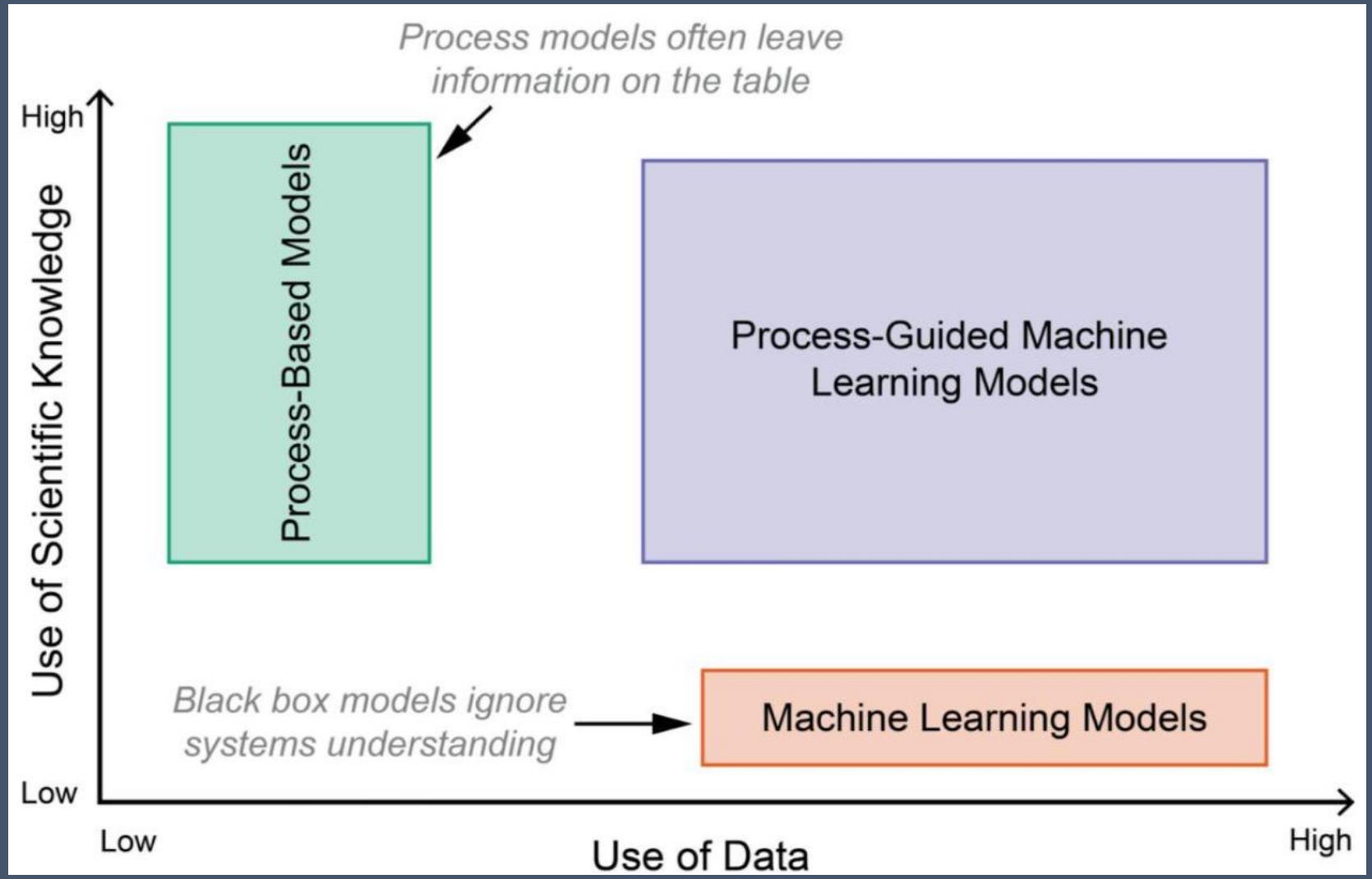
- Is calibrated when possible





Bagstad et al. (in press)

