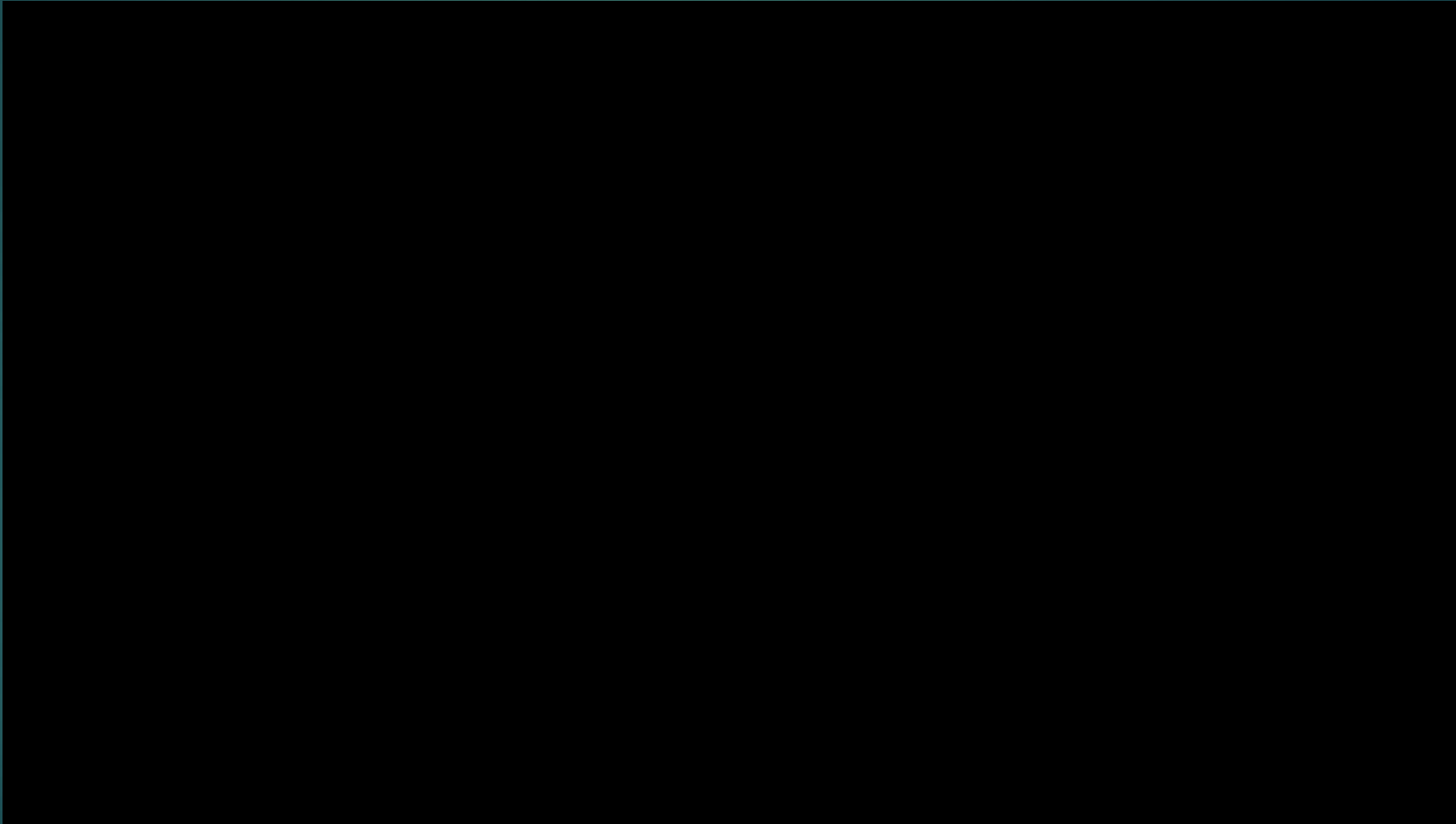


This is the PDF version of an animated slide presentation

SOME FIGURES MIGHT LOOK ODD AND THE VIDEOS WILL NOT WORK
PLEASE, CONTACT ME FOR THE FULL VERSION OF THE CURSE

The Anthropocene & Planetary Boundaries



Lectures: Global change & Pollution science

	Monday Oct 1 st	Tuesday Oct 2 nd	Wednesday Oct 3 rd	Thursday Oct 4 th	Friday Oct 5 th
Seminar 10 am- 2pm	Introduction to global change	Anthropocene, The rise of human enterprise & Planetary boundaries	Bank holiday	Planetary boundaries Agriculture & Fisheries as drivers of change Invasive species	Home activity Student protocol
Lab work 2 pm – 4 pm	Introduction to Pollution Science & Ecotoxicology	Measuring Toxicity: concepts & principles Plastics & Microplastics	Bank holiday	Starting microplastic ecotoxicological test	Home activity Student protocol
	Monday Oct 8 th	Tuesday Oct 9 th	Wednesday Oct 10 th	Thursday Oct 11 th	Friday Oct 12 th
Seminar 10 am- 2pm	Climate change Energy & Environmental health Pollution Types & contaminants	Course evaluation Traditional Micro-contaminants	Light pollution Biodiversity loss Habitat loss	MSc Course enrollment day	Cases of success: Ozone depletion Oil spills, Natural reserves
Lab work 2 pm – 4 pm	Checking microplastic 96 h toxicity	Analysing toxicity data	Emerging contaminants Endocrine disruptors Antibiotic resistance	Predicting & Managing pollution	Overall review Student protocol Evaluation



THE MAIN EVALUATION CRITERIA TO SUCCESSFULLY CONCLUDE THIS COURSE IS TO BE ABLE TO:

Critically rethink the **diverse range of known impacts** that human activities caused **on the environmental health** and elaborate on whether microplastic contamination should be regulated or not.

The Anthropocene & Planetary Boundaries

Introduction to Global Change & Pollution Science

STUDENT ACTIVITY: A-B MONOLOGUE

Anthropocene

THE RISE OF HUMAN ENTERPRISE

Skills you gain:

- 1- Understand the concept of Anthropocene
- 2- Get familiar with the broad range of human impacts on the Earth System
- 3- Obtain knowledge on the rate of change in baselines
- 4- Critically evaluate our life-style

References:

**PHILOSOPHICAL
TRANSACTIONS**
OF
THE ROYAL
SOCIETY

Phil. Trans. R. Soc. A (2011) **369**, 842–867
doi:10.1098/rsta.2010.0327

REVIEW

The Anthropocene: conceptual and historical perspectives

BY WILL STEFFEN^{1,*}, JACQUES GRINEVALD², PAUL CRUTZEN³
AND JOHN MCNEILL⁴

REVIEW

Defaunation in the Anthropocene


Rodolfo Dirzo,^{1,*} Hillary S. Young,² Mauro Galetti,³ Gerardo Ceballos,⁴
Nick J. B. Isaac,⁵ Ben Collen⁶

BioOne RESEARCH
EVOLVED

The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature

Author(s): Will Steffen, Paul J. Crutzen, John R. McNeill
Source: *AMBIO: A Journal of the Human Environment*, 36(8):614-621.
Published By: Royal Swedish Academy of Sciences
[https://doi.org/10.1579/0044-7447\(2007\)36\[614:TAAHNO\]2.0.CO;2](https://doi.org/10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2)
URL: <http://www.bioone.org/doi/full/10.1579/0044-7447%282007%2936%5B614%3ATAAHNO%5D2.0.CO%3B2>

YouTube DE Pesquisar



Beyond the Anthropocene | Johan Rockström

18.005 visualizações

231 12 COMPARTILHAR

WORLD ECONOMIC FORUM
Publicado em 14 de fev de 2017

INSCREVER-SE 215 MIL

It is not an exclusivity of humans, all living beings modify their environment

Cyanobacteria



<https://www.sciencedaily.com>

Japanese puffer fish



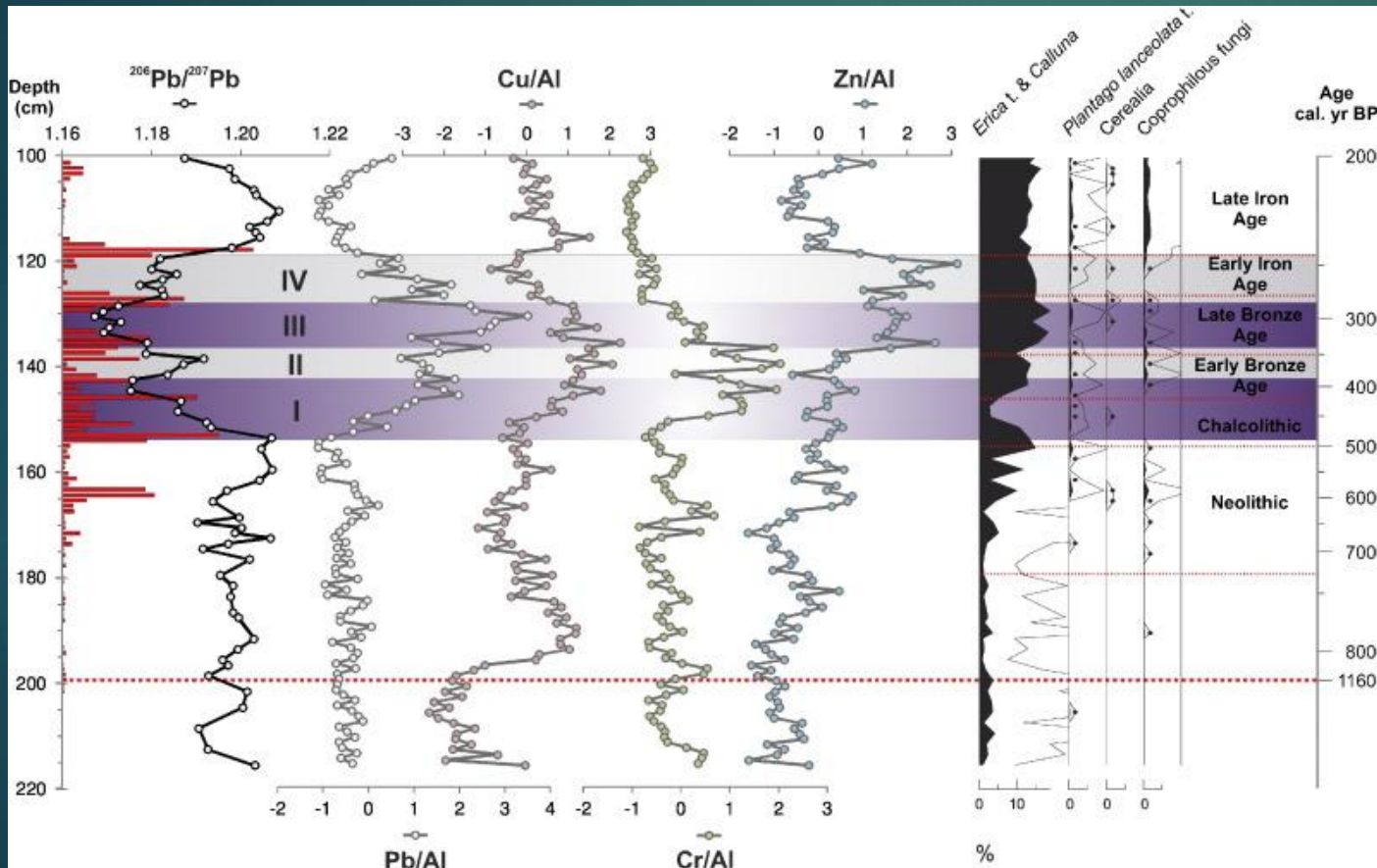
<https://www.pinterest.co.uk/pin/237494580325212903/>

Humans

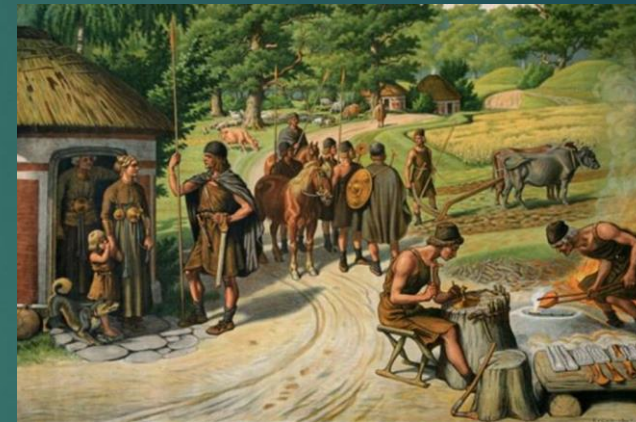


rosacuca.com.br

The first global signs of human presence dates long ago



Changes on metal biochemistry during Bronze age



<http://www.ancient-origins.net>

Evidence of regional/local atmospheric metal pollution triggered by the earliest phases of mining/metallurgy in Southwestern Europe.

<https://doi.org/10.1016/j.scitotenv.2015.12.078>

Anthropocene: The era of mankind

Core concept: The Anthropocene describes the current epoch in which humans reached development and numbers to rival and modify the natural geophysical function of our planet



Started ~ 200 years ago

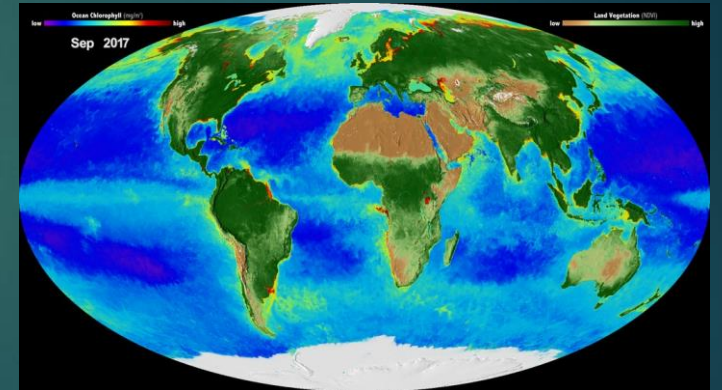


Physical changes

Chemical changes

Geological changes

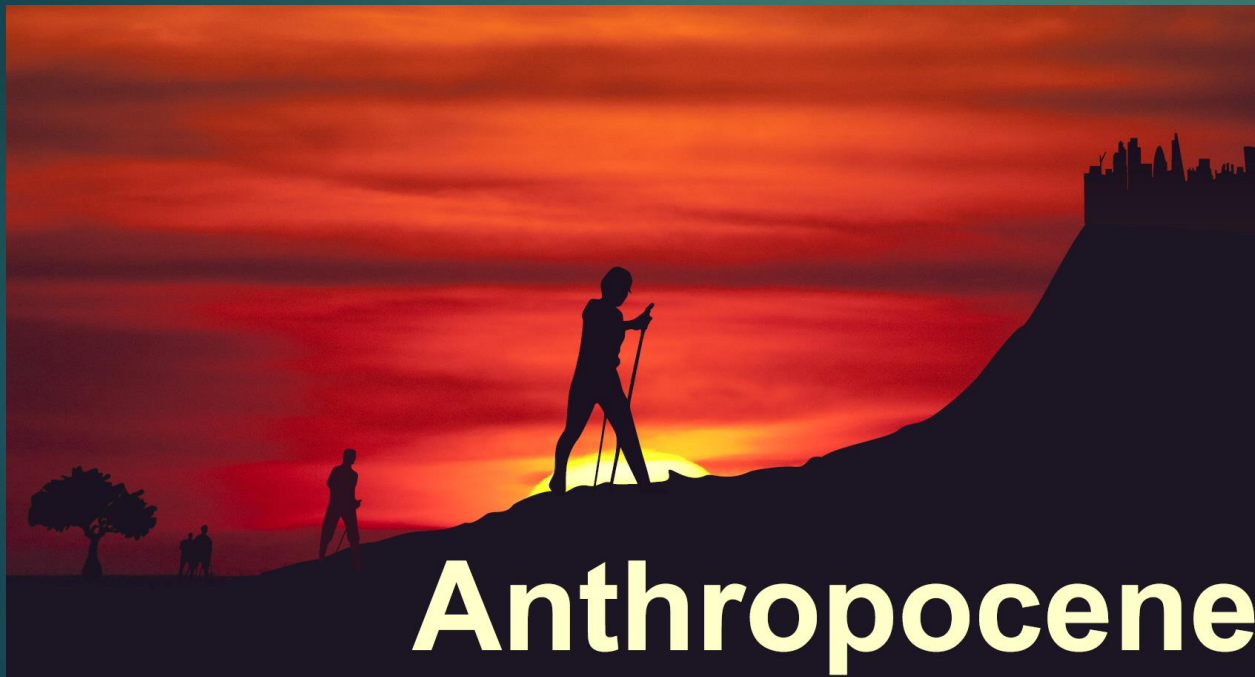
Pollution, environmentalists & social scientists



Biological changes

Anthropocene markers are dynamic, non-linear, & exponential

Student activity (A-B Monologue): Check online the temporal evolution of a process typical of human current activities and share with the group.



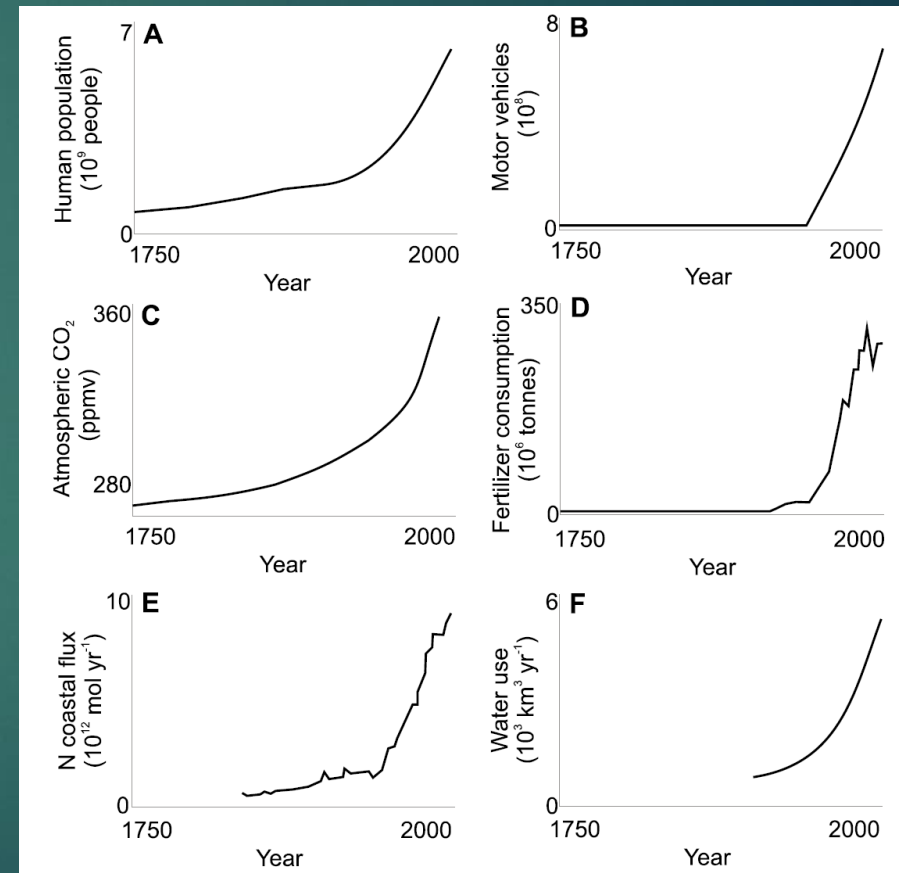
What does it mean to change exponentially?

If we „walk exponentially“ for 35 steps starting with 1m:

- 10 steps: 500m+ within botanical garden
- 17 steps: 130km+ Arriving to Baltic Sea
- 23 steps: 6000km+ Arriving to New York
- 26 steps: 1.5 turns around the Earth
- 35 steps: Millions of Km Arriving to Mars

Anthropocene & the rise of human enterprise

- Remarkable population growth
- The great acceleration (1940)
- Consequences in biogeophysical forces



Characteristic markers of the Anthropocene. Human population (A), popularization and consumption of technology (B), carbon dioxide atmospheric contamination (C), fertilizer consumption (D), coastal nitrogen input (E), and water usage (F). Figures are adapted from Steffen et al. 2011.

The human enterprise in few numbers

- 77 % of ice-free land surface is not pristine
- Highest CO₂ in last 8000 years
- Reactive nitrogen, sulphur, and phosphorus much above natural cycles
- 60-80 % of overfished species
- High extinction rates
- Biomass of humans and domestic mammals equals 96 % of total mammals
- Mean erosion rate 10-30x natural average
- Annual plastic equals human biomass
- Technosphere: 30 trillion tons (4000 tons per living human)



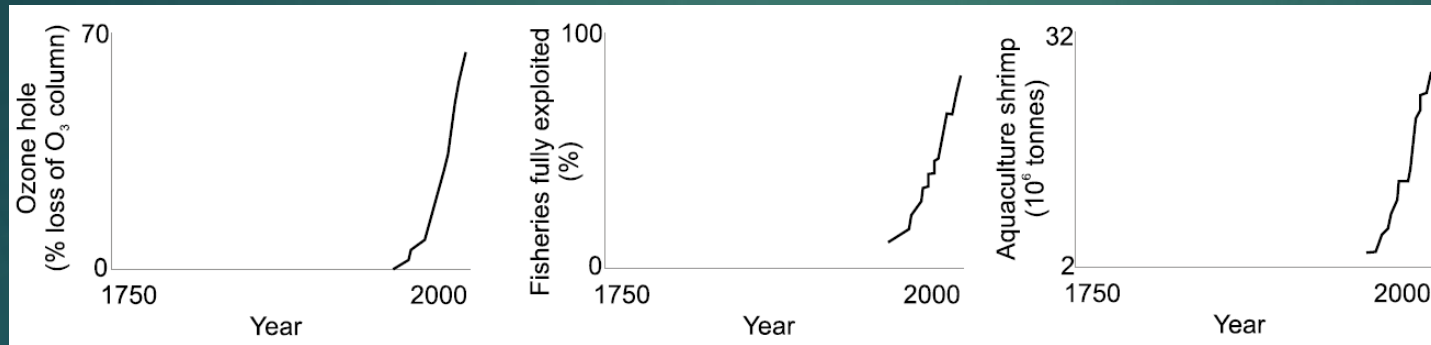
Anthropocene processes: The unequivocal Climate Change

- Temperature changes
- Sea level rise
- Ocean acidification
- Extreme events
- Coastal squeeze
- Climate forcing and feedbacks



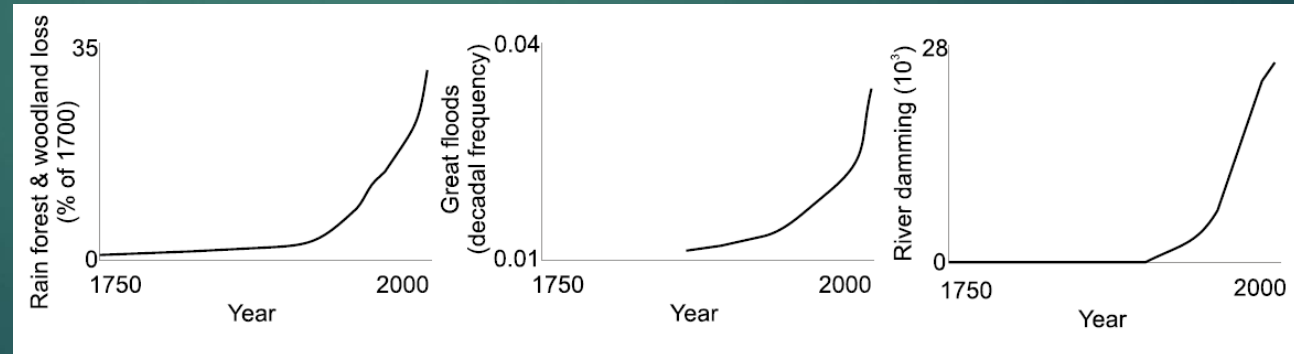
<https://svs.gsfc.nasa.gov>

The human enterprise & Global change



Other global change processes affect broad ranges of processes of Earth System in its physical, chemical, and biological aspects

Loss of vegetal cover and extreme weather are causing erosion and increased suspended particle transport by rivers, resulting in sediment contamination and its effects, which together with other interferences in the water system strongly impacts water cycle at global level.

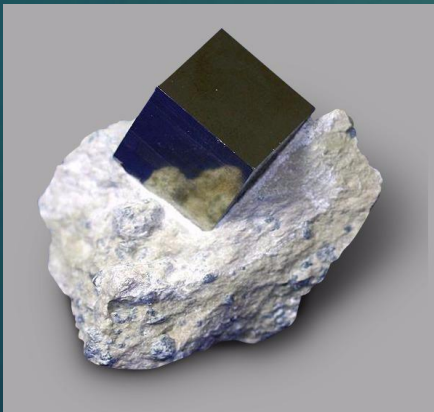


Anthropocene processes adapted from Steffen et al. 2011.

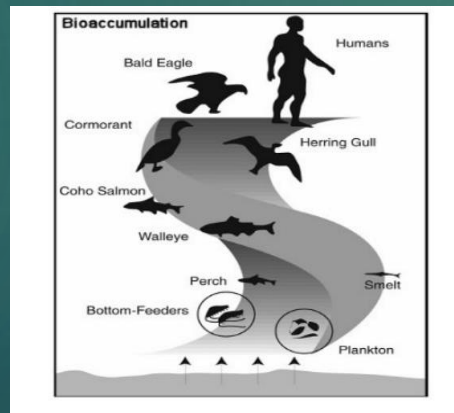
Anthropocene & the chemical cocktail

- American Chemical Society reports >117 million chemical compounds
- ~15,000 new compounds per day
- 1-2 % enter the market

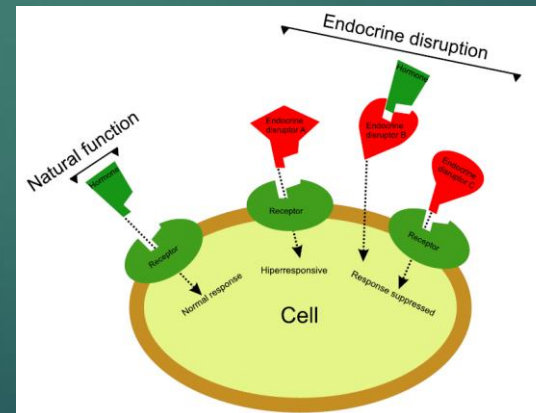
Trace Metals



POPs

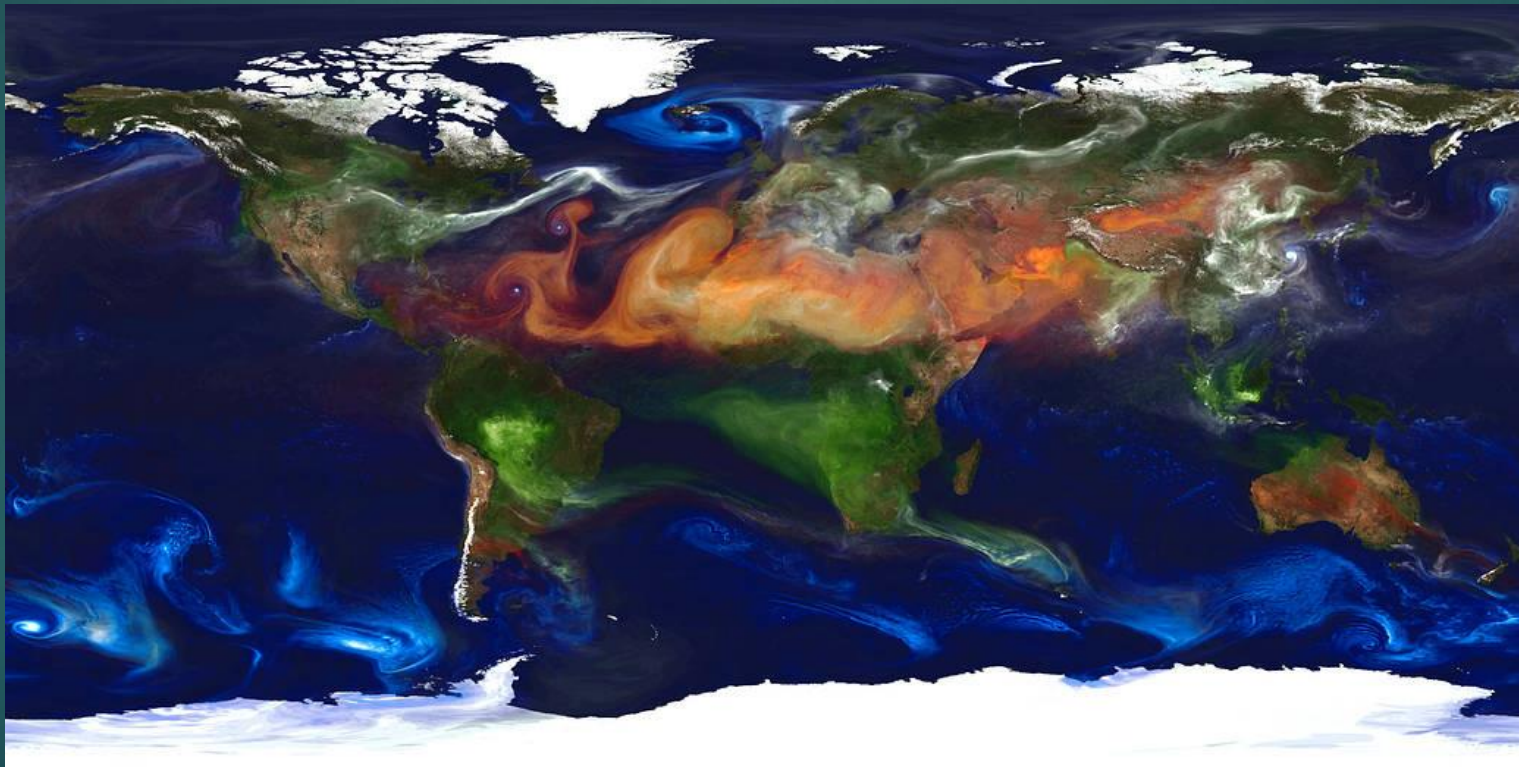


Emerging contaminants & Endocrine disruptors



Global pollution & Atmosphere

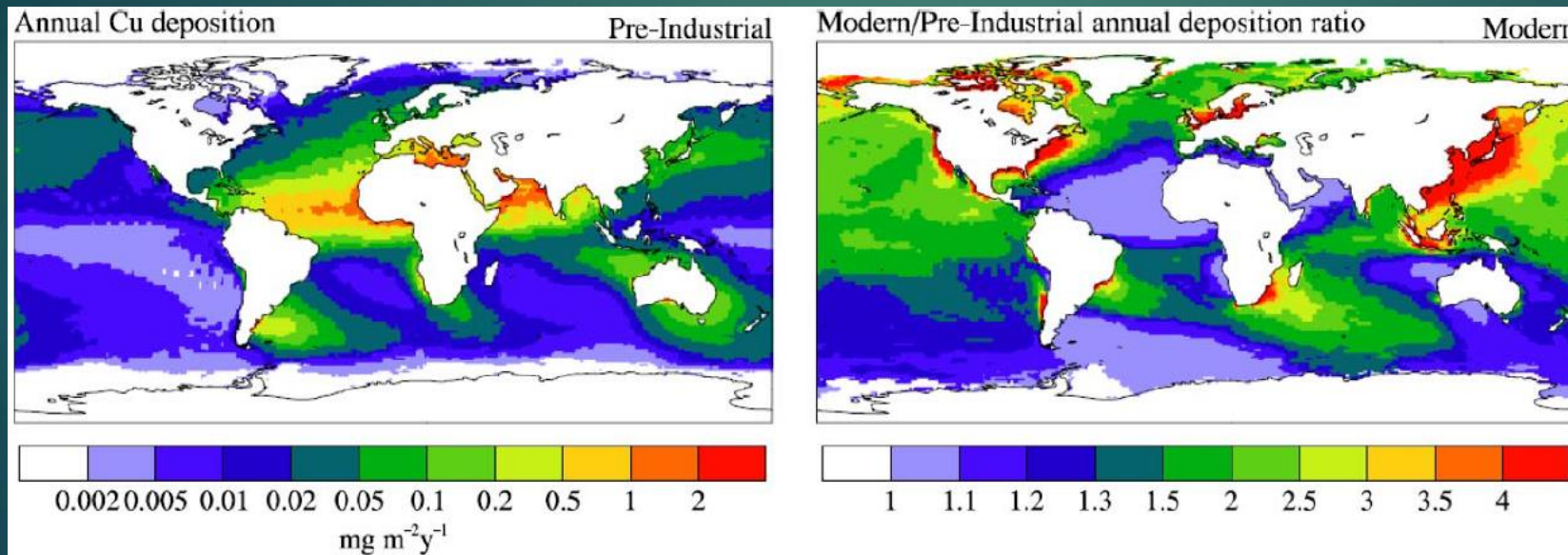
- Aerosols have well-known, serious human health effects, leading to about 7.2 million deaths per year.
- They also affect the functioning of the Earth system in many ways.



https://www.nasa.gov/multimedia/imagegallery/image_feature_2393.html

Global pollution & Atmosphere

Atmospheric deposition of metals can also account for metal input on coastal and marine systems



www.pnas.org/cgi/doi/10.1073/pnas.1207567110
<https://doi.org/10.1073/pnas.0811486106>

Global pollution: Physical & Biological stressors

Multiple contaminants typical from Anthropocene are physical or biological in nature

Table: Examples of non-chemical pollutants

Physical stressors	Biological stressors
Temperature	Pathogens
Ionizing radiation	Invasive species
Microplastics	Microbial biopesticides
Nanoparticles	Viruses

The case of *Bacillus thuringiensis*: the biopesticide



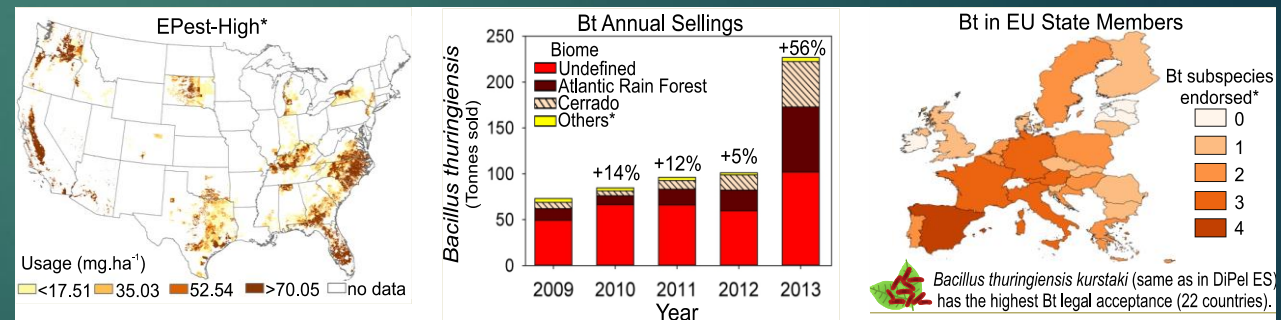
U.S.



Brazil



Europe



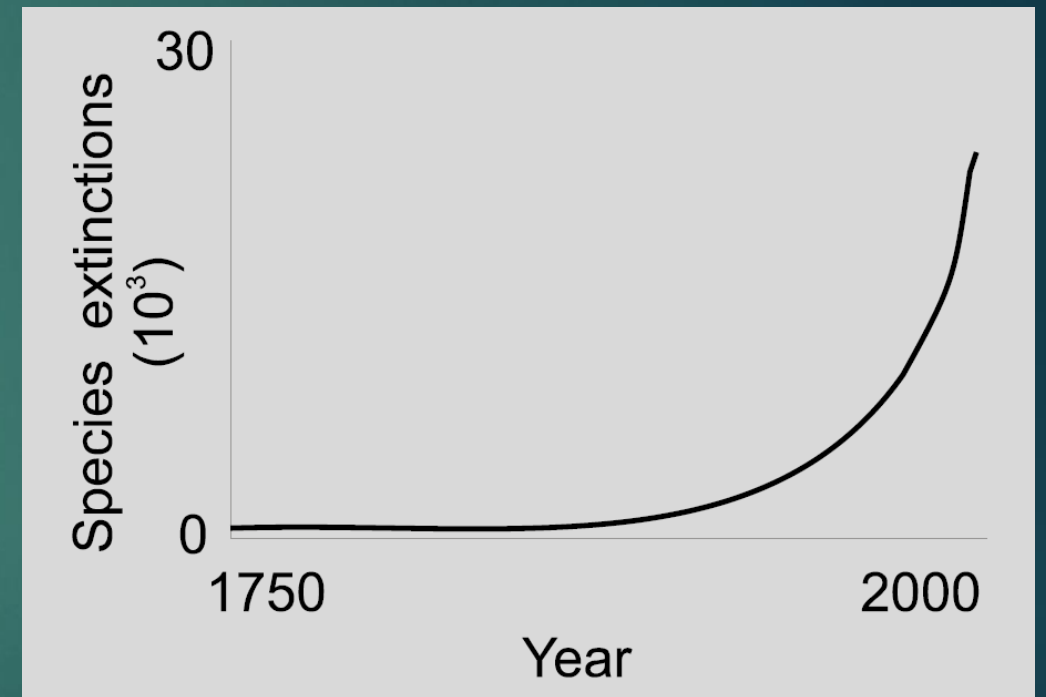
<http://dx.doi.org/10.1021/acs.est.6b03056>

Loss of biosphere integrity

Anthropocene defaunation is a pervasive phenomenon caused by human activity. Many changes already observed in species compositions might have drastic impacts on the functional biodiversity.

