HOCHSCHULE FRESENIUS
UNIVERSITY OF APPLIED SCIENCES

amd

Sustainability in Fashion and Creative Industries (M.A.)

Module Production + Sustainability II

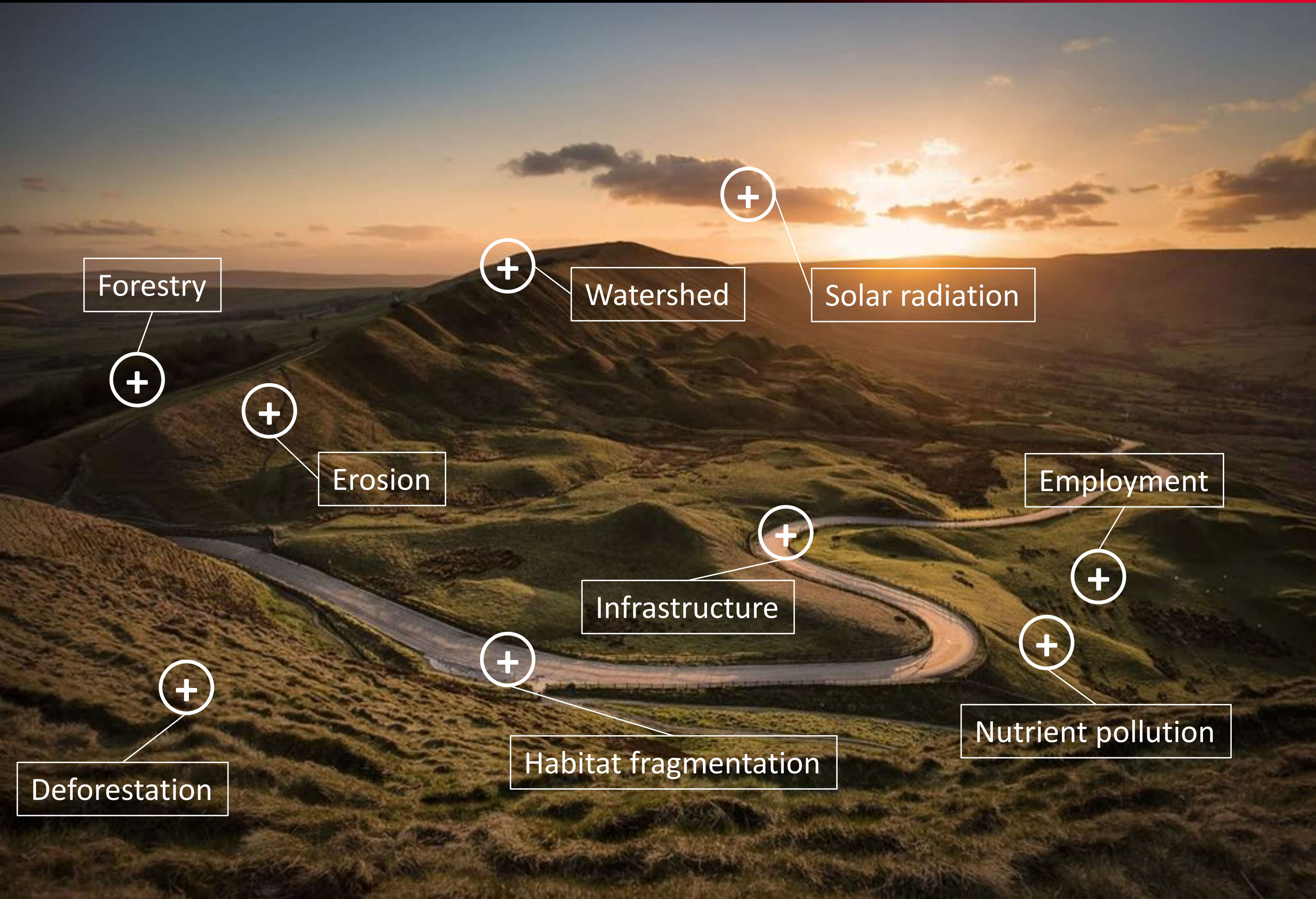
Ecosystems & Economics

Introduction

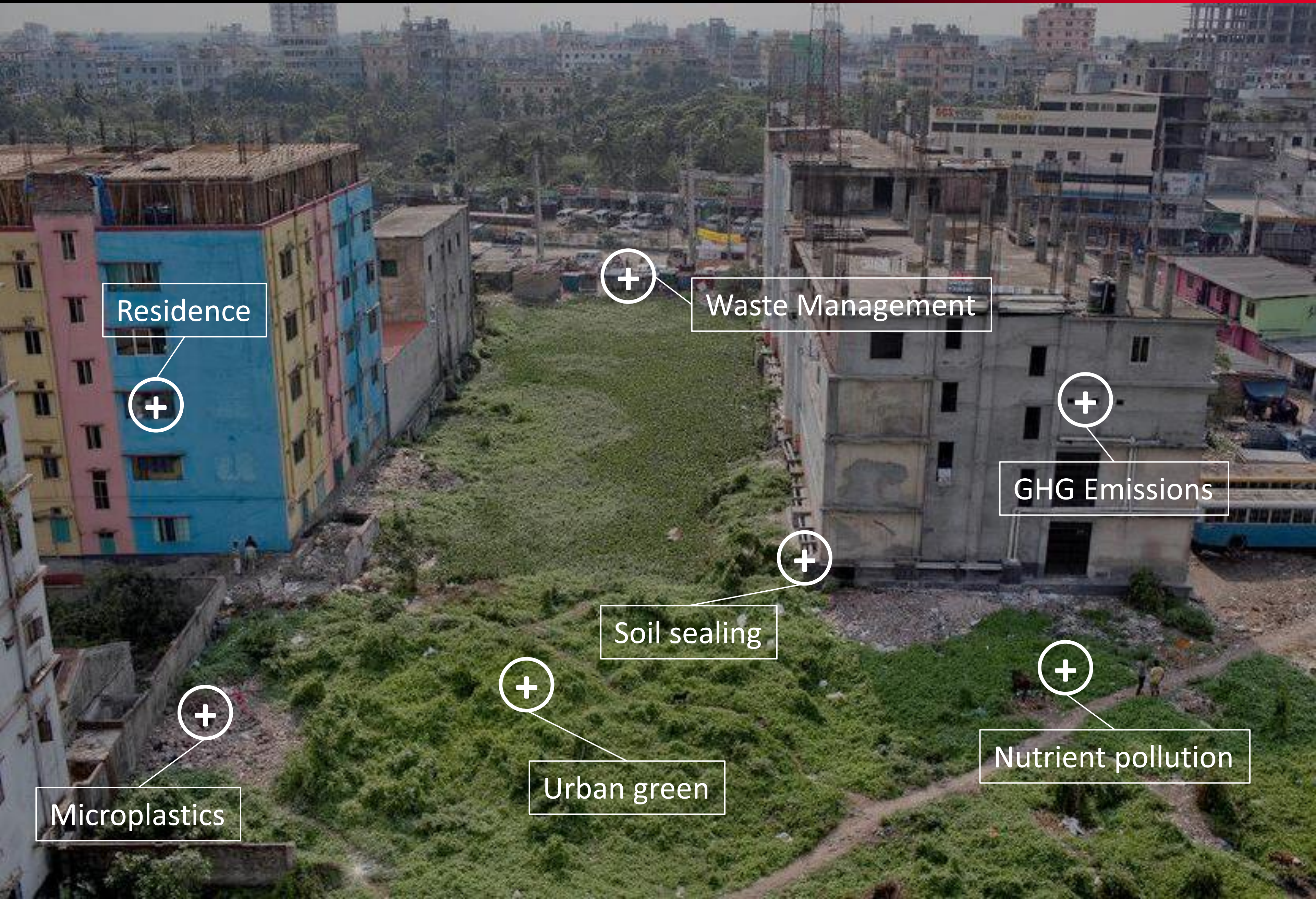
Oliver Peters, M.Sc.

13th of April, 2022

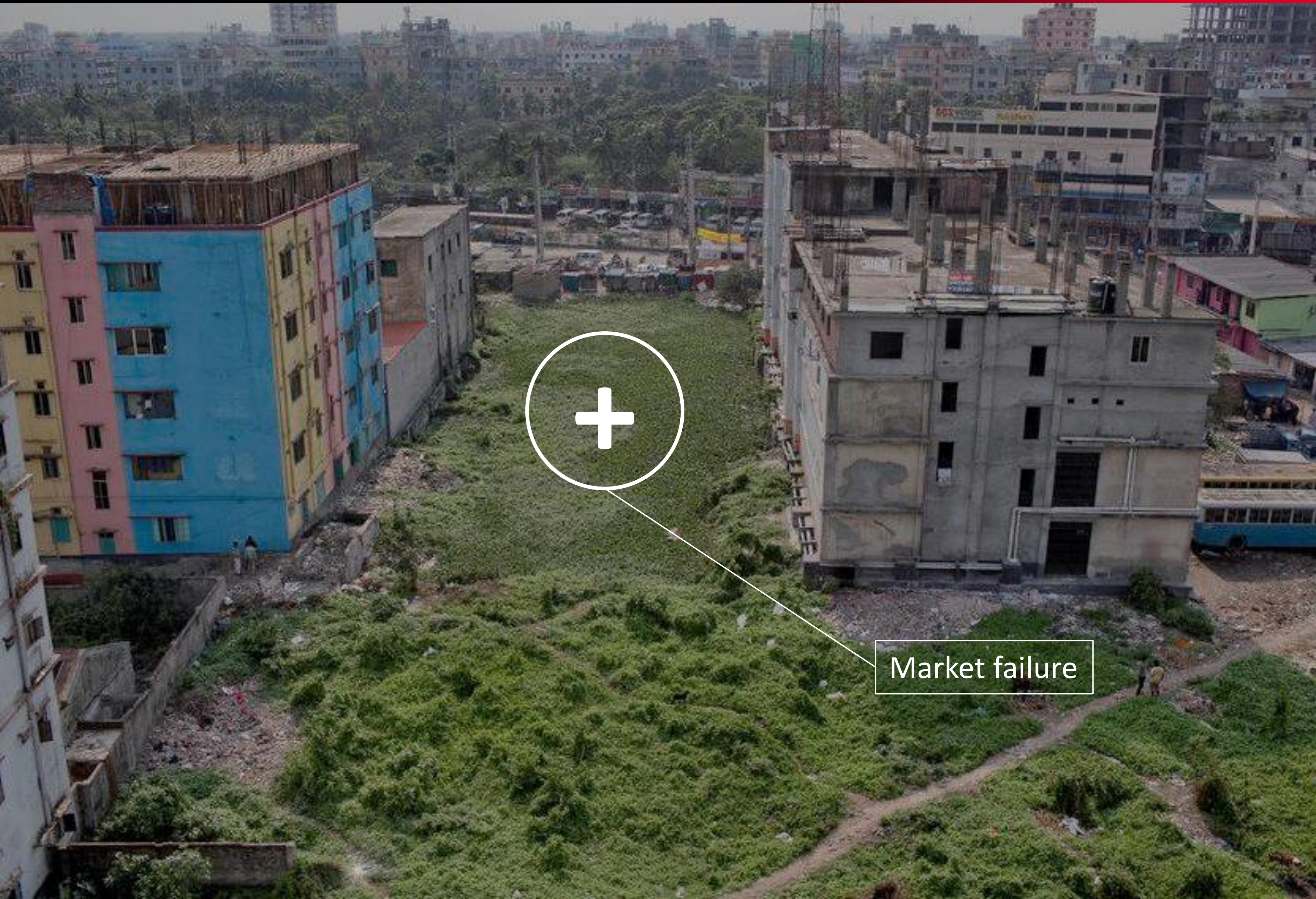
Welcome to Ecosystems & Economics



Welcome to Ecosystems & Economics



Welcome to Ecosystems & Economics



Welcome to Ecosystems & Economics

Organization

Oliver Peters
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Consultations
take place after the lecture and according to individual agreements.

Syllabus

No lecture on 30th of March

#1 & #2 | 6th of April | Wednesday	from WS 2021/22 CSCM: Sustainable Logistics & LCA
#3 | 13th of April |Wednesday	Introduction

No lecture on 20th of April

No lecture on 27th of April

#4 |4th of May | Wednesday	Basics of ecological economics
#5 & #6 | 5th of May | **Thursday**	Biodiversity
#7 & #8 | 11th of May | Wednesday	Biodiversity Loss + Nature Conservation & Biodiversity Policy
#9 | 18th of May | Wednesday	Climate & Greenhouse Gas Effect
#10 |25th of May | Wednesday	Wordpress Workshop

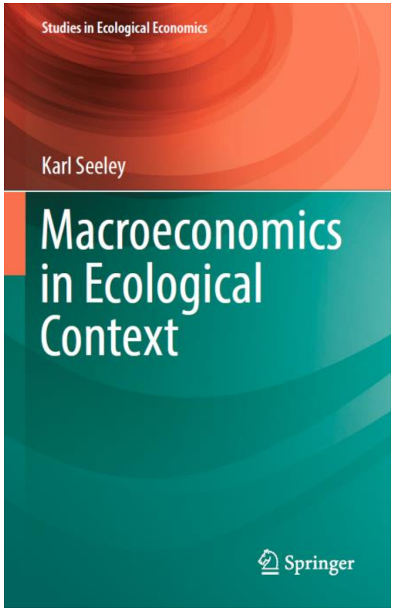
No lecture on 1st of June

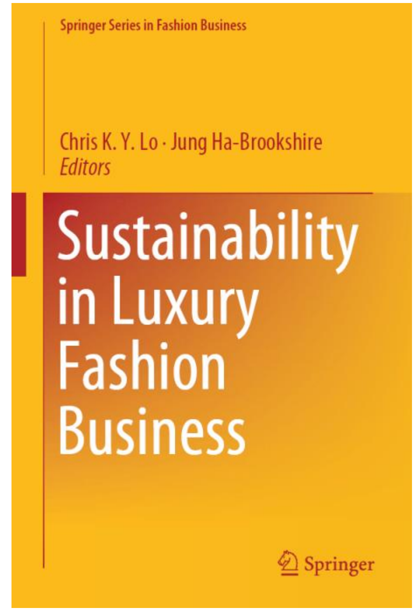
#11 | 8th of June| Wednesday	Climate Change Mitigation and Adaptation, Climate Policy
#12| 15th of June | Wednesday	Biodiversity & Climate Change / TEEB
#13| 22nd of June | Wednesday	Nutrient cycles and chemical pollution

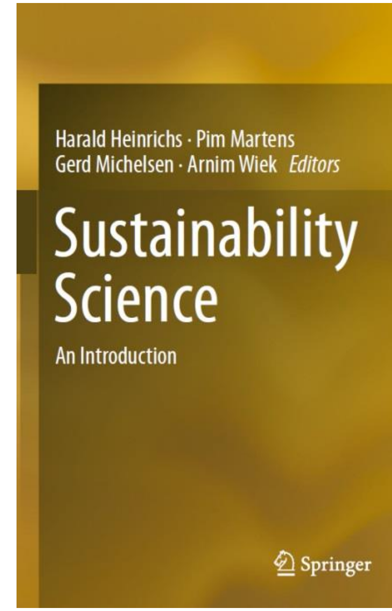
No lecture on 29th of June

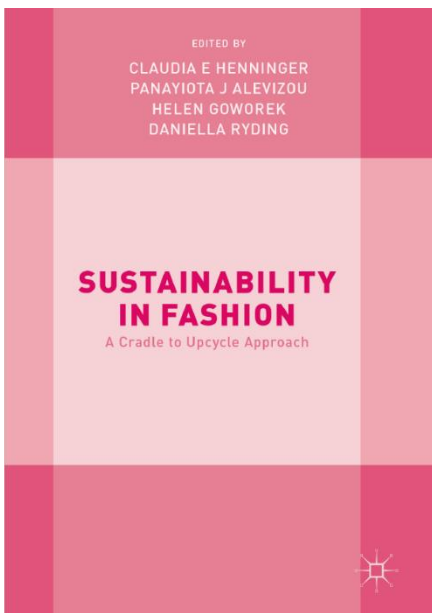
#14 |6th of July | Wednesday	Socio-ecological systems & the ultimate resource

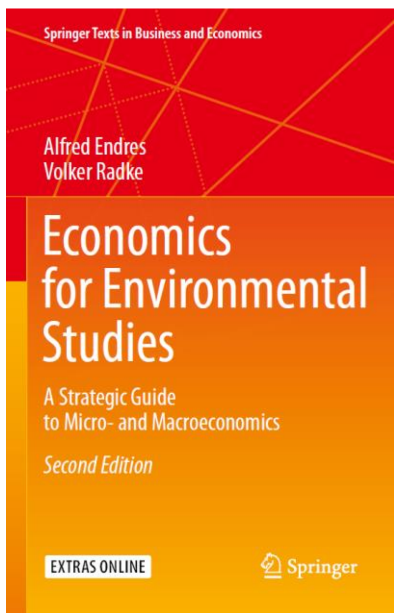
Relevant literature (provided via USB stick)

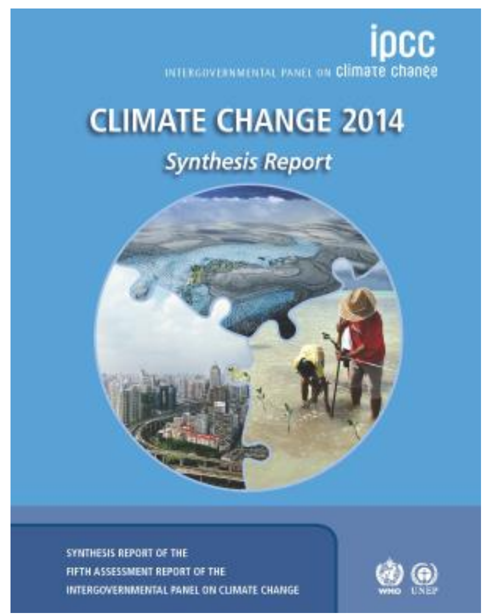


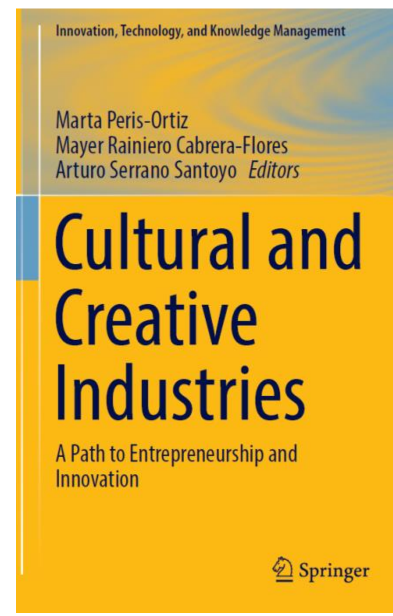




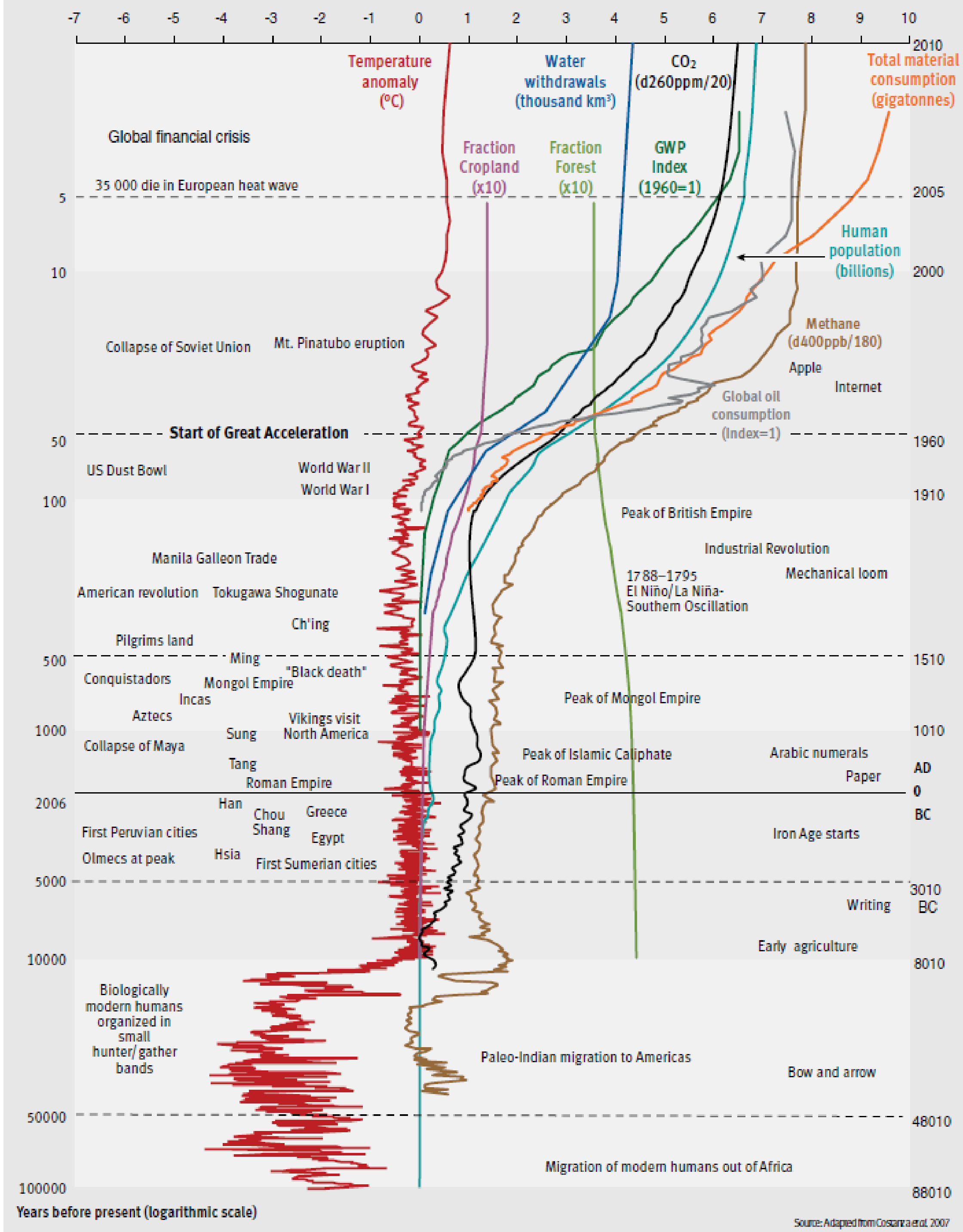






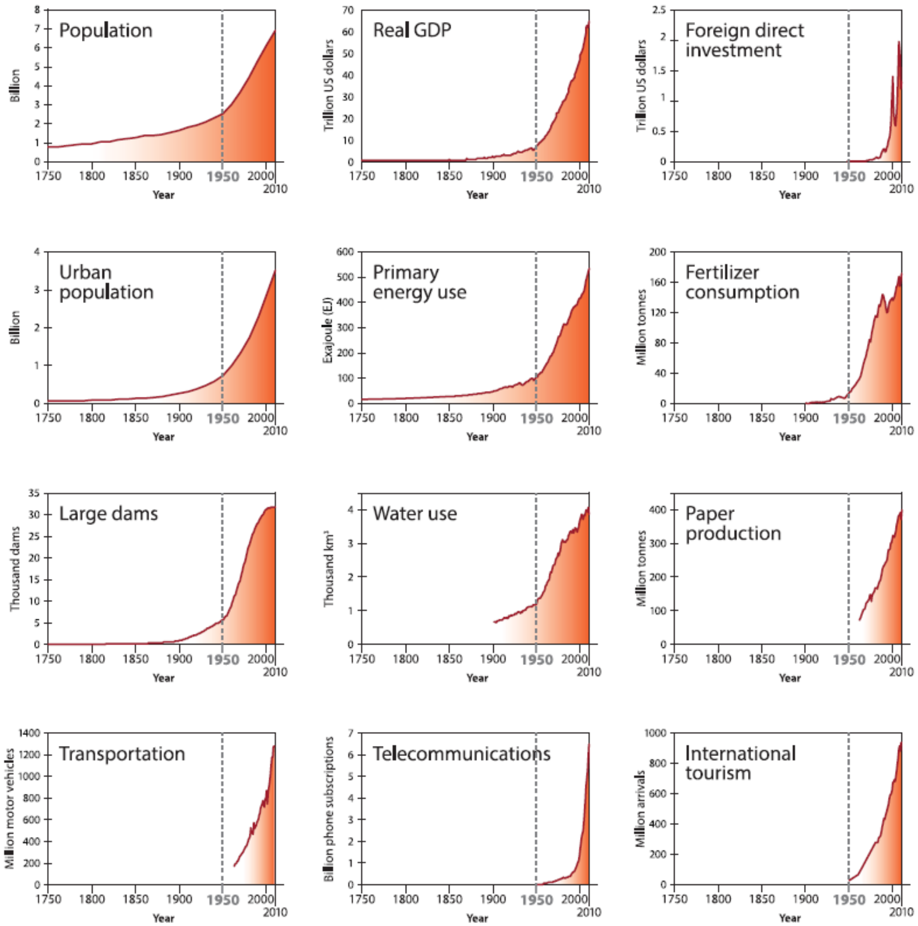


The ‘Great Acceleration’

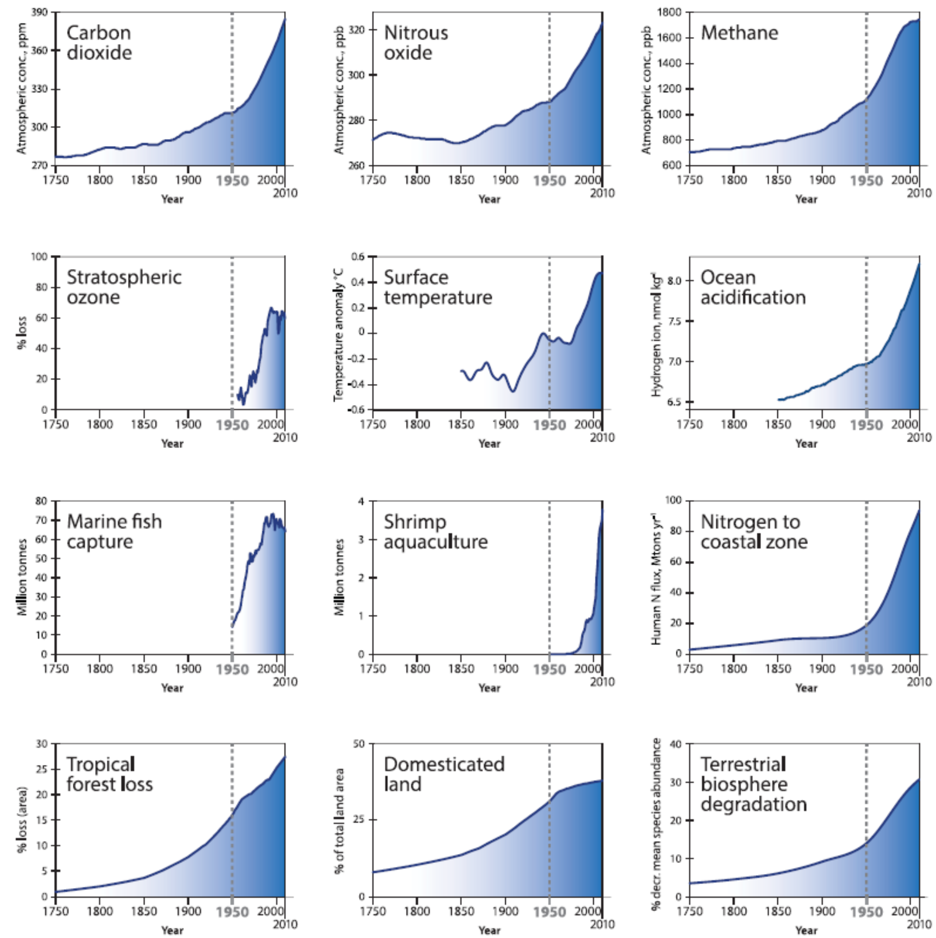


The Great Acceleration

Socio-economic trends



Earth system trends



Source: Steffen et al. 2015

Planetary Boundaries:

Exploring the safe operating space for humanity in the Anthropocene

(*Nature*, 461 : 472 – 475, Sept 24 - 2009)

nature Vol 461|24 September 2009

FEATURE

A safe operating space for humanity

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue Johan Rockström and colleagues.

SUMMARY

- New approach proposed for defining preconditions for human development
- Crossing certain biophysical thresholds could have disastrous consequences for humanity
- Three of nine interlinked planetary boundaries have already been overstepped

ROAD TO COPENHAGEN

Although Earth has undergone many periods of significant environmental change, the planet's environment has been unusually stable for the past 10,000 years[1–3]. This period of stability — known to geologists as the Holocene — has seen human civilizations arise, develop and thrive. Such stability may now be under threat. Since the Industrial Revolution, a new era has arisen, the Anthropocene[4], in which human actions have become the main driver of global environmental change[5]. This could see human activities push the Earth system outside the stable environmental state of the Holocene, with consequences that are detrimental or even catastrophic for large parts of the world.

During the Holocene, environmental change occurred naturally and Earth's regulatory capacity maintained the conditions that enabled human development. Regular temperatures, freshwater availability and biogeochemical flows all stayed within a relatively narrow range. Now, largely because of a rapidly growing reliance on fossil fuels and industrialized forms of agriculture, human activities have reached a level that could damage the systems that keep Earth in the desirable Holocene state. The result could be irreversible and, in some cases, abrupt environmental change, leading to a state less conducive to human development[6]. Without pressure from humans, the Holocene is expected to continue for at least several thousands of years[7].

Planetary boundaries

To meet the challenge of maintaining the Holocene state, we propose a framework based on 'planetary boundaries'. These boundaries define the safe operating space for humanity with respect to the Earth system and are associated with the planet's biophysical subsystems or processes. Although Earth's complex systems sometimes respond smoothly to changing pressures, it seems that this will prove to be the exception rather than the rule. Many subsystems of Earth react in a nonlinear, often abrupt, way and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, then important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humans[8,9].

Most of these thresholds can be defined by a critical value for one or more control variables, such as carbon dioxide concentration. Not all processes or subsystems on Earth have well-defined thresholds, although human actions that undermine the resilience of such processes or subsystems — for example, land and water degradation — can increase the risk that thresholds will also be crossed in other processes, such as the climate system.

We have tried to identify the Earth-system processes and associated thresholds which, if crossed, could generate unacceptable environmental change. We have found nine such processes for which we believe it is necessary to define planetary boundaries: climate change; rate of biodiversity loss (terrestrial and marine); interference with the nitrogen and phosphorus cycles; stratospheric ozone depletion; ocean acidification; global freshwater use; change in land use; chemical pollution; and atmospheric aerosol loading (see Fig. 1 and Table).

In general, planetary boundaries are values for control variables that are either at a 'safe' distance from thresholds — for processes with evidence of threshold behaviour — or at dangerous levels — for processes without

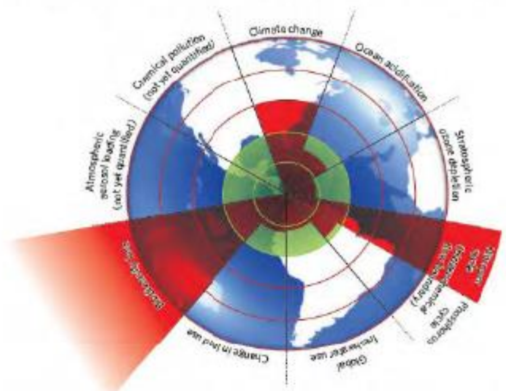
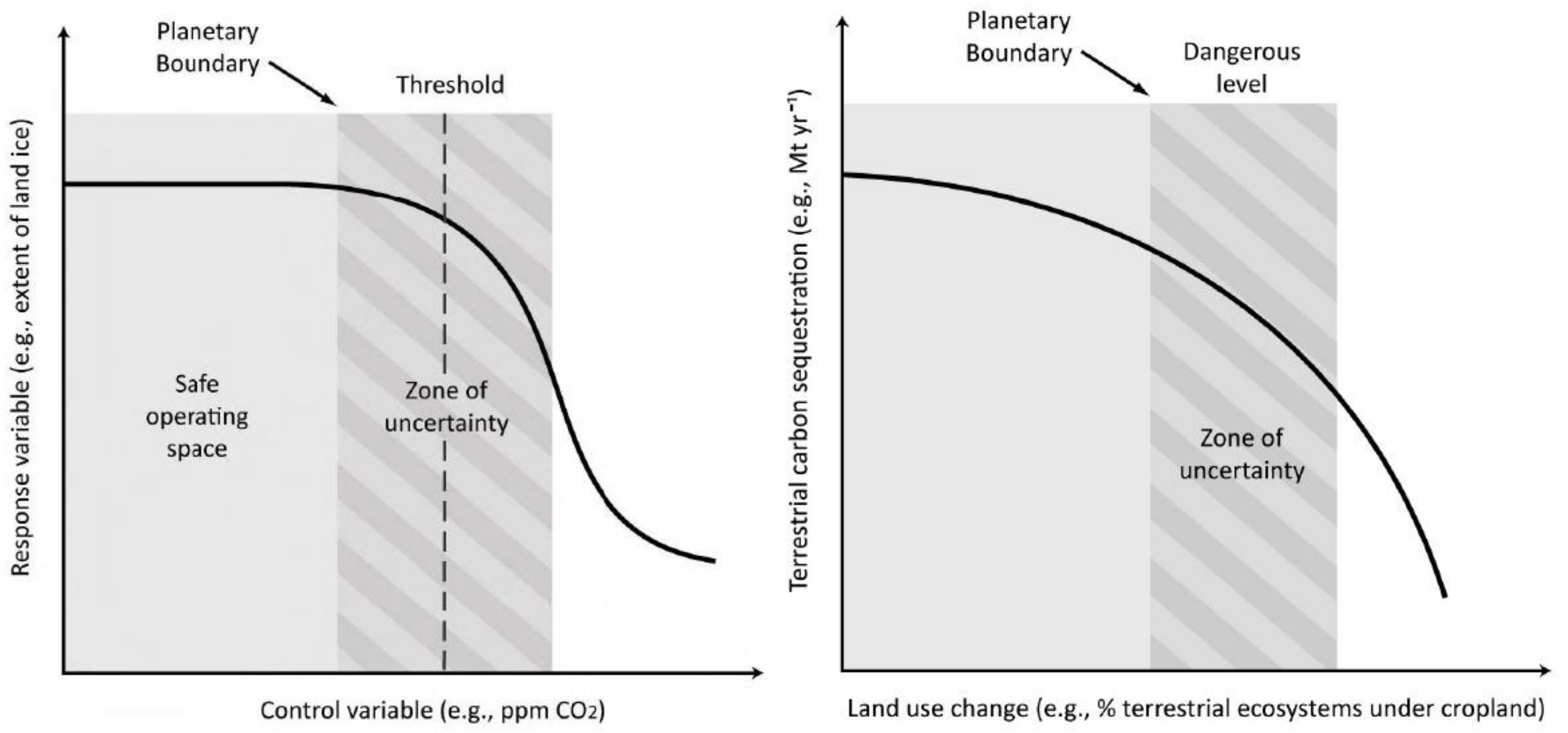


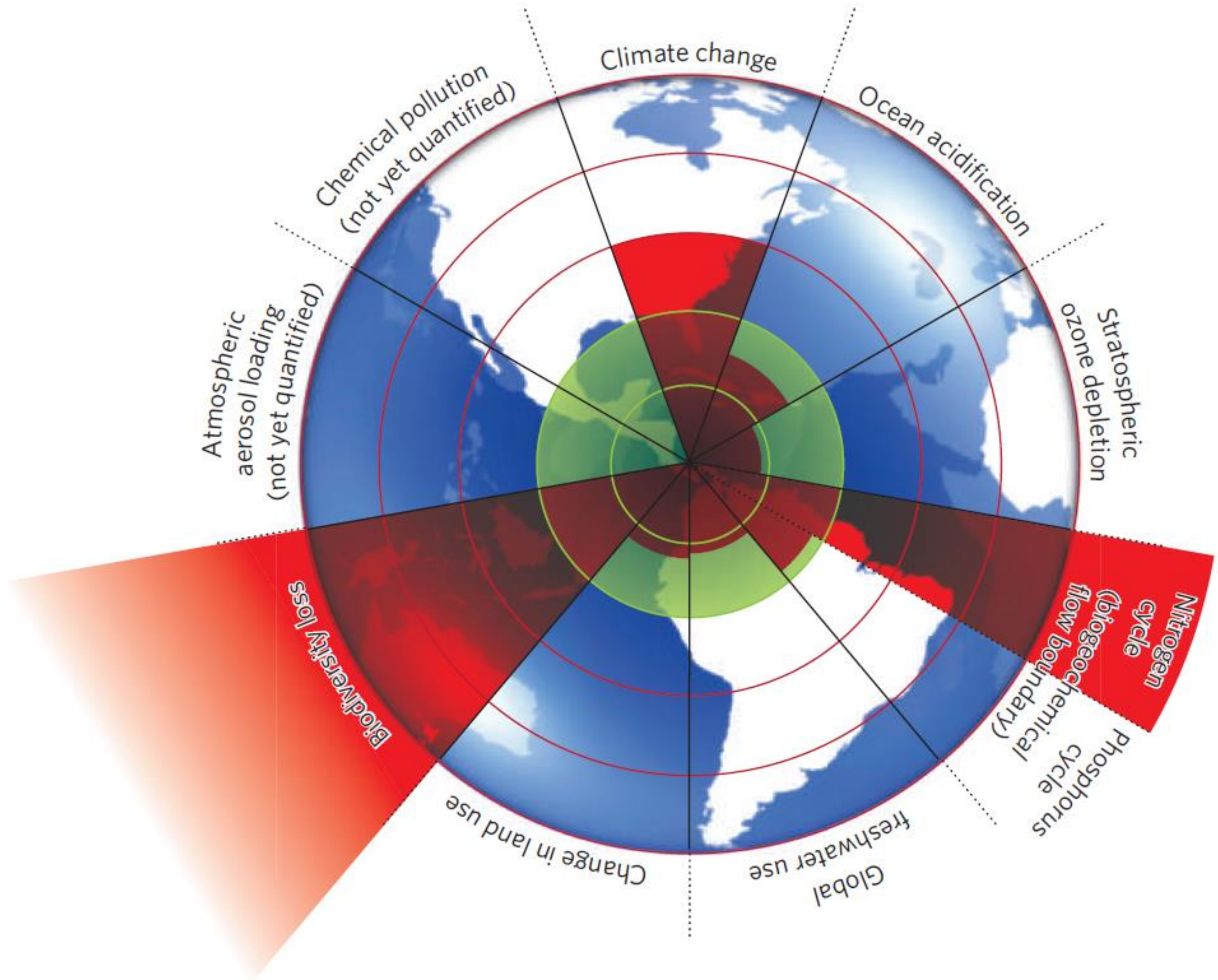
Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

Two different types of planetary boundary processes



1. Critical continental to global threshold **2. No known global threshold effect**

Planetary Boundaries



Planetary Boundaries

PLANETARY BOUNDARIES

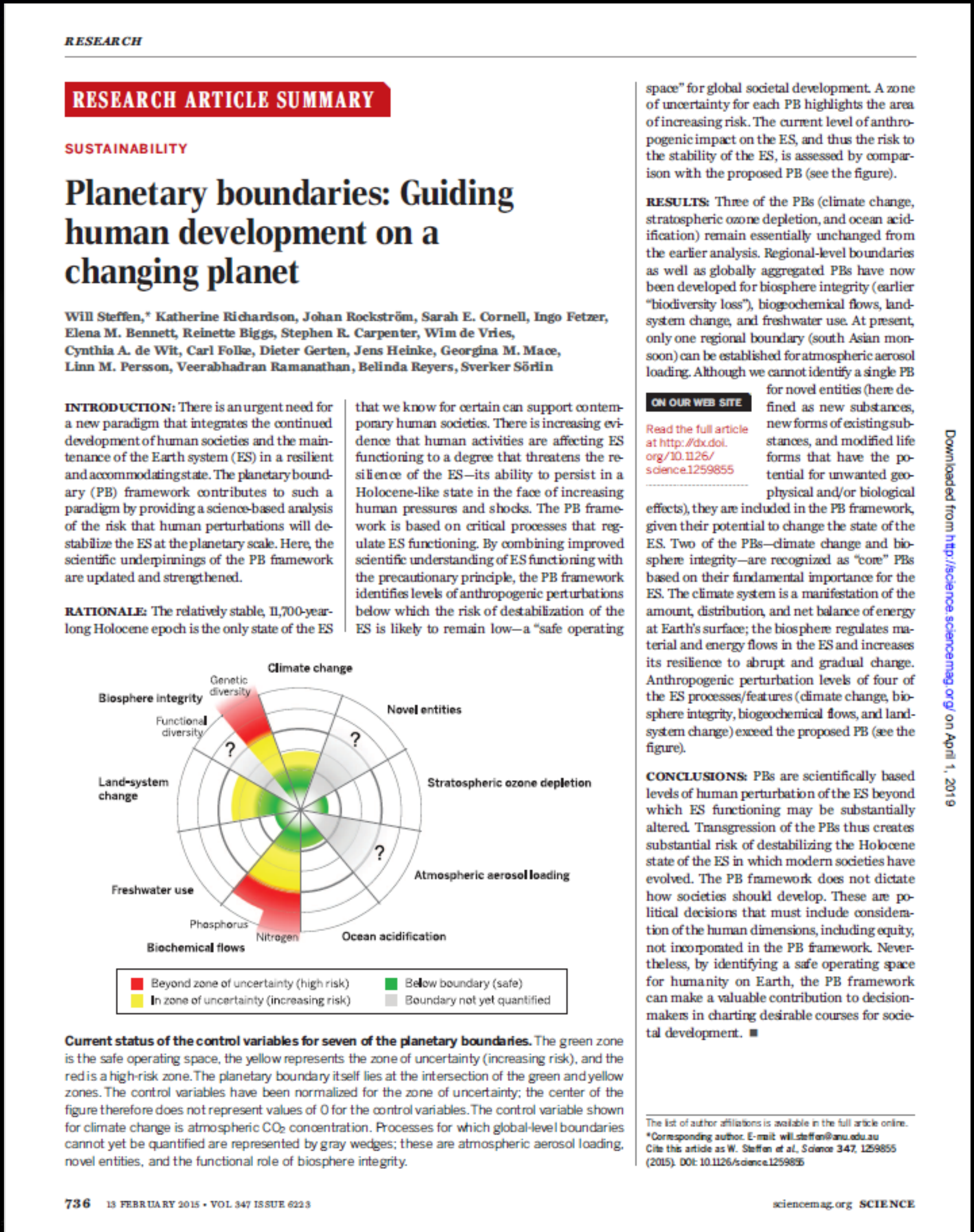
Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	(ii) Change in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number 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 (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions 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 ecosystem and functioning of Earth system thereof		To be determined	

Boundaries for processes in red have been crossed. Data sources: ref. 10 and supplementary information

Source: Steffen, Rockström et al. 2015

Planetary Boundaries

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223).



RESEARCH ARTICLE SUMMARY

SUSTAINABILITY

Planetary boundaries: Guiding human development on a changing planet

Will Steffen,* Katherine Richardson, Johan Rockström, Sarah E. Cornell, Ingo Fetzer, Elena M. Bennett, Reinette Biggs, Stephen R. Carpenter, Wim de Vries, Cynthia A. de Wit, Carl Folke, Dieter Gerten, Jens Heinke, Georgina M. Mace, Linn M. Persson, Veerabhadran Ramanathan, Belinda Reyers, Sverker Sörlin

INTRODUCTION: There is an urgent need for a new paradigm that integrates the continued development of human societies and the maintenance of the Earth system (ES) in a resilient and accommodating state. The planetary boundary (PB) framework contributes to such a paradigm by providing a science-based analysis of the risk that human perturbations will destabilize the ES at the planetary scale. Here, the scientific underpinnings of the PB framework are updated and strengthened.

RATIONALE: The relatively stable, 11,700-year-long Holocene epoch is the only state of the ES that we know for certain can support contemporary human societies. There is increasing evidence that human activities are affecting ES functioning to a degree that threatens the resilience of the ES—its ability to persist in a Holocene-like state in the face of increasing human pressures and shocks. The PB framework is based on critical processes that regulate ES functioning. By combining improved scientific understanding of ES functioning with the precautionary principle, the PB framework identifies levels of anthropogenic perturbations below which the risk of destabilization of the ES is likely to remain low—a "safe operating space" for global societal development. A zone of uncertainty for each PB highlights the area of increasing risk. The current level of anthropogenic impact on the ES, and thus the risk to the stability of the ES, is assessed by comparison with the proposed PB (see the figure).

RESULTS: Three of the PBs (climate change, stratospheric ozone depletion, and ocean acidification) remain essentially unchanged from the earlier analysis. Regional-level boundaries as well as globally aggregated PBs have now been developed for biosphere integrity (earlier "biodiversity loss"), biogeochemical flows, land-system change, and freshwater use. At present, only one regional boundary (south Asian monsoon) can be established for atmospheric aerosol loading. Although we cannot identify a single PB for novel entities (here defined as new substances, new forms of existing substances, and modified life forms that have the potential for unwanted geophysical and/or biological effects), they are included in the PB framework, given their potential to change the state of the ES. Two of the PBs—climate change and biosphere integrity—are recognized as "core" PBs based on their fundamental importance for the ES. The climate system is a manifestation of the amount, distribution, and net balance of energy at Earth's surface; the biosphere regulates material and energy flows in the ES and increases its resilience to abrupt and gradual change. Anthropogenic perturbation levels of four of the ES processes/features (climate change, biosphere integrity, biogeochemical flows, and land-system change) exceed the proposed PB (see the figure).

CONCLUSIONS: PBs are scientifically based levels of human perturbation of the ES beyond which ES functioning may be substantially altered. Transgression of the PBs thus creates substantial risk of destabilizing the Holocene state of the ES in which modern societies have evolved. The PB framework does not dictate how societies should develop. These are political decisions that must include consideration of the human dimensions, including equity, not incorporated in the PB framework. Nevertheless, by identifying a safe operating space for humanity on Earth, the PB framework can make a valuable contribution to decision-makers in charting desirable courses for societal development. ■

ON OUR WEB SITE

Read the full article at http://dx.doi.org/10.1126/science.1259855

Current status of the control variables for seven of the planetary boundaries. The green zone is the safe operating space, the yellow represents the zone of uncertainty (increasing risk), and the red is a high-risk zone. The planetary boundary itself lies at the intersection of the green and yellow zones. The control variables have been normalized for the zone of uncertainty; the center of the figure therefore does not represent values of 0 for the control variables. The control variable shown for climate change is atmospheric CO_2 concentration. Processes for which global-level boundaries cannot yet be quantified are represented by gray wedges; these are atmospheric aerosol loading, novel entities, and the functional role of biosphere integrity.

The list of author affiliations is available in the full article online.
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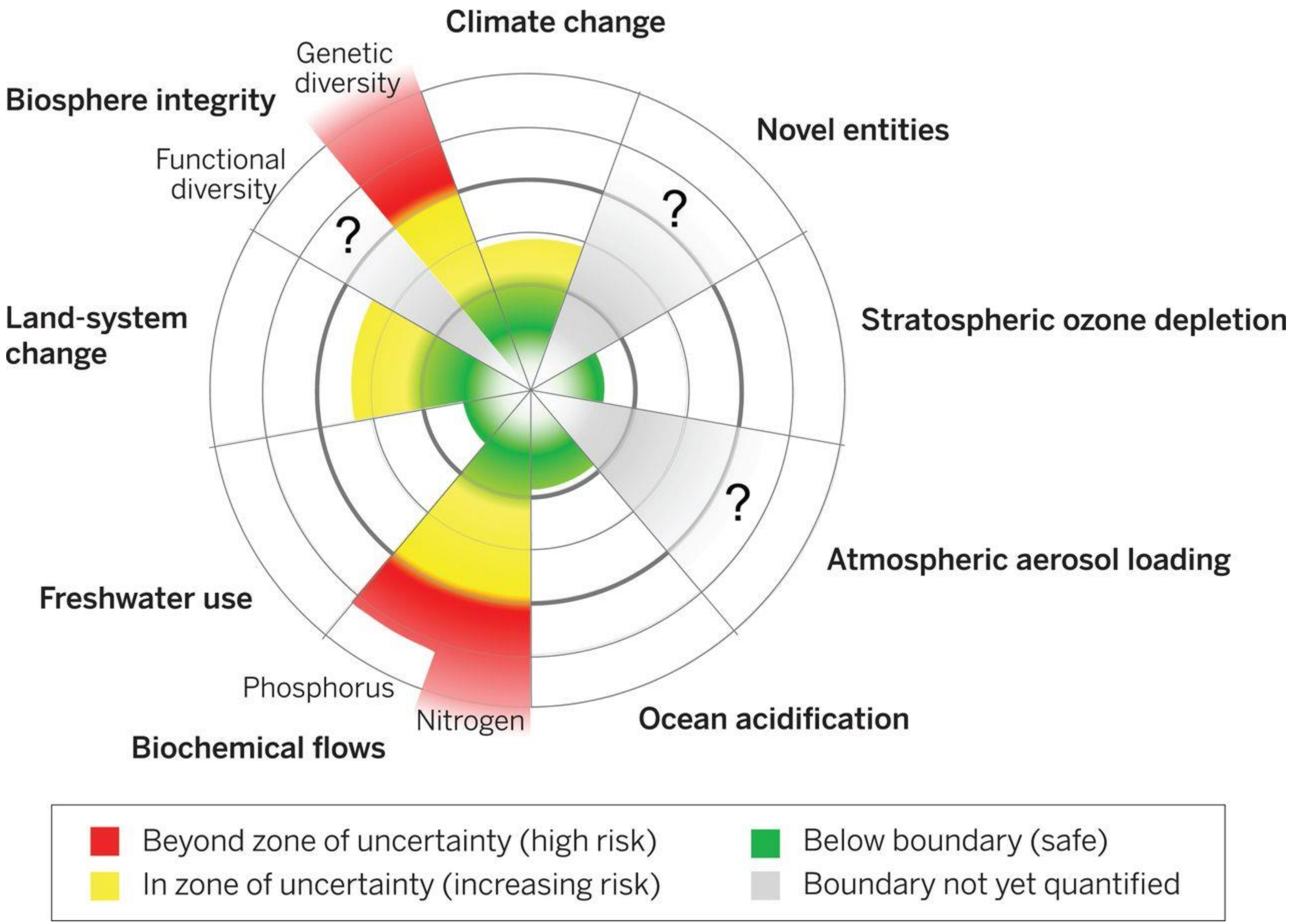
Cite this article as W. Steffen et al., Science 347, 1259855 (2015). DOI: 10.1126/science.1259855

Planetary Boundaries



Source: Steffen, Rockström et al. 2015

Planetary Boundaries

Earth-system process	Control variable(s)	Planetary boundary (zone of uncertainty)	Current value of control variable
Climate change (R2009: same)	Atmospheric CO_2 concentration, ppm	350 ppm CO_2 (350–450 ppm)	398.5 ppm CO_2
	Energy imbalance at top-of-atmosphere, W m^{-2}	+1.0 W m^{-2} (+1.0–1.5 W m^{-2})	2.3 W m^{-2} (1.1–3.3 W m^{-2})
Change in biosphere integrity (R2009: Rate of biodiversity loss)	*Genetic diversity:* Extinction rate	< 10 E/MSY (10–100 E/MSY) but with an aspirational goal of ca. 1 E/MSY (the background rate of extinction loss). E/MSY = extinctions per million species-years	100–1000 E/MSY
	Functional diversity: Biodiversity Intactness Index (BII) Note: These are interim control variables until more appropriate ones are developed	Maintain BII at 90% (90–30%) or above, assessed geographically by biomes/large regional areas (e.g. southern Africa), major marine ecosystems (e.g., coral reefs) or by large functional groups	84%, applied to southern Africa only
Stratospheric ozone depletion (R2009: same)	Stratospheric O_3 concentration, DU	<5% reduction from pre-industrial level of 290 DU (5%–10%), assessed by latitude	Only transgressed over Antarctica in Austral spring (~200 DU)
Ocean acidification (R2009: same)	Carbonate ion concentration, average global surface ocean saturation state with respect to aragonite (Ω_{arag})	≥80% of the pre-industrial aragonite saturation state of mean surface ocean, including natural diel and seasonal variability (≥80%– ≥70%)	~84% of the pre-industrial aragonite saturation state
Biogeochemical flows: (P and N cycles) (R2009: Biogeochemical flows: (interference with P and N cycles))	*P Global:* P flow from freshwater systems into the ocean	11 Tg P yr^{-1} (11–100 Tg P yr^{-1})	~22 Tg P yr^{-1}
	P Regional: P flow from fertilizers to erodible soils	6.2 Tg yr^{-1} mined and applied to erodible (agricultural) soils (6.2-11.2 Tg yr^{-1}). Boundary is a global average but regional distribution is critical for impacts.	~14 Tg P yr^{-1}
	N Global: Industrial and intentional biological fixation of N	62 Tg N yr^{-1} (62–82 Tg N yr^{-1}). Boundary acts as a global 'valve' limiting introduction of new reactive N to Earth System, but regional distribution of fertilizer N is critical for impacts.	~150 Tg N yr^{-1}

Planetary Boundaries

Land-system change (R2009: same)	*Global:* Area of forested land as % of original forest cover	*Global:* 75% (75–54%) Values are a weighted average of the three individual biome boundaries and their uncertainty zones	62%
	Biome: Area of forested land as % of potential forest	*Biome:* Tropical: 85% (85–60%) Temperate: 50% (50–30%) Boreal: 85% (85–60%)	
Freshwater use (R2009: Global freshwater use)	*Global:* Maximum amount of consumptive blue water use (km^3yr^{-1})	*Global:* 4000 km^3 yr^{-1} (4000–6000 km^3 yr^{-1})	~2600 km^3 yr^{-1}
	Basin: Blue water withdrawal as % of mean monthly river flow	*Basin:* Maximum monthly withdrawal as a percentage of mean monthly river flow. For low-flow months: 25% (25–55%); for intermediate-flow months: 30% (30–60%); for high-flow months: 55% (55–85%)	
Atmospheric aerosol loading (R2009: same)	*Global:* Aerosol Optical Depth (AOD), but much regional variation		
	Regional: AOD as a seasonal average over a region. South Asian Monsoon used as a case study	*Regional:* (South Asian Monsoon as a case study): anthropogenic total (absorbing and scattering) AOD over Indian subcontinent of 0.25 (0.25–0.50); absorbing (warming) AOD less than 10% of total AOD	0.30 AOD, over South Asian region
Introduction of novel entities (R2009: Chemical pollution)	No control variable currently defined	No boundary currently identified, but see boundary for stratospheric ozone for an example of a boundary related to a novel entity (CFCs)	

Source: Steffen, Rockström et al. 2015

Module Production + Sustainability II | SCI/A/8

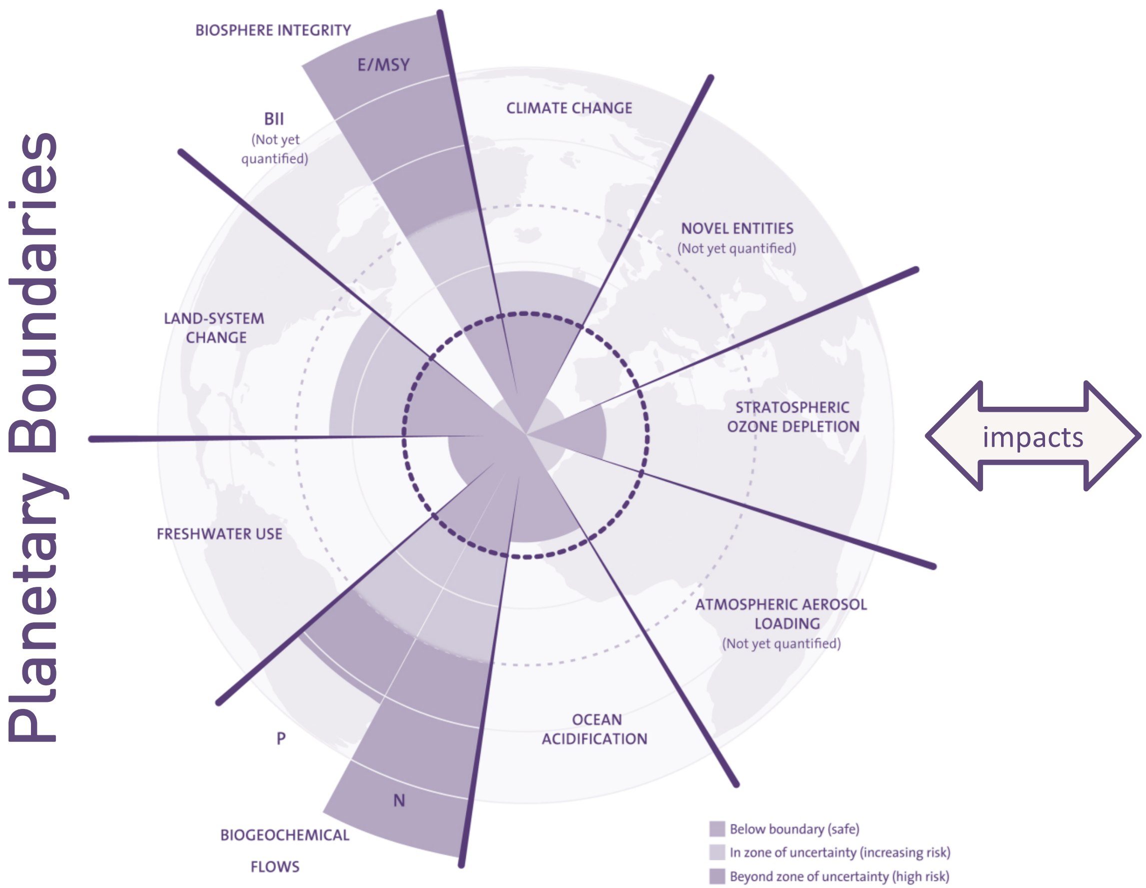
Stage of study	Semester
(A)	2nd semester / spring semester ø 16 weeks incl. assessment weeks

Module number	Module title	Credits overall
SCI/A/8 Compulsory module	Production + Sustainability II	7

Teaching session		Teaching format	P/ WP	Assessment	WCH	PS SE	%	Credits	Lecturer
I	Fashion and Product Management	S	P	-	2	24 h 26 h	-	2	Prof. Winkler
II	Innovative Textiles and Circular Economy	S	P	H*	2	24 h 51 h	30%	3	Prof. Winkler
III	Ecosystems and Economics	V/Ü	P	PRO	2	24 h 26 h	70%	2	Oliver Peters

Project work

Assessment

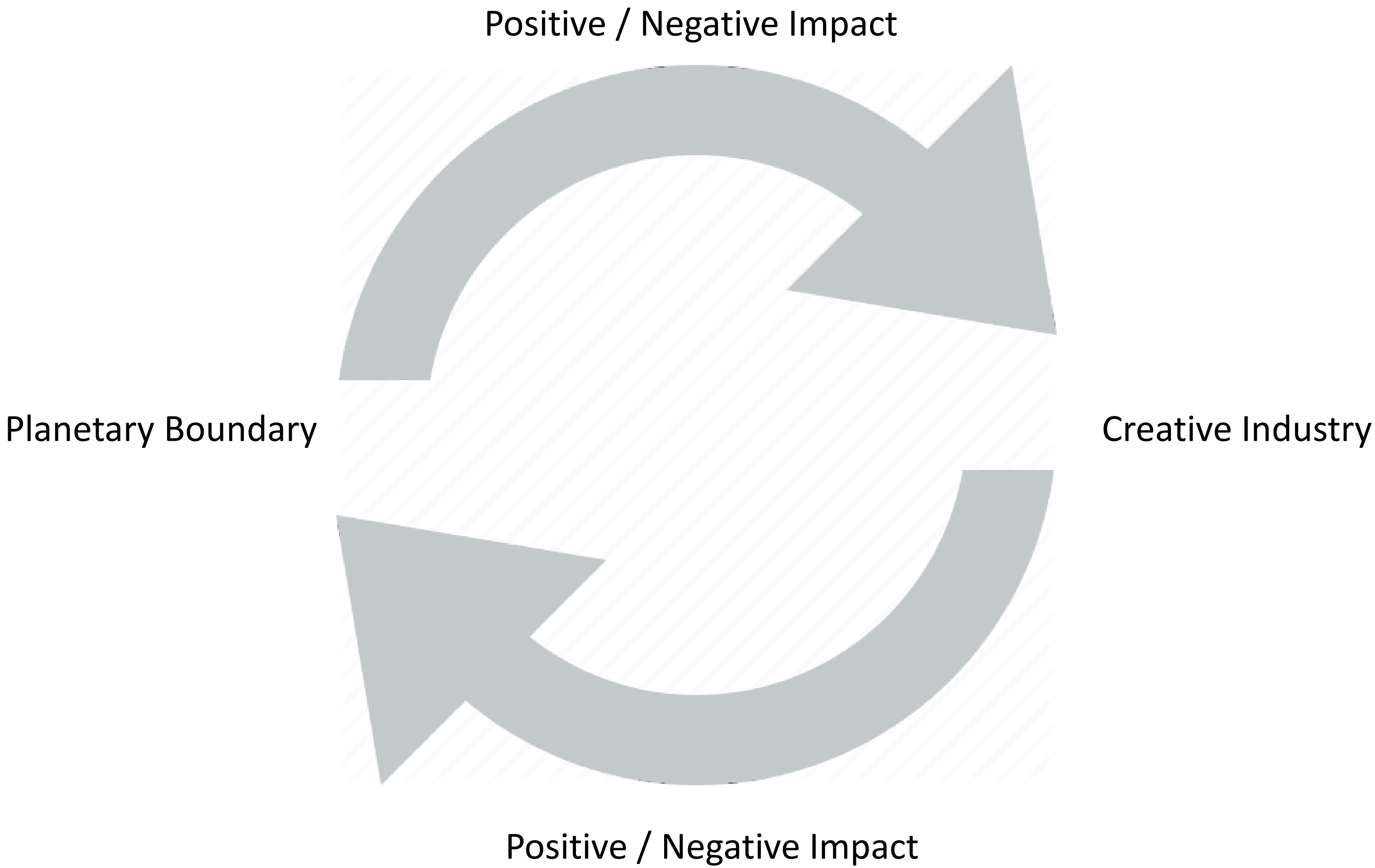


Task: identify the interdependencies between a specific environmental challenge (see planetary boundary concept) and the characteristics of a creative industry

1. Choose a link "Planetary boundaries X Creative Industries"

Creative Industry / Planetary Boundaries	Architecture / construction	Interior / manu-facturing	Fashion industry	Film and video industry	Music industry	(Performing) Arts	Literature / paper industry	Video gaming industry
Loss of biosphere integrity (biodiversity loss and extinctions)	+	+	+	+	+	+	+	+
Climate Change	+	+	+	+	+	+	+	+
Nitrogen and phosphorus flows to the biosphere and oceans	+	+	+	+	+	+	+	+
Land system change	+	+	+	+	+	+	+	+
Ocean acidification	+	+	+	+	+	+	+	+
Atmospheric aerosol loading	+	+	+	+	+	+	+	+
Stratospheric ozone depletion	+	+	+	+	+	+	+	+
Freshwater consumption and the global hydrological cycle	+	+	+	+	+	+	+	+
Chemical pollution and the release of novel entities	+	+	+	+	+	+	+	+

