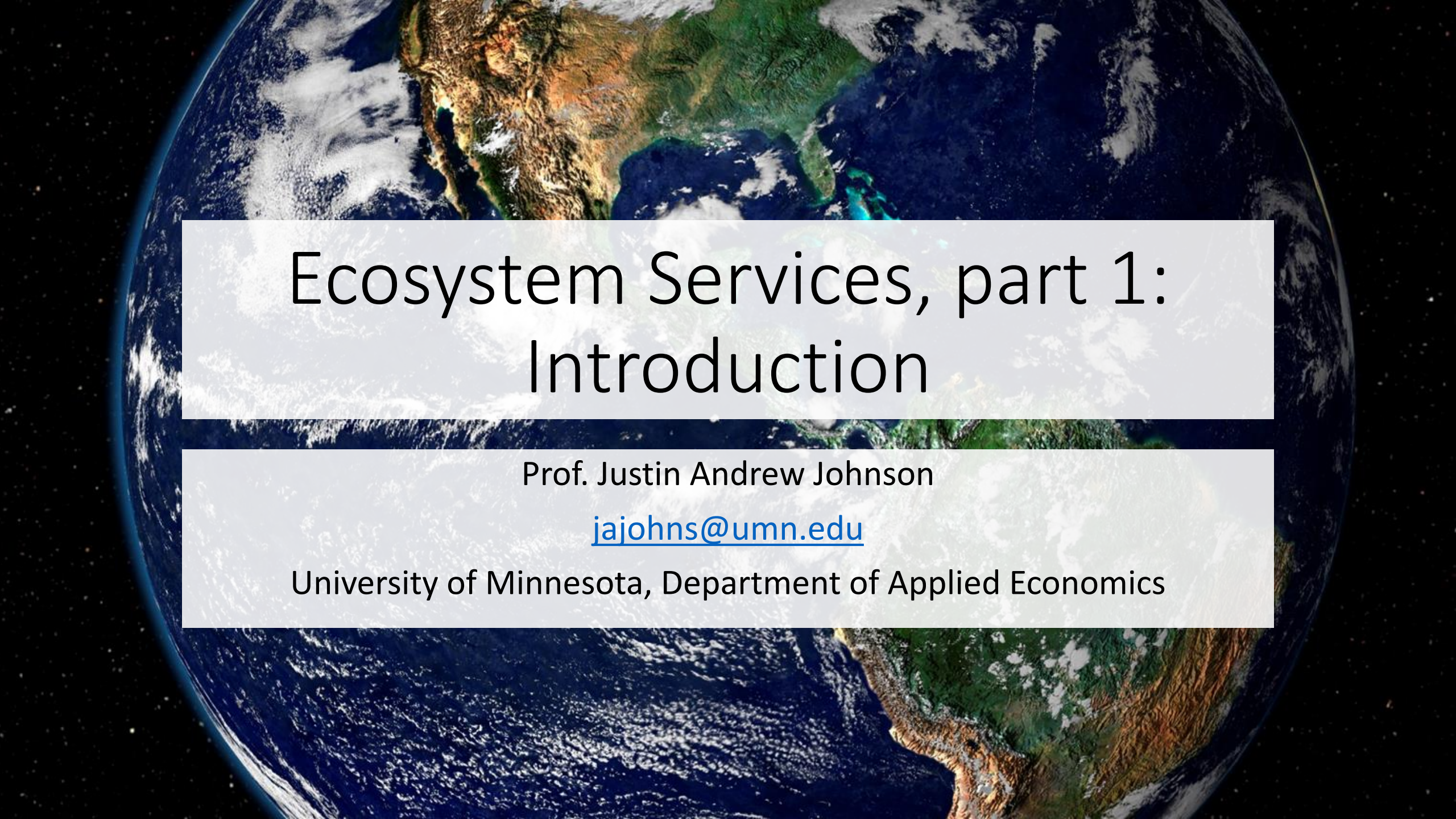

Ecosystem Services, part 1: Introduction

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University of Minnesota, Department of Applied Economics

Overall Agenda

- Introduce the concepts of natural capital and ecosystem services
- Discuss the Natural Capital Project and InVEST
- Hands-on sessions with InVEST models
    1. Carbon storage
    2. Sediment retention
    3. Seasonal water yield
- If time:
    - Scenario generation with the InVEST scenario generator tool

Introduction and key concepts

What are natural capital and ecosystem services?

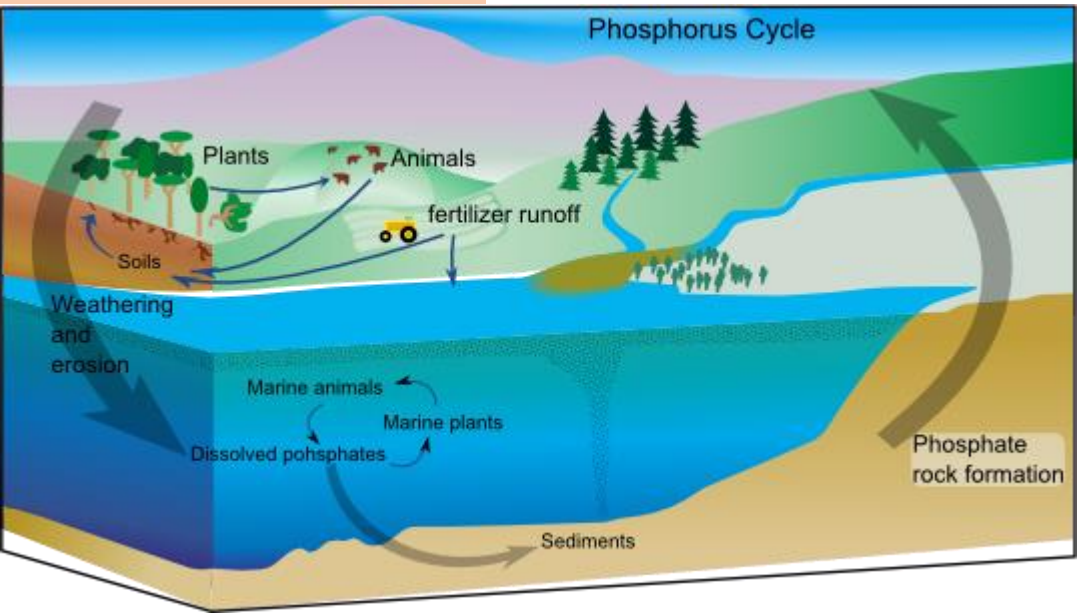
Natural capital: the stock of valuable natural resources and ecosystems

