

Anthropocene and scientific research

Julian Carrey

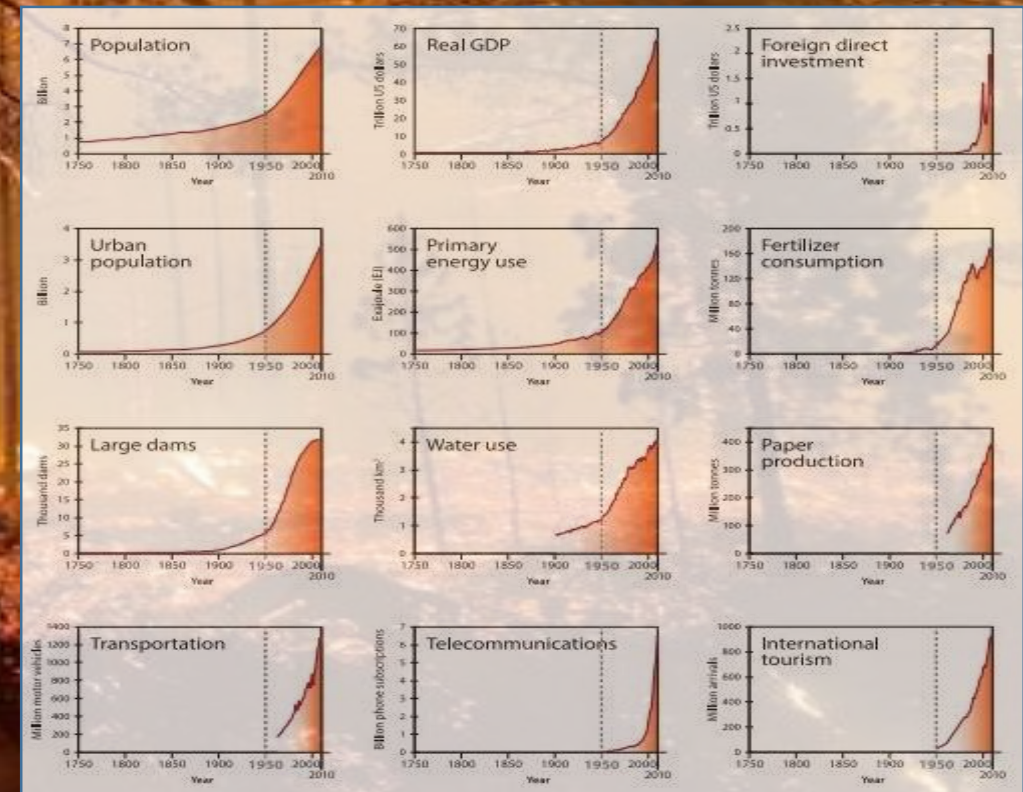
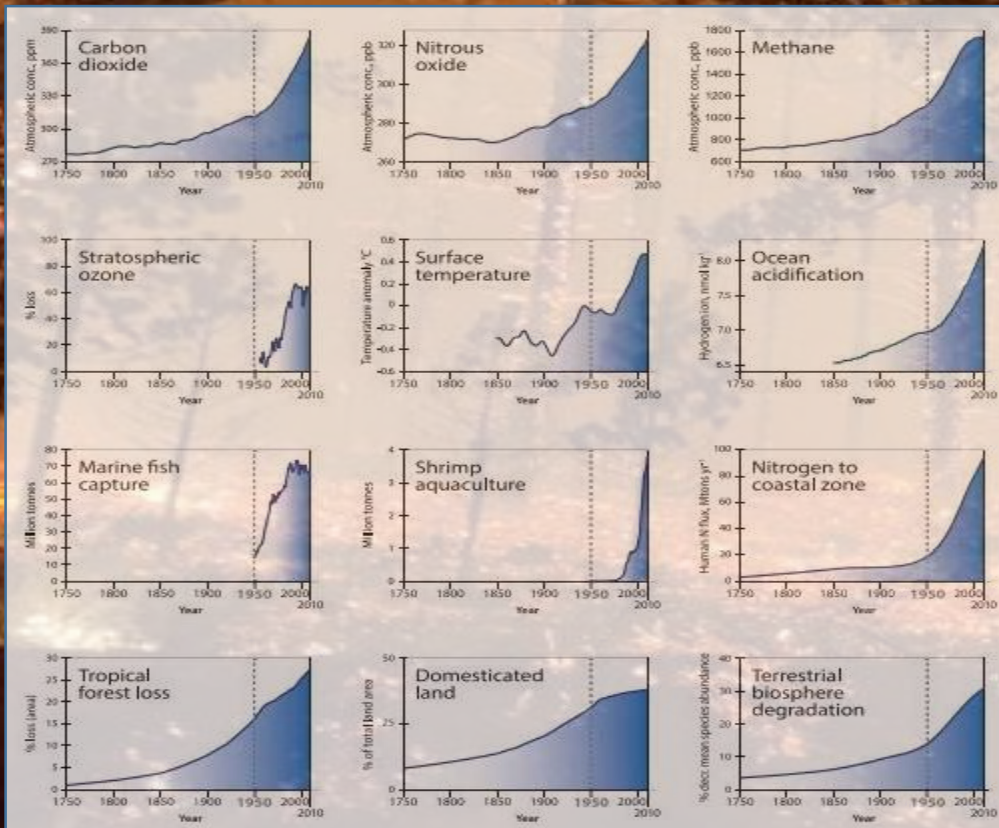
Laboratoire de Physique et chimie des Nano-objets, Toulouse

INSA Toulouse

Atécopol
atecopol.hypotheses.org

Scientifiques en rébellion

Labos point 15



Outline

- ▶ Anthropocene and planet boundaries
- ▶ Focus on biodiversity loss
- ▶ Focus on climate change
- ▶ Why research is concerned
- ▶ What to do as citizens and scientists?



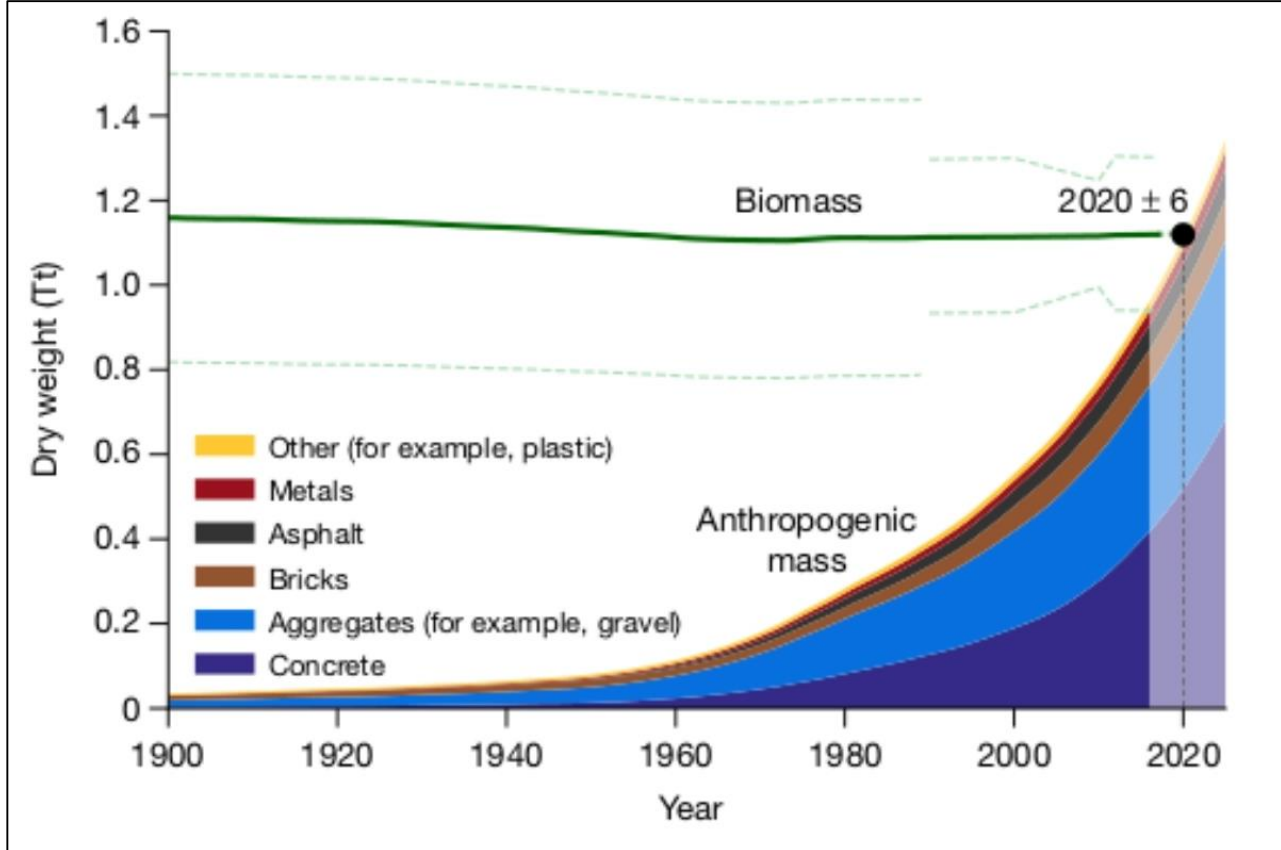
Outline



Anthropocene and
planet boundaries

The power of transformation from mankind has reached the one of natural forces....

More human stuffs than biomass



« Global human-made mass exceeds all living biomass », Emily Elhacham, et al. Nature, 12/2020.

The power of transformation from mankind has reached the one of natural forces....



coal mine in Germany

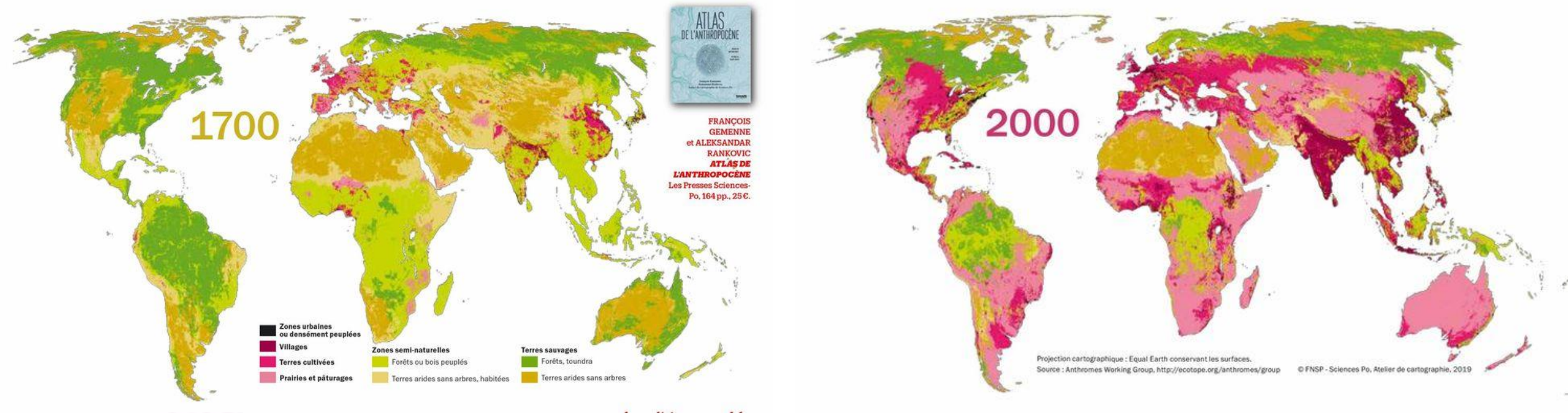
Human activities produce 24 times more sediments than the ones supplied annually by major rivers to the oceans.



