

Changement climatique, santé, société : Menaces et opportunités

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Inserm

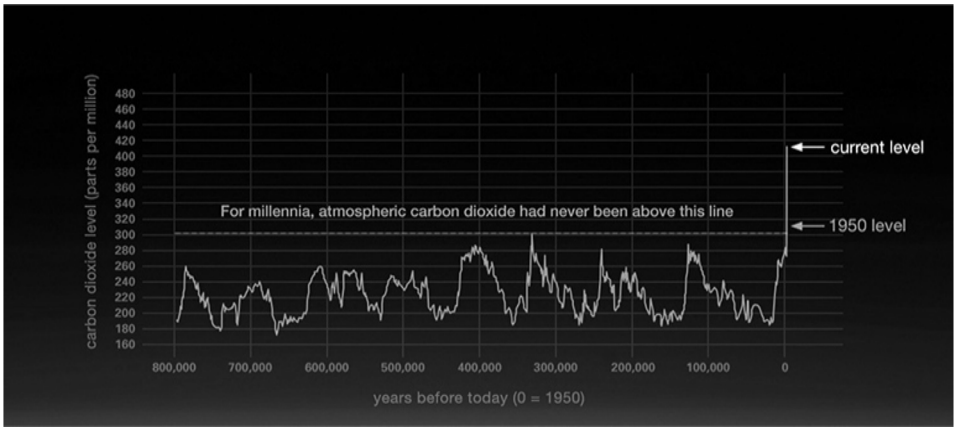
Inserm
La science pour la santé
From science to health

The Transition Institut (TTI 1.5)

Mines de Paris-PSL, 28 novembre 2023

1

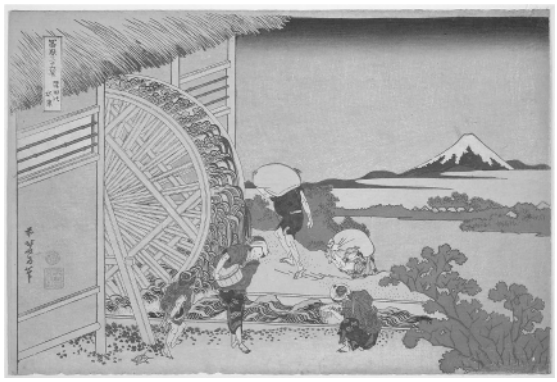
Greenhouse gas atmospheric levels



"Last time CO_2 levels were as high as present was at least 2 million years ago"
(IPCC 6th report, technical summary, 2021)

2

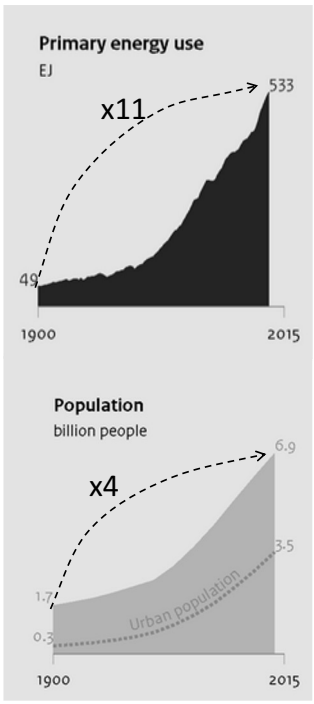
The industrial revolution as an energy evolution

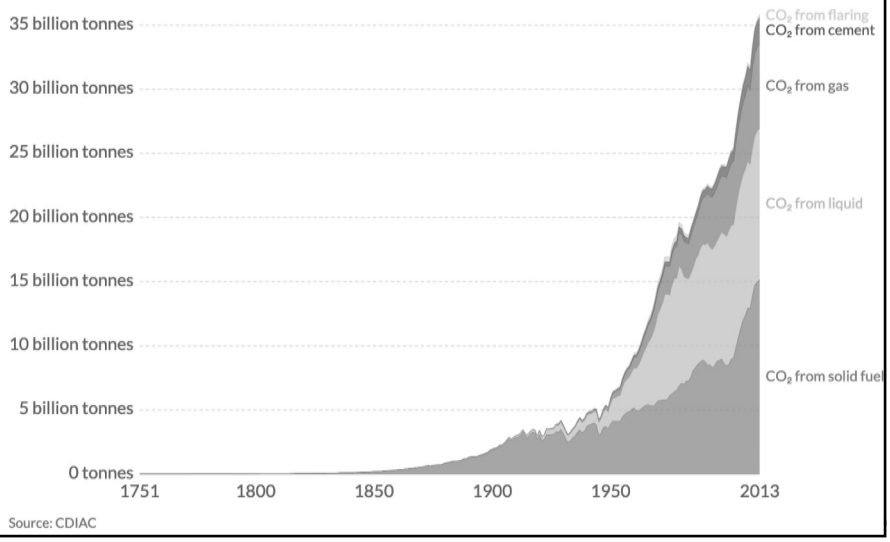


(Hokusai, 1830)

(Hopper, 1940)