Includes the geology, soil, air, water, all living things, biodiversity and natural systems

Natural capital in economics: Similar to other capital

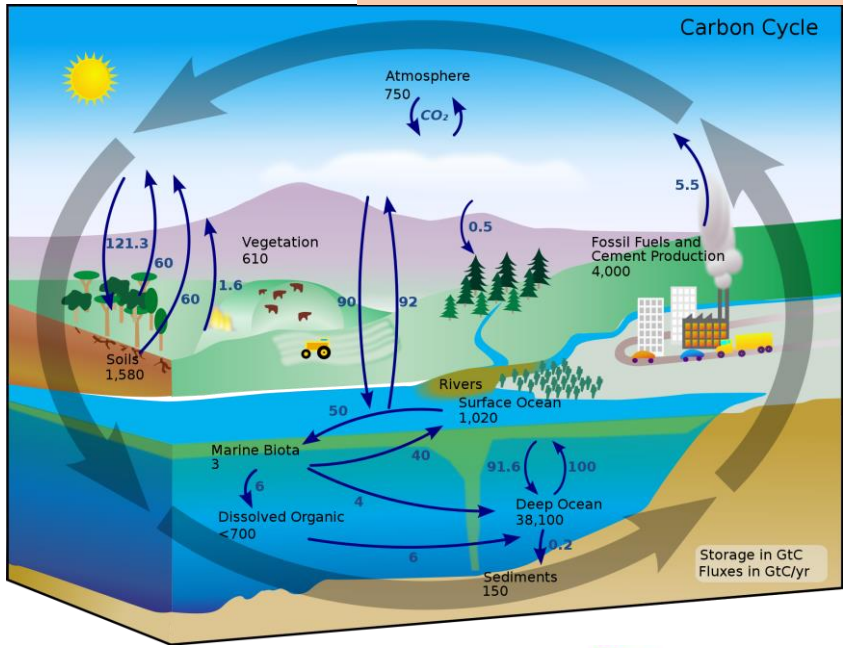
- Economists have long discussed capital and the flow of services we derive from capital
- Other types of capital have emerged
  - Human capital (education)
  - Social capital
- Natural capital extends this tradition
  - Includes easy-to-see natural capital, like minerals or timber
  - More importantly, includes the underlying natural systems that make life possible.

The Phosphorus Cycle

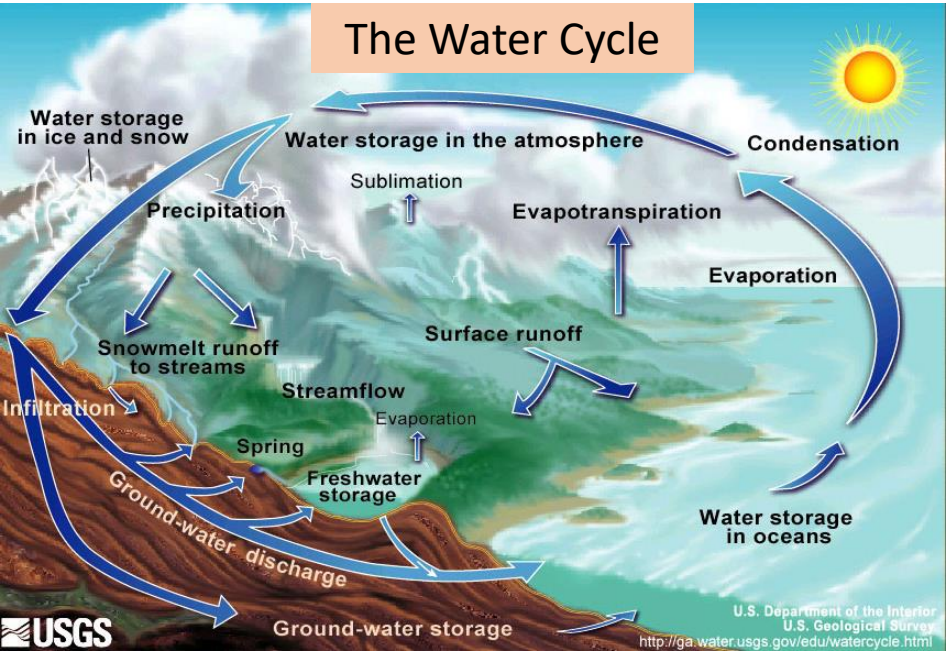


Natural Capital is critical in almost every biophysical "cycle" that makes life possible

