

# PoE lectures:

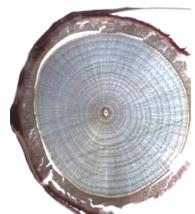
1. Land-use Change
2. Species Distributions
3. Biodiversity Change

Isla Myers-Smith  
Crew Building, School of GeoSciences



# TEAM SHRUB

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# PoE lecture 1: Land-use Change

Isla Myers-Smith  
Crew Building, School of GeoSciences



What is the world human population?



# Human population

Current World Population

**7,582,301,502**

[view all people on 1 page >](#)

TODAY

Births today  
**288,553**

Deaths today  
**119,516**

Population Growth today  
**169,037**

THIS YEAR

Births this year  
**124,530,682**

Deaths this year  
**51,579,650**

Population Growth this year  
**72,951,032**

2016

Current World Population

**7,465,663,401**

[view all people on 1 page >](#)

TODAY

Births today  
**242,069**

Deaths today  
**101,372**

Population Growth today  
**140,697**

THIS YEAR

Births this year  
**127,291,023**

Deaths this year  
**53,306,008**

Population Growth this year  
**73,985,014**

2015

Current World Population

**7,373,981,781**

[view all people on 1 page >](#)

TODAY

Births today  
**155,253**

Deaths today  
**65,016**

Population Growth today  
**90,237**

THIS YEAR

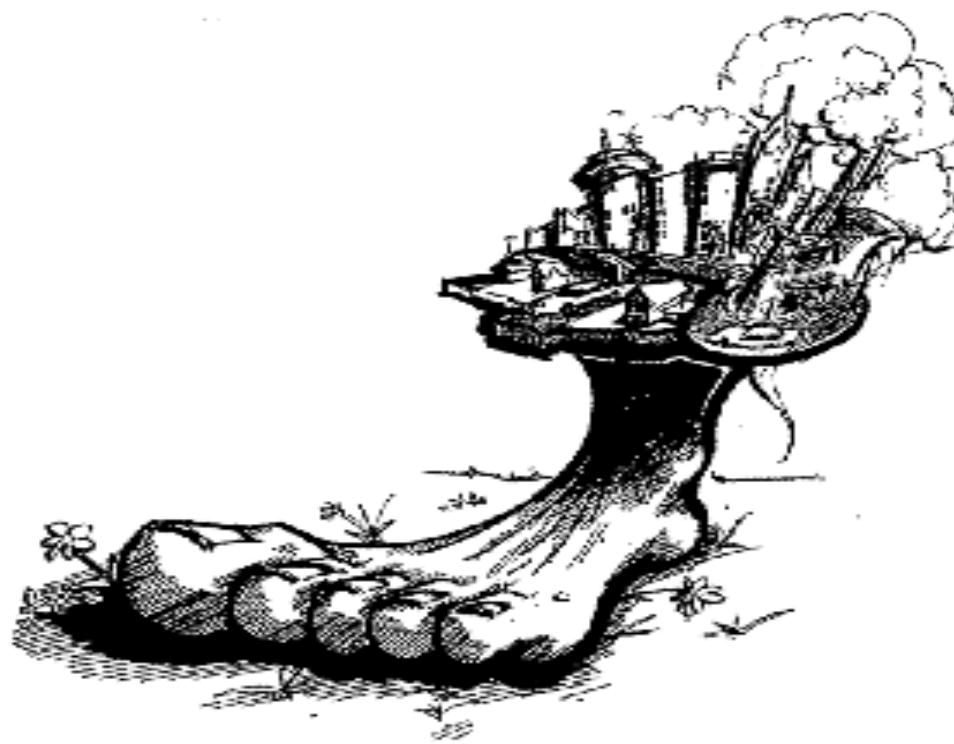
Births this year  
**112,679,191**

Deaths this year  
**47,186,972**

Population Growth this year  
**65,492,219**

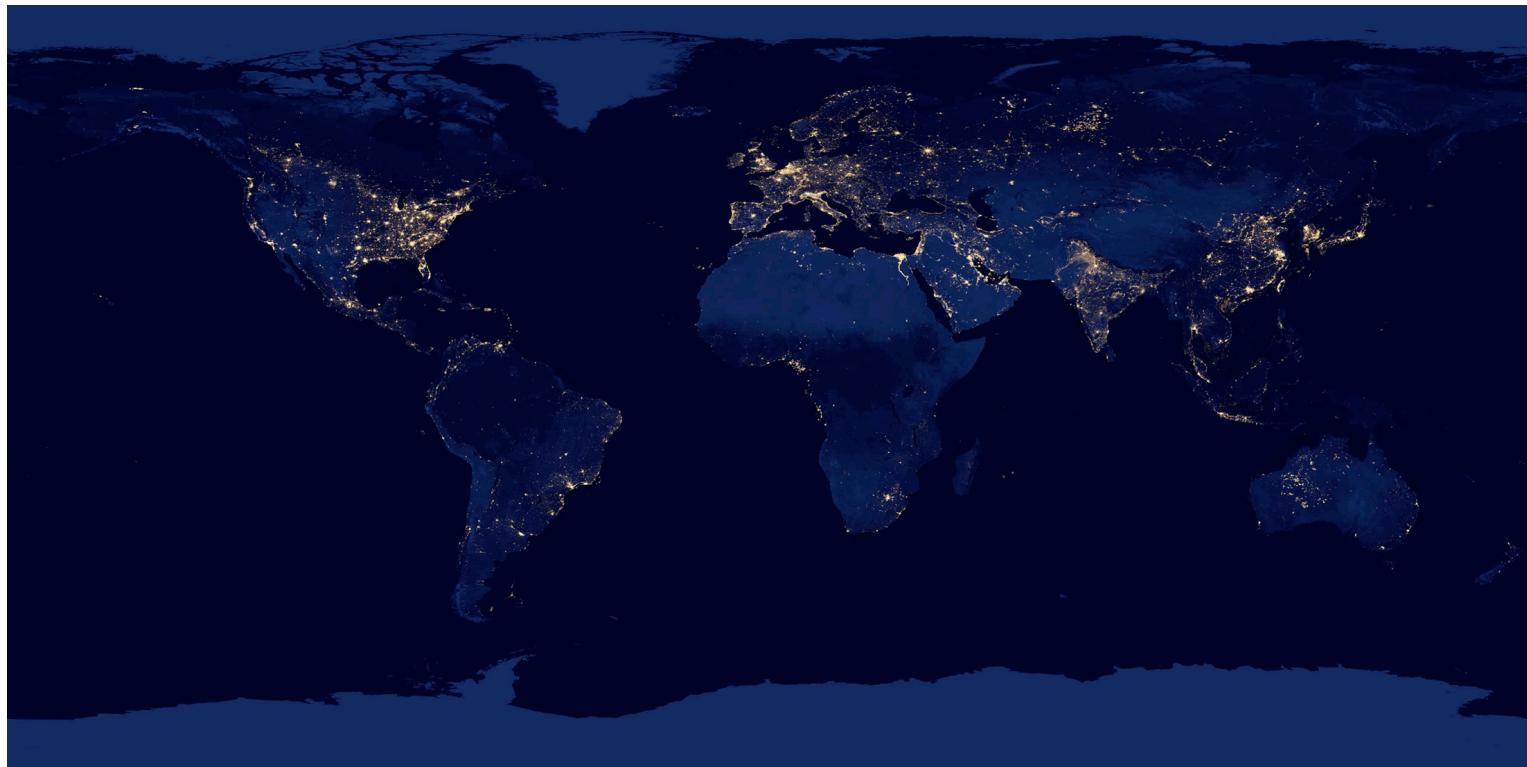
<http://www.worldometers.info/world-population/>

