



Human-made chemicals and the Earth System

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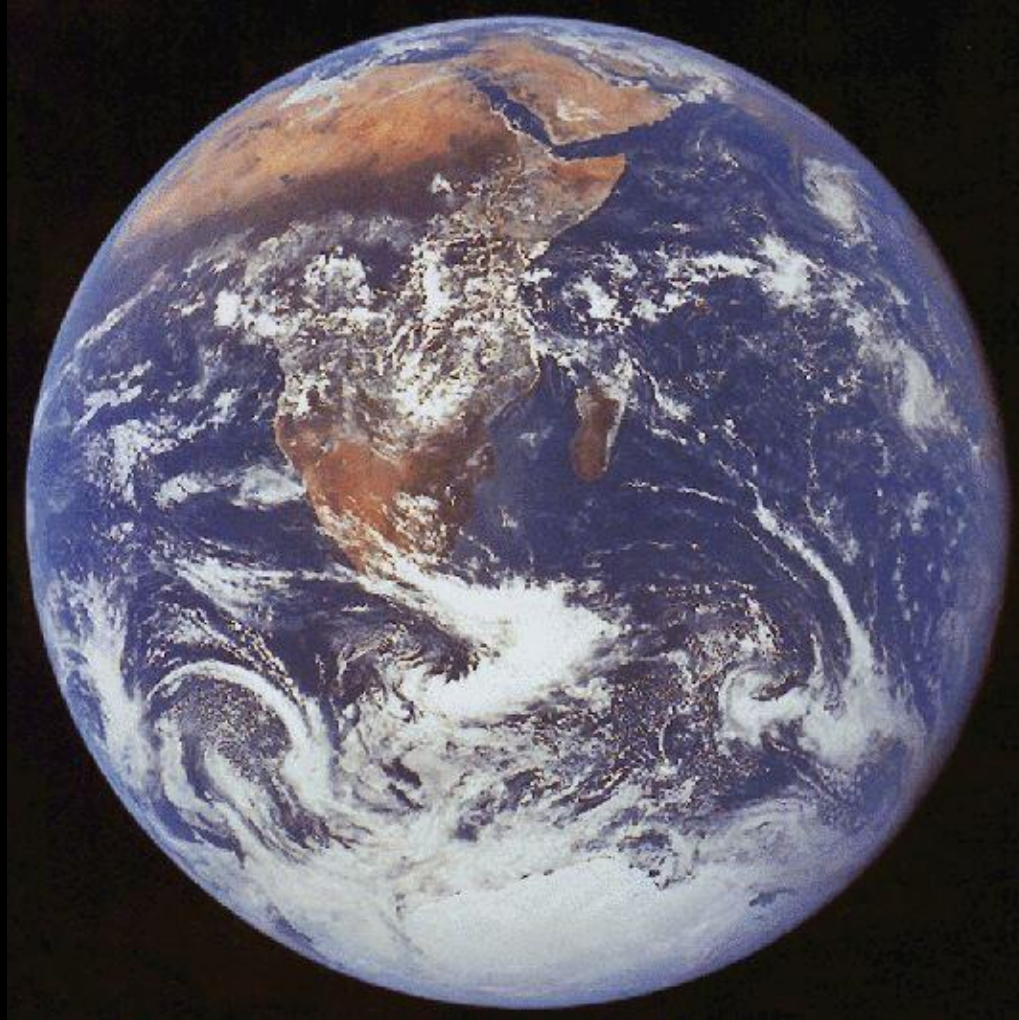
What makes this planet unique is the fact that there is life!



Biodiversity and climate can be used as proxies for the Earth's resources!

Conditions on Earth are a product of the *interaction* between the “biosphere” (all living organisms) and physical-geochemical processes

The Earth behaves as a complex system: the *Earth System*




And we are a part of that system!

SDGs are a vision for how we want to share the Earth's resources!



