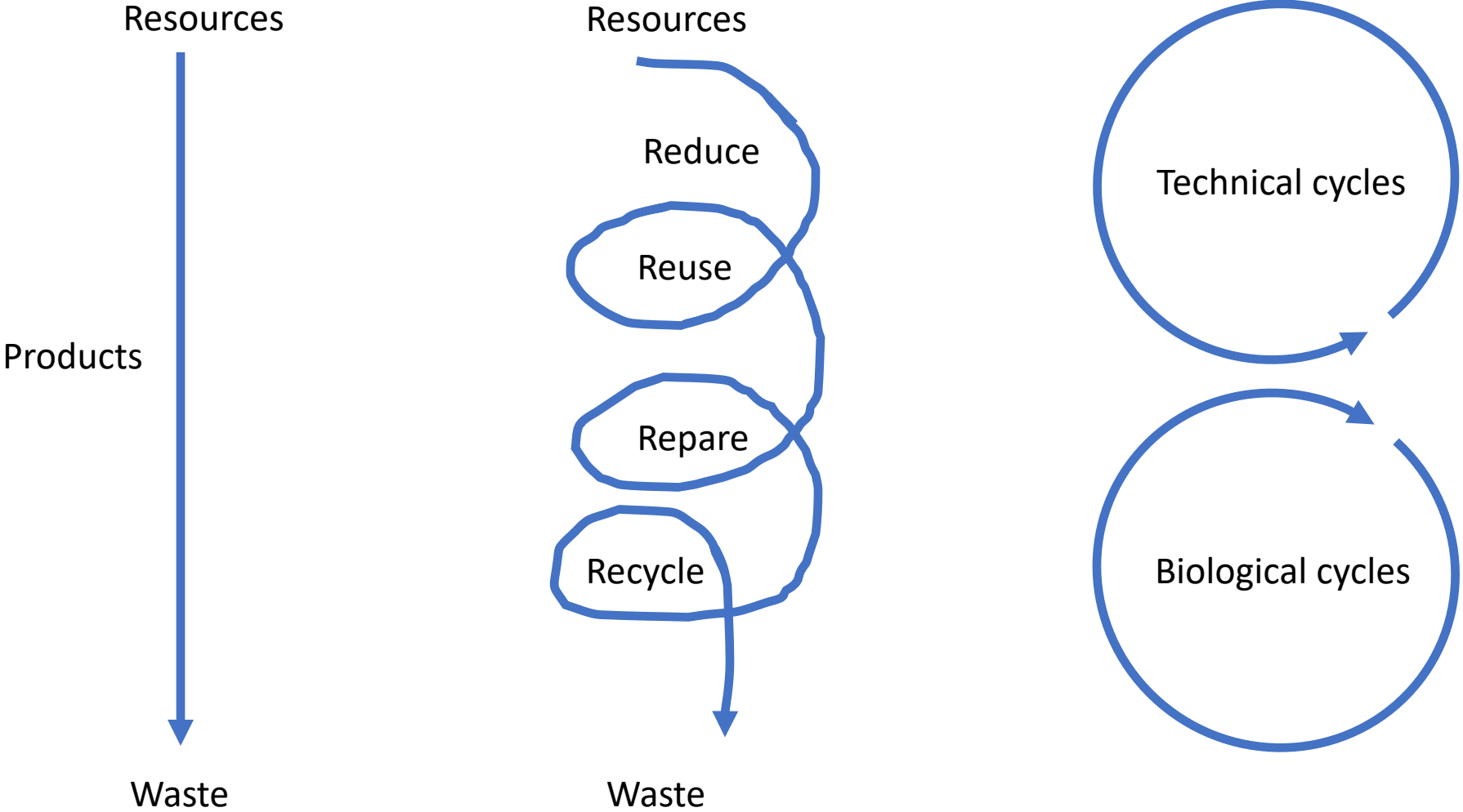




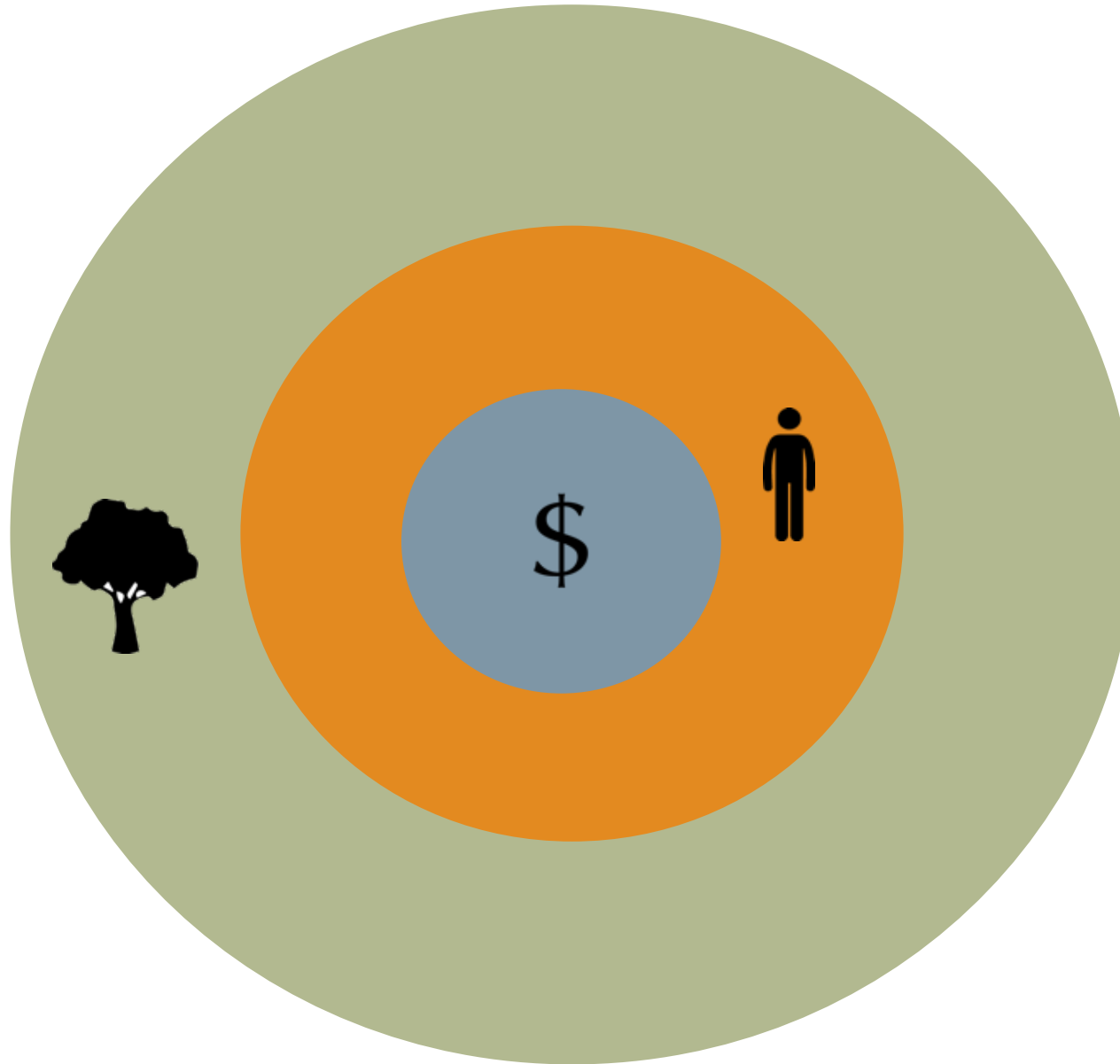
# A resilience perspective on sustainability transformations