Agricultural soil erosion

« Humans are the most significant global geomorphological driving force of the 21st Century », Anthropocene Review 5, 222 (2018)

Artificialisation of the land....



■ Zones urbaines ou densément peuplées
 ■ Villages
 ■ Terres cultivées
 ■ Prairies et pâturages
 ■ Zones semi-naturelles
 ■ Forêts ou bois peuplés
 ■ Terres arides sans arbres, habitées
 ■ Terres sauvages
 ■ Forêts, toundra
 ■ Terres arides sans arbres



Urban area or densely populated zone

Villages

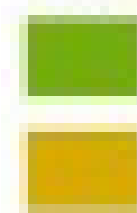
Cultivated lands

Pasture



Populated forest

Populated arid zones

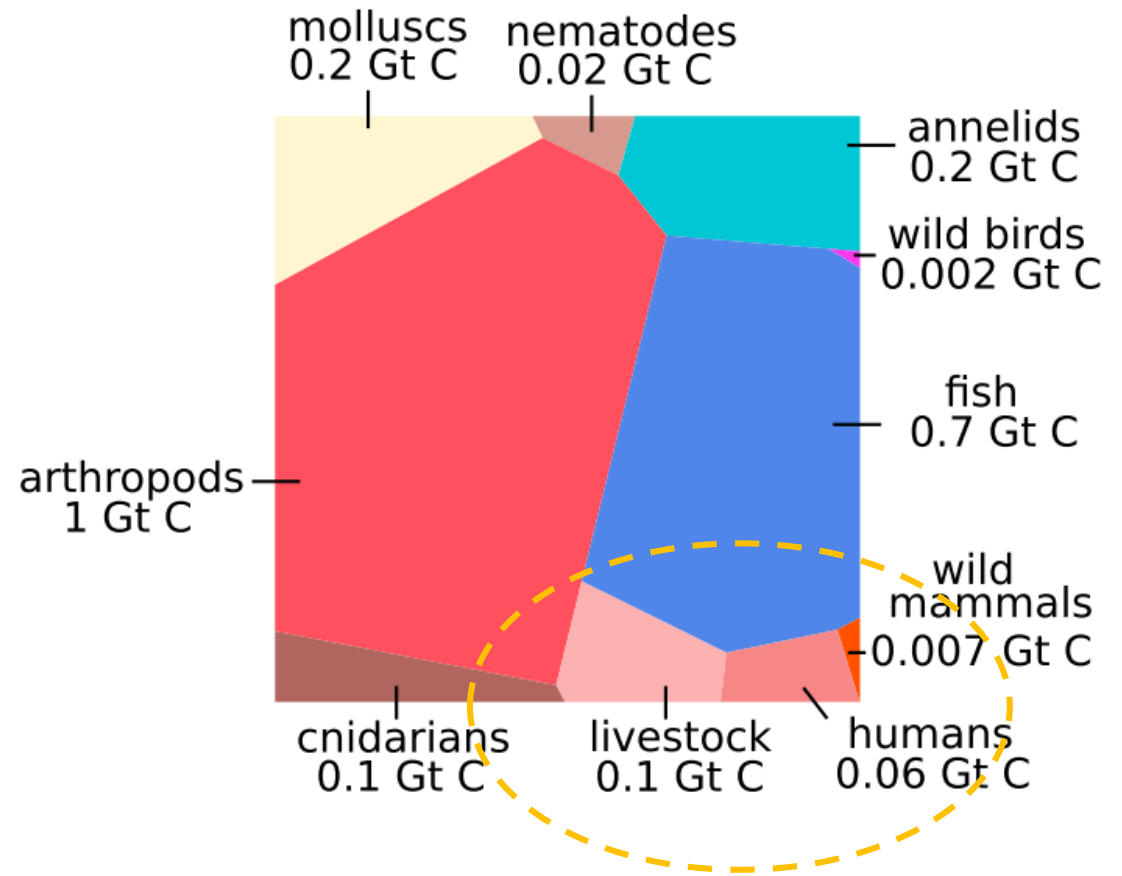
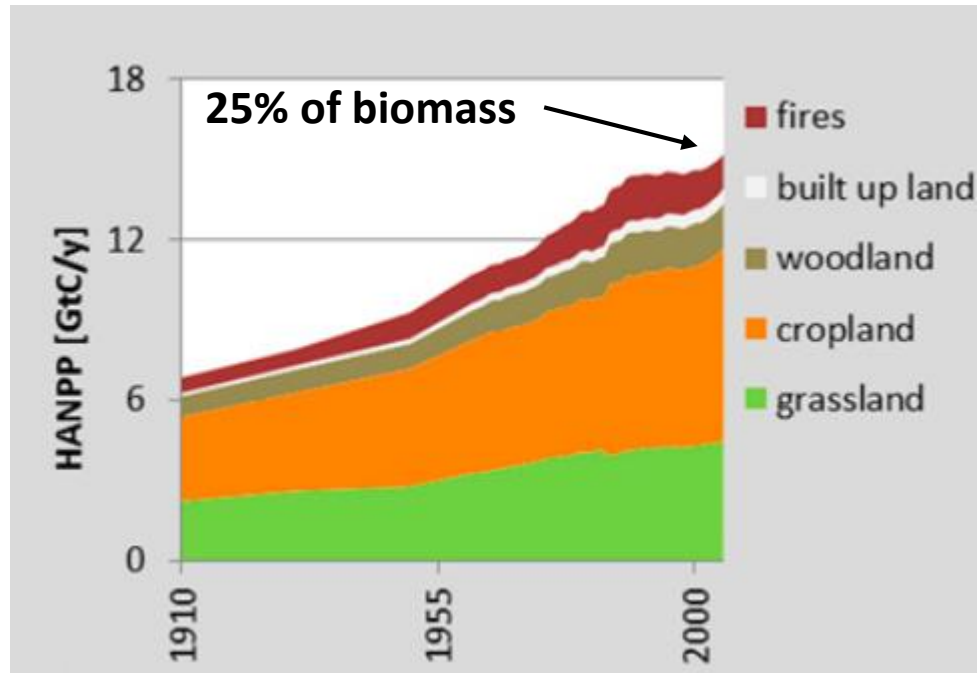


Unhabitated forest

Unhabitated arid zones

Biomass and humans

Human appropriation of primary production



Humans and livestock represent 95% of mammals in weight

“Global human appropriation of net primary production doubled in the 20th century”, F. Krausmann et al., PNAS 110, 10324 (2013) ; “The biomass distribution on Earth” Y. M. Bar-On PNAS 115, 6506 (2018).

Chemical pollution...



