Sustainability

- Information:

  http://zeus.nyf.hu/~szept/kurzusok.htm

- Theis, T. (2015): Sustainability: A Comprehensive Foundation. **https://open.umn.edu/opentextbooks/textbooks/96**

- David Attenborough : A life on our planet

https://www.netflix.com/title/80216393

One man has seen more of the natural world than any other. This unique feature documentary is his witness statement.

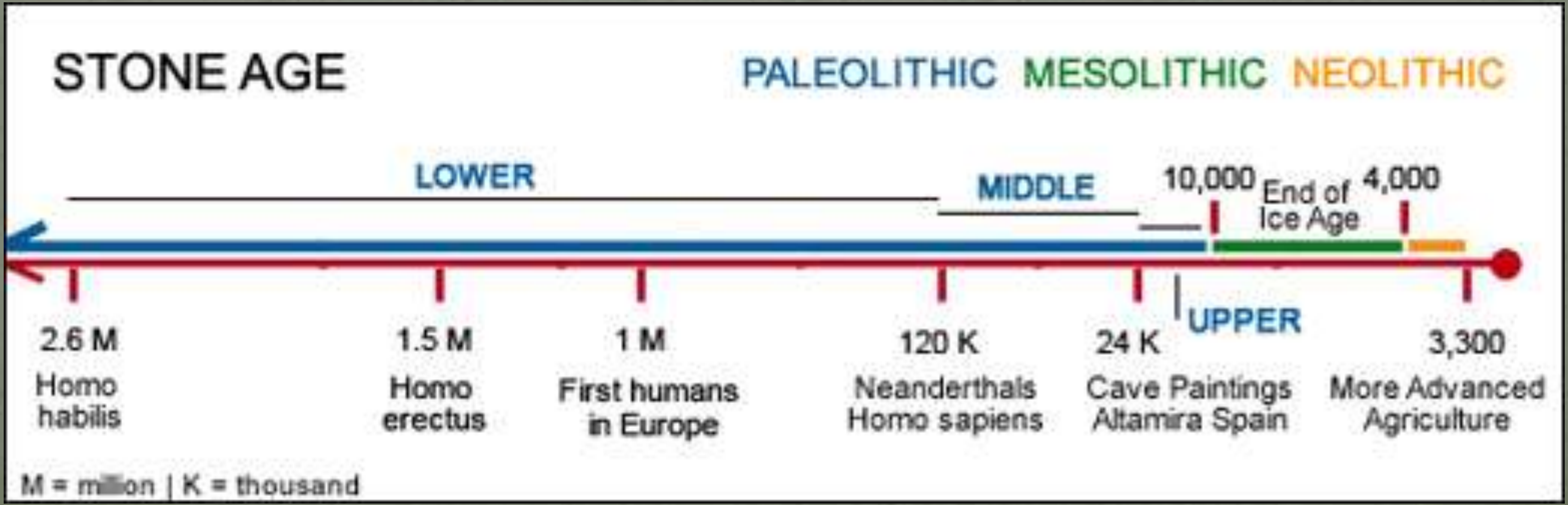
Prehistoric progress traps

Sustainability

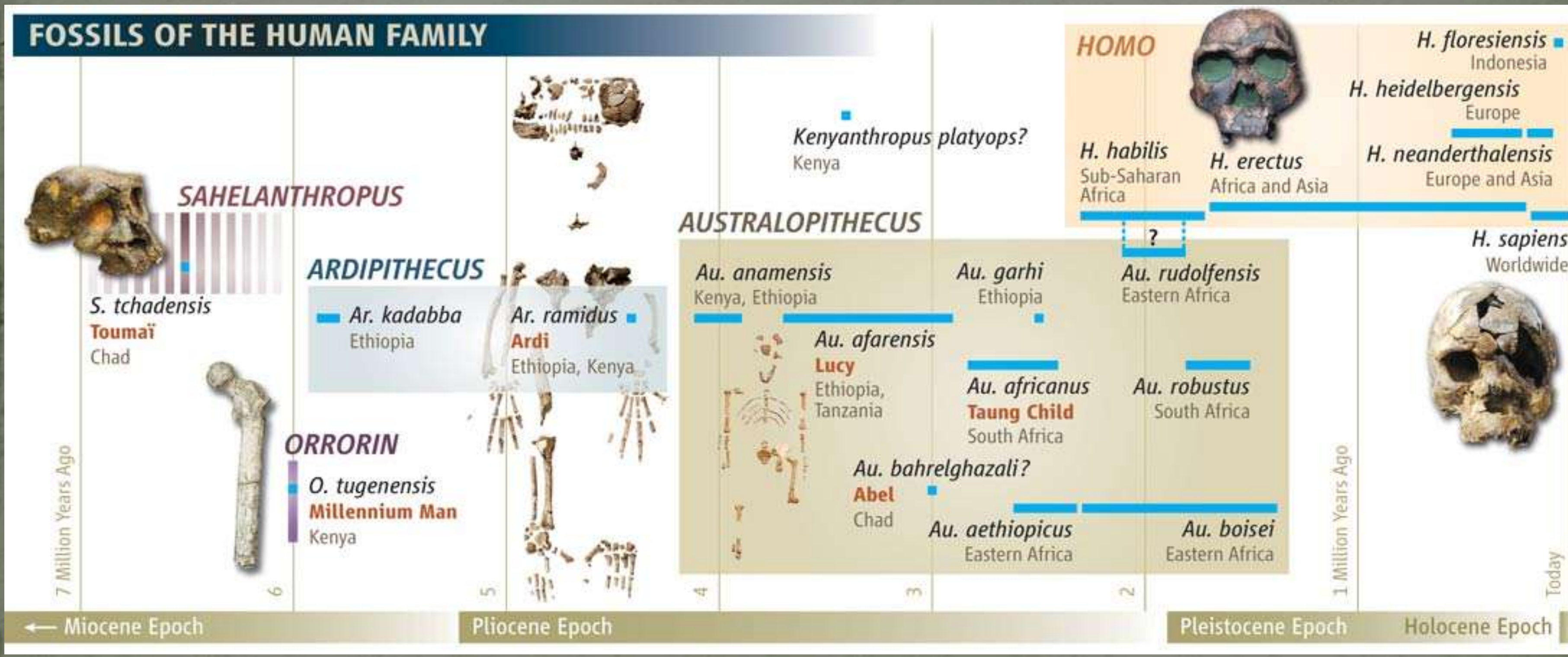
2023/2024

Prehistory

- Stone Age
  - Paleolithic (Old Stone Age)
    - Lower Paleolithic
    - Middle Paleolithic
    - Upper Paleolithic
  - Mesolithic (Middle Stone Age)
  - Neolithic (New Stone Age)



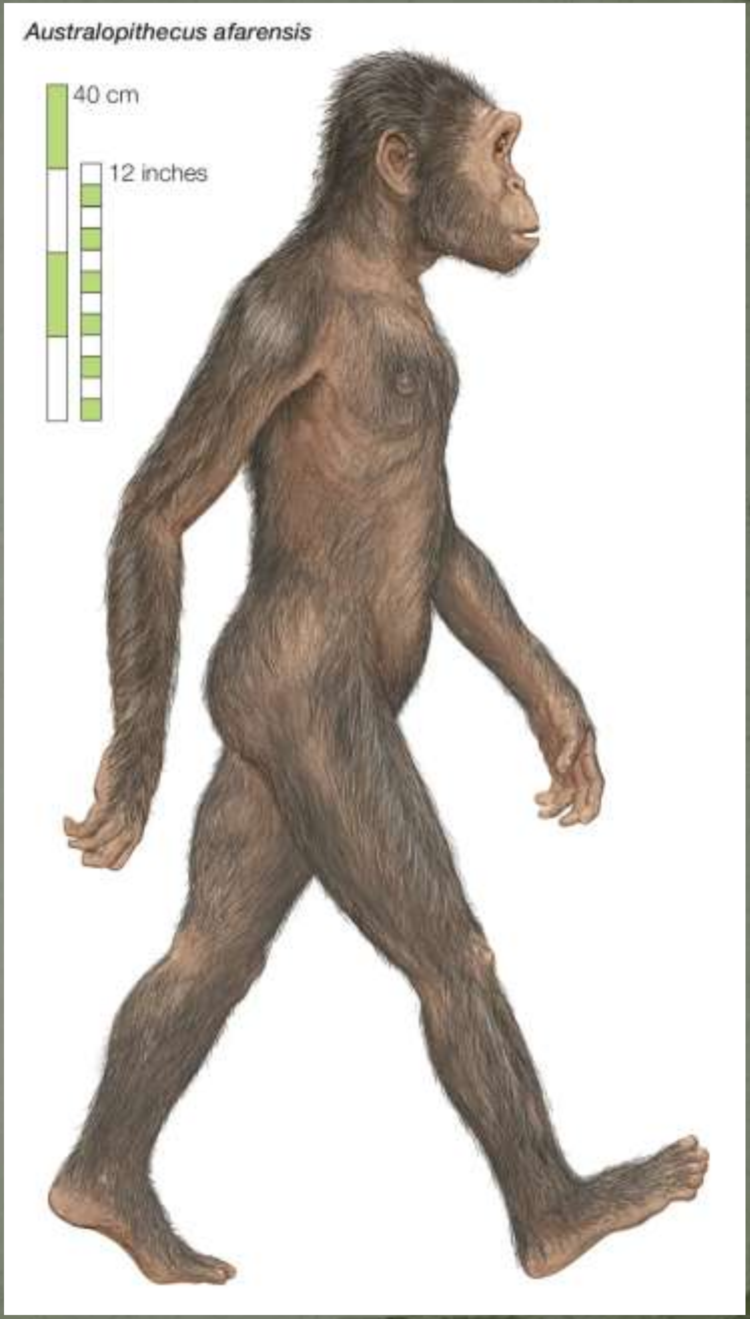
Fossils of the Human family (*Hominidae*)



Early hominins

- Omnivorous
- Hunter-gatherer lifestyle
- Usage of tools
- No creation of artifacts

- Environmental effects were not significant



Creation of artifacts

Homo habilis
(„handy man”)

Creation of chopper

Chopper:
A pebble tool with an irregular cutting edge formed through the removal of flakes from one side of a stone. (wikipedia)

Creation of artifacts

Homo erectus
(„upright man”)

Flake tools

Flake tools:
Stone Age hand tools, usually flint, shaped by flaking off small particles, or by breaking off a large flake which was then used as the tool. (Britannica)

Creation of weapons

Homo sapiens
(„wise man”)

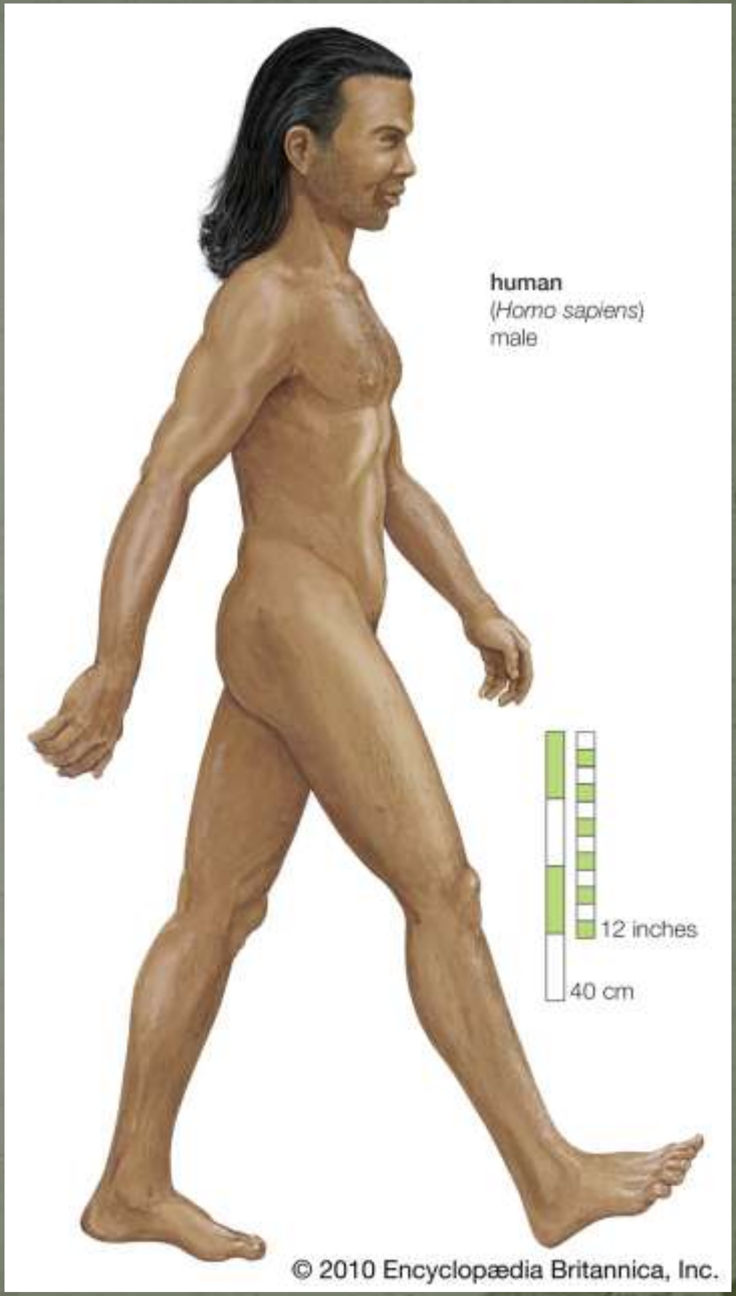
First weapons

- Harpoons
- Bows
- Arrows
- Spears

Homo sapiens

- Hunting in group
- Increasing number of killed wild animals
- Itinerant lifestyle

- Local and regional environmental effects

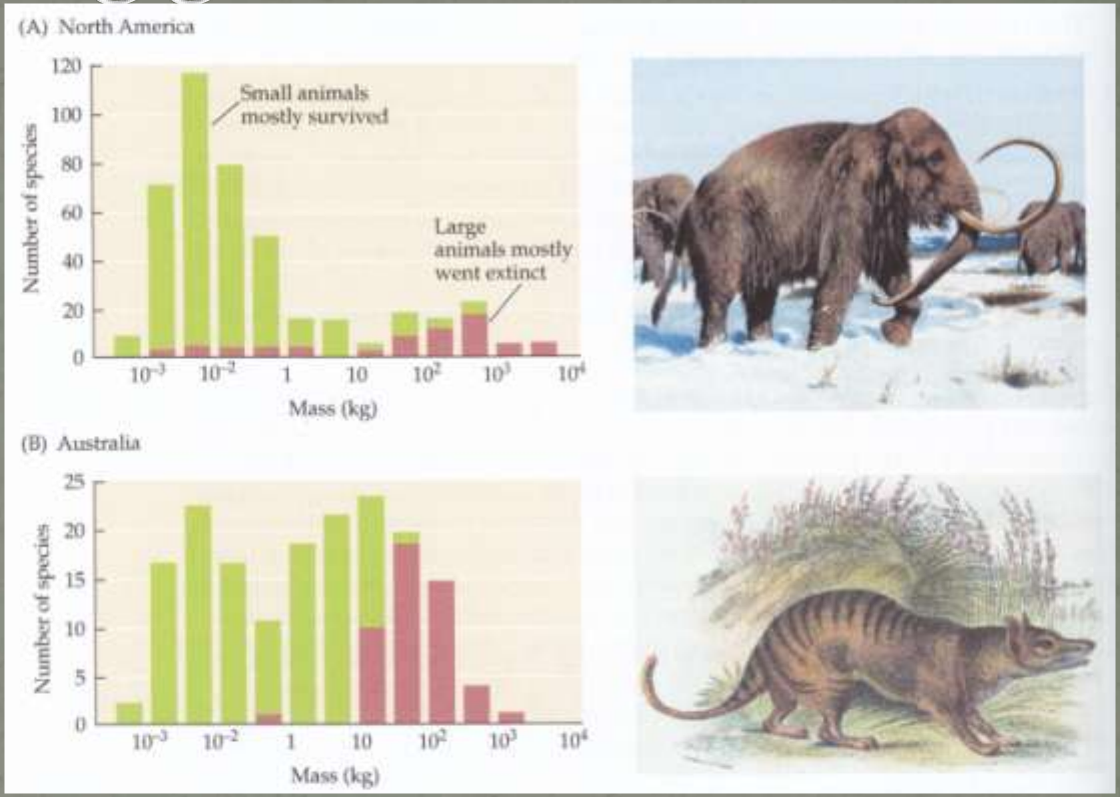


Endless hunting grounds?

- Storage and preserving were unknown
- They were not able to utilize the excess of prey
- Over-hunting
- Extinct animals

(Climate change and human hunting both played a part in the mammoth's demise. Mammoth had slow productive rate and juvenile mammoths were more exposed to hunting.)

Endless hunting grounds?



Body mass of herbivorous mammals from (A) North America and (B) Australia. **Green**: survived until European arrival, **Red**: survived since first human arrival

„Paleolithic hunters who learnt how to kill two mammoths instead of one had made progress.

Those who learnt how to kill 200 – by driving a whole herd over a cliff – had made too much.

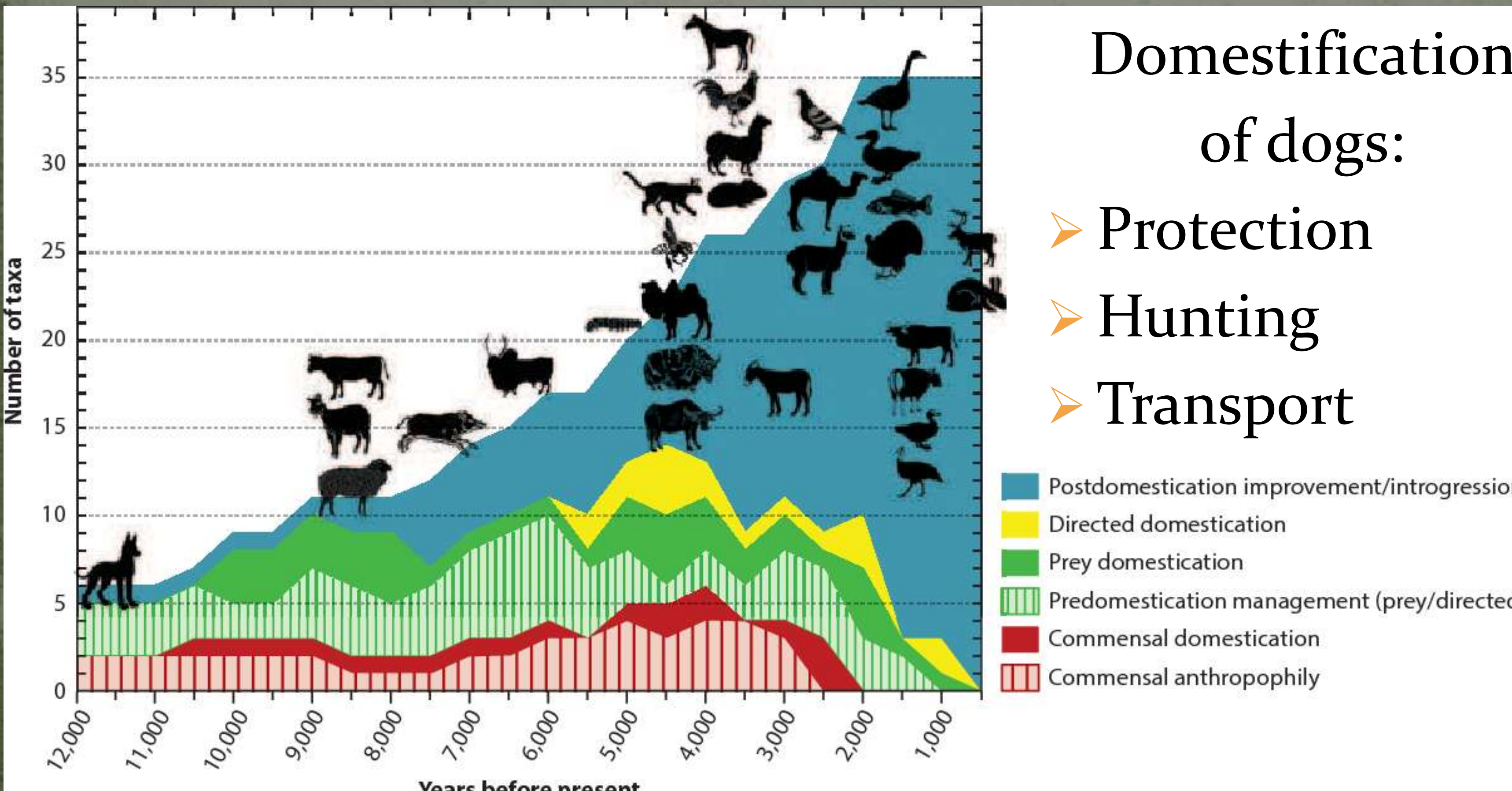
They lived high for a while, then starved.”

(*Ronald Wright:* A Short History of Progress)

Middle Stone Age (Mesolithic)

- The end of the itinerant lifestyle
- Settlements
- Constractions, firing (heating) ← deforestation
- Domestification of wild animals
  (pasturage → deforestation)

A summary of the timing and increase in animal domestications



Domestification of dogs:

- Protection
- Hunting
- Transport

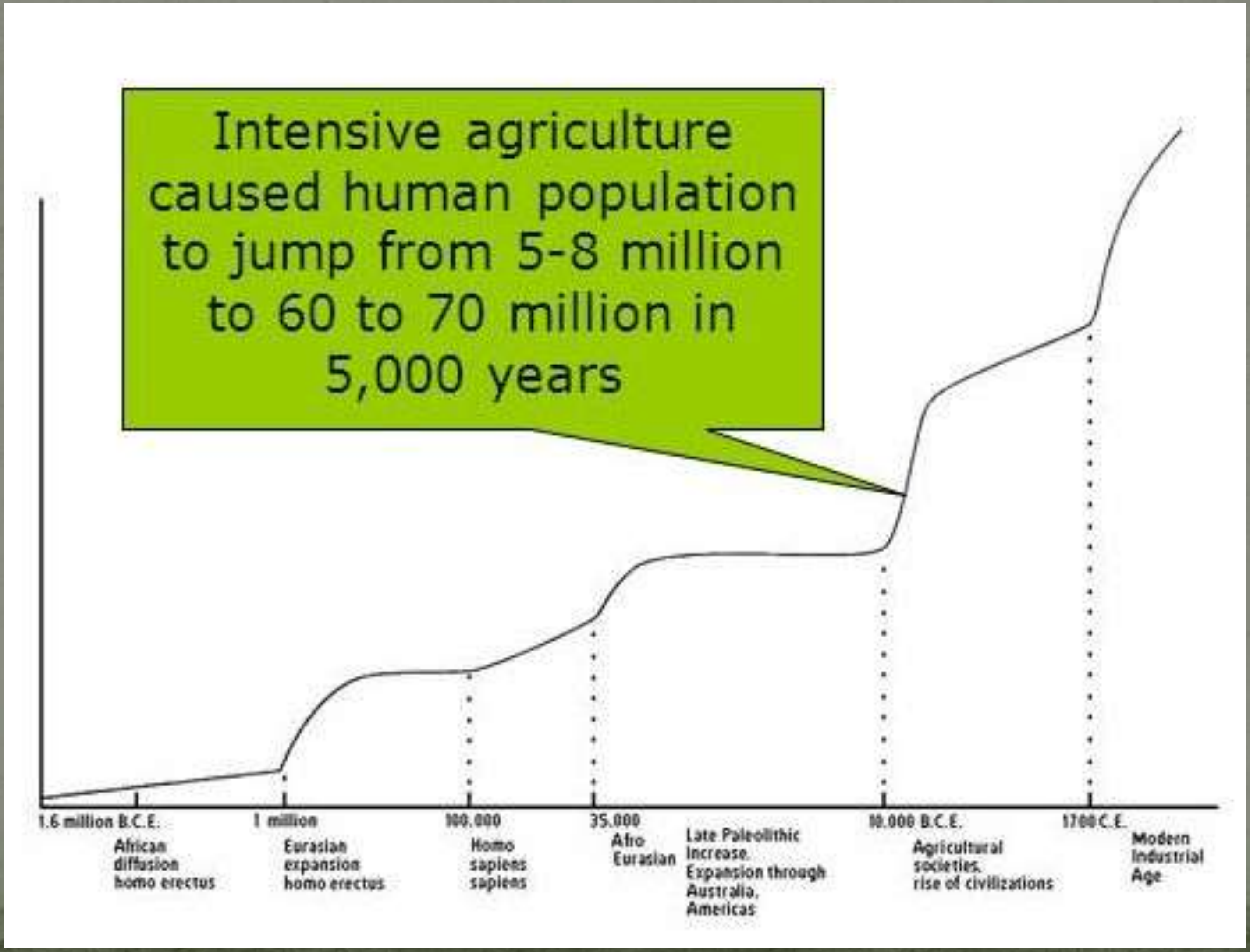
New Stone Age: Neolithic revolution

- Gardening: fruit-trees → fenced gardens
- Raising of cereal: preference of domesticated plants
- Eradication of natural vegetation

  → Biodiversity decreased
- Material and energy flow of soil changed

Animal husbandry and growing plants

- Population growth!



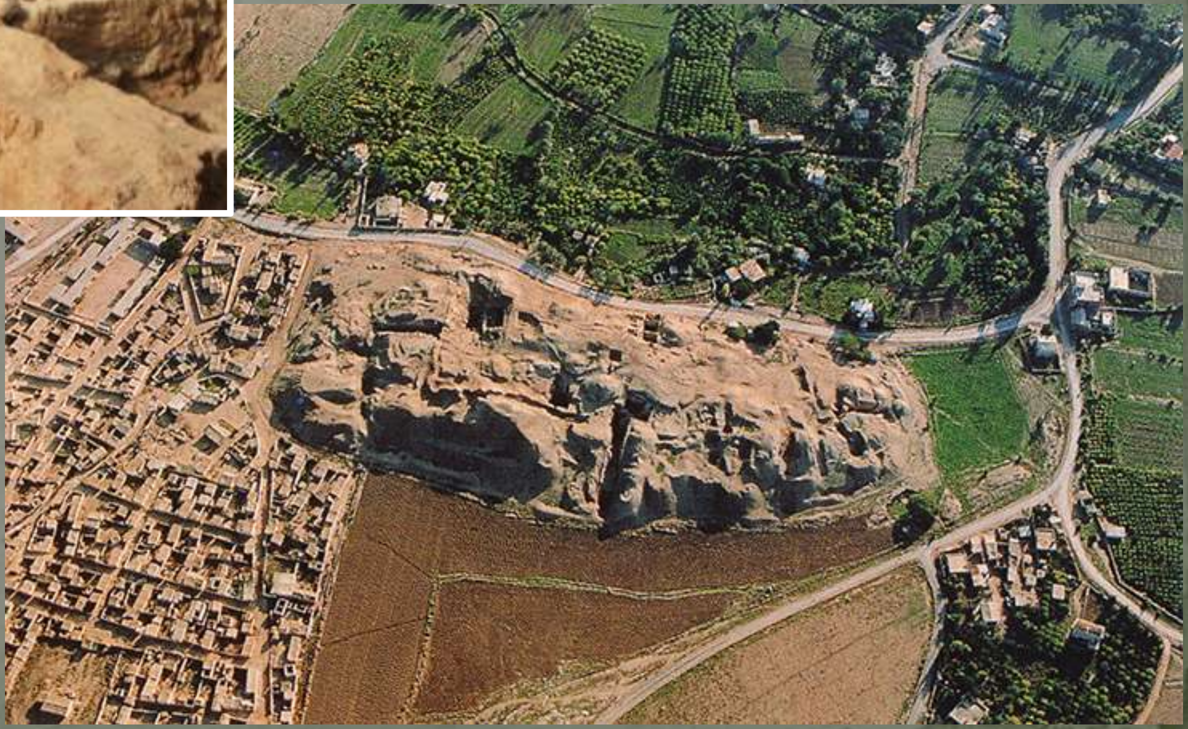
„The transition from hunter-gathering to nomadic herding systems and eventually to settled agriculture during the Neolithic period has been described as 'the most fundamental change in human history'. By allowing output of food to increase, the concept of 'property' to develop, and surplus food production to grow, the agricultural transition became the basis of human revolution. Food surpluses enabled the development of non-farmers within society, including the priesthood, the army and craftsmen. The distribution and collection of food was the basis for power and the development of wealth, and the ability to produce more from a smaller area of land lad the basis for population growth."

(*Adam C. Markham:* A Brief History of Pollution)

„Out of agriculture, grew the community. Small villages at first, then towns and eventually city-states. Jericho was a walled town of ten acres in 6500 BC, and the Mesopotamian temple city of Uruk had a population of 50,000 people by 3000 BC. For a modern comparison it is noteworthy that the French city of Toulouse had only reached a population of 55,000 nearly 5000 years later 1789. This development of towns and cities ushered in the pollution era." (Adam C. Markham: A Brief History of Pollution)

Jericho cityscape from wall ruins

Jericho (Palestine)
„The oldest city in the world"



„Much early sickness was undoubtedly caused by what we would today, call pollution. The very earliest form of pollution must have resulted from the act of defecation. The presence of human gut bacteria such as Escherichia coli in drinking water was the first water pollution and must have been a source of illness for prehistoric man, just as it is for millions of people today.

(Adam C. Markham: A Brief History of Pollution)

„The discovery of fire, at least half a million years ago, created the first significant air pollution source, and smoke remains a major problem in the modern world. Ancient human communities are thought to have suffered from sinusitis and blackening of the lungs (anthracosis) due to regular exposure to smoke."