Machine learning vs. traditional models



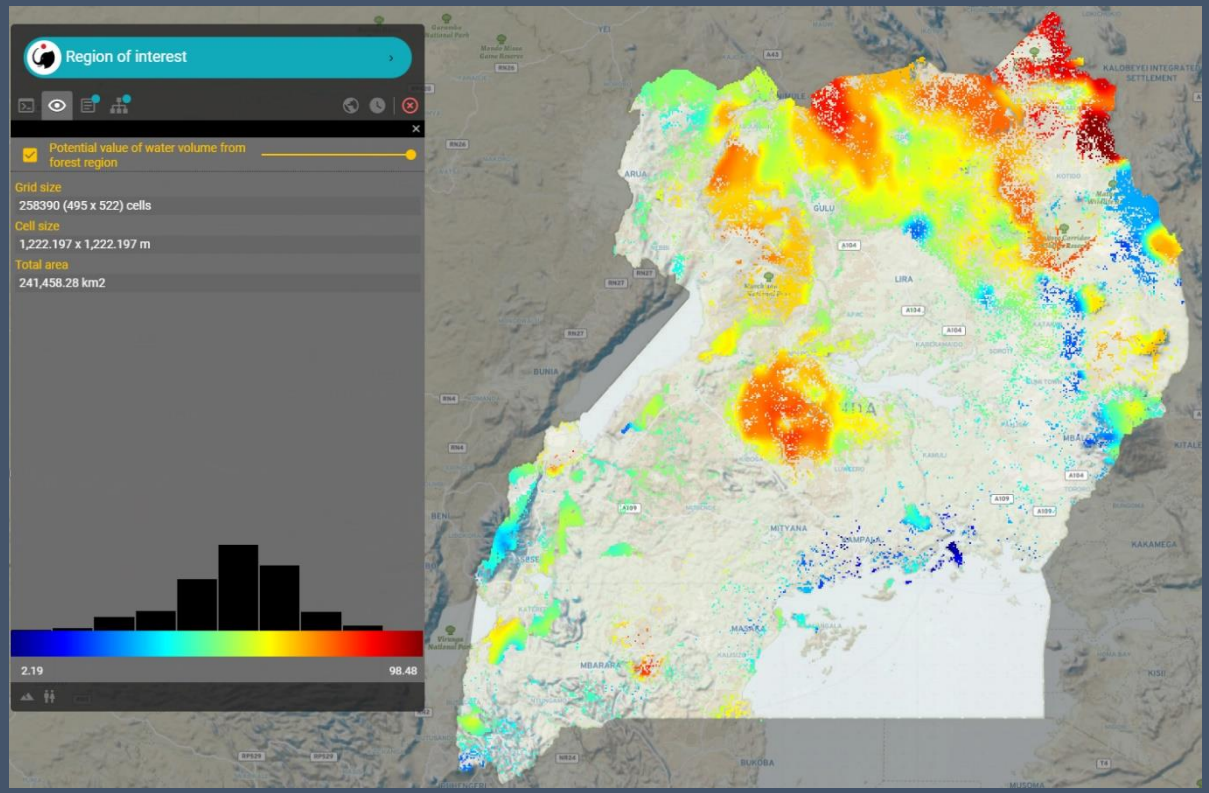
Grounding in theory +

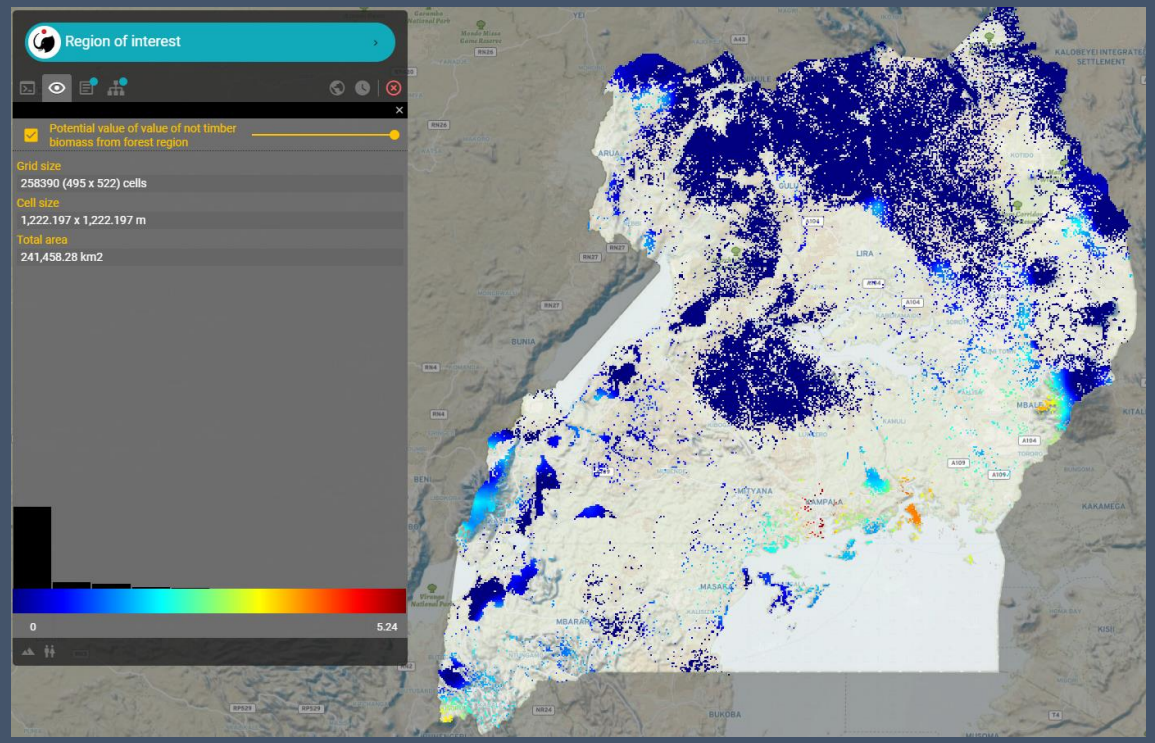
+ Explanatory power & risk of overfitting

Source: USGS

Valuation

- Spatial meta-analysis based value transfer

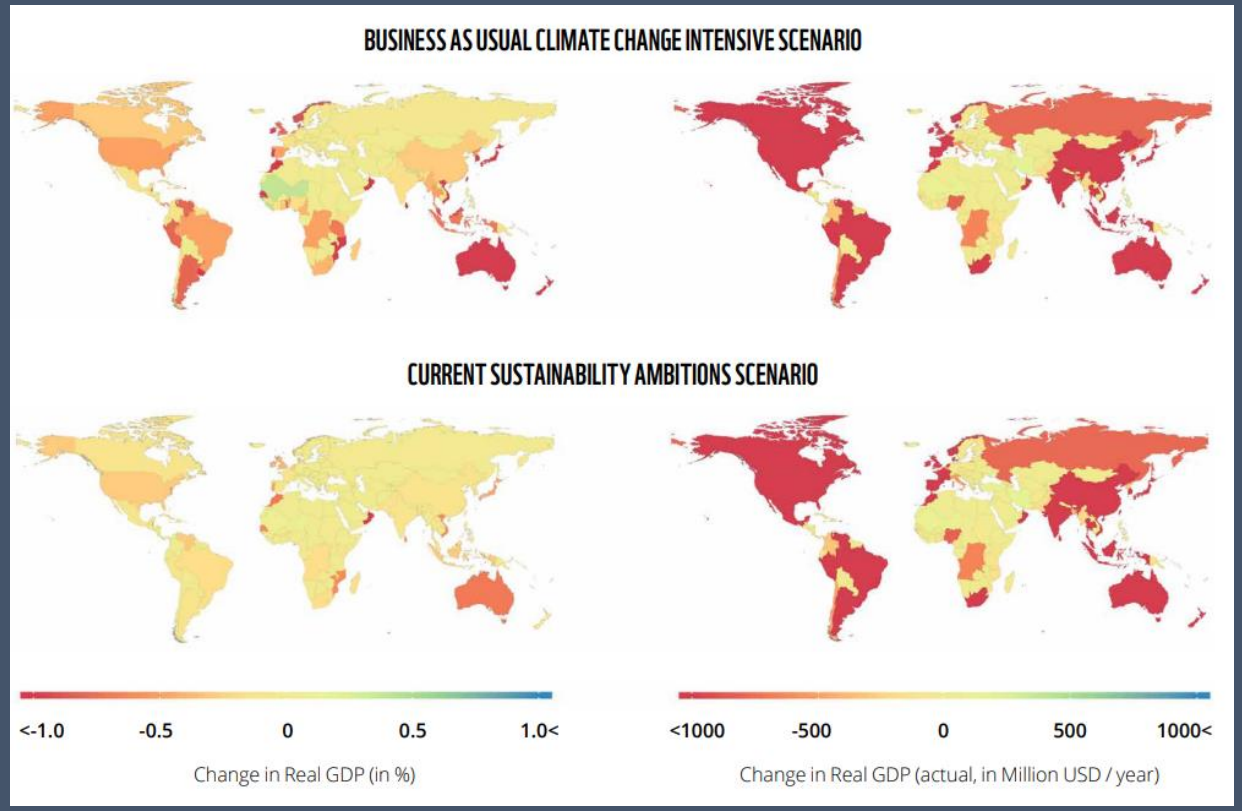




Spatial valuation of water (above), nontimber forest products (left) in ARIES using Siikimaki et al. (2015) global forests meta-analysis