Relevant for all global citizens – not just for those in developing countries





**Few goals are on track
to be met and for
several goals, the trend
is in the wrong
direction!**



Business-as-usual approaches

GOAL	WITHIN 5%	5-10%	>10%	NEGATIVE LONG-TERM TREND
 Goal 1		1.1. Eradicating extreme poverty	1.3. Social protection for all	
 Goal 2		2.1. Ending hunger (undernourishment)	2.2. Ending malnutrition (stunting) 2.5. Maintaining genetic diversity 2.a. Investment in agriculture*	2.2. Ending malnutrition (overweight)
 Goal 3	3.2. Under-5 mortality 3.2. Neonatal mortality		3.1. Maternal mortality 3.4. Premature deaths from non-communicable diseases	
 Goal 4	4.1 Enrolment in primary education	4.6 Literacy among youth and adults	4.2. Early childhood development 4.1 Enrolment in secondary education 4.3 Enrolment in tertiary education	
 Goal 5			5.5. Women political participation	
 Goal 6		6.2. Access to safe sanitation (open defecation practices)	6.1. Access to safely managed drinking water 6.2. Access to safely managed sanitation service	
 Goal 7		7.1. Access to electricity	7.2. Share of renewable energy* 7.3. Energy intensity	
 Goal 8			8.7. Use of child labour*	
 Goal 9		9.5. Enhancing scientific research (R&D expenditure)	9.5. Enhancing scientific research (number of researchers)	
 Goal 10			10.c. Remittance costs	Inequality in income**
 Goal 11			11.1. Urban population living in slums*	
 Goal 12				12.2. Absolute material footprint, and DMC*
 Goal 13				Global GHG emissions relative to Paris targets**
 Goal 14				14.1. Continued deterioration of coastal waters* 14.4. Overfishing*
 Goal 15				15.5. Biodiversity loss* 15.7. Wildlife poaching and trafficking
 Goal 16			16.9 universal birth registration *	

* target not specified ** based on most recently available data

Interactions between the SDGs

Levers for transformation

SCIENCE AND TECHNOLOGY



ECONOMY AND FINANCE



GOVERNANCE



INDIVIDUAL AND COLLECTIVE ACTION



Goals relating to **global environmental commons**



Goals improving **human wellbeing**



Linking goal



But we do not “think” in terms of SDGs!

The challenge of SD is giving all access to the finite resources necessary to allow continued development  This requires  and 

Earth Resources



We need to reduce the size of the arrows!
But how large can they be?

→ **Direct use or habitat change**



"Human potential realization"*

Planetary Boundaries: Exploring the safe operating space for humanity in the Anthropocene (*Nature*, 461 : 472 – 475, Sept 24 - 2009)

Copyright © 2009 by the author(s). Published here under license by the Resilience Alliance. Rockström, J., W. Steffen, K. Noone, A. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society* 14(2): 32. [online] URL: <http://www.ecologyandsociety.org/vol14/iss2/art32/>

Research

Planetary Boundaries: Exploring the Safe Operating Space for Humanity

Johan Rockström^{1,2}, Will Steffen^{1,3}, Kevin Noone^{1,4}, Åsa Persson^{1,2}, F. Stuart III Chapin⁵, Eric Lambin⁶, Timothy M. Lenton⁷, Marten Scheffer⁸, Carl Folke^{1,9}, Hans Joachim Schellnhuber^{10,11}, Björn Nykvist^{1,2}, Cynthia A. de Wit¹, Terry Hughes¹², Sander van der Leeuw¹³, Henning Rodhe¹⁴, Sverker Sörlin^{1,15}, Peter K. Snyder¹⁶, Robert Costanza^{1,17}, Uno Svedin¹, Malin Falkenmark^{1,18}, Louise Karlberg¹², Robert W. Corell¹⁹, Victoria J. Fabry²⁰, James Hansen²¹, Brian Walker^{1,22}, Diana Liverman^{23,24}, Katherine Richardson²⁵, Paul Crutzen²⁶, and Jonathan Foley²⁷