# Human ecological footprint



Wackernagel and Rees, 1998

# Human ecological footprint

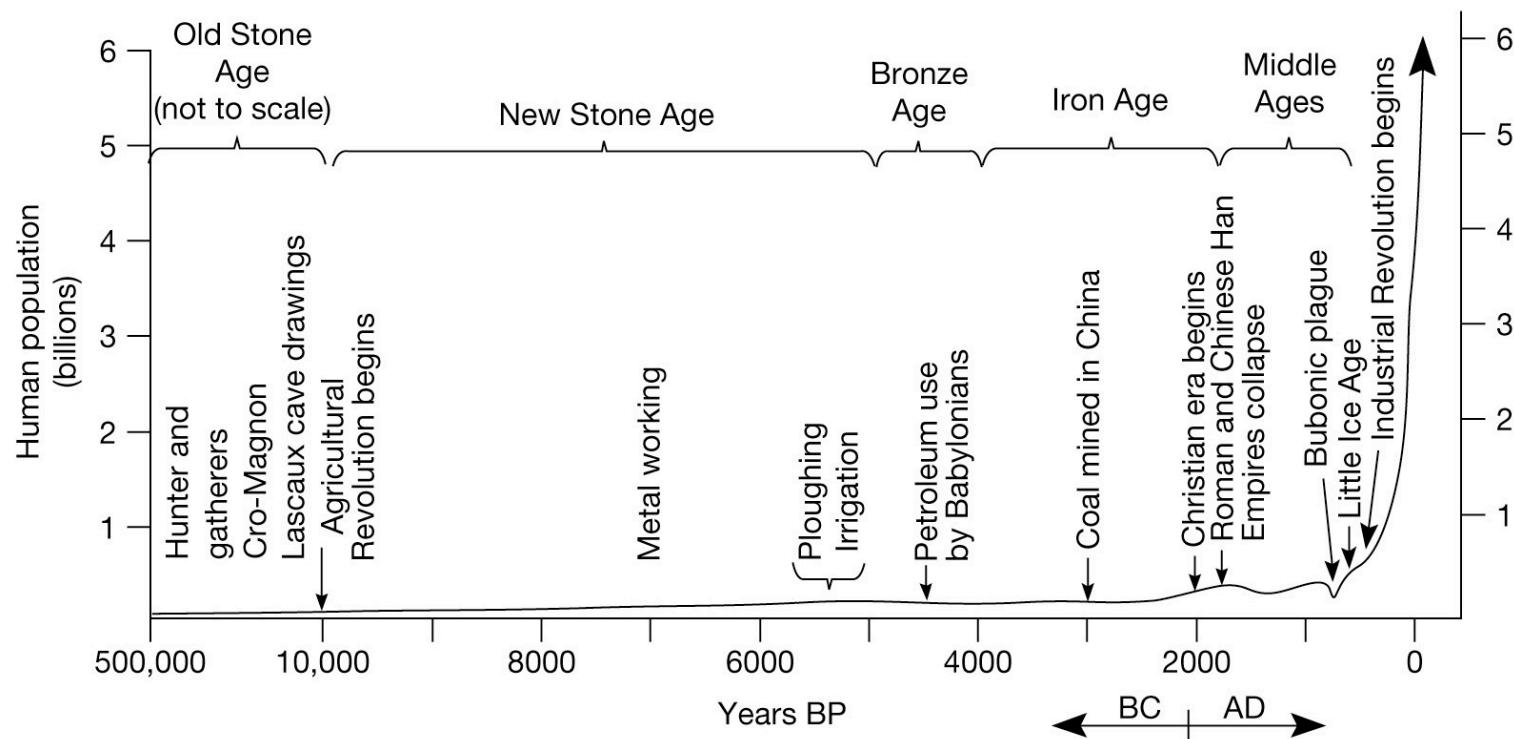


NASA

What was the world human population in 1 AD?