Valuation

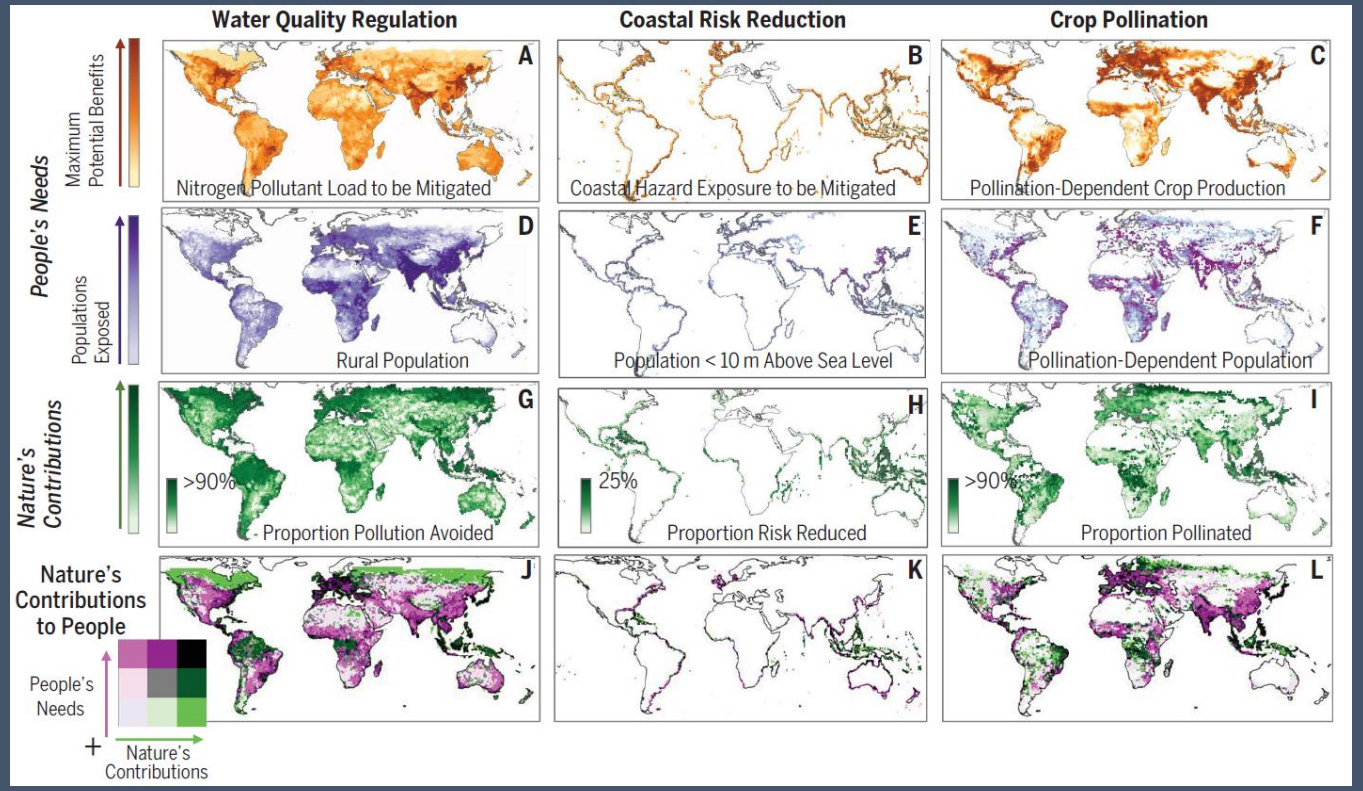
- Integration with economic (CGE) models becoming popular
  - GTAP-U. Minnesota (global)
  - World Bank (Indonesia)
  - Interamerican Development Bank (Colombia, Costa Rica, Guatemala, Rwanda, Uruguay)



Roxborough et al. 2019, global InVEST-GTAP study

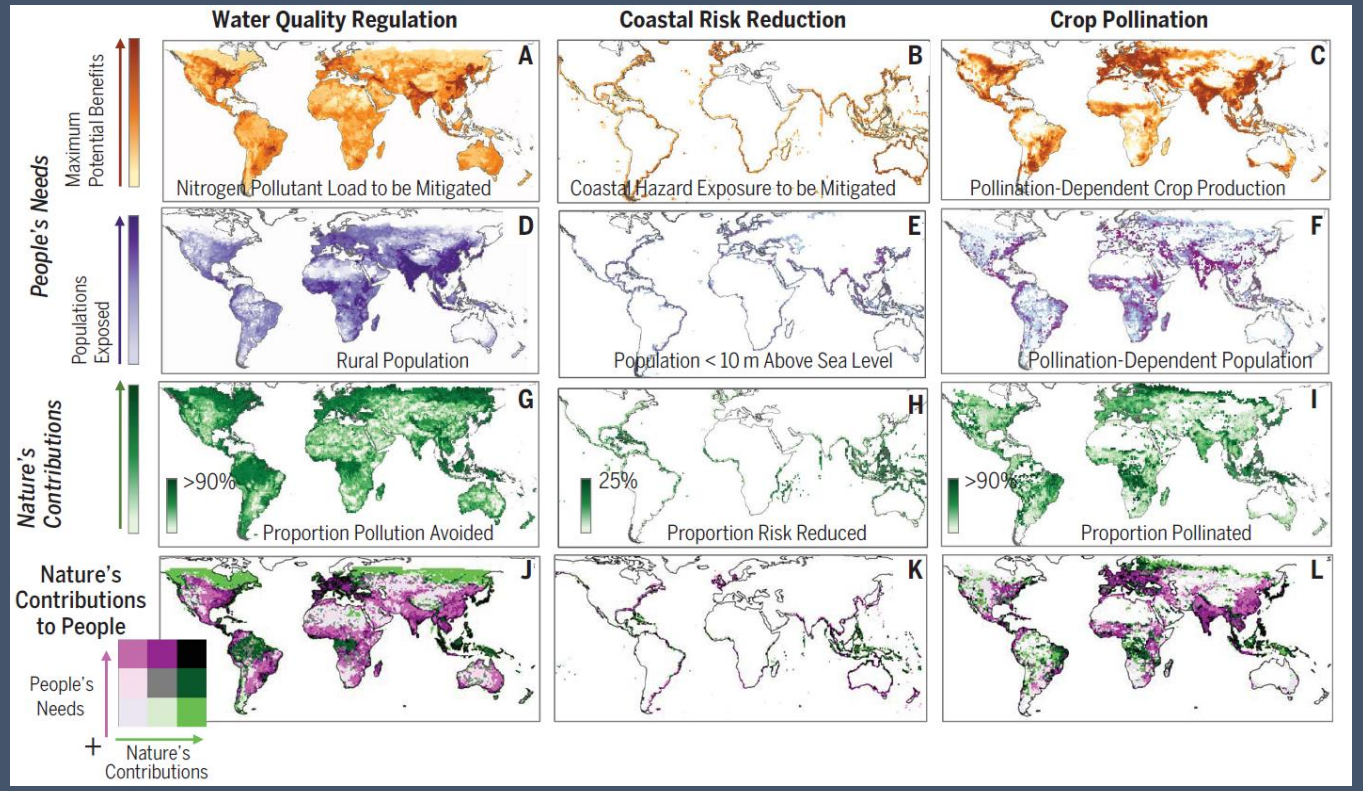
Global ecosystem service models – strengths