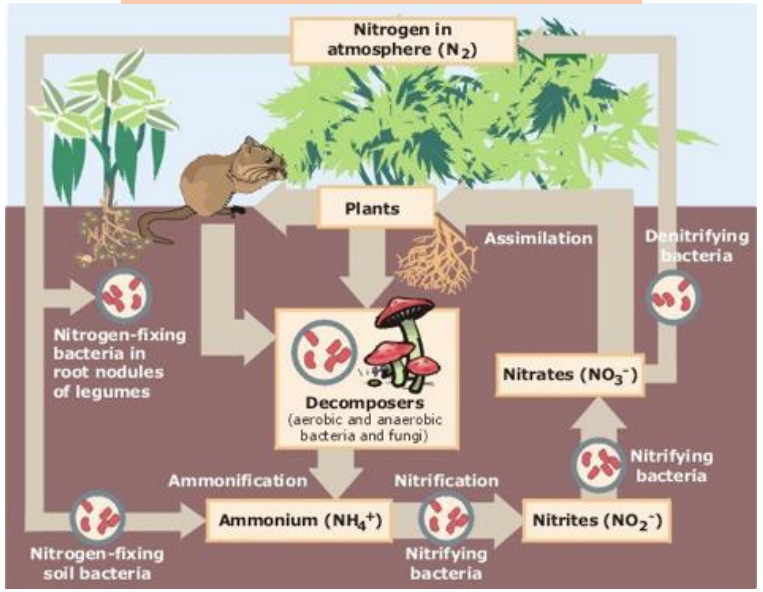
The Carbon Cycle



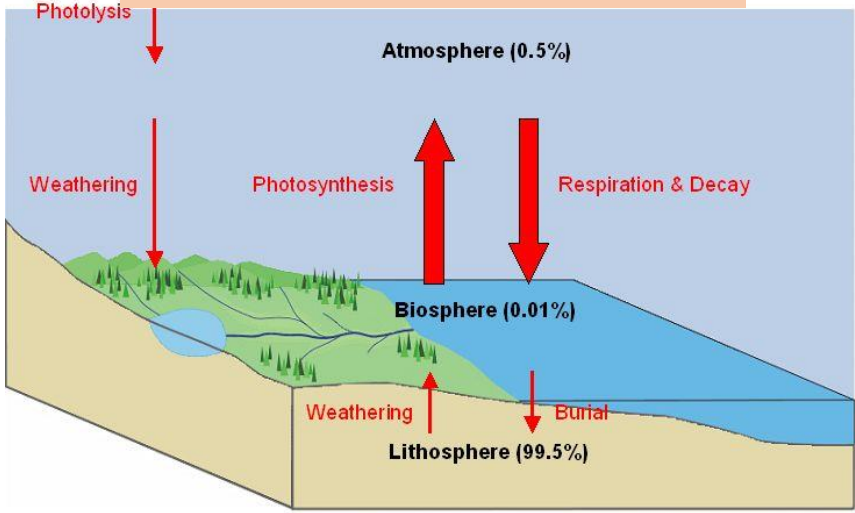
The Water Cycle



The Nitrogen Cycle

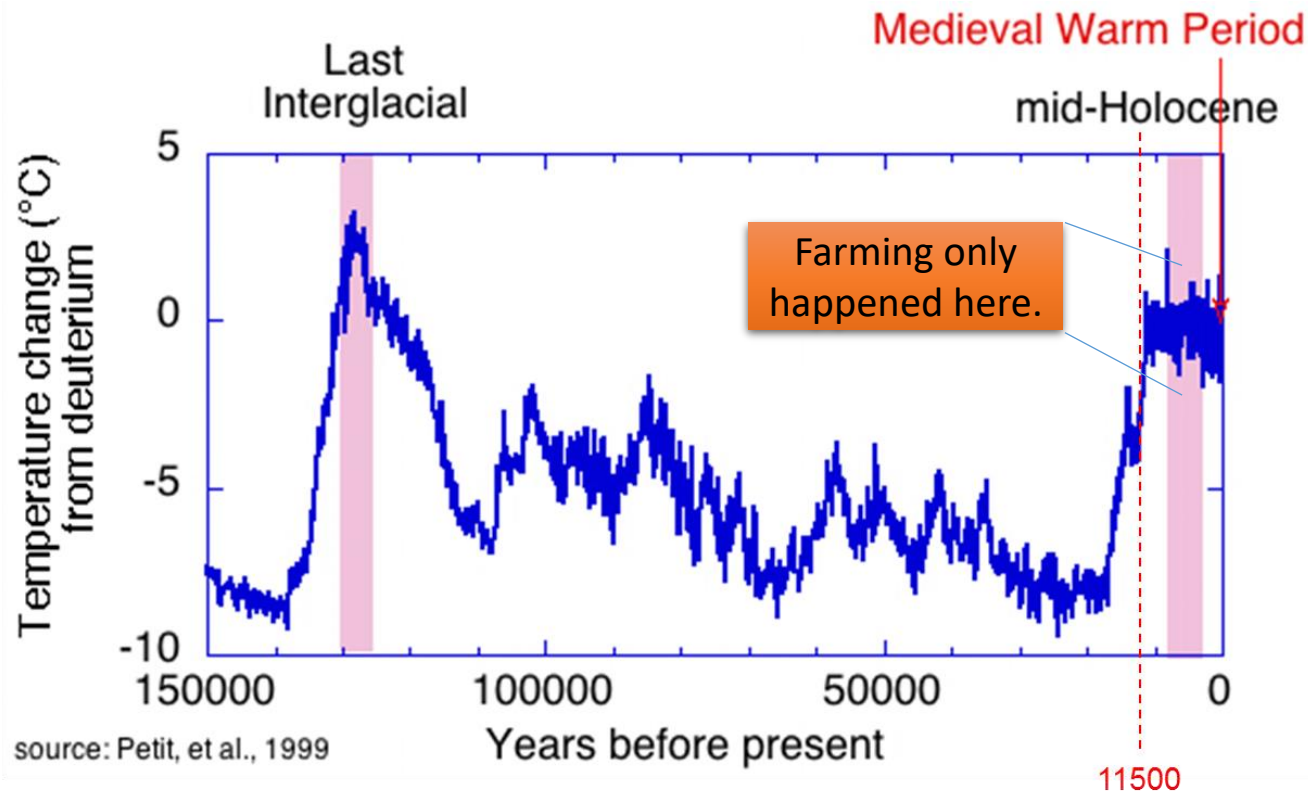


The Oxygen Cycle



What is the "**total value**" of keeping those systems running?

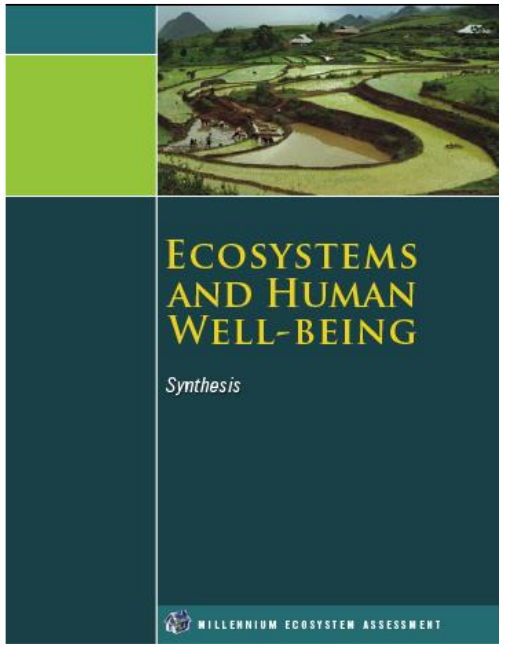
- Infinite?
  - Equivalent to "What is the value of keeping modern civilization around?"
  - These biophysical systems make farming possible.
- This question is probably closer to Philosophy than Economics or Science.
- Total Value is not super relevant to decision making.