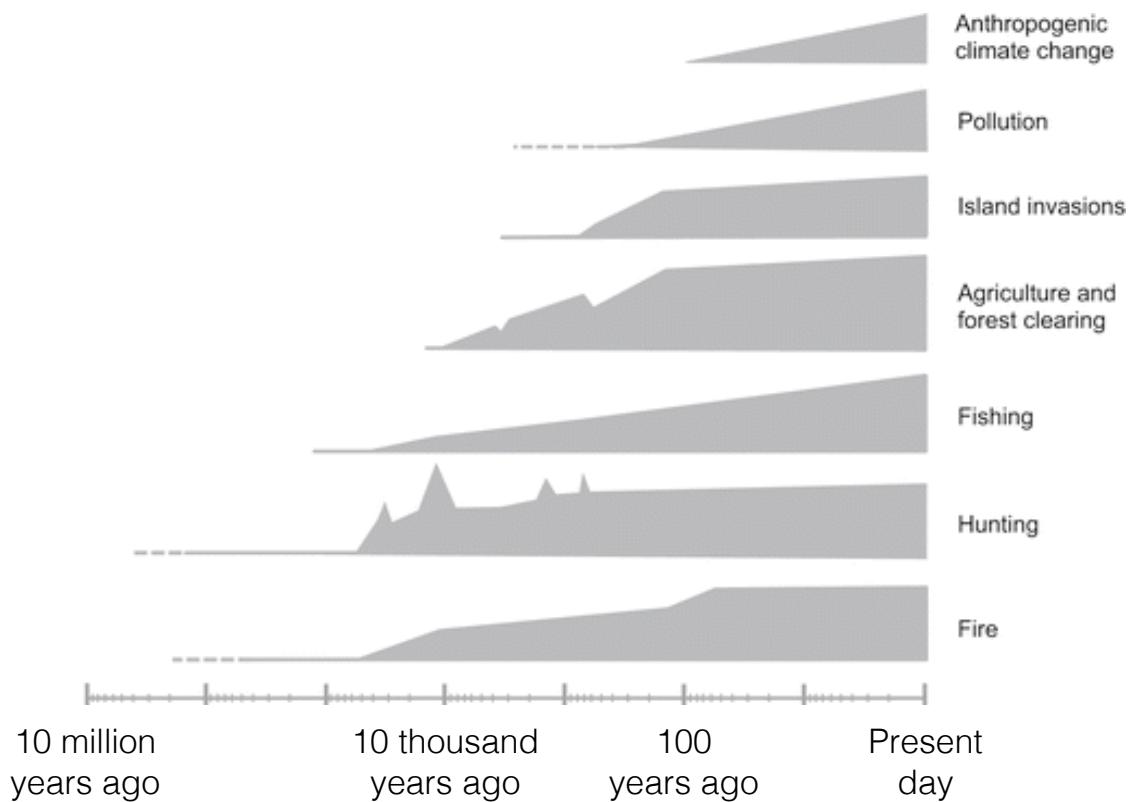


# Historic human population



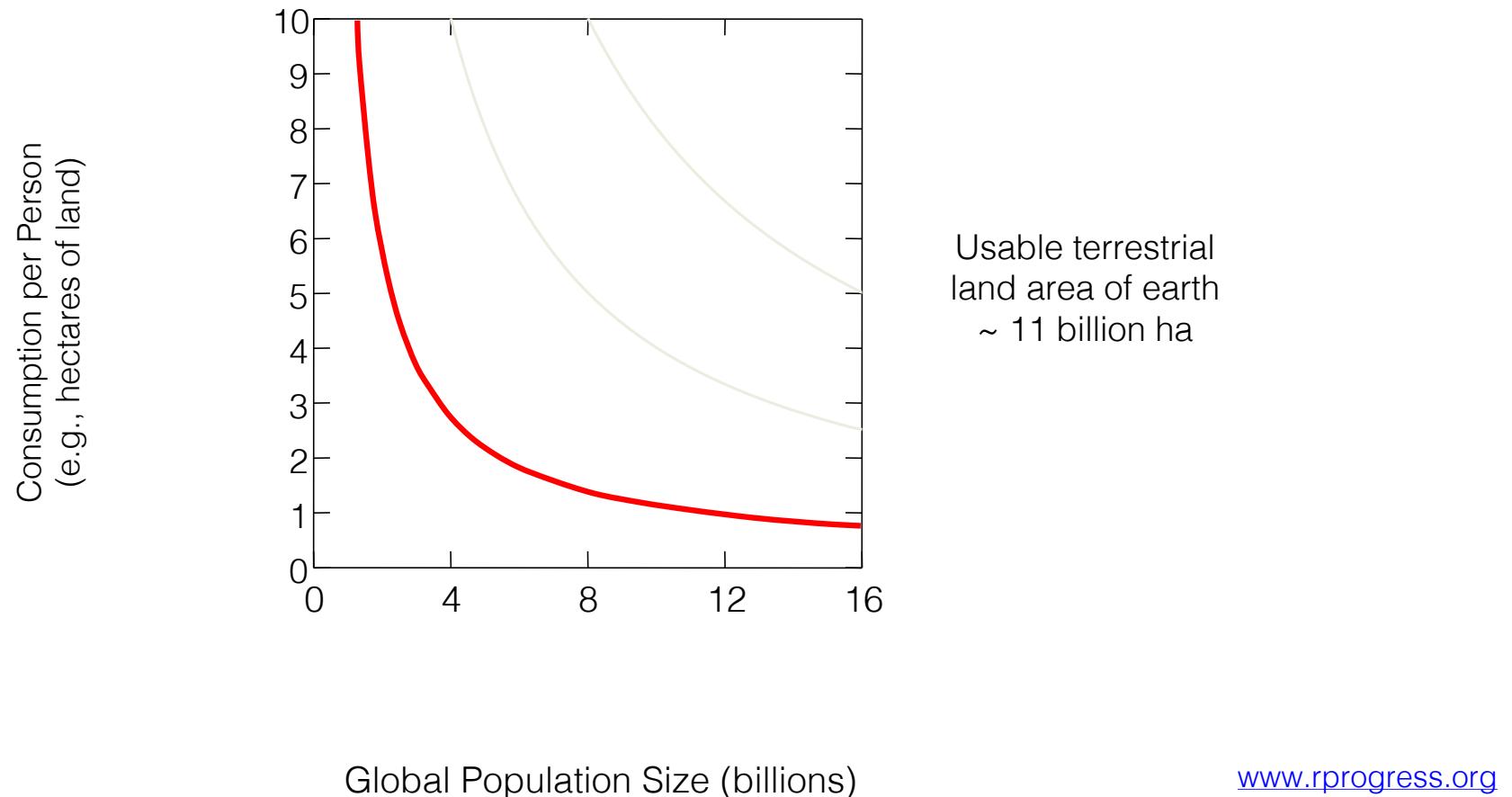
**300 Million**

# Historic human impact

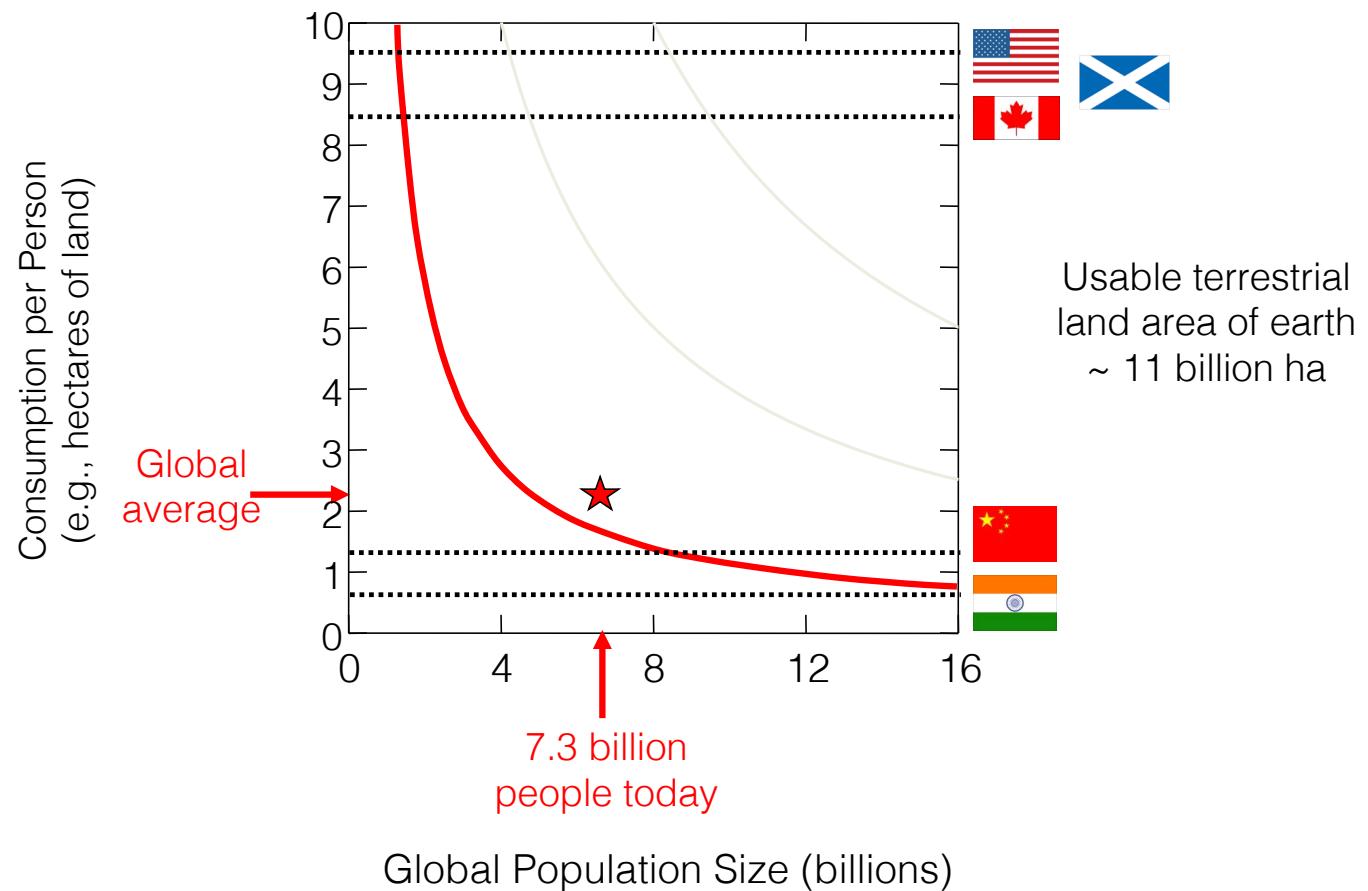


Pereira et al. *Annu. Rev. Environ. Resour.* 2012

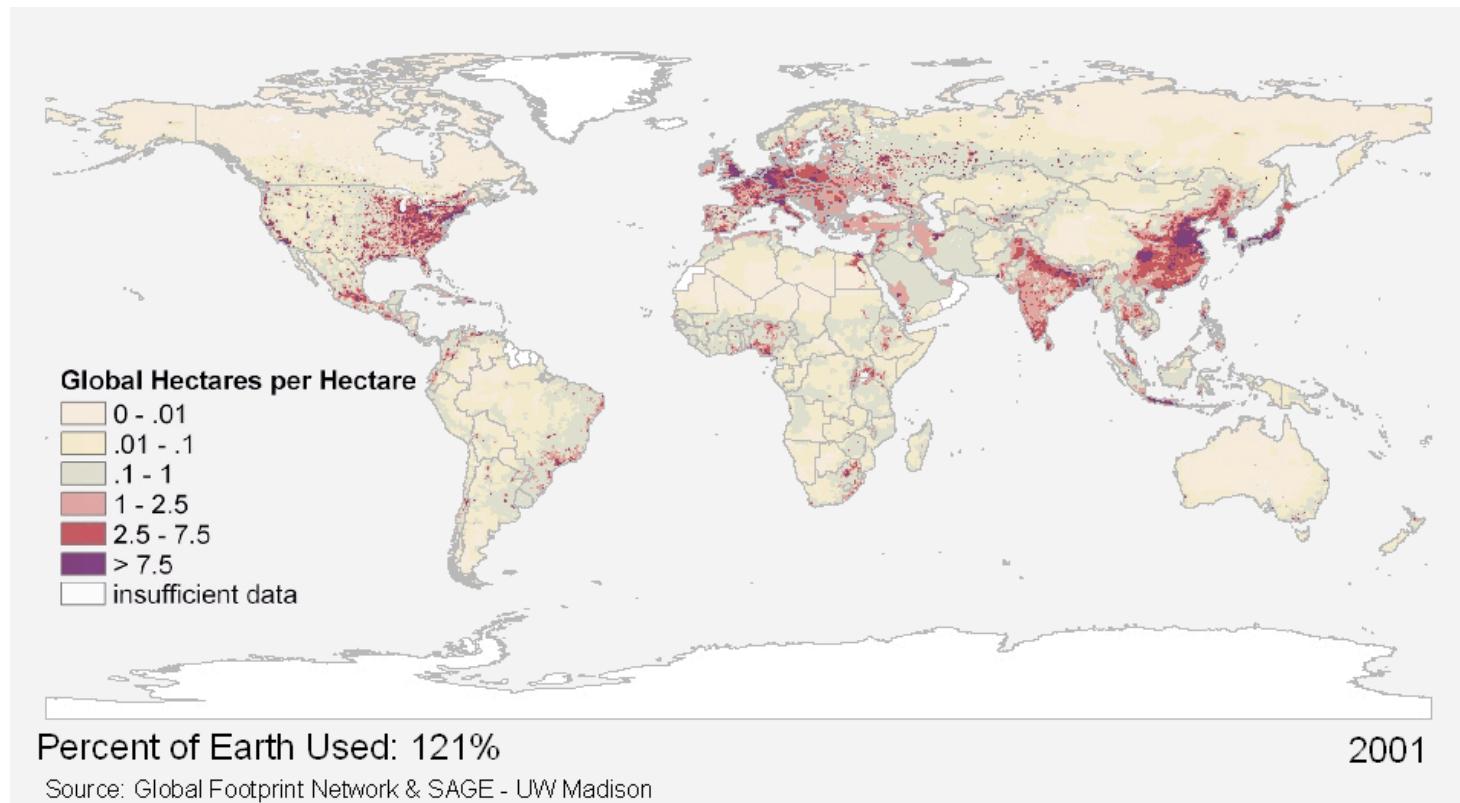