- Data are there & ready for further analysis/reuse
- Enables international comparisons
- Currently at 300 m spatial resolution globally (Chaplin-Kramer et al. 2019, InVEST)



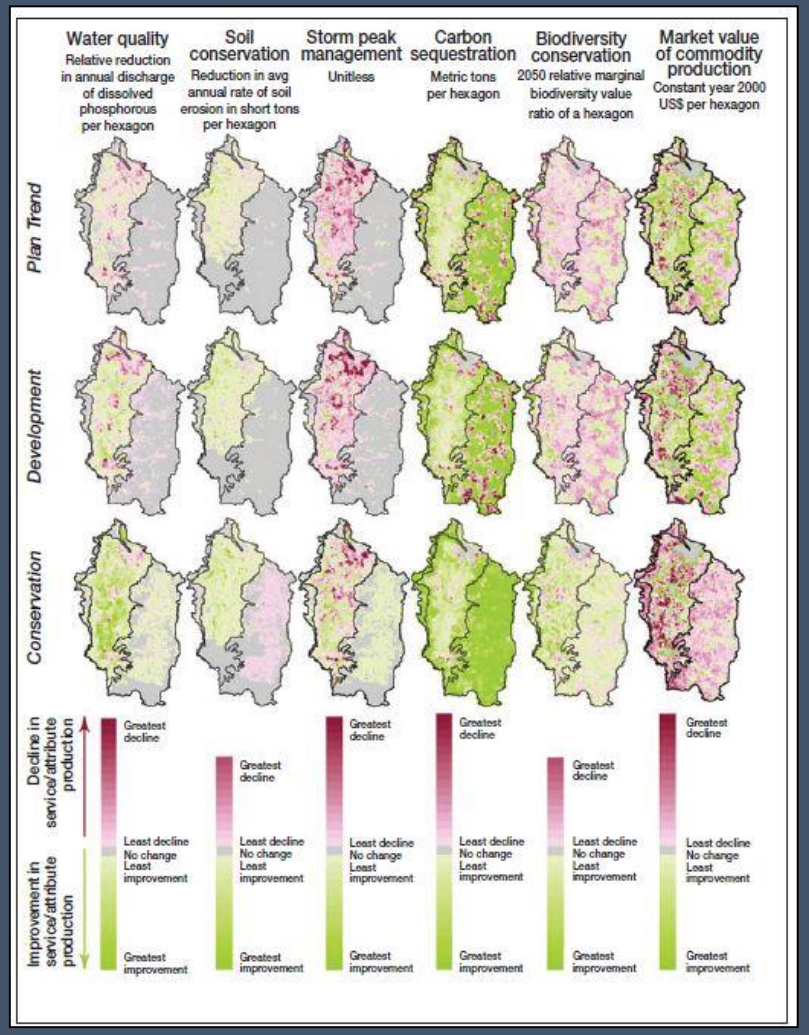
Global ecosystem service models – weaknesses

- Local data & model paramaterizations typically viewed as more trustworthy
  - Research backs this up (Bagstad et al. 2018 for Rwanda + others)
- Spatial planning (ILM) may require higher resolution/accuracy data



