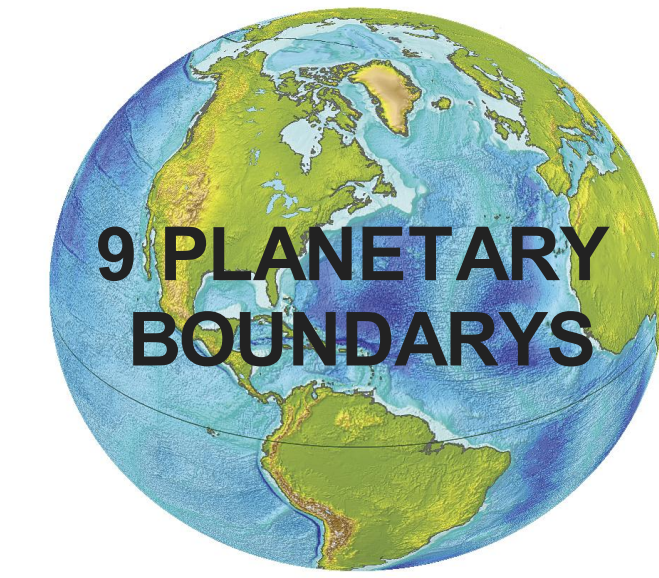


PAPER: Rockstrom et al. 2009. Planetary boundaries exploring the safe operating space for humanity. Ecology and Society 14(2)

SAFE OPERATING SPACE FOR HUMANITY TO LIVE WITHIN-STOCKHOLME RESILIENCE CENTRE

Earth's 9 BIOPHYSICAL systems which impact on each other and the ability of the planet to maintain stable conditions for life to prosper

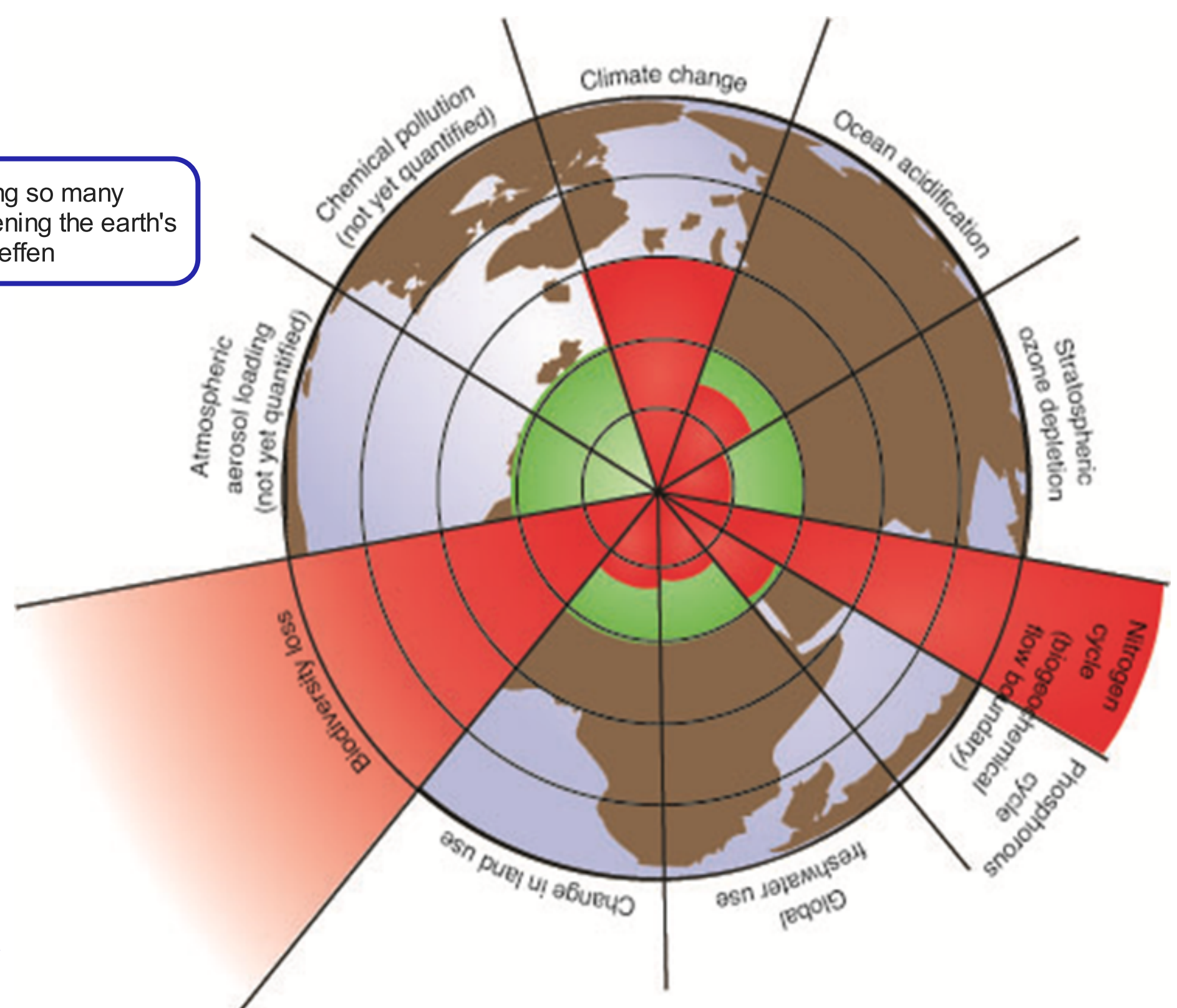
WHAT ARE THEY?



