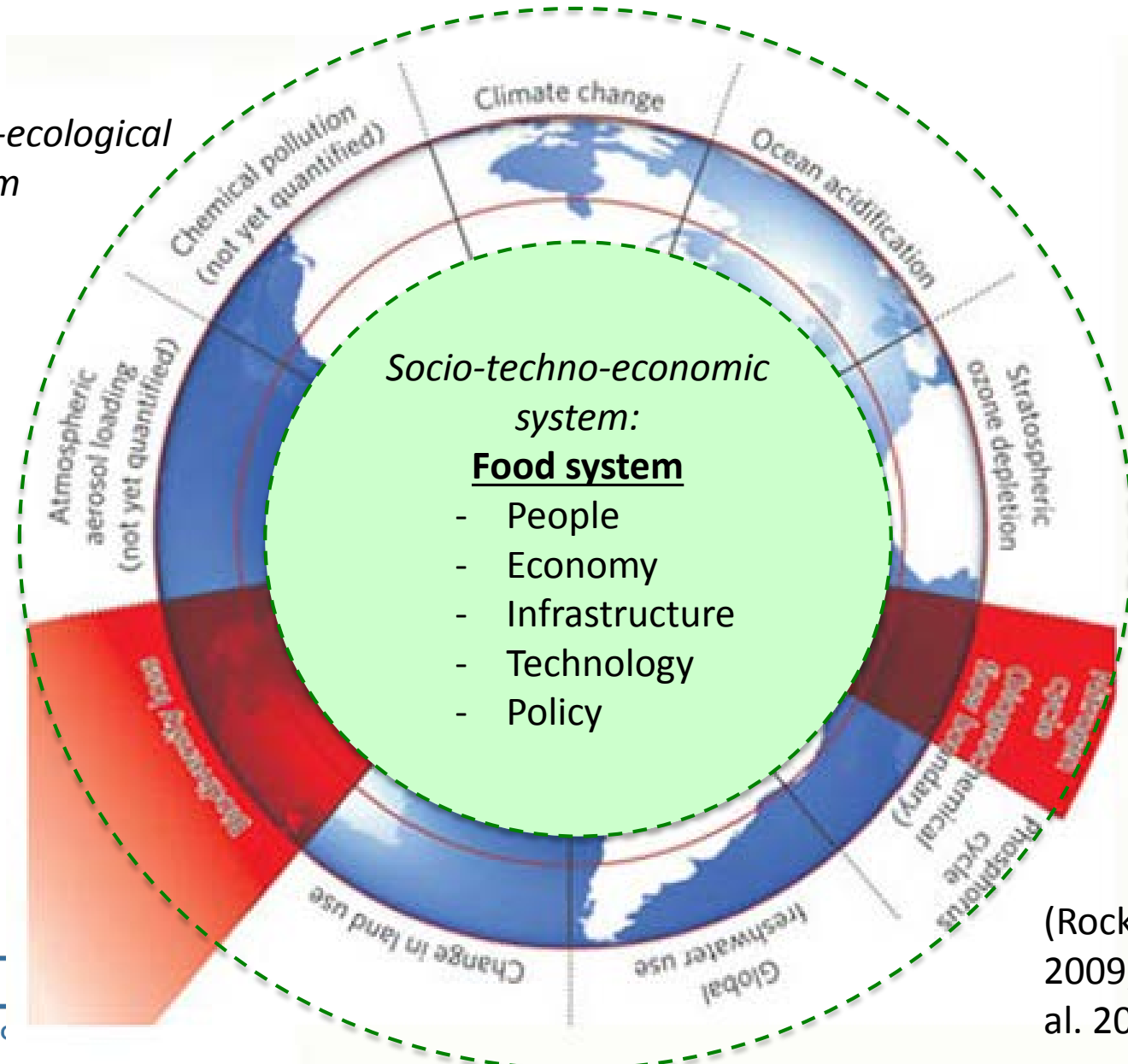


Capturing socio-economic complexity (of food system) to navigate within the nitrogen and phosphorus boundaries