Models & Integrated Landscape Management

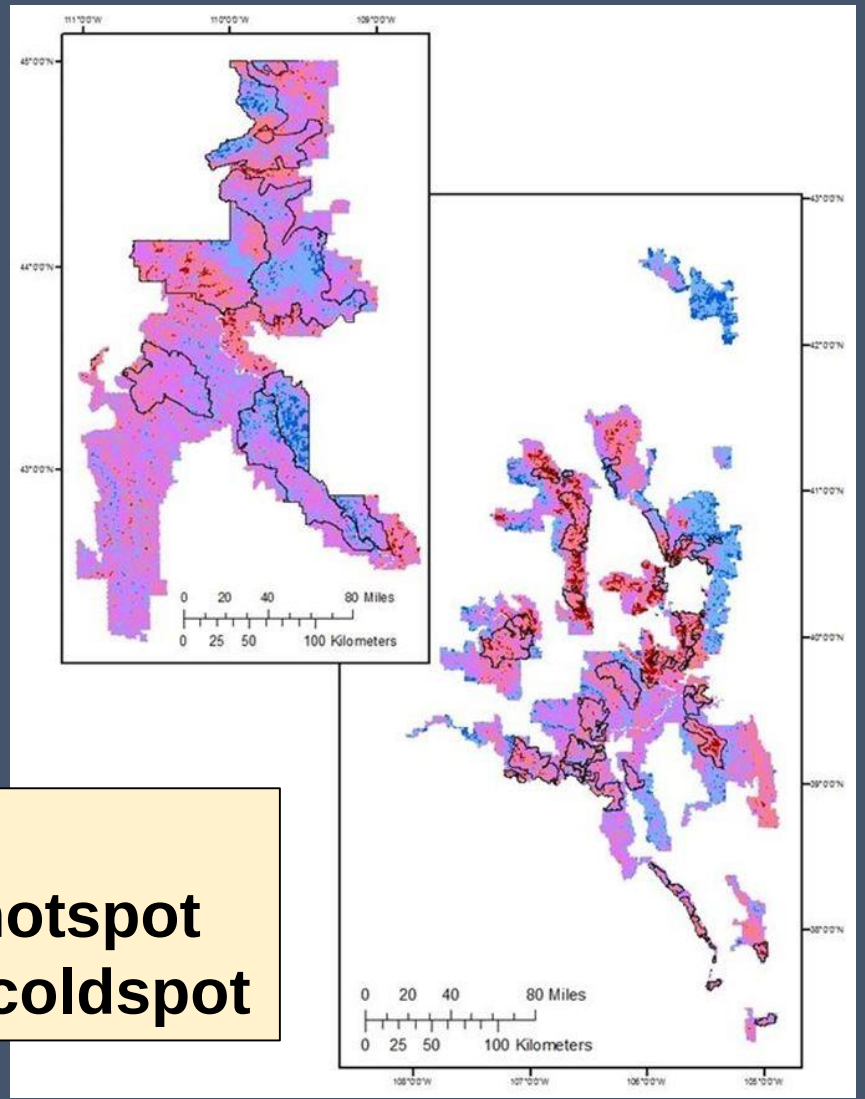
- Analyze scenarios & tradeoffs



Nelson et al. 2009

Models & Integrated Landscape Management

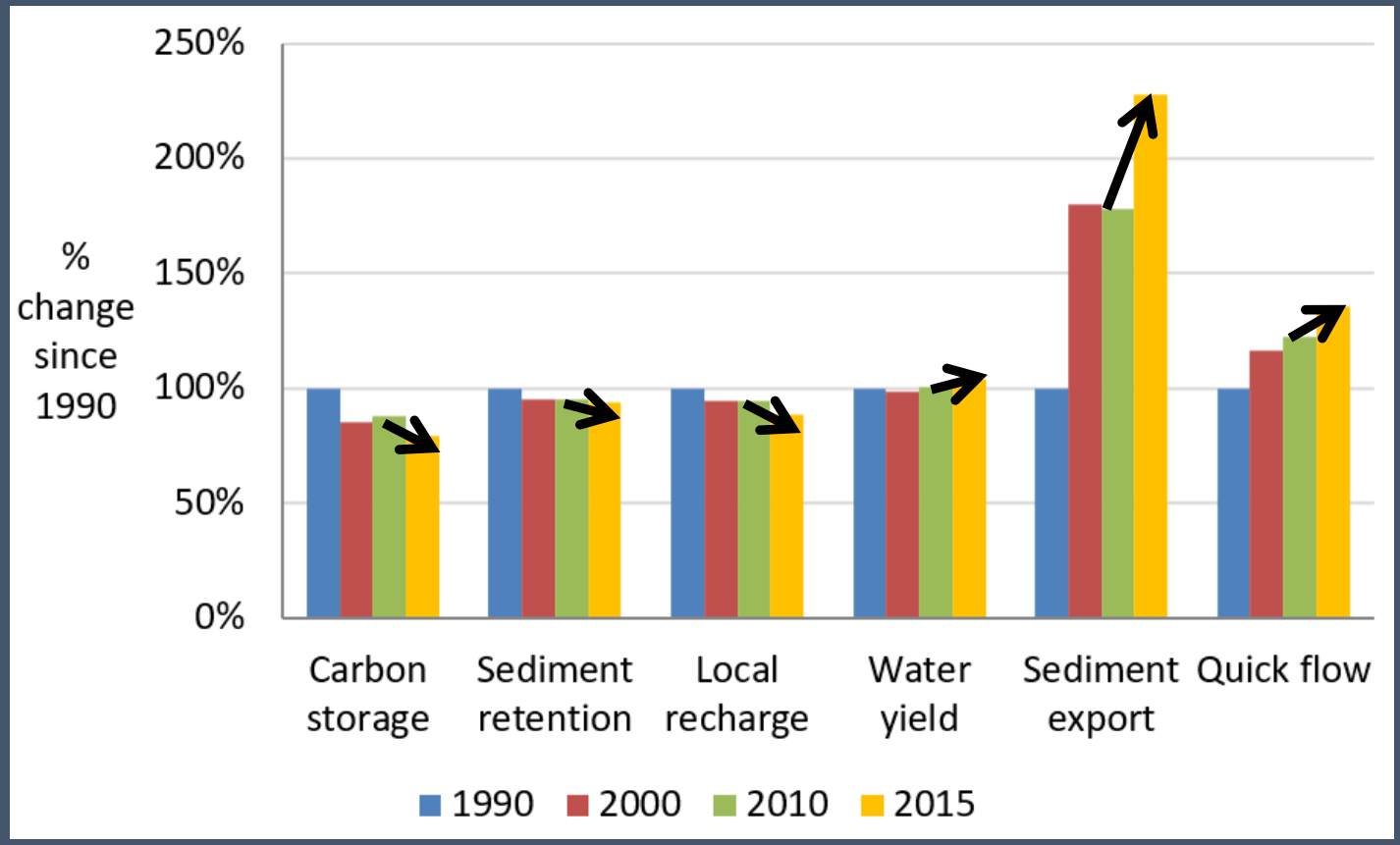
- Identify hot/coldspots to prioritize or avoid activity



Bagstad et al. 2017
Red: Ecosystem services **hotspot**
Blue: Ecosystem services **coldspot**