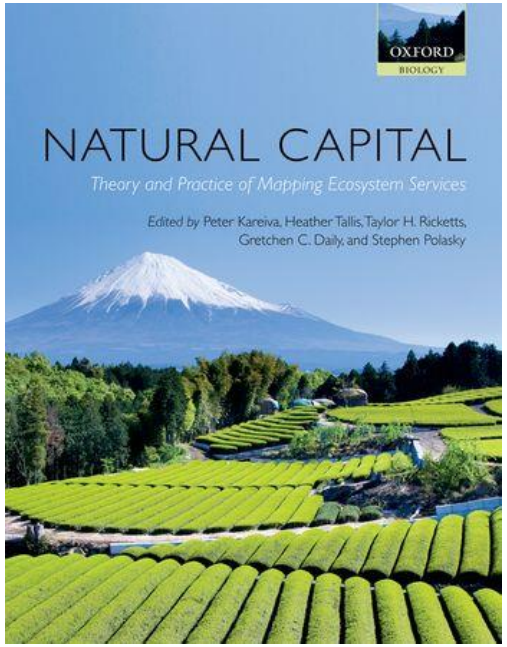


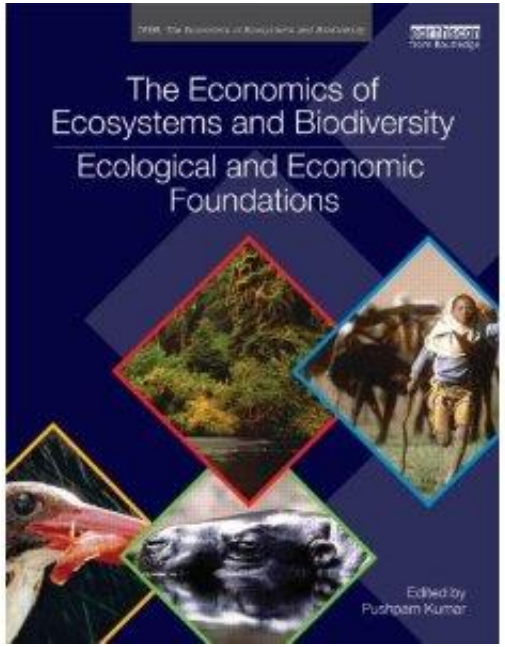
http://www.ncdc.noaa.gov/paleo/globalwarming/paleobefore.html

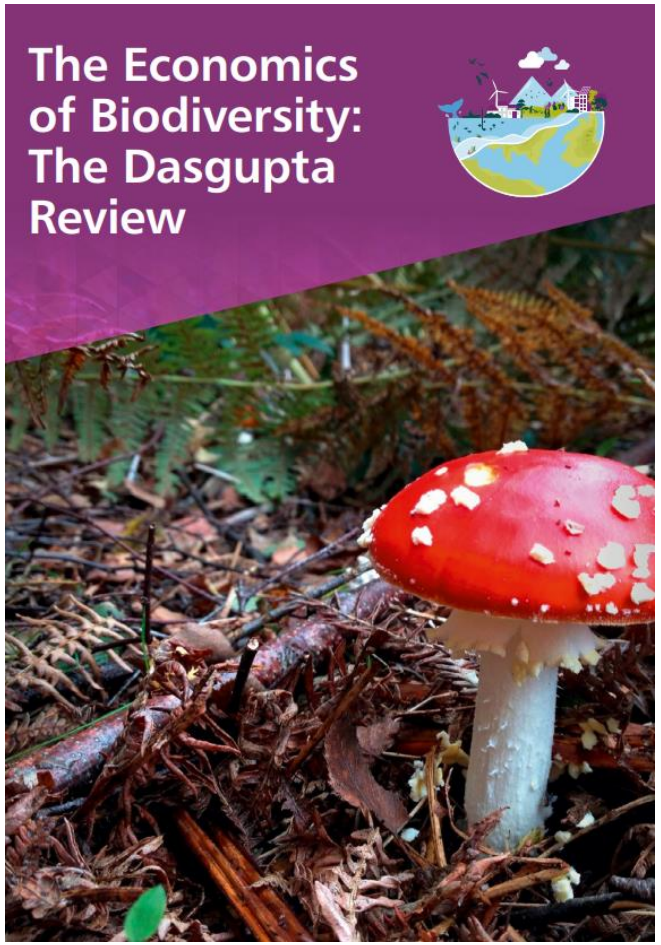
Ecosystem Services: the flow of benefits from natural capital to people

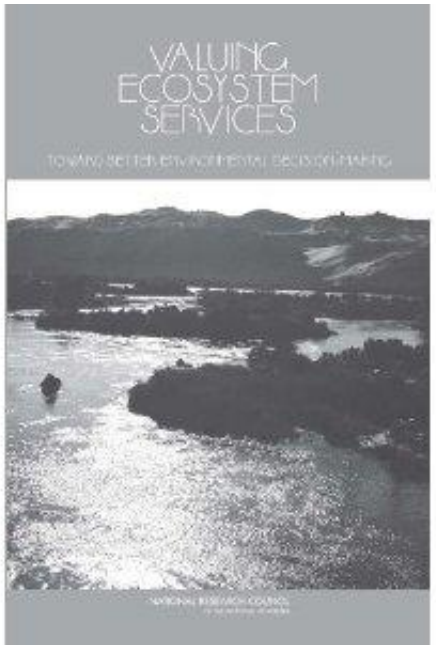
Just like with natural capital, ecosystem services uses the language of economics.