Scienceexpress

Research Articles

Planetary boundaries: Guiding human development on a changing planet

Will Steffen,^{1,2*} Katherine Richardson,³ Johan Rockström,¹ Sarah E. Cornell,¹ Ingo Fetzer,¹ Elena M. Bennett,⁴ R. Biggs,^{1,5} Stephen R. Carpenter,⁶ Wim de Vries,^{7,8} Cynthia A. de Wit,⁹ Carl Folke,^{1,10} Dieter Gerten,¹¹ Jens Heinke,^{11,12,13} Georgina M. Mace,¹⁴ Linn M. Persson,¹⁵ Veerabhadran Ramanathan,^{16,17} B. Reyers,^{1,18} Sverker Sörlin¹⁹

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(ii) updating the quantification of most of the PBEs; (iii) identifying two core boundaries; and (iv) proposing a regional-level quantitative boundary for one of the two that were not quantified earlier (7).

The basic framework: Defining a safe operating space Throughout history, humanity has faced environmental constraints at local and regional levels, with some societies dealing with these challenges more effectively than others (7, 12). More recently, early industrial societies often used local waterways and airsheds as dumping grounds for their waste and effluent from industrial processes. This eroded local and regional environ-

Ecology and Society 14(2): 32

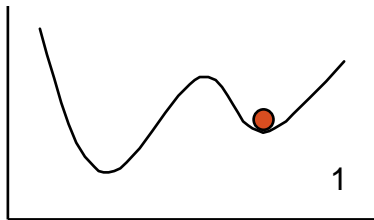
<http://www.ecologyandsociety.org/vol14/iss2/art32/>



Planetary Boundaries: Guiding human development on a changing planet (*Science*, 347, Jan. 15, 2015)

Valuable Ecosystem Services (Desirable)

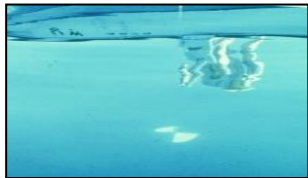
Loss of ecosystem services (Undesirable)



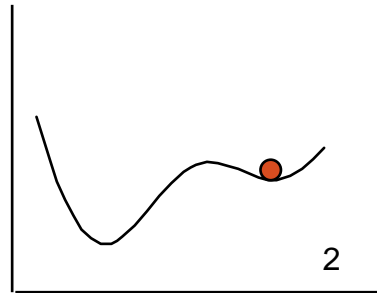
coral dominance



clear water



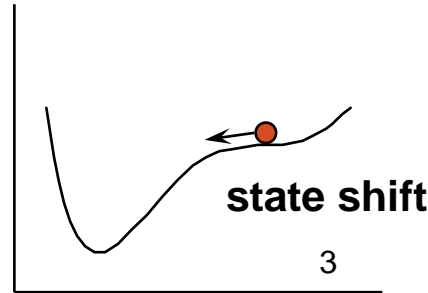
grassland



- overfishing, coastal eutrophication

- phosphorous accumulation in soil and mud

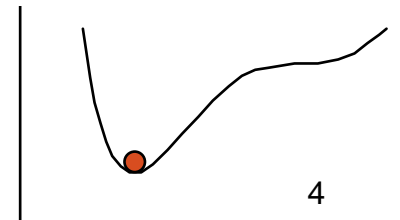
- fire prevention



- disease, hurricane

- flooding, warming, overexploitation of predators

- good rains, continuous heavy grazing



algal dominance



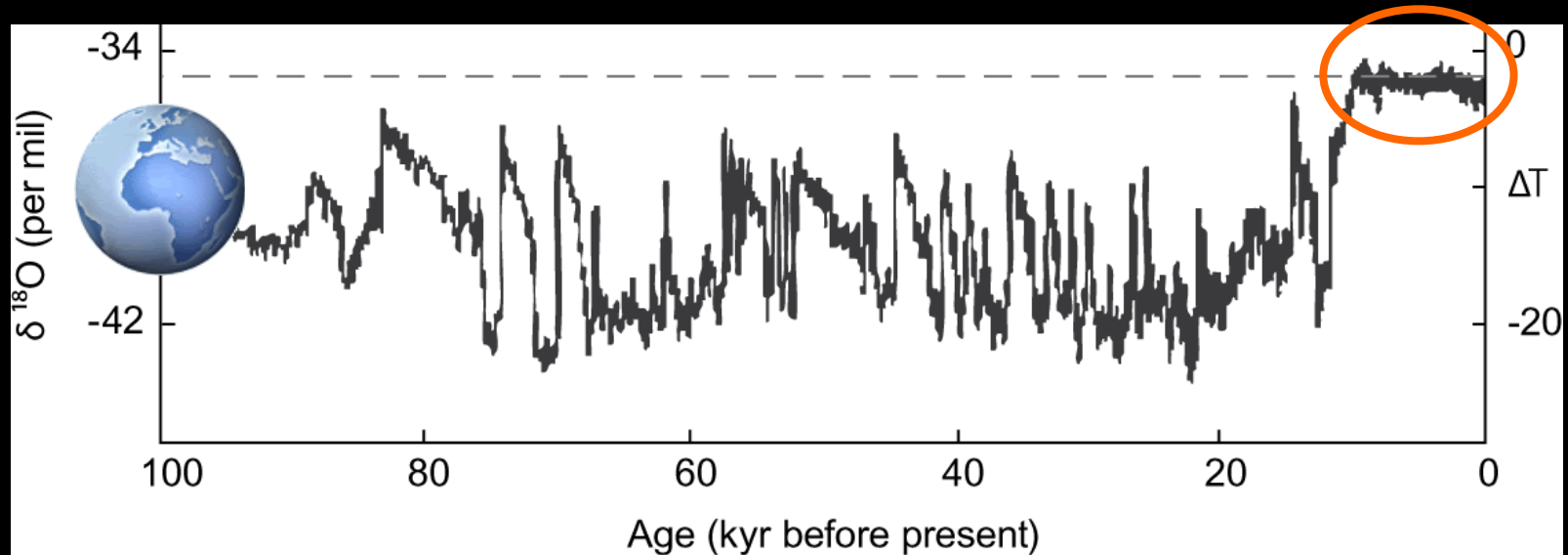