Lisen Schultz, Jan 4, 2021

# From linear to circular economy

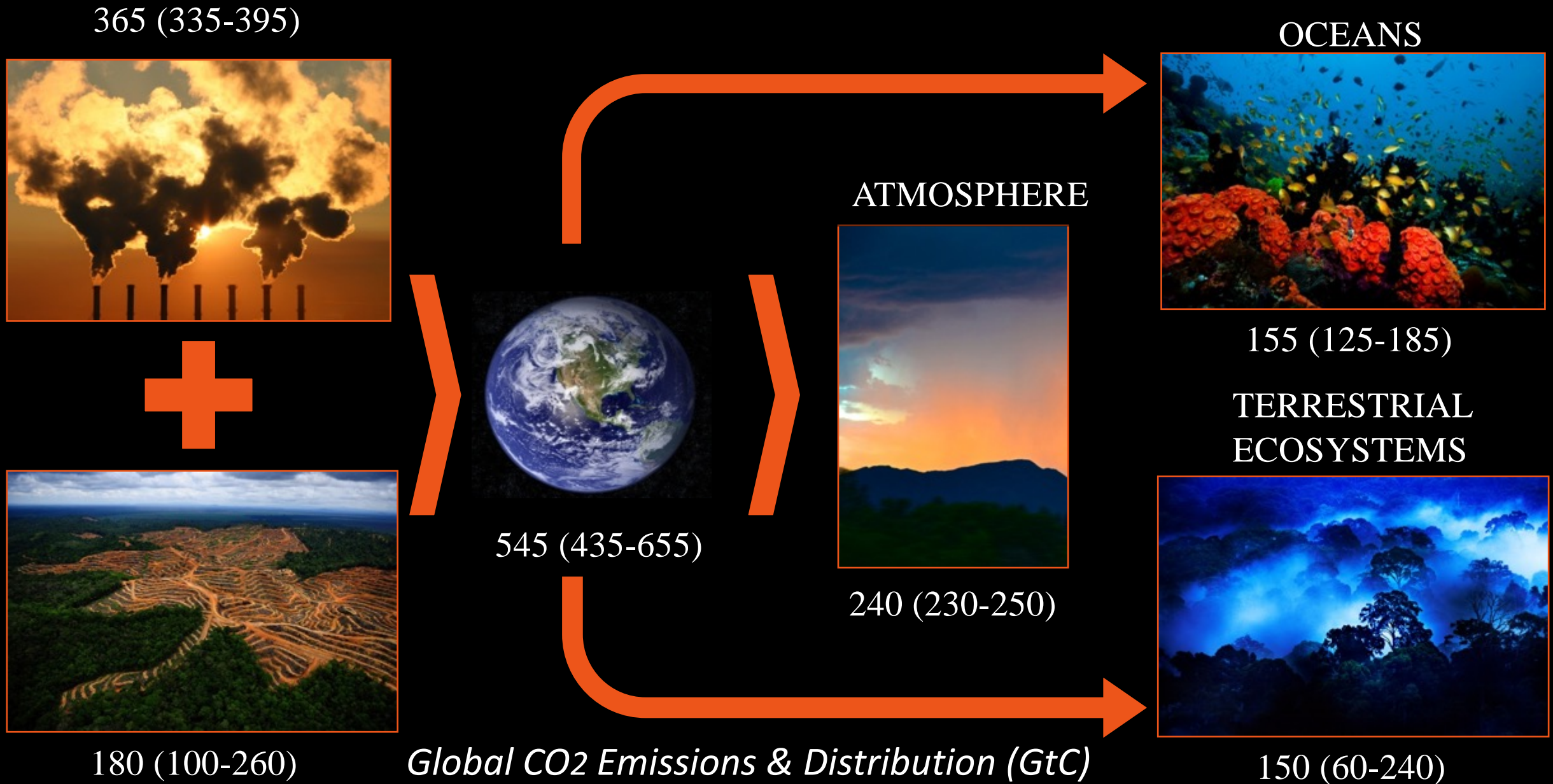


# Our industrial systems are embedded in