Models & Integrated Landscape Management

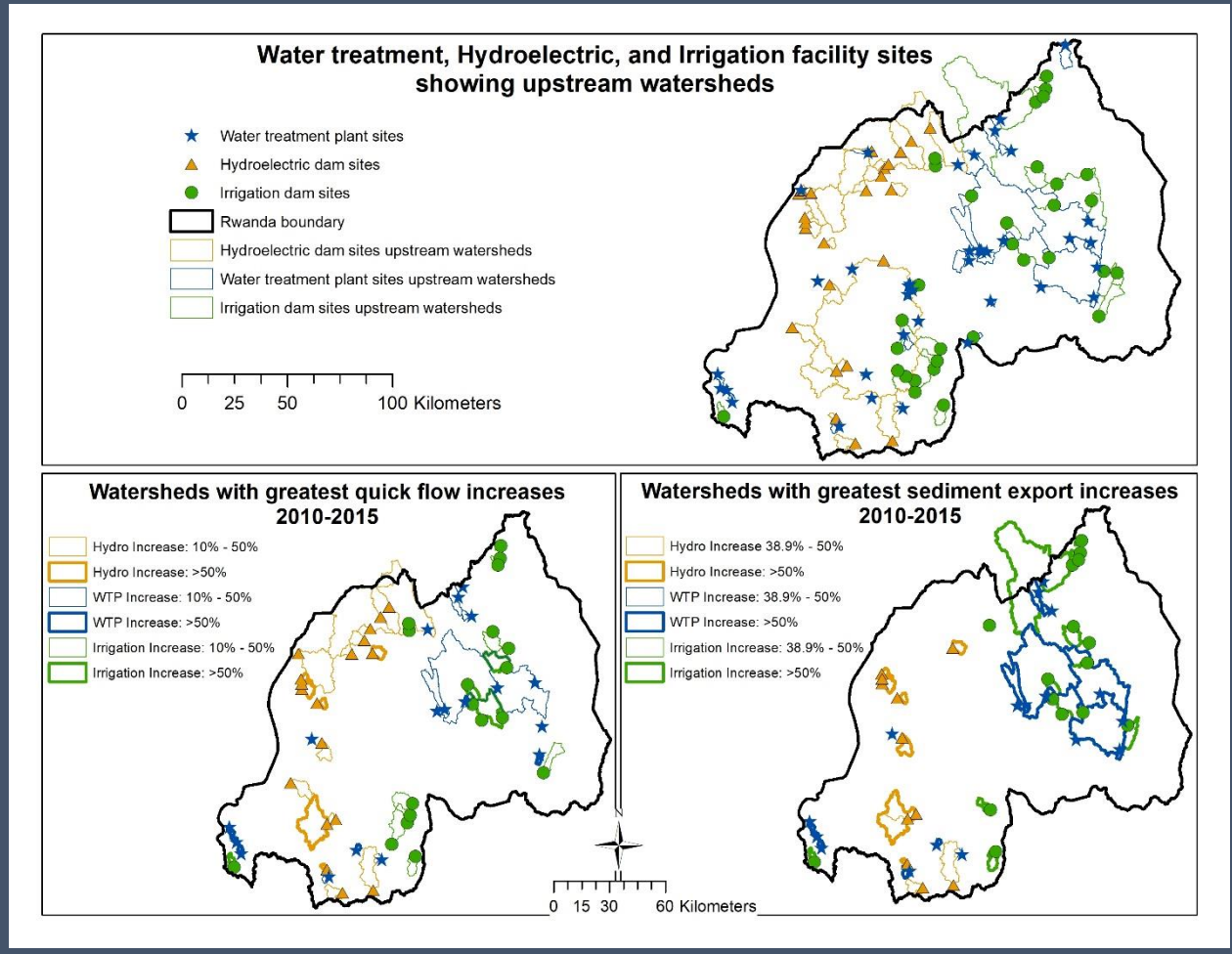
- Baselines (trends) enable analysis of *additionality* of on-the-ground projects



Bagstad et al. (in press)

Models & Integrated Landscape Management

- Identify beneficiaries affected by landscape management decisions



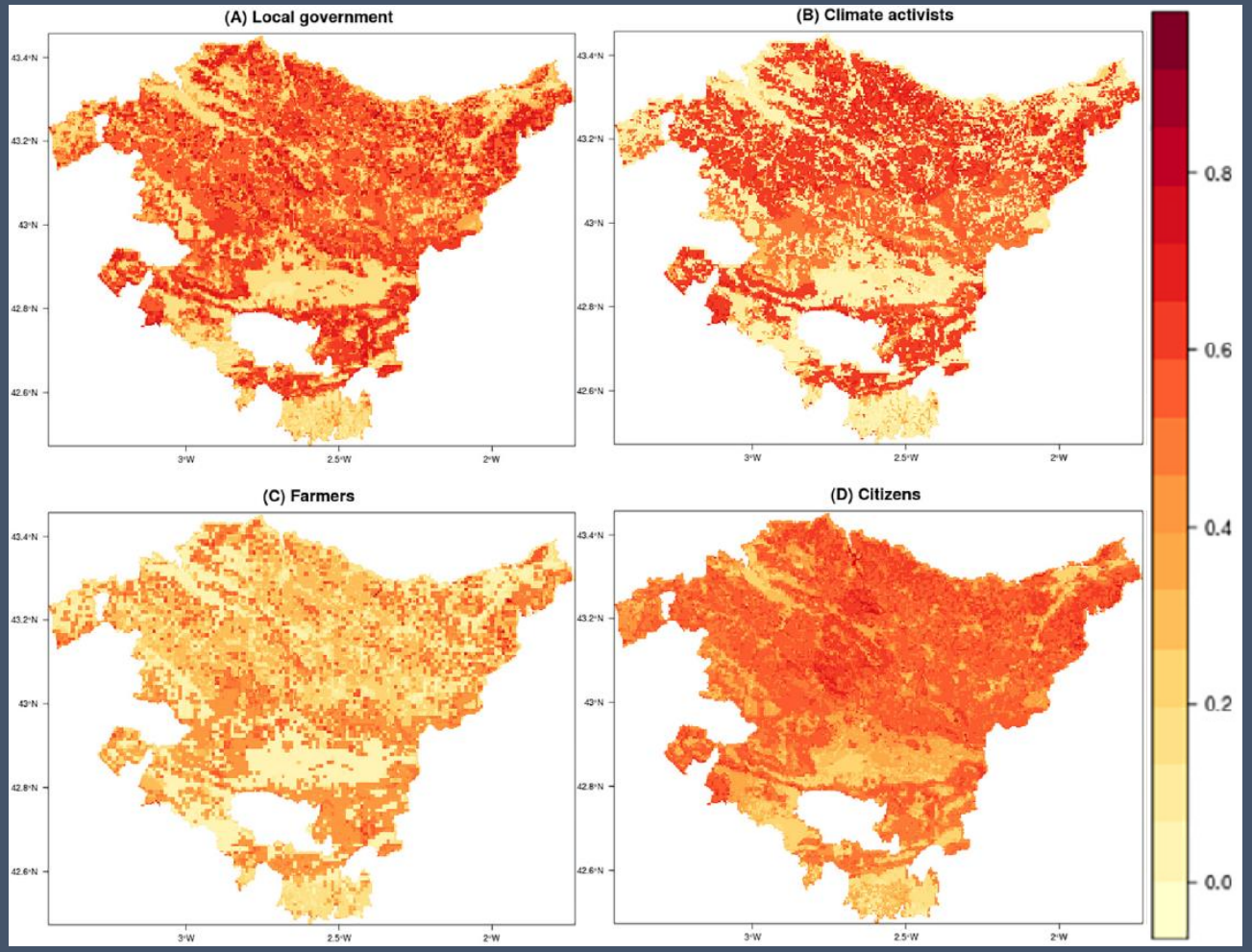
Bagstad et al. (in press)