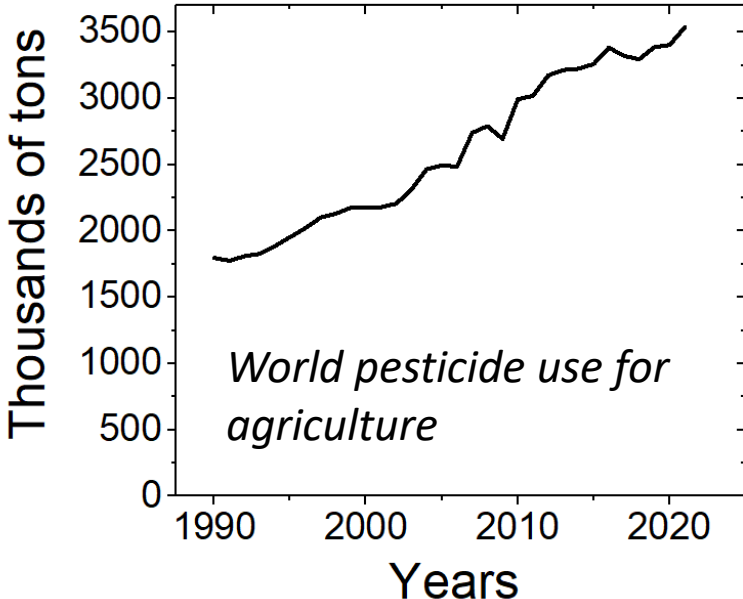
Air and water pollution



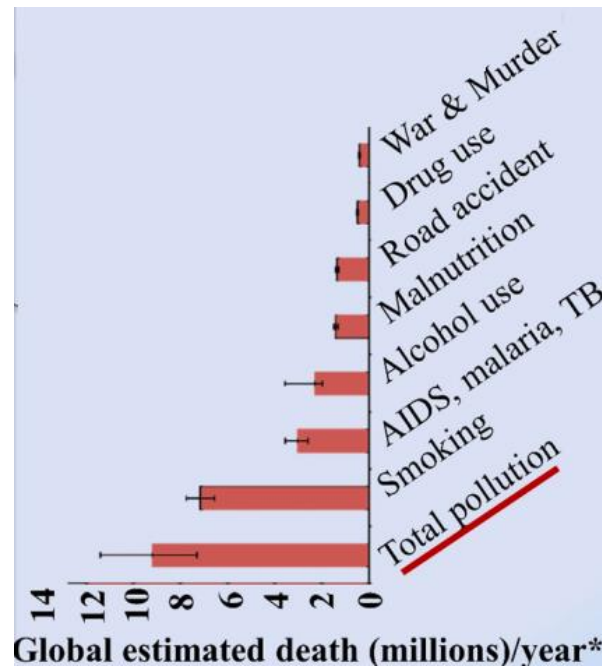
Mining waste



Diminishing returns of material extraction

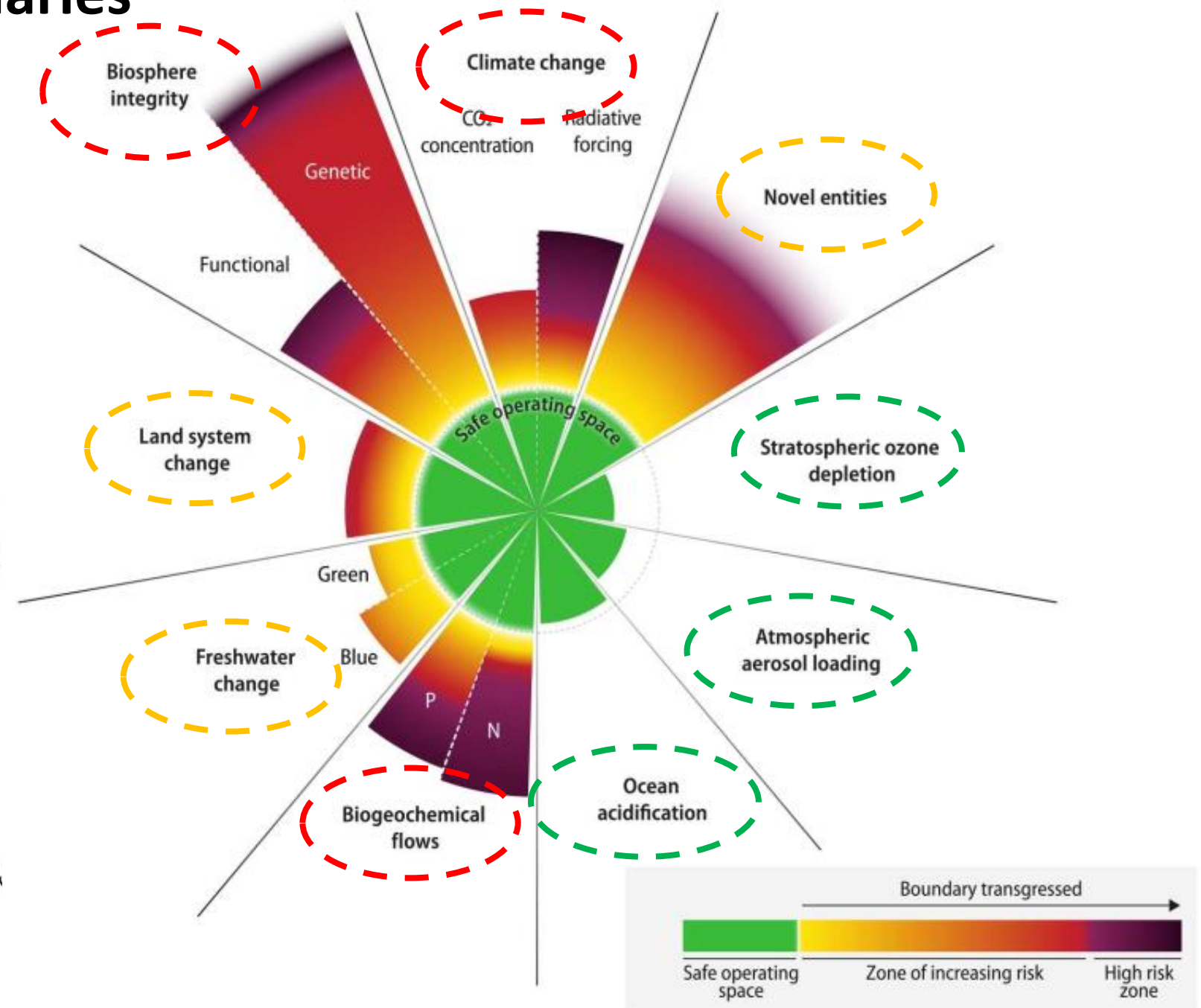
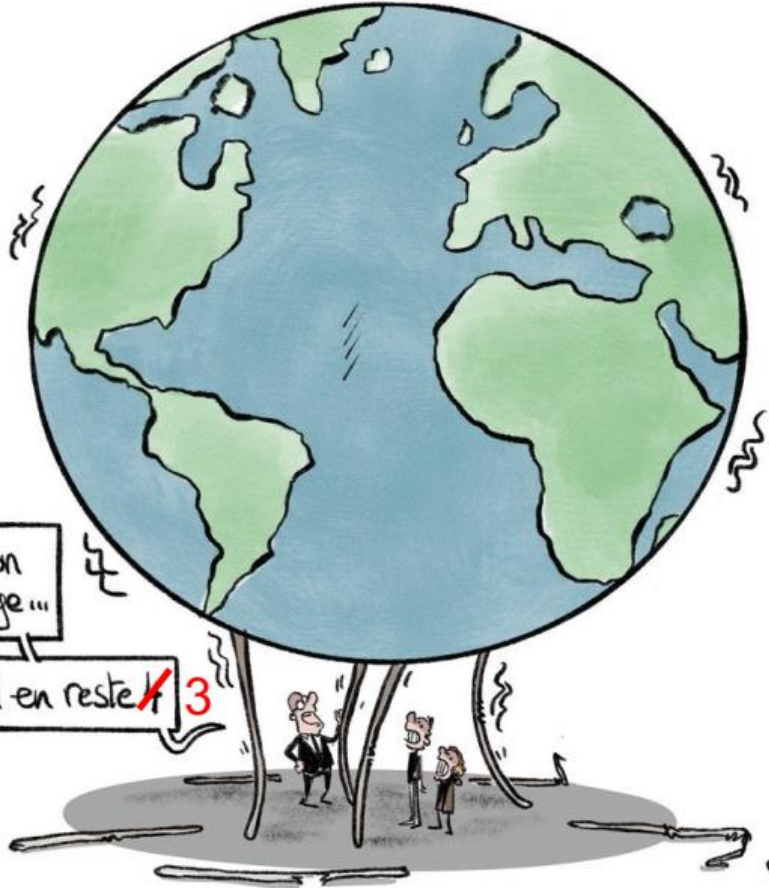


FAO stat. « *Chemical pollution: A growing peril and potential catastrophic risk to humanity*”; R. Naidu et al., *Environment International* 156, 106616 (2021)



Crossing of planet boundaries

UNE ~~5^{ème}~~ ^{6^e} LIMITE PLANÉTAIRE VIENT D'ÊTRE FRANCHIE *



* 6 planet boundaries have been crossed. « we're on tracks, 3 remain »

A new geological era called Anthropocene?

“It seems appropriate to assign the term ‘Anthropocene’ to the present, in many ways human-dominated, geological epoch, supplementing the Holocene — the warm period of the past 10–12 millennia.”

“Geology of mankind”, P. Crutzen, Nature 415, 23 (2002)

Anthropocene requires multidisciplinary approaches: historians, sociologists, biologists, ecologists, geologist, climatologists, etc...

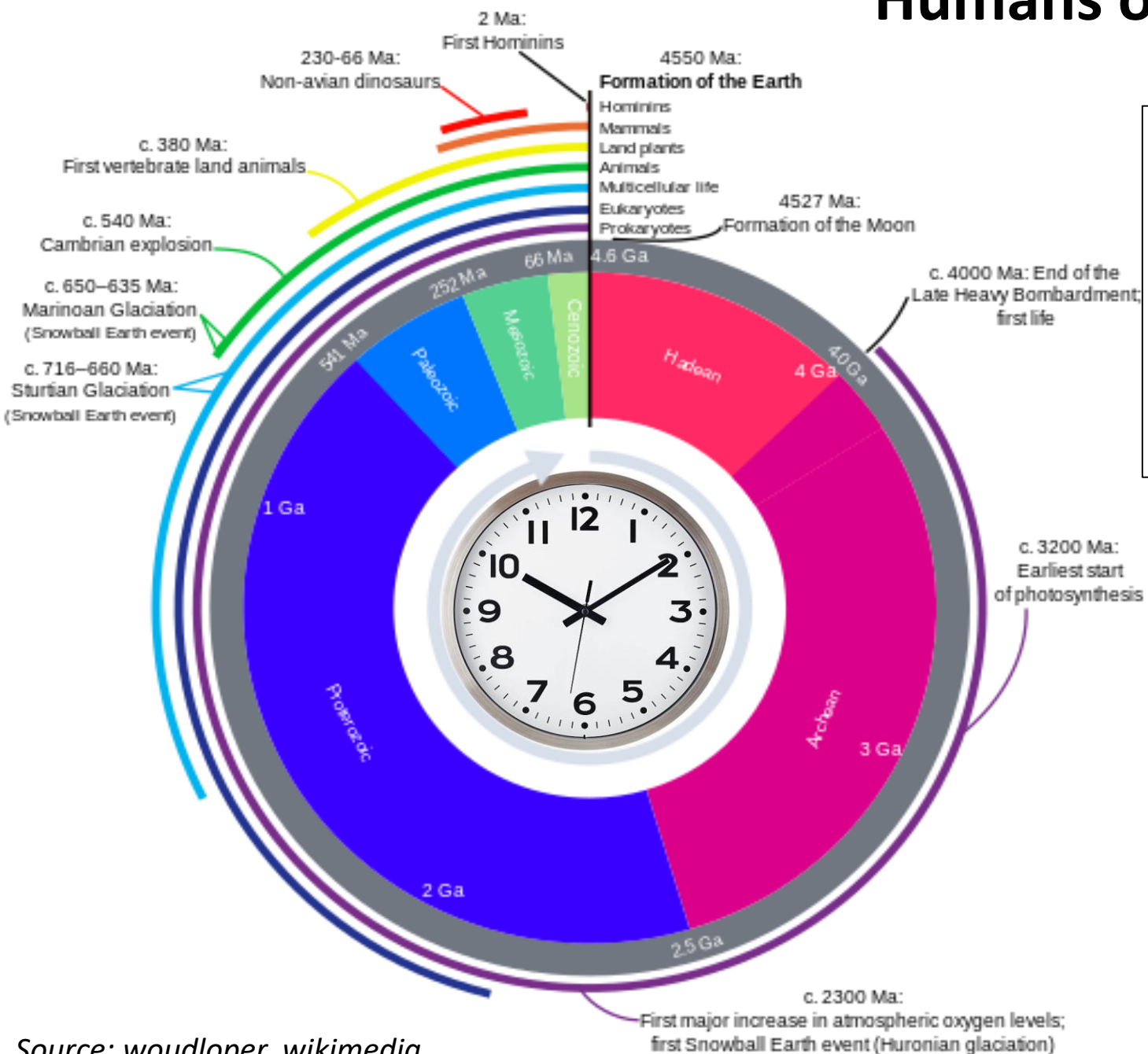
The Anthropocene

The Anthropocene could be said to have started in the late eighteenth century, when analyses of air trapped in polar ice showed the beginning of growing global concentrations of carbon dioxide and methane.

In march 2024, the International Commission on Stratigraphy has rejected the proposition to define Anthropocene as a new geological era after 14 years of discussions !

Too late, the term is now currently used !

