



THE OHIO STATE UNIVERSITY

Land Degradation

Carbon Management and Sequestration Center

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Economics of
Degradation
— A Global
Assessment for
Sustainable Development

Congratulations!



MAJOR RESOURCE QUESTIONS ADDRESSED

- 1. Methods for global assessment of land degradation
- 1. Extent and severity of land degradation and opportunities for improvement
- 1. Key drivers of land degradation
- 1. Economic, social and environmental costs and cost of inaction
- 1. Land degradation and human health
- 1. Feasible policies and development strategies (e.g., SDGs)



SDG-TARGET 2.4

"By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality."



SDG-TARGET 15.3

"By 2020. combat desertification, restore degraded land and soil, including land by desertification, drought and floods, and strive to achieve a land degradation neutral world."



RELEVANCE TO COP-21

The "4 pour Mille" proposal of the French Government implies sequestering 2.8 Gt C yr^{-1} to 40-cm depth in World's soils.



COST OF LAND DEGRADATION

(2007 US\$ 10⁹)

Region	Cost	
SSA	65.2	(LUCC accounts for 93-94% of the cost)
South Asia	23.5	
China	37.0	
Global	296.1	

- >3.2 billion people live on degraded lands
- Fertilizer, irrigation, and other inputs can mask adverse effect on productivity



FUTURISTIC ISSUES AND RESEARCHABLE PRIORITIES

- Land Degradation and Emission of GHGs
- Thresholds or critical limits
- Peak soil or Endangered soils
- Land Degradation and Human Population
- Water renewability and quality (algal bloom)
- Biodiversity