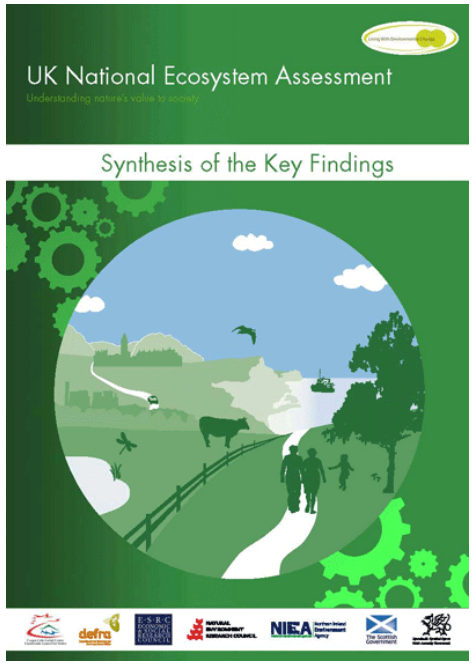

ECOSYSTEMS AND HUMAN WELL-BEING
Synthesis
MILLENNIUM ECOSYSTEM ASSESSMENT

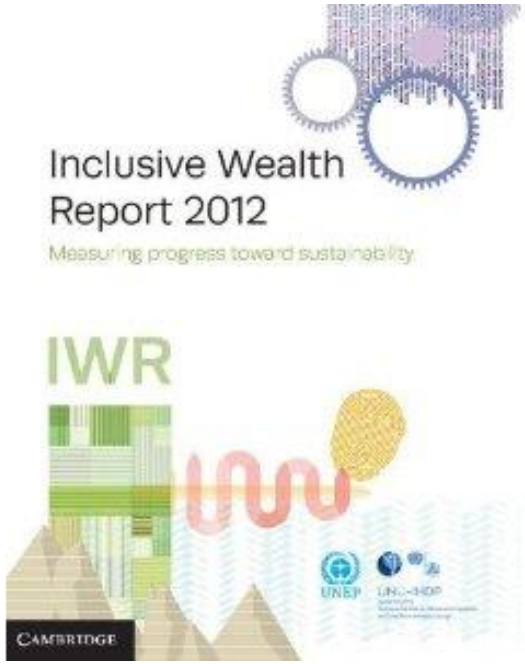

OXFORD
BIOLOGY
NATURAL CAPITAL
Theory and Practice of Mapping Ecosystem Services
Edited by Peter Kareiva, Heather Tallis, Taylor H. Ricketts, Gretchen C. Daily, and Stephen Polasky


The Economics of Ecosystems and Biodiversity
Ecological and Economic Foundations
Edited by Pushpam Kumar


The Economics of Biodiversity: The Dasgupta Review


VALUING ECOSYSTEM SERVICES


UK National Ecosystem Assessment
Synthesis of the Key Findings


Inclusive Wealth Report 2012
Measuring progress toward sustainability
IWR
UNEP
CAMBRIDGE

Theoretical underpinnings of ecosystem services

And application to policy questions

Research focuses on multiple parts of the Social-Ecological System

Biophysical

Human

Ecosystem Structure

Supply

Human locations & activities

Service

Production Function

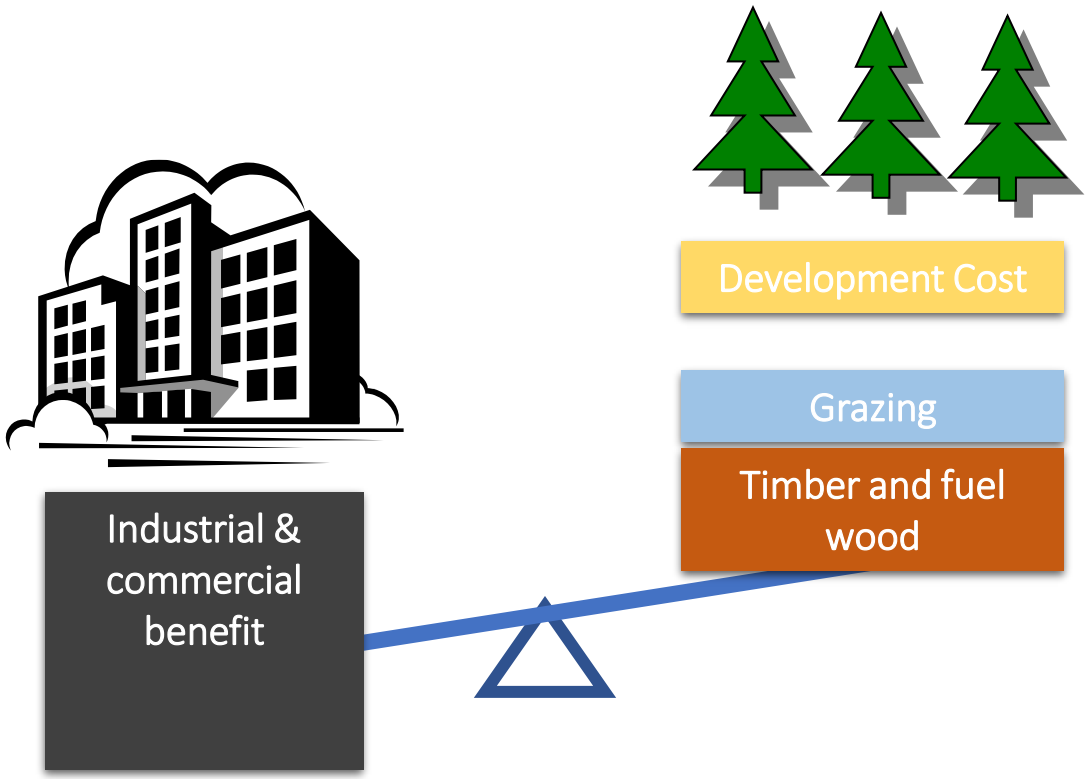
Value ($ or not)