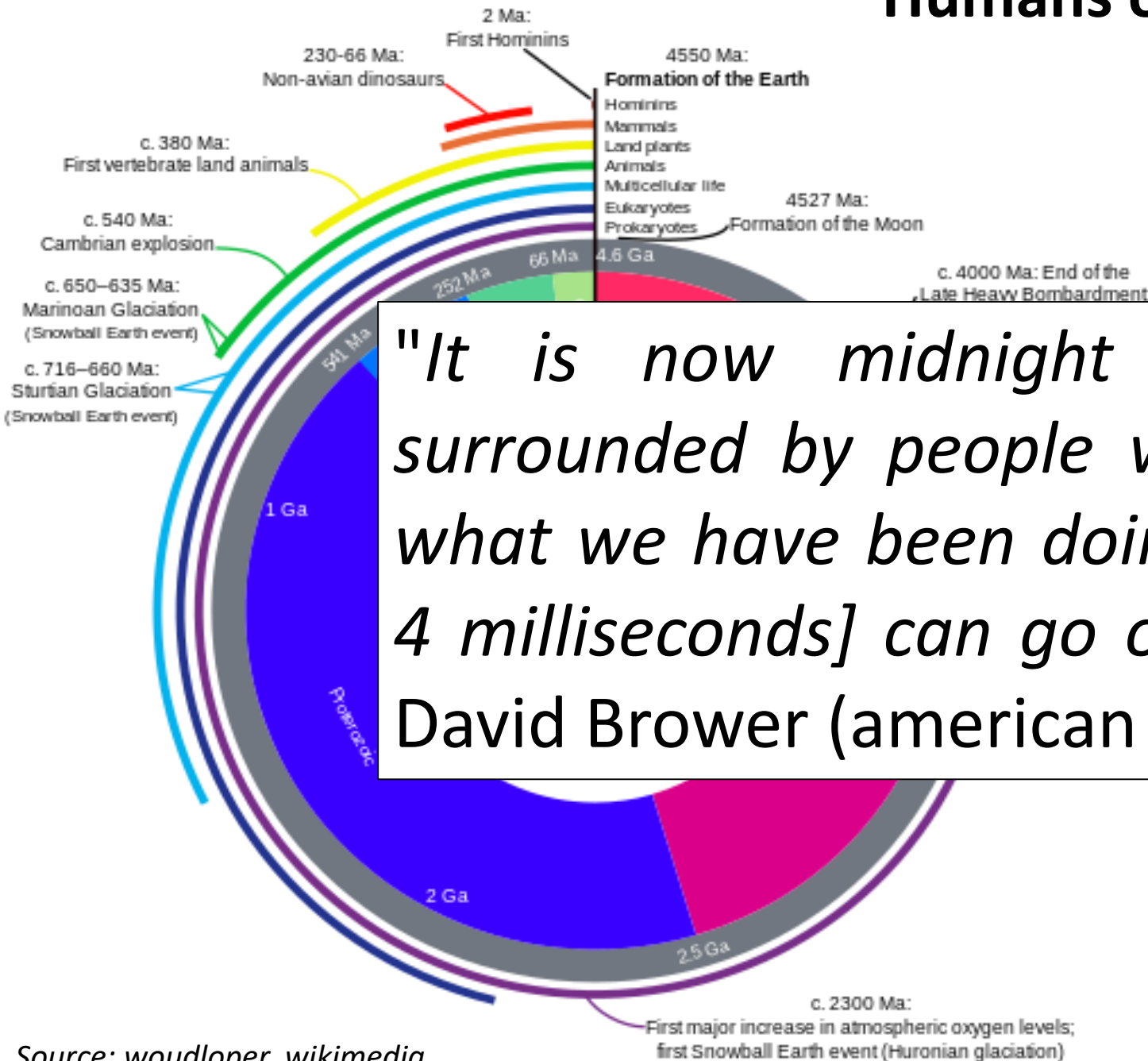
Humans on a geological era



0h00 : Earth formation (4,55 billions years)
 3h00 : Life (4.0 billions years)
 16h00 : Multicellular life (1.5 billions years)
 22h50-23h40 : Dinosaurs (230-65 millions years)
 23h59 : Lucy (3,2 millions years)
 23h59 56'' : Homo Sapiens (200 000 years)
 23h59 59,996'' : Industry (200 years)

Source: woudloper, wikimedia

Humans on a geological era



0h00 : Earth formation (4,55 billions years)
3h00 : Life (4.0 billions years)
16h00 : Multicellular life (1.5 billions years)
22h50-23h40 : Dinosaurs (230-65 millions years)
23h40-23h50 : First Hominins (200 000 years)
23h50-24h00 : Humans (200 years)

"It is now midnight and we are surrounded by people who think that what we have been doing for [the last 4 milliseconds] can go on indefinitely."
 David Brower (american ecologist)

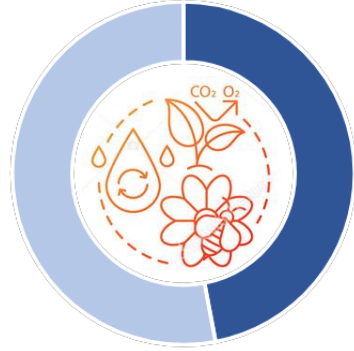
Source: woudloper, wikimedia

Outline

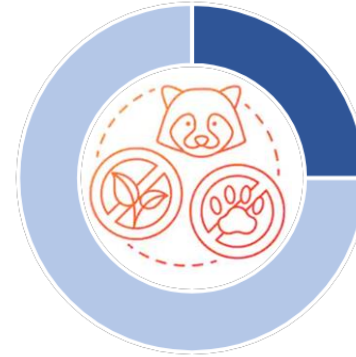


Focus on
biodiversity loss

Biodiversity



Degraded ecosystems



Species threatened
of extinction

1 million endangered species, most of them at the scale of a few tens of years.

Extinction rate tens or hundreds faster than the one in the last millions years.







Reasons for the biodiversity loss

Terrestrial



Marine



-  Climate change
-  Direct exploitation
-  Change of land use
-  Pollution
-  Dissemination of species
-  Others

Reasons to care

US beekeepers lost 40% of honeybee colonies over past year, survey finds

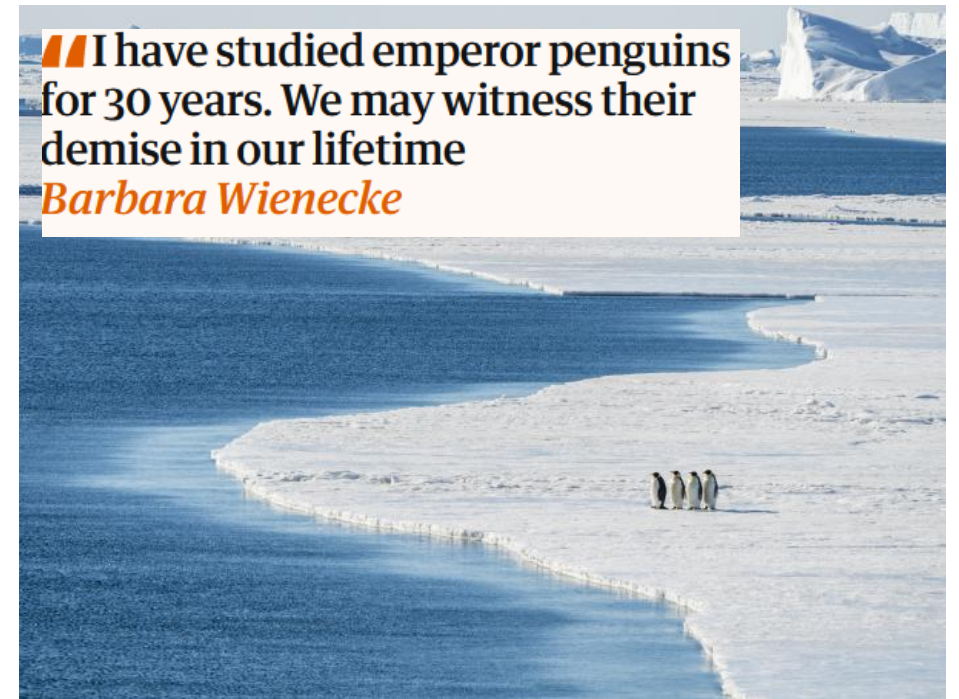
Animal populations experience average decline of almost 70% since 1970, report reveals

Sixth mass extinction of wildlife accelerating, scientists warn

Bees are worth billions to farmers across the globe, study suggests

- ▶ Intrinsic values ?
- ▶ Economic value ?

“I have studied emperor penguins for 30 years. We may witness their demise in our lifetime”
Barbara Wienecke



Pollinating insects replaced by paintbrushes



Outline

A photograph of a forest at night, illuminated by a warm, golden light that creates a misty and atmospheric scene. The trees are silhouetted against the light, and the ground is covered in fallen leaves. The text "Focus on climate change" is overlaid in white, centered in the image.

Focus on climate
change

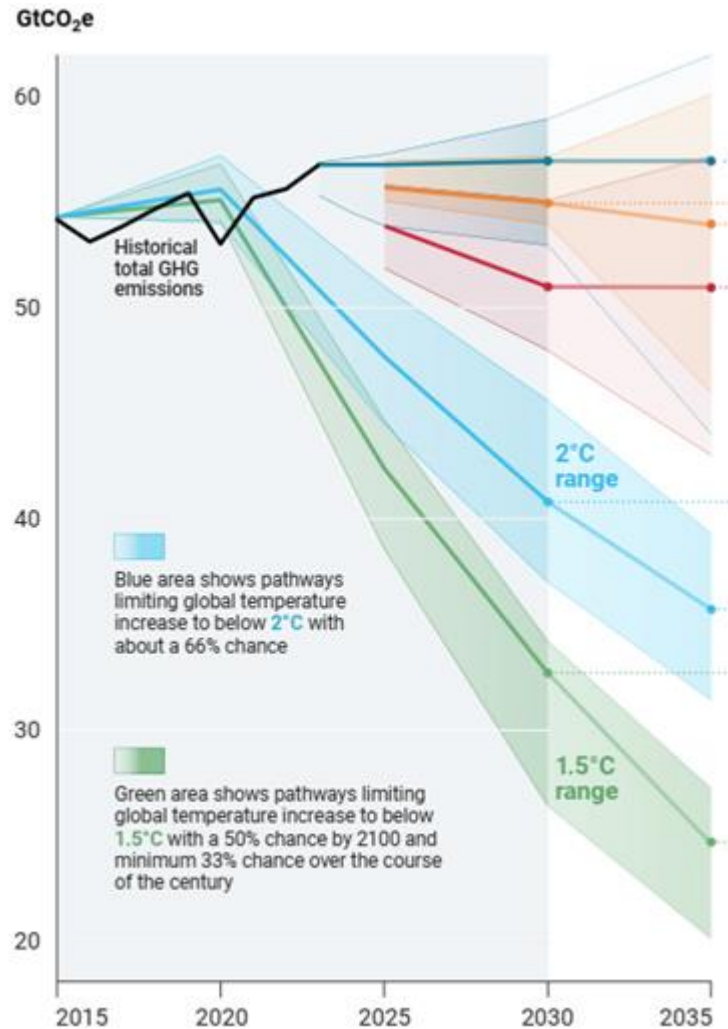
Highway to hell : progress report in 2024