the biosphere



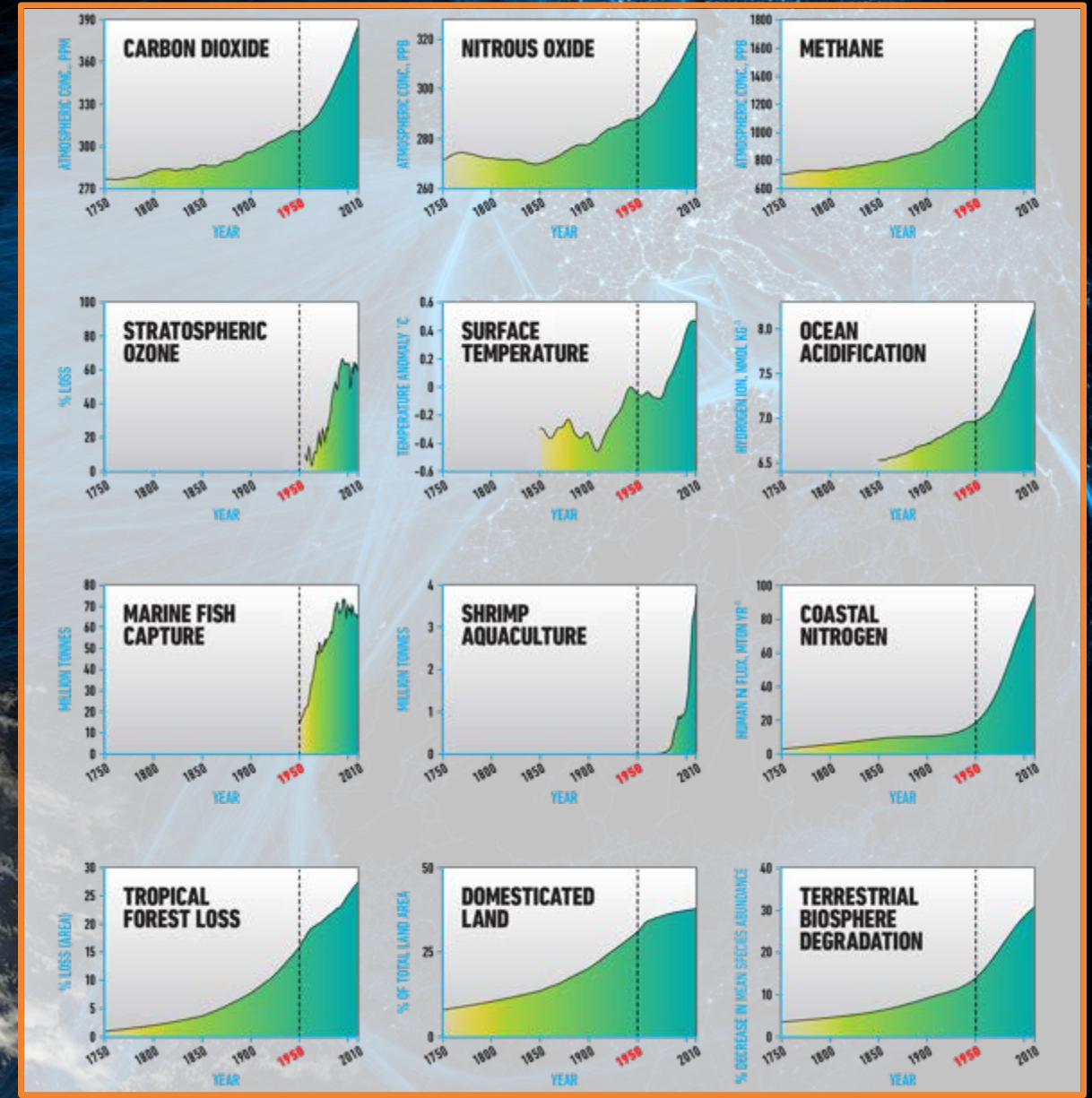
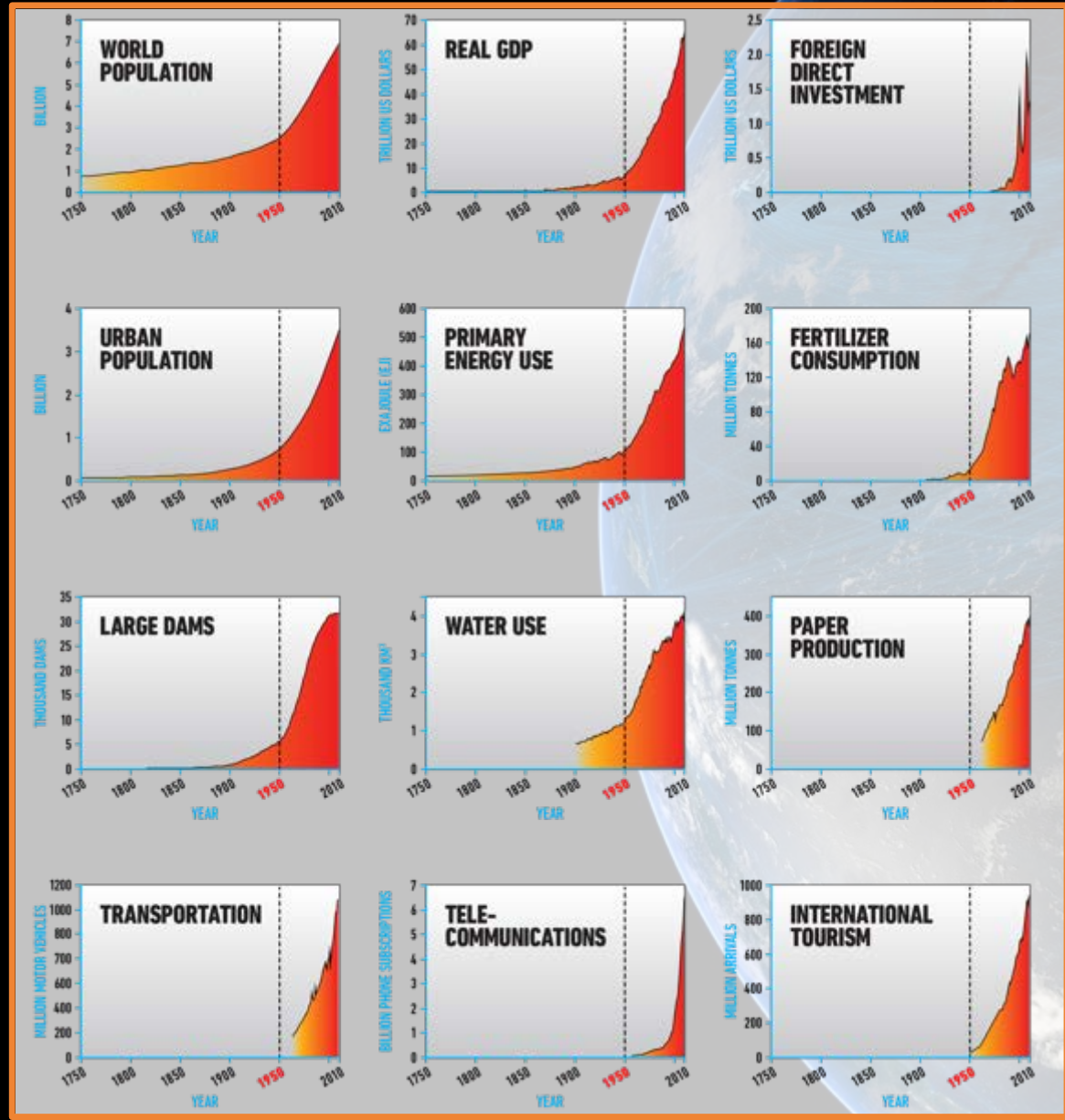
# The largest ecosystem service? Carbon storage