Kuokkanen, A; Linnanen, L; Mikkilä, M; Kahiluoto, H; Kuisma, M

Socio-ecological system



N: 710
kcal/cap/day
P: 250
kcal/cap/day

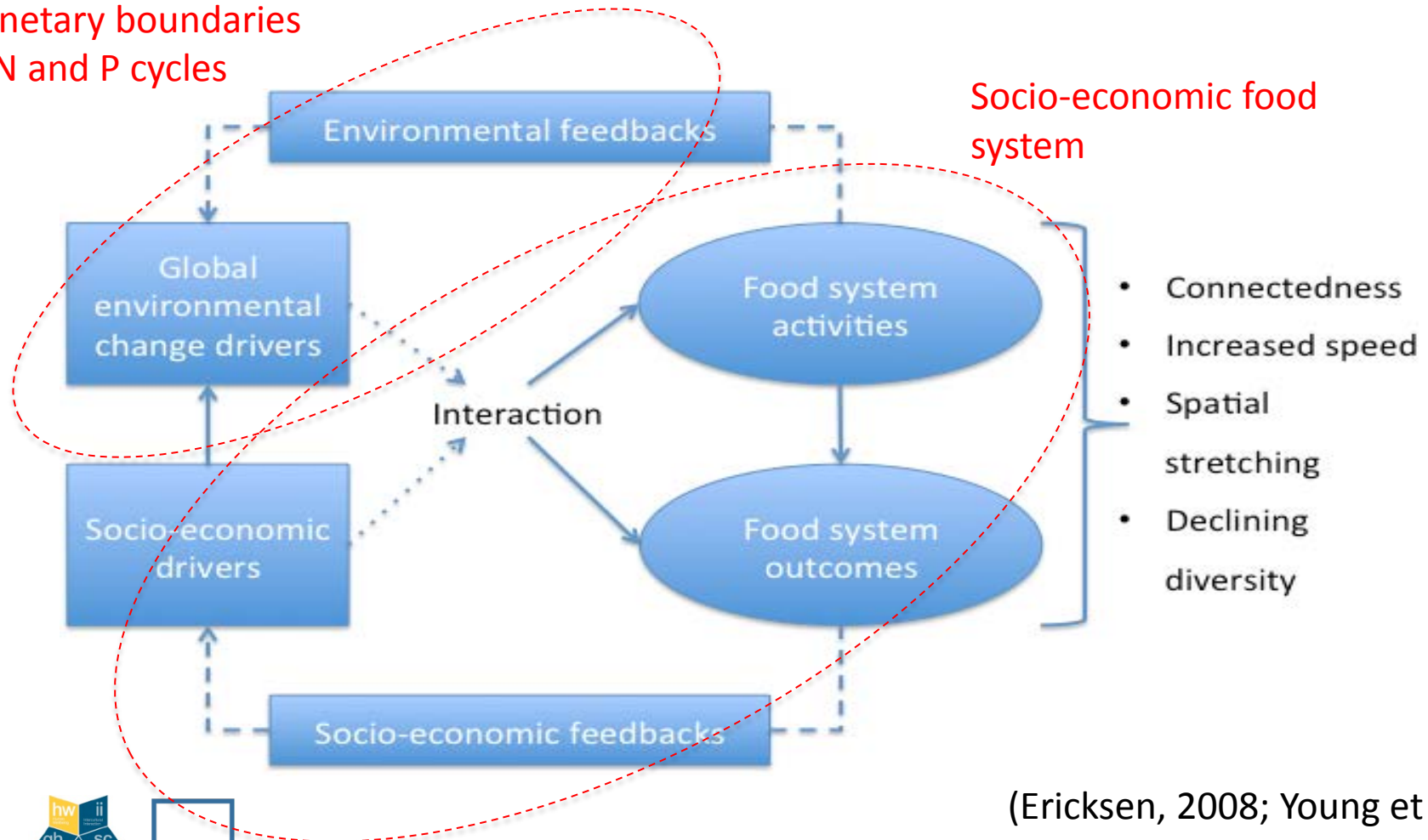
(Rockström et al.
2009; Kahiluoto et
al. 2014)

Background

- Adaptive capacity of a system is compromised as rigidity increases and resilience decreases
- Long-term risks can accumulate into crises and system collapse
- Research questions:
 1. Which socio-techno-economic processes increase complexity and reduce resilience in the food system?
 2. Which activities need to be addressed for improving adaptive capacity and food security?