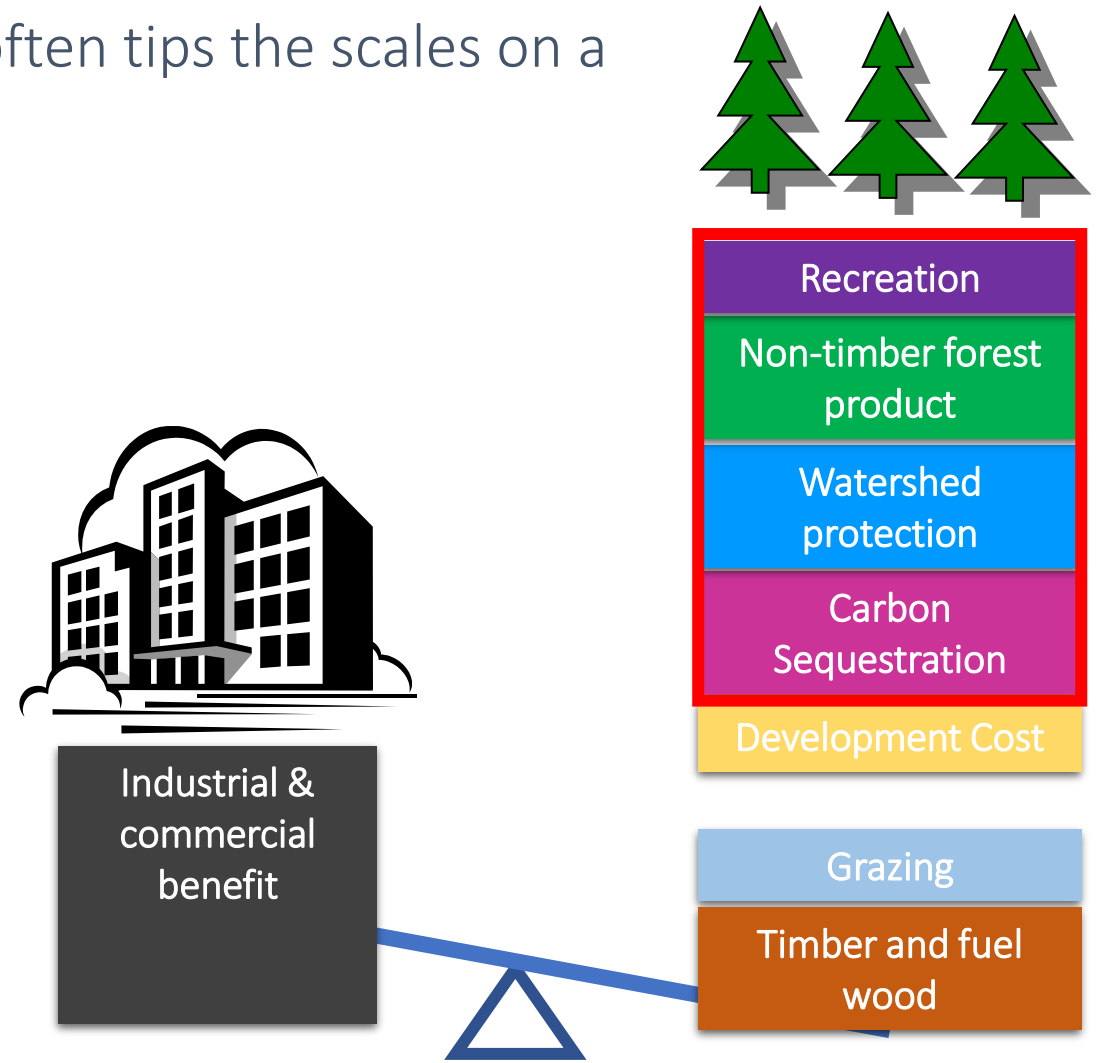
Social preferences

Tallis et al BioScience 2012

Why is this important? Environmental benefits often ignored in market prices and development decisions

- Including the value of ecosystem services (ES) often tips the scales on a decision





Pagiola, von Ritter & Bishop 2004

Early attempts at valuation… & controversy

nature
International journal of science

Article

The value of the world's ecosystem services and natural capital

Robert Costanza, Ralph d'Arge, Rudolf de Gro
Karin Limburg, Shahid Naeem, Robert V. O'Ne
Marjan van den Belt

Nature **387**, 253–260 (15 May 1997)
doi:10.1038/387253a0

For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16-54 trillion ($10^{12}$) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.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[Innovation] springs from nature.
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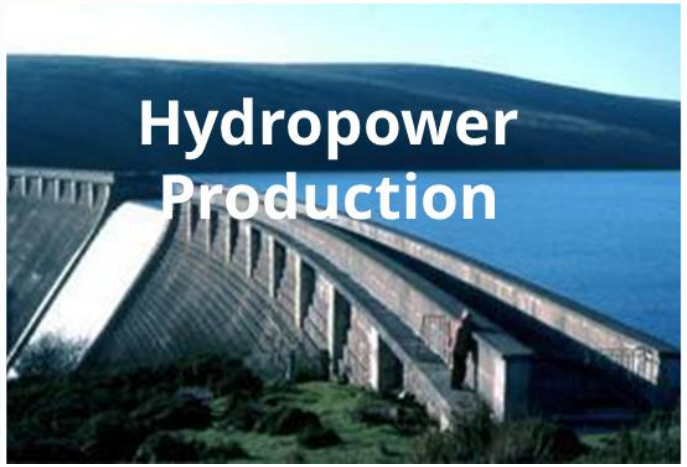
InVEST provides spatially explicit production function models

changes in ecosystems → changes in ecosystem services → changes in benefits to people