ANTHROPOGENIC EMISSIONS (Pg) BY CARBON CIVILIZATION

I. Land use : 486

(i) Prehistoric : 320

(ii) 1750-2010 : 166

(iii) 2010-2030 : 100

II. Combustion: 390

200

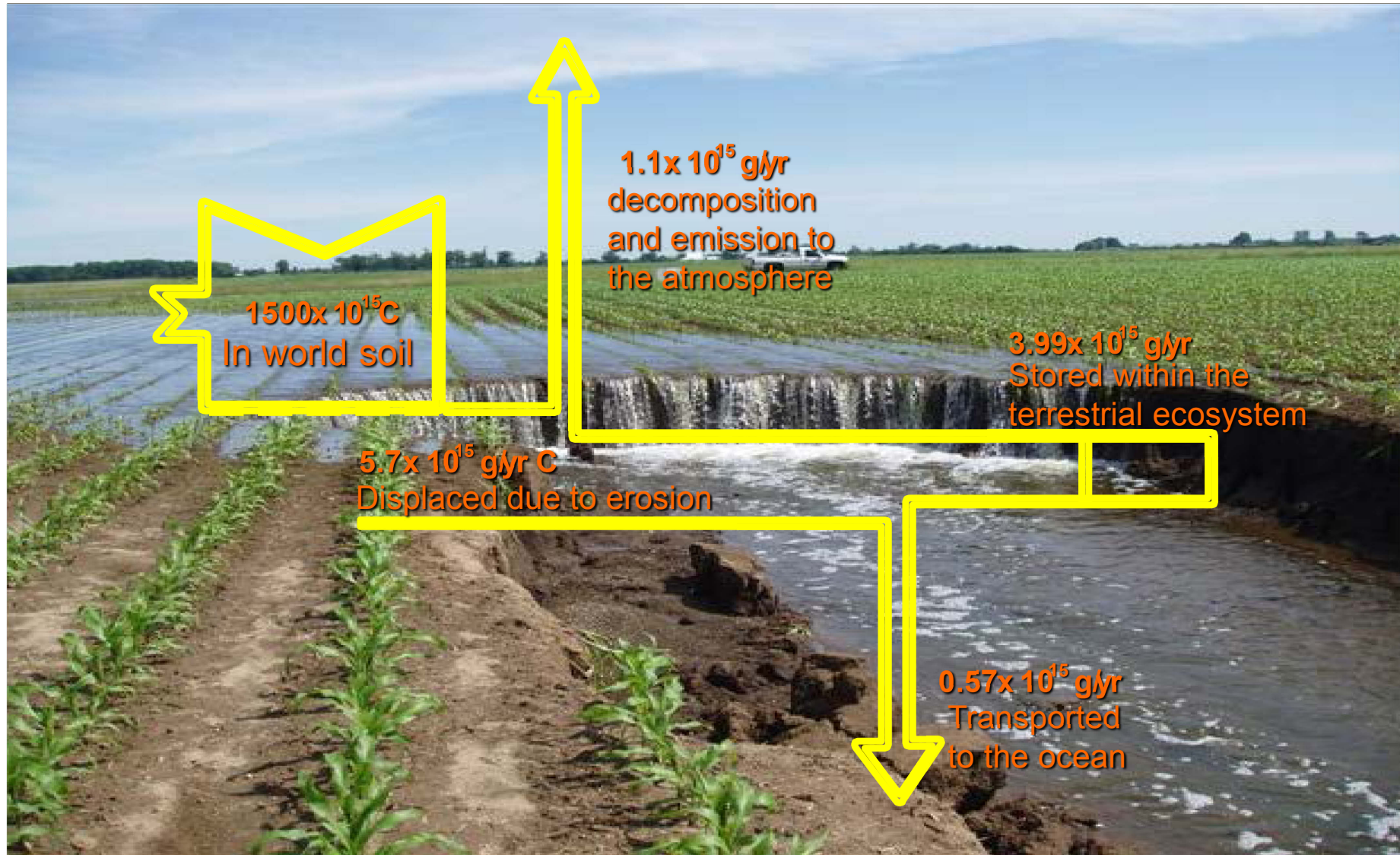
2030 : 190

The cause of Super-interglaciation

Emissions have and will affect the ecosystems
from which we derive food, feed, fiber, fuel and shelter.