*Global carbon project*



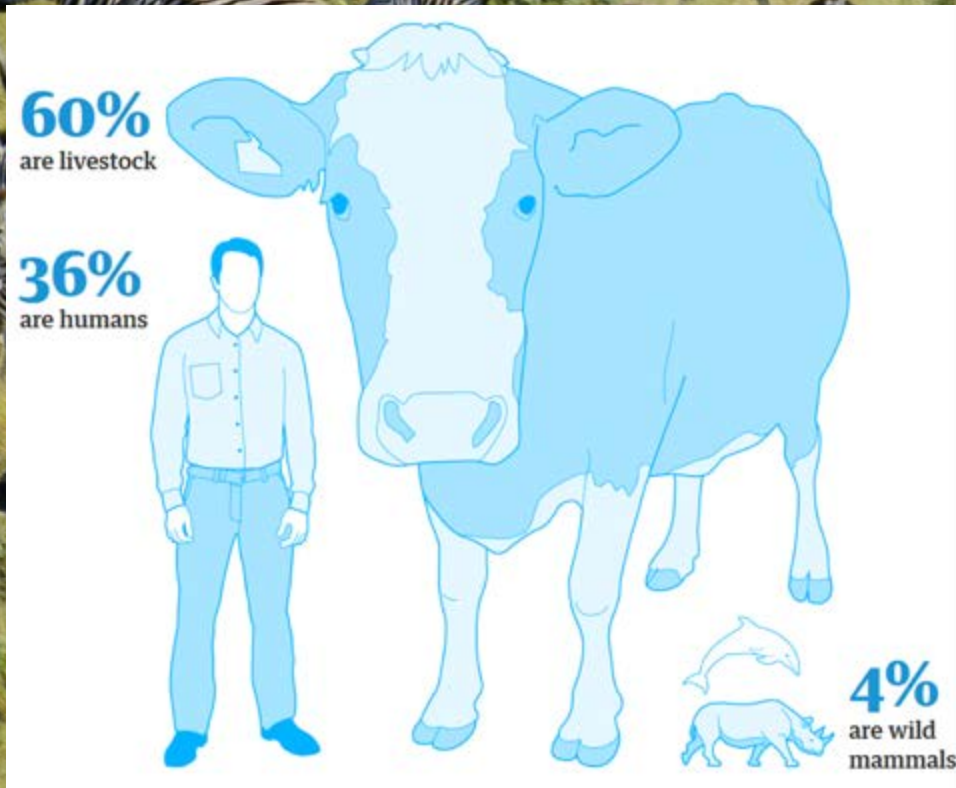


# People shape the biosphere – the Great Acceleration





# Human total biomass ten times bigger than wild mammals'





THE NEXT GOLDEN STATE: A 16-PAGE SPECIAL REPORT ON AUSTRALIA

The  
Economist

MAY 28TH-JUNE 3RD 2011

Economist.com

Obama, Bibi and peace  
Huntsman blows his horn  
A soft landing for China  
The costly war on cancer  
How the brain drain reduces poverty

Welcome to the Anthropocene



Geology's new age

**“Humans have changed the way the world works. Now they have to change the way they think about it, too”**

# A resilience perspective on sustainable development

Humanity depends on and shapes the biosphere – focus on intertwined **social-ecological systems**

SES are **complex** and **adaptive** – acknowledge **tipping points, uncertainty, change**

SES are nested across **scales** – **concerted action** from the **local** to the **global** is necessary



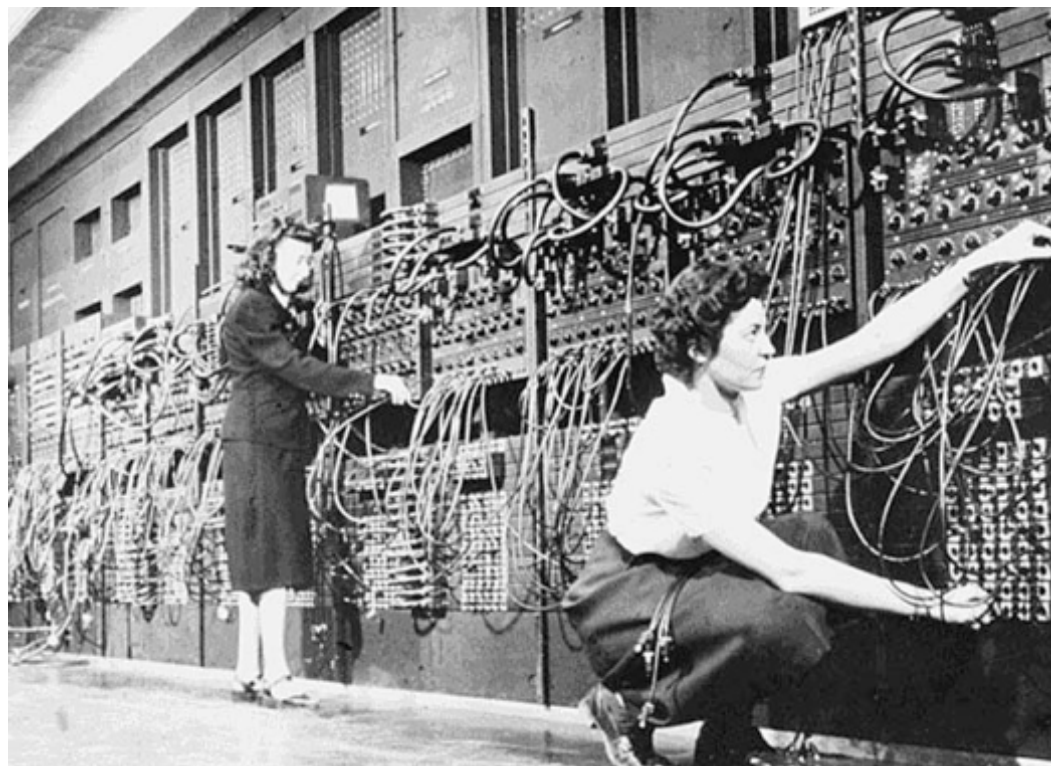
# Complex adaptive systems, more than just complicated systems

- Independent interacting components
- Selection process that acts on components and interactions
- Variation and novelty added over time

Sum of components greater than just pieces together – **Emergence**

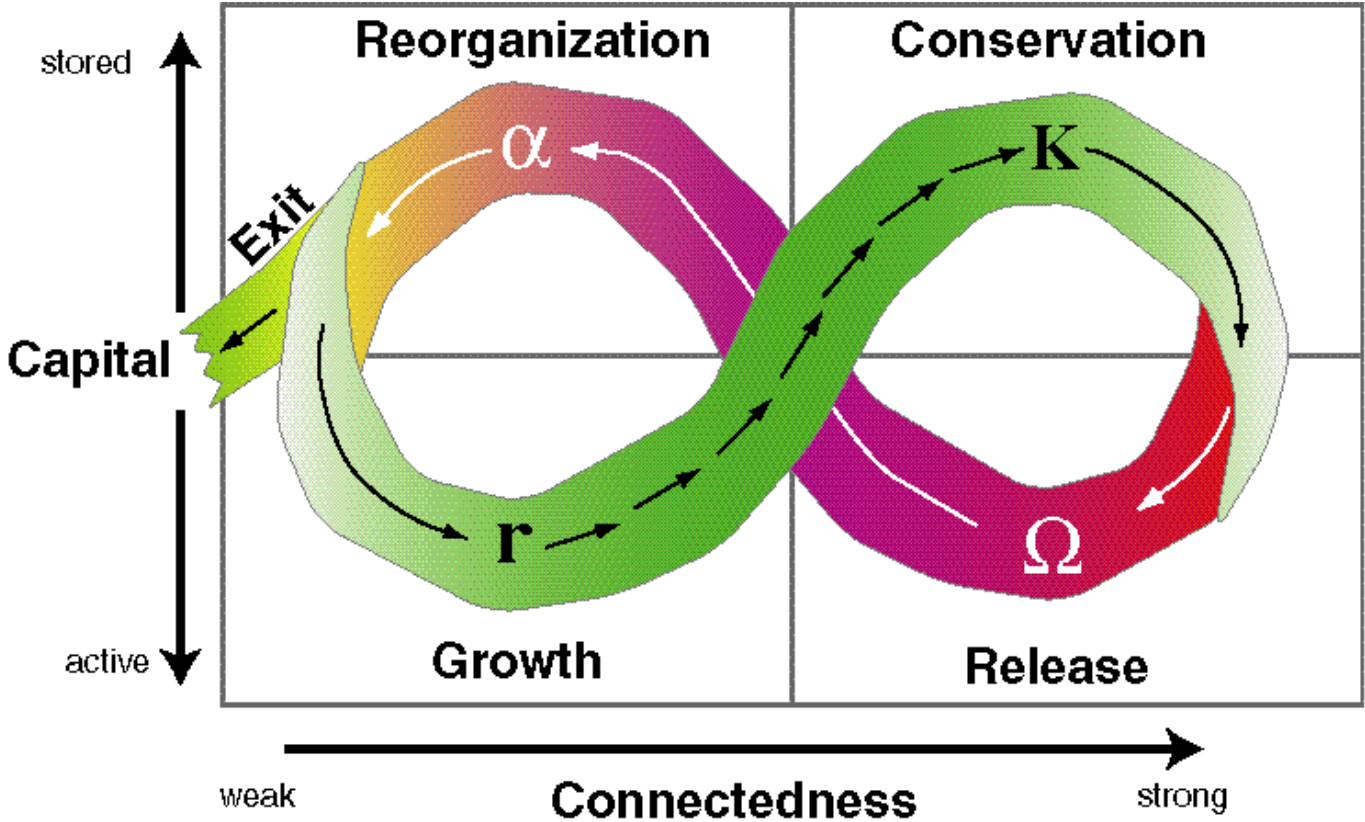
**Self-organization** – No one in control