WHY HAVE WE EXCEEDED BOUNDARIES?

EVIDENCE FOR IMPORTANCE

PLANETARY RESILIENCE

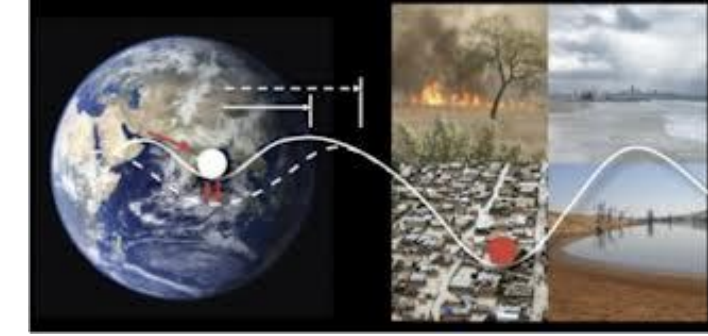
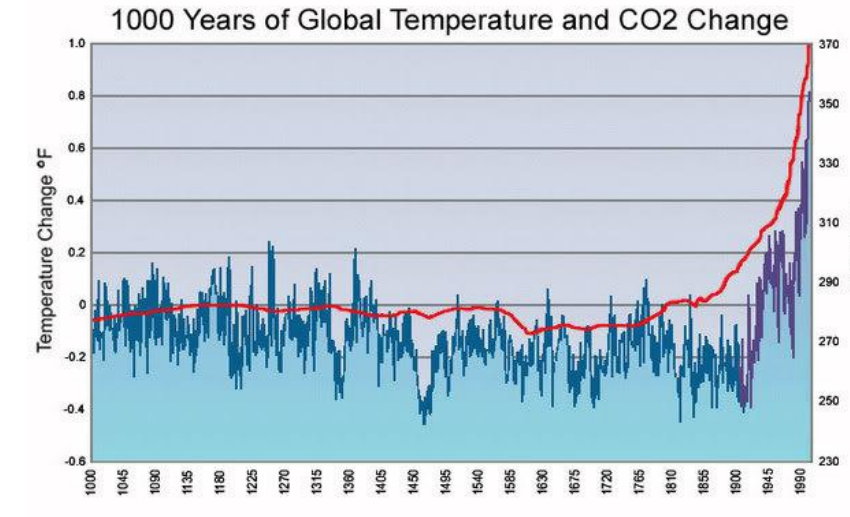


'There are so many of us using so many resources that we are threatening the earth's capacity to regulate itself.' Steffen