# Human ecological footprint



# Human ecological footprint



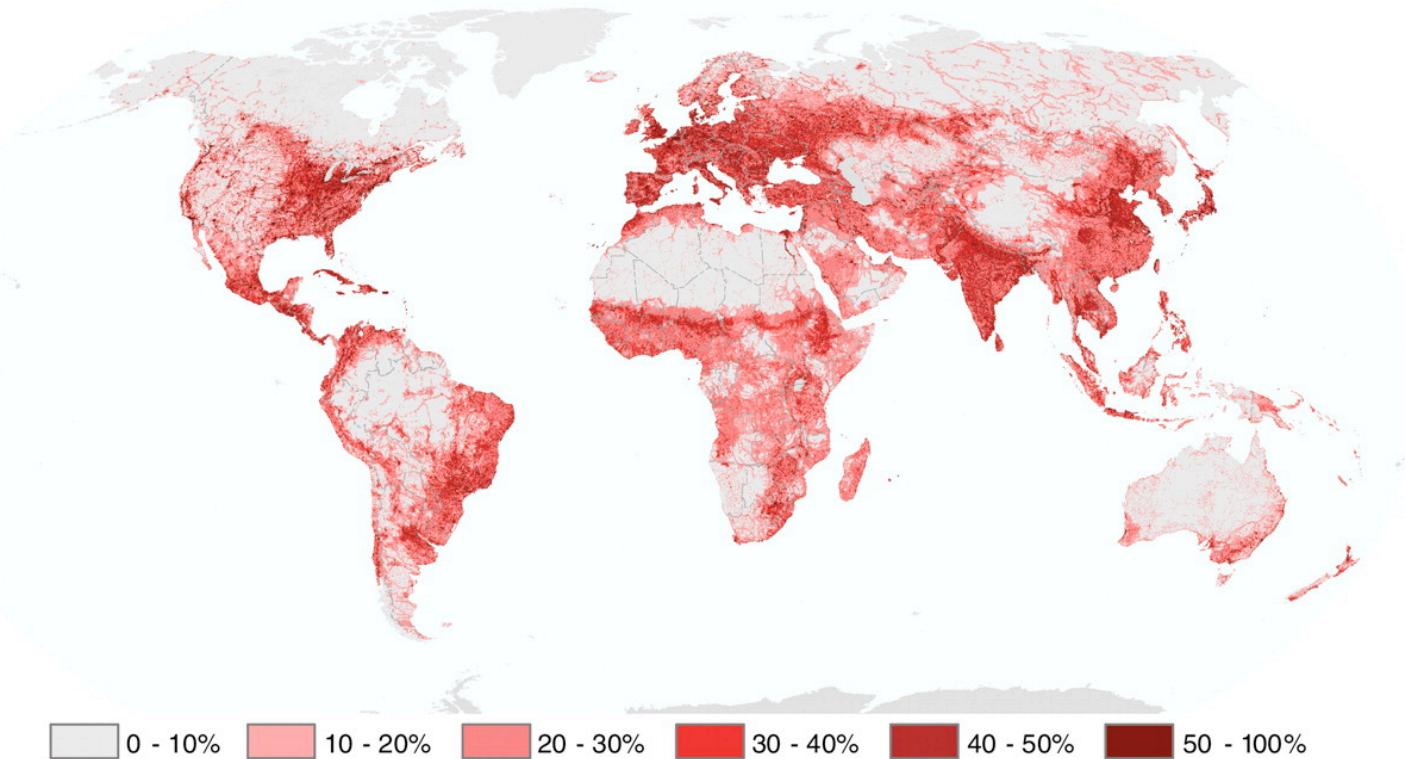
# Human ecological footprint



# How is land use changing?



# Human impact



Percentage of human influence relative to the maximum influence recorded for each biome

Kareiva et al. *Science* 2007

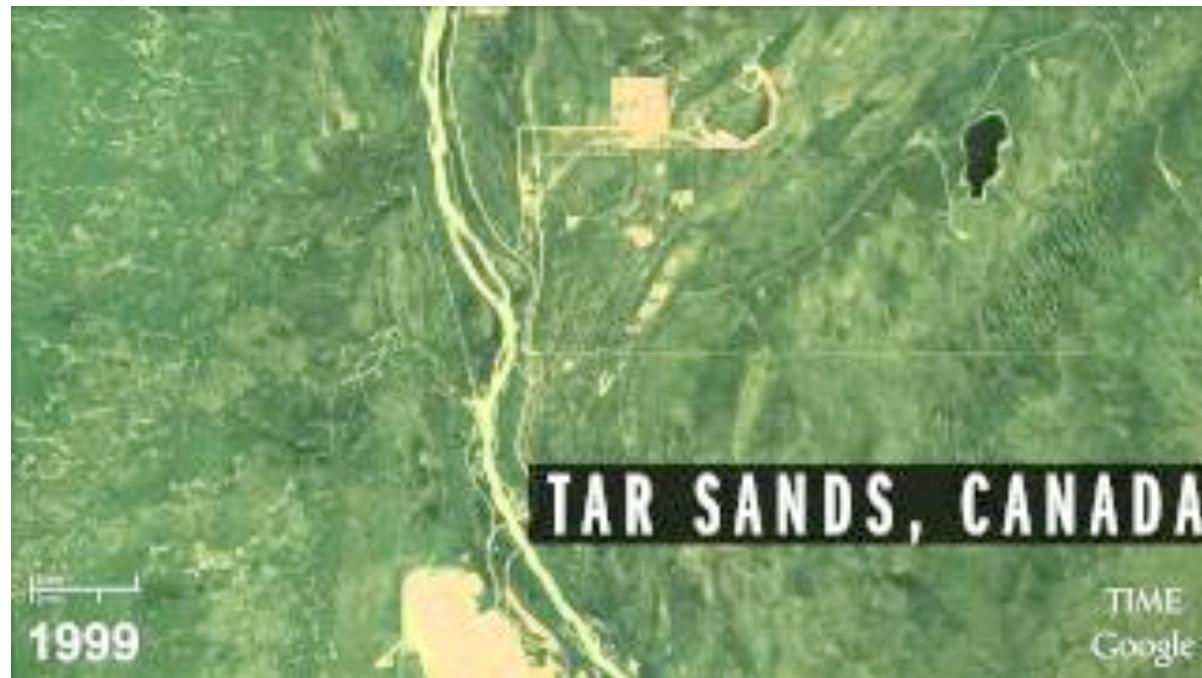
# How is land use changing?