Models & Integrated Landscape Management

- Can bring together multiple stakeholders to address tradeoffs (i.e., spatial multicriteria analysis)

Priority weights (descending from 1 to 10) assigned to four hypothetical stakeholder groups to each potential ecosystem service (ES) supply, used in the Spatial Multi-Criteria Analysis.

Criteria/ES supply	Citizens	Farmers	Local government	Climate activists
Pollination	10	1	5	10
Carbon Storage	10	10	5	1
Outdoor Recreation	1	10	5	10
Flood regulation	1	5	5	5
Sediment regulation	10	2	5	5



Martinez-Lopez et al. (2019)

Is there another way?

"One important constraint here is that the time and resources available for such modeling are very limited."

- Pagiola & Chonabayashi 2019

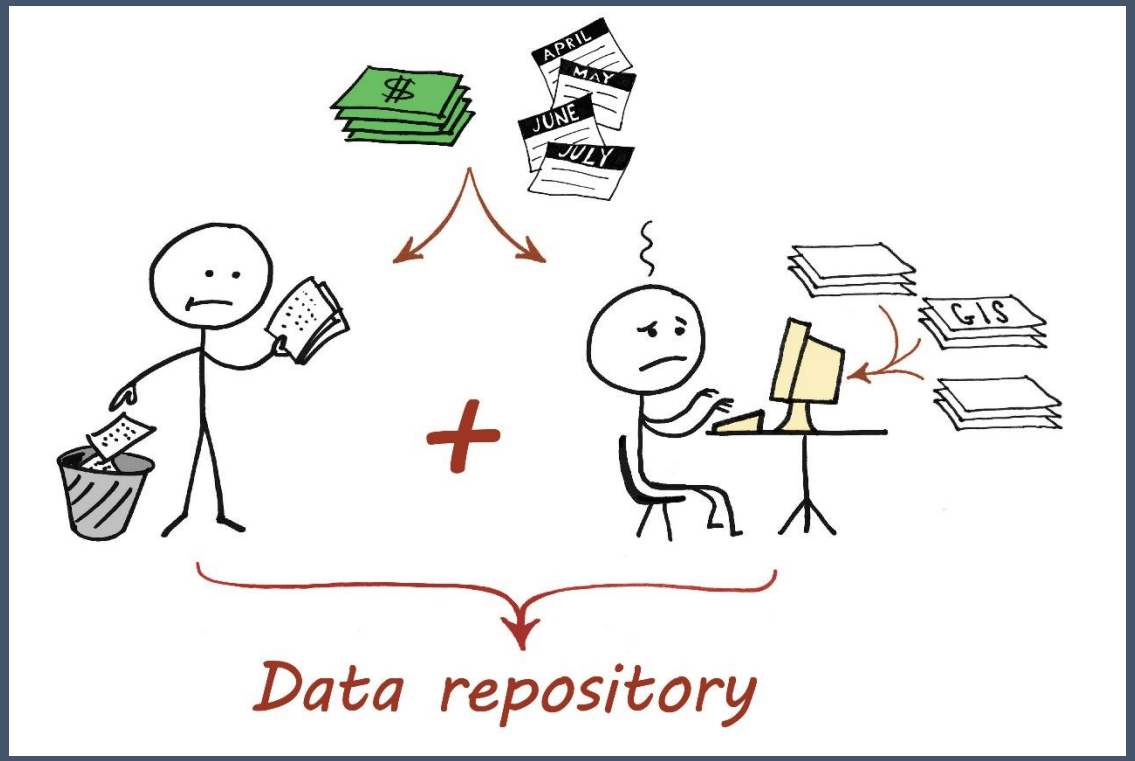
NCA data & models must be open & reusable to be of use for ILM (obviously)

Ecosystem accounts have taken substantial time to build (several

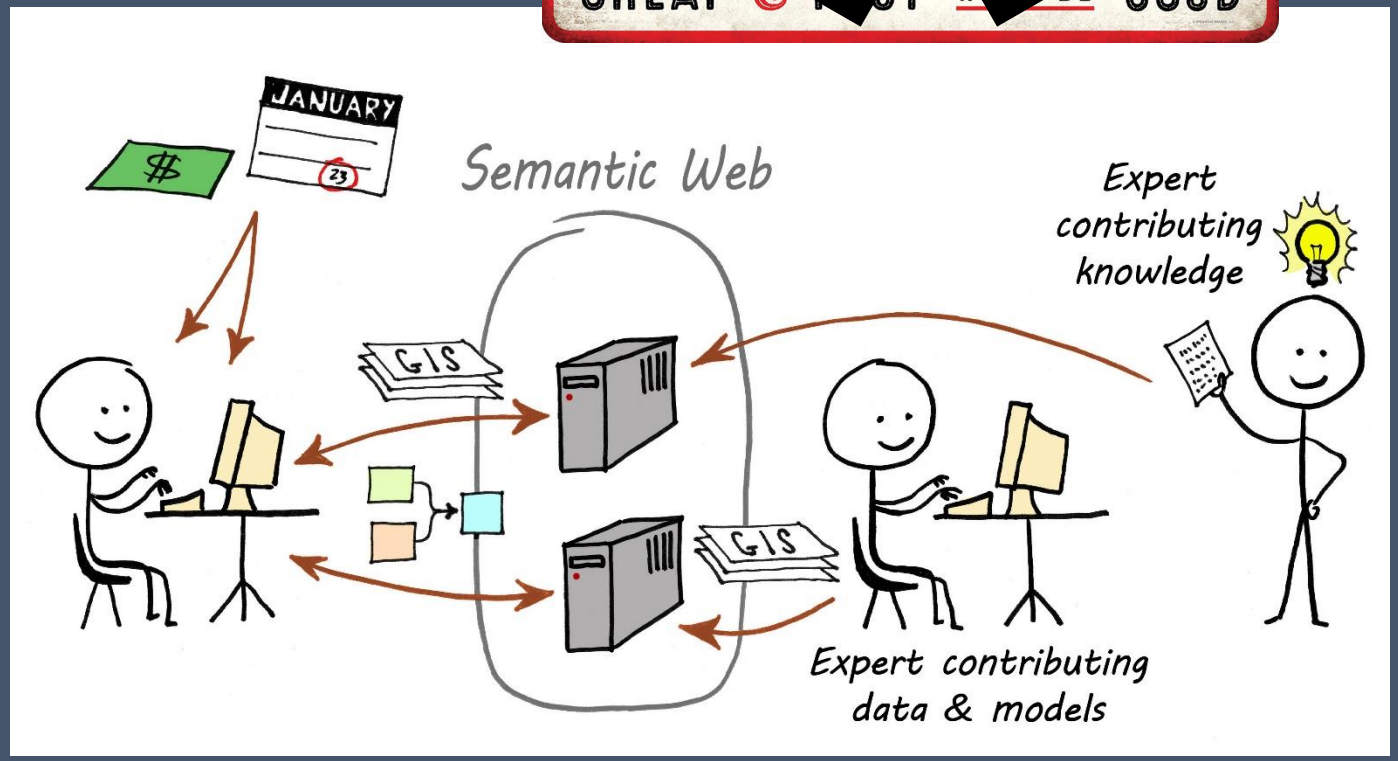
Maybe not!