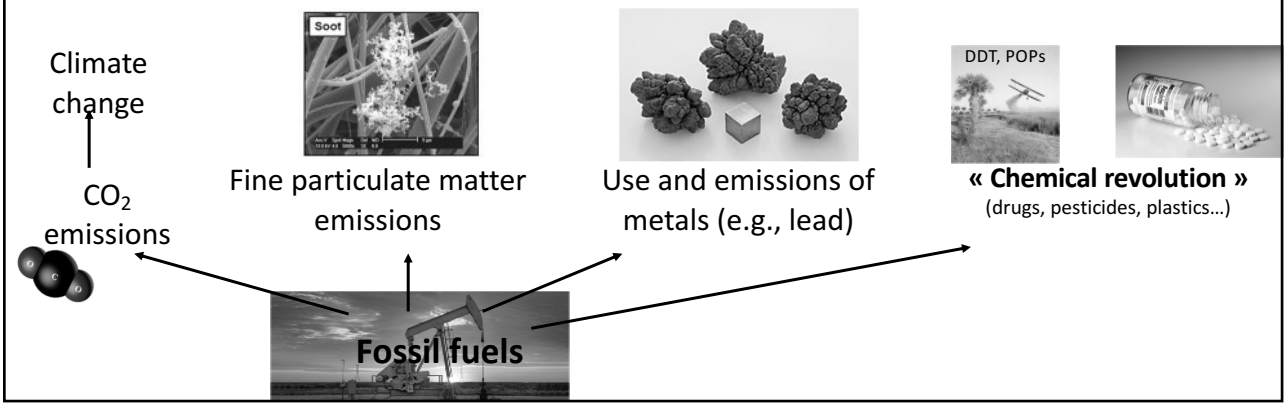
3





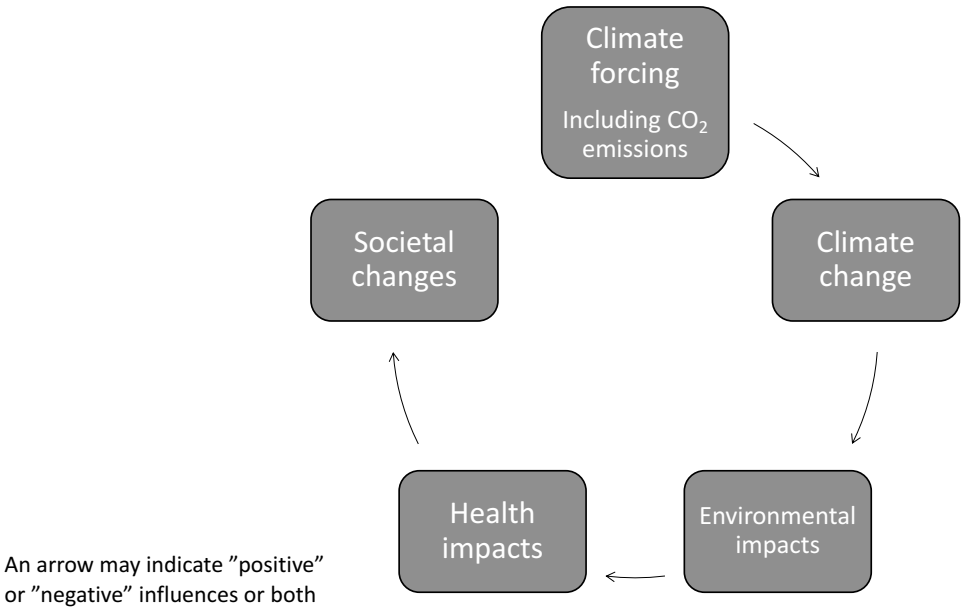
4

Some environmental and health changes related to fossil fuels combustion



5

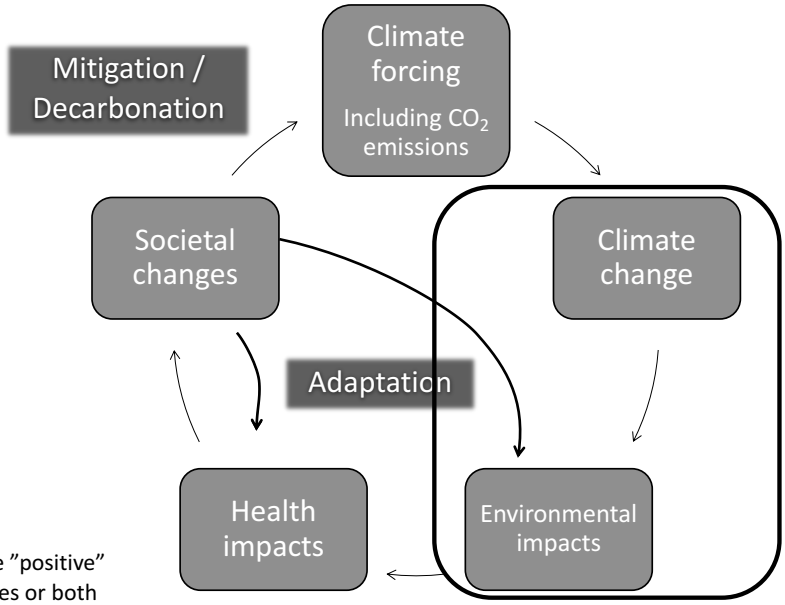
From climate change to societies and health



An arrow may indicate ”positive” or ”negative” influences or both

6

From climate change to societies and health



An arrow may indicate ”positive” or ”negative” influences or both

7

(Source: IPCC, 2022)

Climate change – *level one* manifestations (physical environment)

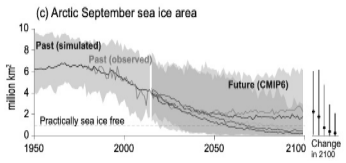
Atmosphere

- Concentration of greenhouse gases (GHG)
- Warming of the troposphere
- Temperature change
- Changes in the frequency of precipitations
- Increase in frequency of extreme weather events

Land

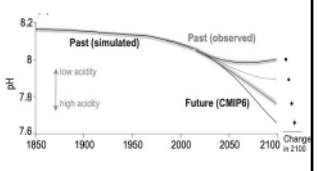
Cryosphere

- Greenland ice sheet mass loss
- Arctic and Antarctic sea ice loss
- Reduction in Northern hemisphere spring snow cover
- Retreat of glaciers



Oceans

- Ocean acidification
- Ocean heat content
- Rising sea levels



8

(Source: IPCC, 2022)

Climate change – *level one* manifestations (physical environment)

Atmosphere

- Concentration of greenhouse gases (GHG)
- Warming of the troposphere
- Temperature change
- Changes in the frequency of precipitations
- Increase in frequency of extreme weather events

Land

- Wildfires

Cryosphere

- Greenland ice sheet mass loss
- Arctic and Antarctic sea ice loss
- Reduction in Northern hemisphere spring snow cover
- Retreat of glaciers

Oceans

- Ocean acidification
- Ocean heat content
- Rising sea levels

Land species

Water species

- Change in ecosystem structure
- Species range shift
- Changes in timing

9

Wildfire risk

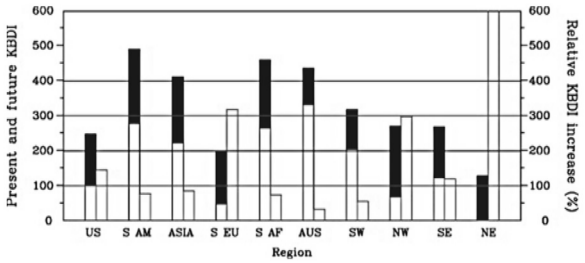
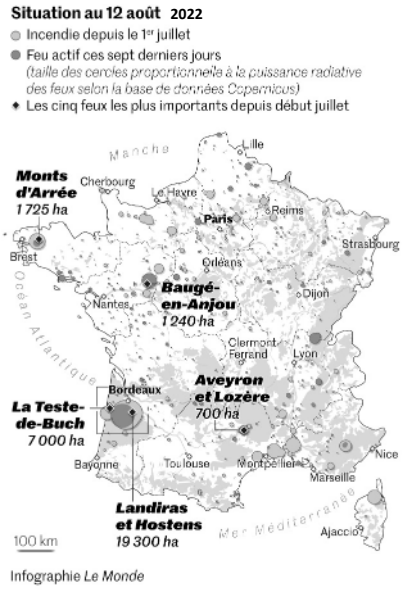


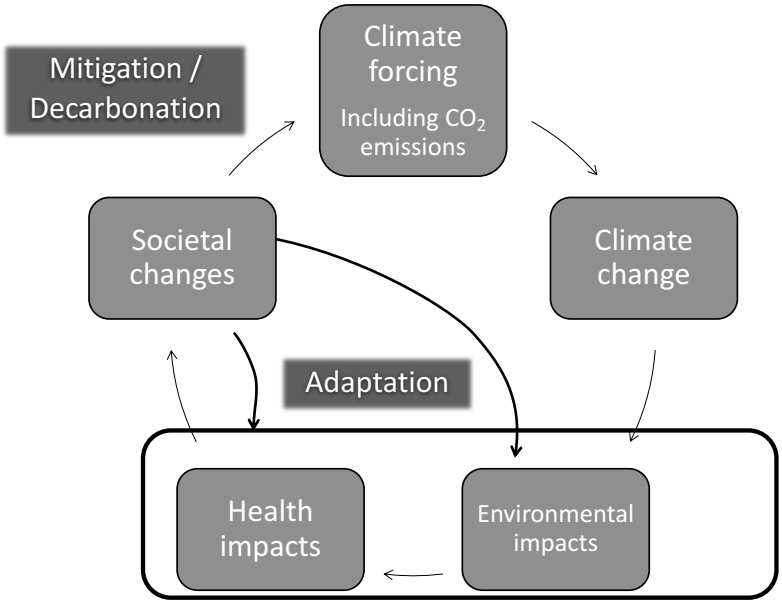
Figure 38. Model-estimated regional changes in wildfire risk due to climate change. Results are shown as the magnitude of regional Keetch–Byram drought index (KBDI) for 1961–1990 (present, open bars) and 2070–2100 (future, shaded bars). The percentage change between these two periods is shown on the right axis. The future KBDI changes were calculated using the climate change projected by the HadCM3 (Hadley Centre Coupled Model) with the A2a emissions scenario (Liu et al., 2010).



Infographie *Le Monde*

10

From climate change to societies and health



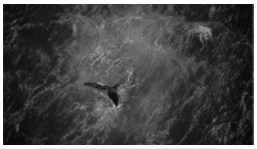
11

Effects mediated by CC-related changes in the physical environment

Atmosphere

Land

Cryosphere



Oceans

- Concentration of greenhouse gases (GHG)
- Warming of the troposphere

- Temperature change

- Precipitations
- Extreme weather events

- Greenland ice sheet mass loss
- Arctic and Antarctic sea ice loss
- Reduction in Northern hemisphere spring snow cover
- Retreat of glaciers

- Ocean acidification
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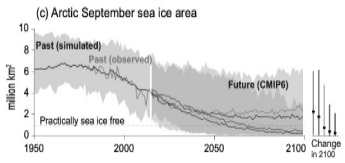
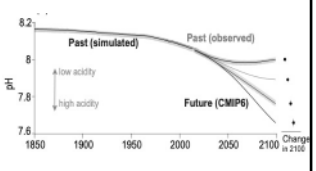
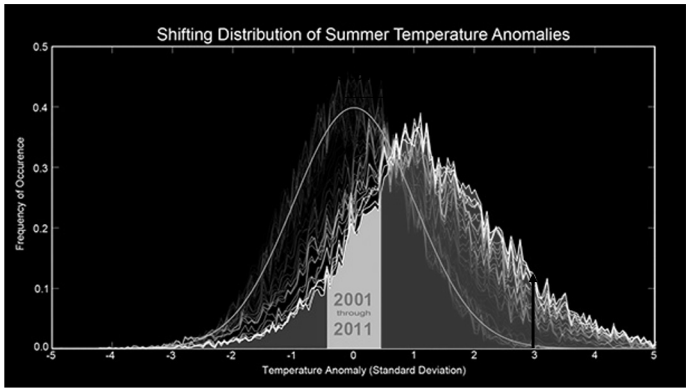
- Rising sea levels