**Change is unpredictable**, often non linear



*Electronic Numerical Integrator and Calculator (ENIAC)*

# The adaptive cycle of all living systems



(Holling 1986)



# Regime shifts in ecosystems



Coral reef



Grassland



Tropical forests

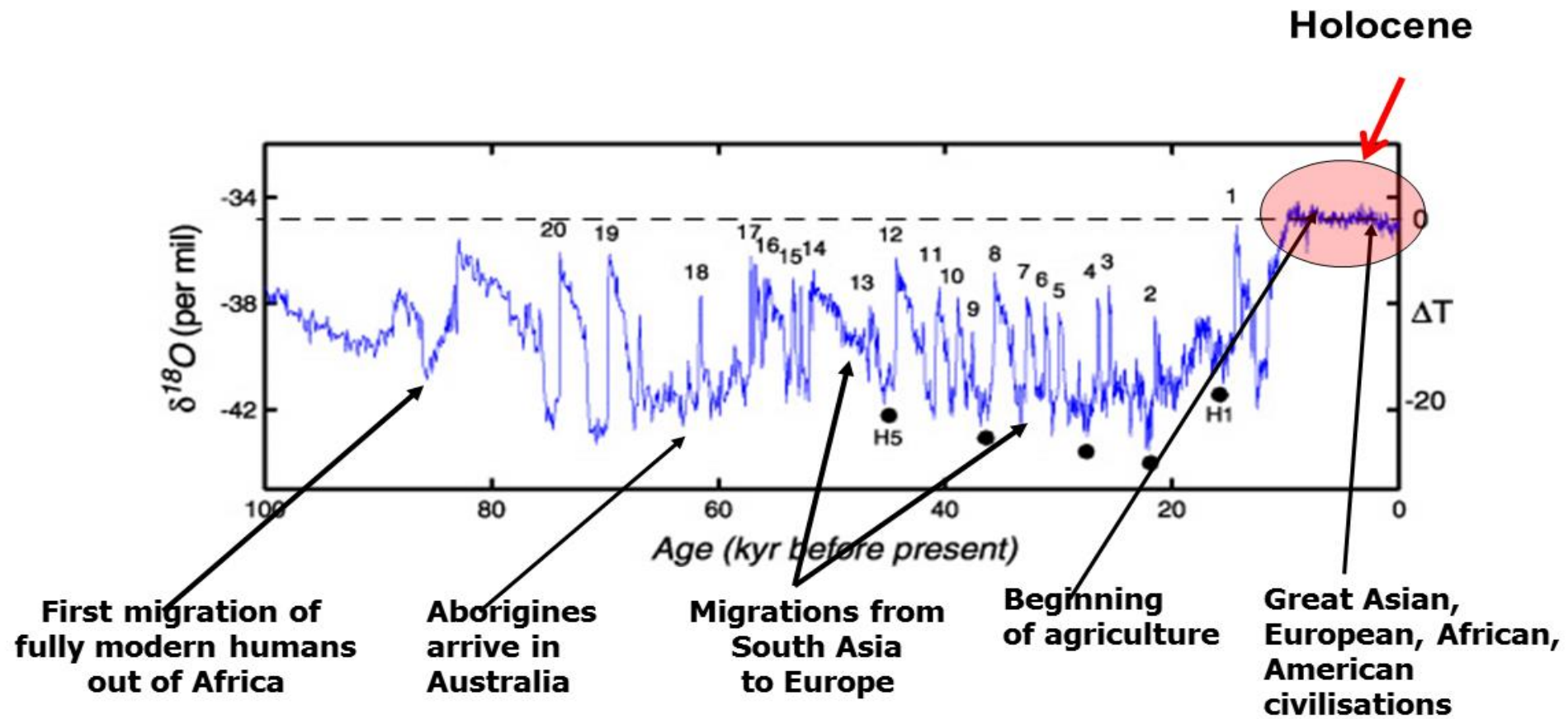
# Resilience in a nutshell

- Resilience is the capacity to deal with change and continue to develop – turning crisis into opportunity
- Involves persistence, adaptation and transformation
- Specific resilience: resilience of a particular aspect to a particular disturbance
- General resilience: dealing with the unexpected