So this will always be an expensive/painstaking process?

Is there another way?



Status quo



Linked, web-based collaborative modeling

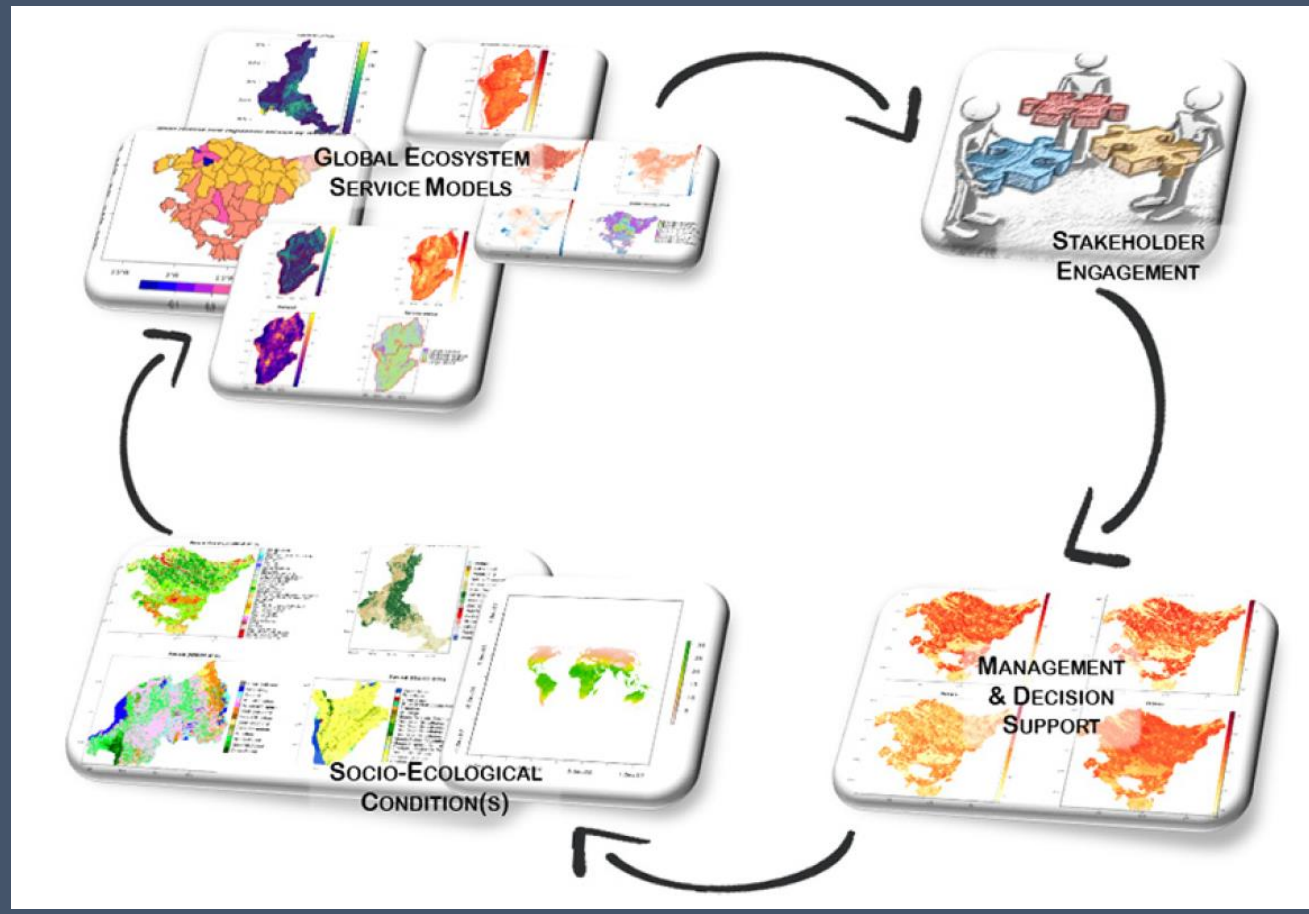
Interoperable data & models

1. *Share data on the web* – enabling it to be automatically ingested by models
2. *Share models on the web*, and specify when & where to use each model
   - Models are *global* (run anywhere) yet *highly customizable*
3. Open-source software for stakeholders (modeling & visualization) & modelers (to contribute data & models)
4. Fast & transparent (show all data sources & calculations)
   1. Enables *co-generation/analysis* of accounts with stakeholders

http://aries.integratedmodelling.org/?p=1458

ARIES: a *global knowledge network* for ecosystem service data & models

- "Global yet customizable" models
- Work with Interamerican Development Bank to do so for Western Hemisphere
- Could do the same elsewhere



Martínez-López et al. 2019

https://blogs.iadb.org/sostenibilidad/en/developing-tools-for-valuing-natural-capitals-contribution-to-economic-well-being-open-ieem/

Software download/installation: https://www.integratedmodelling.org/statics/pages/gettingstarted.html