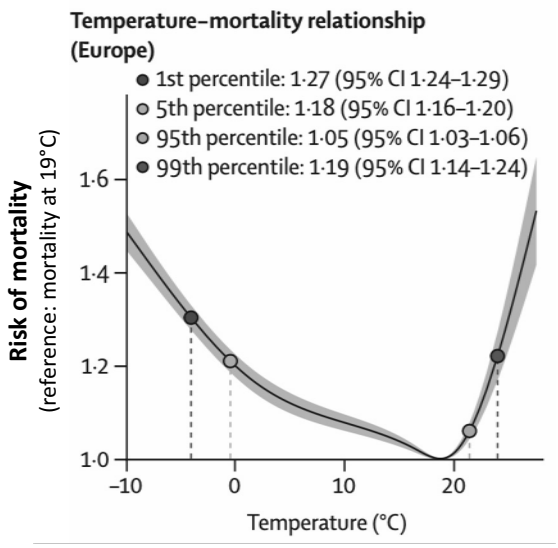
12

A small shift of the average value can induce huge changes in extreme values



13

On the short-term: daily temperatures generally influence all-cause mortality following a U-shape relation



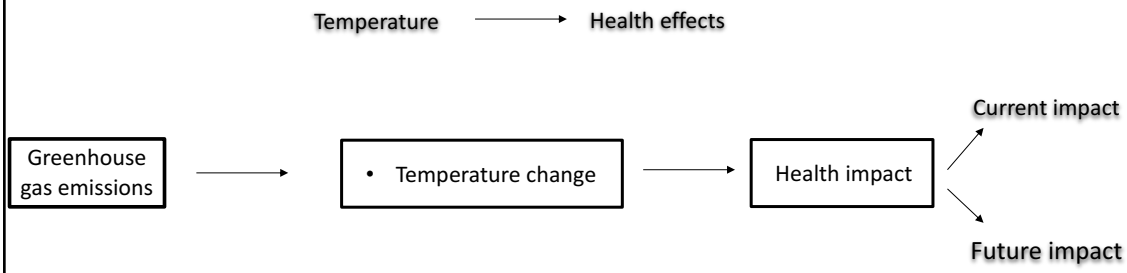
Time-series analysis based on daily mortality and temperature data (Europe)

Both
➔ "unusually" high and
➔ "unusually" low
temperatures increase mortality.

(Martinez-Solanas, *Lancet Plan Health*, 2021)

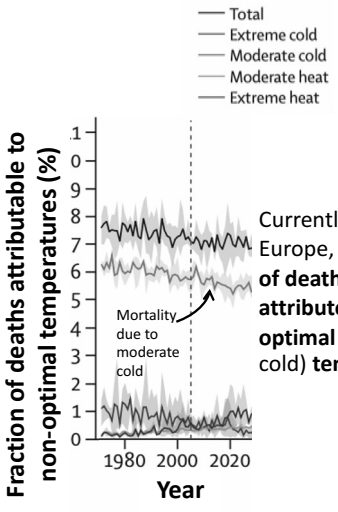
14

The temperature-mortality causal chain



17

Predicted changes in the mortality attributable to extreme temperatures in Europe under various scenarios

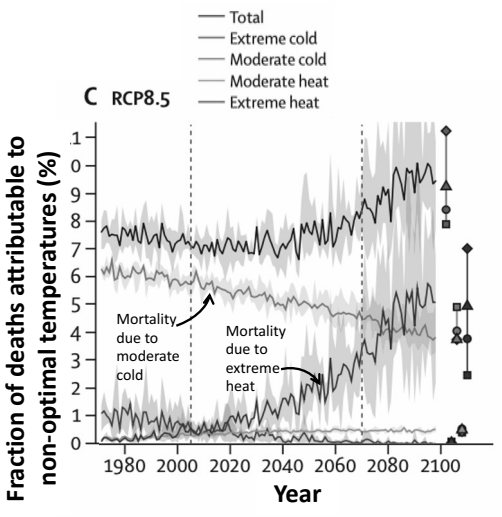


Currently, in Europe, about **7% of deaths are attributed to non-optimal** (mostly cold) **temperatures**

(Martinez-Solanas, *Lancet Plan Health*, 2021)

18

Predicted changes in the mortality attributable to extreme temperatures in Europe under *RCP8.5* scenario



RCP: Representative concentration pathway

(no strong action against climate change)

Without action against climate change and greenhouse gas emissions (RCP8.5 emission scenario), in Europe,

- deaths attributed to cold temperatures temperatures are likely to decrease,
- and those attributable to extremely hot temperatures will increase even more,

so that without control of GHG emissions**, mortality attributed to non-optimal temperatures is likely to increase in the 2nd half of the century.**

Similar situations are expected in areas with currently temperate or warm climates.

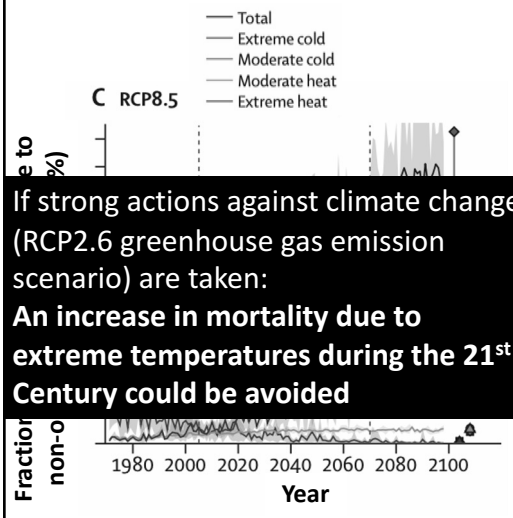
(Estimates assume lack of varying adaptation to warm or cold temperatures as climate gets warmer)

(Martinez-Solanas, *Lancet Plan Health*, 2021)

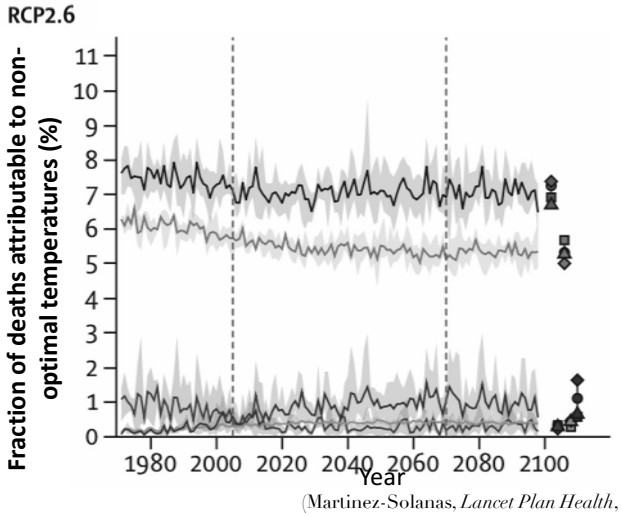
19

Predicted changes in the mortality attributable to extreme temperatures in Europe under *RCP2.6* scenario

(strong actions against GHG emissions)



If strong actions against climate change (RCP2.6 greenhouse gas emission scenario) are taken:
An increase in mortality due to extreme temperatures during the 21st Century could be avoided

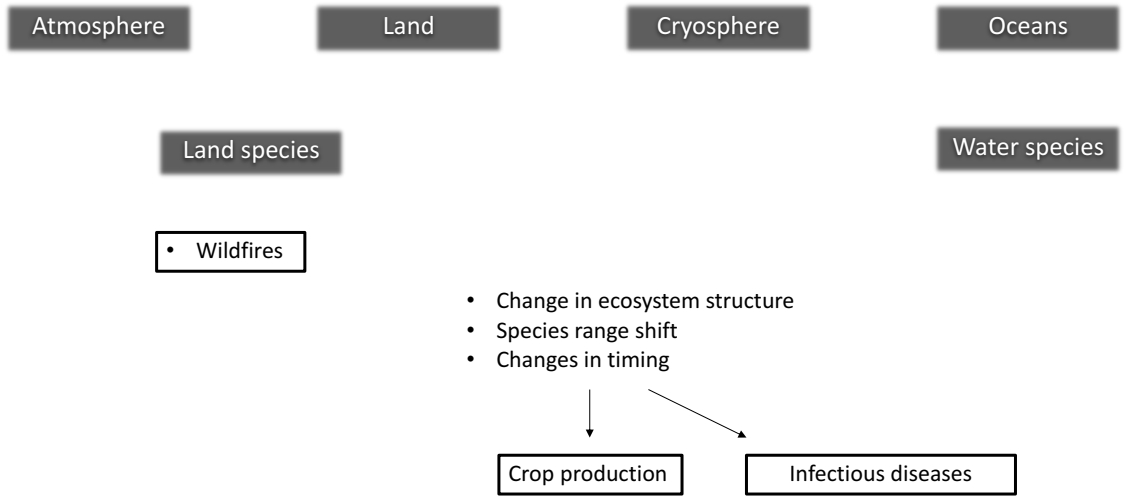


RCP: Representative concentration pathway

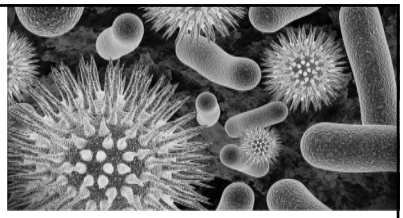
(Martinez-Solanas, *Lancet Plan Health*, 2021)

20

Effects mediated by CC-related changes in the living environment



21



Climate and infectious diseases

- Many infectious pathogens are sensitive to climate
  - In Europe, 63% of the pathogens with the largest health impact are climate sensitive (in particular to rainfall and temperature)(McIntyre, *Sci Rep*, 2018)
- Vector-borne, soil-borne, water-borne and foodborne pathogens are more likely to be influenced by climate (McIntyre, *Sci Rep*, 2018)
- The life cycle of mosquitoes is strongly influenced by temperature and humidity (e.g., Anopheles, responsible of malaria transmission)

➔ Could climate change influence the incidence of infectious diseases or at least human exposure to vector-/soil-/water-/food-borne infectious agents?

22

nature climate change

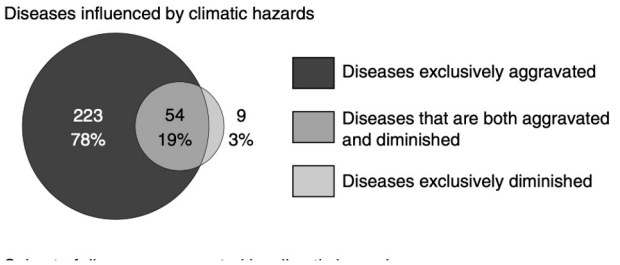
ANALYSIS

https://doi.org/10.1038/s41558-022-01426-1

Check for updates

Over half of known human pathogenic diseases can be aggravated by climate change

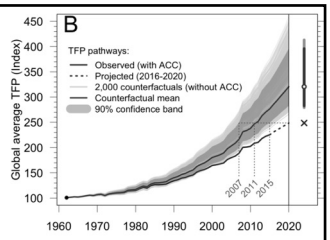
Camilo Mora[1]✉, Tristan McKenzie[2,3], Isabella M. Gaw[4], Jacqueline M. Dean[1],

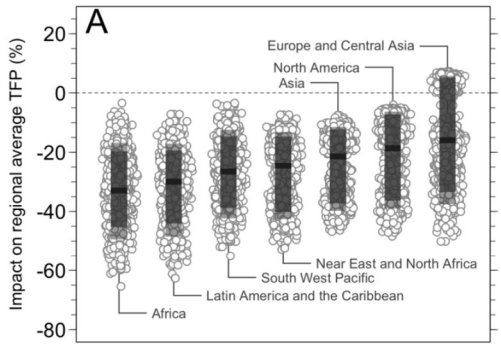


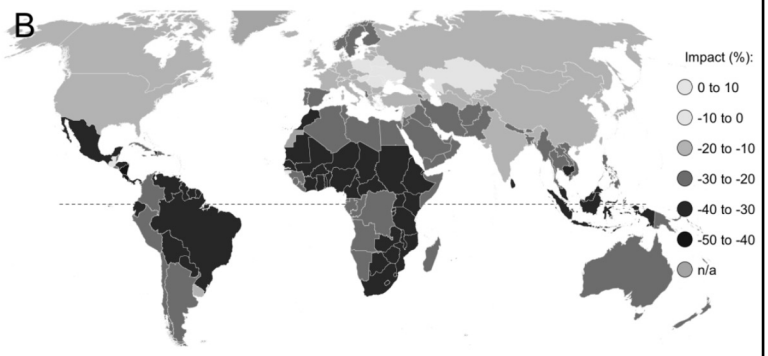
« 58% (218 out of 375) of infectious diseases confronted by humanity worldwide have been at some point aggravated by climatic hazards; 16% were at times diminished. »

23

Climate-change effects on agriculture (1961-2015)



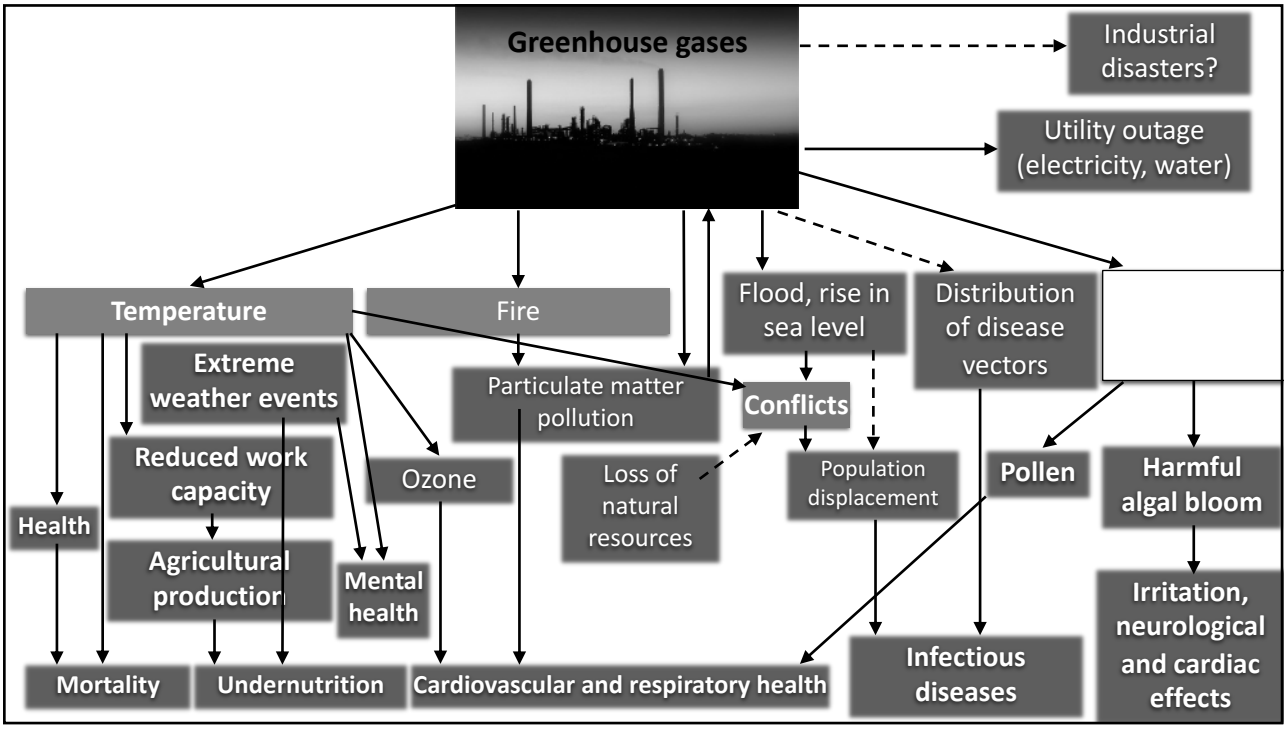




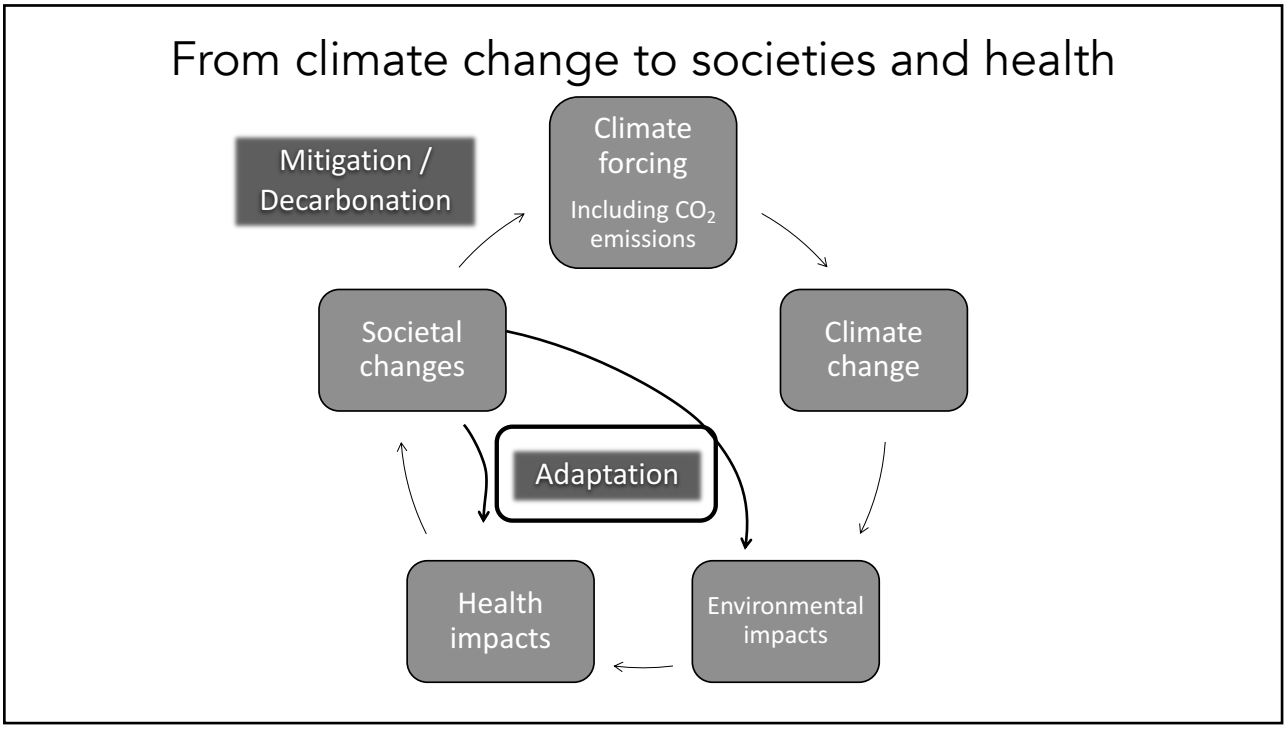
Anthropogenic climate change is estimated to have reduced global agricultural productivity (total factor productivity, TFP) by about 21% since 1961.
The impact is more severe in warmer regions (Africa, Latin America…).

(Ortiz-Bobea, *Nature Clim Change*, 2021)

24


Greenhouse gases
Industrial disasters?
Utility outage (electricity, water)
Temperature
Fire
Flood, rise in sea level
Distribution of disease vectors
Extreme weather events
Particulate matter pollution
Conflicts
Reduced work capacity
Ozone
Loss of natural resources
Population displacement
Pollen
Harmful algal bloom
Health
Agricultural production
Mental health
Irritation, neurological and cardiac effects
Mortality
Undernutrition
Cardiovascular and respiratory health
Infectious diseases

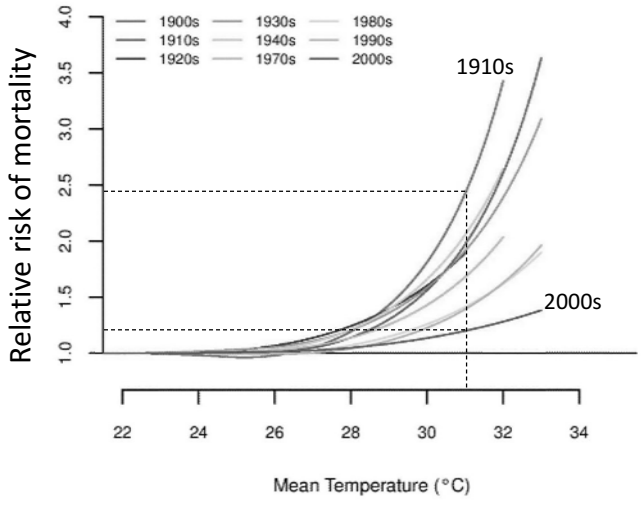
25


From climate change to societies and health
Mitigation / Decarbonation
Climate forcing
Including CO_2 emissions
Societal changes
Climate change
Adaptation
Health impacts
Environmental impacts

26

27

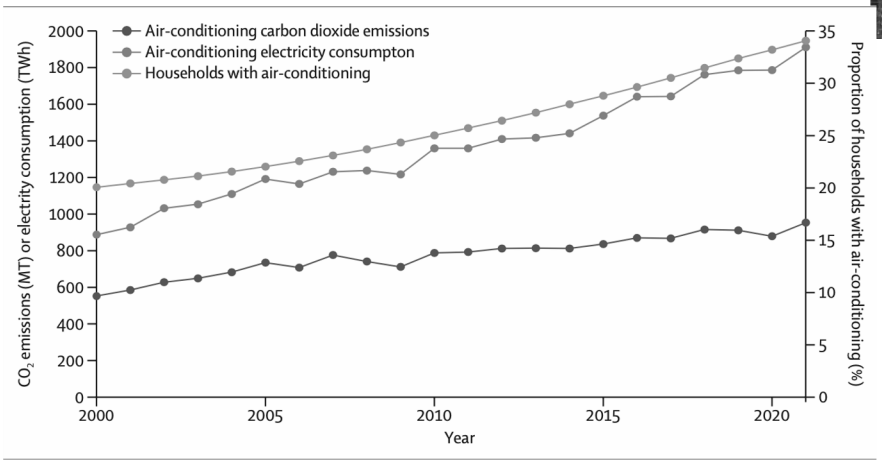
High temperatures and mortality: Is adaptation of societies possible? New-York city example



(Petkova, *Epidemiology*, 2014)

28

Increasing the number of homes with air conditioning allowed to **limit heat-related mortality** while increasing CO_2 emissions*

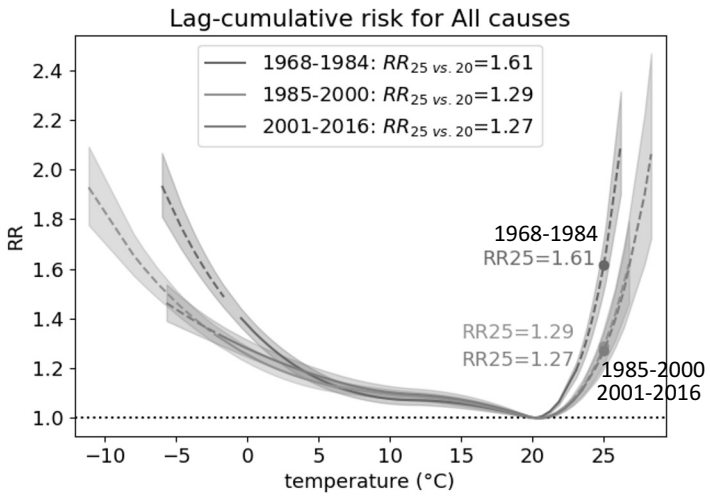


*Because a large fraction of air conditioning devices run on fossil fuel energy.