Free & open source

InVEST

integrated valuation of ecosystem services and tradeoffs




Carbon
Storage &
Sequestration


Blue Carbon
Storage &
Sequestration


Wave Energy


Crop
Pollination


Finfish
Aquacultural
Production

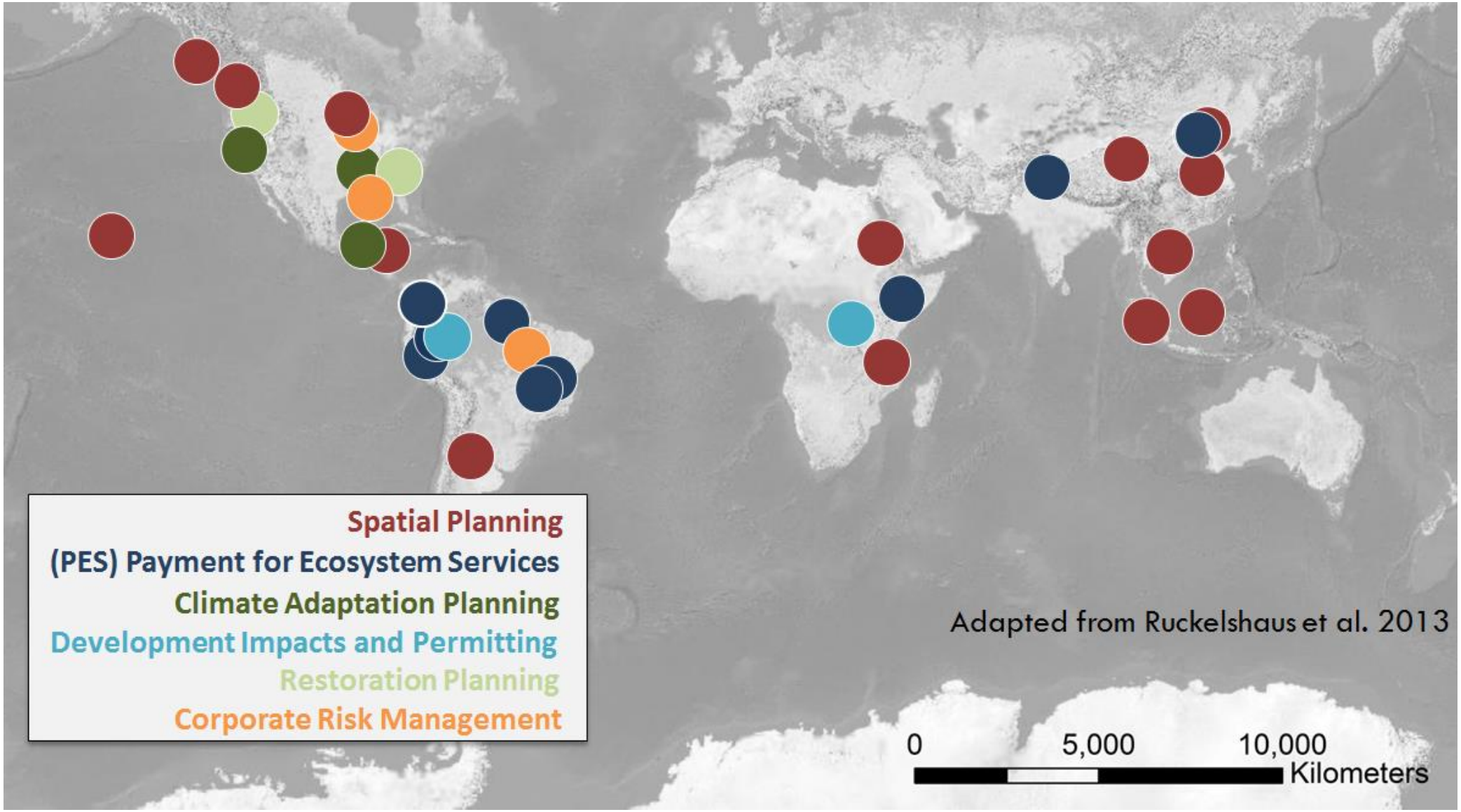

Coastal
Protection


Managed
Timber
Production

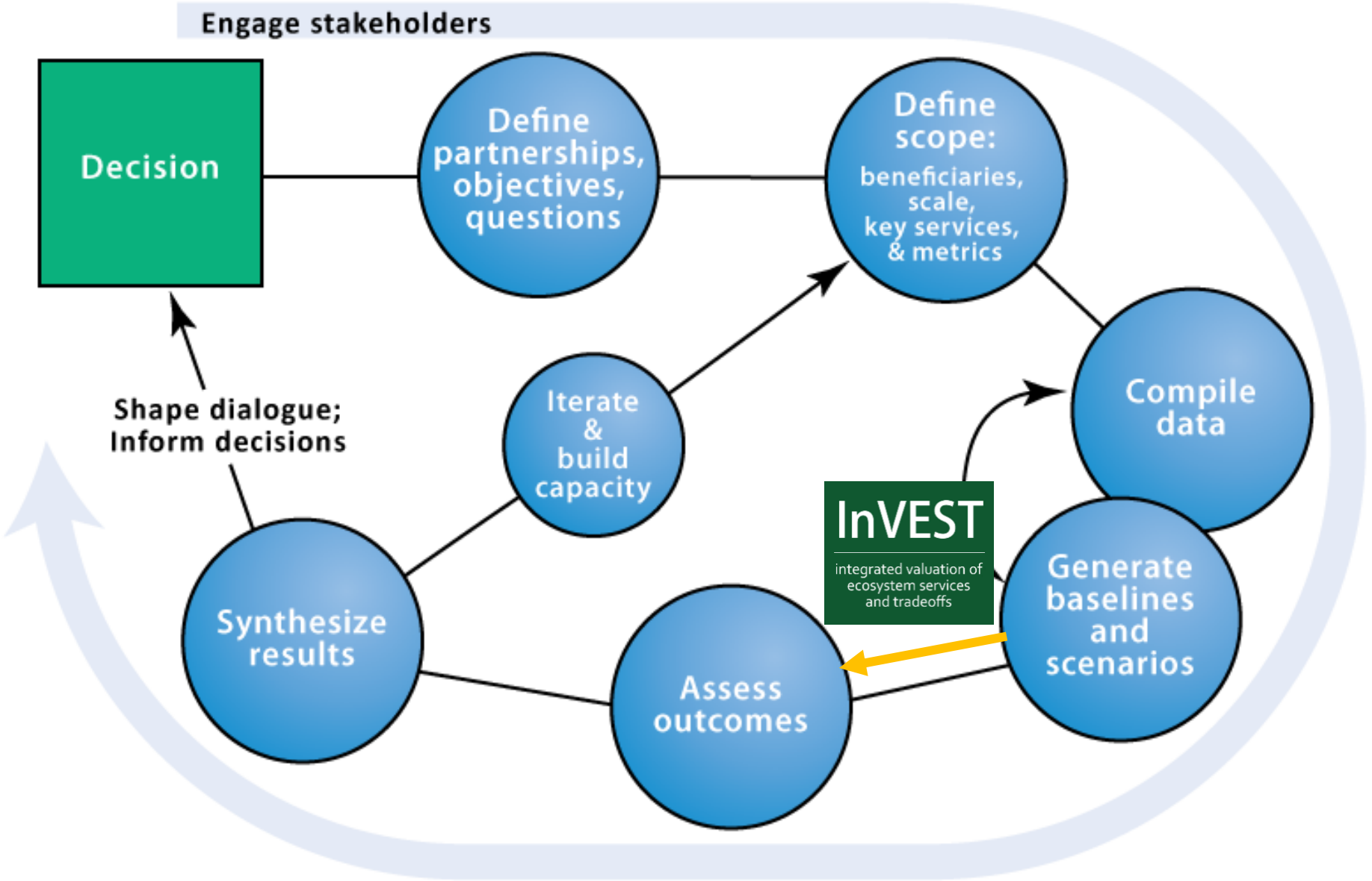

Fisheries
Production*


Offshore
Wind Energy

Implemented in many locations

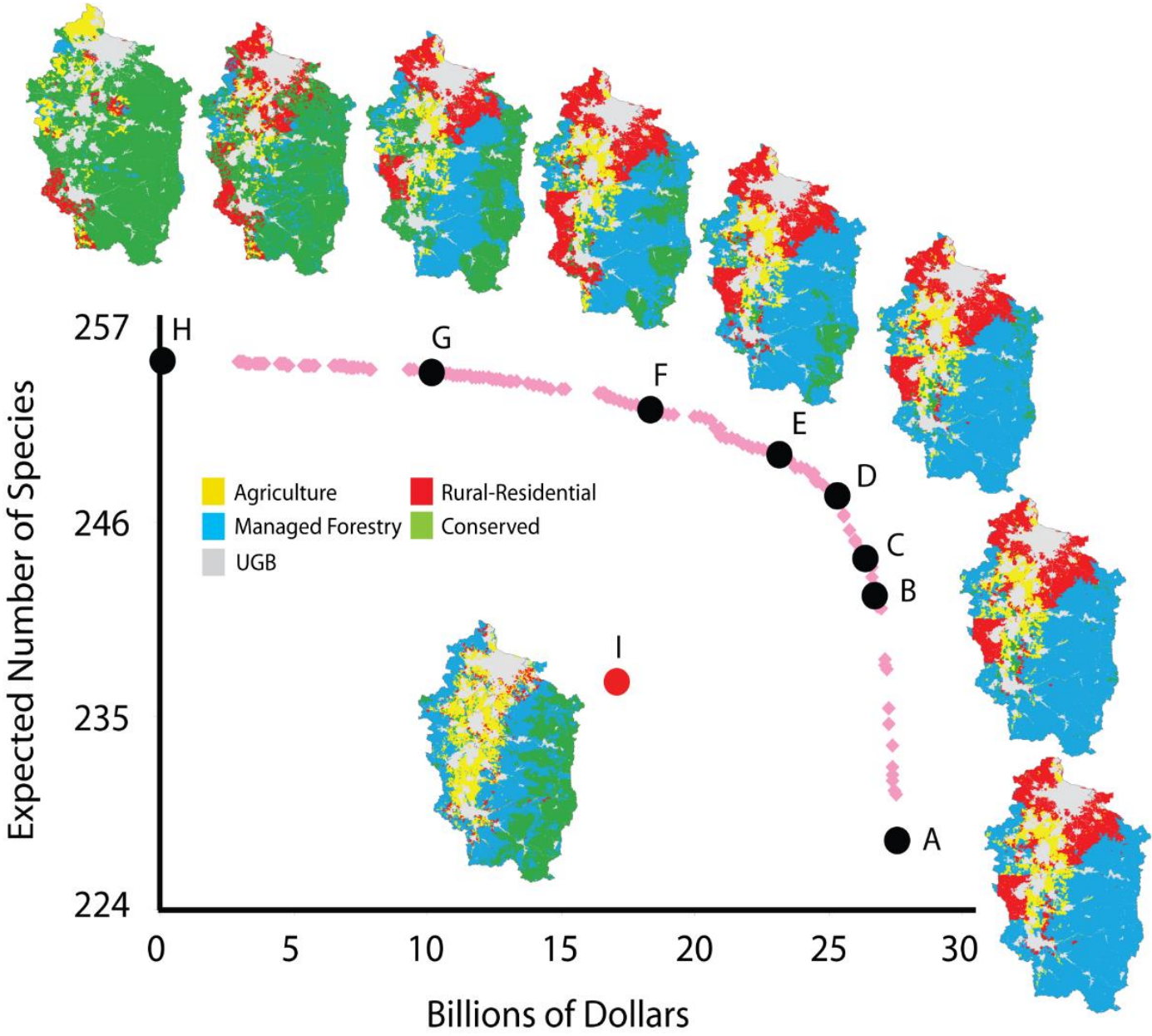


Use of InVEST fits within a stakeholder driven decision process



Land-use decisions matter

- Foundational work from Polasky et al. (2008) showed that optimization of land-use, land-cover (LULC) can lead to win-win changes
- This is a production-possibilities frontier (PPF) the combines economic and biophysical
- Most critically, we see the current landscape ***I*** is inferior to landscapes on the efficiency frontier



TYPICAL INVEST APPLICATION

The value of InVEST is that it (relatively) easy to use in new decision contexts

So now, we'll switch to hands-on work with 3 of the ecosystem service models.

Appendix

Khoa Vu @KhoaVuUmn · 2h

"You can do this in R, and R is free!"

R: