

General overview about the planetary boundary concept and its recent update

PD Dr. **Dieter Gerten**

Research Domain of Earth System Analysis
Potsdam Institute for Climate Impact Research

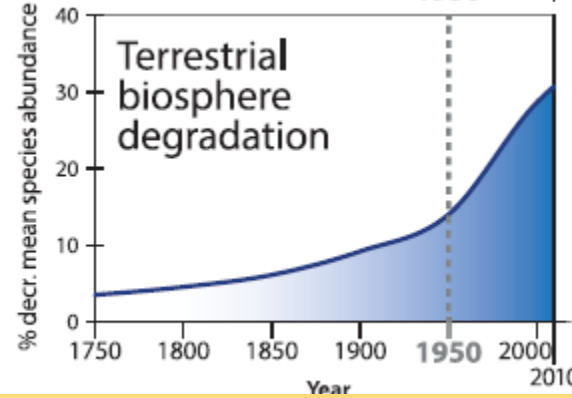
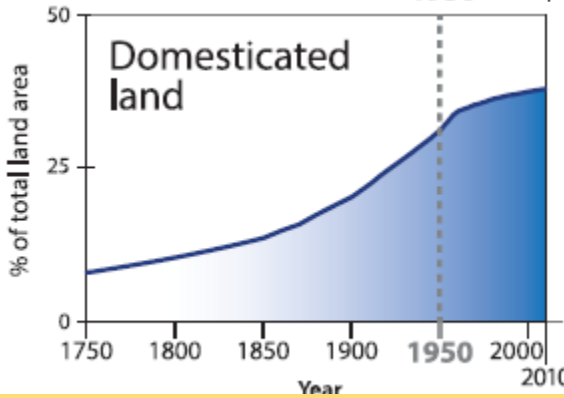
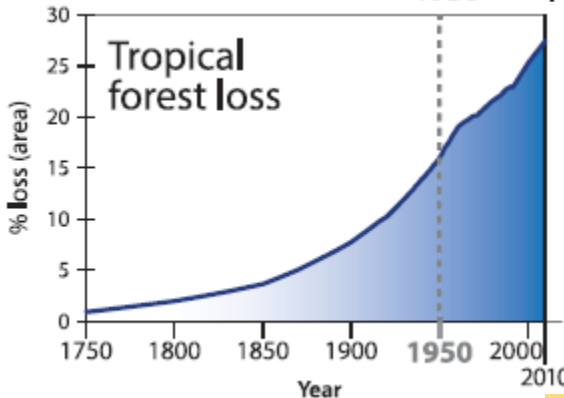
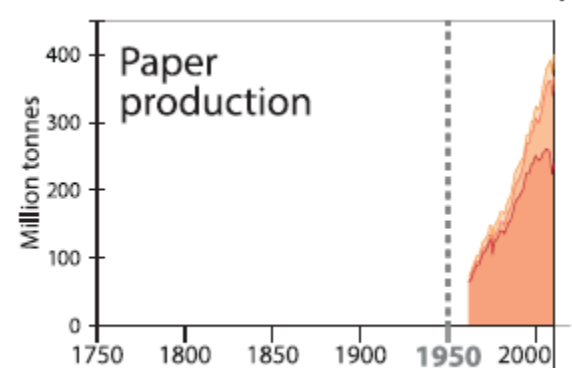
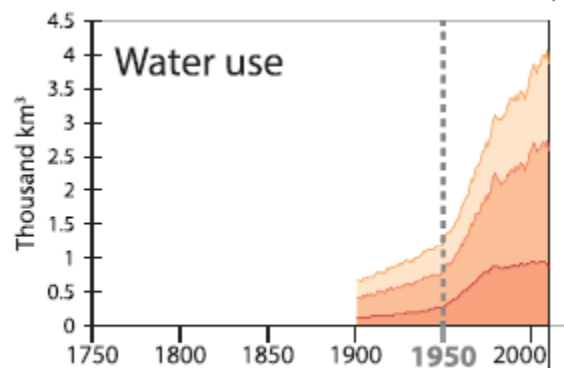
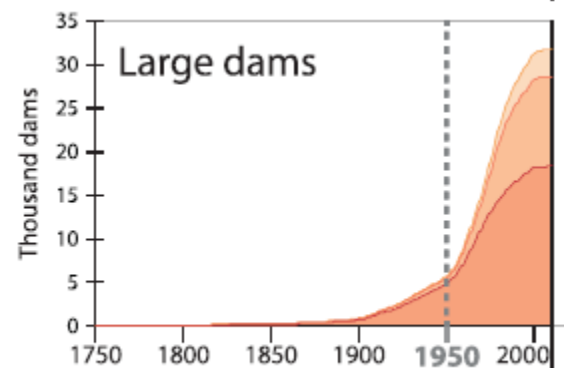
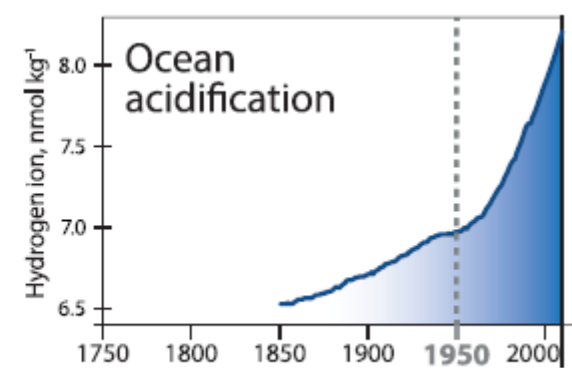
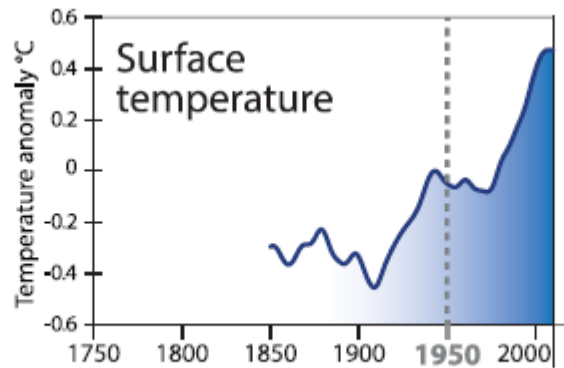
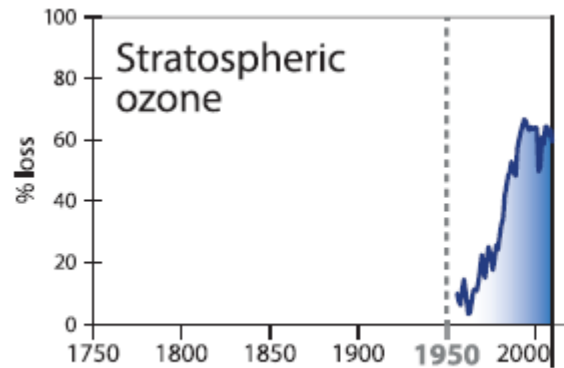
Potsdam, Germany

gerten@pik-potsdam.de



Features of the Anthropocene

Recent update by Steffen et al. 2015

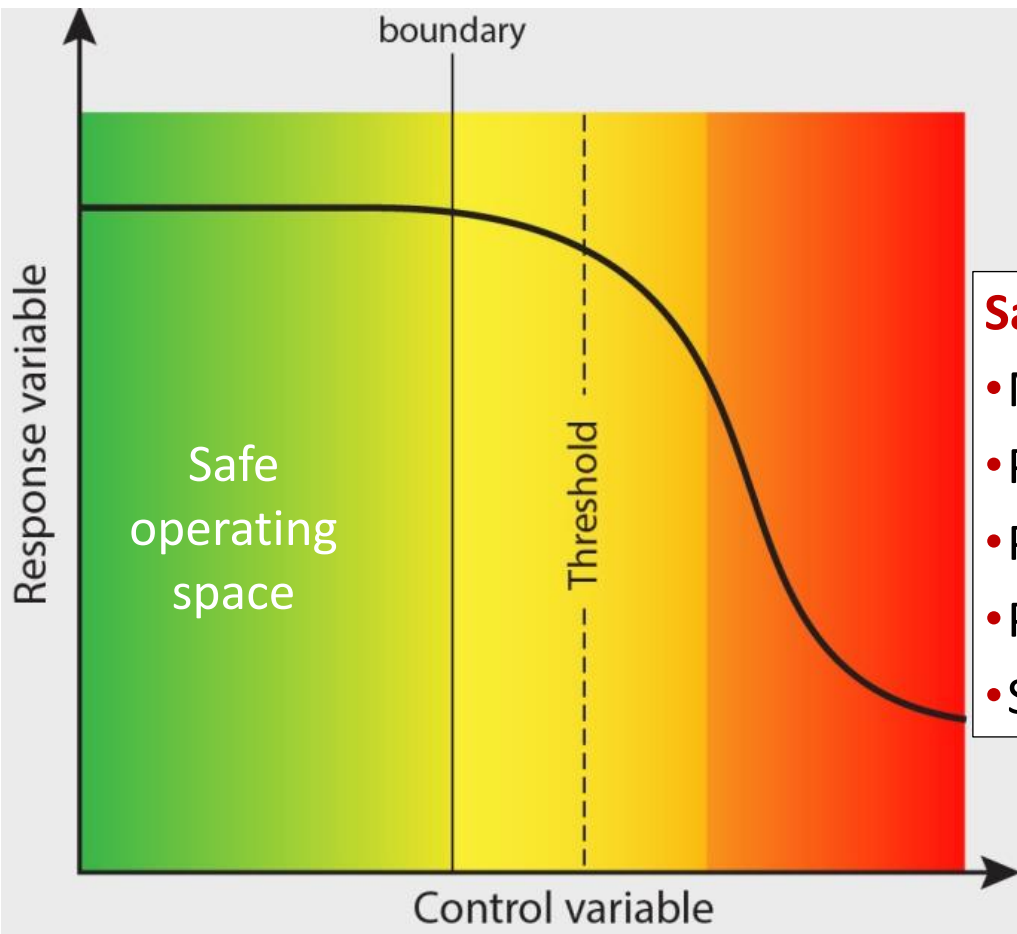


→ Where to put a cap on these developments?

The concept of „planetary boundaries“ (PBs)

- For **nine** interacting earth system processes **PBs** were identified, demarcating the **Holocene state** of the Earth system:
 - Climate change | Stratospheric ozone depletion | Atmospheric aerosol loading
 - Ocean acidification | Biogeochemical flows | Chemical pollution
 - Land use change | Biodiversity loss | Freshwater use
- Holocene is regarded as a **safe operating space** within which human civilization could develop and which therefore should not be left
- PBs point to the risks of leaving the safe space, applying the **precautionary principle** (normative)

The concept of the „safe operating space“



Safe distance needed:

- Minimise risk of disastrous development
- Position of critical thresholds unknown
- Positive feedbacks may occur
- Processes with long time lags
- Societies unprepared, reacting with delay

Safe operating space

Zone of uncertainty: Increasing risk of impacts

Dangerous level: High risk of serious impacts

Original and updated PB definition and status

Rockström et al. 2009, *Nature*

Steffen et al. 2015, *Science*

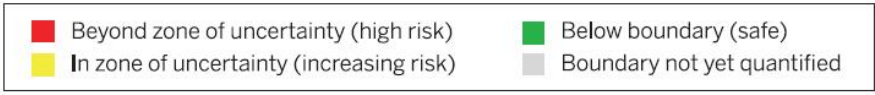
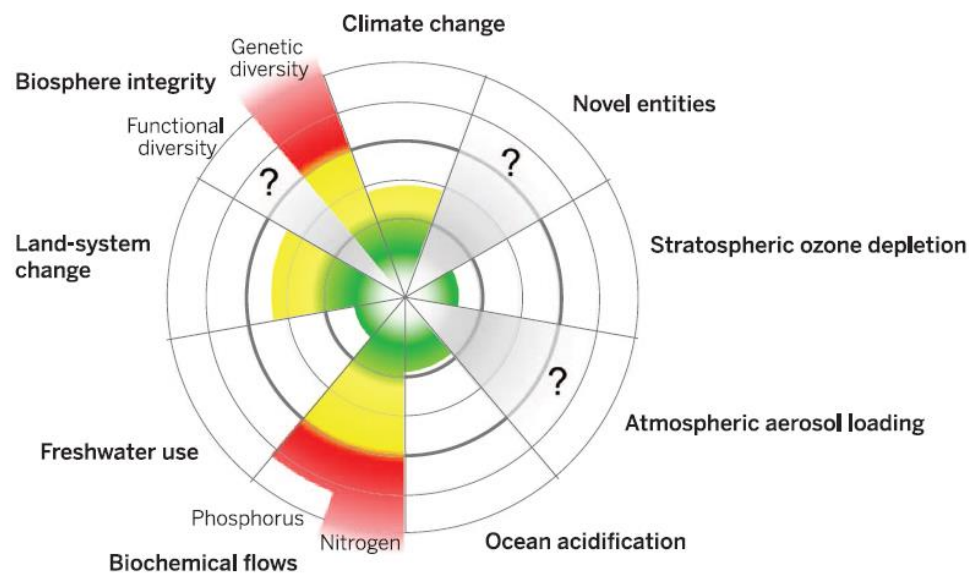
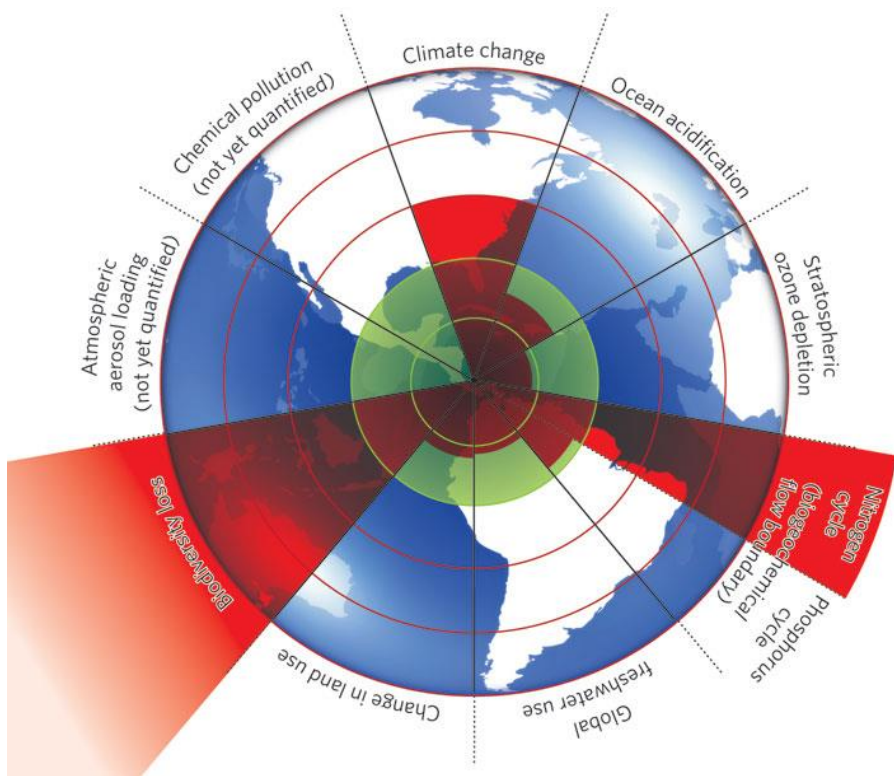
FEATURE