# Habitat Conversion

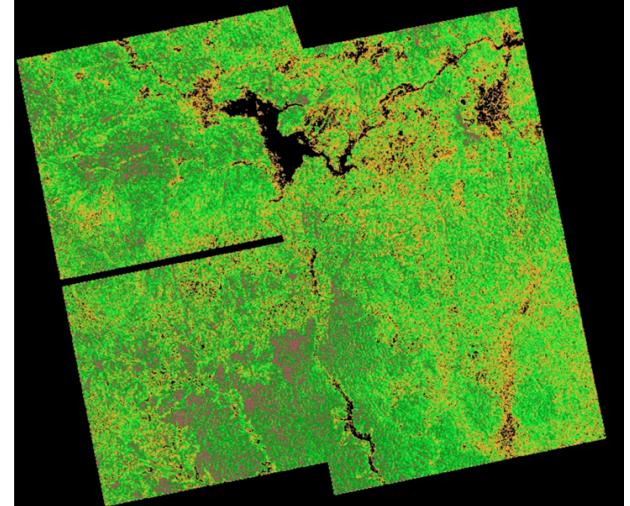
- Agriculture  
(cropping, livestock, plantations, aquaculture)
- Extraction activities  
(mining, fisheries, logging)
- Development  
(human settlement, industry, river diversion)
- Pollution  
(acid rain, industrial effluent, etc.)

# How is land use changing?



[https://www.youtube.com/watch?v=E-4DeQ2TPcc&list=PLWw80tqUZ5J\\_T8EKLKEWYd\\_NcFPiq9zTN&index=8](https://www.youtube.com/watch?v=E-4DeQ2TPcc&list=PLWw80tqUZ5J_T8EKLKEWYd_NcFPiq9zTN&index=8)

# Edward Mitchard



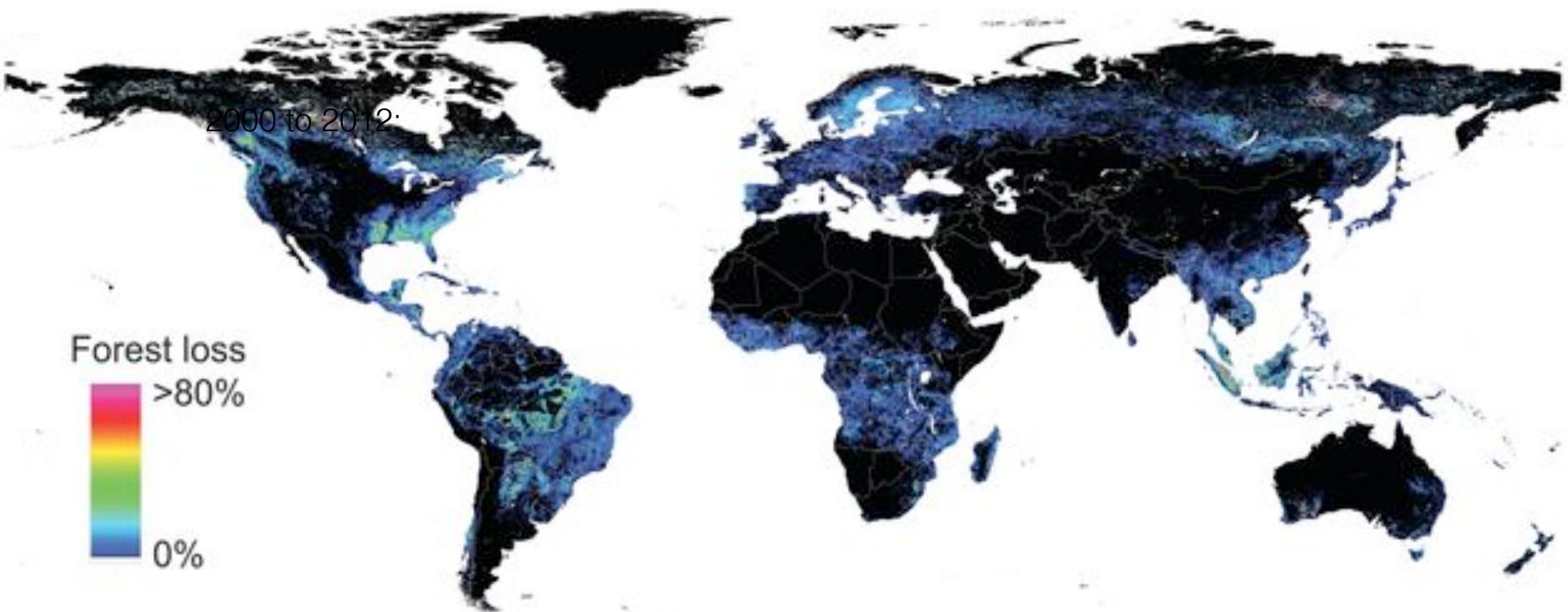
“I study ways in which we can use satellite data to monitor woody cover and biomass from space, especially in the forests, savannas and woodlands of Africa.”

<http://deforestationwatch.wordpress.com/>

<http://www.nutshell-videos.ed.ac.uk/edward-mitchard-mapping-deforestation/>

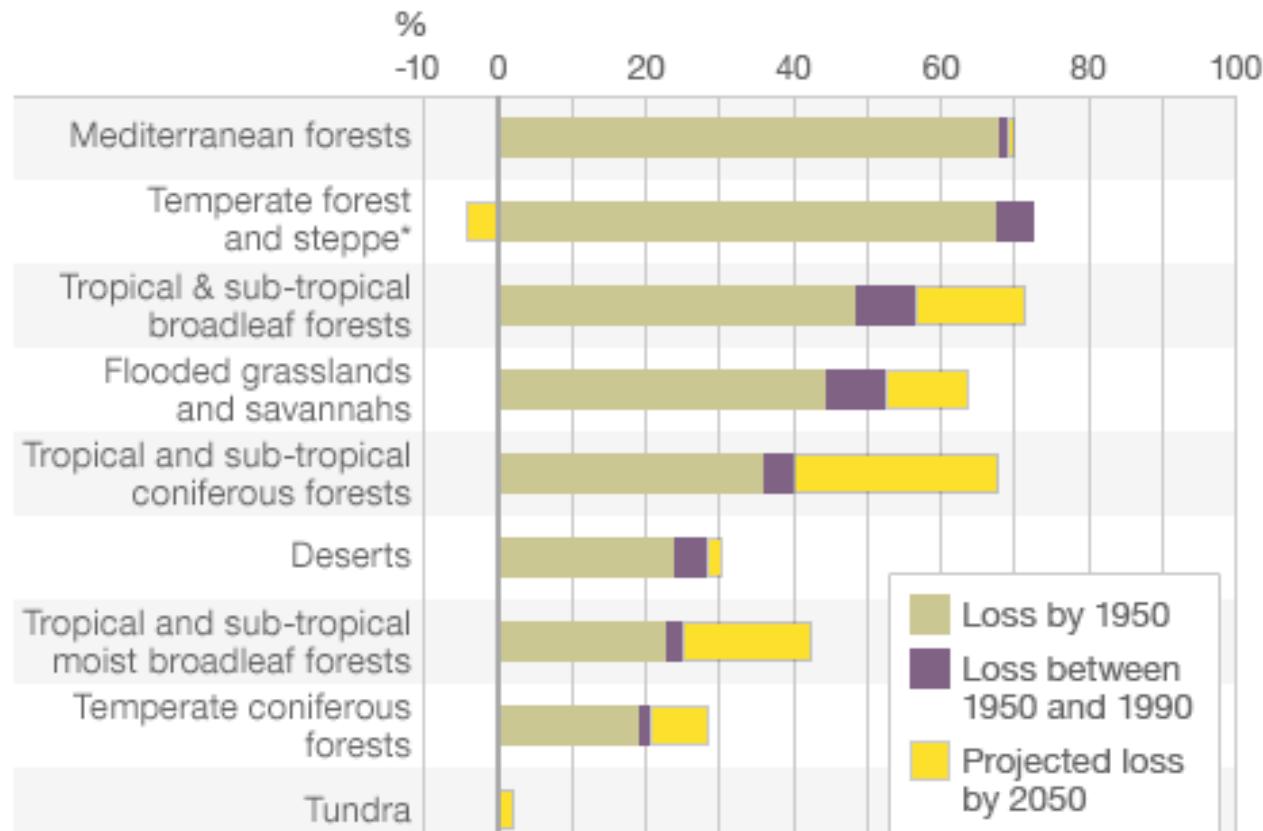


# Habitat Conversion



Hansen et al. *Science* 2013

## Land converted for human use



\*Projected growth result of replanting trees

Source: IUCN

Millennium Ecosystem Assessment, 2005/IUCN

Do converted habitats return to their previous state?