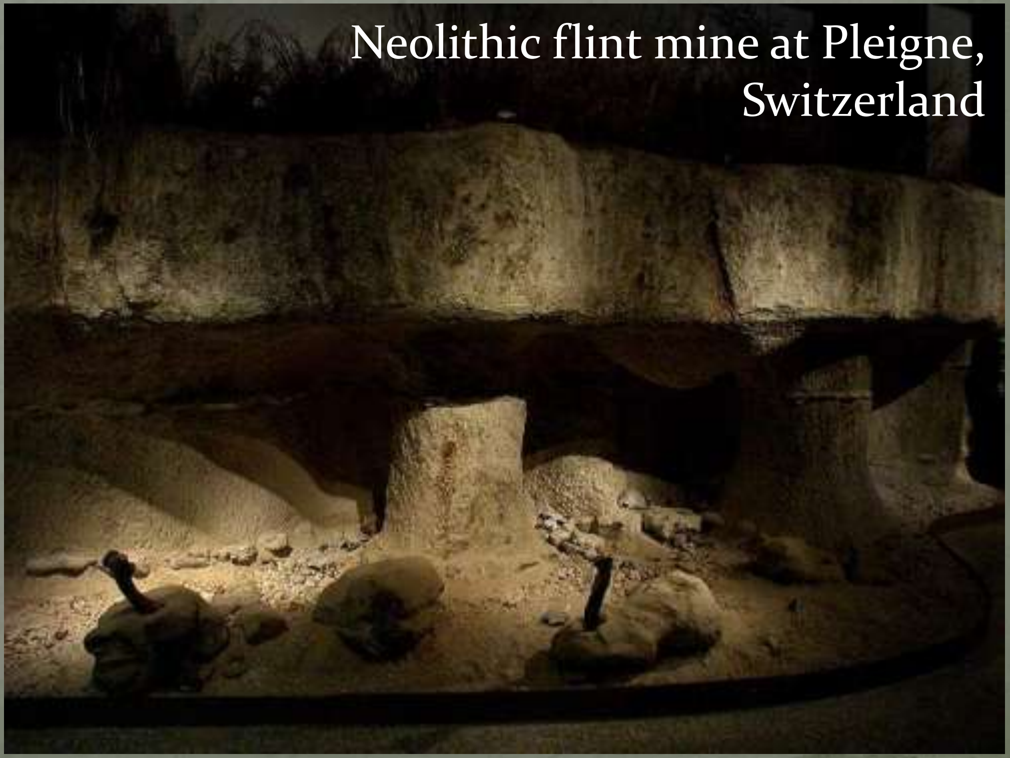
(*Adam C. Markham:* A Brief History of Pollution)

„Dust pollution also has early origins and Janssens speculated that the Neolithic miners of central Europe, who daily chipped flints from limestone quarries like that of Obourg, suffered from silicosis. Their every breath during the working day would have drawn in air polluted with dust from their labours. Simple geography sometimes influenced historical exposure to pollutants.

„ Recent analysis of the 200,000 year old Broken Hill hominid from Zambia has produced evidence that he suffered from lead poisoning due to an ore lode underlying the water supply of the cave dwelling.” (Adam C. Markham: A Brief History of Pollution)

Pollutions

- Heavy metals in bones (e.g. lead/Pb)
  - Dissolution of metal ores to drinking water
- Stone pits, carving of flint stone
  - Pulmonary silicosis


Neolithic flint mine at Pleigne, Switzerland

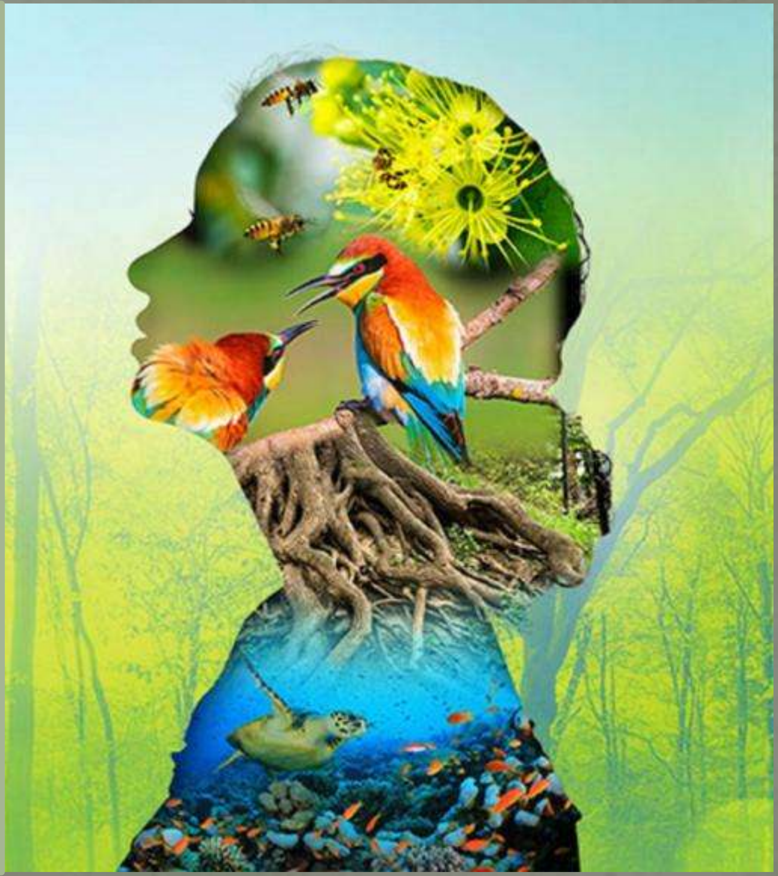
Questions

- What invention has basically changed the lifestyle of Homo sapiens?
- What caused the extinction of wolly mammoth?
- How sustainable was paleolithic hunting?
- How did neolithic revolution impact biodiversity?
- How has population changed in the stone age? What was the most remarkable step, and what was its background?

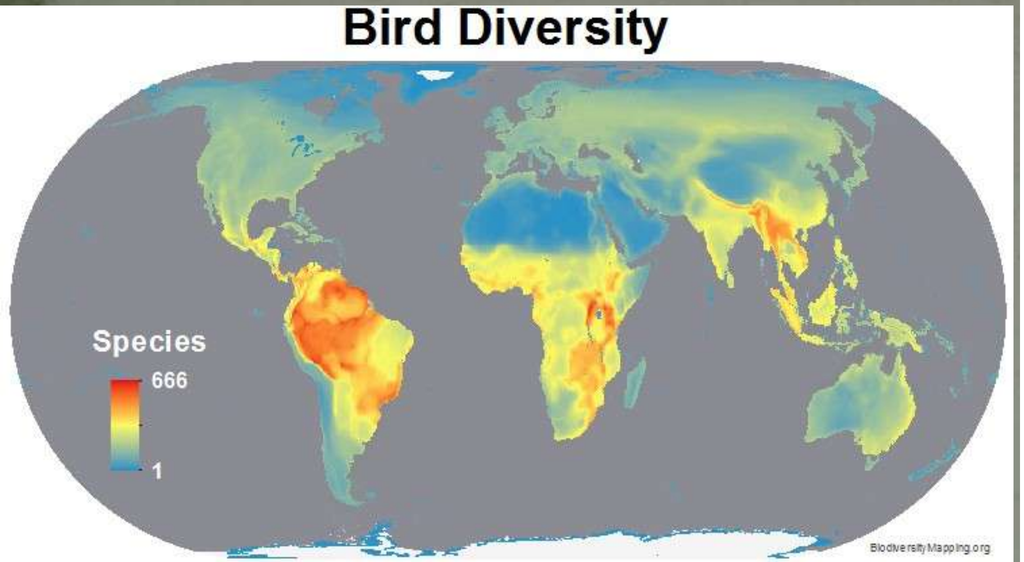
Biodiversity

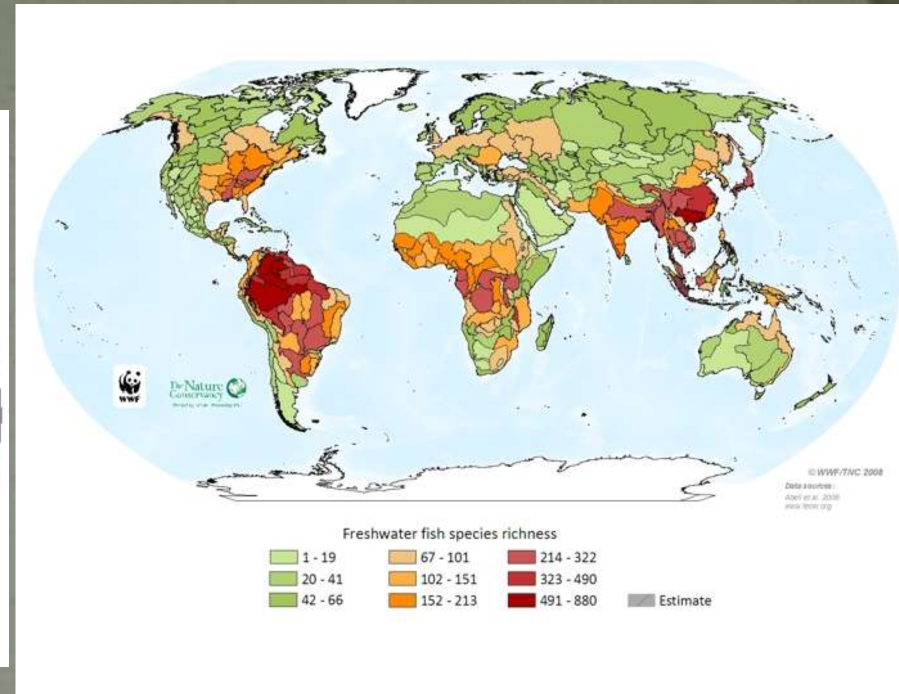
Biodiversity:

the variety of life found in a place on Earth or, often, the total variety of life on Earth. A common measure of this variety, called species richness, is the count of species in an area.

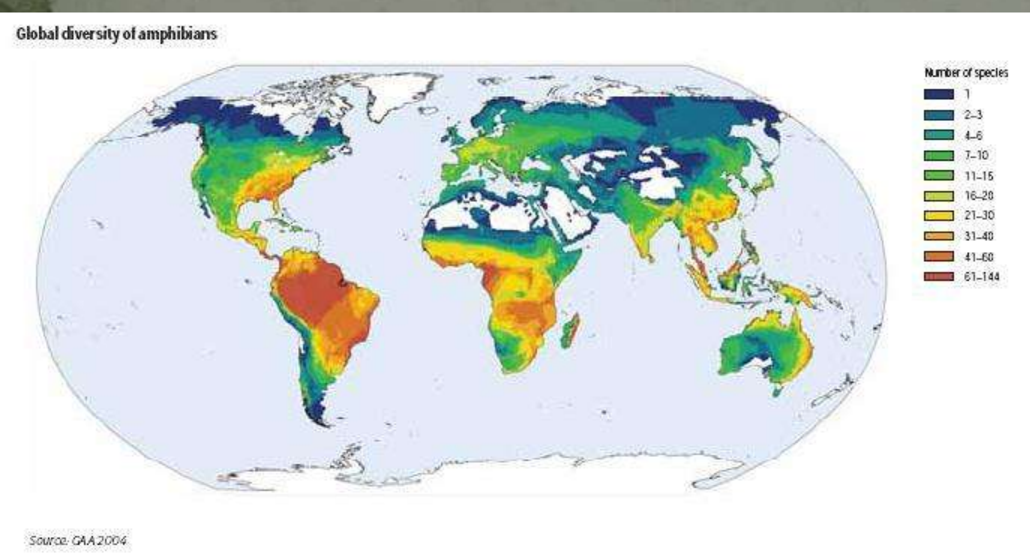


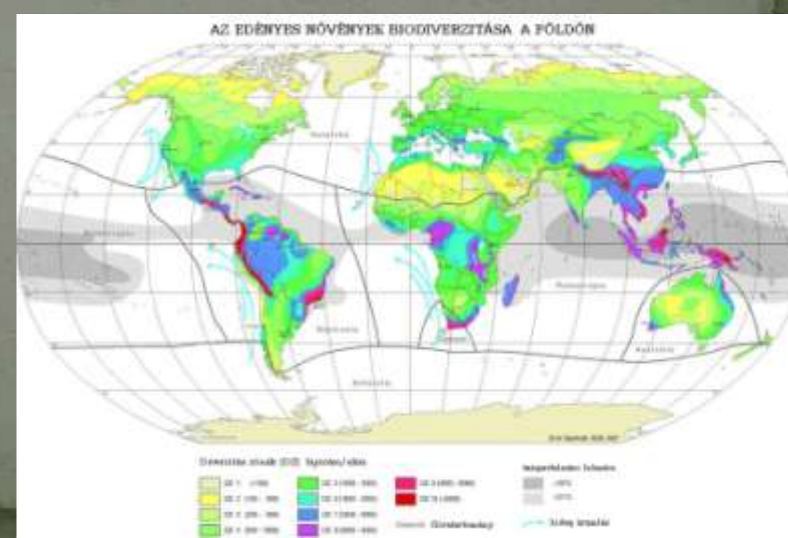
Biodiversity on the Earth





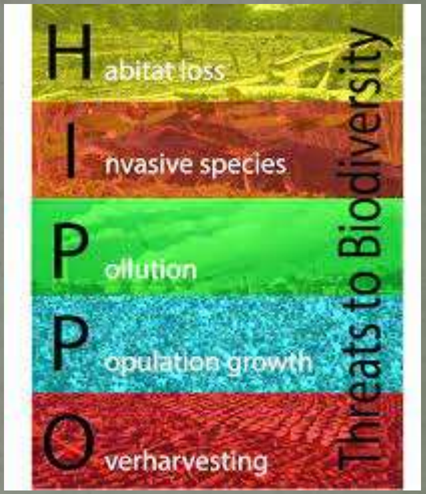
Plants



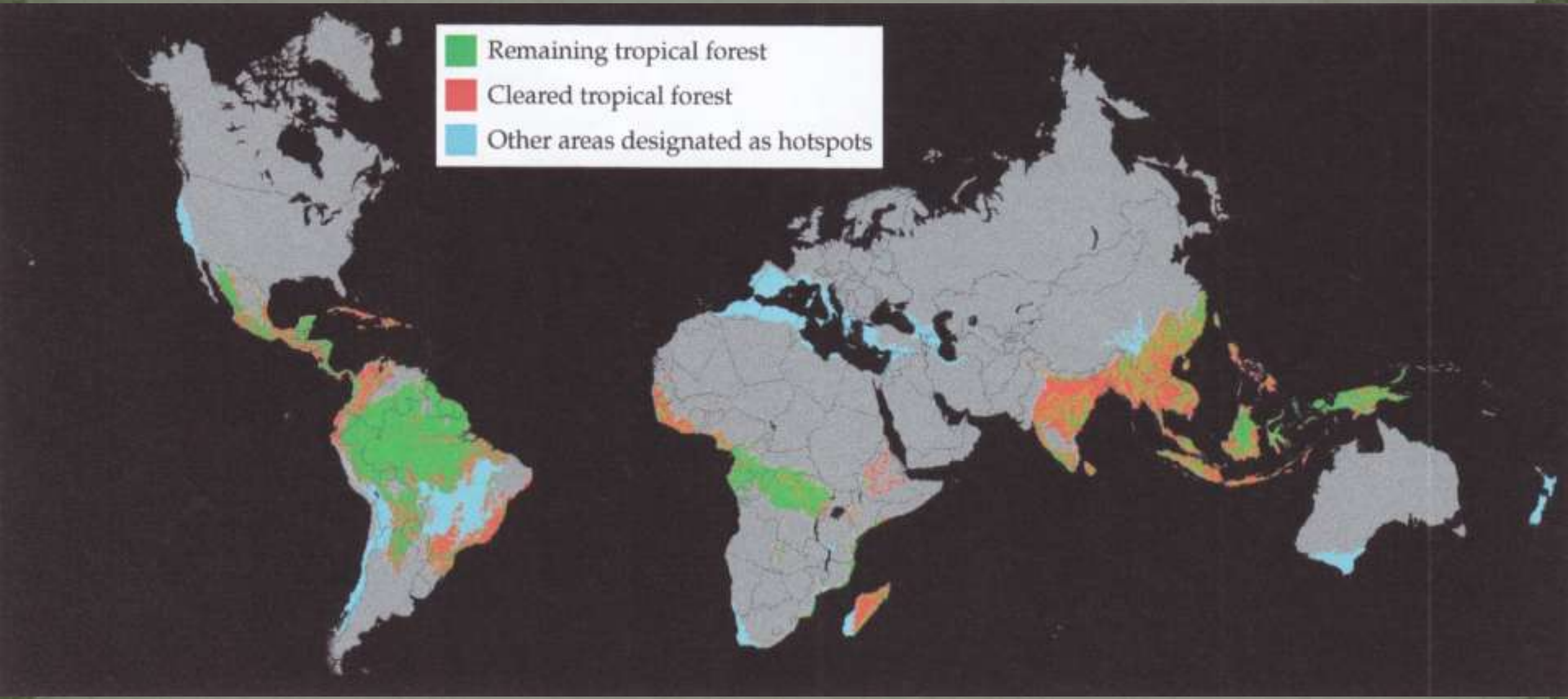


Causes of biodiversity loss (HIPPO)

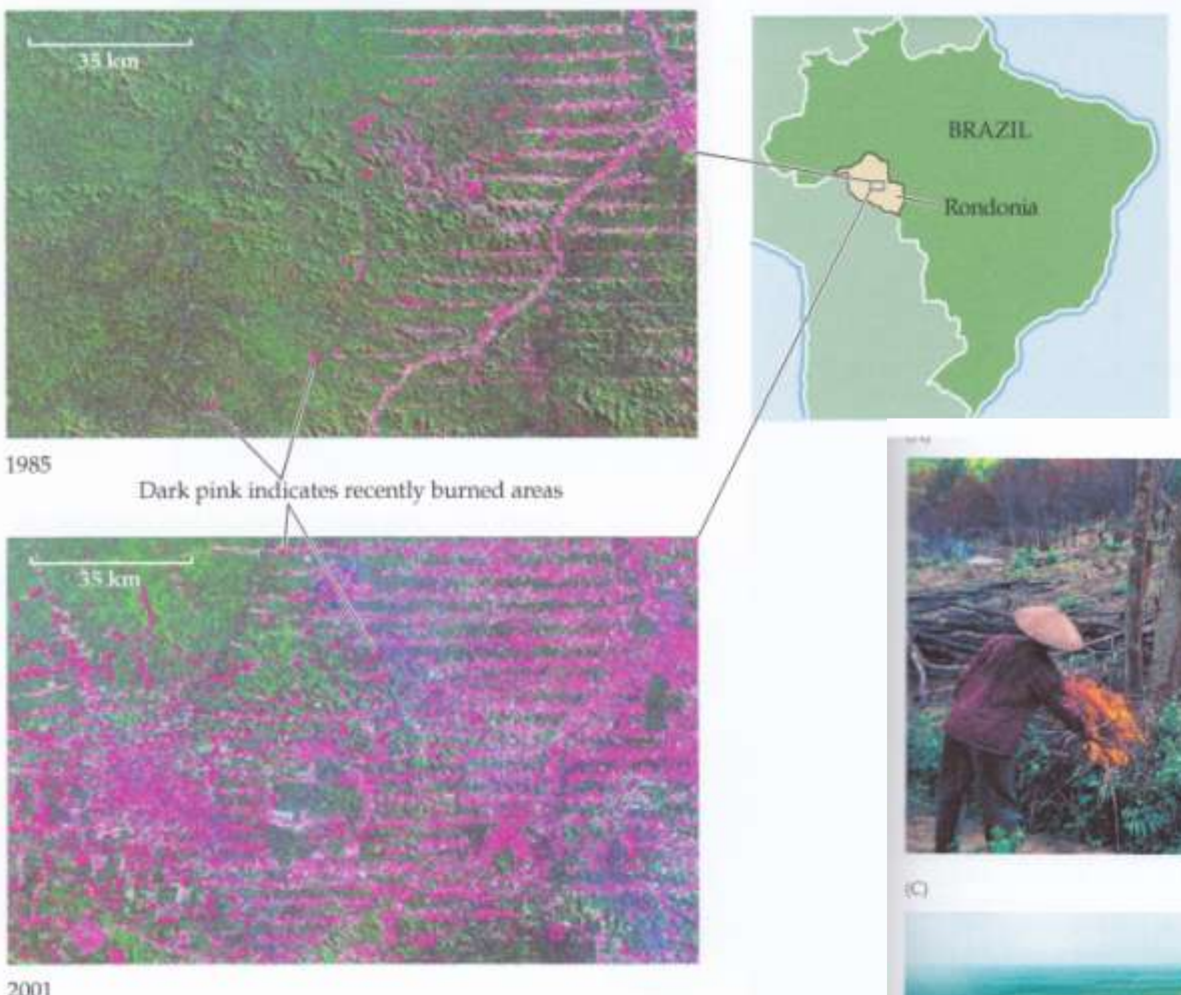
- Habitat loss
- Invasive species
- Pollution
- Population Growth (human)
- Overconsumption,
  Overharvesting,
  Overexploitation



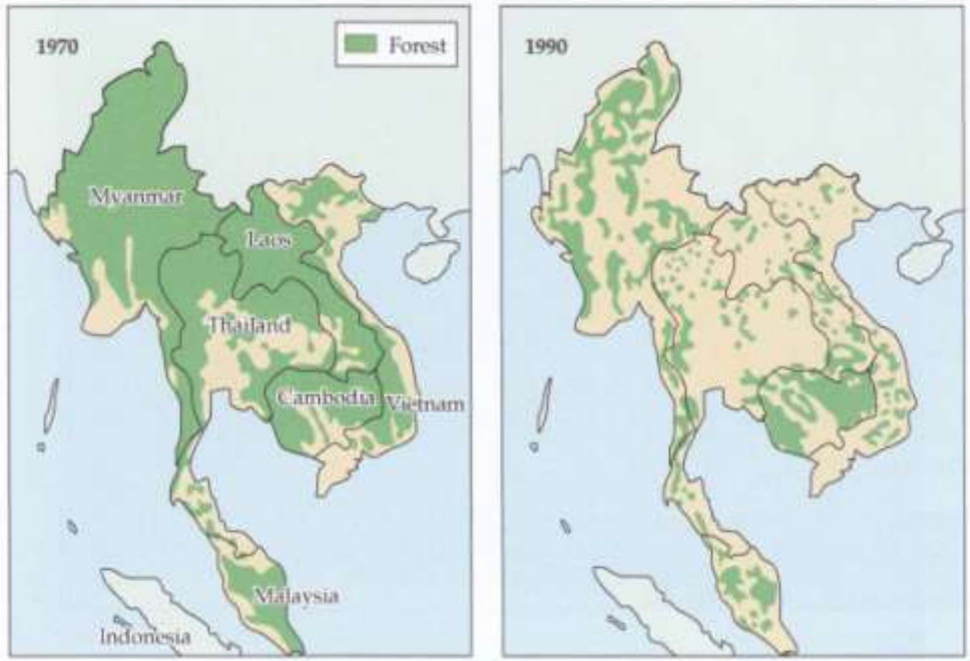
Loss of biodiversity in the tropical regions



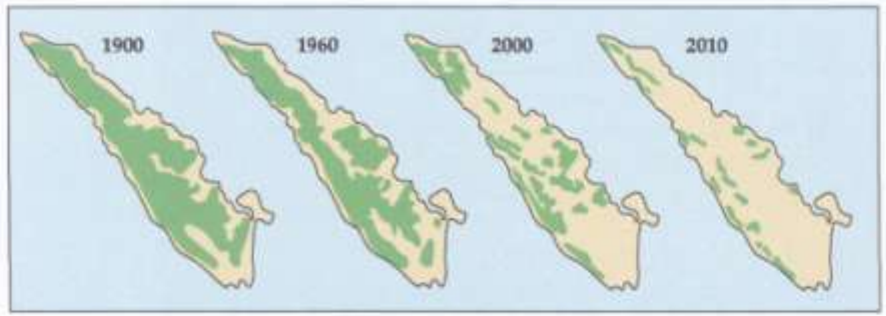
Esőerdők pusztulása



(A)



(B)



(C)

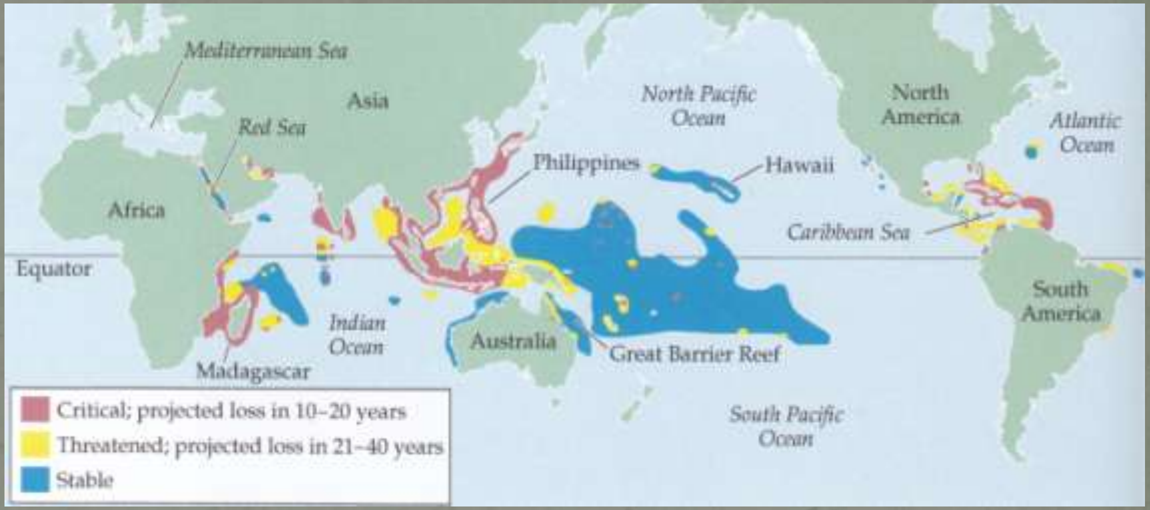
Figure 9.11 The forests of tropical Asia have experienced massive deforestation and fragmentation in recent decades. (A) Two forest maps of Southeast Asia from 1970 and 1990. (B) Sumatra, a large island of Indonesia, has experienced intense habitat destruction over the past 100 years. (C) A wide path (note the car for scale) has been cut through rain forest to allow construction of a gas pipeline in Thailand. Such disturbances often lead to the far-reaching effects of habitat fragmentation. (After Bradshaw et al. 2009.)