RESEARCH ARTICLE

SUSTAINABILITY

A safe operating space for humanity

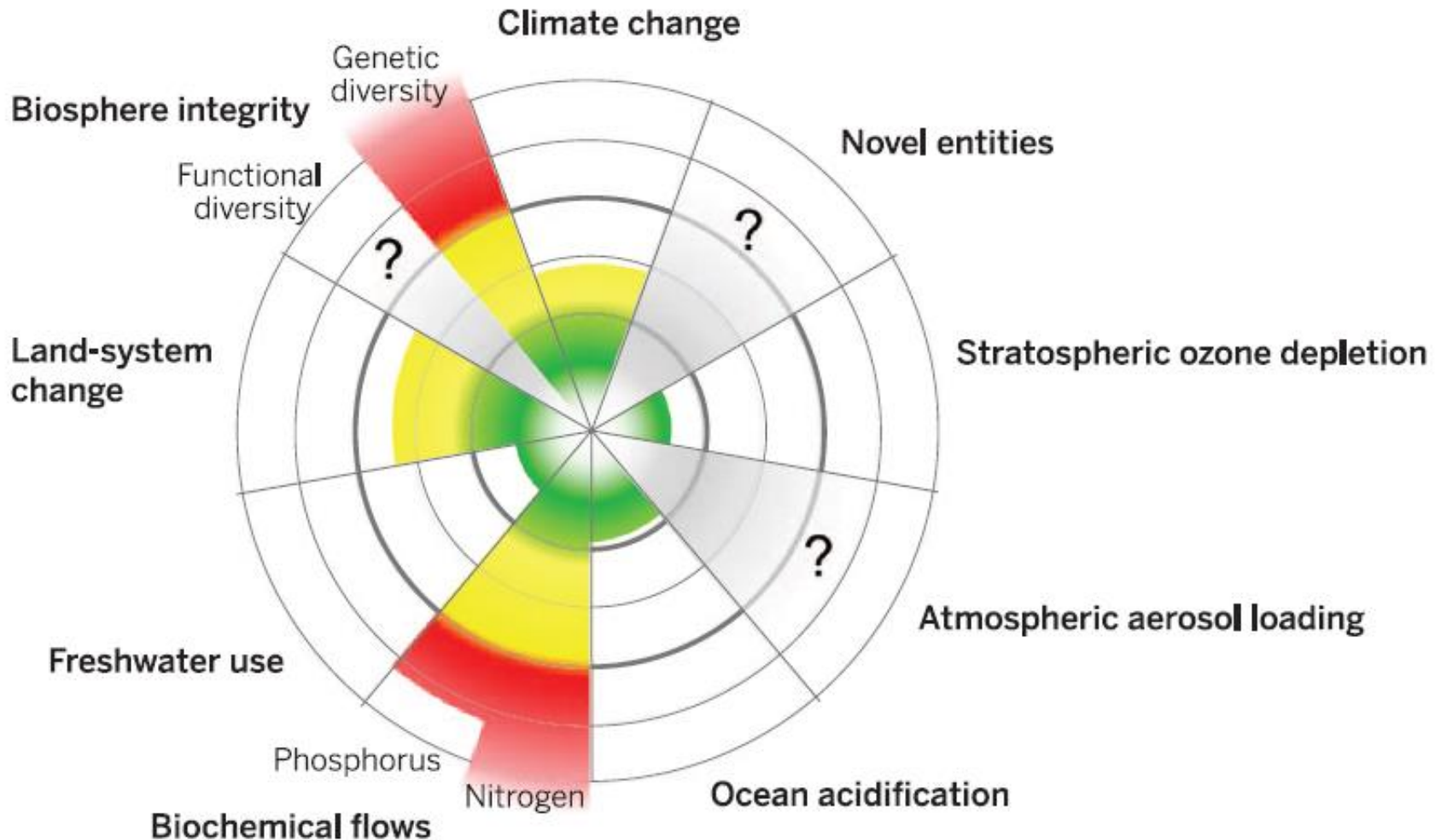
Planetary boundaries: Guiding human development on a changing planet



What's new?

- Definitions **revised** and uncertainties reduced based on new science
- Initial **downscaling**, i.e. spatial mapping of some PBs
→ regional boundaries
- Stronger **emphasis on risk**-based approach
- **Four** (not three) PBs **transgressed** already

Four PBs transgressed already



■ Beyond zone of uncertainty (high risk)
■ In zone of uncertainty (increasing risk)

■ Below boundary (safe)
■ Boundary not yet quantified

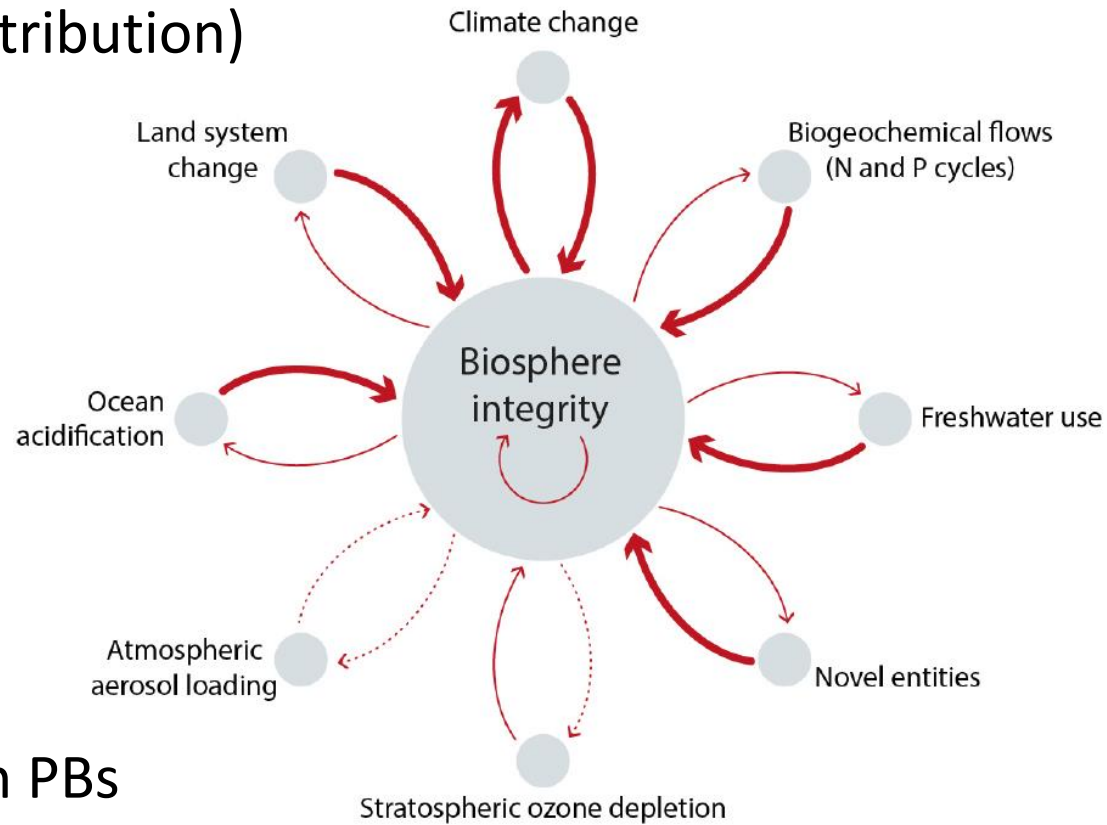
Four PBs already transgressed

Earth system process (<i>and control variable</i>)	PB (\pm uncertainty)	Current status
Climate change (<i>atm. CO₂ concentration</i>)	350(-450) ppm	399 ppm
Change in biosphere integrity (<i>extinction rate</i>)	<10(-100) E/MSY	100-1000 E/MSY
Land-system change (<i>fraction of original forest land</i>)	75(-54)%	62%
Biogeochemical flows (<i>P flow into oceans, intentional N fixation</i>)	11(-100) Tg P yr ⁻¹ 62(-82) Tg N yr ⁻¹	22 Tg P yr⁻¹ 150 Tg N yr⁻¹