# Earth system resilience



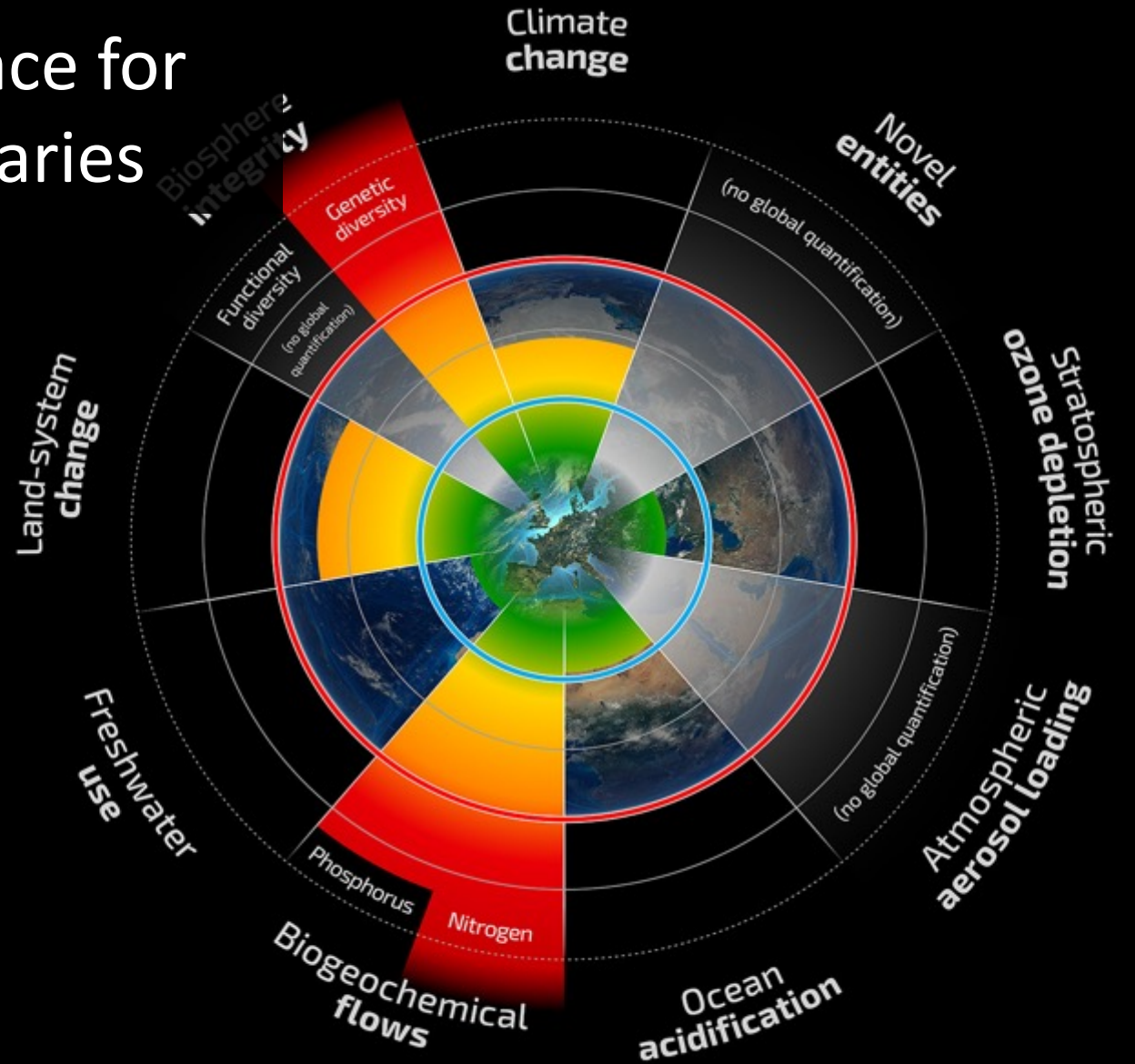
Source: GRIP ice core data (Greenland) and S. Oppenheimer, "Out of Eden", 2004

# Defining a safe operating space for humanity – planetary boundaries

Safe Operating Space

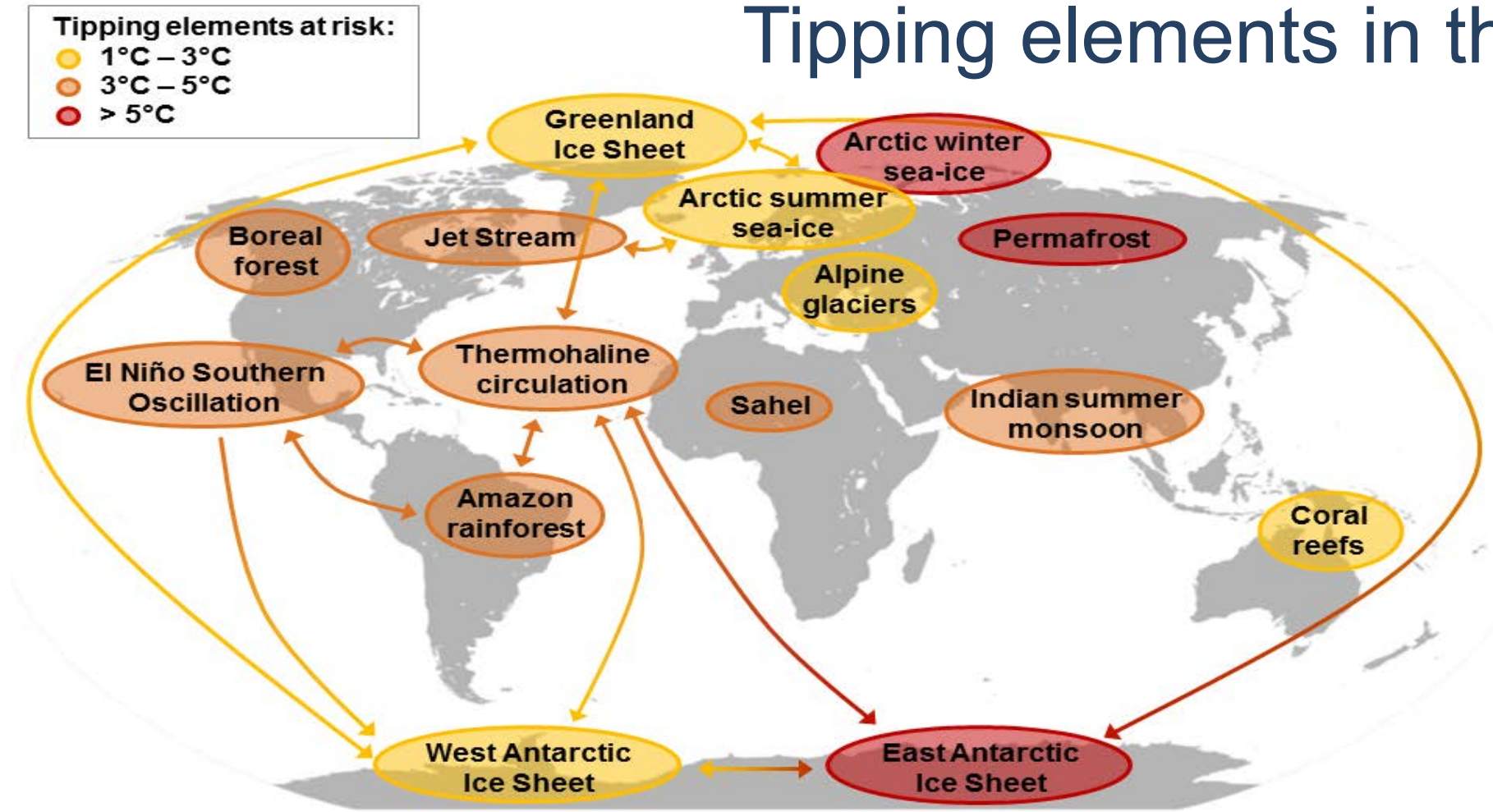
Zone of uncertainty

High risk





# Tipping elements in the Earth system



## Trajectories of the Earth System in the Anthropocene

Will Steffen<sup>a,b,1</sup>, Johan Rockström<sup>a</sup>, Katherine Richardson<sup>c</sup>, Timothy M. Lenton<sup>d</sup>, Carl Folke<sup>a,e</sup>, Diana Liverman<sup>f</sup>, Colin P. Summerhayes<sup>g</sup>, Anthony D. Barnosky<sup>h</sup>, Sarah E. Cornell<sup>i</sup>, Michel Crucifix<sup>j,i</sup>, Jonathan F. Donges<sup>a,k</sup>, Ingo Fetzer<sup>a</sup>, Steven J. Lade<sup>a,b</sup>, Marten Scheffer<sup>l</sup>, Ricarda Winkelmann<sup>k,m</sup>, and Hans Joachim Schellnhuber<sup>a,k,m,1</sup>