GLOBAL SOIL EROSION & DYNAMICS OF SOIL ORGANIC CARBON



SOIL CARBON AND THE ENVIRONMENT

- Extractive Farming/Subsistence

- Depletion of SOC and Nutrients
- Decline in Soil Structure

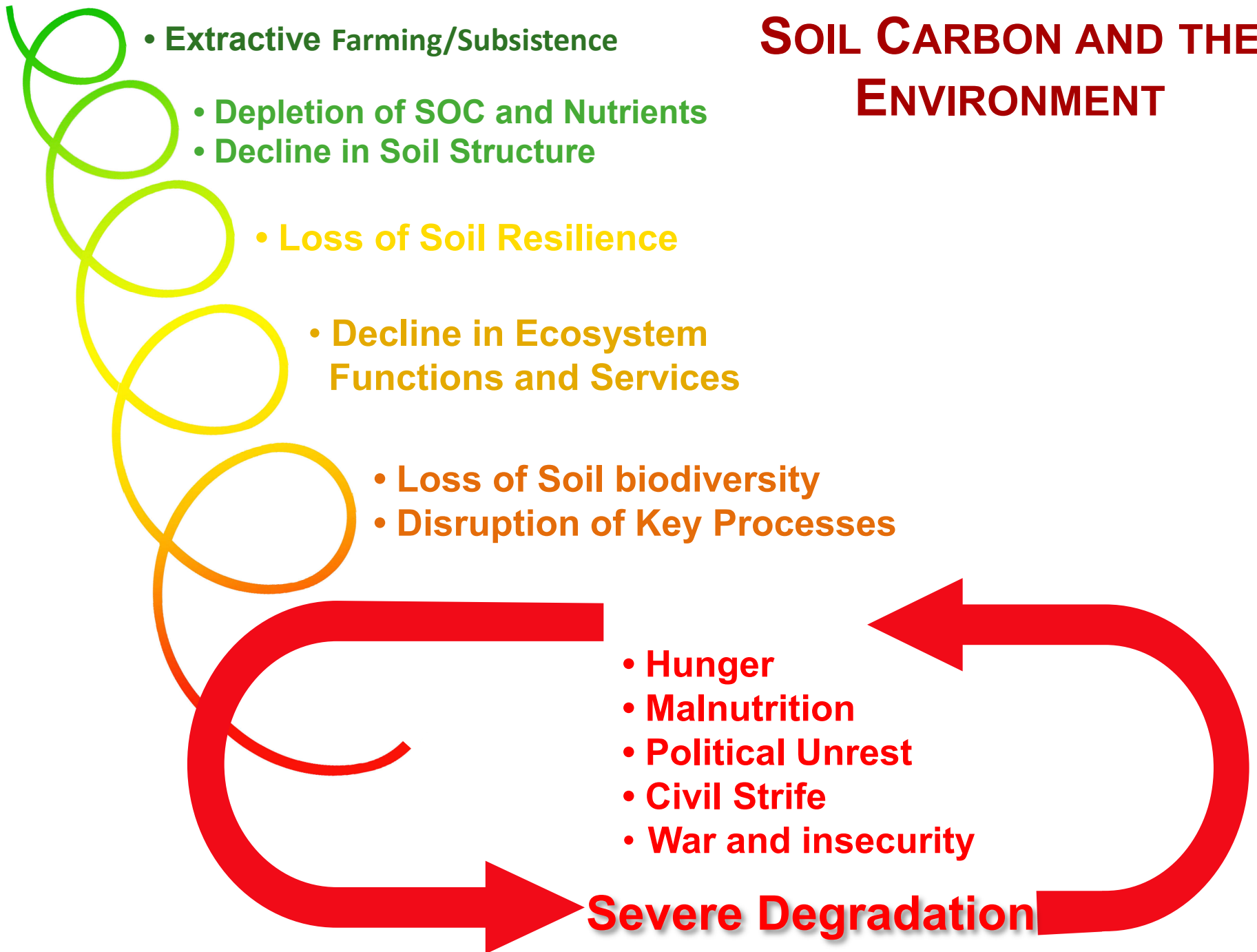