+ Widespread transgression of **regional boundaries** (e.g. freshwater use)

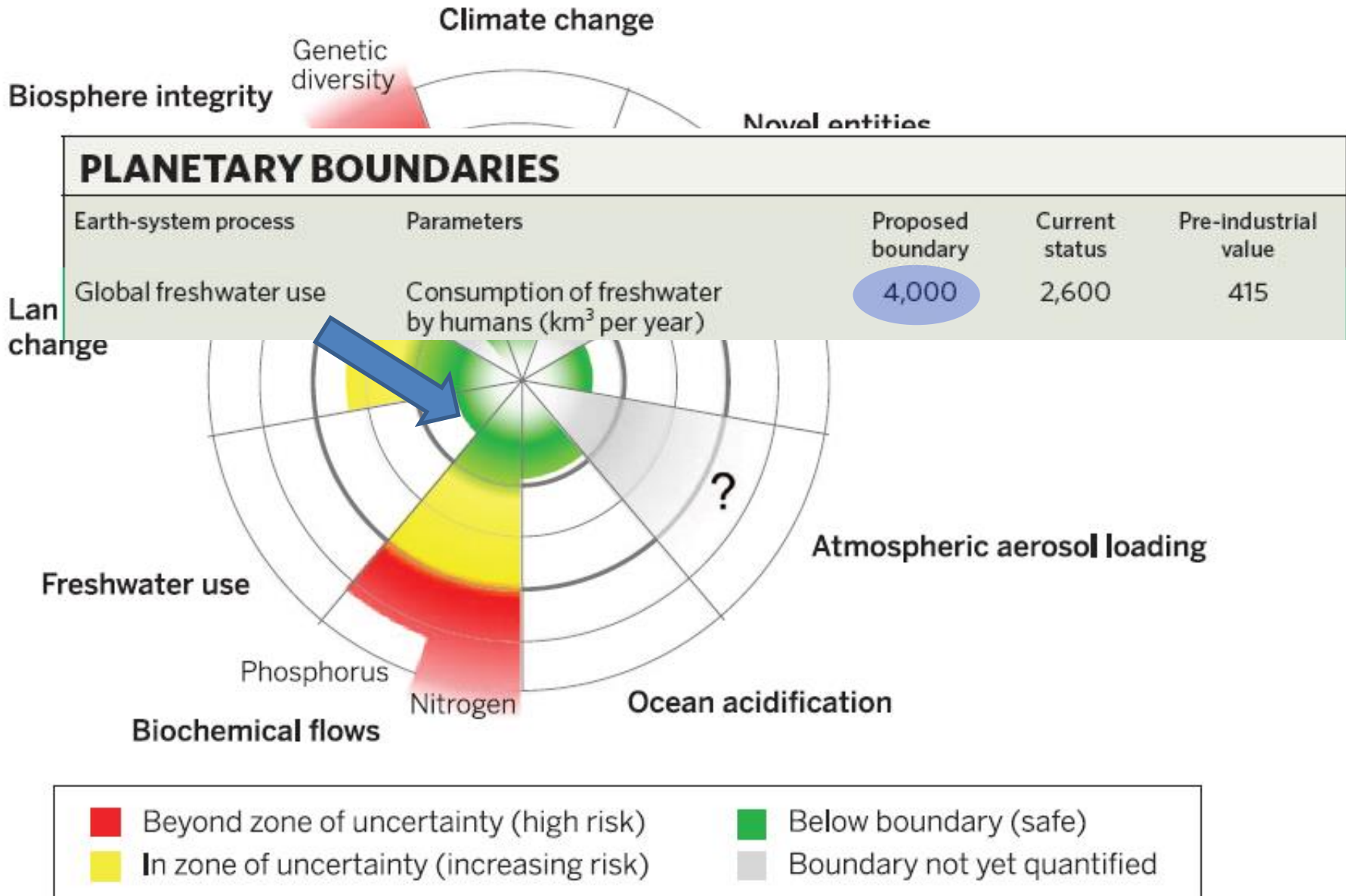
PB definition and quantification ongoing...

- PB positions, and consequences of transgressions
- Spatial „upscaling“ and „downscaling“ of PBs
- Normative aspects (risk, distribution)
- Interaction of PBs