(Romanello, *The Lancet*, 2023)

29

Evidence for adaptation in temperature effects on mortality: the French case (1968-2016)



(Lehmann, *Am J Epid*, 2022)

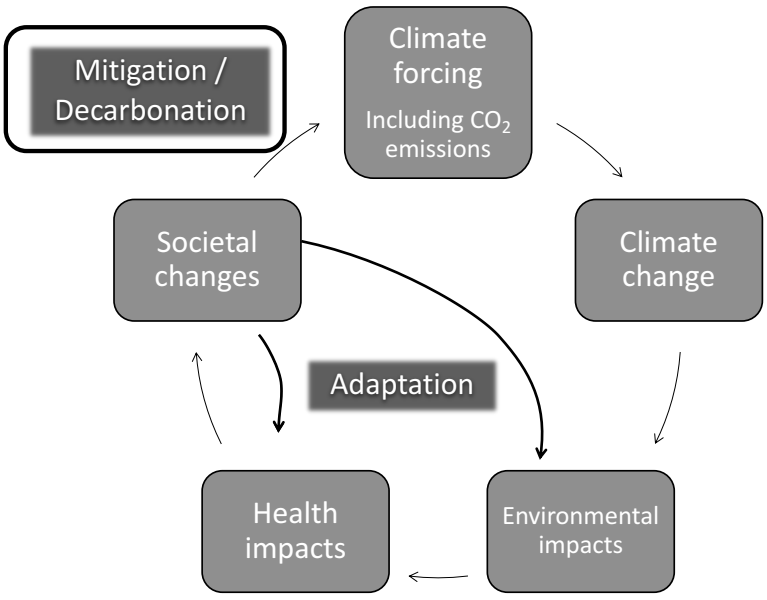
30

Adaptation to climate change impacts

- Adaptation (in terms of impact on mortality) to some key components of climate change has been evidenced in some areas of the world
  - In particular in relation to high temperatures or extreme weather events
  - Adaptation can be very costly
- The ability to adapt is not distributed homogeneously within and across countries
- Some means of adaptation to high temperatures or extreme weather events used so far have led to increased emissions of GHG, pollutants and possibly social inequalities in environmental exposures
- Current estimates indicate that it would be cheaper to limit greenhouse gas emissions than to adapt to climate change (Burke, *Nature*, 2018)

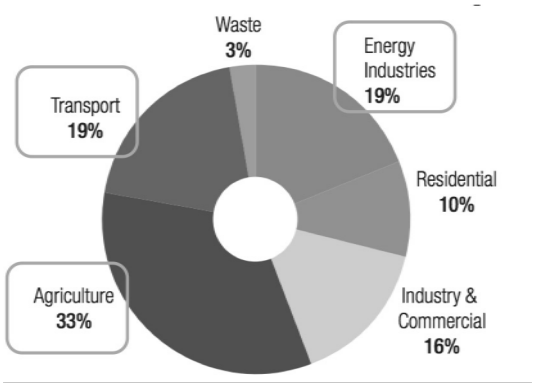
31

From climate change to societies and health



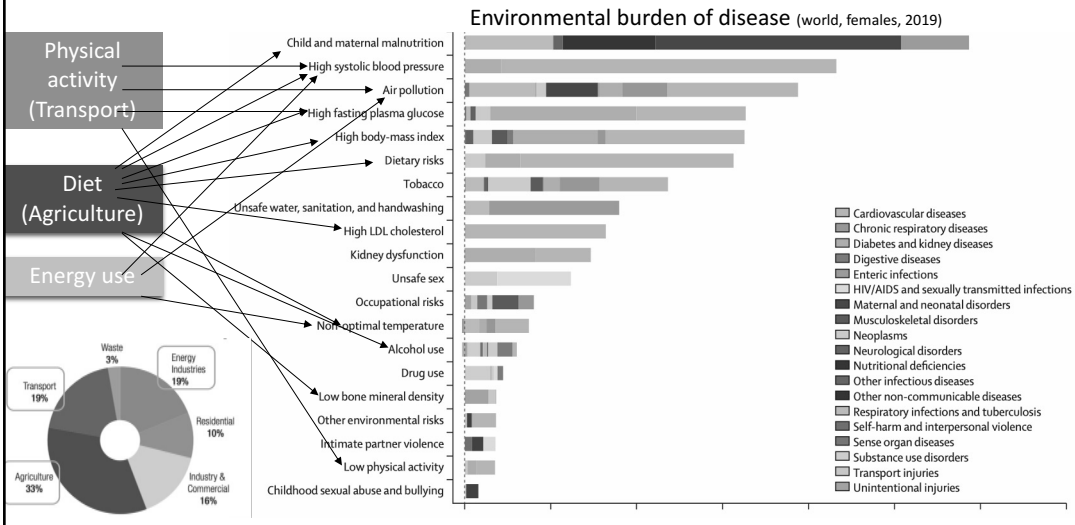
32

Greenhouse gas emissions (2015)



33

The sectors with the largest greenhouse gases emissions also contribute strongly to the disease burden

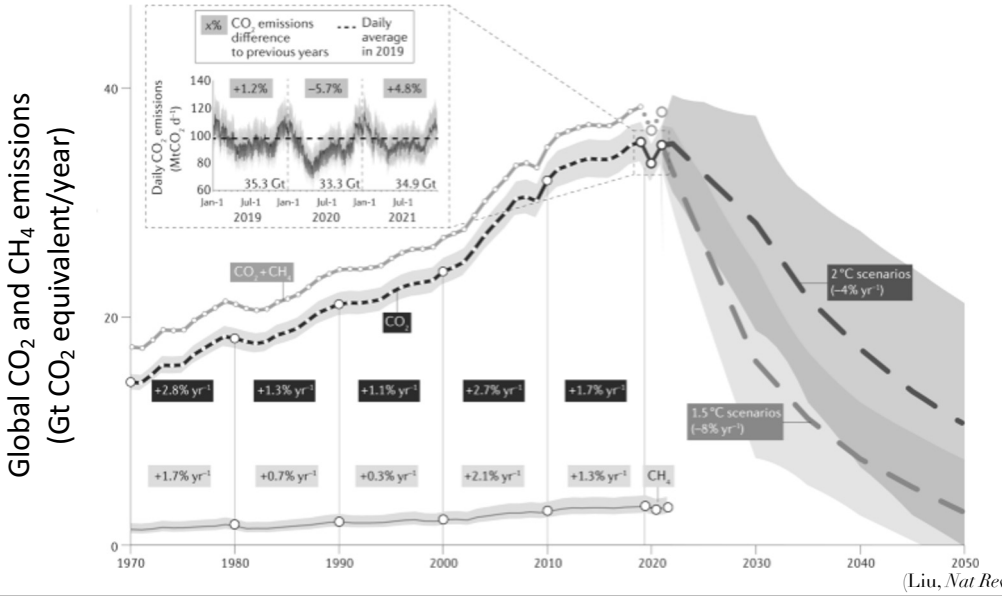


DALYs (Disability-adjusted Life Years) lost

➔ By acting on sectors emitting GHG emissions we will also influence health – possibly positively

34

CO_2 emission trajectory to limit the mean temperature increase below 2°C compared to pre-industrial levels



(Liu, *Nat Rev Health Env*, 2022)

35

Une alimentation émettant peu de carbone pour être produite est aussi une alimentation saine…

« shifts towards universally sustainable diets could lead to co-benefits, such as minimising diet-related greenhouse gas emissions and land use, reducing the environmental footprint, aiding in climate change mitigation, and improving population health »

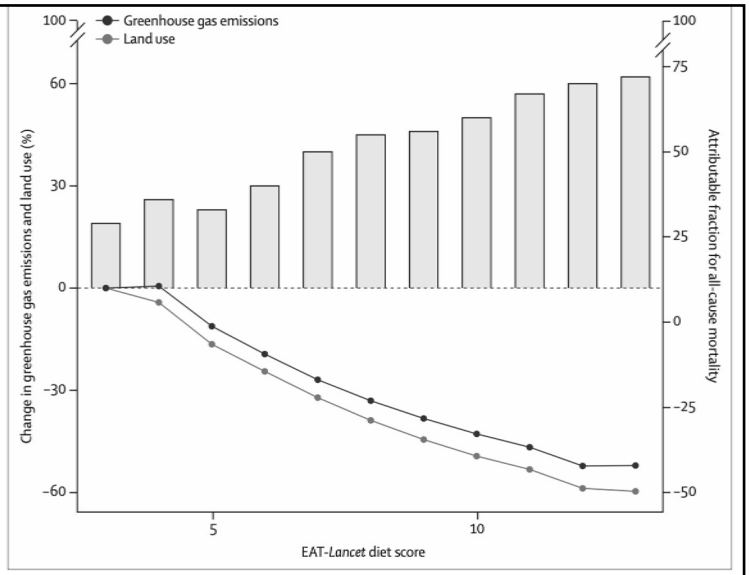
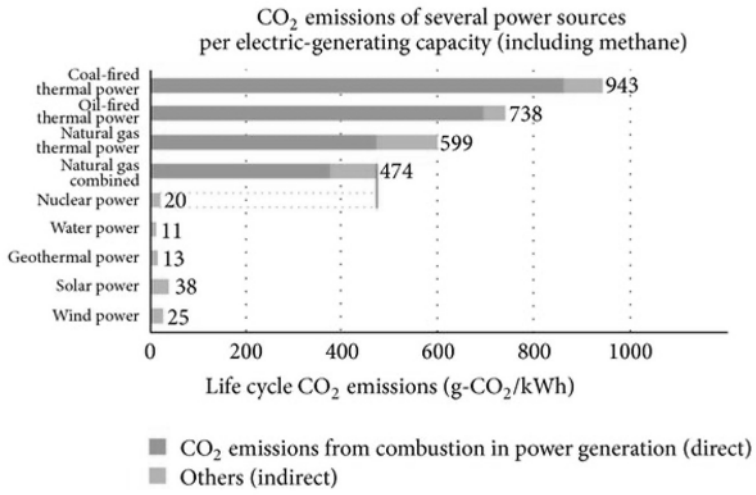


***Figure 2*: Co-benefits of the EAT–*Lancet* diet score**
Lines represent the proportion of greenhouse gas emissions and land use that would change with adherence to EAT–*Lancet* diet scores (compared to lower adherence: ie, a score of 3) and the bars represent the counterfactual attributable fraction from modelling shifts in diets and in deaths (ie, all-cause mortality) that could be prevented over a 20-year risk period from adhering to a higher score of the EAT–*Lancet* reference diet.

(Laine, *Lancet Pub Health*, 2021)

36

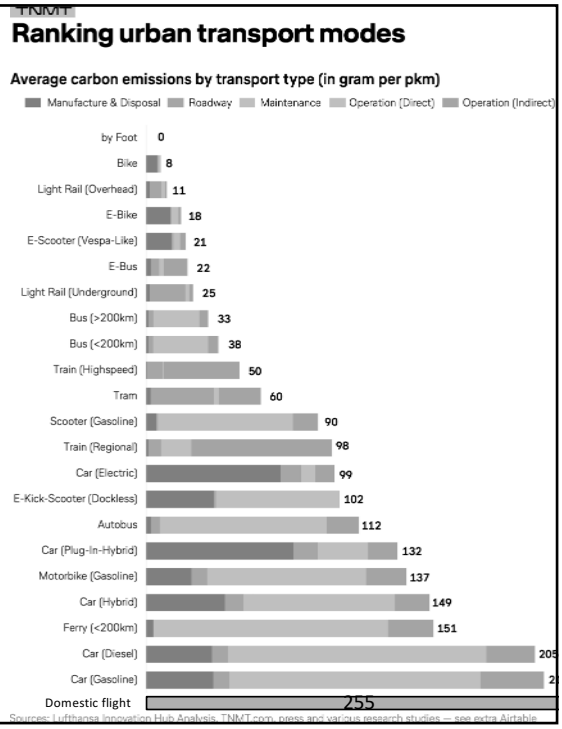
Decarbonization pathways: *energy sector*



37

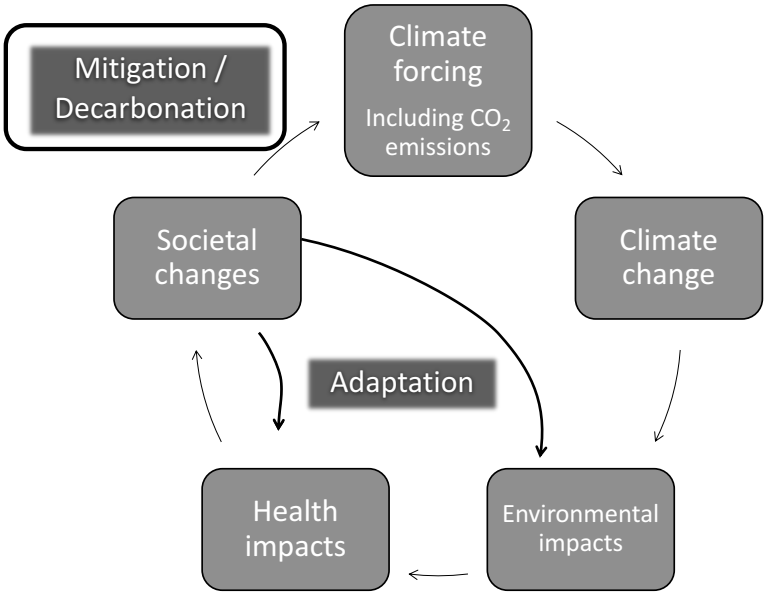
Carbon emissions by transport type

The most carbon-intensive modes of transportation also tend to be those associated with negative health externalities (decreased physical activity and increased noise, atmospheric pollution emission and space occupation)



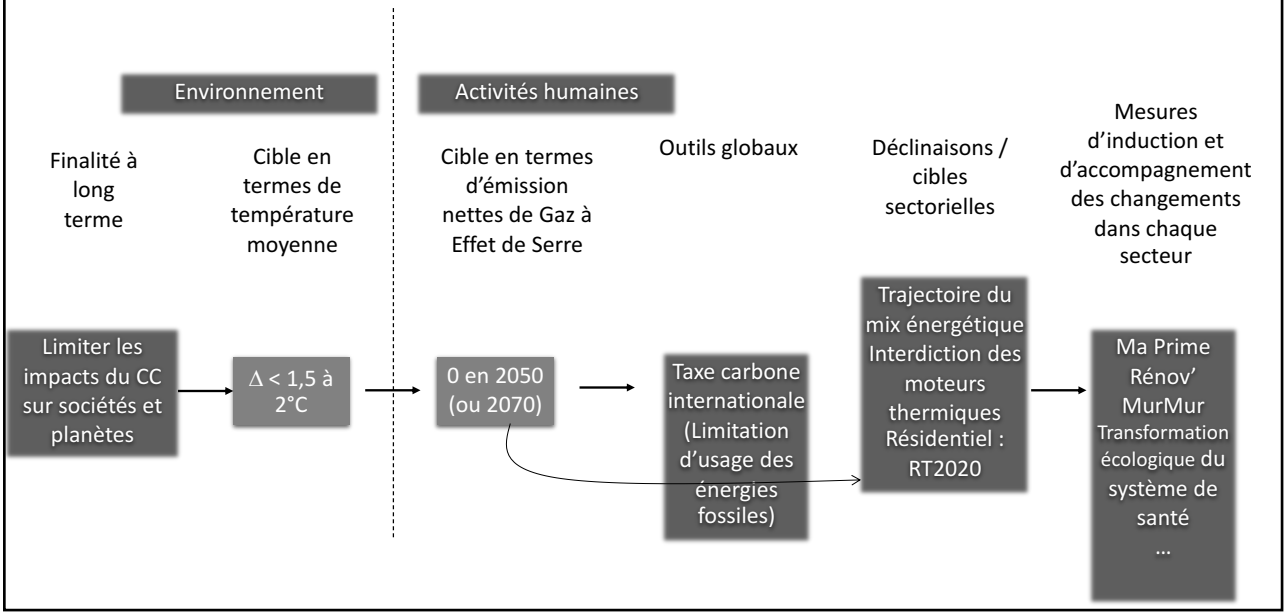
38

Some challenges to decarbonation: *making change happen*



39

Du problème global aux solutions sectorielles



40

Are we on the right track?