- Loss of Soil Resilience

- Decline in Ecosystem Functions and Services

- Loss of Soil biodiversity
- Disruption of Key Processes

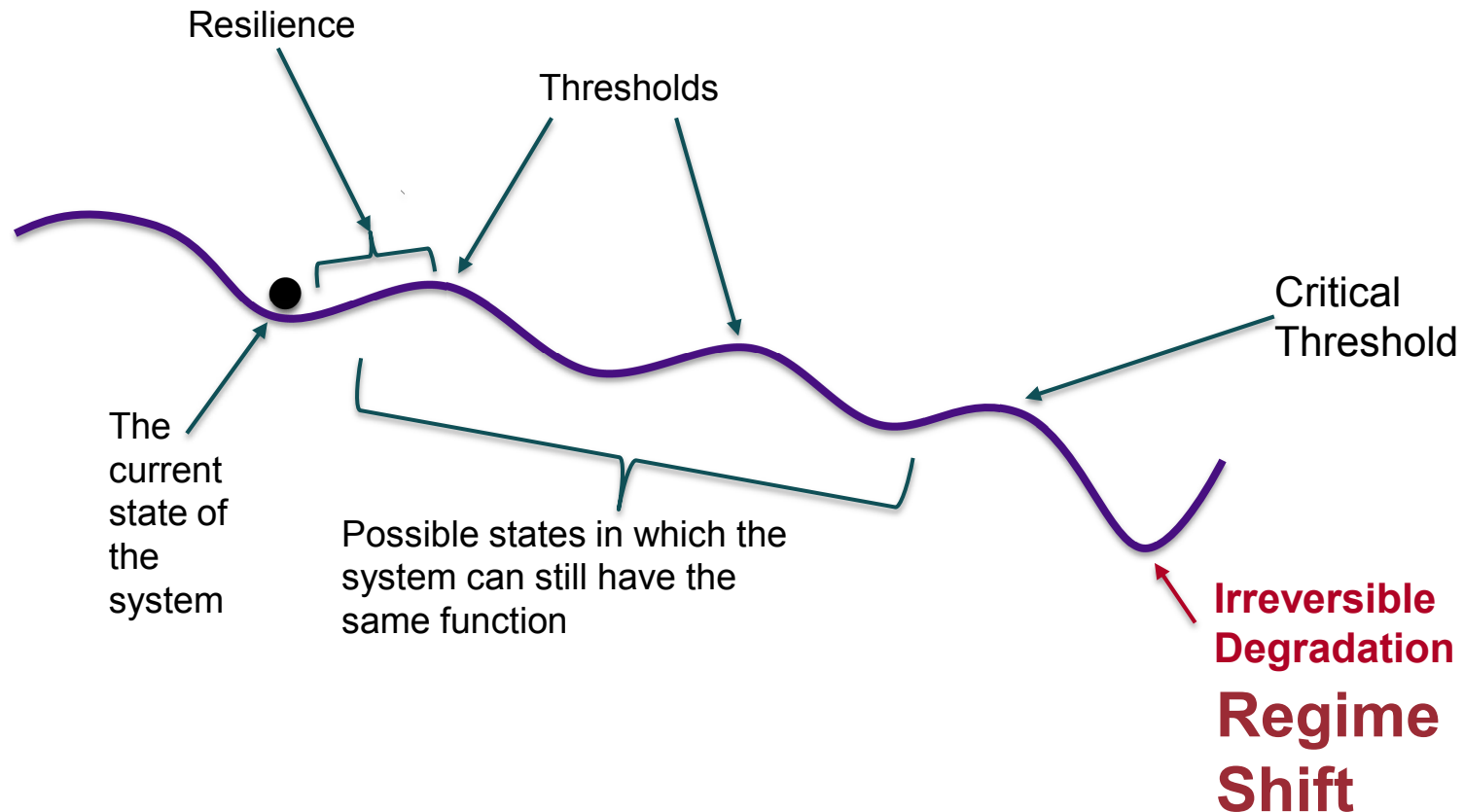
- Hunger
- Malnutrition
- Political Unrest
- Civil Strife
- War and insecurity