- Opportunities to stay within PBs
- Operationalisation of PBs

Refining the PB for freshwater use

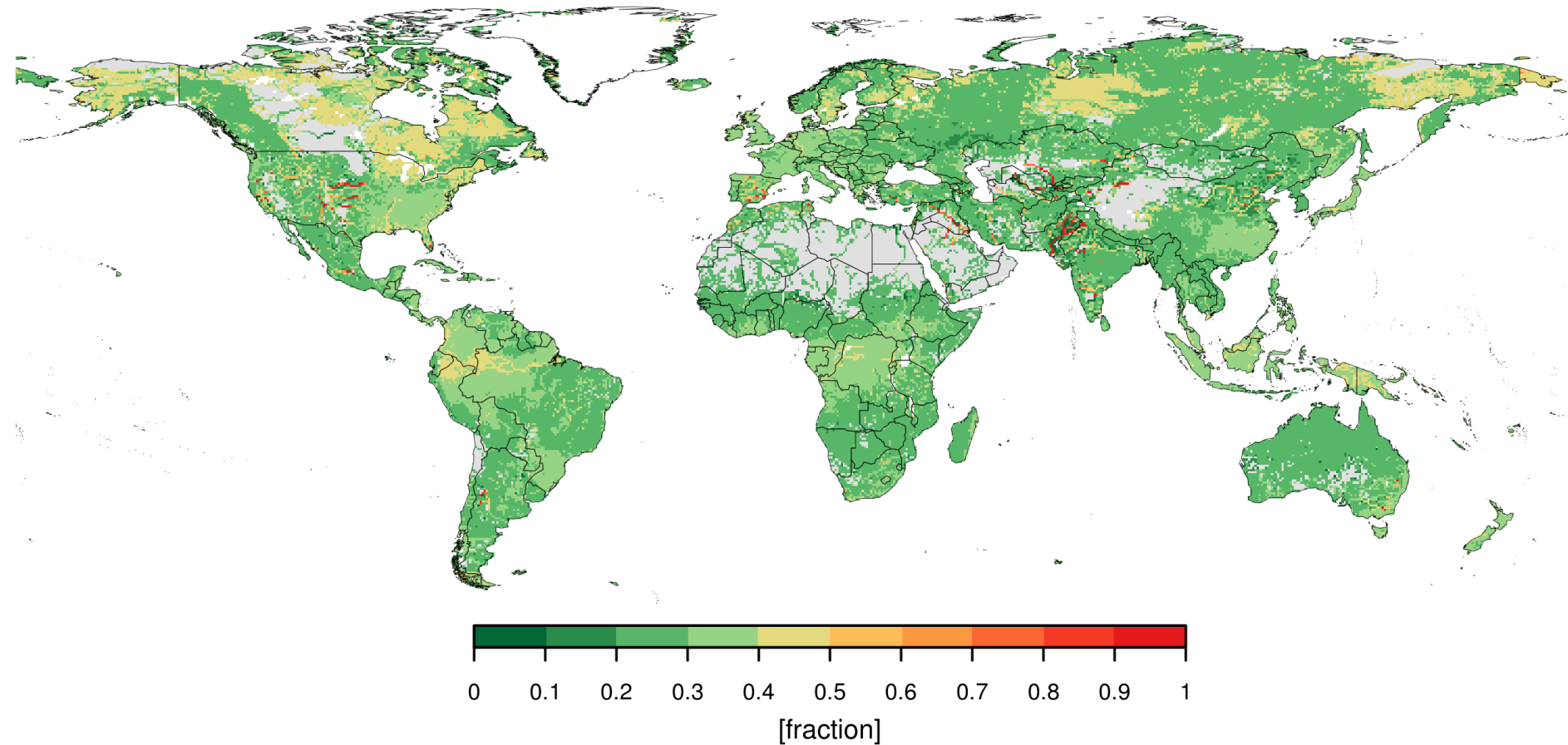


Original top-down calculation of freshwater PB

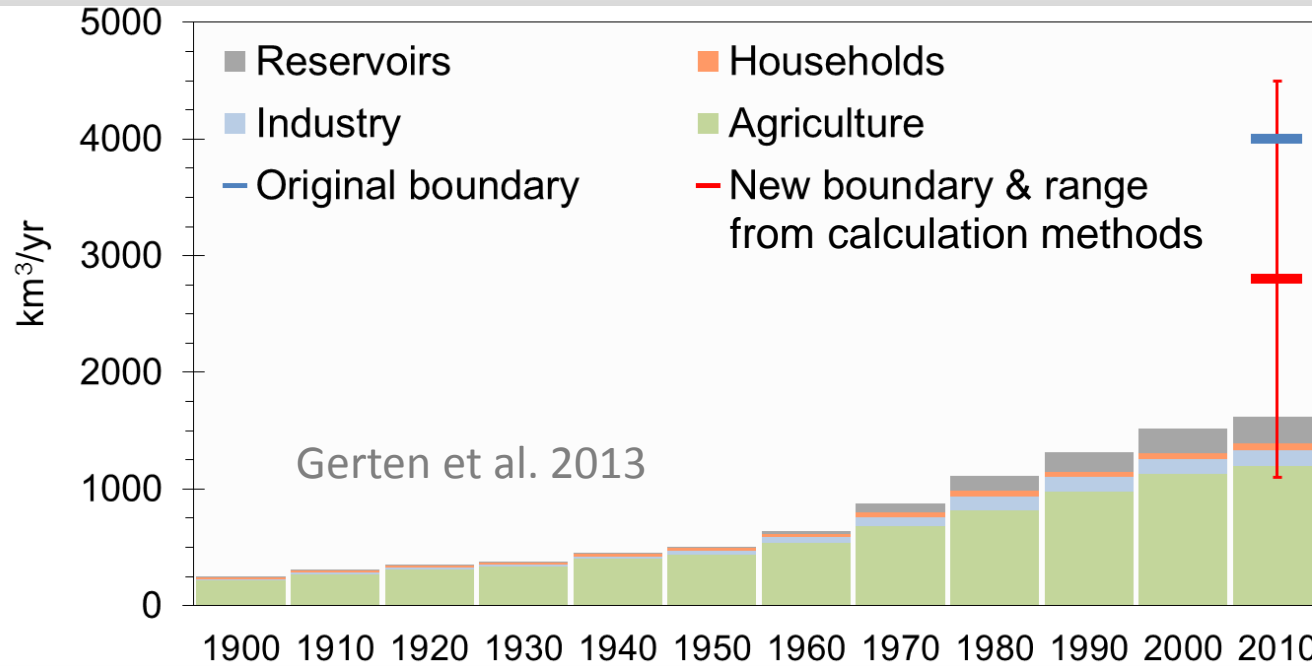
- Global discharge = maximum available freshwater: $40,700 \text{ km}^3 \text{ yr}^{-1}$
- Minus inaccessible flow (69%): remainder $12,500 \text{ km}^3 \text{ yr}^{-1}$
- Minus environmental flow requirements (30%) & volumes to avoid water stress (30%): remainder $5,000 \text{ km}^3 \text{ yr}^{-1}$
- Apply lower end of an uncertainty range $(\pm 1,000 \text{ km}^3 \text{ yr}^{-1})$
- PB = $4,000 \text{ km}^3 \text{ yr}^{-1}$