Conceptual Framework - Resilience

Planetary boundaries
of N and P cycles



	Resources	Agriculture	Supply chain	Urbanization	Political Economy
Connectedness	Concentrated resource reserves and input market	Dependence on global trade of inputs and outputs; Transmission of price shocks	Global agro-food chains with private standards and regionally standardized products	Consumers' dependence on global food chains	National food systems' dependence on global trade relations; Global market of inputs and basic commodities
Speed	Increase of fertilizer use in the past 50 years	Agricultural modernization transition	Consolidation of agro-food chains	Increasing urbanization and converging high-resource consuming diets	International transmission of tariff imposition or trade restrictions
Spatial stretching	Few countries control most N and P production	Comparative advantage based on returns to capital	Standardization of supply chains and 'super-marketization'	Draw of resources globally and concentrating residues and waste streams	Global power and capitalist relations reflecting on national food systems; Growth of global corporate power
Declining diversity	Globally fertilizers' share as nutrient source has outpaced soil and manure	Typically industrial monocultures and high external input use agriculture; Product and regional specialization	Convergence of global resource-rich diets	Centralization of waste and sanitation systems	Manifestation of agricultural modernization and 'ecological' intensification
Equity	Disproportional nutrient use globally; Imbalances created by virtual nutrient trade	Squeeze of smallholder farmers; Private research and innovation	Regional inequalities between food supplies and access to food	Disconnection between resource-producing and resource-consuming areas	Influence of subsidizing in the North to global South and their food systems

Resources and Agriculture

- **Connectedness:** only 5 countries control over 50% of ammonia, urea, phosphoric acid and other fertilizer markets; transmission of price shocks
- **Speed:** dramatic increase of mineral fertilizer use in the past 50 years; significant drop in soil productivity
- **Spatial stretching:** dependence on fertilizer trade (a share of imported fertilizer nutrients over consumption): Sub-Saharan Africa 100%, West and Central Europe 79%, Latin America 74%, Oceania 64%, and North America 58%
- **Declining diversity:** in 1970s 48% of nutrients from soil, in 1990s only 30% from soil; industrial production paradigm
- **Equity:** 10% of land receives over 50% of applied nutrients; increasingly privatized agriculture research and innovation

Supply Chain and Urbanization

- **Connectedness:** consumers' dependence on global food chains with private standards
- **Speed:** only 10 global retail chains control over 60% agro-food market share, whereas only 7 agrochemical companies control over 90% of sales
- **Spatial stretching:** standardization of supply chains and 'supermarketization'; cities concentrate resource and residue streams
- **Declining diversity:** convergence of resource-rich diets globally
- **Equity:** regional inequalities between food supply and access to food; disconnection between resource-producing and resource-consuming areas

Conclusions

- Growing complexity in the food system can cause internal stress and lead to local and regional collapses
- Speed of socio-economic changes has increased in global food value chain, transmission of shocks is faster and more global
- Equity should be added to the list of resilience-threatening properties
 - Tentatively: inequality coupled to resource constraints has a greater influence on societal collapse than merely resource constraints

What to do?

- For achieving more sustainable food systems and better food security, attention should be paid:
 - Productivity per natural capital - not only per labor or per physical capital
 - Price of mineral fertilizers
 - Metabolism of cities
 - Political economy of energy-food-water nexus, including equity in access to resources
 - Consumption responsibility