2. Analyze the interdependencies

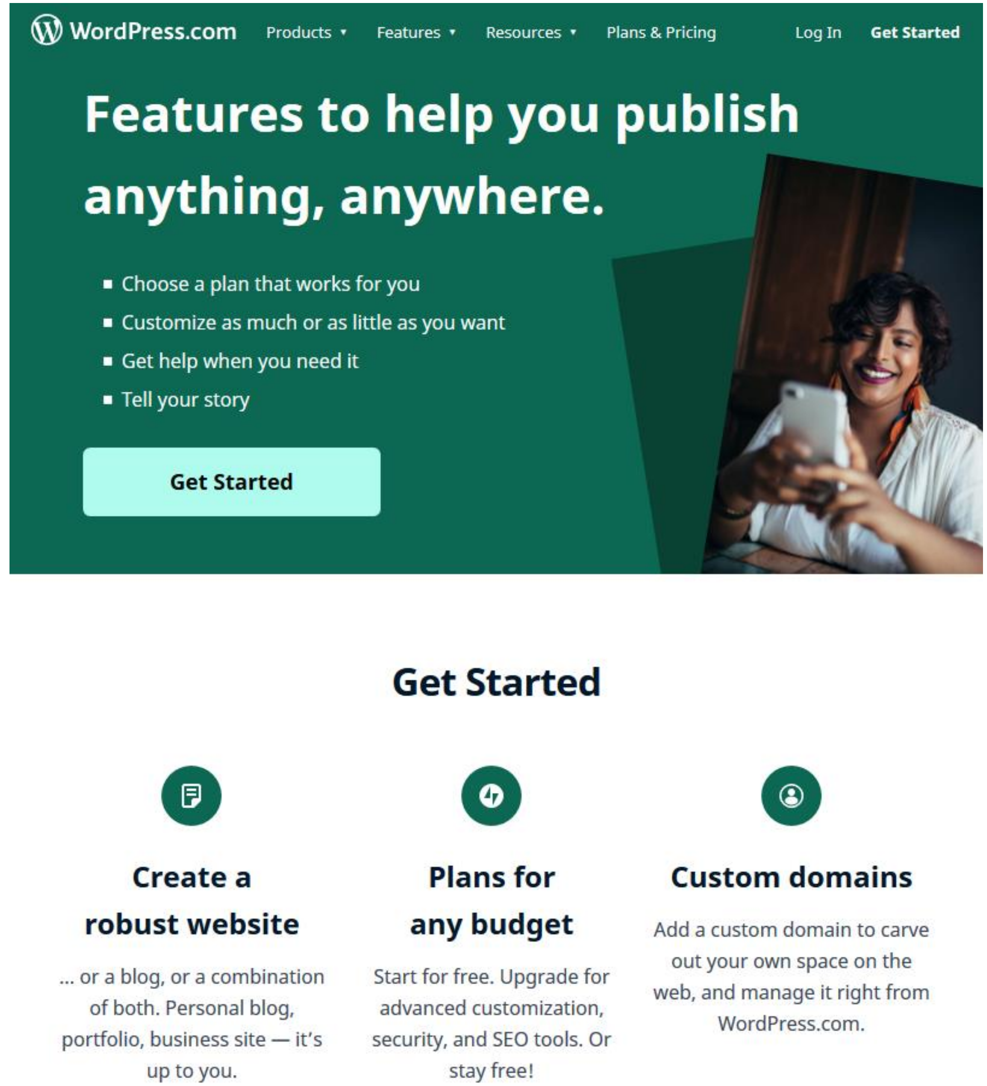


2. Visualize the results on your own webpage

http://future-link.org/planetary-boundaries/

WordPress (WordPress.org) is a free and open-source content management system (CMS) based on PHP & MySQL. Features include a plugin architecture and a template system. It is most associated with blogging but supports other types of web content including more traditional mailing lists and forums, media galleries, and online stores.

Used by more than 60 million websites, including 33.6% of the top 10 million websites as of April 2019, WordPress is the most popular website management system in use.



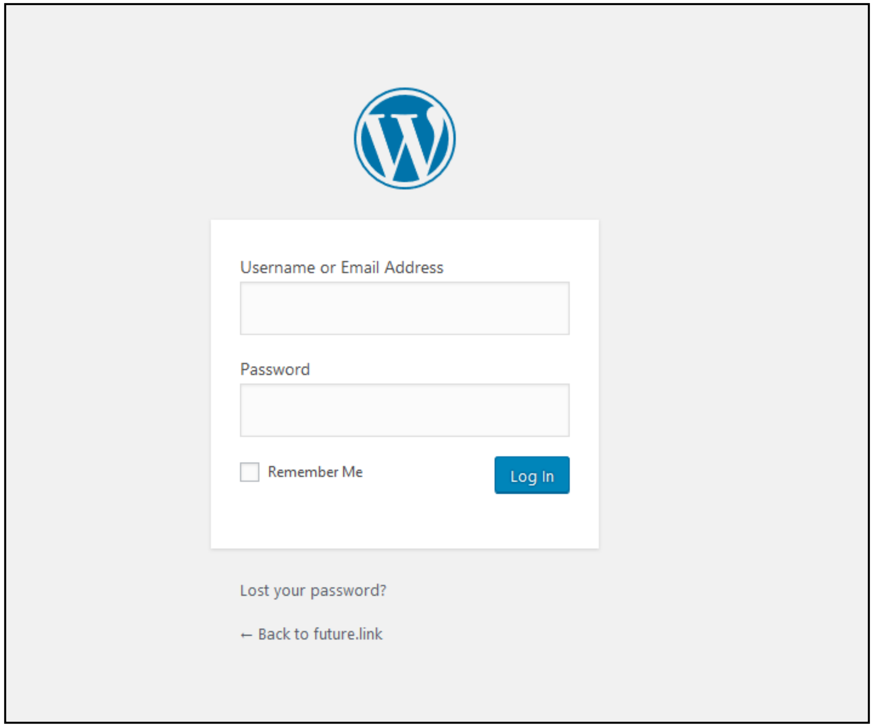
future-link

Preliminary access to the backend of future-link.org!

Your login will be set in order to give you a first impression, to test some functions or to create your personal profile. This offer is aimed at all those who already have experience with Wordpress.

Please note: There will be an official introduction to web development with Wordpress in May, where you will get to know the relevant functions and which will enable you to design / visualize your research content (for the exam).

Go to www.future-link.org/admin



Username: “common” first name or full name (blank, no special characters) or AMD email address

Password: futureclass_ddmmyyyy (date of birth)

Assessment

Milestone 3: Oral Project Exam (in preparation for your master defense)

expected July 22, 2022

9:00 – 18:30

Structure of individual exams

4 min: Introduction of your project

4 min: Q&A to project related planetary boundary and creative industry

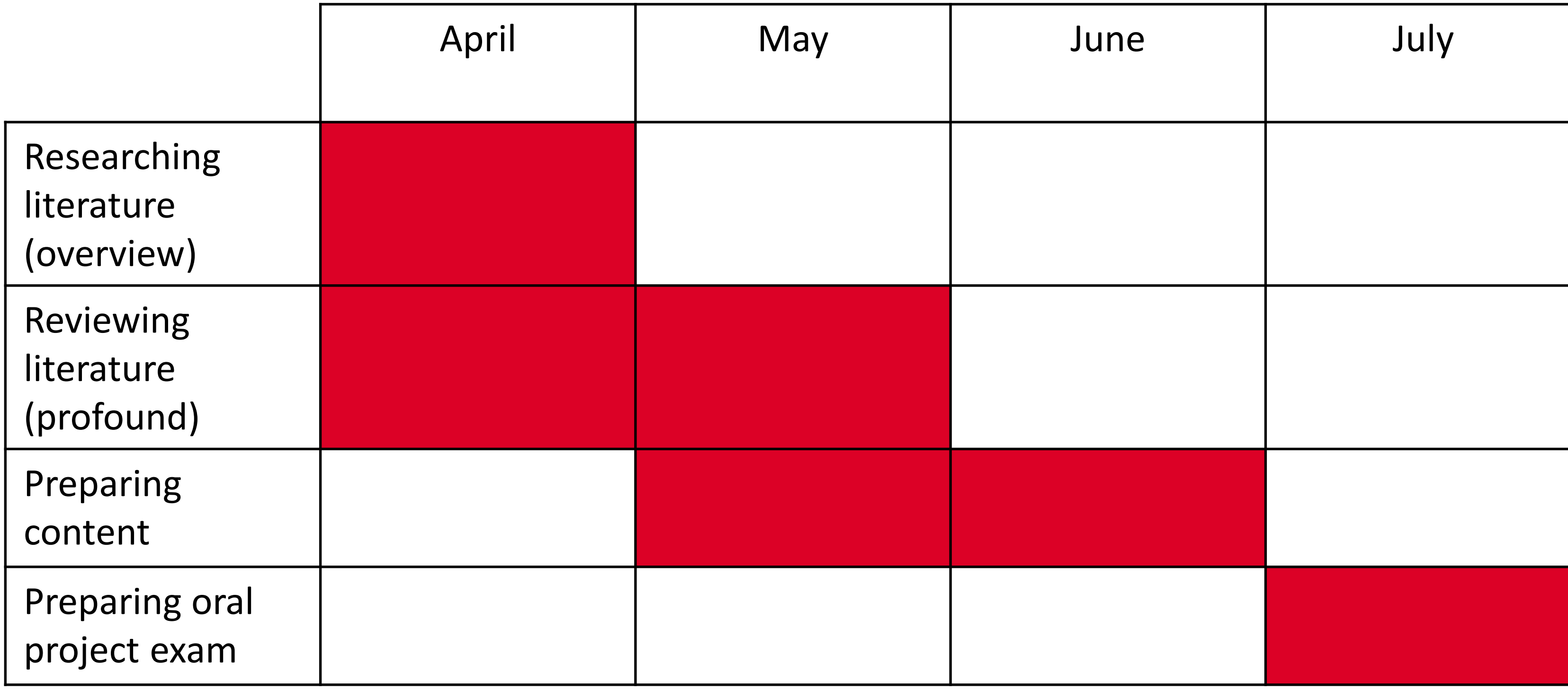
4 min: Q&A to lecture content

3 min: Feedback

= 15 min in total

The final exam schedule will be disseminated in May.

Assessment



Milestone 1: Decision and announcement of the subject

May 11, 2022

Milestone 2: Final upload and visualization of content on future-link.org*

June 22, 2022

Milestone 3: Oral Project Exam

expected July 22, 2022

*Everyone is encouraged to create a website to acquire very helpful web development skills. However, the content can also be blocked for the public (not visible on future-link.org) if desired.