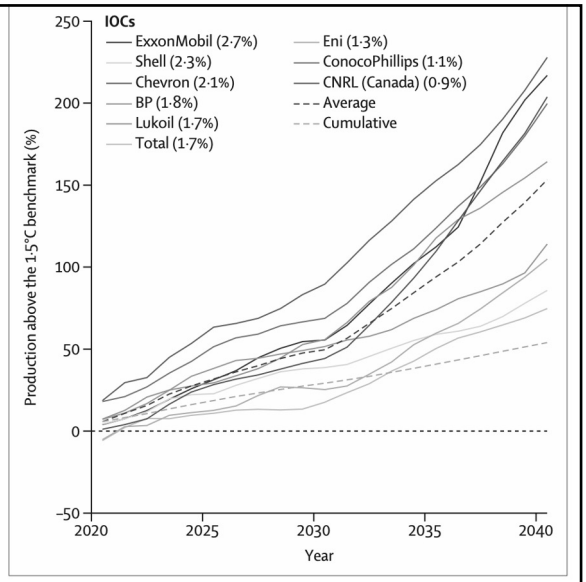
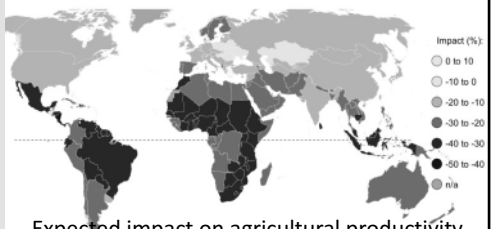


Figure 13: **Compatibility of 20 large oil and gas company production strategies with the Paris 1·5°C climate target**
Percentages in brackets in the legend represent the average 2015–20 global market share. CNRL=Canadian Natural Resources Limited. IOCs=International oil and gas companies. KPC=Kuwait Petroleum Corporation. NIOC=National Iranian Oil Company. NOCs=national oil and gas companies.

(Romanello, Lancet, 2023)

41

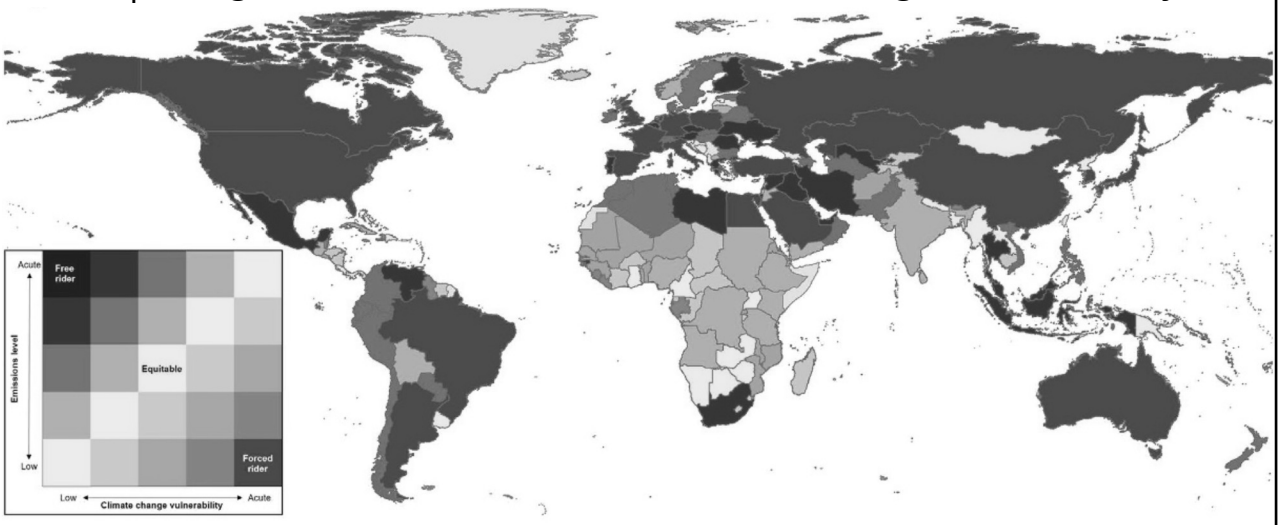
Geographic differences in CO_2 emissions/person



Expected impact on agricultural productivity

42

Comparing GHG emissions and climate change vulnerability



20 of the 36 highest emitting countries are among the least vulnerable to negative impacts of future climate change. Conversely, 11 of the 17 countries with low or moderate GHG emissions, are acutely vulnerable to negative impacts of CC. In 2010, only 28 (16%) countries had an equitable balance between emissions and vulnerability.

(Althor, *Sci Rep*, 2016)

43

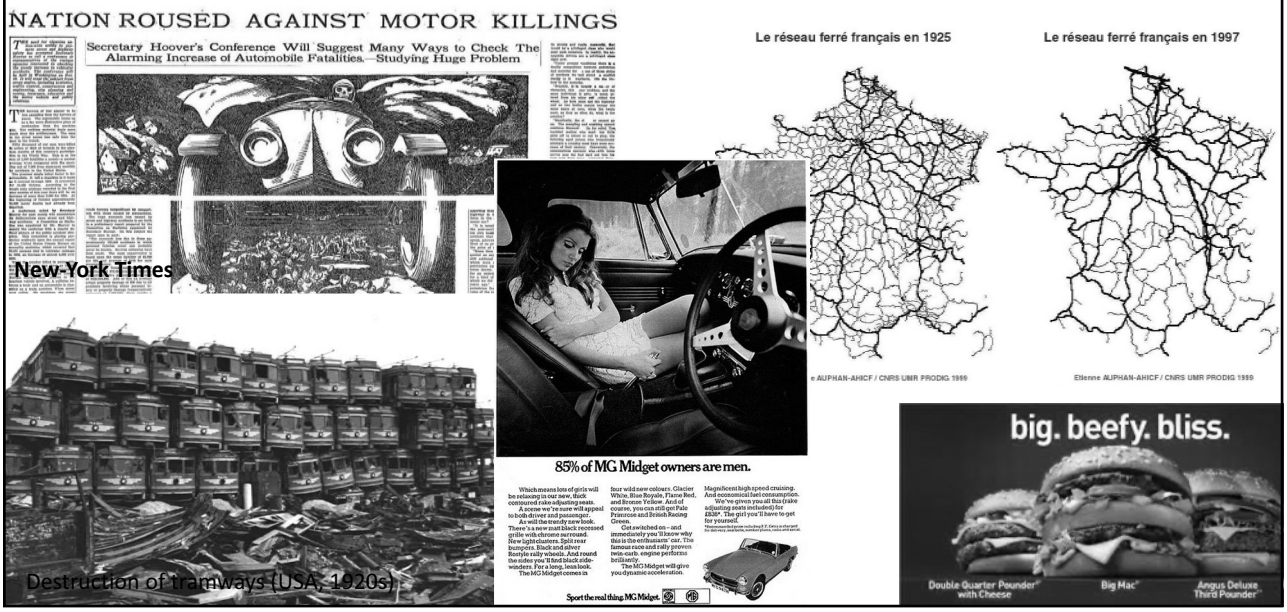
Decision-making at the climate change era - Challenges

- The problem is not suited to the political framework – neither temporally nor spatially
  - Decisions/actions regarding CC will often have impacts only/mainly on the long term
- The issue is is intertwined in all sectors of human activities
- Many uncertainties (various natures: inaccuracy, tipping points, unknown effects…)
- No time/possibility for a full assessment of the situation before making decisions
- Analysis paralysis (e.g., because of *decision precision paralysis*)
- *Climatosceptiscm/climate change denial*: Conflicts of interest
- *"Fairness doctrine"-Functioning of the media:* Habit of always trying to present both sides of a question, giving equal time to each option even if one option is strongly minority
- *Cornucopianism:* Dream of the miracle "one size fits all" technological solution
- Fear of the political consequences of strong measures against CC, such as threats against capitalism or our "way of life"
- Implementing change is difficult

➔The democratic challenge of our time?

44

Making (quick) choices relevant for health and society



45

Conclusion: Climate change as a threat, decarbonation as a public health opportunity?

- ***Climate*** has always influenced human well-being, as well as the living environment as a whole
- ***Climate change*** can influence health and social and geographic inequalities by multiple pathways – it already started doing so
- Adaptation is necessary as a short- or mid-term solution and possible in some areas
  - it cannot constitute the unique long-term answer: issues related to equity, cost, long-term viability
- In most key emission sectors, decarbonization may constitute an opportunity to improve health
  - E.g., huge expected co-benefits in moving away from fossil fuel burning, "one person" car model…
- Research efforts are needed to define the pathways towards carbon neutrality entailing the largest benefits in terms of health improvement and inequality reduction
- Highlighting these cobenefits is essential, as they may happen on a shorter time scale than climate-related benefits
- Health has been to a large extent ignored when adopting fossil fuels – it wouldn't be wise not to consider it in the process aiming at phasing them out
- Climate change constitutes a huge challenge for science, health, democracy – and for the health sector

46