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved July 6, 2018 (received for review June 19, 2018)

# A resilience perspective on sustainable development

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# Principles for Building Resilience

Sustaining ecosystem services in social-ecological systems



CAMBRIDGE

**Reinette (Oonsie) Biggs, Maja Schlüter, Michael Schoon (Eds)**

Erin Bohensky, Georgina Cundill, Vasilis Dakos, Karen Kotschy, Anne Leitch, Allyson Quinlan, Marty Anderies, Derek Armitage, Jacopo Baggio, Elena Bennett, Duan Biggs, Örjan Bodin, Katrina Brown, Shauna BurnSilver, Tim Daw, Nathan Engle, Louisa Evans, Christo Fabricius, Carl Folke, Victor Galaz, Line Gordon, Chanda Meek, Garry Peterson, Ciara Raudsepp-Hearne, Martin Robards, Lisen Schultz, Brian Walker, Paul West

# Identified 7 principles

1. Maintain diversity & redundancy
2. Manage connectivity
3. Manage slow variables and feedbacks
4. Foster complex adaptive systems thinking
5. Encourage learning
6. Broaden participation
7. Promote polycentric governance systems





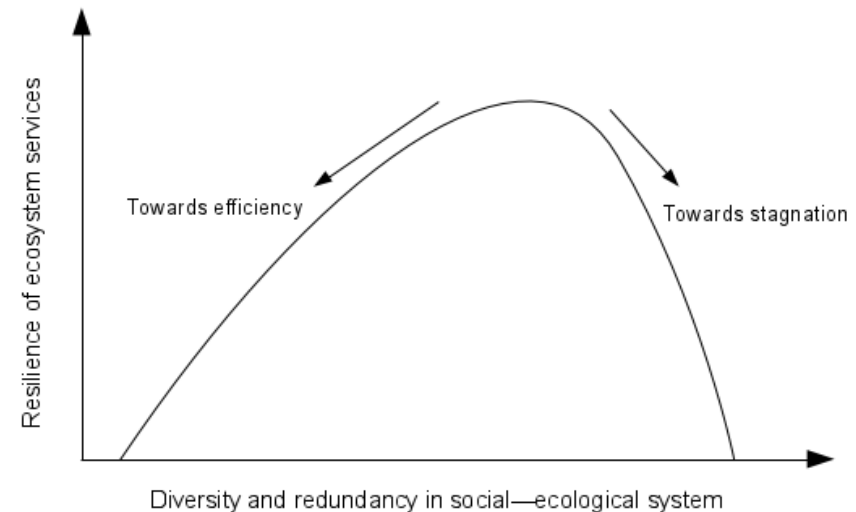
# P1 – Maintain Diversity and Redundancy

**Response diversity:** SES elements (species, landscapes, actors, institutions) that respond differently to disturbance and change

**Functional redundancy:** System elements that can functionally compensate for one another

## Take home messages

- Response diversity *in combination with* functional redundancy provides options to maintain ES in the face of disturbance, and adapt ES in the face of slower ongoing change
- More diversity is not always better – can increase SES complexity and reduce potential for adaptation to slower ongoing change

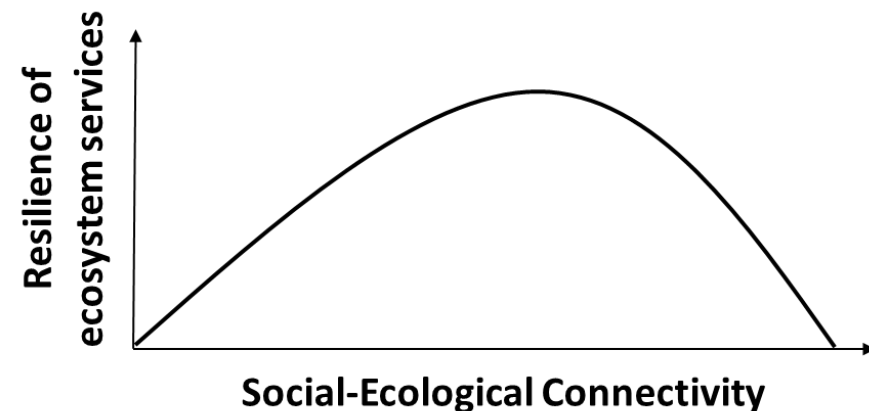


## P2 – Manage connectivity

*Connectivity*: The way and degree to which resources, species and people interact, migrate or disperse in a social-ecological system

### Take home messages

- Increased connectivity can enhance resilience by providing links to sources of recovery after a disturbance or providing new information and building trust in social networks.
- However, if connectivity is too high a localized disturbance can spread throughout the system or knowledge can become overly homogenized.





# P5 – Encourage Learning

*Learning:* Acquiring new information, skills or understanding, individually or collectively, at different levels

## Take home messages

- Learning through experimentation and monitoring as well as co-production and collaboration is essential to enable adaptation in response to changes in SES and ES
- Learning at societal levels requires trust and appropriate relationships and institutions to flourish.
- What types of learning are most appropriate under different conditions is currently unclear and requires further research