# Succession



# Habitat Recovery



Mount St. Helens  
– example of primary succession

# Alternative Stable States in Scotland?



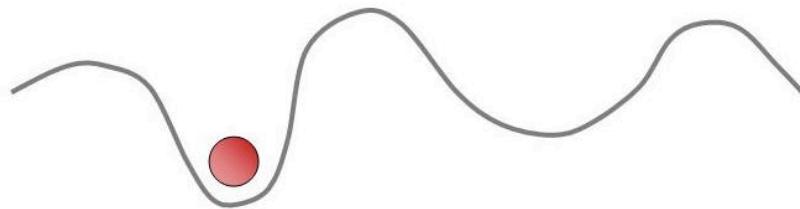
# Herbivory?



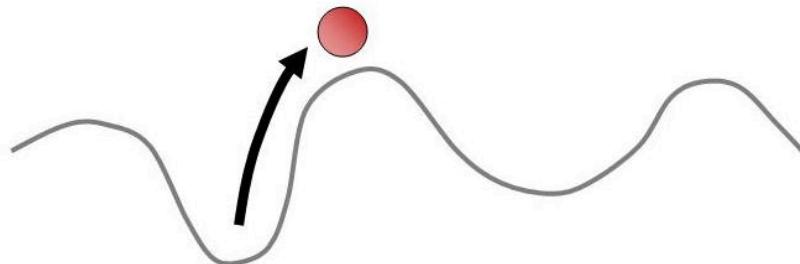
# Caledonian Forest



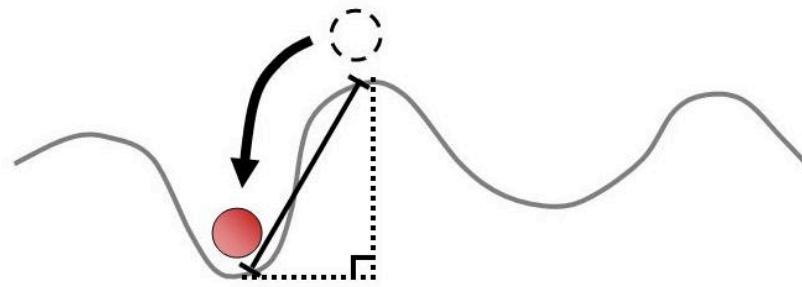
# Alternative Stable States



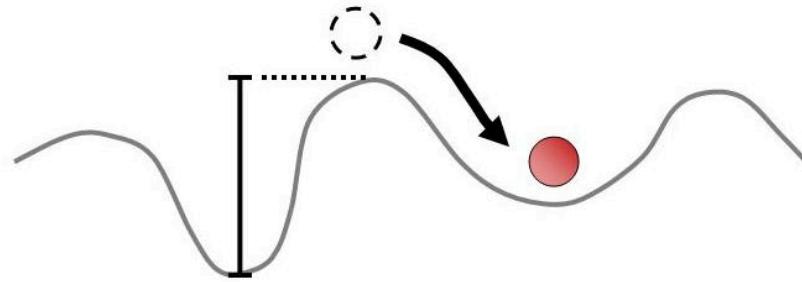
A) The ecosystem is in a steady state



B) A disturbance occurs



C) The rate of return to the first steady state

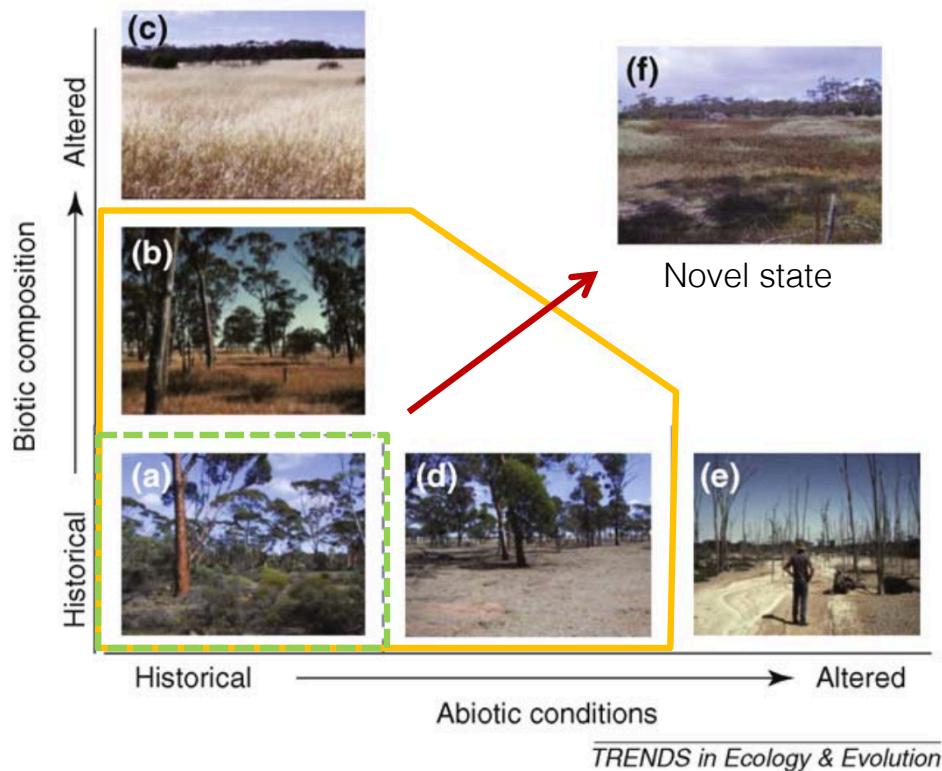


D) The amount of disturbance required to shift the ecosystem to a new steady state

Beisner et al. *Frontiers* 2003

# Novel Ecosystems

Australian Eucalyptus Forests



Hobbs et al. *Trends in Ecol. Evol.* 2009

“A system of abiotic, biotic, and social components (and their interactions) that, by virtue of human influence, differs from those that prevailed historically, having a tendency to self-organize and manifest novel qualities without intensive human management.”

Hobbs et al. 2013

## Box 1. Reiterating our still unchallenged points

- The concept of novel ecosystems is ill defined and can lead to undesirable practical and policy outcomes.
- Successful restoration projects abound in areas that could have been considered novel.
- Socioeconomic and political limitations to ecological restoration should not be confused with ecological thresholds.
- Hobbs et al. [2] agree that ‘novel ecosystems’ is a term that has morphed many times in its short lifetime. They argue that this is normal; we suggest that this level of morphing and re-morphing indicates only that it has not hit a true target and should be handled much more cautiously.

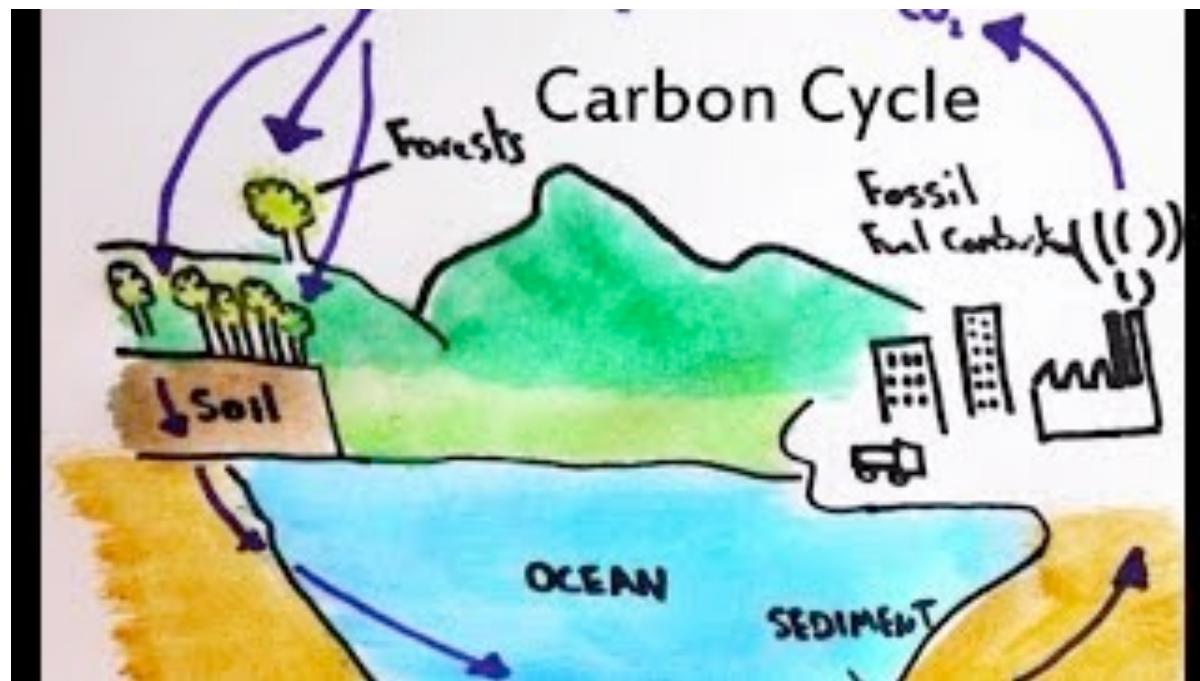
Aronson et al. *Trends in Ecol. Evol.* 2014

# How does land-use change alter ecosystems?



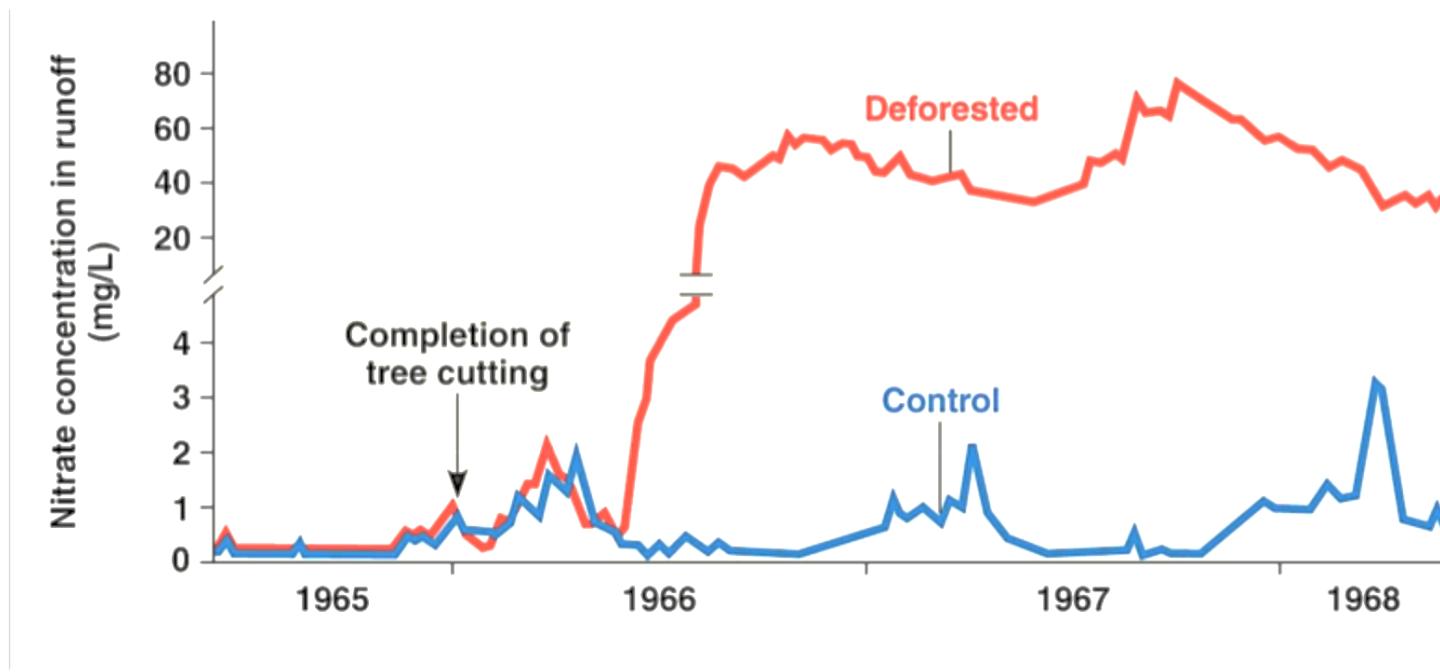
Hubbard Brook Experimental Forest

# Deforestation



<https://www.youtube.com/watch?v=pT4YpinTIOQ>

# How does land-use change alter ecosystems?



Vitousek and Melillo *Forest Science* 1979

# Ecosystem Functions

"Ecosystem functions are biological, geochemical and physical processes that occur within an ecosystem that underpin the capacity of an ecosystem to provide ecosystem services."

Millennium Ecosystem Assessment, 2005



# Ecosystem Functions

- Carbon fixation
- Water purification
- Pollination
- Decomposition
- Pest suppression
- Production of biomass
- Nitrogen fixation
- Energy flow through food webs
- Etc.

# Why do we alter ecosystems?



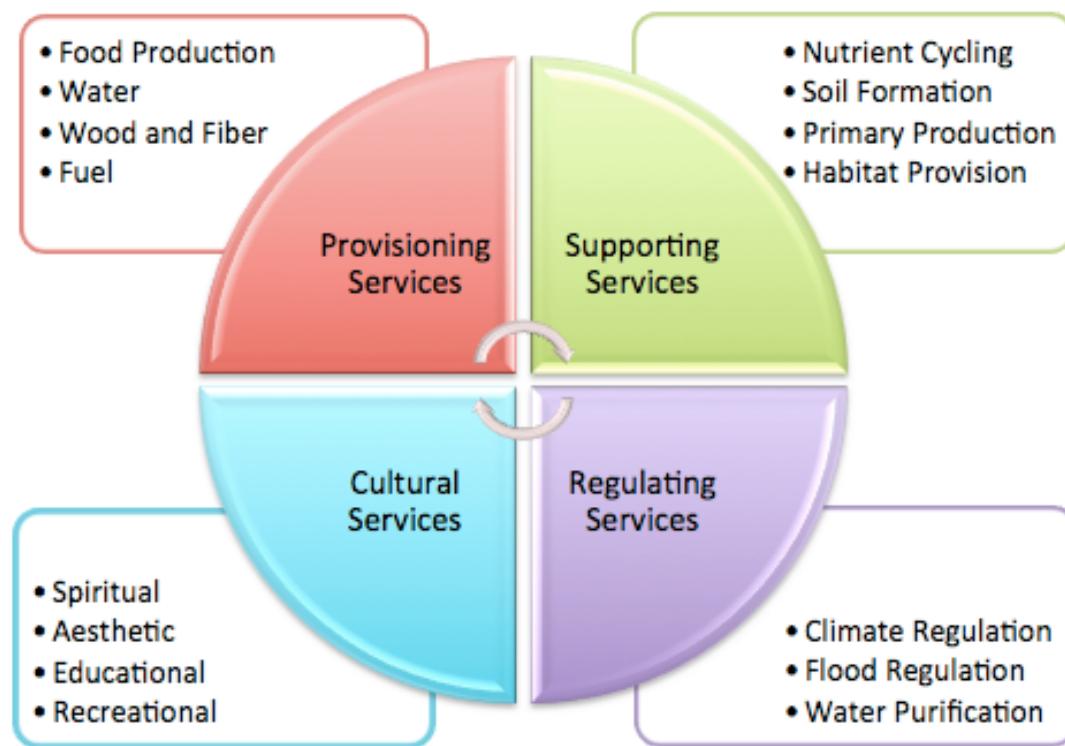
# Ecosystem Services

“Ecosystem services are the benefits that humans derive from ecosystems. In the Services have been classified into four categories: provisioning, regulating, cultural and supporting services.”