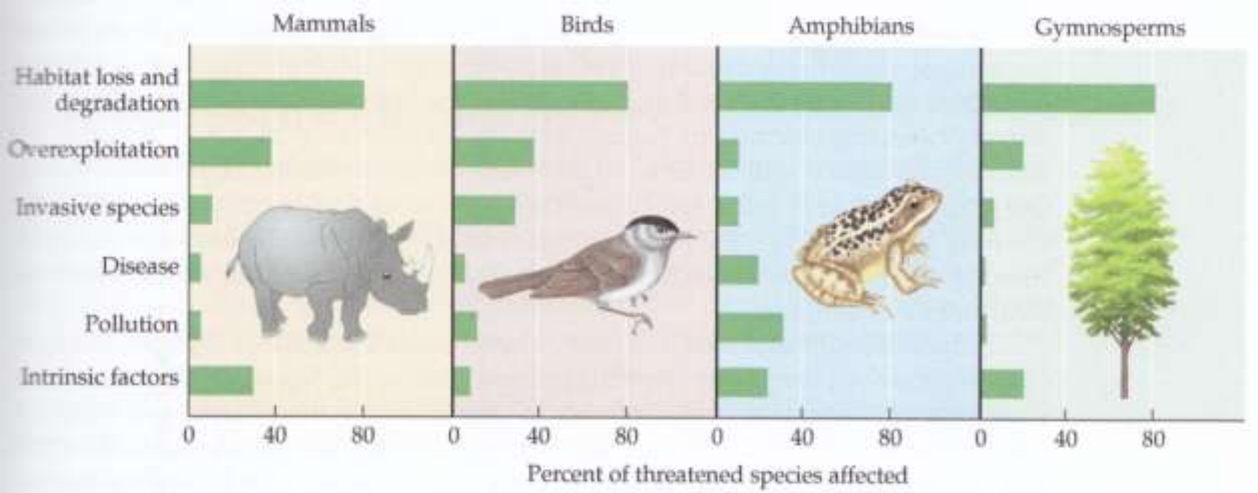
Wetlands

-

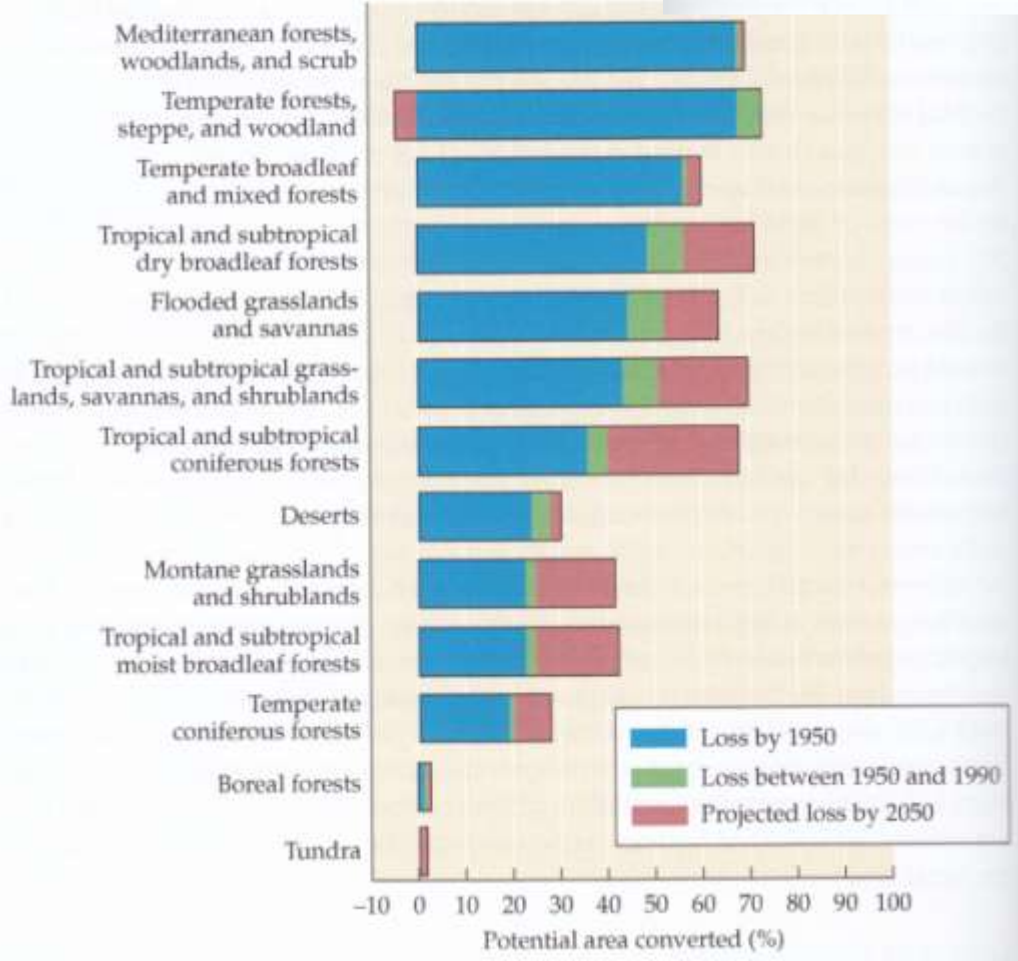
Coral reefs

Mangrove





Mammals
Birds
Amphibians
Gymnosperms
Habitat loss and degradation
Overexploitation
Invasive species
Disease
Pollution
Intrinsic factors
0
40
80
Percent of threatened species affected

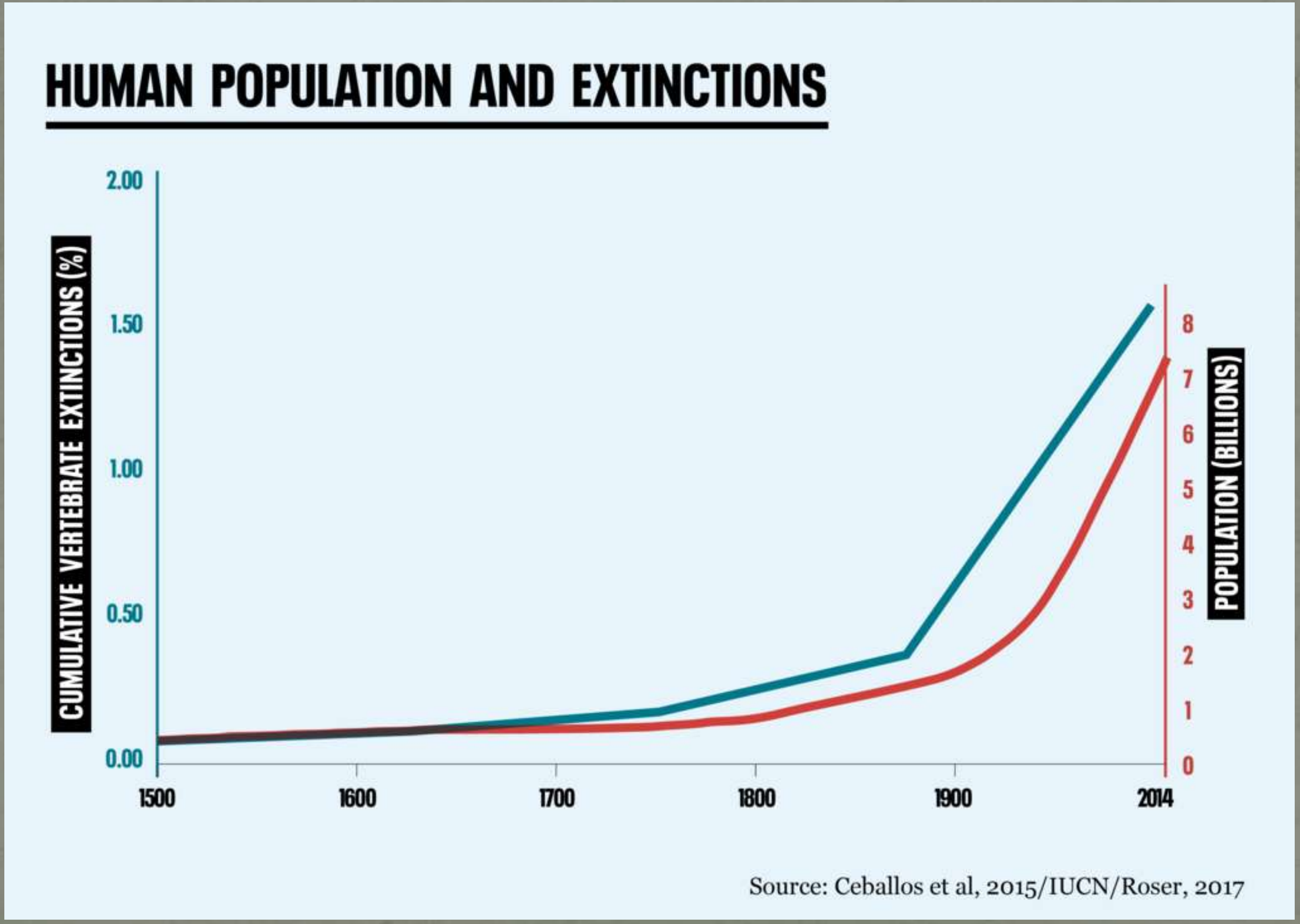


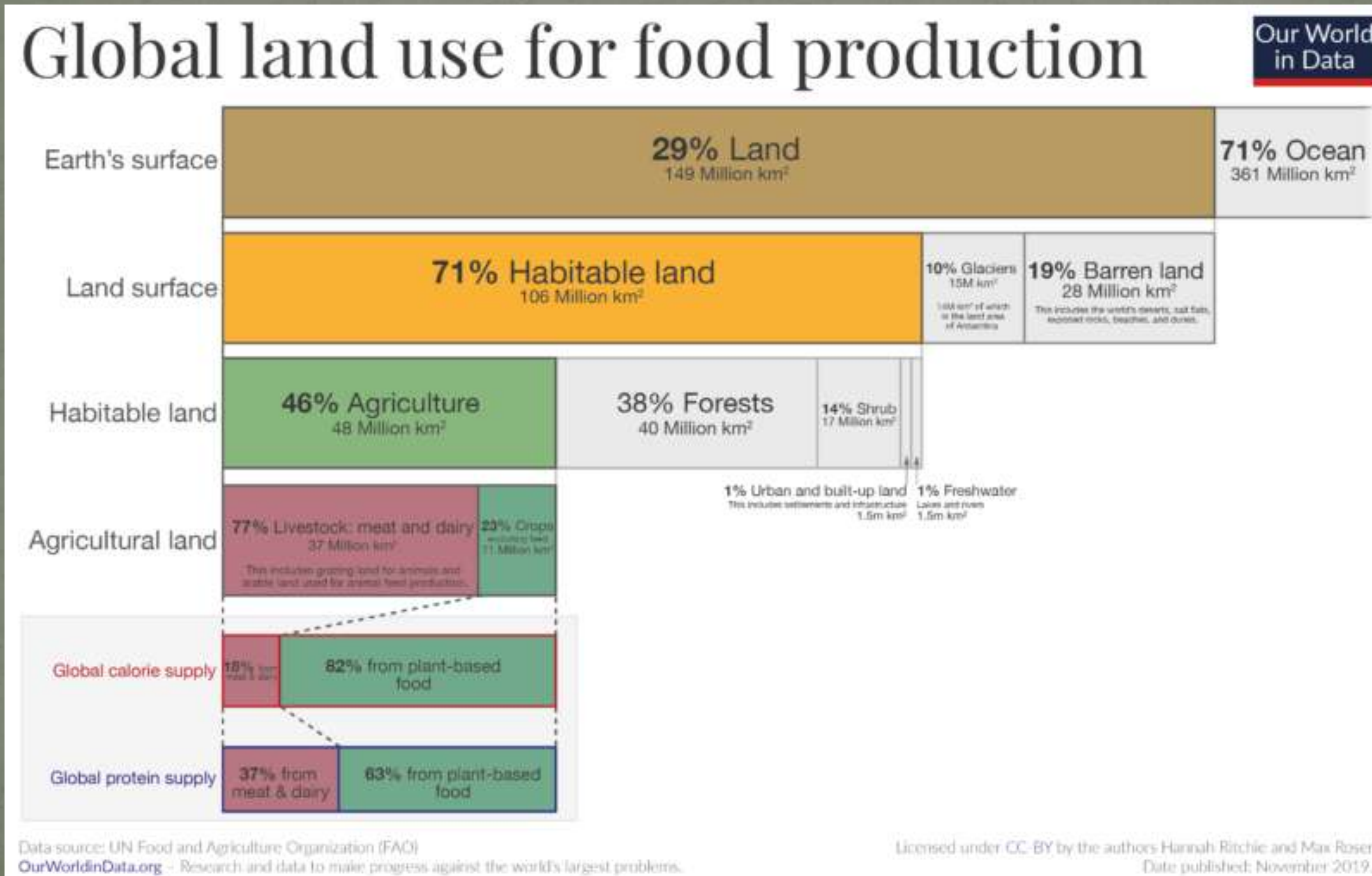
Mediterranean forests, woodlands, and scrub
Temperate forests, steppe, and woodland
Temperate broadleaf and mixed forests
Tropical and subtropical dry broadleaf forests
Flooded grasslands and savannas
Tropical and subtropical grasslands, savannas, and shrublands
Tropical and subtropical coniferous forests
Deserts
Montane grasslands and shrublands
Tropical and subtropical moist broadleaf forests
Temperate coniferous forests
Boreal forests
Tundra
Loss by 1950
Loss between 1950 and 1990
Projected loss by 2050
−10 0 10 20 30 40 50 60 70 80 90 100
Potential area converted (%)

Habitat loss

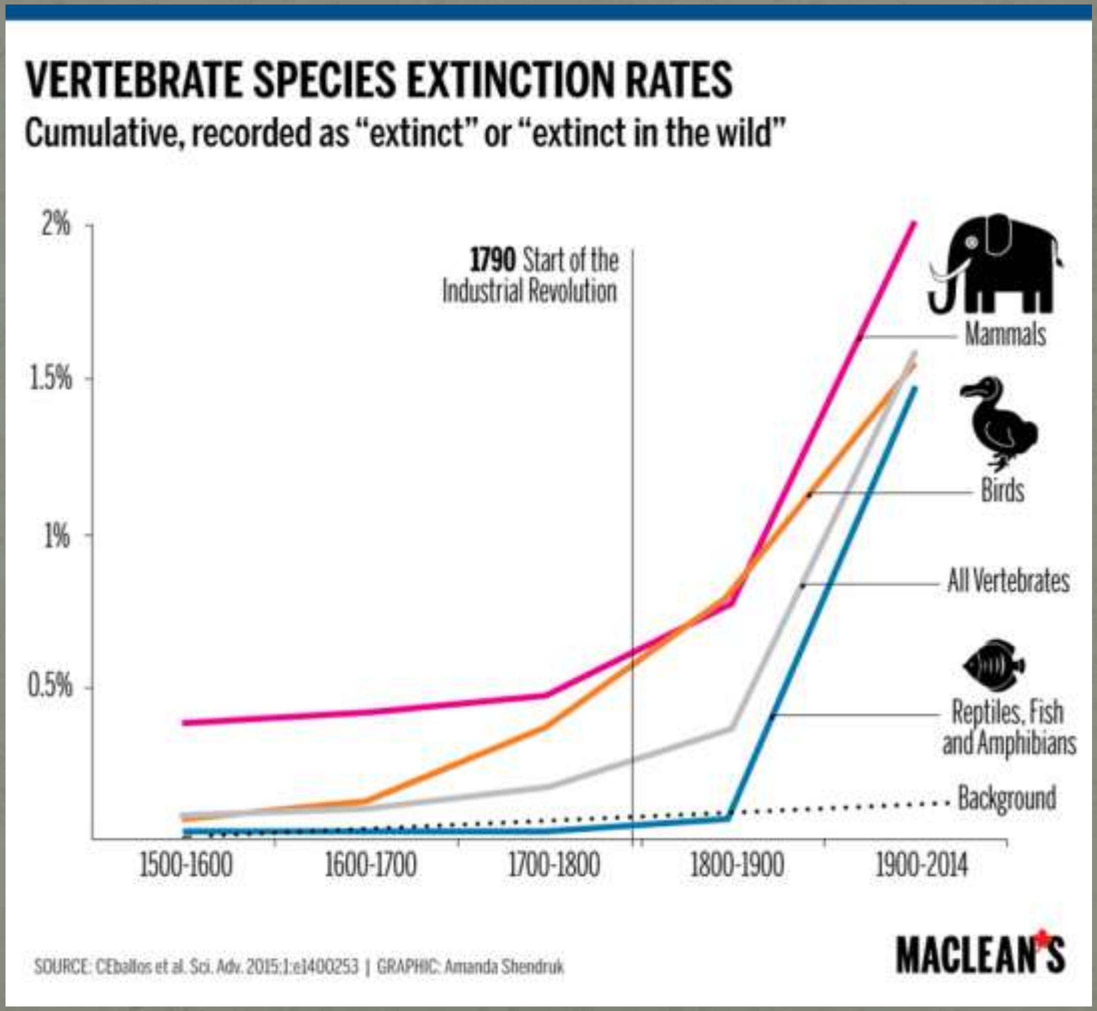
- Agriculture practices
- Urbanization
- Global climate change

Population growth





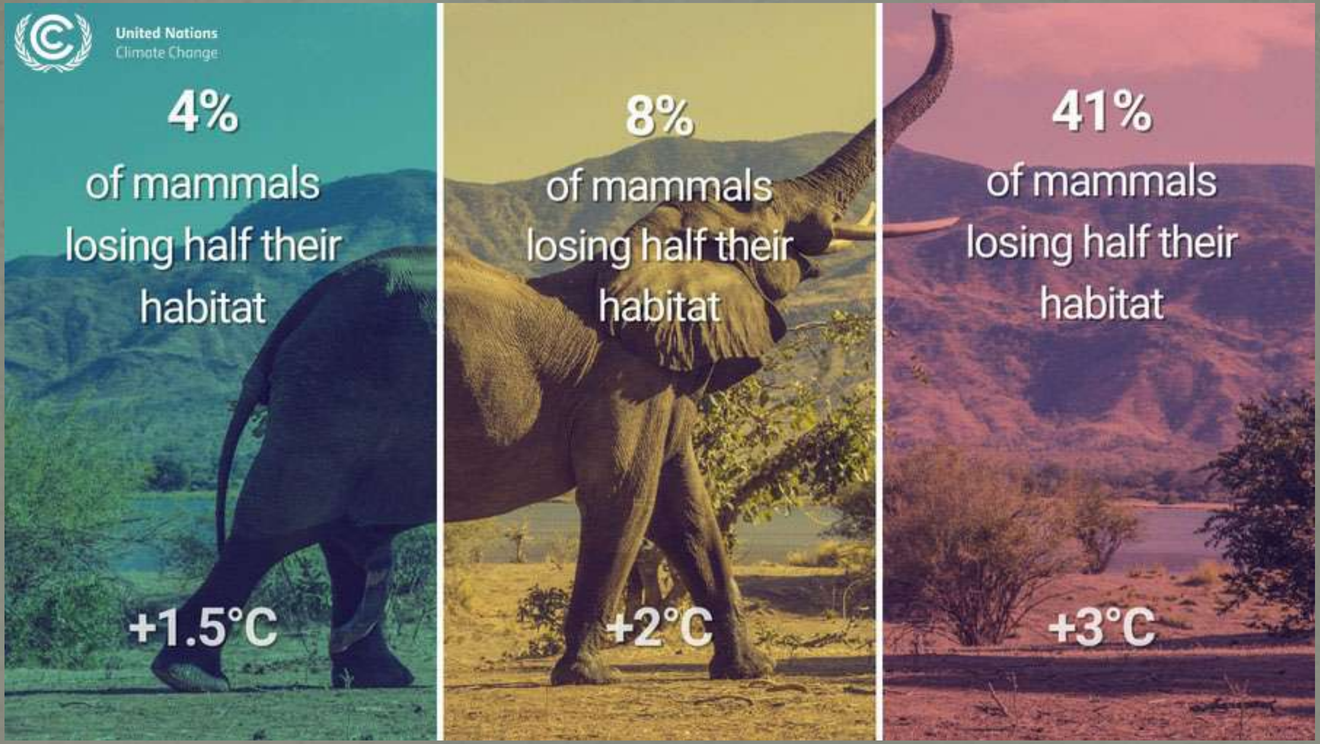
Global land use for food production
Our World in Data
Earth's surface
29% Land
149 Million km²
71% Ocean
361 Million km²
Land surface
71% Habitable land
106 Million km²
10% Glaciers
15M km²
19% Barren land
28 Million km²
Habitable land
46% Agriculture
48 Million km²
38% Forests
40 Million km²
14% Shrub
17 Million km²
1% Urban and built-up land
This includes settlements and infrastructure
1.5m km²
1% Freshwater
Lakes and rivers
1.5m km²
Agricultural land
77% Livestock: meat and dairy
37 Million km²
This includes grazing land for animals and arable land used for animal feed production.
23% Crops
11 Million km²
Global calorie supply
18%
82% from plant-based food
Global protein supply
37% from meat & dairy
63% from plant-based food
Data source: UN Food and Agriculture Organization (FAO)
OurWorldinData.org – Research and data to make progress against the world's largest problems.
Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.
Date published: November 2019.

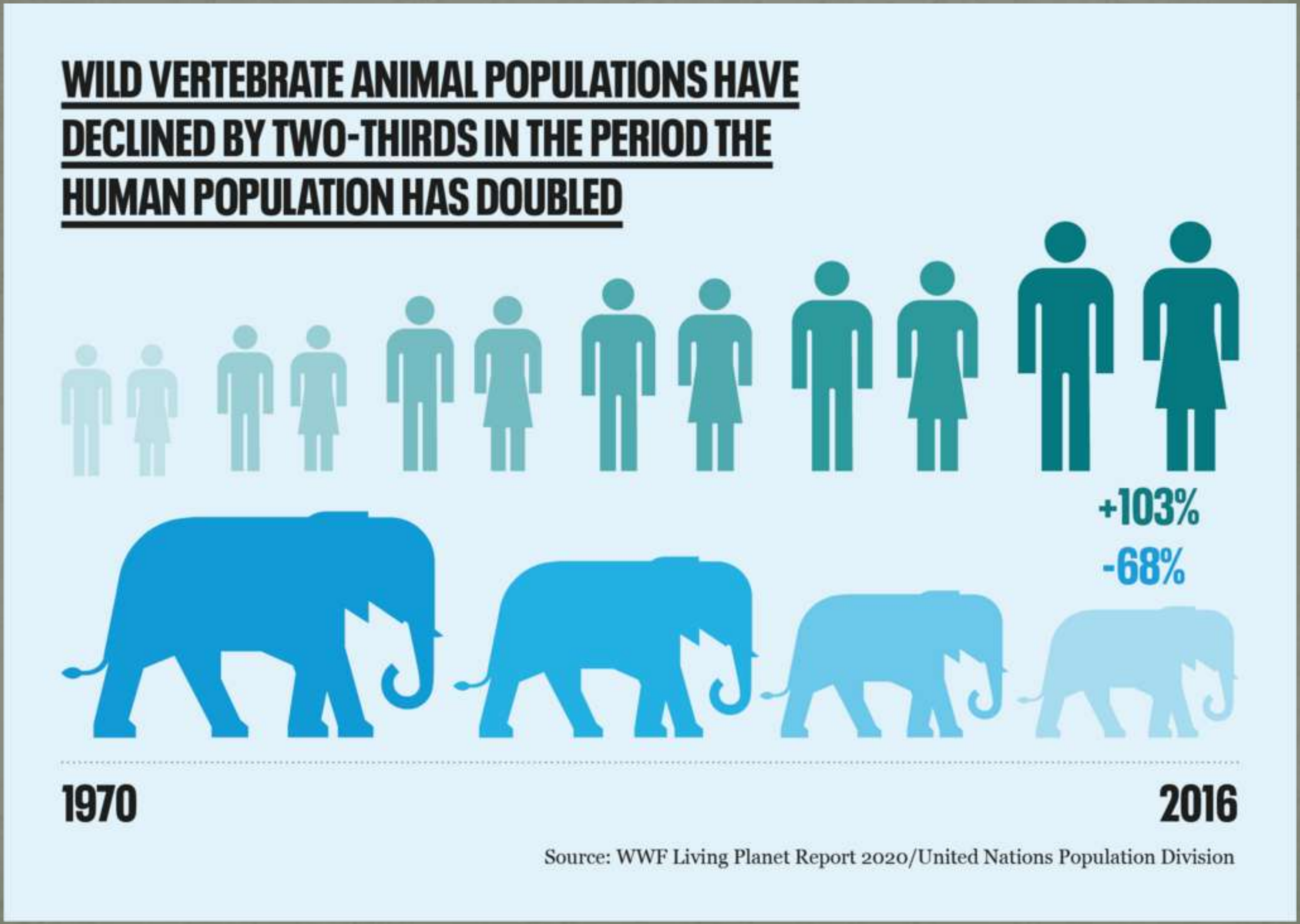

VERTEBRATE SPECIES EXTINCTION RATES
Cumulative, recorded as "extinct" or "extinct in the wild"
2%
1.5%
1%
0.5%
1790 Start of the Industrial Revolution
Mammals
Birds
All Vertebrates
Reptiles, Fish and Amphibians
Background
1500-1600
1600-1700
1700-1800
1800-1900
1900-2014
SOURCE: CEballos et al. Sci. Adv. 2015;1:e1400253 | GRAPHIC: Amanda Shendruk
MACLEAN'S

3. Pollution


"Climate change is a primary driver of biodiversity loss. And climate change depends on biodiversity as part of the solution. So clearly the two are linked, and cannot be separated."
Elizabeth Mrema, Executive Secretary, United Nations Convention on Biological Diversity
MAY 2022

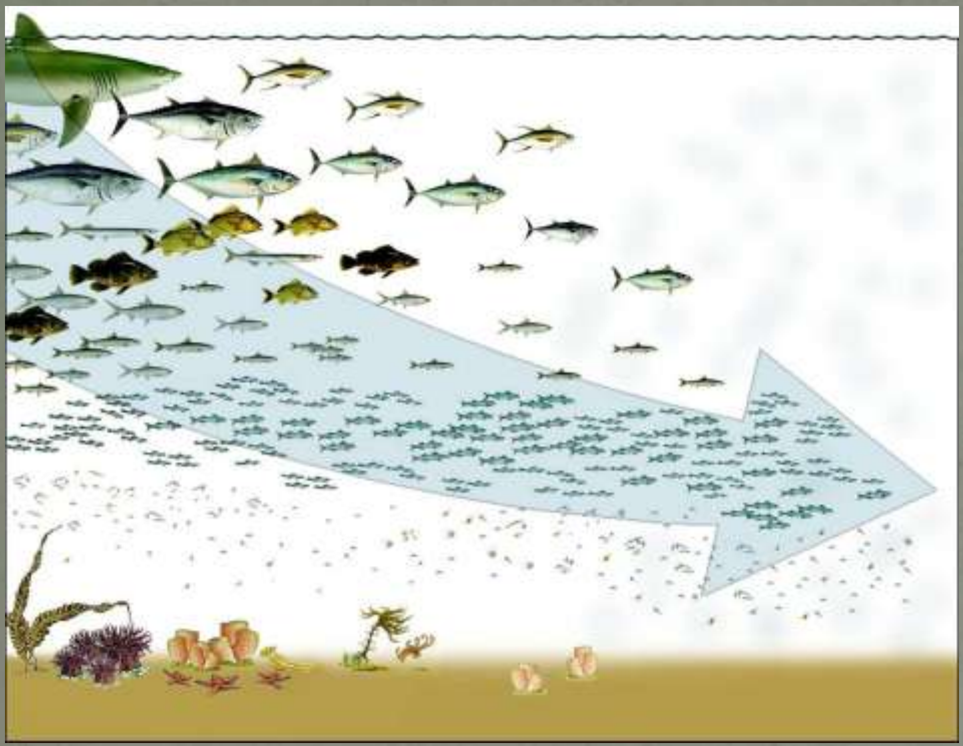
How is climate change affecting biodiversity?




WILD VERTEBRATE ANIMAL POPULATIONS HAVE DECLINED BY TWO-THIRDS IN THE PERIOD THE HUMAN POPULATION HAS DOUBLED
+103%
-68%
1970
2016
Source: WWF Living Planet Report 2020/United Nations Population Division

IUCN Red List of Treathened Species (2021.05.21.)

5. Overexploitation



The fishing industry will then specifically target these smaller fish because they are considered the "largest" fish by then. This phenomenon is called "Fishing Down" (Pauly, 2009).

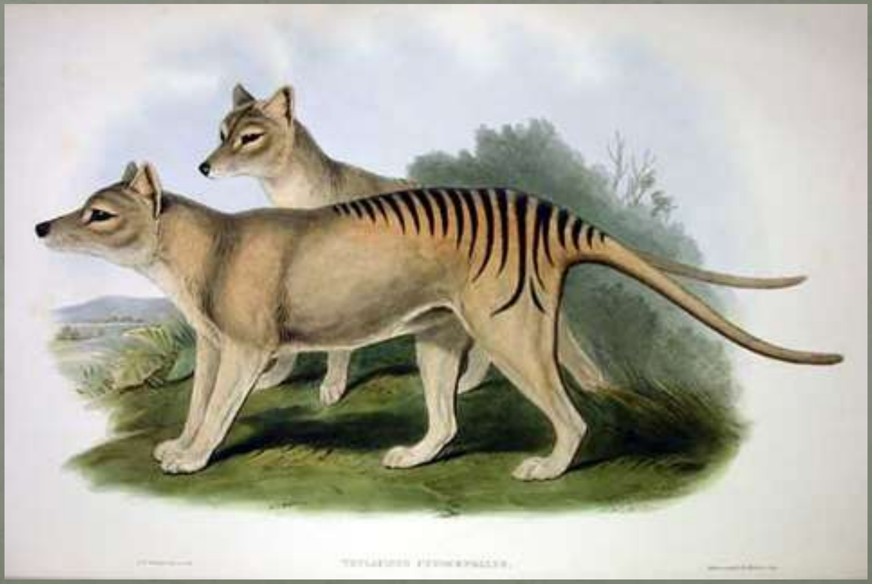
Fishing down: Commercial fishing selects for larger fish in order to get the most bang for their buck. This means that the fishing industry would rather harvest large fish and generally ignore the small ones. Due to the continuous selective pressure of over-exploitation, all the large fish will eventually die out, leaving just the smaller fish to take their place.

Extinct animals

Passenger pigeon 1914✝
(*Ectopistes migratorius*)

Thylacine, Tasmanian tiger 1936† (Thylacinus cynocephalus)

- Thylacine, the last existing member of family Thylacinidae, was the largest known carnivorous marsupial of the modern era. This species went extinct in the twentieth century. At times, they are referred as a cryptid.

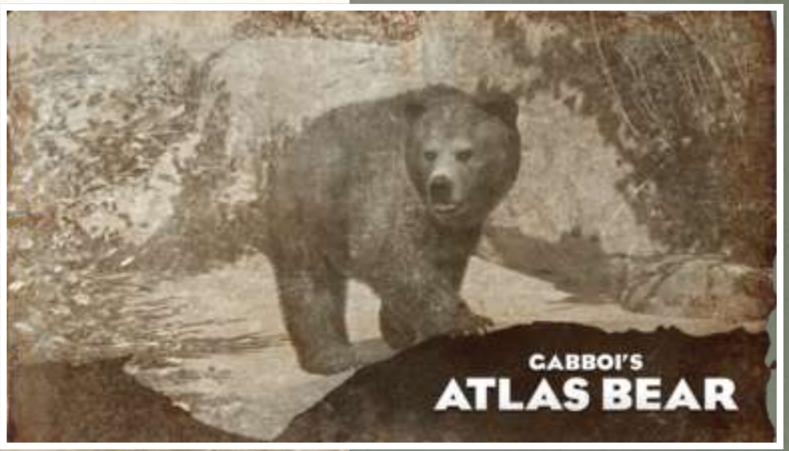


Pyrenean Ibex 2000✝
(Capra pyrenaica pyrenaica)

Pyrenean ibex, once commonly found in Southern France, Northern Pyrenees and Cantabrian Mountains, was one of the four subspecies of Iberian wild goat or Spanish ibex. This subspecies went extinct in early 2000. They were found in huge numbers even a few hundred years ago. However, by 1900 the numbers went down to less than 100, and after 1910, the number never went up above 40.

Dodo Bird 1662✝ *(Raphus cucullatus)*

Atlas Bear 1870✞
(Ursus arctos crowtheri)



Carolina Parakeet
(Conuropsis carolinensis) 1918✝

Golden Toad
(Incilius periglenes) 1989✝

TABLE 7.1 Some Species and Subspecies That Have Gone Extinct since 1985

Species	Common name	Date of extinction	Original range
Amphibians			
Atelopus ignescens	Jambato toad	1988 (last record)	Ecuador
Bufo baxteri	Wyoming toad	Mid 1990s*	United States
Bufo periglenes	Monteverde golden toad	2004	Costa Rica
Rheobatrachus vitellinus	Northern gastric brooding frog	1985 (last record)	Australia
Cynops wolterstorffi	Yunnan Lake newt	1986 (last record)	China
Birds			
Corvus hawaiiensis	Hawaiian crow	2002*	Hawaiian Islands
Cyanopsitta spixii	Spix's macaw	2000 (last record)	Brazil
Gallirallus owstoni	Guam rail	1987*	Guam
Melamprosops phaeosoma	Black-faced honeycreeper	2004 (last record)	Hawaiian Islands
Moho braccatus	Kaua'i	1987 (last report of vocalizations)	Hawaiian Islands
Myadestes myadestinus	Kama'o	2004	Hawaiian Islands
Tachybaptus rufolavatus	Alaotra Grebe	2010	Madagascar
Mammals			
Diceros bicornis longipes	West African black rhinoceros	2013	Cameroon
Lutra lutra whiteleyi	Japanese river otter	2012	Japan
Neofelis nebulosa brachyuran	Formosan clouded leopard	2013	Taiwan
Oryx dammah	Scimitar-horned oryx	1996*	Chad
Plants			
Argyroxiphium virescens	Silversword	1996	Hawaiian Islands
Commidendrum rotundifolium	Bastard gumwood	1986*	St. Helena Island
Nesiota elliptica	St. Helena olive	2003	St. Helena Island

Source: IUCN 2013 (www.iucnredlist.org).
*Species still exists in captivity.















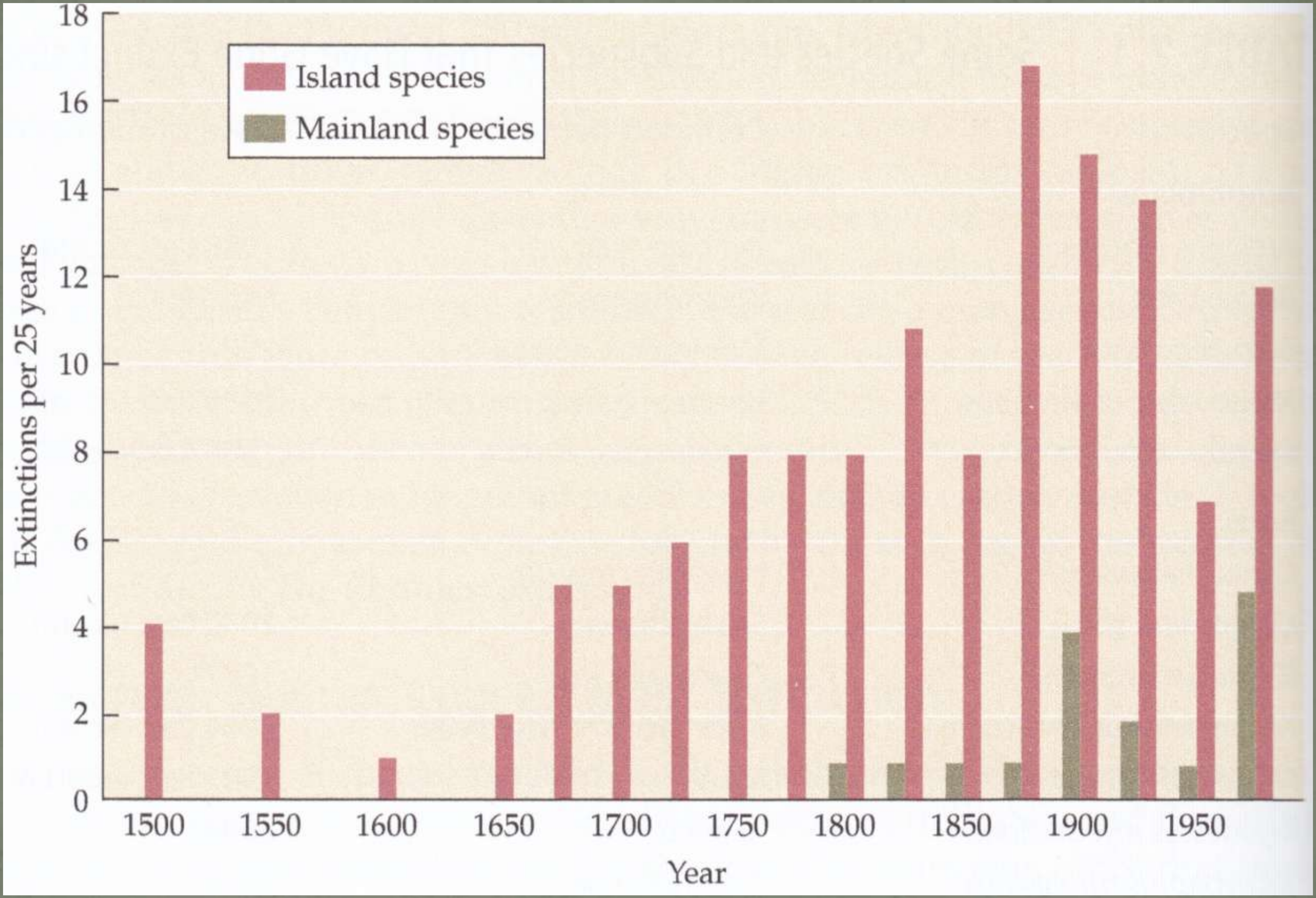

TABLE 7.2 Numbers of Species Threatened with Extinction in Major Groups of Animals and Plants[a]

Group	Approximate number of species	Number of species threatened with extinction	Percent of species threatened with extinction
Vertebrate animals			
Fishes	28,000	2523	9[b]
Amphibians	6409	2339	36
Reptiles	9400	1160	12[b]
Crocodiles	23	10	43
Turtles	228	170	75
Birds	10,065	2196	22
Penguins	18	15	83
Mammals	5506	1467	27
Primates	420	229	54
Manatees, dugongs	5	4	80
Horses, tapirs, rhinos	16	14	88
Plants			
Gymnosperms	1010	567	56[b]
Angiosperms (flowering plants)	260,000	10,686	4[b]
Palms	521	371	71
Fungi	100,000	3	0

Source: IUCN 2013 (www.iucnredlist.org).

[a]Data include the categories critically endangered, endangered, vulnerable, and near threatened.

[b]Low percentages reflect inadequate data due to the small number of species evaluated. For example, 12% of reptiles are listed as endangered, but only about one-third of species have been evaluated. For reptile species that have been evaluated, 31% are considered endangered.



Island species
Mainland species
Extinctions per 25 years
18
16
14
12
10
8
6
4
2
0
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
Year

Progress Traps in Middle Ages

Sustainability

Antecedents in the Middle Stone Age

- The end of the itinerant lifestyle
- Settlements
- Constructions, firing (heating) ← deforestation
- Domestification of wild animals

  (pasturage → deforestation)

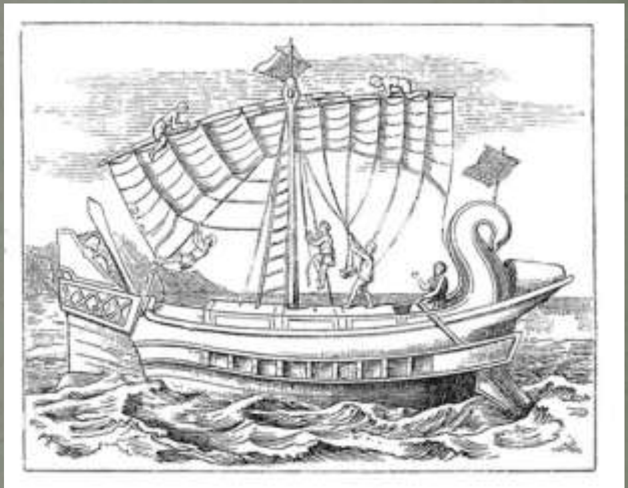
Antecedents in the New Stone Age

- Gardening: fruit-trees → fenced gardens
- Raising of cereal: preference of domesticated plants
- Eradication of natural vegetation (deforestation)

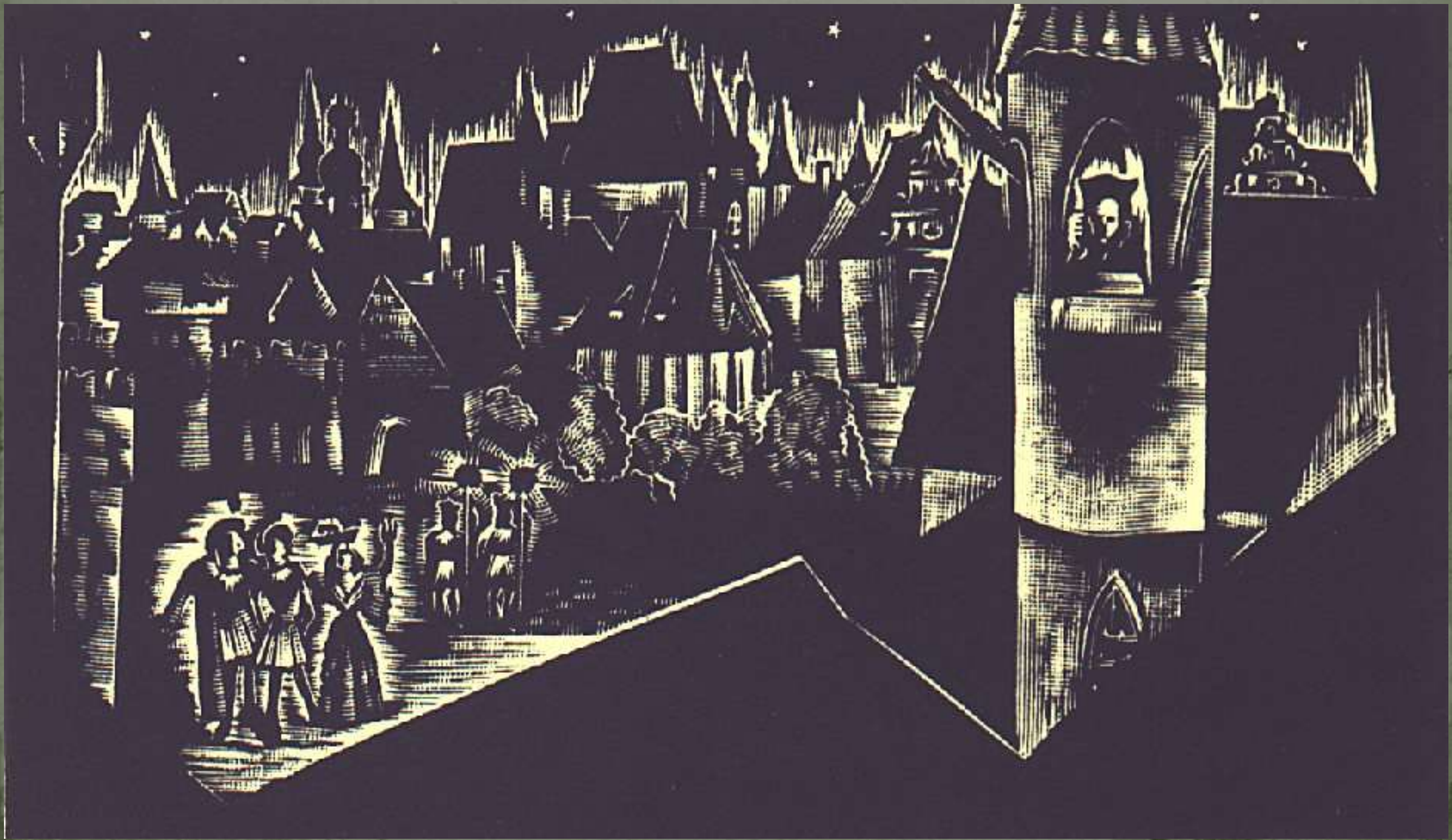
  → Biodiversity decreased
- Material and energy flow of soil changed!

Antecedents in Ancient Times

- Increasing population increasing growing plants, pastourage → deforestation
  (demand for agricultural land)
- Use of timber:
  - Building material from wood
  - Vehicles from wood
  - Metallurgy (with charcoal)
- Heating of houses
  (and roman spa)



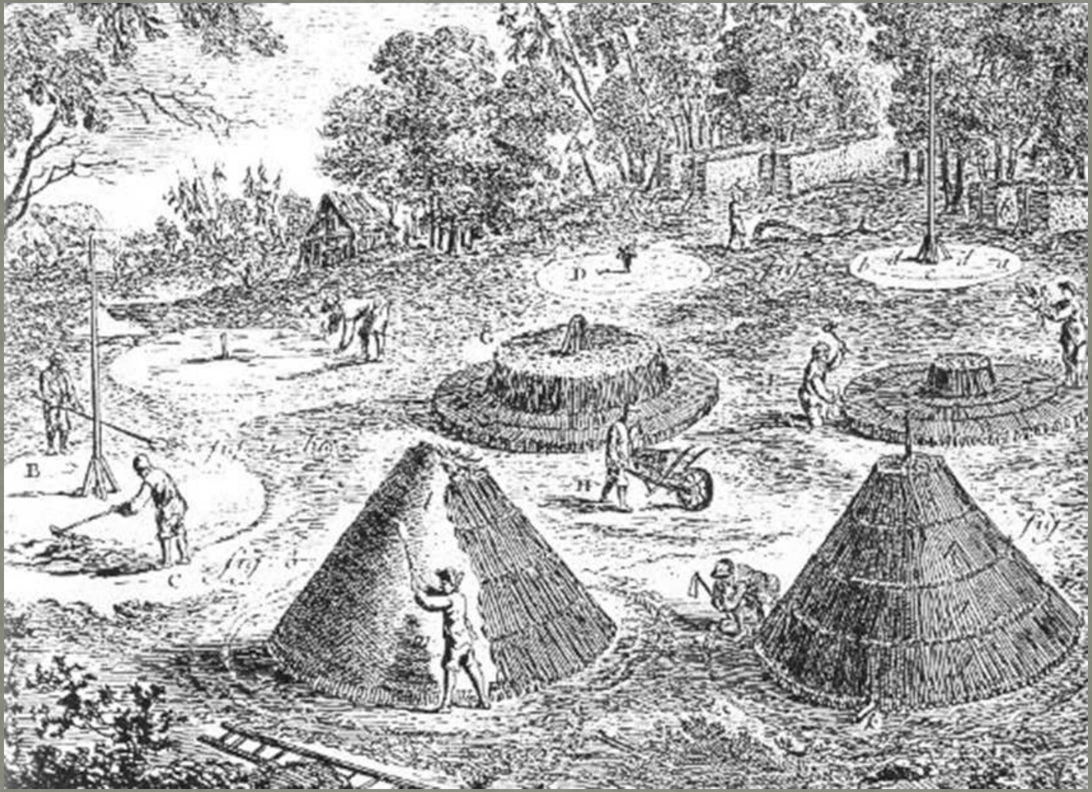
Medieval Era



Medieval Environmental Effects

- Further decrease of forest areas
  - Demand for wool↑ → pasture lands ↑
  - Brick burning ← demand for wood
  - Construction of mills
  - ←Building materials from wood
  - Vehicles from wood
  - Heating of houses
  - Wood ash for laundring
  - Wood charcoal production

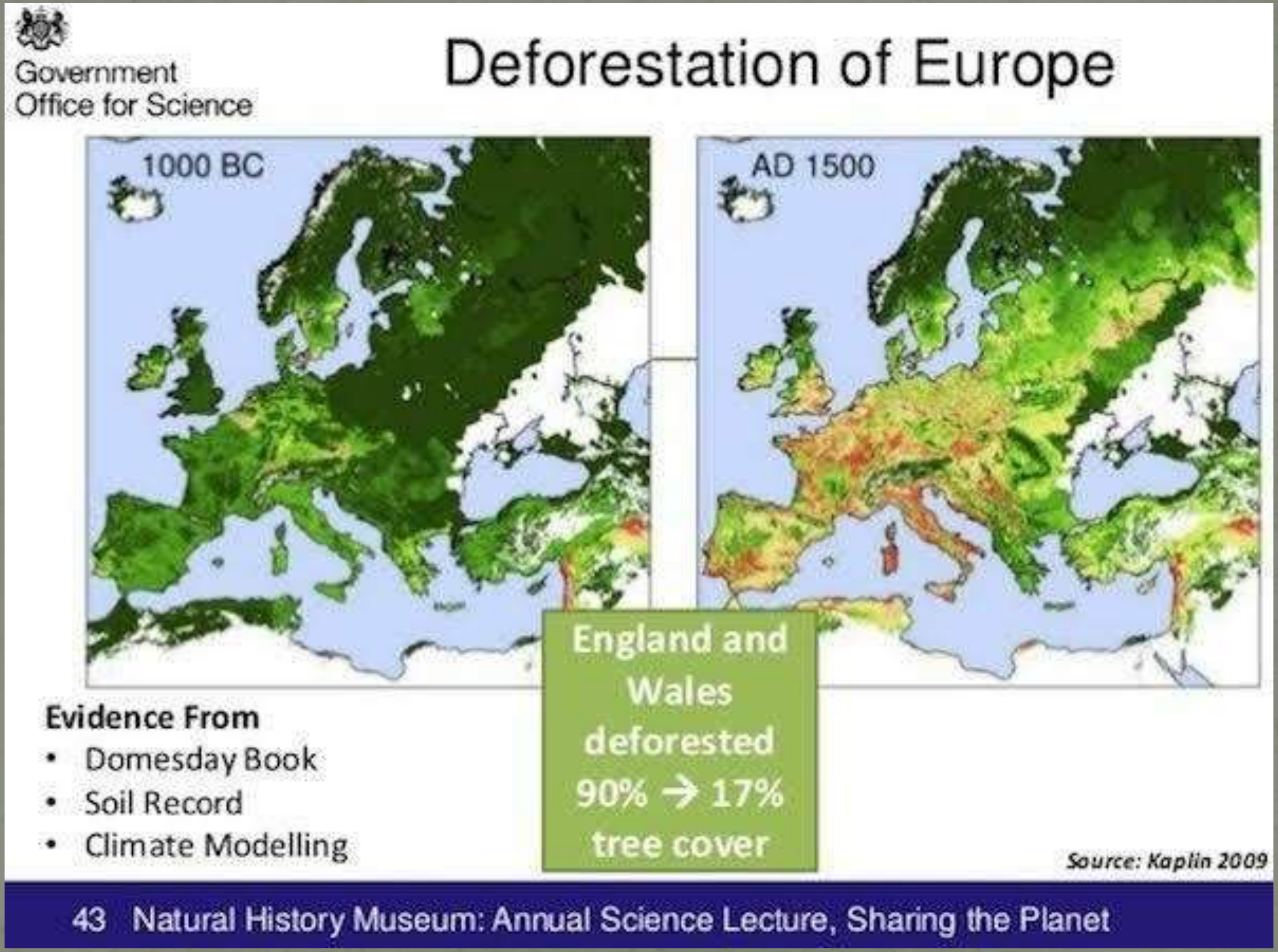
Increasing energy demand



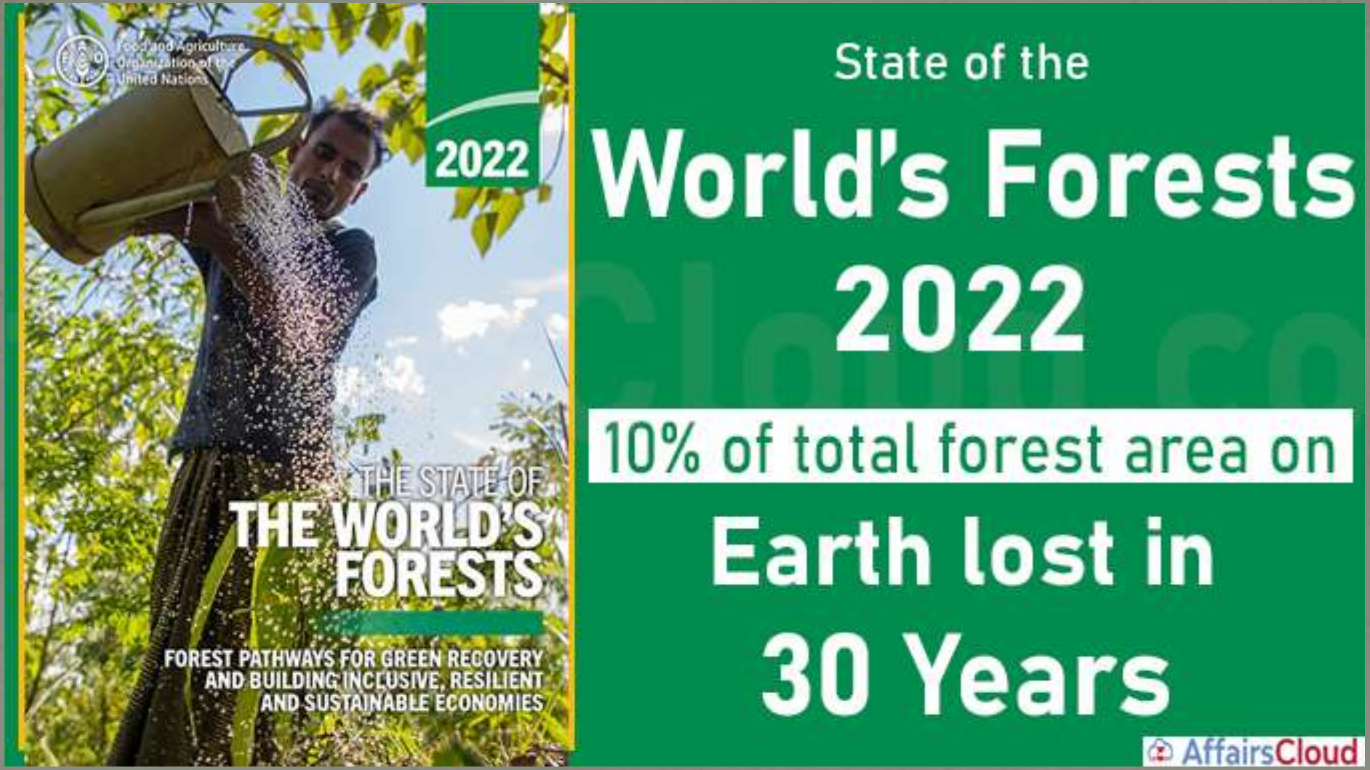
- Wood
- Charcoal
- Mining of hard coal

(not earlier than 16th century!)

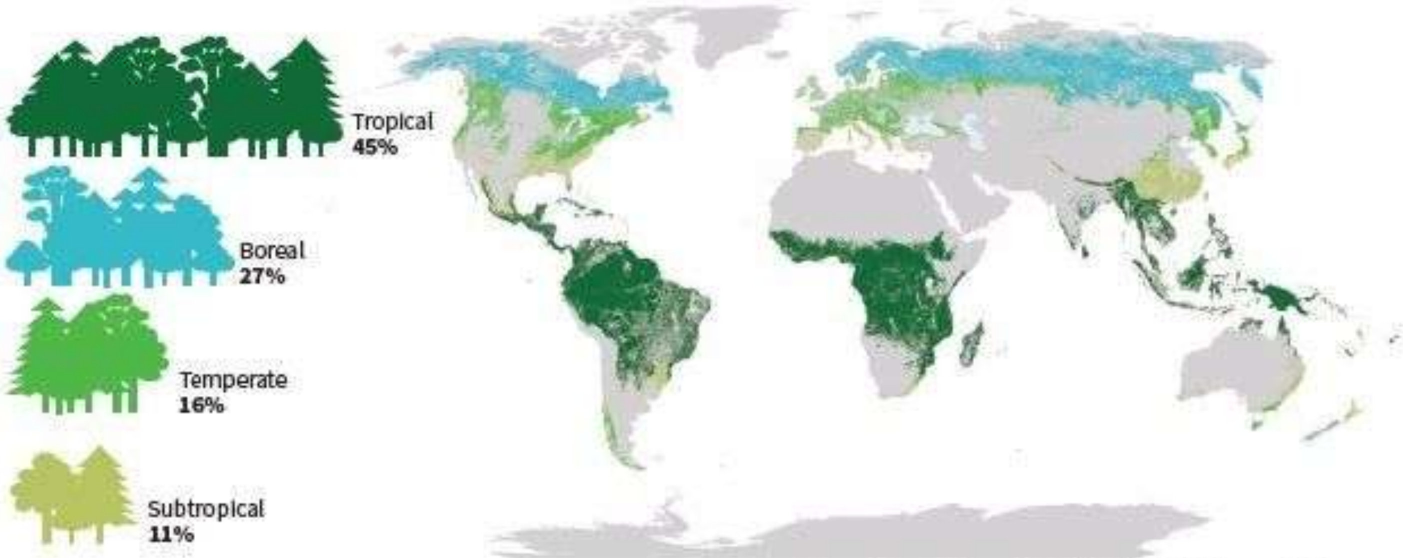
Medieval deforestation



The State of Forests in these days

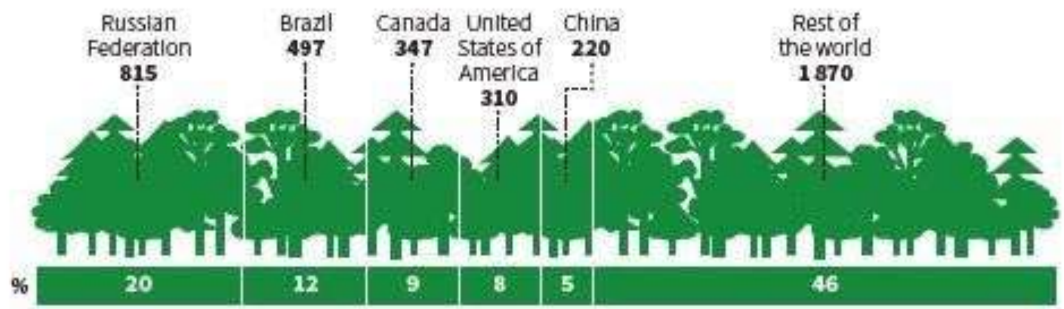


Proportion and distribution of global forest area by climatic domain, 2020

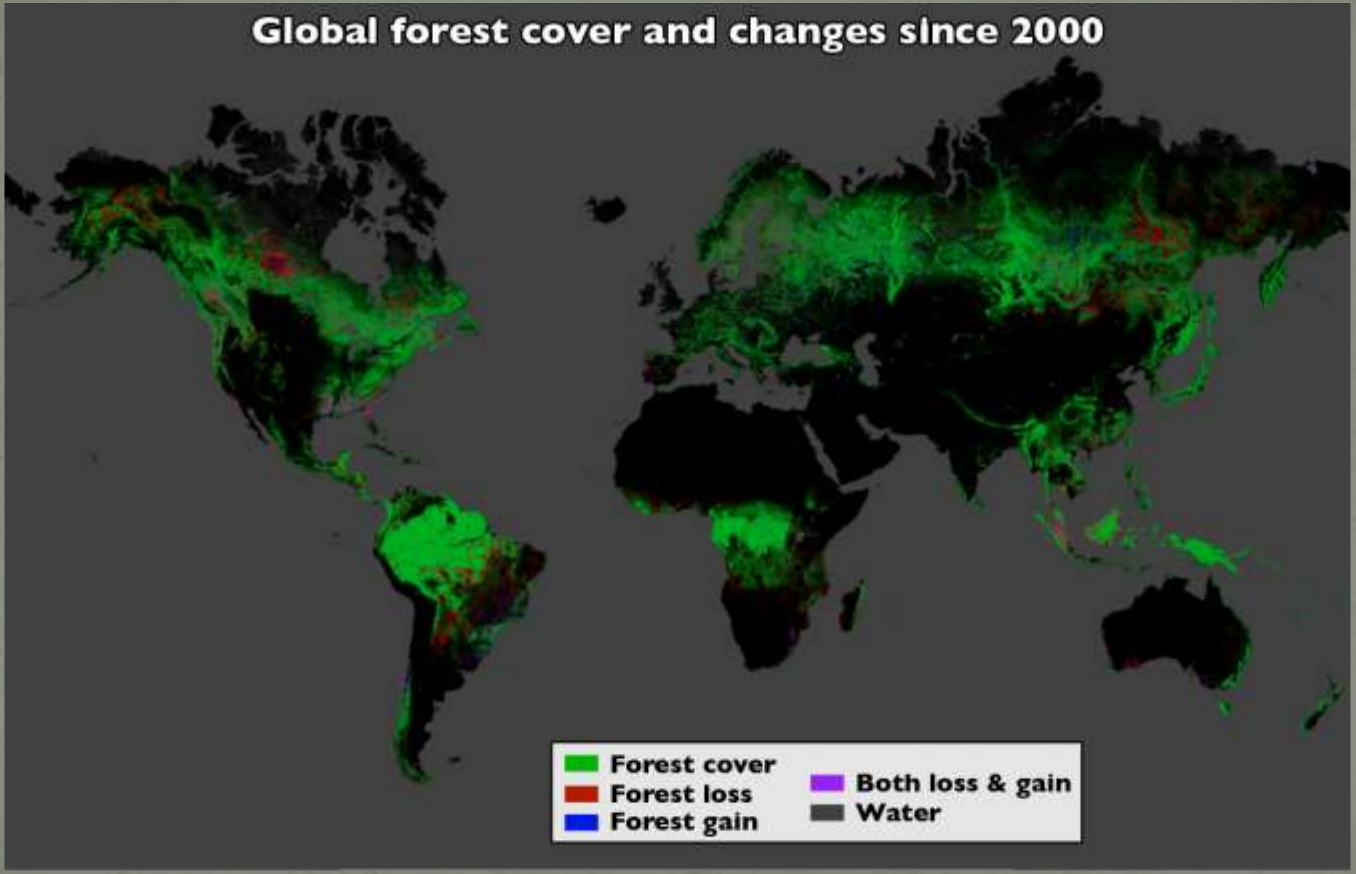


Source: Adapted from United Nations World map, 2020.

Top five countries for forest area, 2020 (million ha)



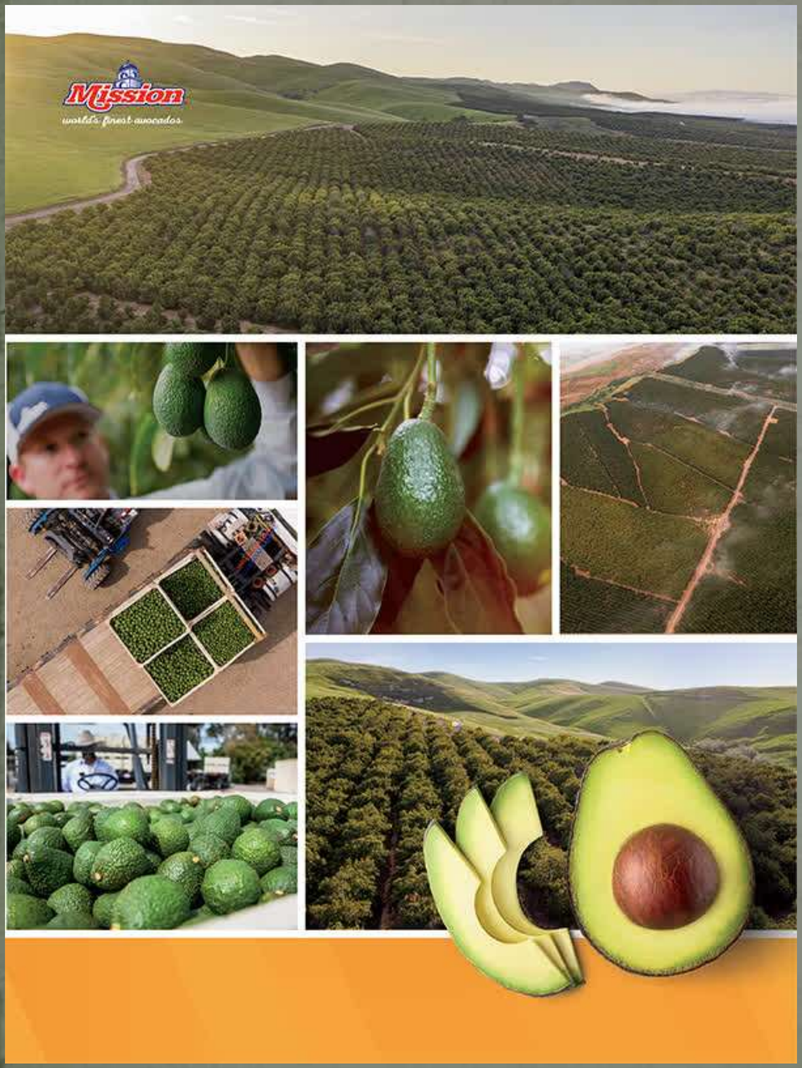
Changes in world's forest from other space 2000-2013(NASA)



Examples of deforestation

1. Pine forests of Mexico (avocado)
2. Rain forests of Southeast–Asia (oil palm)
3. Rain forests of West-Africa (cocoa)

1. Avocado (Mexico)



- Destruction of pine forest
- Endangerment of native species
- Avocado trees need double amount of water
- Long-distance transport
- Its production is profitable for drug cartels also (!)

https://www.theecoexperts.co.uk/blog/avocados-bad-for-environment

2. Palm oil (Southeast–Asia)

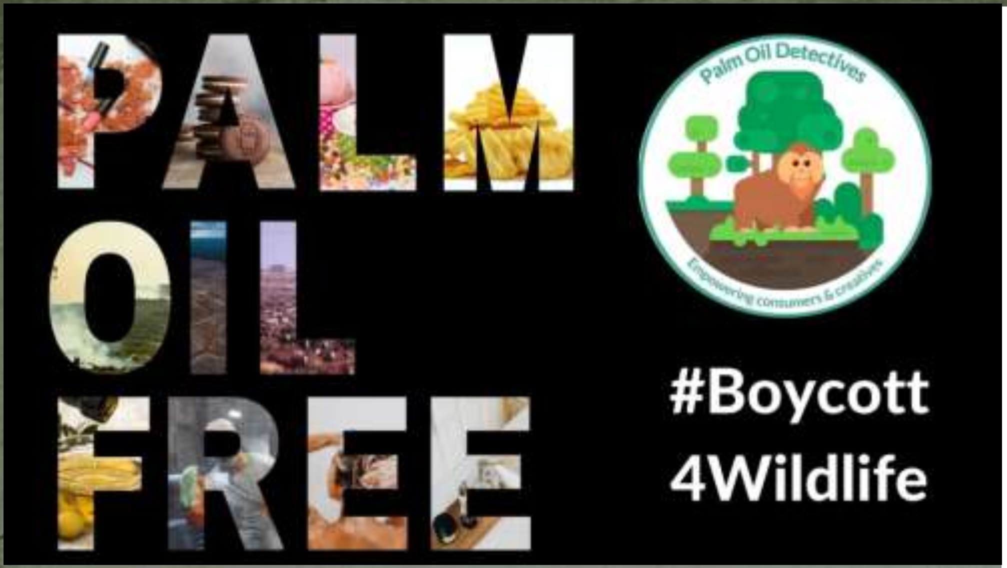
- Indonesia, Borneo, Sumatra
- Eradication of rain-forests (480 ha/day)
- Forest burning

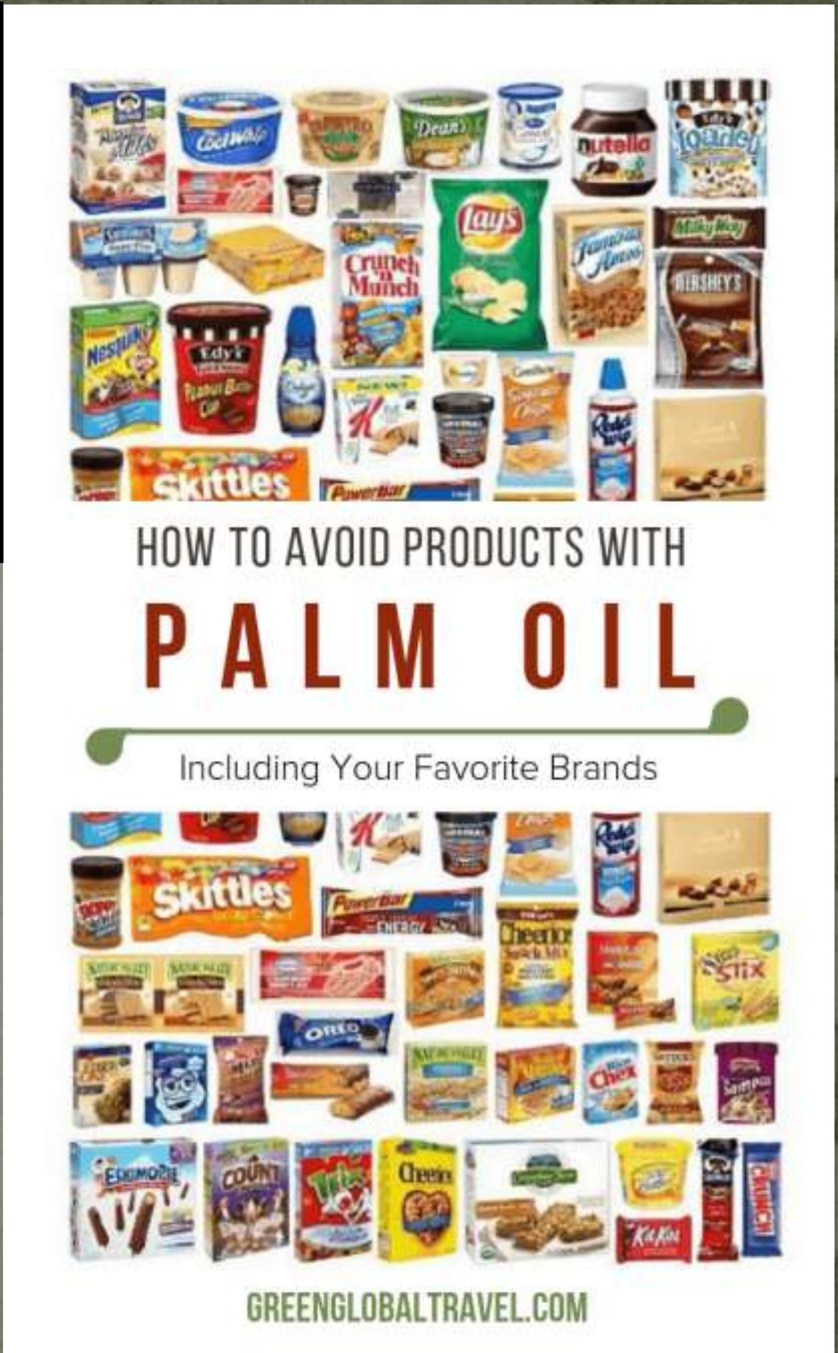
high carbon content of peat bog → carbon dioxide emission

- Endangered species

(orangutan, sumatran tiger)

- Water pollution
- Exploitation of inhabitants
- Child labour!

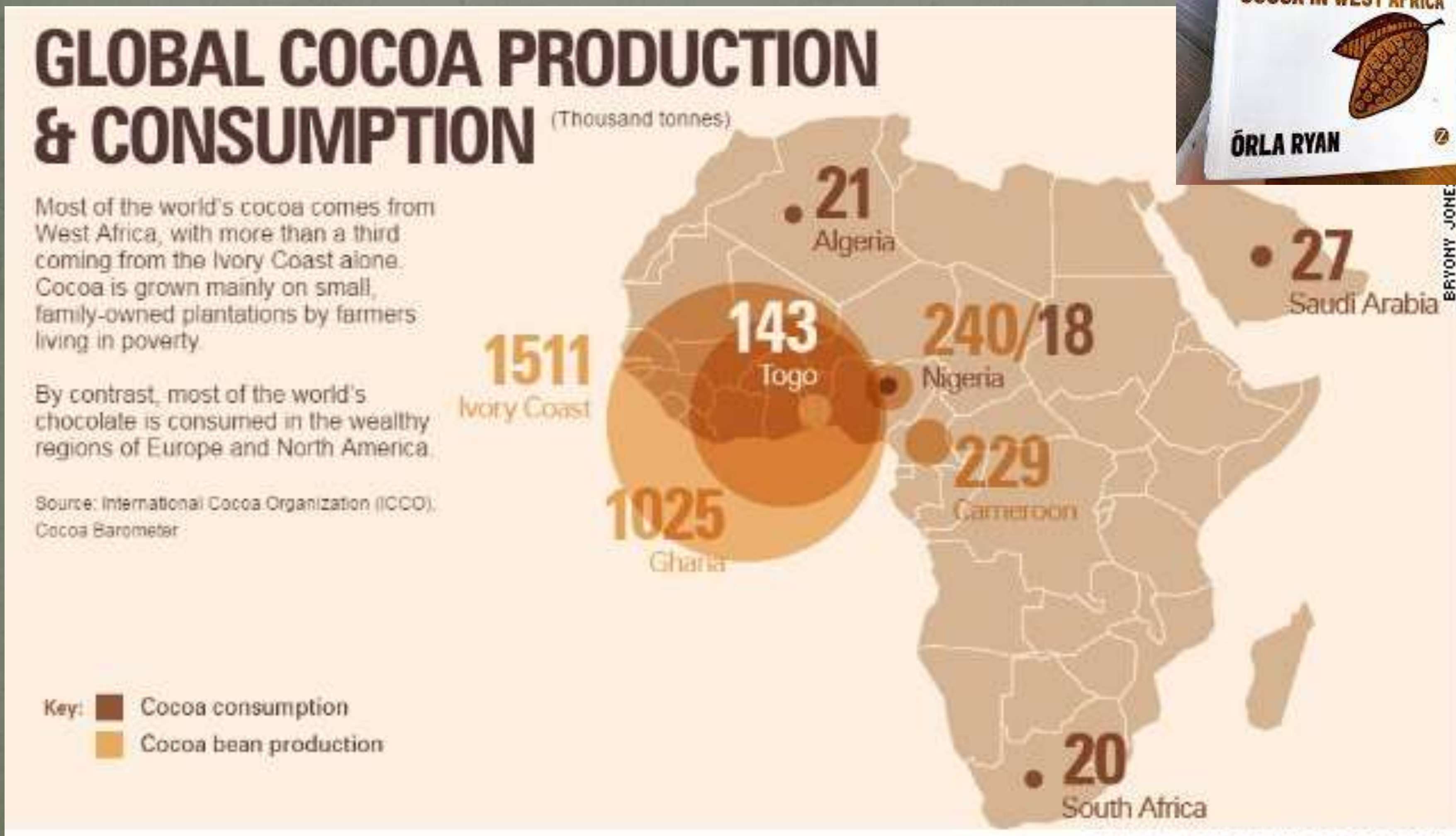

PALM
OIL
FREE
Palm Oil Detectives
Empowering consumers & creatives
#Boycott
4Wildlife


HOW TO AVOID PRODUCTS WITH
PALM OIL
Including Your Favorite Brands
GREENGLOBALTRAVEL.COM

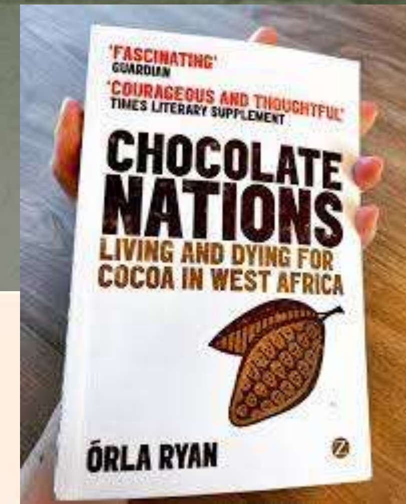
Nutella Unmasked
8% cocoa and milk powder
14% hazelnut
23% palm oil
55% sugar
nut
FERRERO
Mercola.com

https://www.worldwildlife.org/pages/which-everyday-products-contain-palm-oil

Cocoa, chocolate (West-Africa)



Global cocoa production and consumption, year 2010/2011.



Cocoa, chocolate (West-Africa)

- Eradication of rain-forests
  (80% decrease since 1960)
- Illegal plantations in national parks and protected forests
- Farmers in deep poverty
  (modern slavery)
- Child labour!


PROBLEMS
CHOCOLATE UNWRAPPED
SOLUTIONS
LAND RIGHTS
LOW PRICES
CHILD LABOR
DEFORESTATION
FOREST EXTRACTION
CLIMATE CRISIS
LIVING INCOMES
MORE FAIR TRADE CHOCOLATE
LAND REFORM
INCOME DIVERSIFICATION
AGROFORESTRY
STEPS YOU CAN TAKE
1 BUY CHOCOLATE FROM COMPANIES COMMITTED TO FAIR TRADE.
Find a list at FairWorldProject.org.
2 INVEST IN FARMER-LED AGROFORESTRY PROJECTS.
Learn more at GrowAhead.org.
3 IS YOUR CHOCOLATE SUPPORTING FORCED AND CHILD LABOR?
Ask your favorite chocolate company what steps they are taking in their supply chains.
4 SUPPORT SMALL-SCALE FARMERS AND COMBAT CORPORATE CONSOLIDATION.
Find current campaigns at FairWorldProject.org.

Fairtrade and Sustainability!

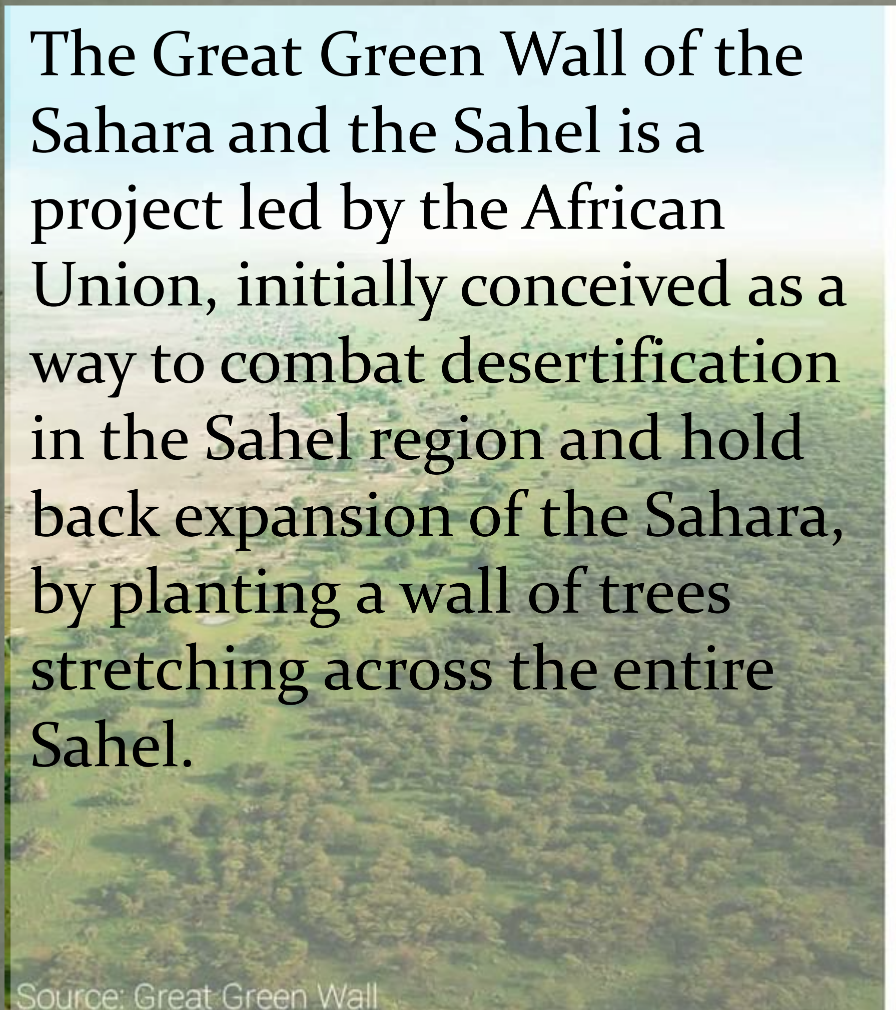
RAINFOREST ALLIANCE • PEOPLE & NATURE •

https://www.fairtrade.org.uk/buying-fairtrade/chocolate/

Effects of deforestation

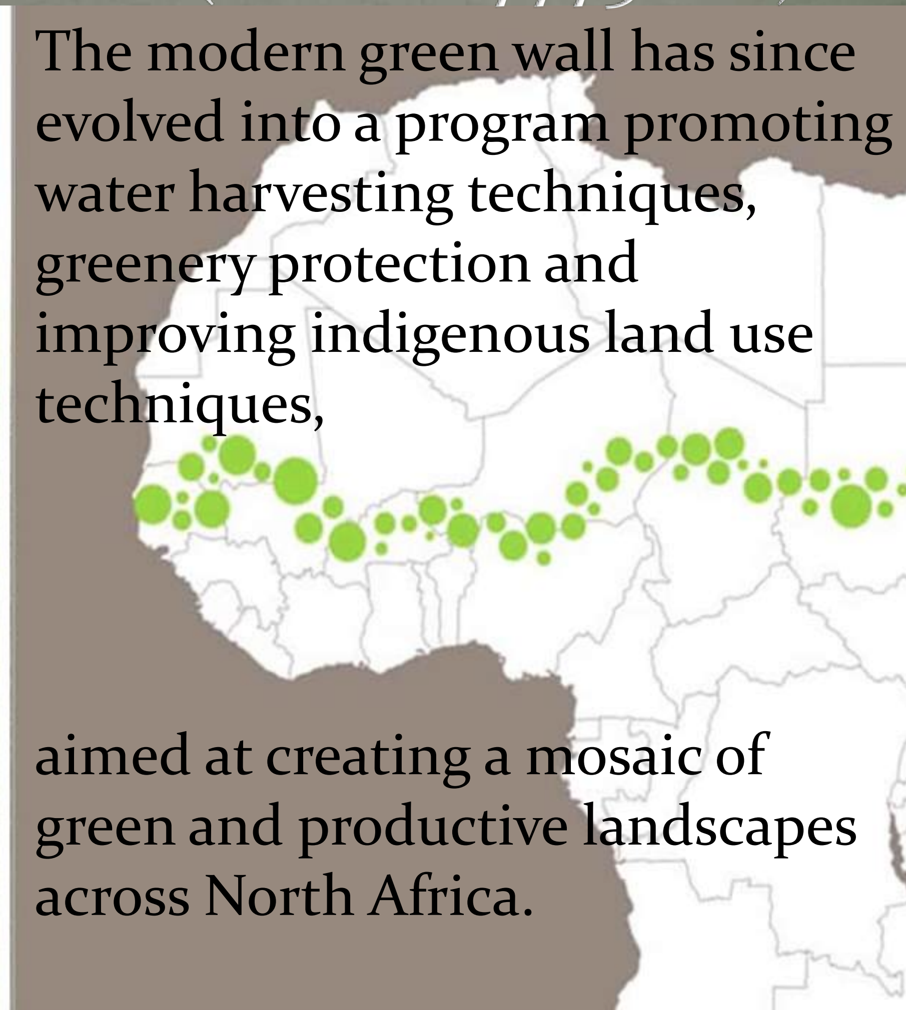
- Oxigen production ↓
- Carbon dioxide absorption ↓
- Forest burning → carbon dioxide emission ↑

The Great Green Wall Project (16 km x 7775 km)



The Great Green Wall of the Sahara and the Sahel is a project led by the African Union, initially conceived as a way to combat desertification in the Sahel region and hold back expansion of the Sahara, by planting a wall of trees stretching across the entire Sahel.

Source: Great Green Wall



The modern green wall has since evolved into a program promoting water harvesting techniques, greenery protection and improving indigenous land use techniques,

aimed at creating a mosaic of green and productive landscapes across North Africa.

Questions

- What where the reason of deforestation in Mesolithic?
- How are these reasons changed later?
- How did the application of wood broaden?
- Why do we immolate our forests?
- What is the wrongest way of deforestation?

Progress and Regression in Waste Management

Solid waste

- „Any garbage
- or refuse,
- or sludge
  - from a waste water treatment plant,
  - water supply treatment plant,
  - or air pollution control facility
- and other discarded material,

including solid, liquid, semi-solid,

or contained gaseous material

resulting from industrial,
commercial,
mining,
and agricultural operations,
and from community activities.„

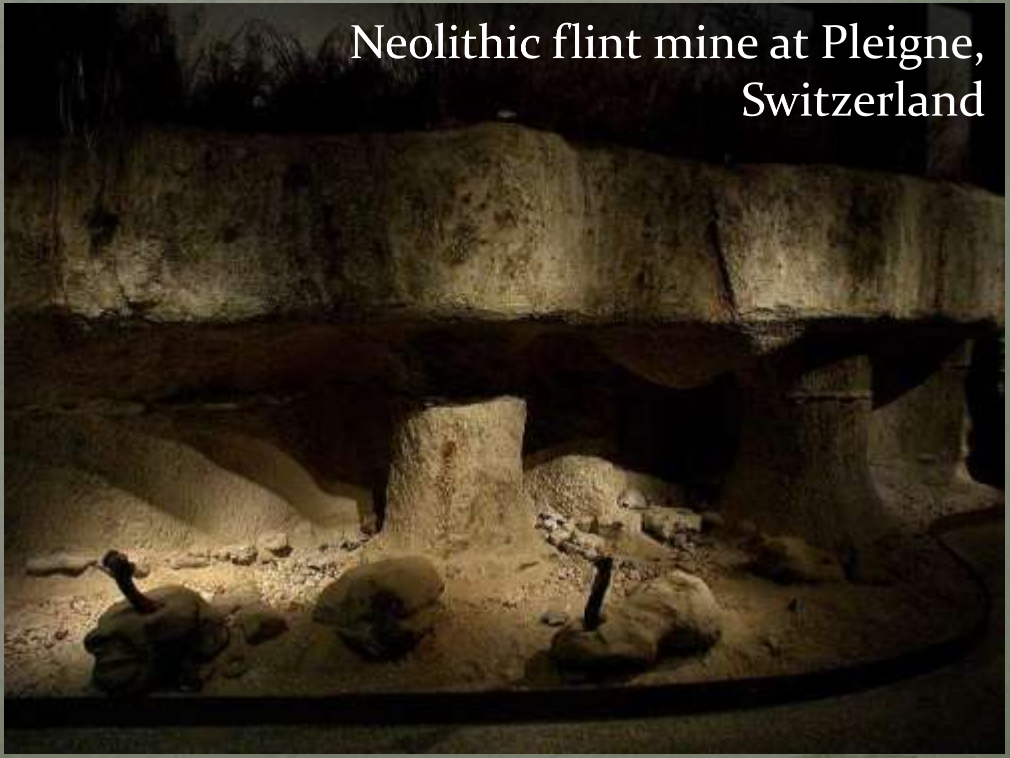
(epa.gov/rcra)

Upper Paleolithic

- Natural waste materials
  - Conclusions about lifestyle:
    e.g.: seashells ← fishing

Pollutions in New Stone Age

- Heavy metals in bones (e.g. lead/Pb)
  - Dissolution of metal ores to drinking water
- Stone pits, carving of flint stone
  - Pulmonary silicosis



Neolithic flint mine at Pleigne, Switzerland

Ancient villages, cities, city-states

- Enormous water demand
- Sewage drain
- Waste production

← Channelling

- Irrigation of agricultural areas
- Water supply in the cities

Ancient Times: Counterbalancing of harmful effects

- Garbage collection
  (e.g. manure)
- Location

of polluting workrooms:
  - Distance!
  - Wind direction!
- Parks and resorts (Rome)

„The first sewage system was the Roman Cloaca Maxima, built in the sixth century BC during the Etruscan dynasty of the Tarquins. The initial purpose of this massive structure was to drain the swamp between the Palatine and Capitoline hills, leading eventually to the Roman Forum, which became the hub of the Republic and later the Empire. The hydraulic pioneers of the ancient world, the Romans constructed a whole network of cloacae, or sewers, as well as a maze of aqueducts bringing water into the city. (Adam Markham: A Brief History of Pollution)

Medieval living conditions

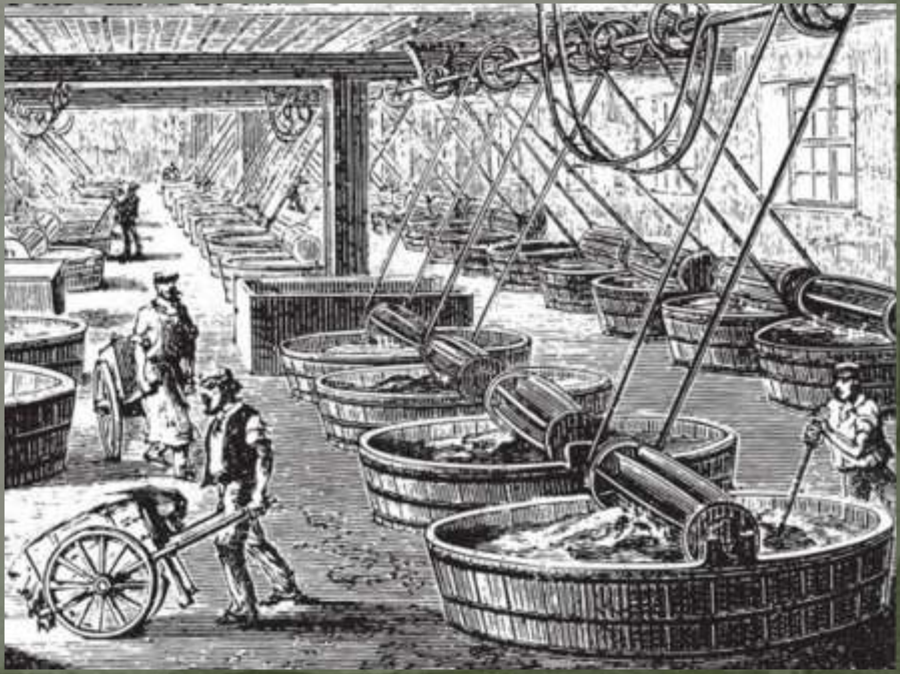
„Despite the lead taken by the Romans, public access to sanitation and safe water did not become a priority for most countries until the nineteenth century. The usual motivation behind the removal of organic waste and sewage was the problem of odour, the desire for clean drinking water, and a dislike of wading through streets running with ordure. The direct connection of disease-carrying organism with water pollution was not proven until the second half of the nineteenth century, when the germ theorists finally proved their case against miasmists.” (Adam Markham: A Brief History of Pollution)

Medieval water pollution and waste

- Water demand and the problem of sewage
  - Not enough drinking water
  - Continuous smell
  - Chemical and biological pollutions in rivers

  e. g. from tanneries and butcheries
  - Saturation of digestive pits

  → Pollution of surface waters



„Nevertheless, hard-pressed municipal administration were already attempting to tackle water pollution problems in the early fourteenth century. An official investigation into the state of the Fleet River in London in 1307 concluded that the main cause of pollution problems was tanning waste and butchers' offal from Smithfield market. In the same year, the Palace of Westminster installed a pipe connection the King's lavatory with another sewage pipe that had been constructed earlier to remove waste from the palace kitchen. Needless to say, this was not a privilege available to many commoners, and most people's sewage continued to flow direct from privies jutting over the river, or into the open gullies and trenches that ran down the streets. Sewers and cesspools were being developed, but their efficacy was doubtful. Sewers were often blocked (and in any case simply emptied into the nearest river or stream), while cesspools stank, overflowed and tended to leak into neighbours' wells."
((Adam Markham: A Brief History of Pollution)

Medieval water pollution and waste

- Accumulation of urban waste

was a continuous problem.

  - Waste on the street
  - Waste was washed away by the rain to channels and rivers
  - Rudimentary actions,

    e.g. scavengers

„The towns and villages of medieval Europe seem not to have been very sweet-smelling places. Pigs were a convenient means of removing waste, and what they didn't eat would eventually be washed away by rains. Many towns and cities had rudimentary regulations for the disposal of waste and teams of 'rakers' or 'scavengers' were often employed to remove garbage from city. But by and large, the water management advances of the Roman Empire had been long forgotten. (Adam Markham: A Brief History of Pollution))

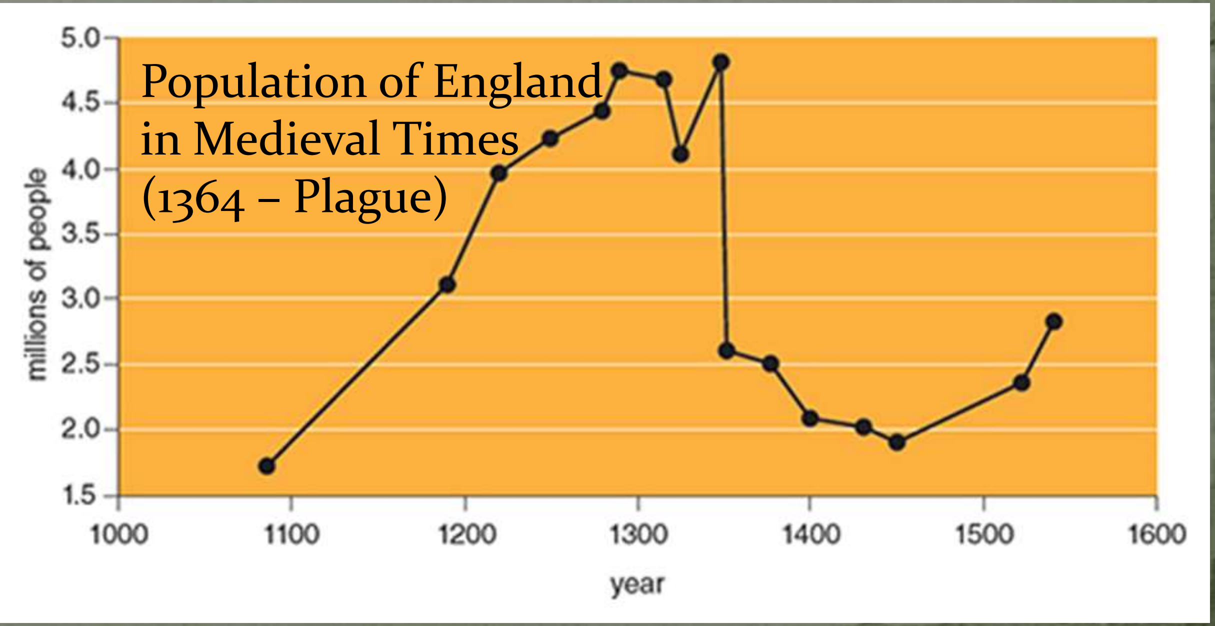
Emergence of epidemics

- Waste → epidemics e. g. plague
  - e.g.: ships → rats → fleas → humans
- Not enough infield + unusual cold weather

  → starvation

  → weakened people

  → epidemics → DEATH



Changes in modern history

Industrial revolution

More waste!

- Discovery of steam engine
- Mechanization of textile industry
- Mechanization → mass production
- New branches
  - Chemical industry
  - Production of plastics

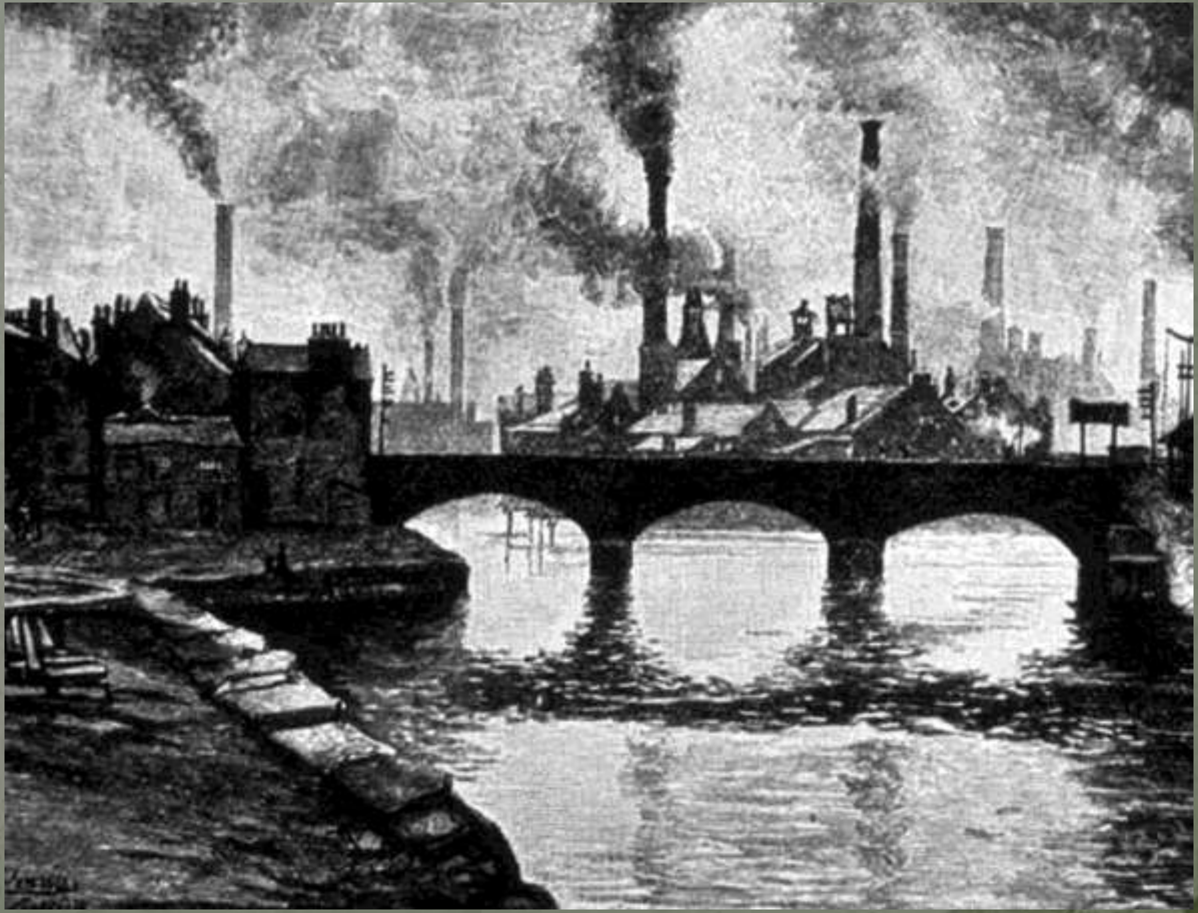
  (e.g.: artificial silk „Chardonnet”)
- Growth of population → new consumers

Effect in society

- Population ↑
- Urbanization!
- Pollution ↑
- Deteriorating

health conditions

Typhus
Tuberculosis
Cholera

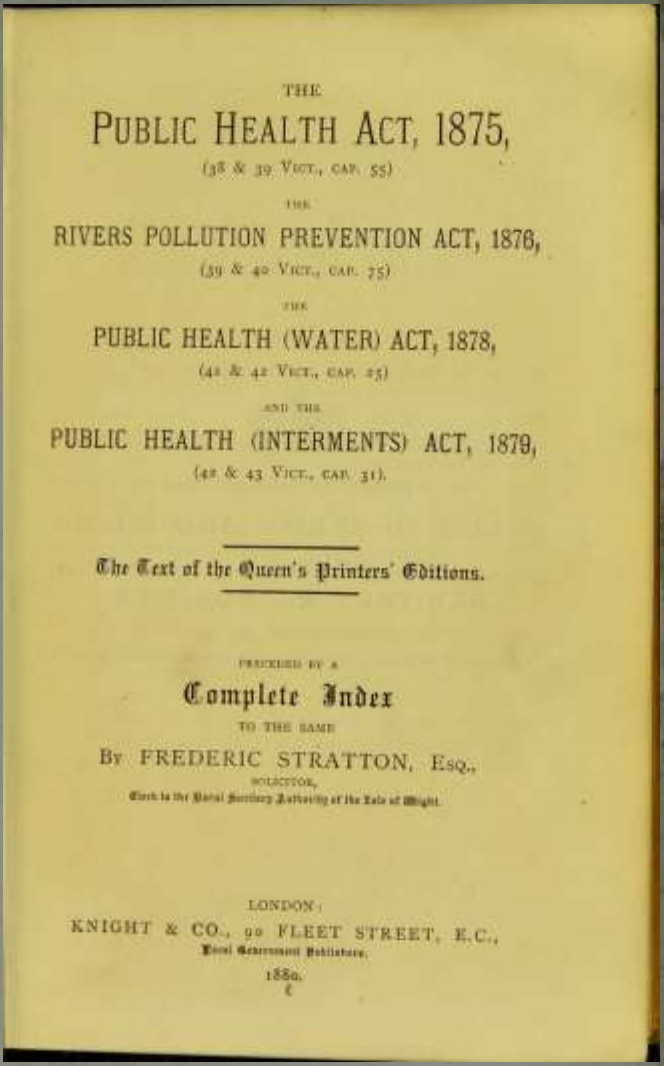


First Public Health Acts

- 1875 – Great Britain
  - Improvement

  of health conditions of people
  - Improving conditions

  of the living world of wetlands



THE

PUBLIC HEALTH ACT, 1875,

(38 & 39 VICT., CAP. 55)

THE

RIVERS POLLUTION PREVENTION ACT, 1876,

(39 & 40 VICT., CAP. 75)

THE

PUBLIC HEALTH (WATER) ACT, 1878,

(41 & 42 VICT., CAP. 25)

AND THE

PUBLIC HEALTH (INTERMENTS) ACT, 1879,

(42 & 43 VICT., CAP. 31).

The Text of the Queen's Printers' Editions.

PRECEDED BY A

Complete Index

TO THE SAME

BY FREDERIC STRATTON, ESQ.,

SOLICITOR,

[illegible]

LONDON:

KNIGHT & CO., 90 FLEET STREET, E.C.,

[illegible]

1880.

e.g.: London

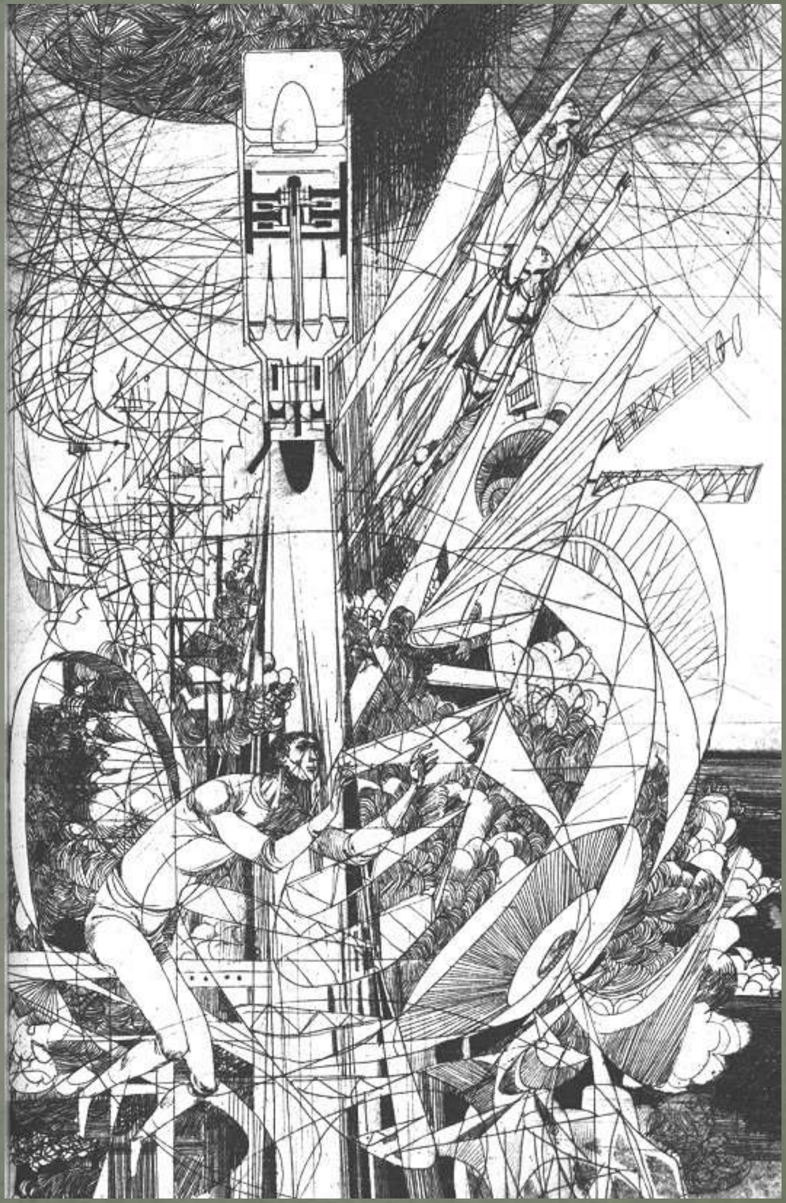
Filtration of solid waste from sewage

+ They didn't release sewage to the river directly.

→ Return of fishes

Global waste problem in these days

Few examples



Microplastics

Small pieces of plastic, less than 5 mm (0.2 inch) in length, that occur in the environment as a consequence of plastic pollution. Microplastics are present in a variety of products, from cosmetics to synthetic clothing to plastic bags and bottles. Many of these products readily enter the environment in wastes.

(britannica)

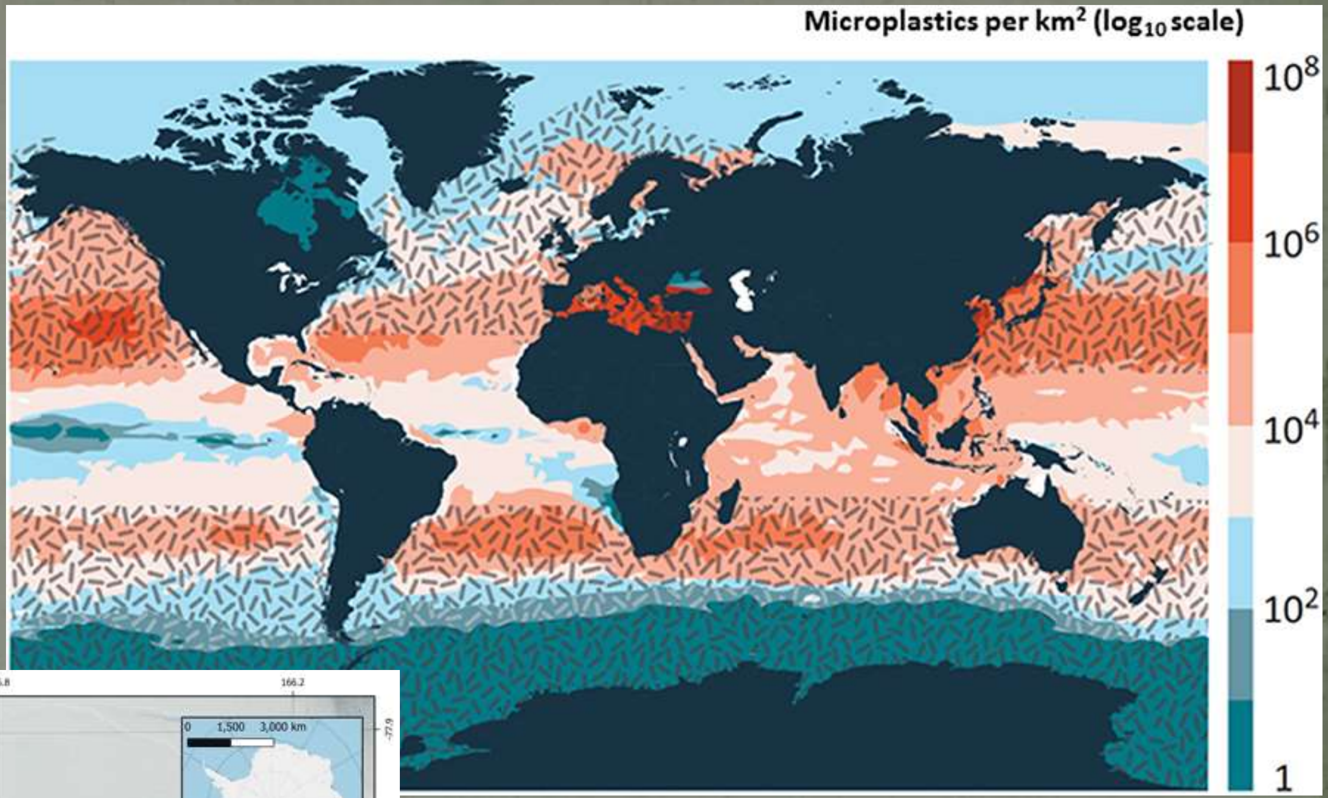
- <u>Primary microplastics:</u>

Examples of primary microplastics include microbeads found in personal care products, plastic pellets (or nurdles) used in industrial manufacturing, and plastic fibres used in synthetic textiles (e.g. nylon).

- <u>Secondary microplastics</u>

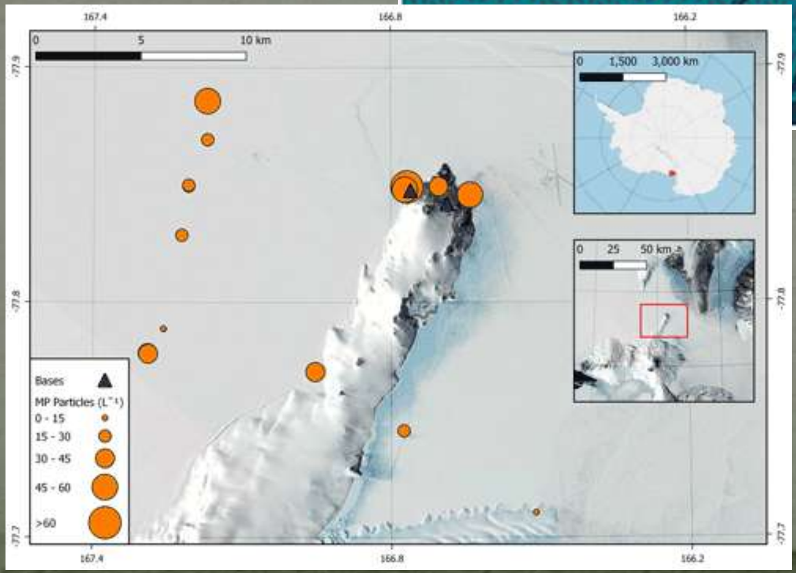
form from the breakdown of larger plastics; this typically happens when larger plastics undergo weathering, through exposure to, for example, wave action, wind abrasion, and ultraviolet radiation from sunlight.

Incidence of microplastics



Concentration of microplastics in world ocean

Concentration of microplastics in the Ross Island region of Antarctica



- By 2018, in marine and freshwater ecosystems combined, microplastics had been found in more than 114 aquatic species. Microplastics have been found lodged in the digestive tracts and tissues of various invertebrate sea animals, including crustaceans such as crabs. Fish and birds are likely to ingest microplastics floating on the water surface, mistaking the plastic bits for food.
- The ingestion of microplastics can cause aquatic species to consume less food and therefore to have less energy to carry out life functions, and it can result in neurological and reproductive toxicity. Microplastics are suspected of working their way up the marine food chains, from zooplankton and small fish to large marine predators. (britannica)

Cosmic pollution: space debris

Artificial material that is orbiting Earth but is no longer functional. This material can be as large as a discarded rocket stage or as small as a microscopic chip of paint… (britannica)

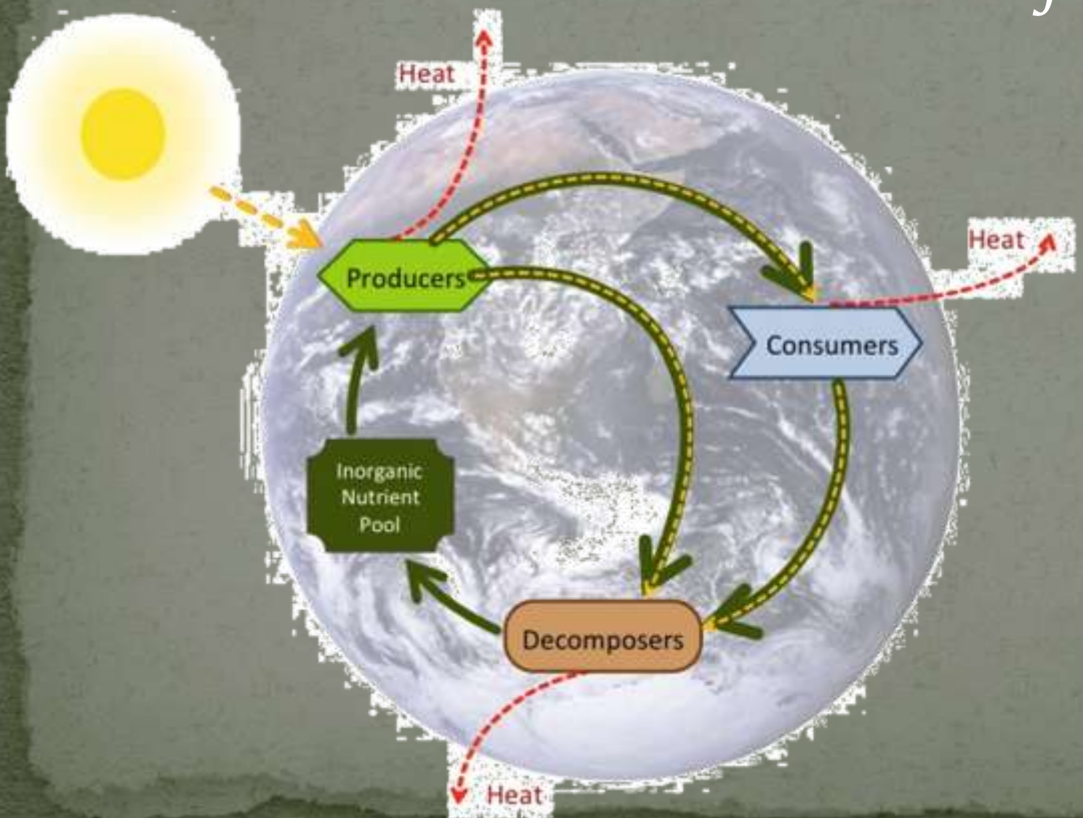
As of 2021, the United States Space Surveillance Network was tracking more than 15,000 pieces of space debris larger than 10 cm (4 inches) across. It is estimated that there are about 200,000 pieces between 1 and 10 cm (0.4 and 4 inches) across and that there could be millions of pieces smaller than 1 cm.

Because of the high speeds at which objects orbit Earth, a collision with even a small piece of space debris can damage a spacecraft.

The Nature of Nature

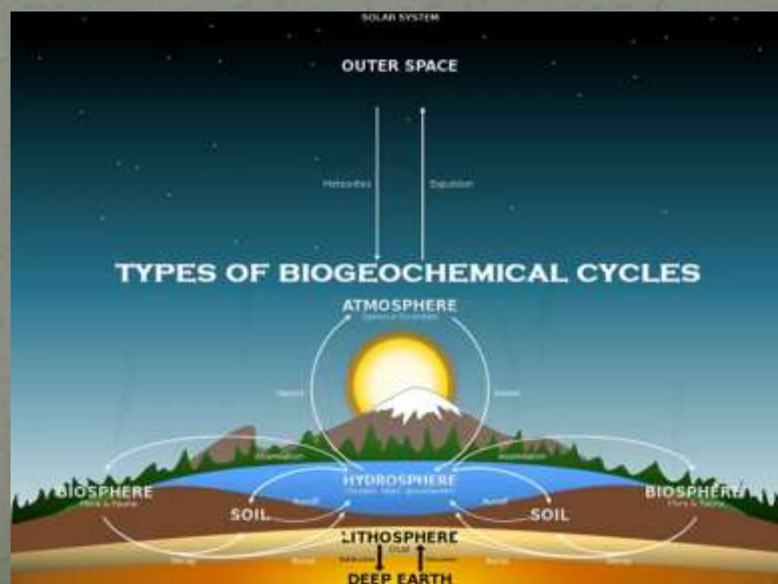
"Everything is reused or repurposed in nonhuman ecosystems. The natural world is the perfect circular economy, where everything, even after its lifetime, becomes a source for something else."

(Enric Sala)



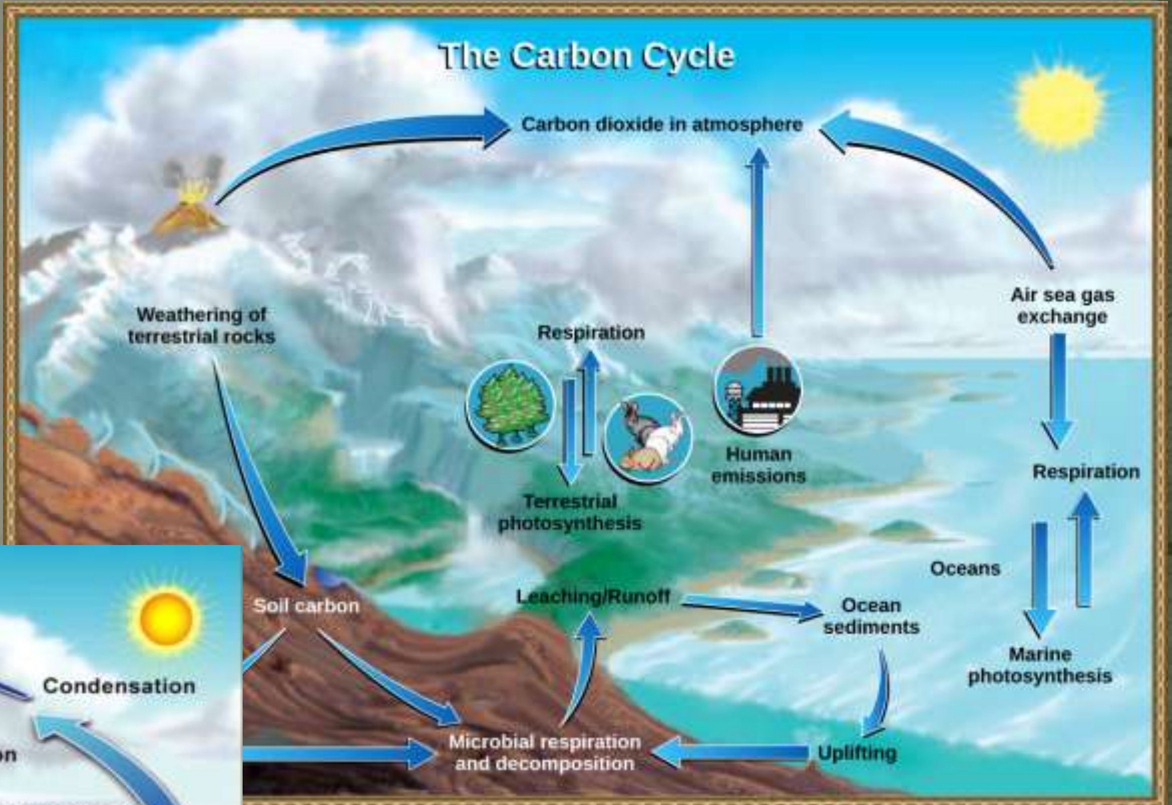
BIOSPHERE → Biogeochemical cycles

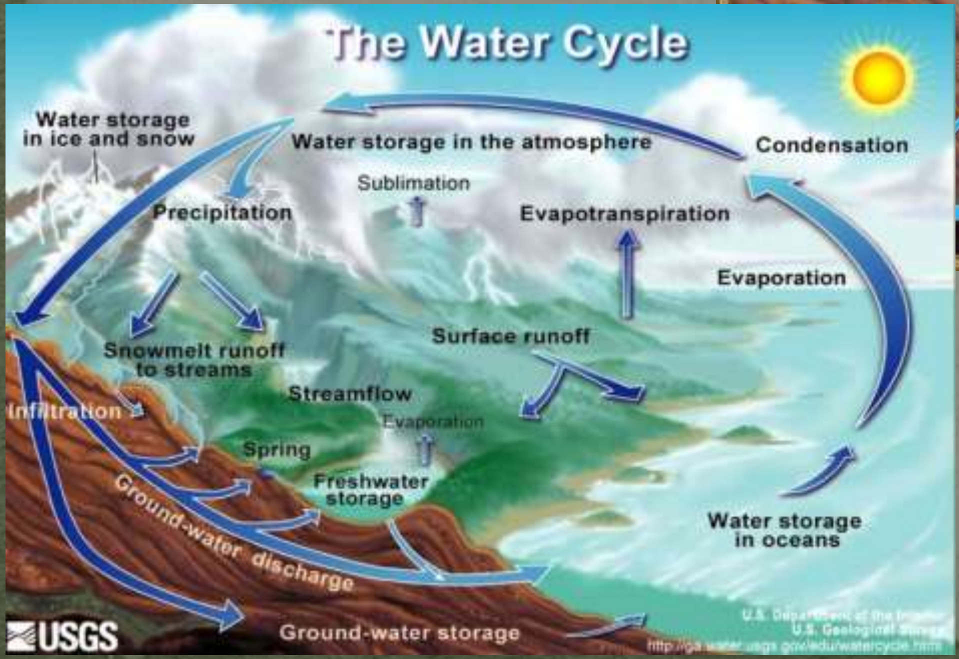
Artificial any of the natural pathways by which essential elements of living matter are circulated. The term *biogeochemical* is a contraction that refers to the consideration of the biological, geological, and chemical aspects of each cycle.



Renew and Regenerate!