# P6 – Broaden participation

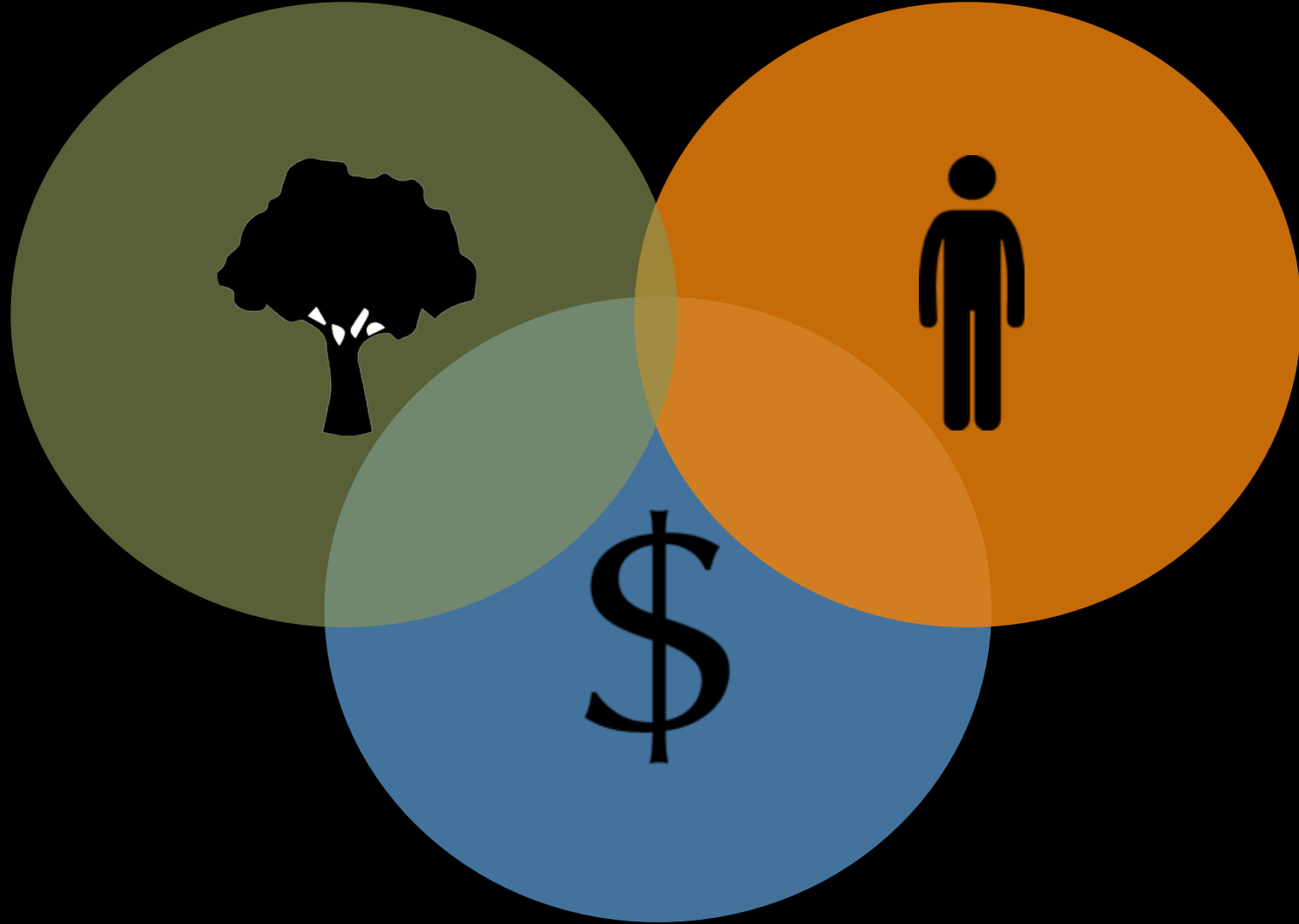
*Participation:* The active engagement of relevant stakeholders in the management and governance process

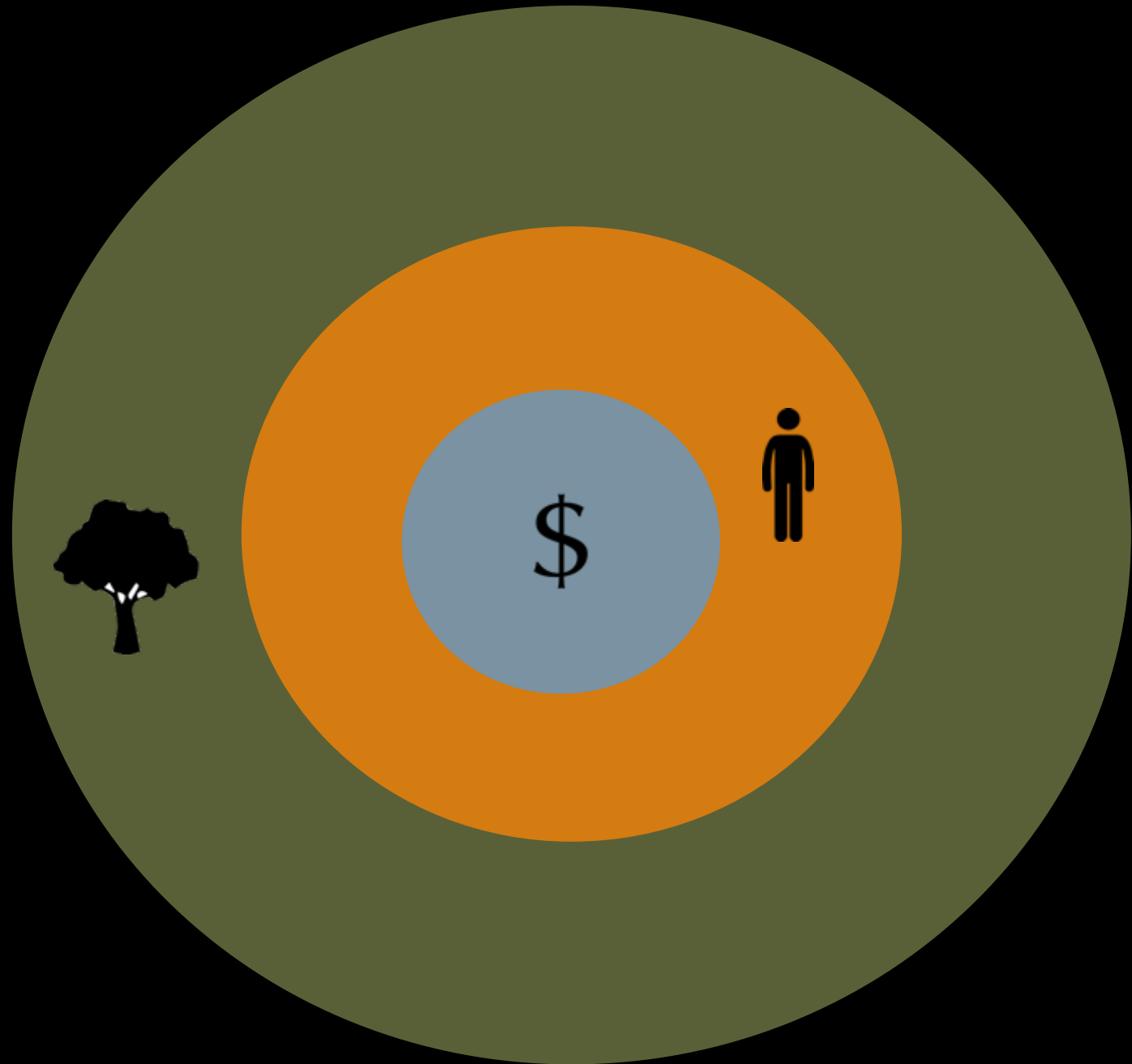
## Take home messages

- Participation is important for building trust and relationships, and facilitating the learning and collective action needed to respond to change and disturbance in SES.
- However, a nuanced understanding is needed of who participates, under which conditions participation is appropriate, and how participation takes place.











Azote, Stockholm Resilience Centre





Thank you!