Severe Degradation

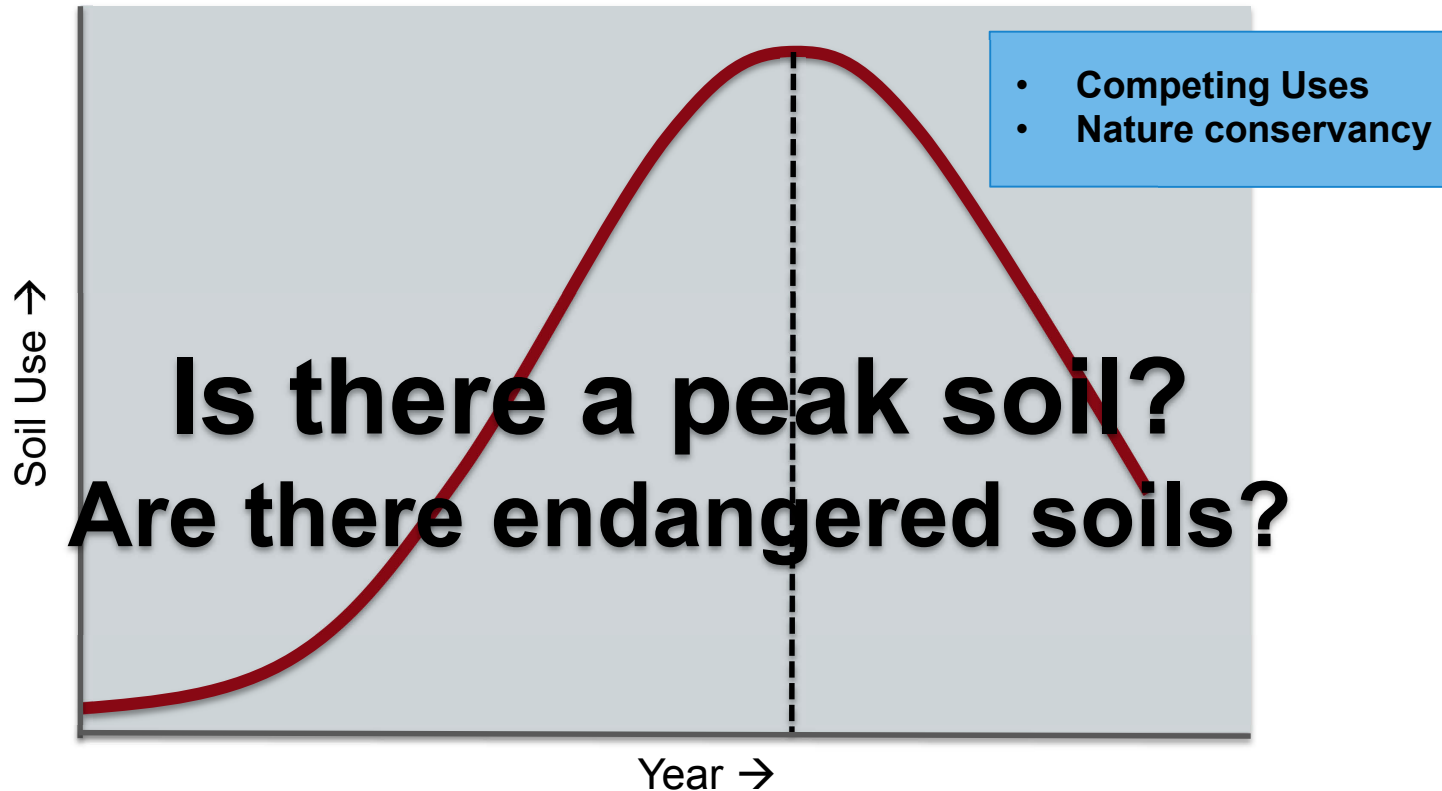


RESILIENCE OF SOIL-ECOLOGICAL SYSTEMS

It has multiple regimes (stable states) which are separated by thresholds



HUBERT CURVE



- Land resources already allocated to agriculture production are adequate through sustainable intensification, soil restoration, and carbon sequestration.



DIGGING UP ANTIBIOTICS FROM SOIL

- Most antibiotic are produced by screening soil microorganisms.
- Penicillin came from *Penicillium*, Streptomycin from *Streptomyces*, and Vanomycin from *Amycolatopsis orientalis*.
- Uncultured bacteria make up ~99% of all species in external environments, and are an untapped sources of antibiotics (Lewis, 2015. Nature)
- An antibiotic discovered from soil in Maine can kill *Mycibaterium tuberculosis* (Ling et al., 2015. Nature)
- A new antibiotic "Teixbactin" from soil can sill the bacteria that cause pneumonia, staph, and blood infections (Fink, 2015. Nature)
- Almost 50% of Actinomycetes isolated from soil are capable of synthesizing antibiotics. There are a lost of unanticipated surprises still lurking in soil



MALTHUS VS BOSERUP THEORY

Malthus: Human population is at risk of outgrowing carrying capacity of land. Thus, size of the population is limited by the amount of food it can produce. (An Essay on the Principle of Population, 1798).

Boserup: Food production can, and will, increase to match the needs of population. Threat of starvation and the challenge of feeding more mouths motivates people to improve their farming methods and invent new technologies to produce more food. (The Conditions of Agricultural Growth, 1965).



GREEN GROWTH

“Fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our wellbeing relies”

OECD, 2011



THE LIMITS TO GROWTH?

1. If the present growth trend (population, resource depletion, pollution, etc) continues unchanged, the limits to growth on this planet will be reached sometime within the next 100 years.
1. It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future.
1. If the world's people decide to strive for this second outcome rather than the first, the sooner they begin working to attain it, the greater will be their chances of success

Meadows et al. (1972)



POLICY STRATEGY FOR GREEN INNOVATION AND STRUCTURAL TRANSFORMATION

Step One

- Phase out environmentally harmful subsidies
- Rationalize/Phase out many environmentally motivated subsidies

Step Two

Expand and improve effective incentives for private sector investments for sustainable growth and job creation

Restore Degraded Lands?

Step Three

Use any resulting revenues and savings to finance the necessary public support for private green R&D and investments



THE PLANETARY BOUNDARIES

1. Stratospheric O₃ Depletion
2. * Biodiversity loss and extinction
3. Chemical pollution (novel)
4. * Climate change
5. Ocean acidification
6. Fresh water consumption and the global hydrological cycle
7. * Biosphere and land use change
8. Atmospheric aerosol loading
9. * Land system change

Land Degradation?

Stockholm Resilience Center (2007)



MEETING FOOD DEMAND BY 2050

The world produces enough food to feed 10 billion people . Thus, food and nutritional security must be achieved by:

- **Reducing** waste (30-50%),
- **Increasing** access to food by addressing poverty, inequality, wars and political instability,
- **Improving** distribution,
- **Increasing** use of plant-based diet,
- **Accepting** personal responsibility of not taking things for granted, and
- **Increasing** agronomic productivity from existing land, restoring degraded lands ,and converting some agricultural land for nature conservancy without any conversion of natural land to agroecosystems.



SOIL: THE ESSENCE OF LIFE

“Hello there folks. Do you know who I am? I am the geomembrane under your protective filter. I am the source of energy, water, and nutrients. I am your soil. I am the habitat for most of the life on this planet. I am the source of the dust from which you are made. I am a soil”.

- Soil matters
- It is the answer to important global issues
- Food production must be soil-centric
- Soil management is essential to saving energy

*Richard Arnold (2006)
Senior Soil Scientist*