- Declining farm yields ✓
- Regional famines ✓
- Villages disappearing due to rising water ✓
- Mega-fires and increased fire frequency ✓
- Migration of plant and animal species ✓
- Displacement of mosquitoes and diseases ✓
- Forests in distress ✓
- Decrease in hydroelectric and nuclear power ✓
- More violent hurricanes, storms and floods ✓
- Difficulty feeding livestock ✓
- Production disruptions for certain technologies ✓

In upcoming episodes... if we go on like this

- ▶ Disappearance of forests, of numerous ecosystems (desertification), of glaciers and seashells
- ▶ Increase in epidemics and emergence of new diseases
- ▶ Entire regions uninhabitable (humidity + $T^{\circ} = \dagger$)
- ▶ Submergence of large coastal regions
- ▶ Salinization of arable lands and groundwater tables in large deltas
- ▶ Hundreds of millions (?) of refugees/dead (?)
- ▶ Famines on a global scale
- ▶ Tipping points & runaway events, ruptures, abrupt changes

Required trajectories vs commitments



Paris agreement (COP21, 2015)

“Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”

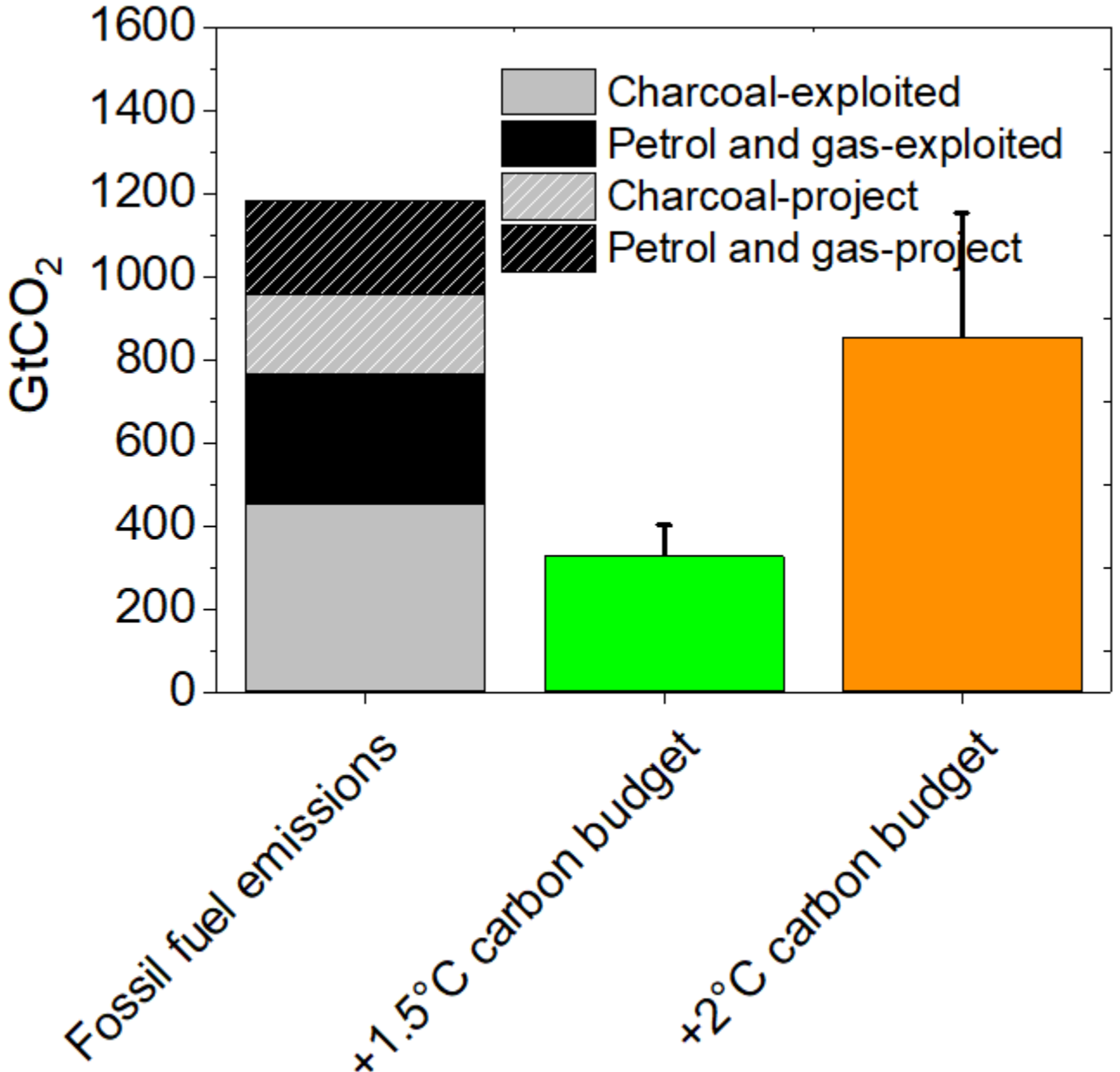
- Current policies scenario
- Unconditional NDC scenario
- Conditional NDC scenario

NDC : nationally determined contribution

« Emission Gap Report », United Nations (2024)

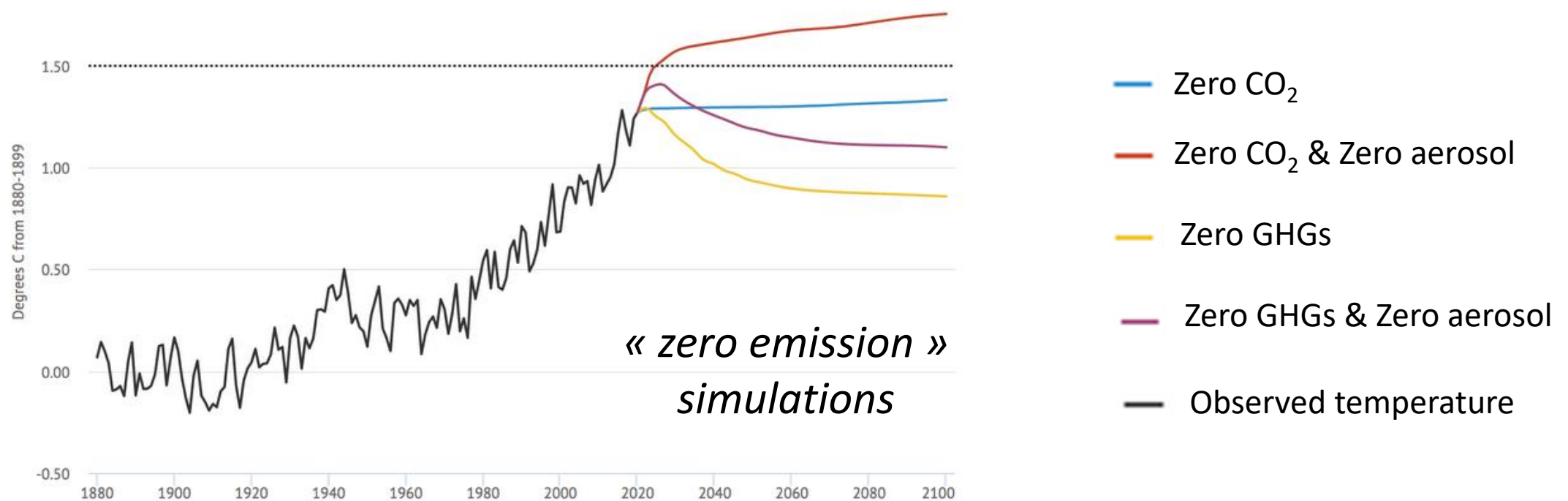
1.5°C : - 8% per year in average (larger for richer countries)
2°C : - 3,5% per year in average (larger for richer countries)
2,9°C-3,6°C : pursuing of current policies.

New fossil fuel projects are not compatible with Paris agreement




Any good news?

- ▶ There is almost no climate inertia on the temperature values (on the water rise, yes)
- ▶ We have (probably) not (yet) crossed tipping points
- ▶ History is not written
- ▶ It is never too late to avoid the worst



Outline

A photograph of a forest at night, illuminated by warm, orange lights, possibly from string lights or lanterns. The trees are silhouetted against the glowing background, and the ground is covered in fallen leaves. The text "Why research is concerned ..." is overlaid in white, centered in the image.

Why research is
concerned ...

All activities are concerned

« *Research is only 2 % of the emissions ! Let us wait that the Chinese and the other sectors start... »*

Aviation

France

Numerics

....

- metallurgy: 7%
- ruminants: 5%
- air transport: 5%
- I.T. (numerics): 4%
- cement: 6%
- medecine : 4-5%

- ▶ A "sanctuarized" activity requires other sectors to decrease faster.
- ▶ Between 2 and 3 "small" "sanctuarized" make the necessary emissions cuts impossible to achieve.

Medecine has – of course – a stronger legitimacy than SUV driving or international tourism to get a larger share of our carbon budget. It cannot however be excluded of reflexivity.

Research must be exemplary

Calls from scientists multiply...

but they will only be heard if we are exemplary...

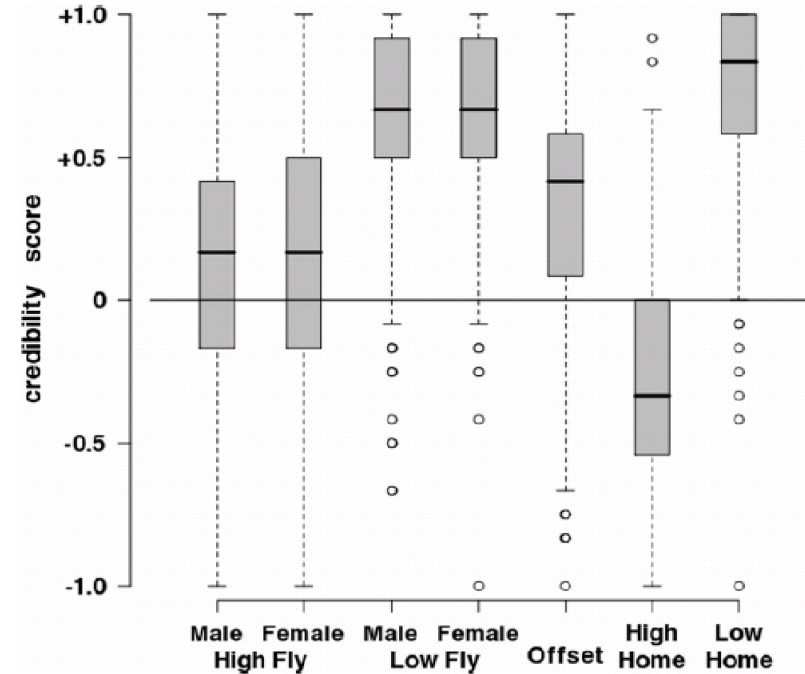
Climate crisis: 11,000 scientists warn of 'untold suffering'

Statement sets out 'vital signs' as indicators of magnitude of the climate emergency

● Most countries' climate plans 'totally inadequate' - experts



▲ A man uses a garden hose to try to save his home from wildfire in Granada Hills, California, on 11 October 2019. Photograph: Michael Owen Baker/AP

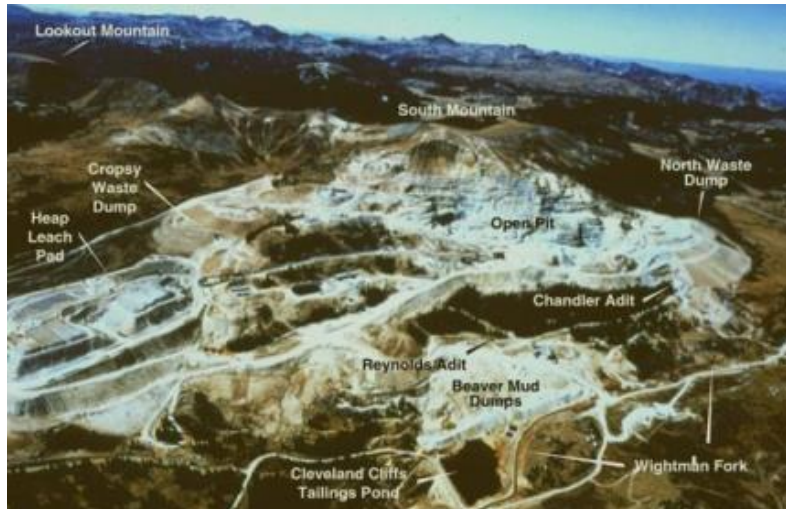


Influence of a scientist's professional behavior (steals little / steals a lot) and personal behavior (sober house or not) on the credibility and effectiveness of his or her message aimed at convincing the public to adopt "low-carbon" behavior.

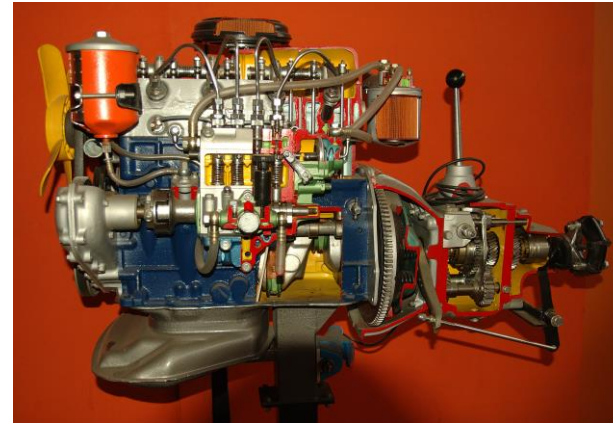
Research has direct environmental and social impacts *and* contributes to shape the world



* This smartphone is the lightest on the market. With or without its ecological footprint?



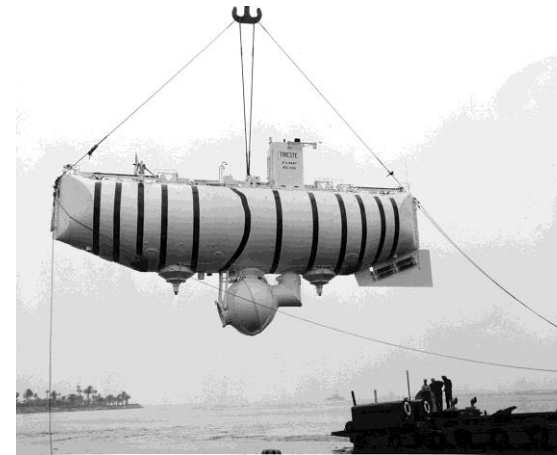
Consequences of our material footprint



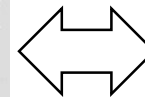
Explosion engine



Impacts of I.T. on child development




Bathyscaph



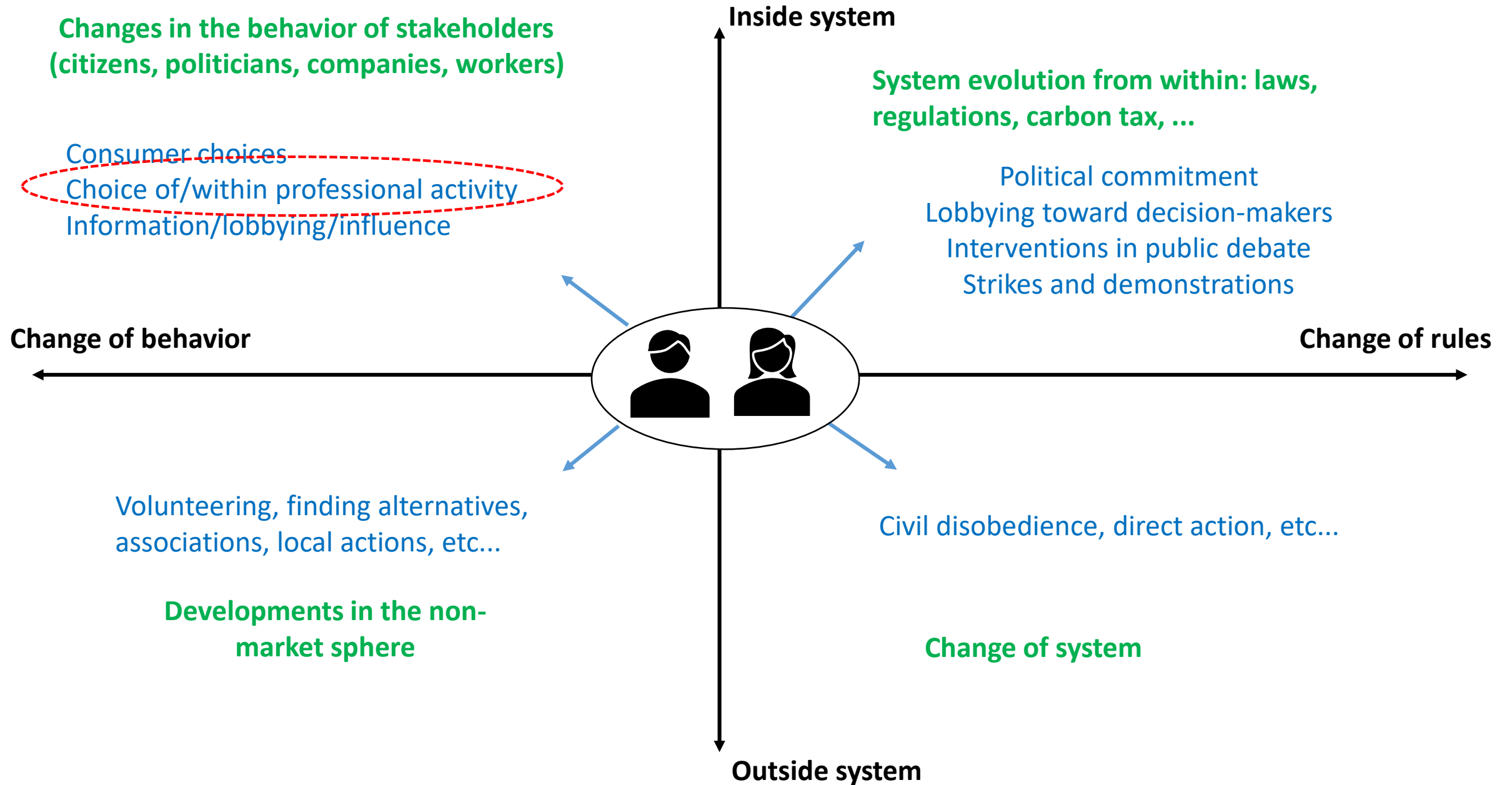
Oil platform

Outline



What to do as citizens
and scientists ?

What to do ?



What to do ?

Decreasing the direct impact of research



Choice of/within professional activity

Evolution of research subjects

Building research projects with citizens



Fighting business-as-usual and research-as-usual

Atécopol
atecopol.hypotheses.org



Scientist Rebellion

Outline

A photograph of a forest at night, illuminated by warm, orange light. The ground is covered in fallen leaves, and the trees are silhouetted against the light. The text "Decreasing the direct impact of research..." is overlaid in white.

Decreasing the direct
impact of research...

Carbon footprint of laboratories

My lab...

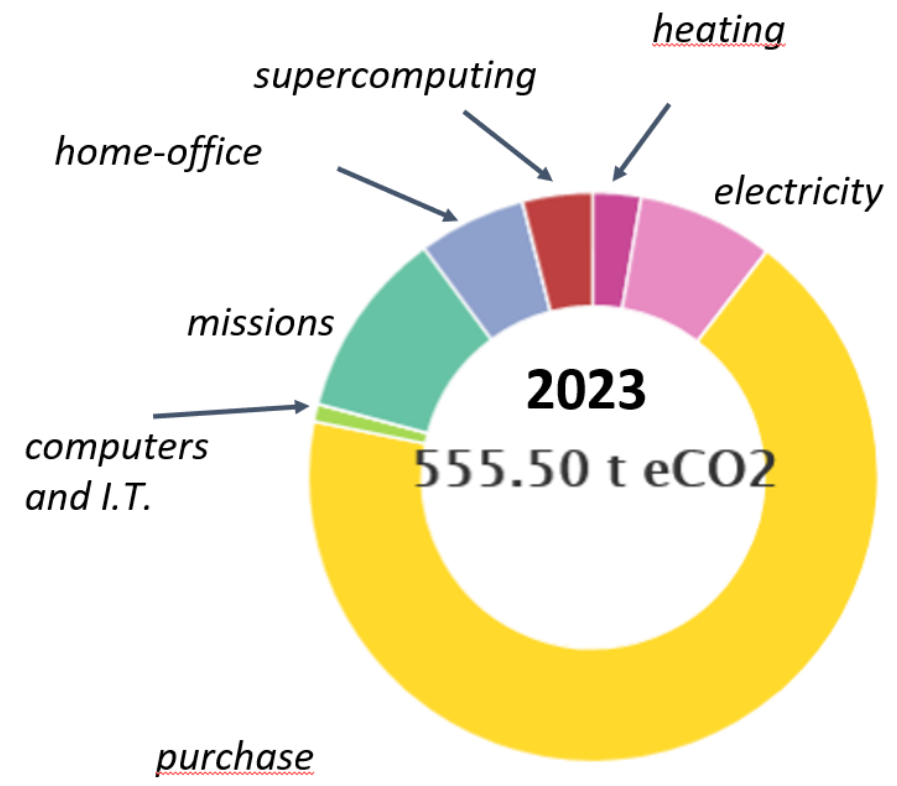
- ▶ Electricity: 8600 kWh / person (one household: 2350 kWh)
- ▶ **7.1 tCO₂eq / pers in 2019**
- ▶ Purchases are the preponderant share



Focus on purchases

Of the lab's 413 tCO₂eq

- 113 t chemicals
- 73 t purchase of equipment
- 53 t optical equipment
- 27 t glassware
- 26 t gases and cryogenics
- 18 t tools, consumables, etc...
- 11 t microscopy
- 9 t bio products and services
- 9 t information technology
- 7 t catering
- 6 t vacuum
- 6 t structural analysis Etc...



Outline



Which medicine and
biomedical research?

Facing the contribution of research to our unsustainable society

Several themes promoted by funding agencies lead to **increased energy consumption**, fuel **economic growth**, reinforce our **dependence on machines**. Some also **erode the relationship** between patients and physicians.



A.I., single cell, spatial biology, telemedecine, transhumanism, big data, continuous monitoring, ...



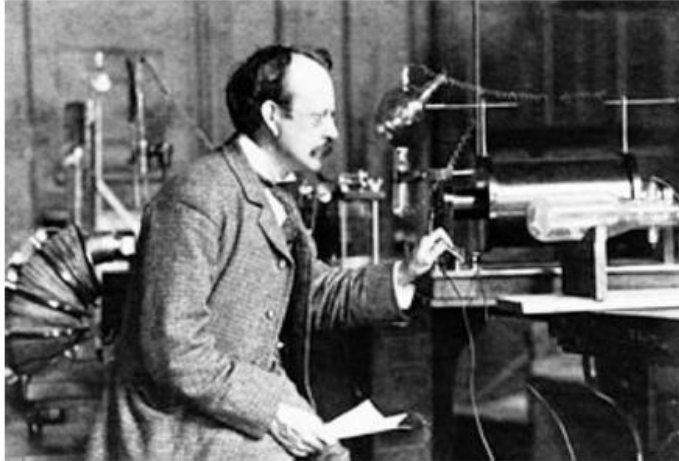
—
TRIBUNE
Bruno Falissard
Professeur de santé publique
Le Monde
Publié le 13 septembre 2022

« La médecine est le meilleur alibi de l'hubris technoscientifique »

A l'heure où la question de la sobriété s'impose dans la société, les professionnels doivent aussi faire l'examen de leurs pratiques, affirme le professeur de santé publique Bruno Falissard, dans une tribune au « Monde ». La techno-médecine pourrait bien être un mirage.

« Sur les traces de la santé environnementale », R. Bécot et al., Écologie & Politique 58, 9 (2019)

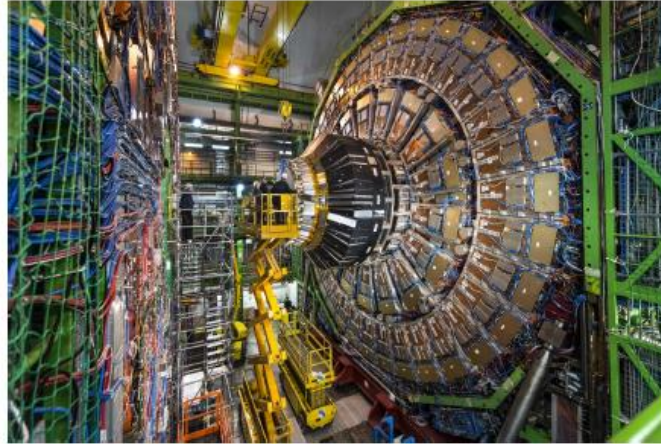
Facing diminishing returns



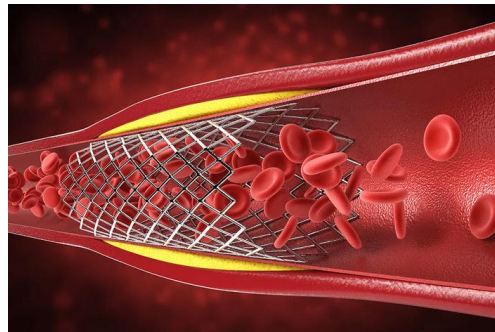
**Electron discovery
(1000 t CO₂ ?)**



Soap and hygiene: 5 €

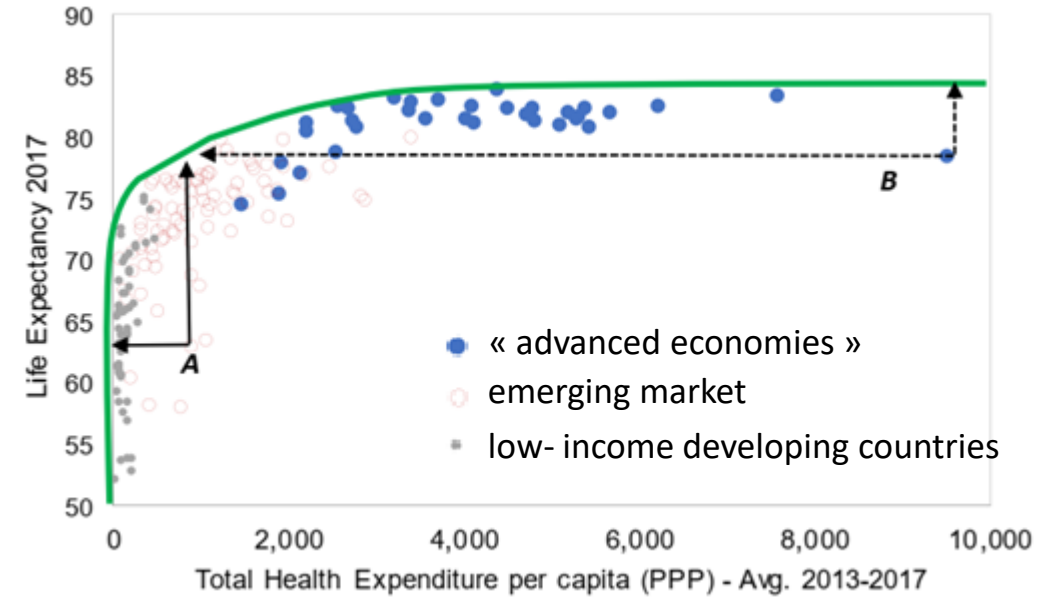


**Higgs boson discovery
(construction ≈ 400 000 t CO₂)**



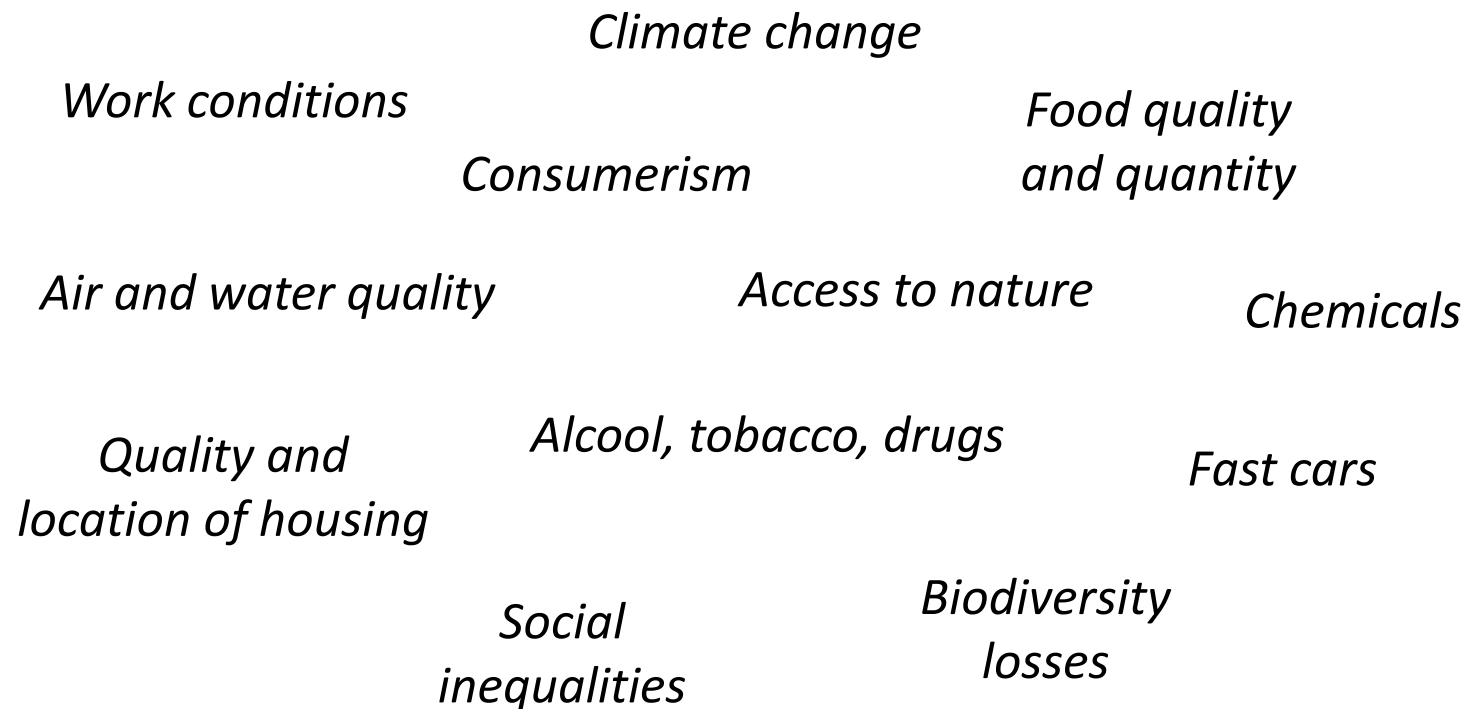
Stent placement : 10000 €

Life expectancy vs health expenditure for all countries in the world



- ▶ Diminishing returns appear in all fields, including research... and medicine.
- ▶ Energy: Photovoltaics 1839; Superconductivity 1911; Fusion 1934; Fission 1938
- ▶ An increase of life expectancy boosted by fossil fuels...

Facing the link between politics and health



- ▶ Curing diseases vs fighting the causes of the diseases?
- ▶ Curing people vs curing our socio-economic system ?
- ▶ Co-benefices on health of politics focused on environmental and equity issues.



Medicine, research, Anthropocene and degrowth

► Medicine so far linked to high-tech, unlimited growth and techno-solutionism. How to take care of people with reduced energy, materials, complexity? Which research for Anthropocene? Which research for degrowth?

→ Prevention / curation ?

→ Care / technology ?

→ Fighting consequences / causes?