turbid water

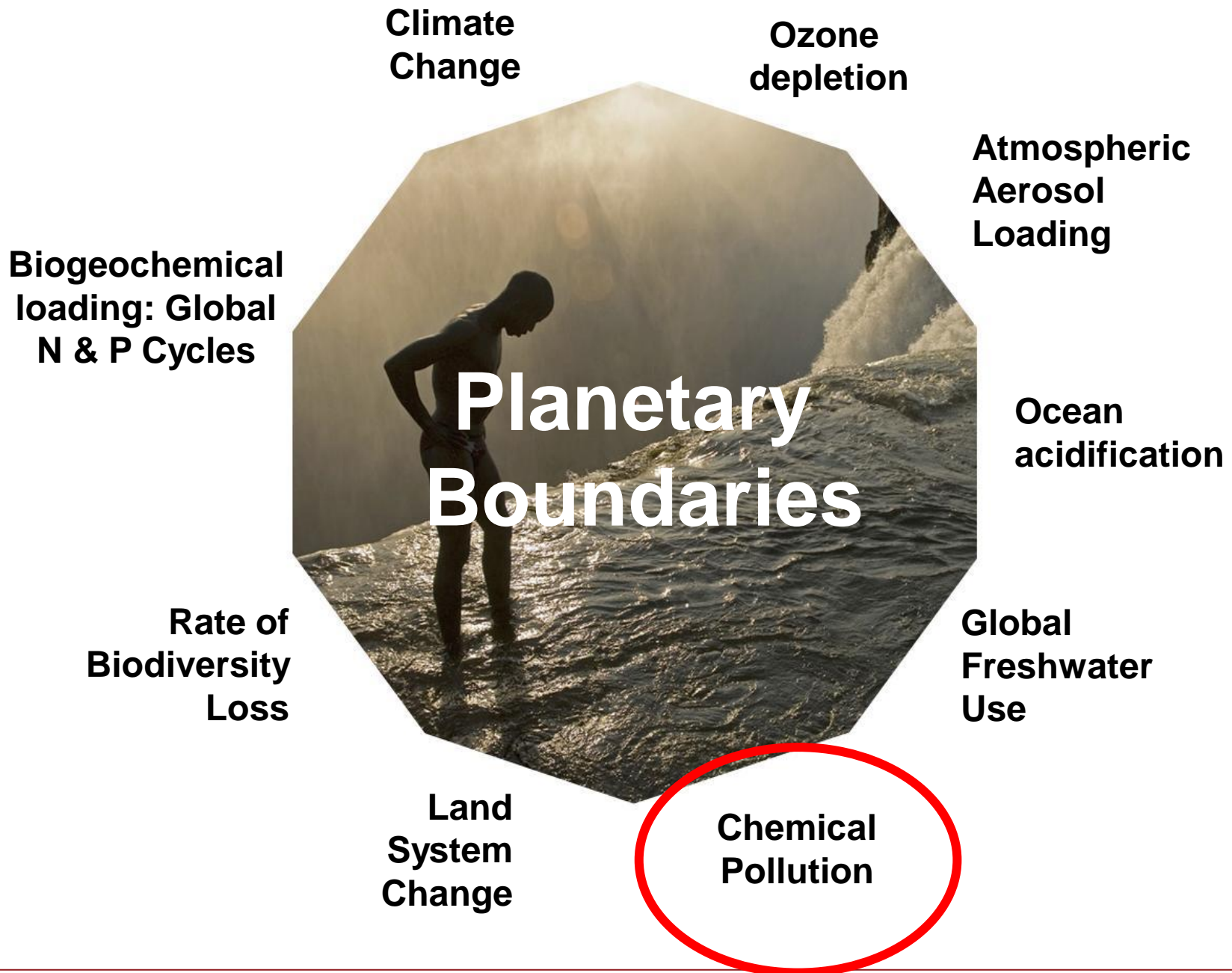


shrub-bushland



Humanity's 12,000 years of grace

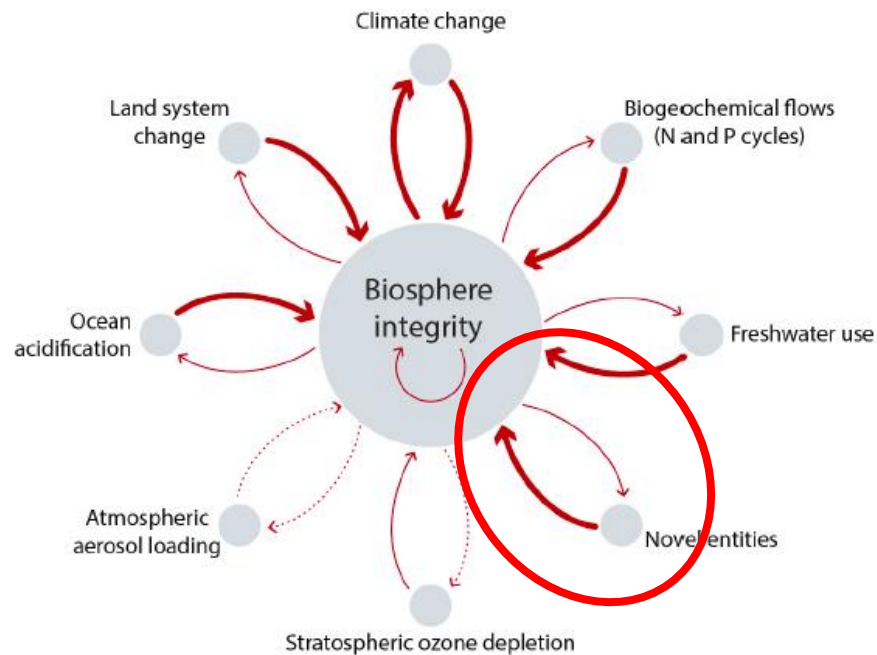




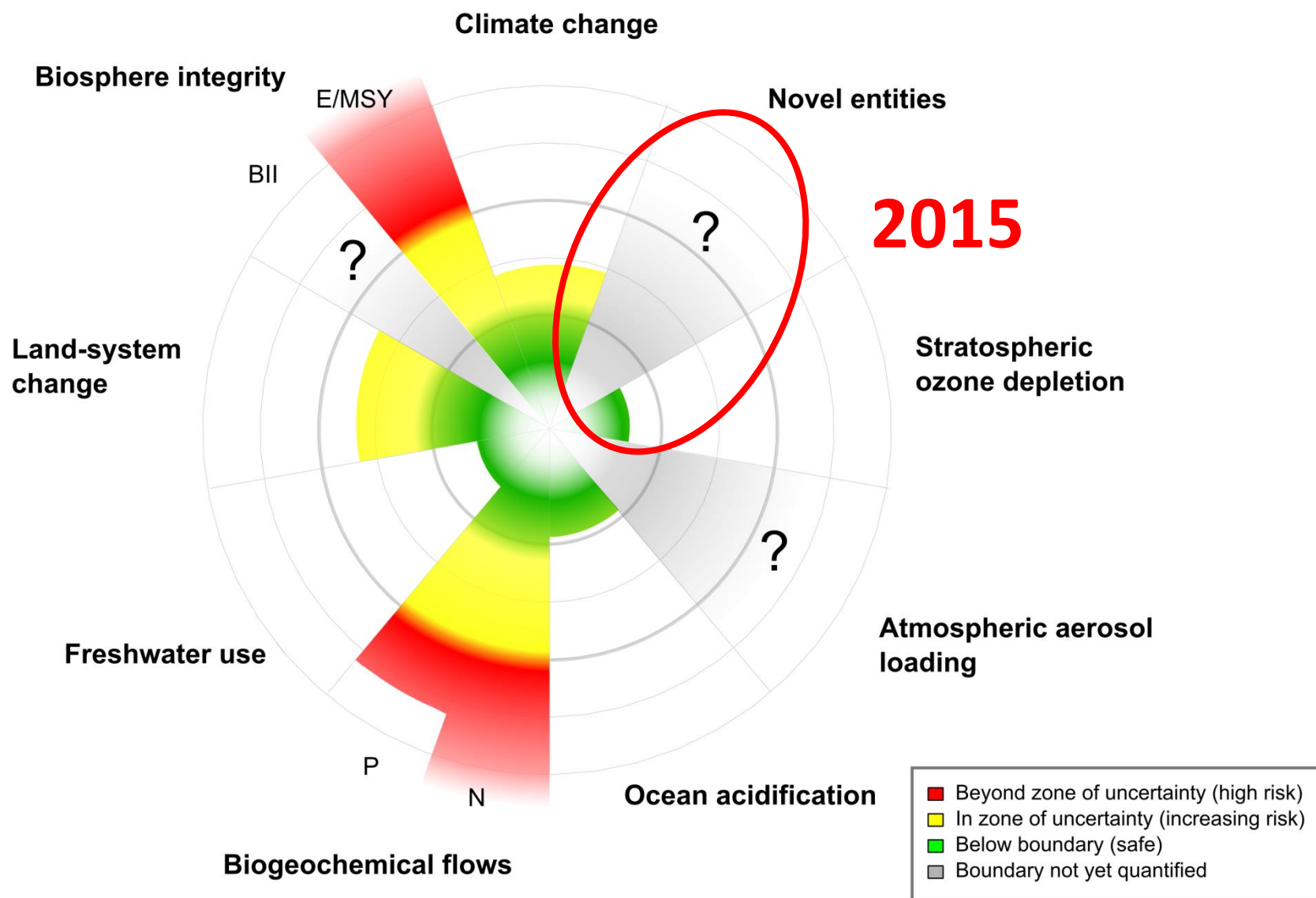
Two "CORE" boundaries:

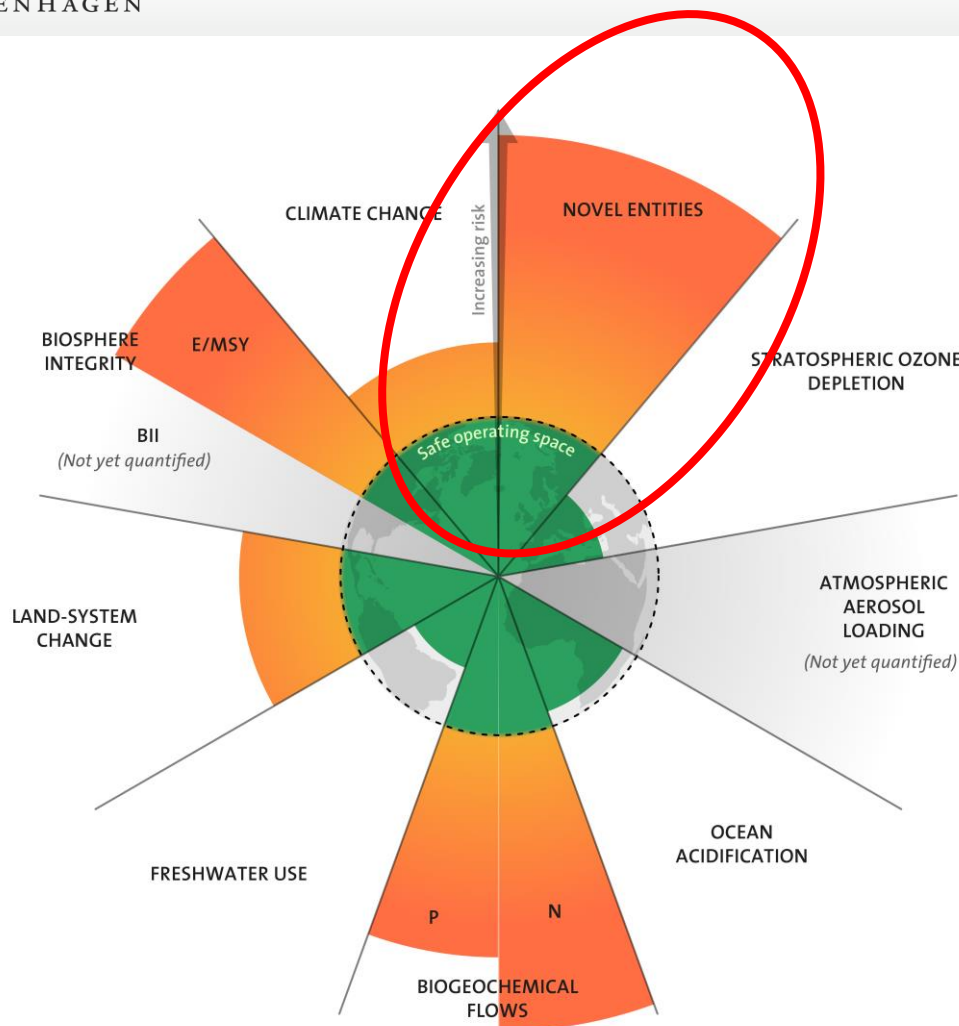
Climate

Biosphere Integrity



-> Weak effect reducing the safe space of the affected factor, or complex effect with large uncertainties
- > As this factor moves away from its safe space, the safe space for the affected factor shrinks a little
- > As this factor moves away from its safe space, the safe space for the affected factor shrinks a lot



**2022**

Outside the Safe Operating Space of the Planetary Boundary for Novel Entities

Linn Persson*, Bethanie M. Carney Almroth, Christopher D. Collins, Sarah Cornell, Cynthia A. de Wit*, Miriam L. Diamond, Peter Fantke, Martin Hassellöv, Matthew MacLeod, Morten W. Ryberg, Peter Søgaard Jørgensen, Patricia Villarrubia-Gómez, Zhanyun Wang, and Michael Zwicky Hauschild

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- The only known “safe” concentration for human-made chemicals in the Earth system is ZERO
- Majority of human-made chemicals are released to the ES without adequate safety assessment



Science argues that some land areas need to be reserved for nature. Likewise, some areas must be made free from human-made chemicals!