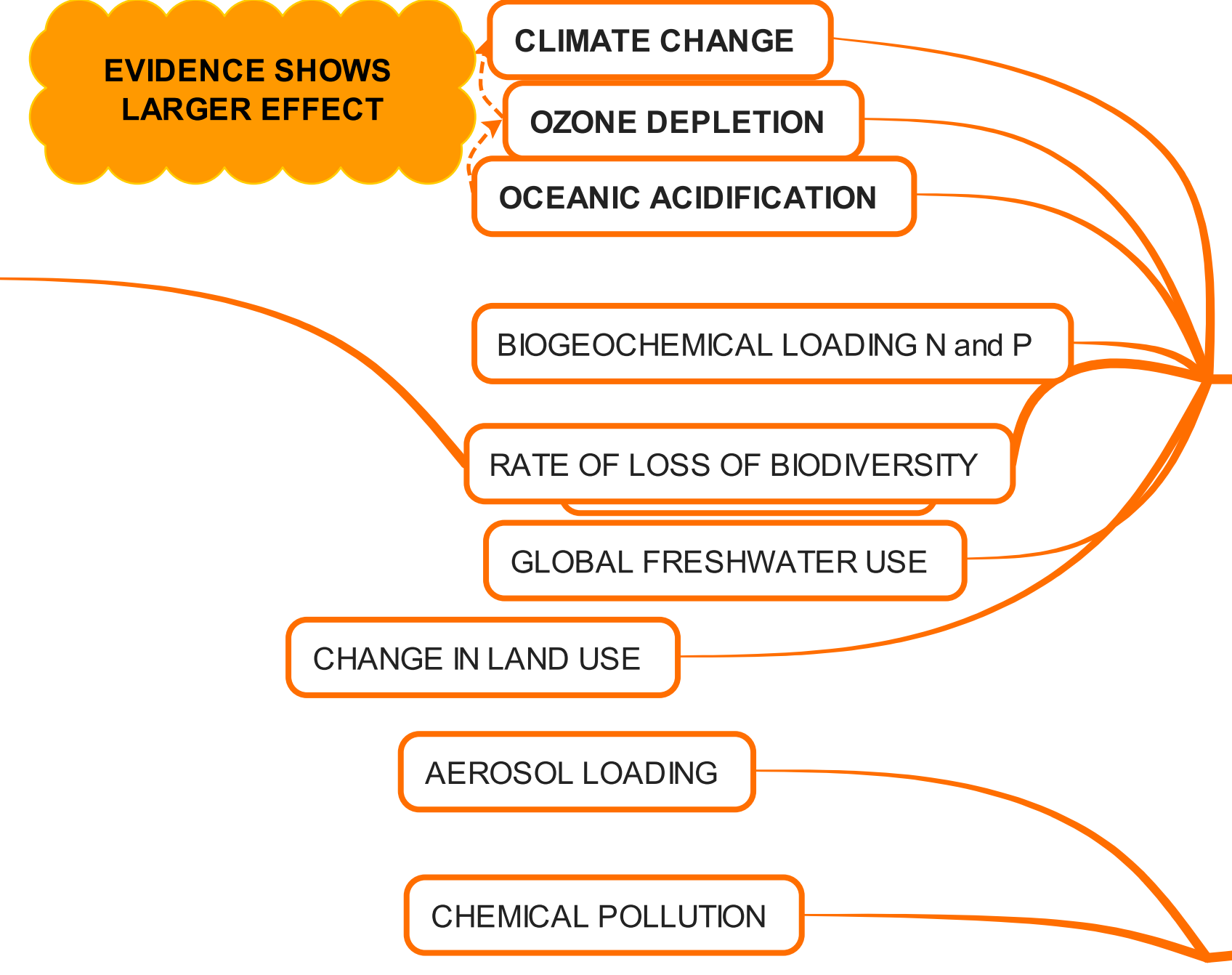
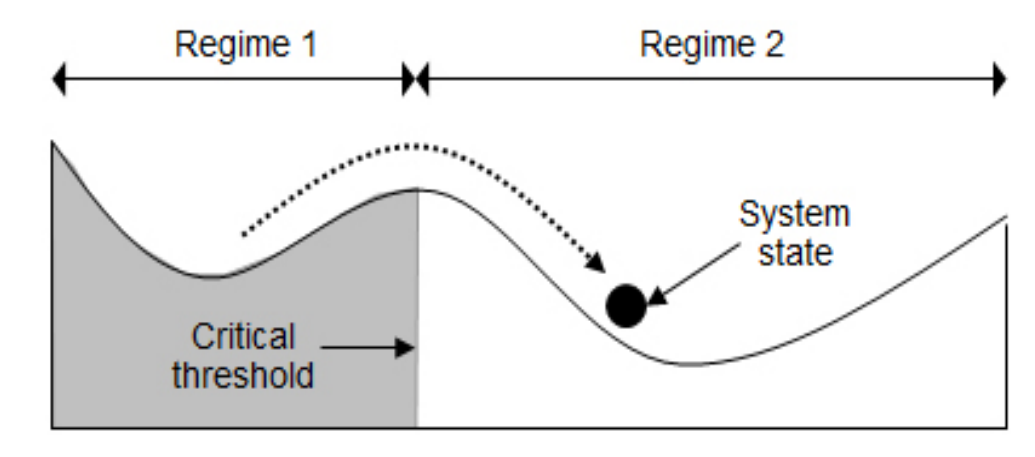
To continue to live and operate safely humanity has to stay away from critical hard wired thresholds. Rockstrom.

Human pressure on earth biophysical systems has reached a scale where abrupt global environmental change can no longer be excluded. Rockstrom.

causal loop diagram shows feedback structure of a system S Terman 2000



LINK TO PDF OF RESEARCH EVIDENCE



Earth-System Process	Parameters	Proposed Boundary	Current Status	Pre-industrial Value
Climate Change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	(ii) Change in radiative forcing (watts per meter squared)	1	1.5	0
Rate of Biodiversity Loss	Extinction Rate (number of species per million species per year)	10	>100	0.1-1
Nitrogen Cycle (part of a boundary with the phosphorus cycle)	Amount of N ₂ removed from the atmosphere for human use (million of tonnes per year)	35	121	0
Phosphorus Cycle (part of a boundary with the nitrogen cycle)	Quality of P flowing into the oceans (million of tonnes per year)	11	8.5-9.5	-1
Stratospheric Ozone Depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean Acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global Freshwater Use	Consumption of freshwater by humans (km ³ per year)	4,000	2,600	415
Change in Land Use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	To be determined		
Chemical Pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals, and nuclear waste in, the global environment or the effects on the ecosystem and functioning of Earth system thereof	To be determined		

ball and cup model

the ability of the planet to deal with change

not linear reactions

Only so much resilience before a tipping point is reached

ecosystems get locked into undesired states

milenium ecosystem assessment