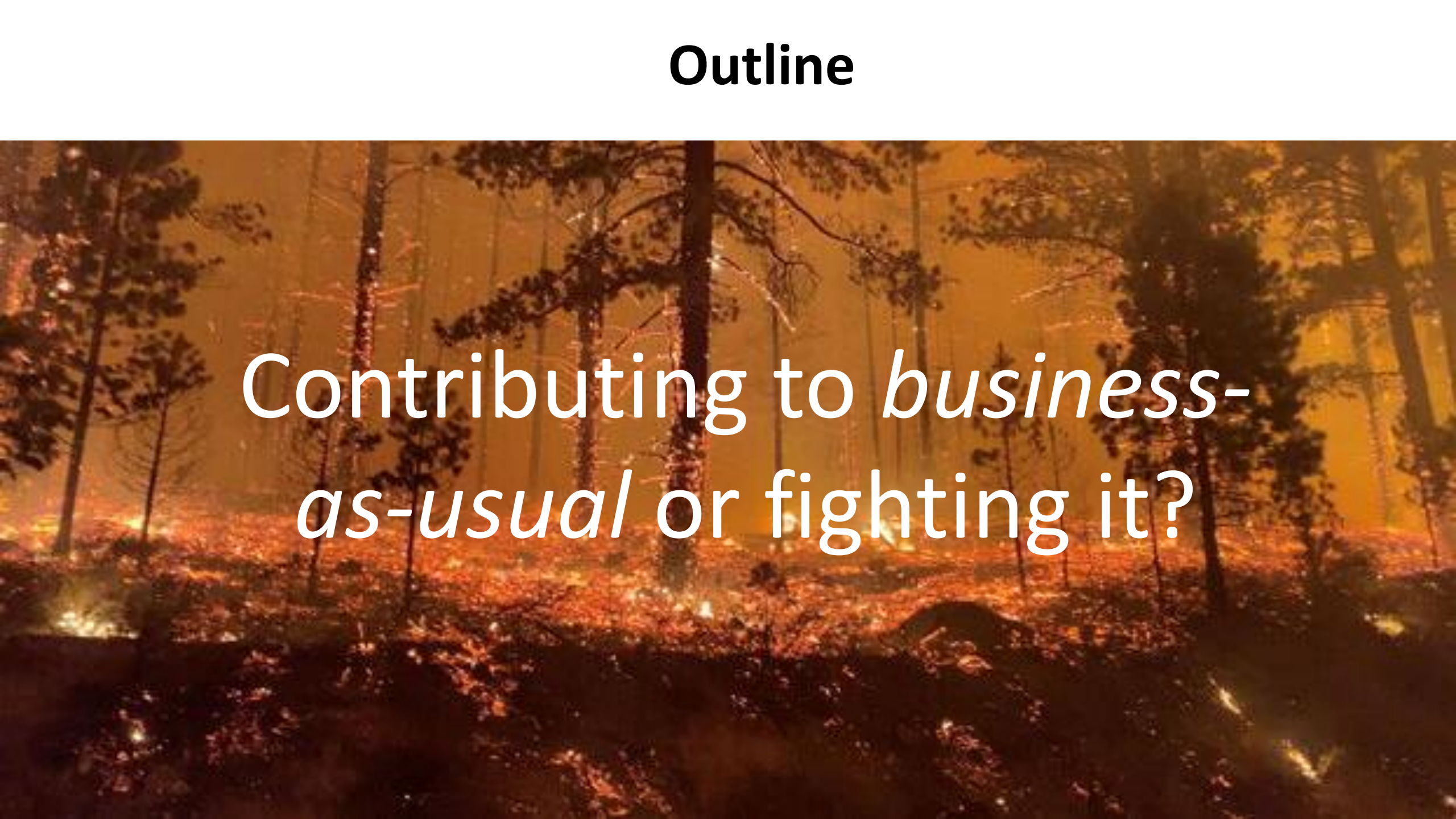
→ Ethics : Curing on the short term but harming on the long term. Curing people here with tools harming people elsewhere...

→ **Low-tech & medicine**

→ **Degrowth & medicine**

To be explored

Outline



Contributing to *business-as-usual* or fighting it?

New roles of scientists facing ecological emergency

Atécopol

atecopol.hypotheses.org



La nature :
quelles perceptions, quelle gestion ?

Partager nos expériences de nature
pour participer aux transformations majeures
de nos modèles de société ?

Anne-Caroline Prévot,
Directrice de recherches CNRS au CESCO (UME 7204),
Muséum national d'histoire naturelle de Paris.

Nous sommes tous forestiers :
contributions de l'écologie forestière
pour s'adapter aux changements globaux

Marc Deconchat,
Directeur de recherche à Dynafor (UMR1201),
INRAE Toulouse.

Mardi
8
décembre
2020
10h-12h30
Webinaire

Séminaire
SÉMÉCOL

dans le cadre du Labex SMS
(Sécurité des mondes vivants)

coordonné
par Laure Guillevin (EJ21),
avec Gaël Plumet (ANR)
et Julien Reboutier (ONIS)

sous le patronage
de Catherine Jourd'heuil (ONIS)
et Christophe Bonneil (ONIS)

Site internet:
<https://atecopol.hypotheses.org>

Documenting and thinking the ecological crisis

"How should we manage our **forests** in the face of climate change and society's many expectations ?"

"The **commodification** of nature"

"Decolonial ecology: what links between ecology and **colonization** ?"

"**Pesticides**, health and the environment: what science is needed to break the deadlock ?"

"Transition in a world of **finite resources**"

"The **computerisation** of our lives"

"Saved by techno-scientific **promises** ?"

New roles of scientists facing ecological emergency

Atécopol

atecopol.hypotheses.org

Fighting greenwashing and thinking technologies

"Are health and the environment soluble in chemistry? A textbook case of the instrumentalisation of science by **agribusiness**"

"**Hydrogen-powered aircraft**: a few things to clear the air"

"Letter to researchers, funders, industrialists and aficionados of the **autonomous vehicle**"

"Controversies over the health risks of **5G**: For a democratic debate on technological choices for society"

Scientific research and anthropocene

"**Public research** must no longer be used to **destroy the planet**".

"**CNRS** must not be a pyromaniac **fire-fighter**"



New roles of scientists facing ecological emergency



Helping citizen associations and their battles.



ANV-COP21



TOGETHER FOR EARTH



New roles of scientists facing ecological emergency

Scientifiques en rébellion



Scientist Rebellion



Bordeaux



Bordeaux



BMW showroom

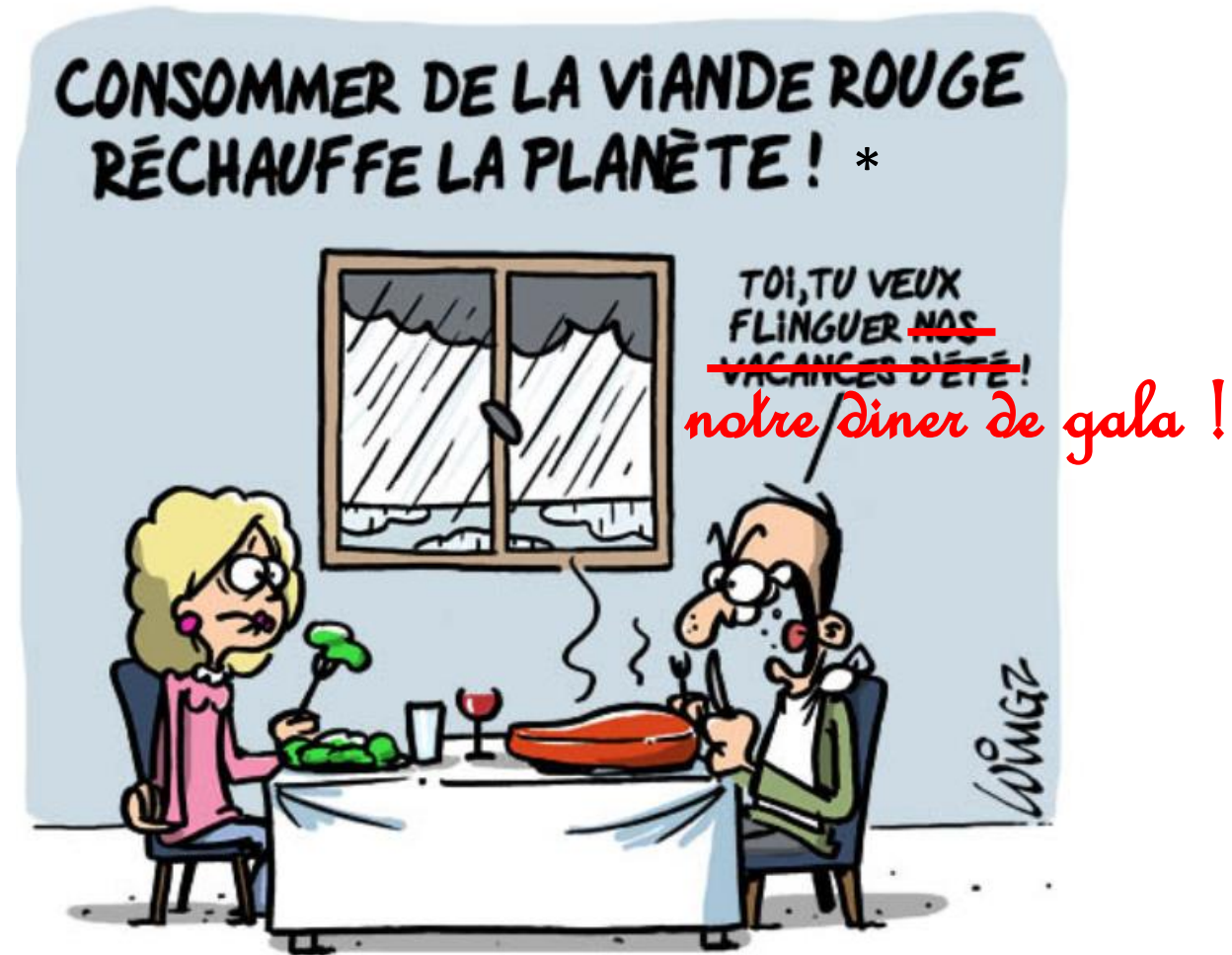


Odeonplatz (Munich)

Take-home messages

- ▶ Climate change and biodiversity loss are serious threats to humanity.
- ▶ The challenge is huge : high-level of transformation required, not much time to act, technical solutions not sufficient, major changes of life style unavoidable.
- ▶ The role of scientists and citizens can be manifold.
- ▶ The future of medicine and biomedical research is probably one of the more complex issue of the « transition »

Hope you will enjoy your evening anyway 😊



- Eating red meat heat the planet
You want to ruin our ~~summer holidays~~ gala dinner !

Many thanks for your attention 😊