Millennium Ecosystem Assessment, 2005



# Ecosystem Services



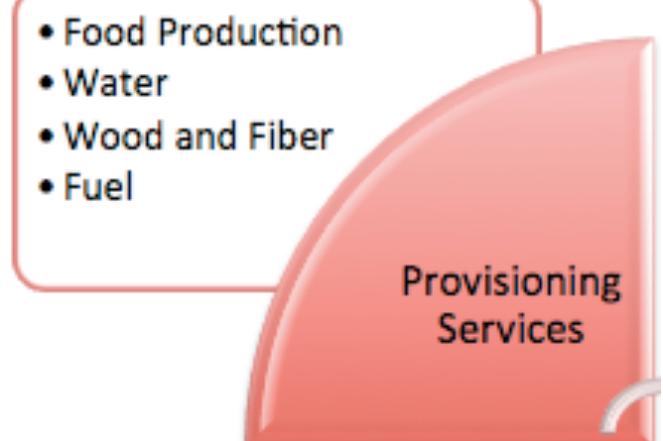
Millennium Ecosystem Assessment 2005

# Ecosystem Services

## Provisioning services

Products obtained from ecosystems

- Food - crops, fish, wildlife
- Raw materials – wood, textiles
- Drinking water

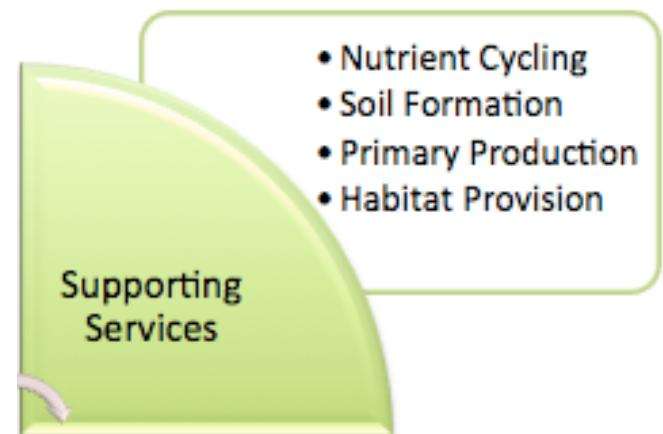


# Ecosystem Services

## Supporting services

Ecosystem services that are necessary for the production of all other ecosystem services

- Nutrient cycling
- Soil production
- Primary productivity

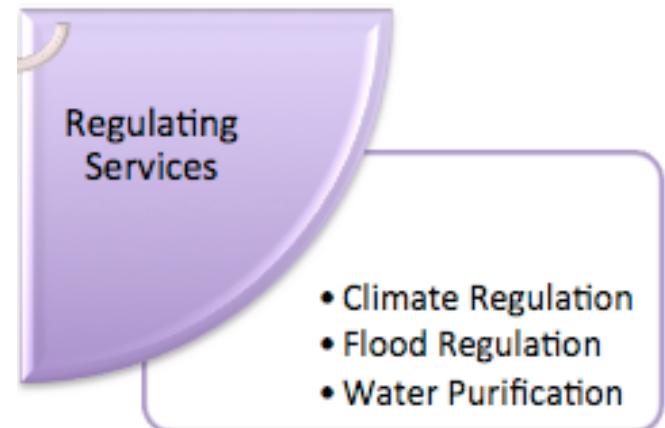


# Ecosystem Services

## Regulating services

Benefits obtained from the regulation of ecosystem processes

- Carbon sequestration and climate regulation
- Waste decomposition and detoxification
- Purification of water and air
- Pest and disease control

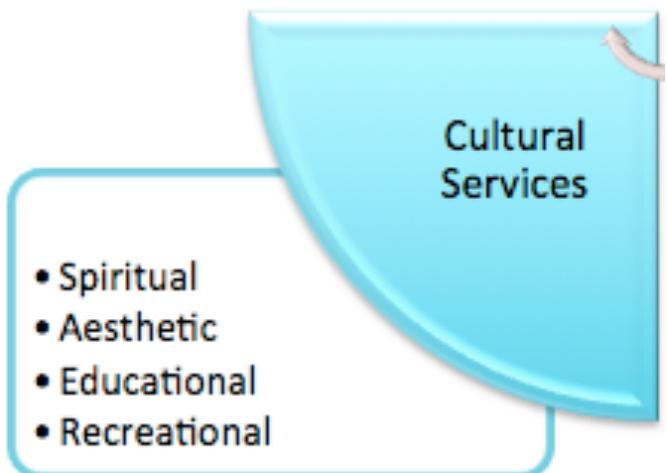


# Ecosystem Services

## Cultural services

Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences

- Cultural
- Spiritual and historical
- Recreational experiences
- Science and education



# Casey Ryan



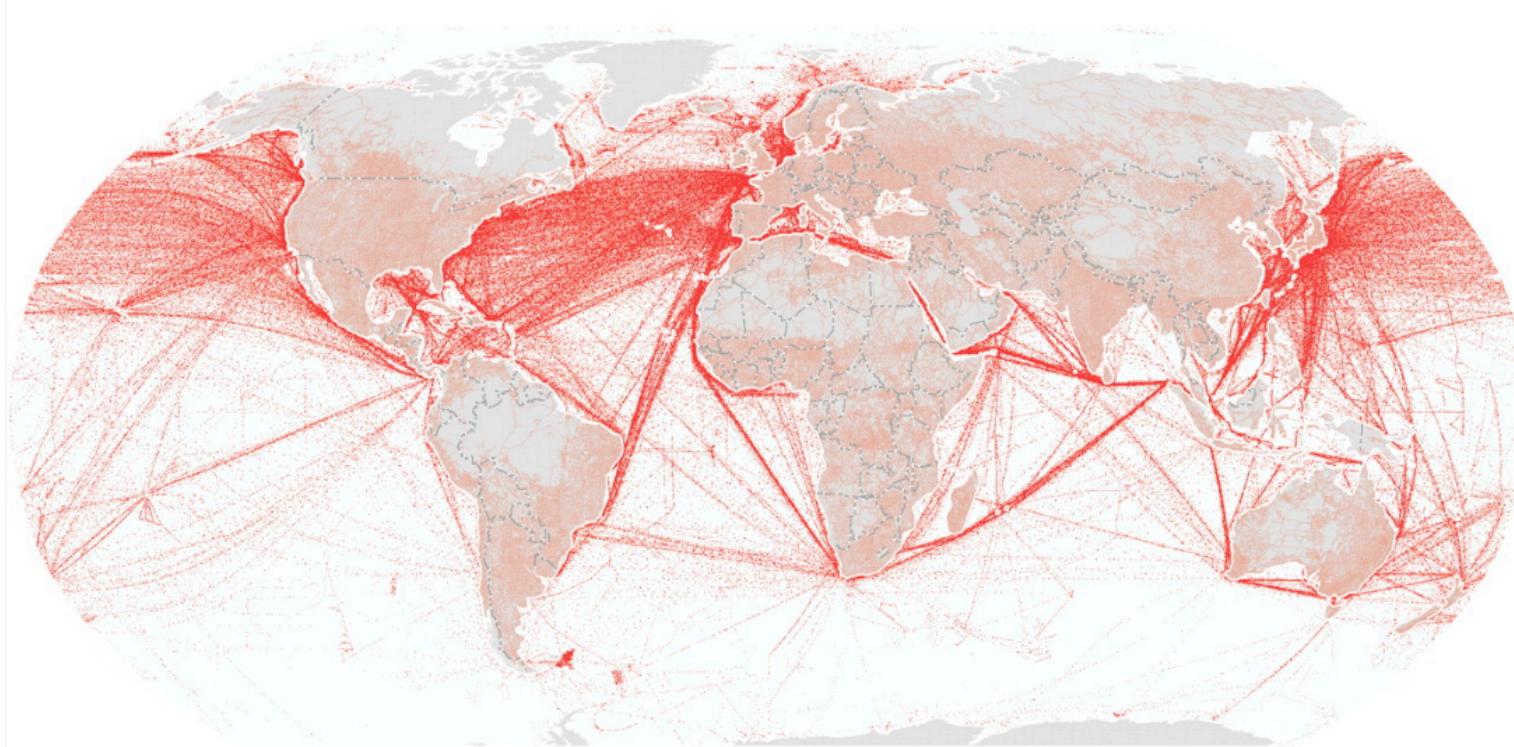
“My research is mainly focused on the Miombo woodlands of Southern Africa, their ecology and the ecosystem services that they provide.”

<https://www.youtube.com/watch?v=IBn7ypHhp4>

How does land-use change influence ecology?



# How does land-use change alter species distributions?



The world's roads and shipping routes

# Extra Reading

Millennium ecosystem assessment synthesis report. Millennium Ecosystem Assessment, 2005.

<http://www.millenniumassessment.org/en/index.html>

Kareiva, P., et al. 2007. Domesticated nature: shaping landscapes and ecosystems for human welfare. *Science*, 316(5833), 1866-1869.

Hansen, M. C., et al. 2013. High-resolution global maps of 21st-century forest cover change. *Science*, 342(6160), 850-853.

Beisner, B. E., et al. 2003. Alternative stable states in ecology. *Frontiers in Ecology and the Environment*, 1(7), 376-382.