- The circular economy of nature is the cycling of resources back into new or existing systems. E.g.: Water, Carbon, Minerals

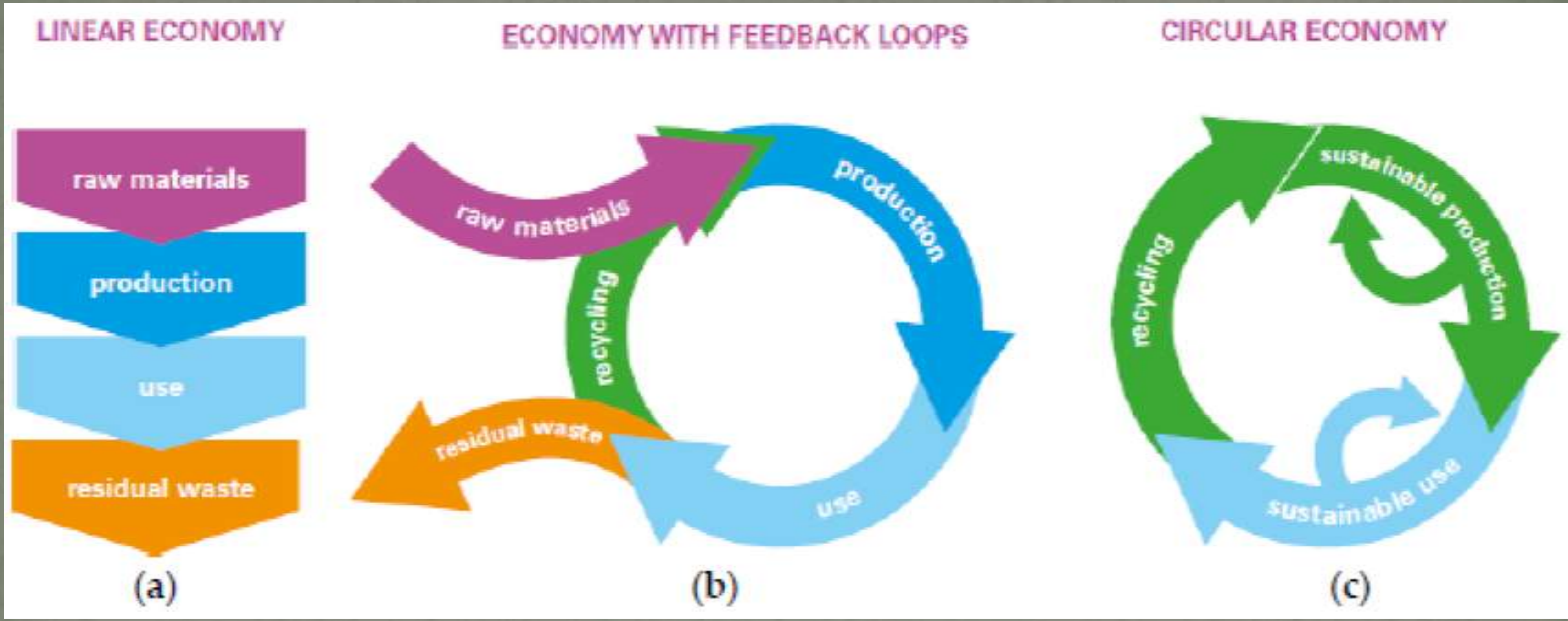




TECHNOSPHERE → Linear economy

An economic system based on collecting raw materials, using them to create consumer goods, and disposing of resulting waste products.

From LINEAR to CIRCULAR economy

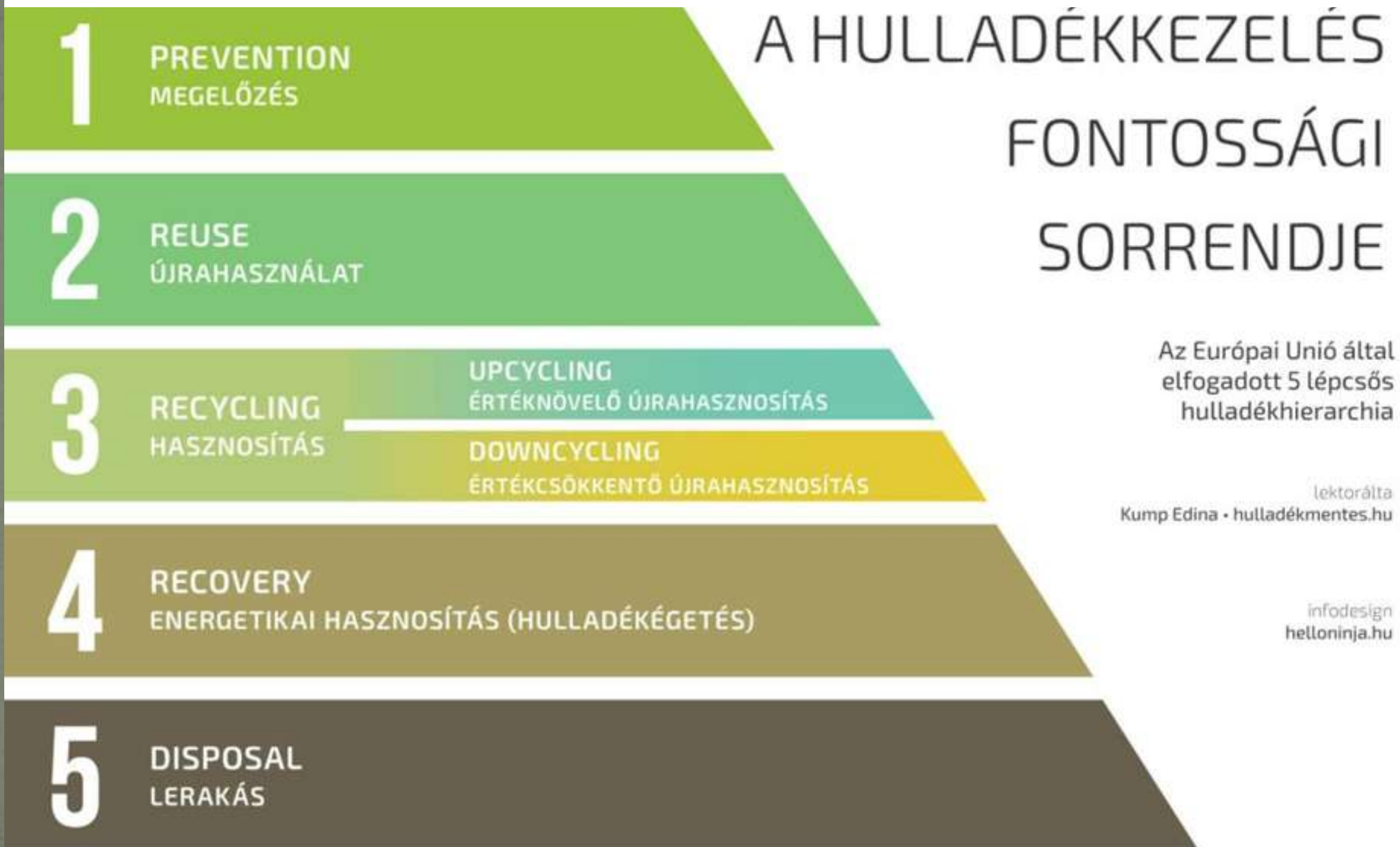


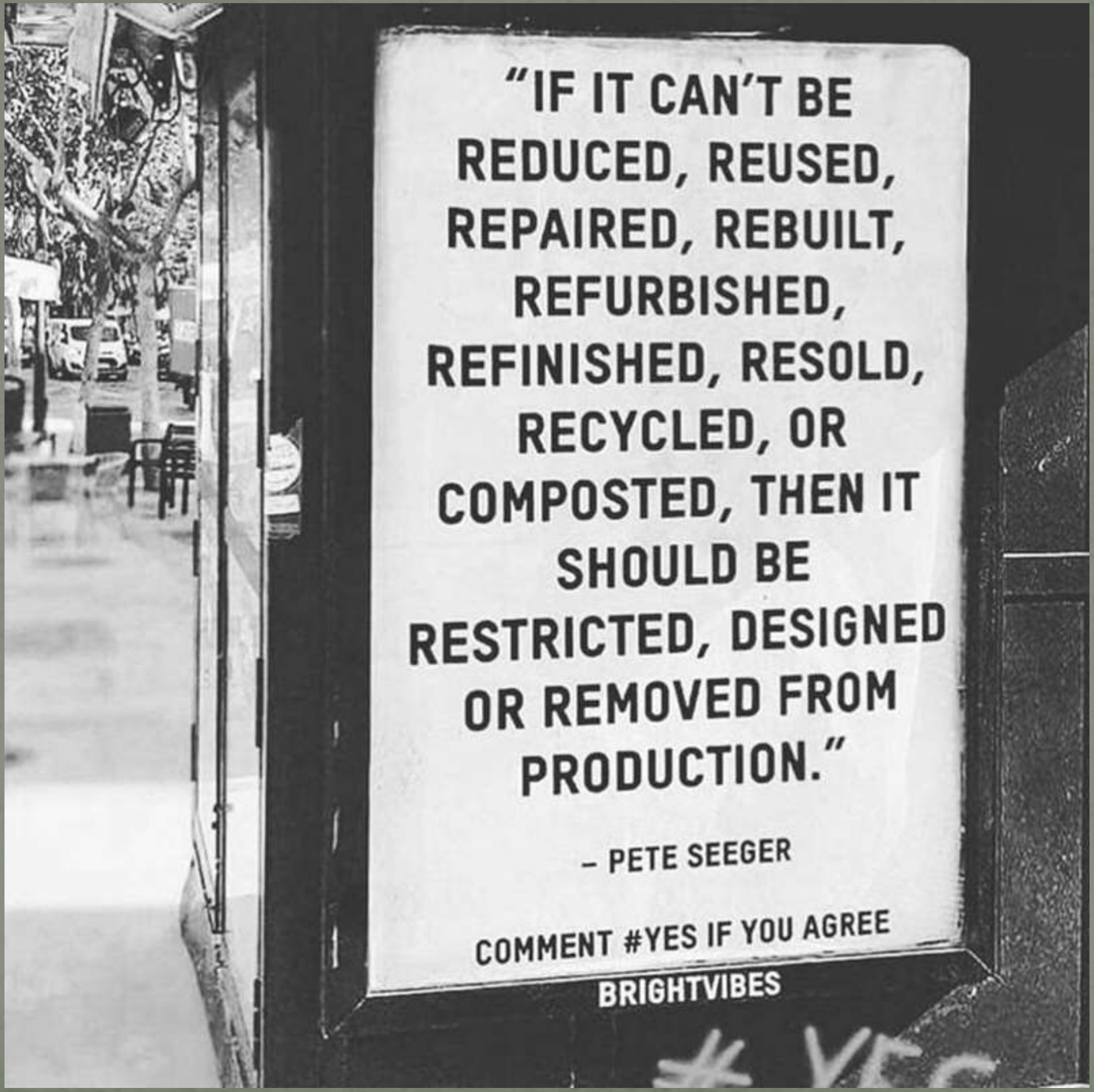
- Sustainable production
- Sustainable use
- Recycling

New values in waste management

1. Inhibition of formation of waste
2. Reduction of amount of produced waste
3. Utilization of waste

Responsible Waste Management Hierarchy




"IF IT CAN'T BE
REDUCED, REUSED,
REPAIRED, REBUILT,
REFURBISHED,
REFINISHED, RESOLD,
RECYCLED, OR
COMPOSTED, THEN IT
SHOULD BE
RESTRICTED, DESIGNED
OR REMOVED FROM
PRODUCTION."
– PETE SEEGER
COMMENT #YES IF YOU AGREE
BRIGHTVIBES

Advantages of RECYCLING

→ Production of secondary raw material
→ Saving the reserves of raw materials
→ Reduced energy demand

Branches	Primary commodities	Recycled commodities
Paper production	6.3-10.5	2.94
Plastic manufacturing	2.94	0.42
Glass-making	11.76	1.26
Steel production	25.2	2.52
Aluminium production	58.8	8.40

Importance of Saving of Mineral Resources

→ Lack of rare noble metals

← Disruption in catalytic converter production

← Thefts! from parking automobiles → Recycling

→ Switching to renewable energy ← Disruption in solar panel production because of the lack of rare metals

← Importance of recycling

→ Production of smart tools (coating of condensers)

← mining of coltan in Congo

→ illegal mines

→ child labour

→ Exploitation of inhabitants

→Endangered species

(mountain gorilla, Grauer's gorilla, bonobos, chimpanzees)

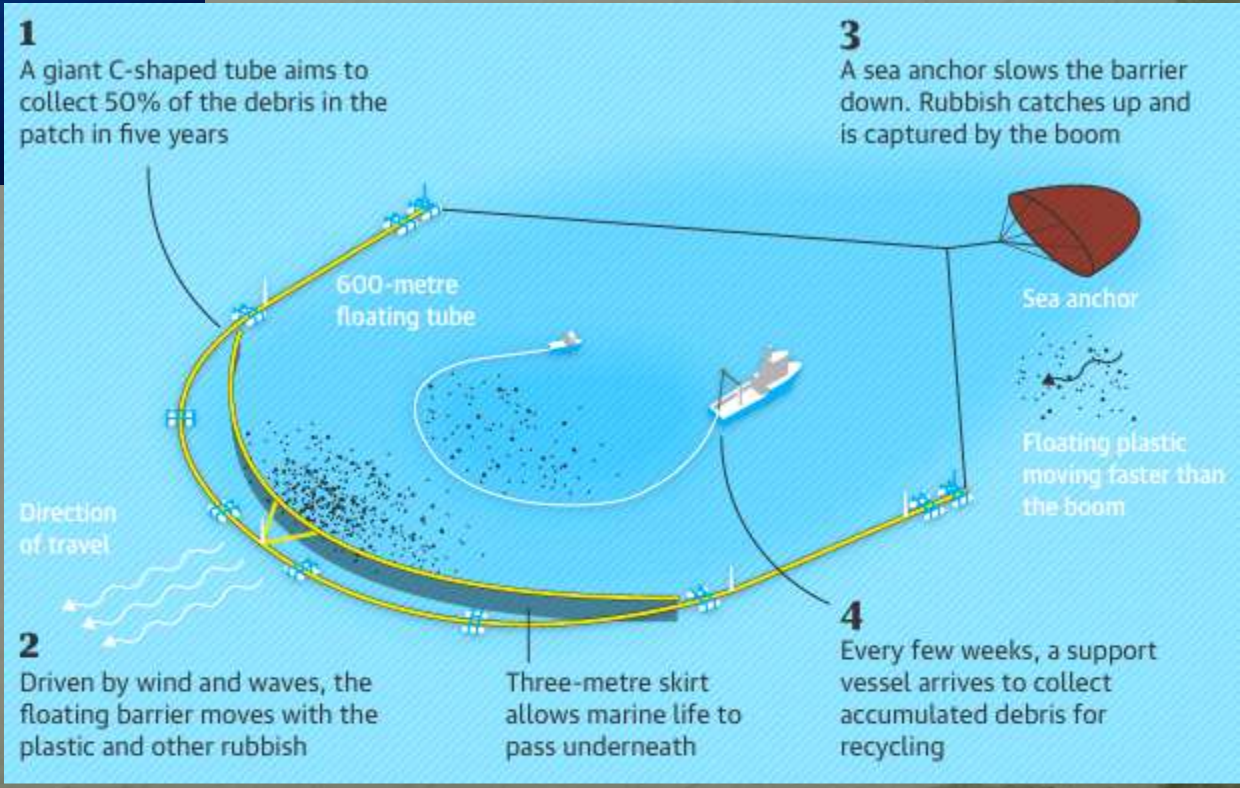
Collection and recycling of outdated mobiles!


The eastern Democratic Republic of Congo (DRC) is a major source of gold, tin ore, tungsten, cobalt and
coltan.
There is forest clearing for mining.
Grauer's gorillas and eastern chimpanzees are being
affected by this mining.
Telecommunications industry accounts for ~18%
global demand for coltan.
Armed groups
control many mine sites, preventing eco-guard patrols.
Estimated 3.6 billion smartphone units in circulation
by 2020
There is an estimated 730% increase in
greenhouse gas emissions
from the production and use of smartphones between 2010-2020
Mining in EDRC results in
1. Illegal bushmeat hunting.
2. Habitat loss, degradation, fragmentation from mining and agricultural expansion.
3. Increased human-ape disease transmission around mine sites.
Up to 99%
of materials are recoverable when mobile devices are recycled.
REDUSE, REUSE, RECYCLE
WILL YOU ANSWER THE CALL?
Photo: JGI/Bill Wallauer
Learn more at mobilerecyclingday.org
#forestiscalling
The forest is calling
the Jane Goodall Institute

Zero Waste.
Can you do that?

„- I'll pick up only one trash
– said 8 billion people
and the Earth depurated." *(unknown)*

The Ocean Cleanup



Questions

- In which period did the waste and sewage management become a remarkable problem?
- What were the consequences of the inadequate sanitary conditions in the Middle Ages?
- Which branches were the origins of waste production after the industrial revolution?
- What is the main difference between the operation of biosphere and technosphere? How can we change our economy from linear to circular?
- How can we change primary commidities and mineral resources?

Effects of Industrial Revolution: The Beginning of Air Pollution

Sustainability

Discovery of Fire (Lower Paleolithic)

- Recognition of wildfires
- Passive use of fire
  - Burned animals and fruits/vegetables
- Active use of fire: repetition and contol a natural phenomenon
  - Hunting
  - Protection
  - Alleviation of weather conditions
  - Food preparation
  - Preservation
- Indirect use of fire

Discovery of Fire (Lower Paleolithic)

- Indirect use of fire
  - Burn of earthenwares
  - Science of cooking

  e.g.: soups and extracts of plants

Legend of endless forests

- Firewood was the single energy source.

Application of metals in Ancient Times

- Gold, lead, copper
- Arsenic bronze and tin bronze
- Iron tools and weapons (Greece)

Charcoal is needed to reduce metal ores

Air pollution!

Ancient villages, cities, city-states

- Heating with firewood

(e. g. roman spa)

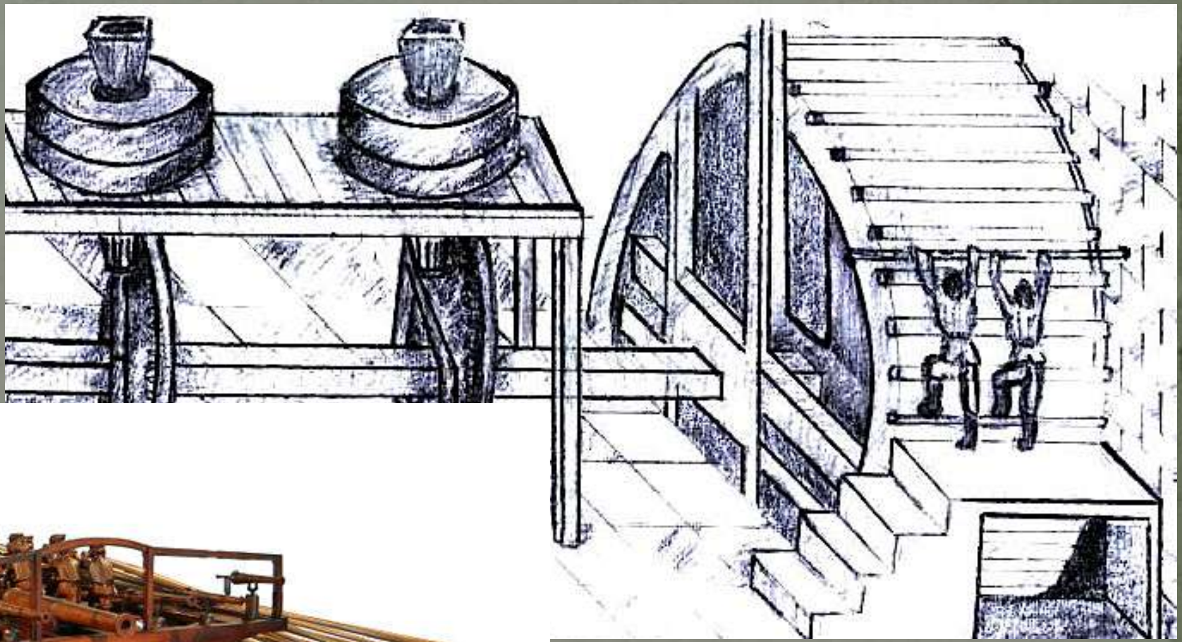
- Metallurgy with charcoal

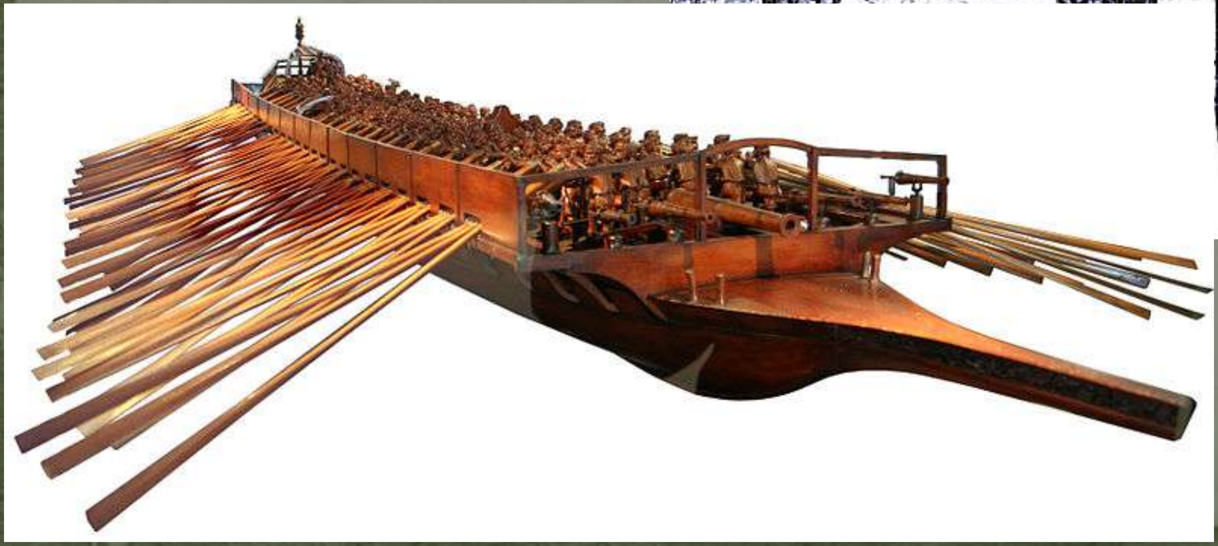
AIR POLLUTION

- Counterbalancing of harmful effects:
  - Location of polluting workrooms was controlled. (Distance based on wind direction)
  - Establishment of parks and resorts (Rome)

Energy Sources in Ancient Times

- Force of muscles / animal or human
  (treadmills, rowing galley)

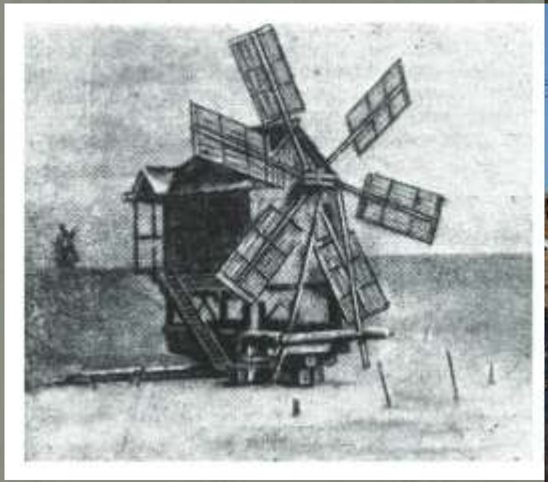




Energy Sources in Ancient Times

- Wind power
  - Sailing boats
  - Wind mills

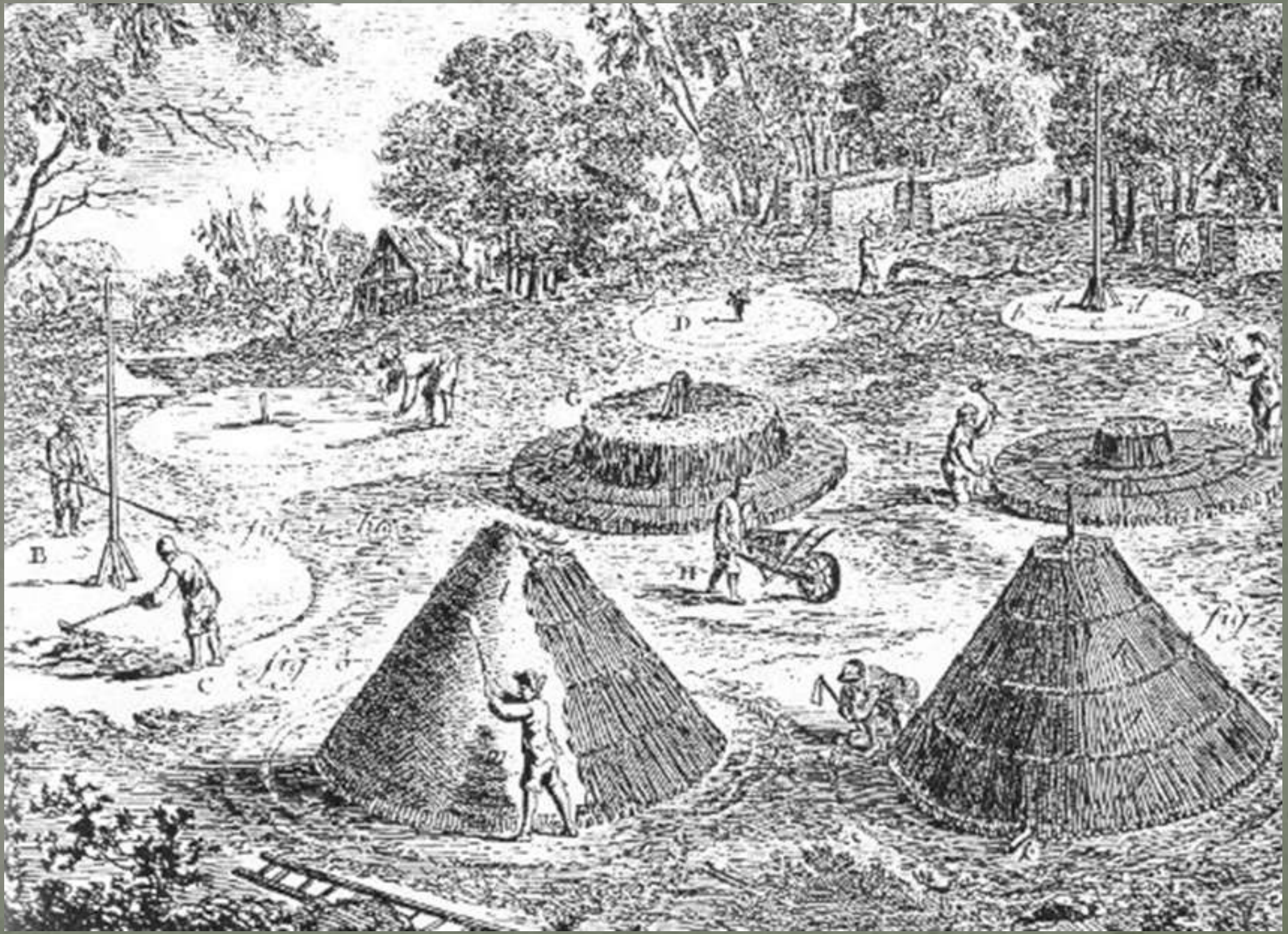
  (BC 1200, Egypt)
  - Wind wheels



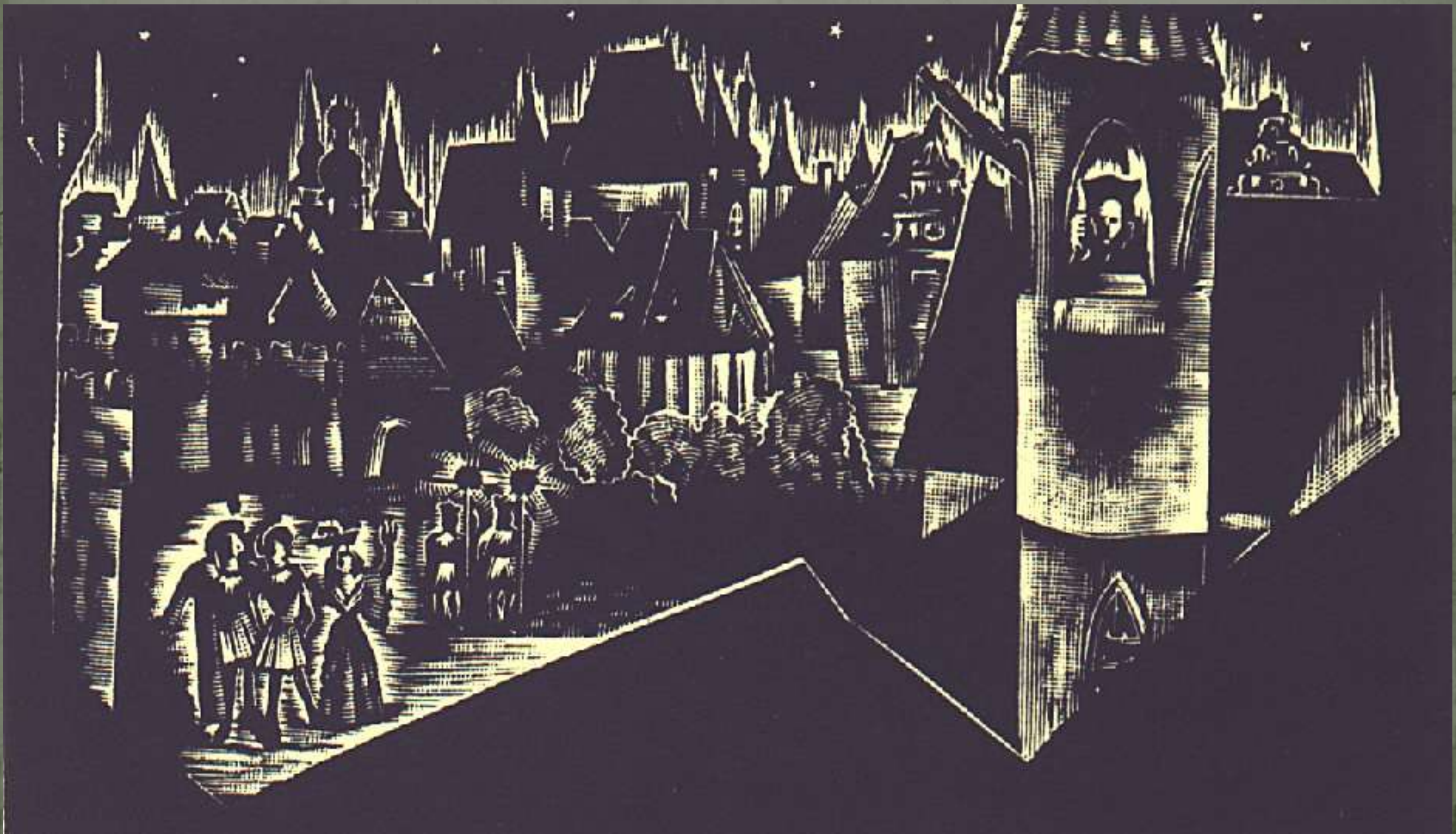
Energy Sources in Ancient Times

- Firewood
- Charcoal

AIR
POLLUTION



Medieval living conditions



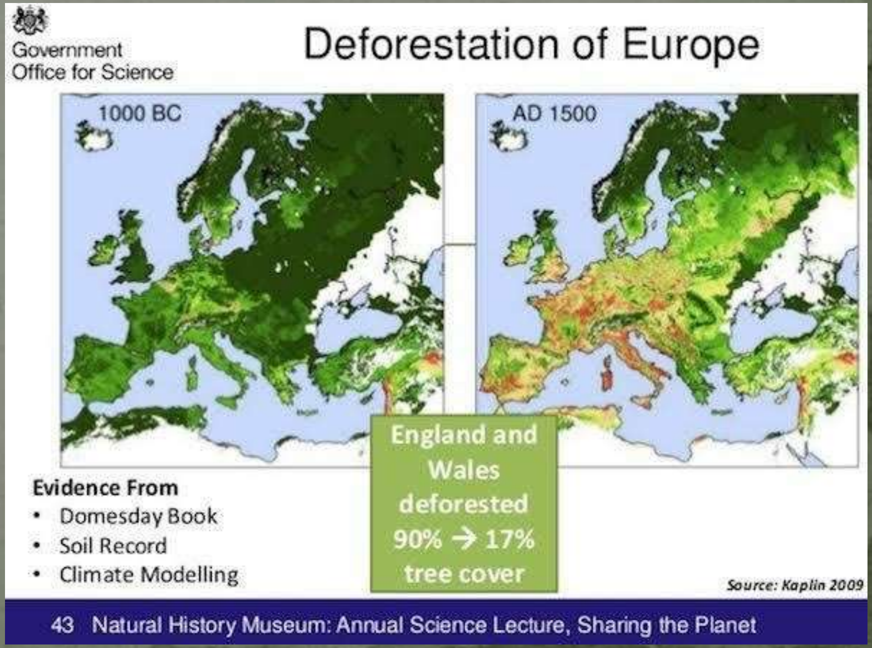
Environmental effects

- Further decrease of forest areas
  - Demand for wool↑ → pasture lands ↑
  - Wood charcoal production
  - Brick burning