Causes:

- Habitat destruction
- Chemical pollution
- Physical pollution
- “Microbial pollution” & Dysbiosys
- Climate changes
- Invasive and range-expanding species
- Predation



Adapted from Steffen et al. 2011.

Anthropocene: The era of Global Changes

Anthropogenic stressors

Type	Examples
Chemical	Gases, Metals; Persistent organic pollutants; Emerging contaminants
Physical	Microplastics; Sediment loads; Temperature
Biological	Microbes; Viruses; Invasive species

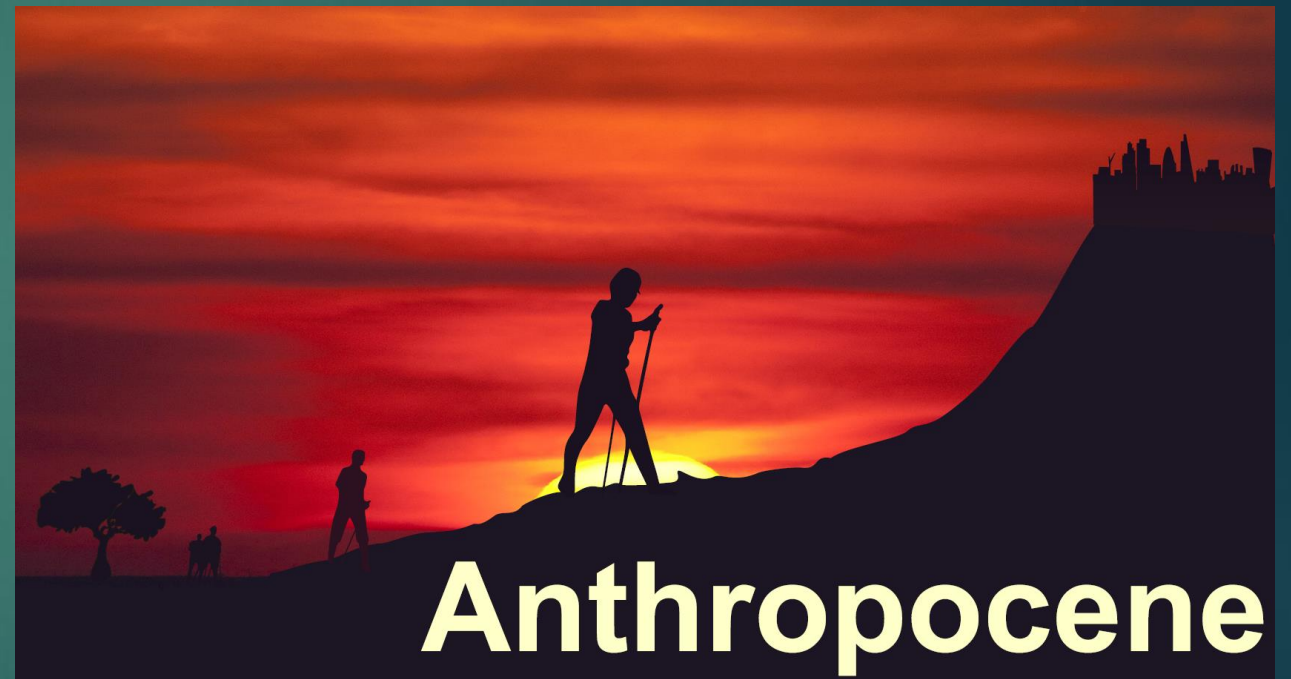
Environmental processes

Type	Examples
Global Changes	Coastal squeeze; Climate change;
Atmospheric Circulation	Global destilation; Global contaminant transport
Biological Phenomena	Biodiversity loss; Morphophysiological selection

A improved understanding of the controls of pollution is essential to better quantify impacts and elaborate mitigation actions

Summary: The Anthropocene

- ▶ Epoch in which humans rival with the natural forces on the Earth System.
- ▶ Anthropogenic activities exponentially modify the physical, chemical, and biological function of the planet.
- ▶ The changes in the natural function push the Earth system towards a new 'equilibrium' state.
- ▶ Awareness is important to ensure future sustainability .



STUDENT ACTIVITY: A-B DIALOGUE

THE ANTHROPOCENE RAISES A NEW QUESTION: "WHAT ARE THE NON-NEGOTIABLE PLANETARY PRECONDITIONS THAT HUMANITY NEEDS TO RESPECT IN ORDER TO AVOID THE RISK OF DELETERIOUS OR EVEN CATASTROPHIC ENVIRONMENTAL CHANGE AT CONTINENTAL TO GLOBAL SCALES?"





Thanks

TOMORROW WE WILL DISCUSS SOME OF THE CONCEPTS FROM TODAY, DON'T FORGET TO BRING SOMETHING NEW TO SHARE WITH US!