Towards a bottom-up calculation

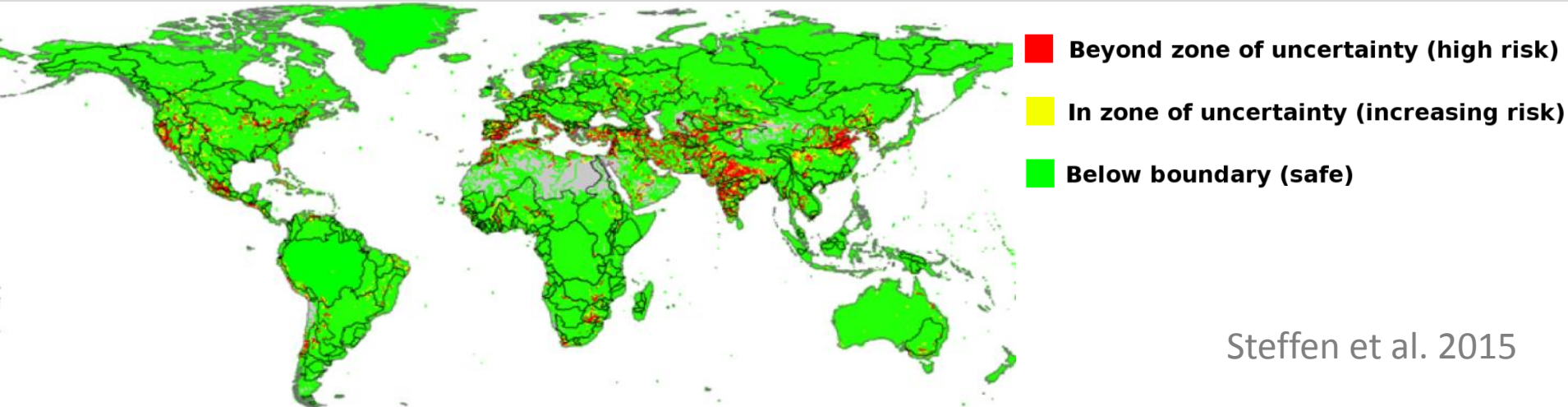
Simulated **environmental flow requirements**
(fraction of river flow, average of five methods)



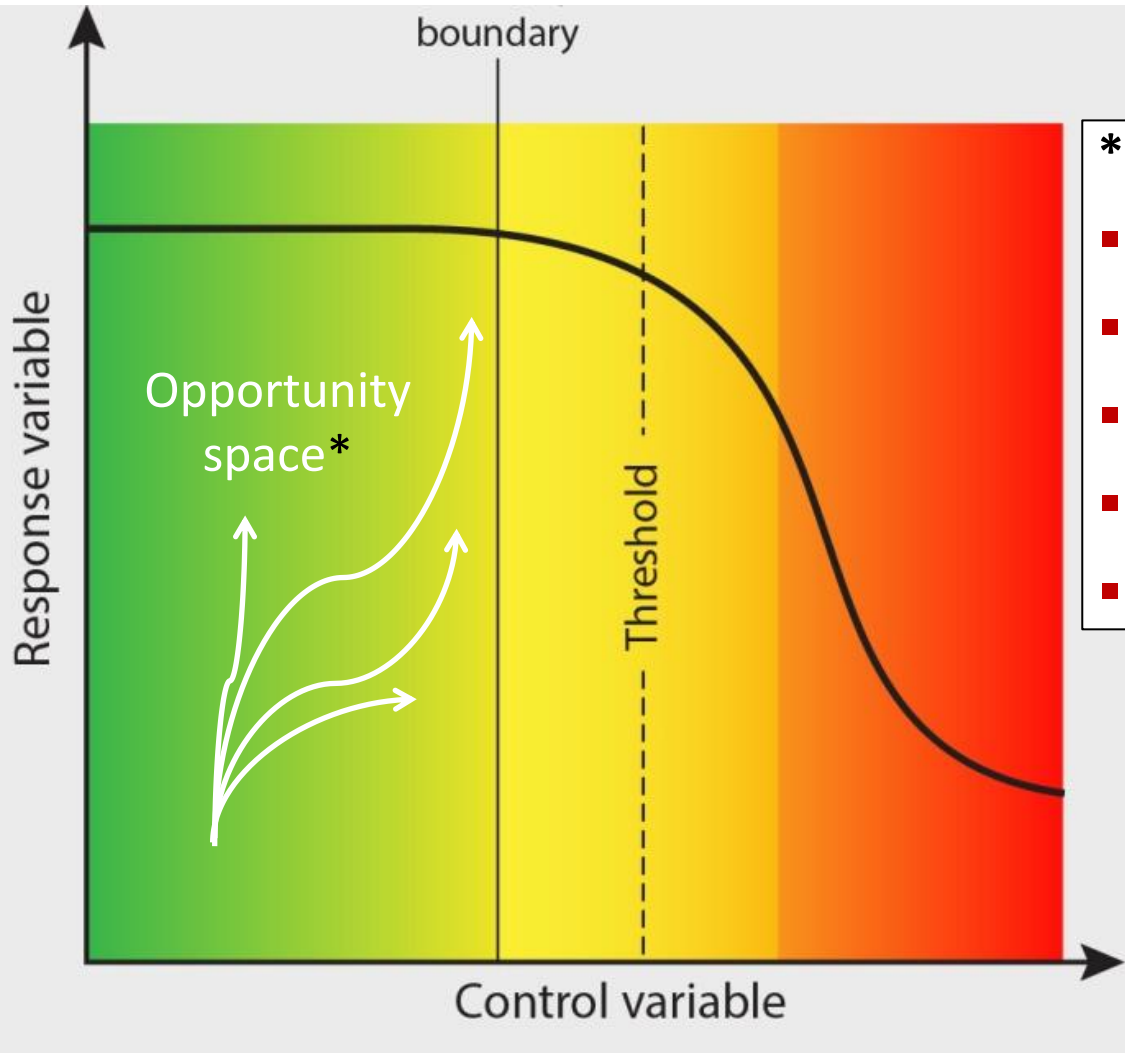
Freshwater PB may be lower than thought



Regional boundary crossed in many places



PBs as a chance for transformation



* „Planetary opportunities“:

- Technical innovation
- Improved resource use efficiency
- Improved access to resources
- Improved spatial redistribution
- Concern for justice and equity



Safe operating space



Zone of uncertainty: Increasing risk of impacts



Dangerous level: High risk of serious impacts

Efficient water use: a planetary opportunity

Upgrade of irrigation systems

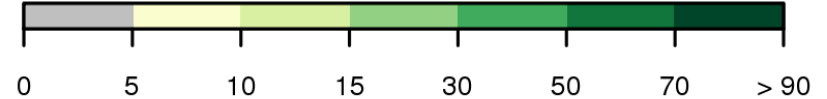
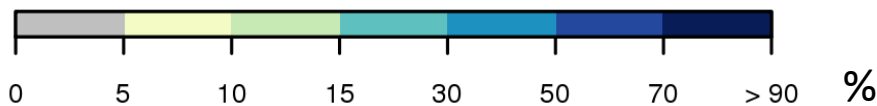
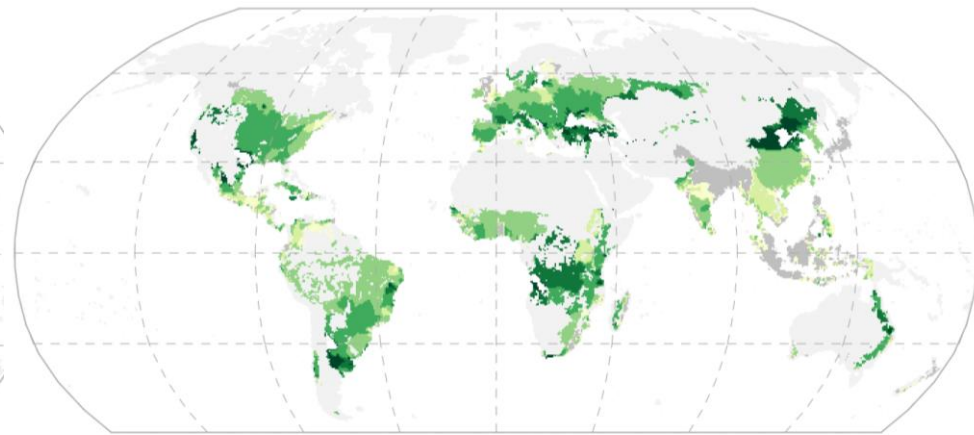
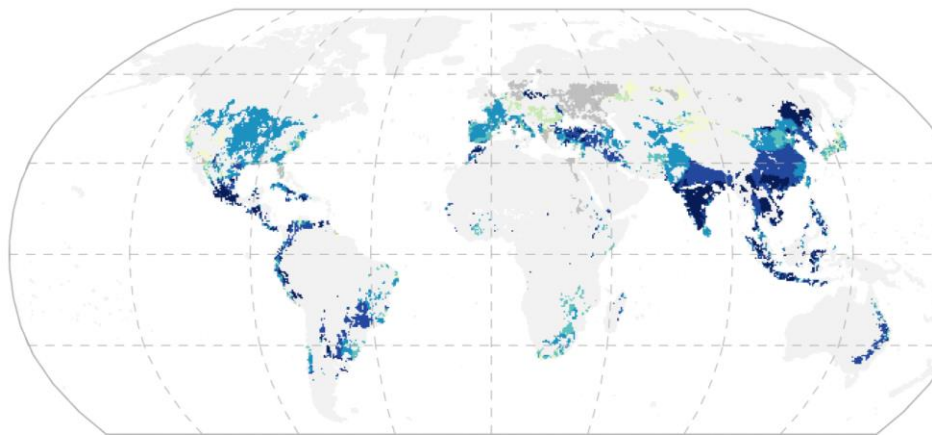
(surface replaced by sprinkler irrigation, irrigated area expanded with saved water)

→ Global yield increase: **48%**

Upgrade of rainfed systems

(50% runoff water harvested, 50% unproductive evaporation avoided)

→ Global yield increase: **29%**



**Environmental flow restrictions
(regional freshwater PB)**



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**Available cropland
(land-system & biosphere PB)**



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Our activities

Flagship Activity
„Planetary Opportunities & Planetary Boundaries“
at PIK



Planetary Boundaries
Research Network (PB.Net)
at PIK & SRC

Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship



Project „Planetare Grenzen – Anforderungen an die
Wissenschaft, Zivilgesellschaft & Politik “
at adelphi & PIK; funded by BMUB/UBA



Project „Planetary Boundaries – Challenges for Science, Civil Society and Policy“

Topics of research and advice:

- 1) Identify **entry points** (new policies, revision thereof) for PB concept **in Germany** (e.g. new integrated environment program, national sustainability strategy)
- 2) **Co-produce** relevant knowledge between science, policy and decision-makers
- 3) **Integrate** PBs with **local to national** environmental targets and policies
- 4) Thus support **vertical** (across scales) and **horizontal integration** (across sectors)
- 5) Use “safe space” for **positive framing**: opportunities for sustainable co-transitions

A conclusion

- PB concept now comprehensively updated
- But quantification and refinements still in progress
- (Concepts for) operationalization in place for some countries and also companies
- PBs being recognized as a scientific basis (and communication tool) for integrated sustainability/co-transformation policies across sectors/scales

**Thank you for
your attention!**