  ← demand for wood
  - Heating of houses
  - Wood ash for laundring
  - Stock of vehicles
  - Construction of mills

  ← Building materials from wood

AIR POLLUTION



Energy Sources in Medieval Era

- Hydropower
  - Water wheels

  (ancient Greek invention)
  - Water mills
  - Ebb/flow force power, tidal mills

    (7th century)

Energy Sources in Medieval Era

- Force of muscles (tread mills)
- Wind power

(sailing boats, wind wheels , wind mills)

- Hydropower

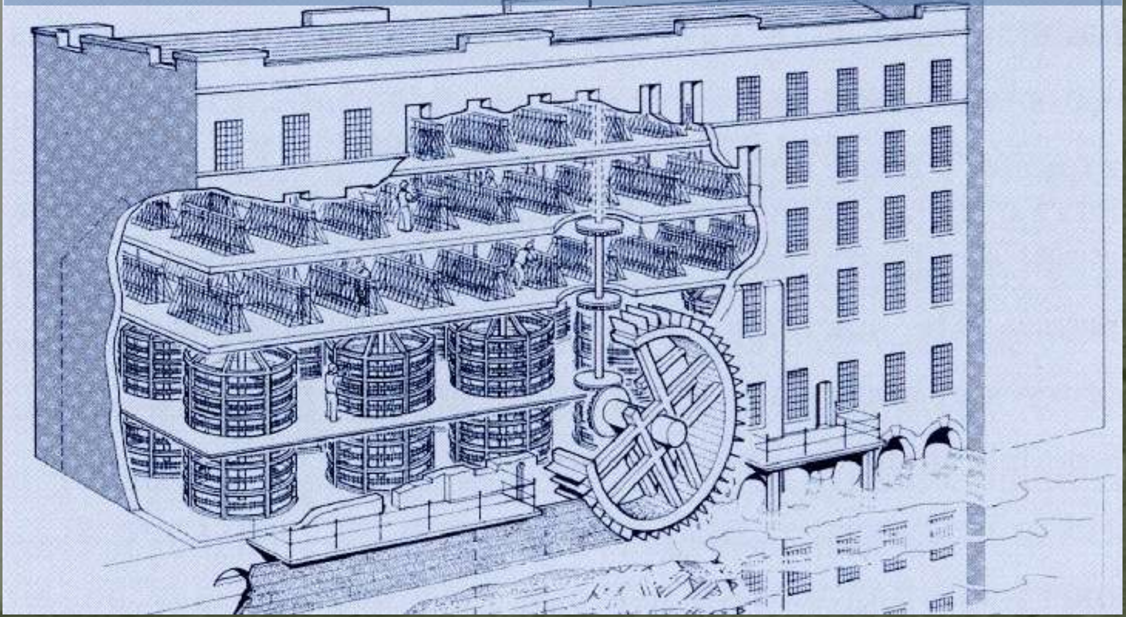
(water wheels, water mills, tidal mills)

- Smelters
- Mining: ore moving devices
- Wire-drawing mills

- Paper mills
- Sawmills
- Silk weaving mills

Albertini: Medieval sawmill with hydraulic power


Dürer: The Wire-drawing mill


Water driven silk throwing mill at Tring (19th century)


Medieval paper mill in Vetrní

Increasing energy demand

- Wood and charcoal weren’t enough
- Hard coal is an option
- But they perceived
harmful effects of its usage
- Strict control of coal burning

- Extensive use of hard coal
just from 16th century

Chinese coal miners
(17th century)

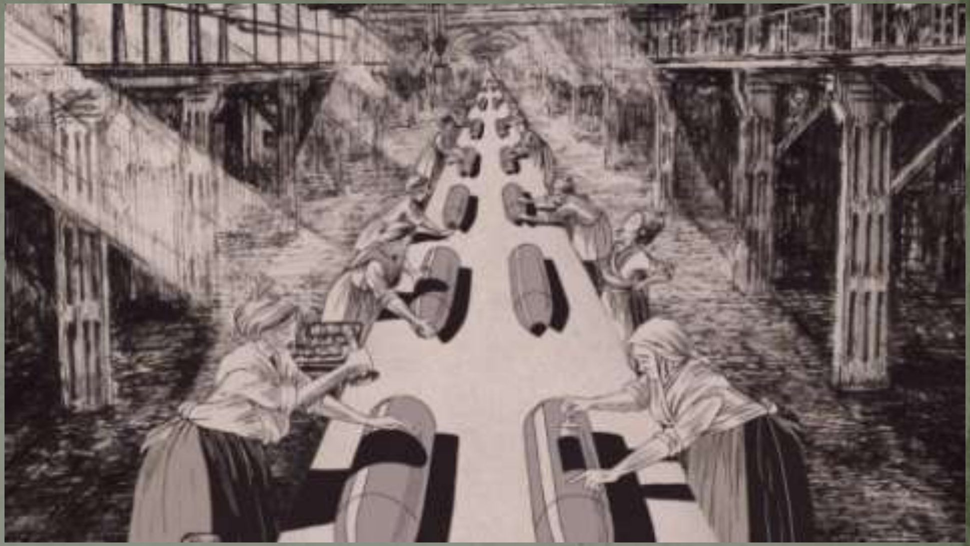
New chapter of air pollution

„Air pollution has been a political issue in Britain for almost 800 years. When Queen Elenaor of Provence visited Nottingham Castle in 1257 the fouled atmosphere, full of heavy coal smoke, forced her to move to Tutbury Castle. Numerous attempts to control coal burning and punish offenders were made during the thirteenth and fourteenth centuries, but largely failed. Queen Elizabeth the First was herself 'greatly grieved and annoyed' by coal smoke in the Palace of Westminster; a complaint which led the local brewers to agree to burn wood instead. Widespread damage to vegetation was reported in the first years of the seventeenth century, as was soiling of household leather furniture and wall hangings.

(Adam Markham: A Brief History of Pollution)

Changes in modern history

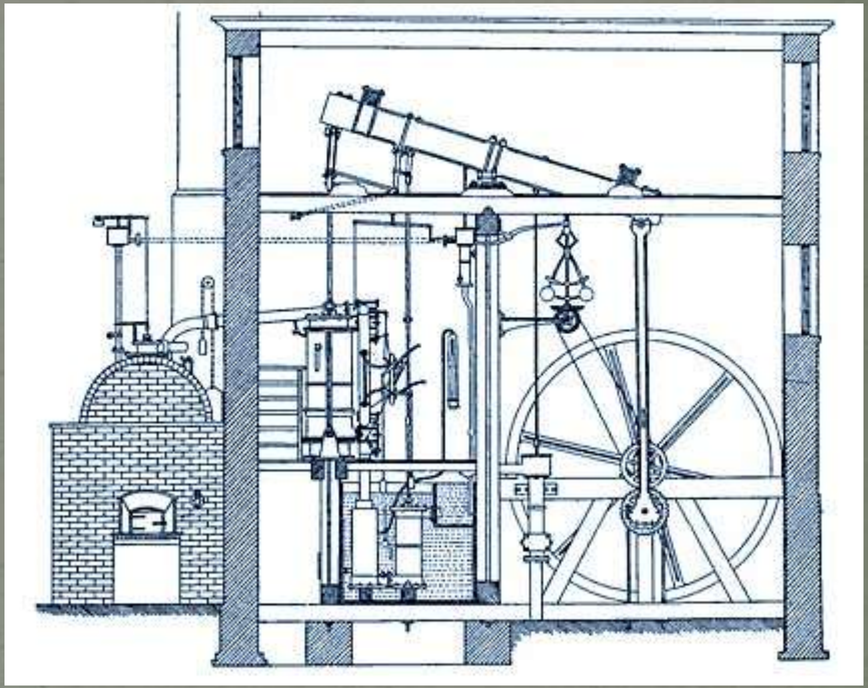
Industrial revolution



- Starting point:
  England
- Antecedents:
  - Advanced agriculture
    (crop rotation, industrial crops from America)
  - Saltatory growth of population
  - Manpower for industry
  - Demand for clothing
    (Merino sheep, yarn production, mechanization of weave)

Increasing demand in military industry

- It stimulated:
  - Mining,
  - Metallurgy,
  - Metalworking.



- Discovery of steam engine
- Increasing use of coal
- Production of cast iron/steel in large quantities

New branch: Machine manufacturing

- Means of production for other branches
(e.g.: textile industry)
- Railway network,
  steam locomotives,
  ships form iron/steel
- Agricultural machines

- Demand for clothing (textile industry)
- Increasing demand in military industry

Discovery of steam engine

Increasing use of hard coal

Machine manufacturing

- Mining
- Metallurgy
- Metalworking

- Agricultural machines
- Vehicles

Increasing use of coal

- Major fuel
- Propellant of vehicles
- Raw materials of chemical industry
- Increasing CO_2-emission

STARTING POINT OF GLOBAL AIR POLLUTION

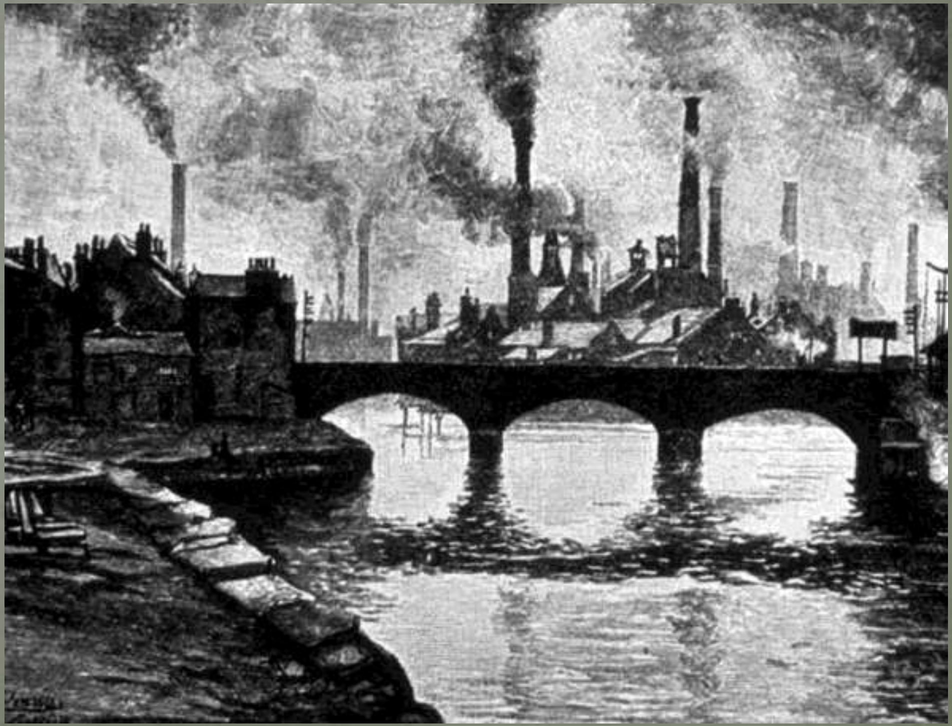
Effect in society

- Importance of craftmen and farmers ↓
- Mass production

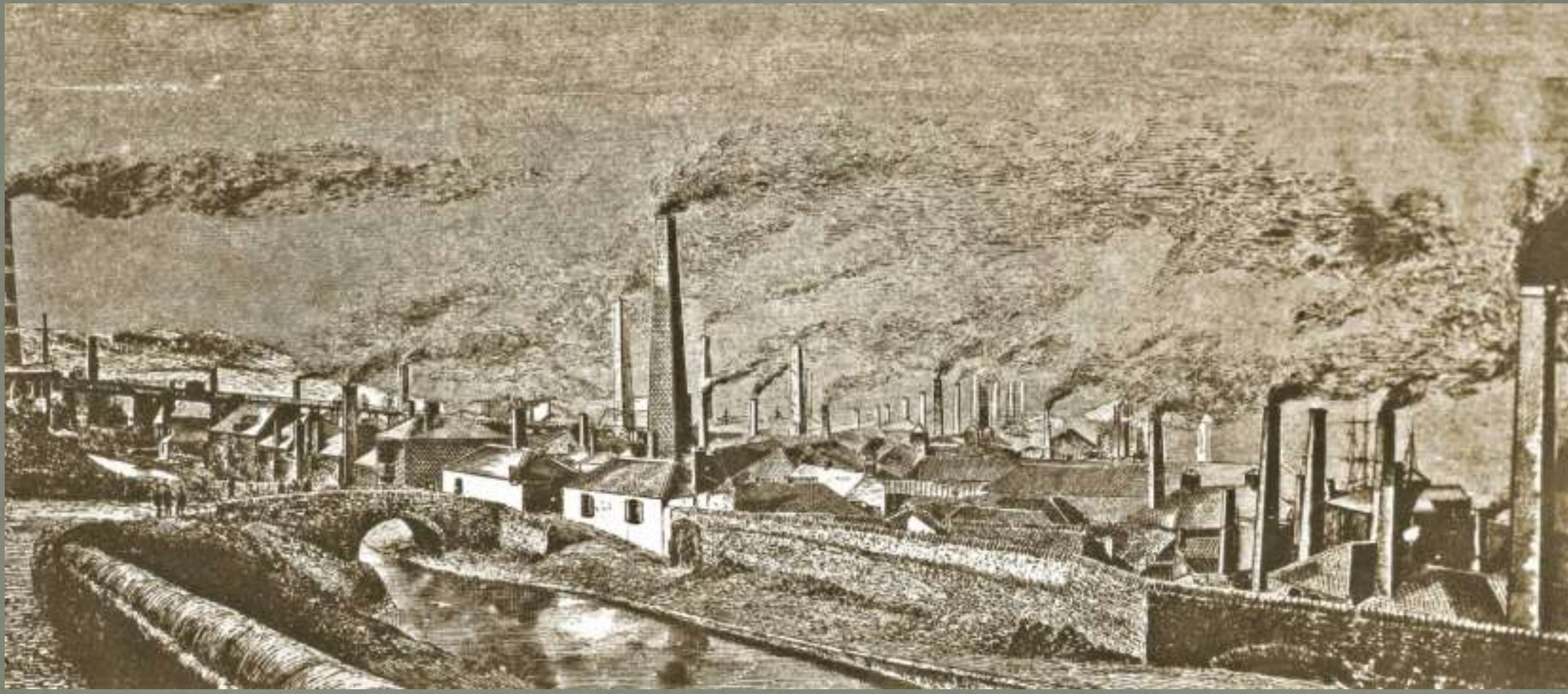
(instead of handicrafts)

- Mechanization
- Urbanization
- Population ↑

  = New consumers!
- Pollution ↑
- Health conditions ↓



Increasing environmental pollution



„Indeed, South Wales was a veritable witches cauldron of industrial pollution. In the early nineteenth century the English Vivian family and the Anglesey mine owner, Thomas Williams, were able to turn the 75 hectare lower Tawe Valley into the world's most powerful metallurgy centre. At the peak of the region's prosperity there were probably 400 chimneys belching smoke in this tiny Glamorganshire valley. In nearby Llanelli the world's highest stack (320 feet) was erected in 1861 to carry away fumes from the tiny town's huge copper works.

(Adam Markham:

A Brief History of Pollution)

„The 1880s saw the Welsh copper industry being replaced primarily by zinc, but also lead, nickel, arsenic and silver, to be followed in the early twentieth century by tin plate and steel. For more than a century, local rivers were sterilized and forests died. As early as the 1830s farmers began to report the death of cattle and by 1888 the average age of people in Swansea was only 24. Similar depressing statistics could be cited for the rest of the country, and the impact of industrial pollution was breaking out like environmental eczema on the English landscape.

(Adam Markham:

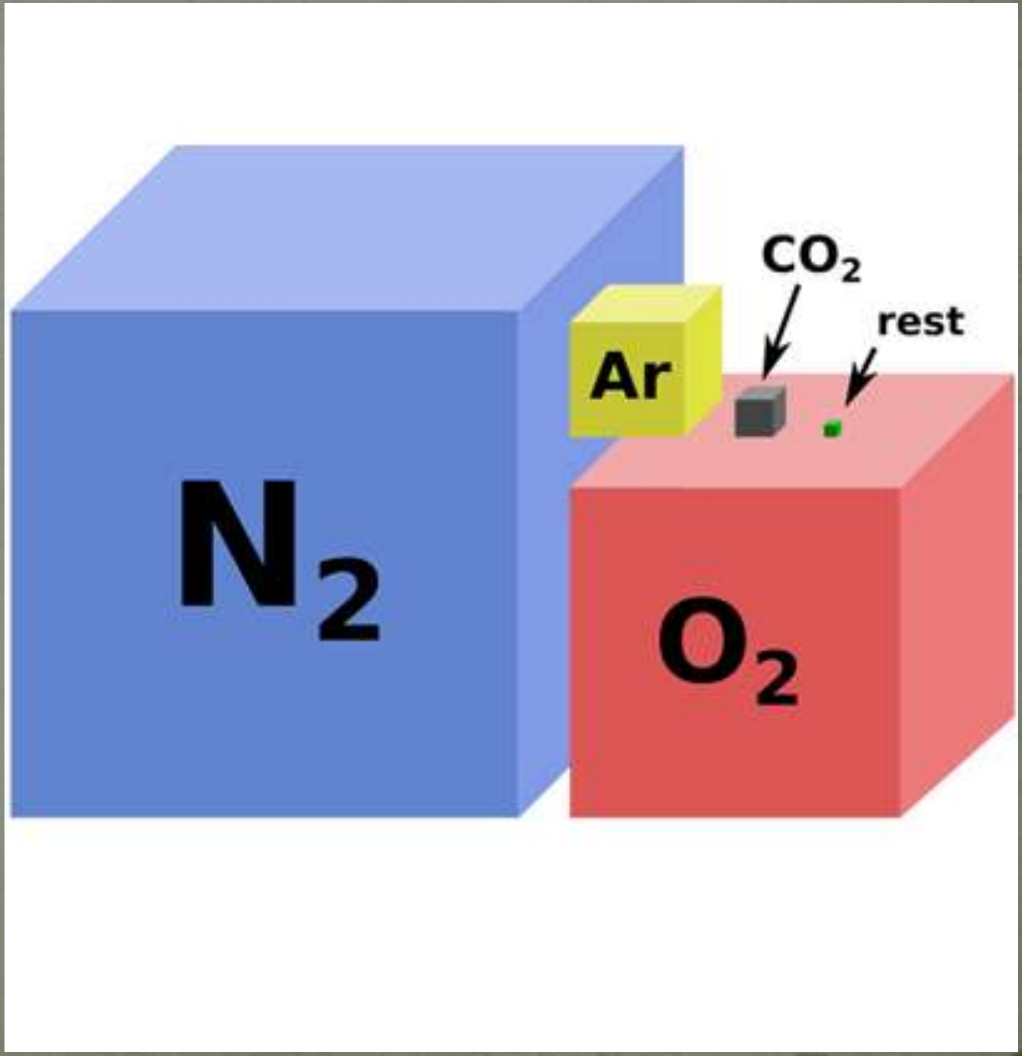
A Brief History of Pollution)

Global problems in the atmosphere

Composition of the atmosphere

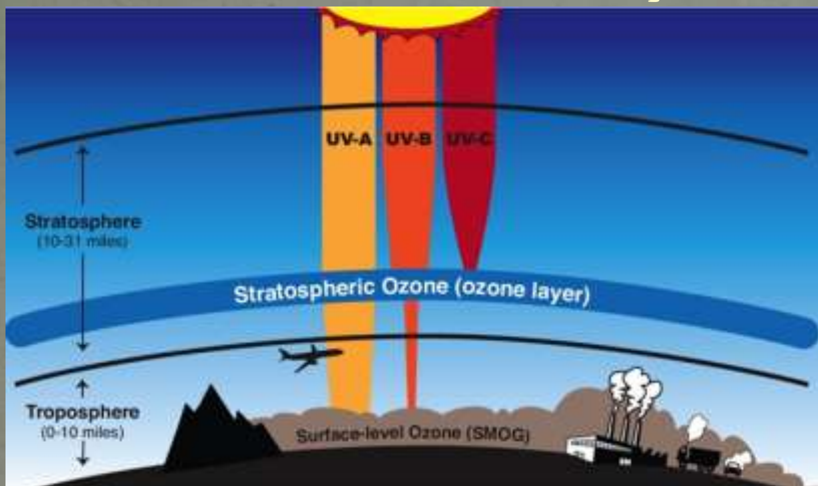
- Nitrogen ~ 78%
- Oxygen ~ 21%
- Argon ~ 0.9%
- Carbon dioxide et al.

  ~ 0.1%



The roles of the atmosphere

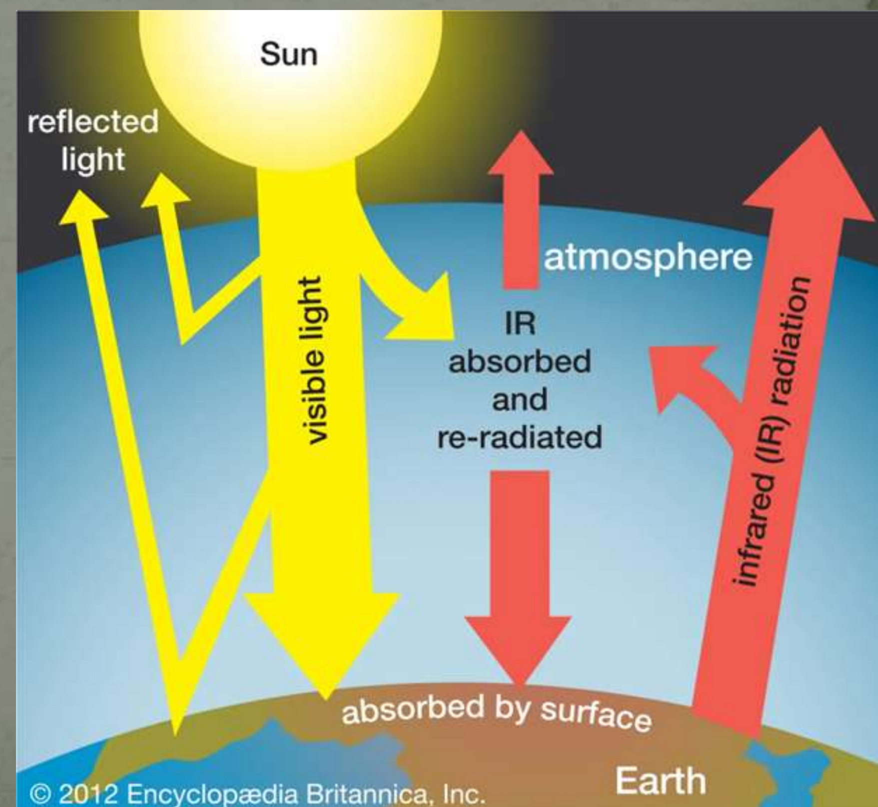
- Ozone layer → Protection from harmful radiation (X-ray, UV)



- Greenhouse gases in normal level → Advantageous greenhouse effect

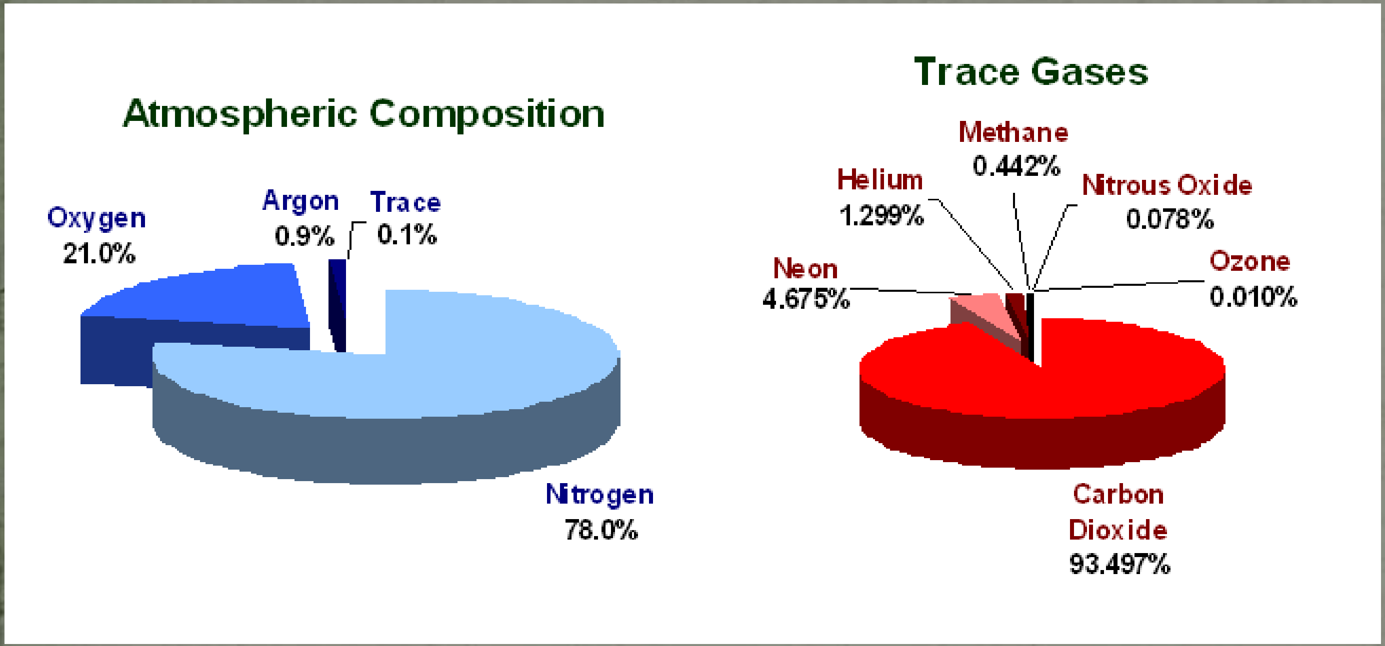
(It warms the planet to its comfortable average of 15 degrees Celsius)

- Oxigen content → Breathing



TECHNOSPHERE → Linear economy

Composition of the atmosphere



Carbon dioxie ↑

- Carbon monoxide ↑
- Oxides of nitrogen ↑
- Halogenated hydrocarbons ↑
- Oxides of sulfur ↑
- Methane ↑

Global effects

- Gas phase ozone decomposition catalysts

  (Halogenated hydrocarbons)

  → Concentration of ozone ↓

  → Harmful UV-radiation ↑

Global effects

- Emission of greenhouse gases ↑

  → abnormal greenhouse effect

  → global warming, climate change

Global effects

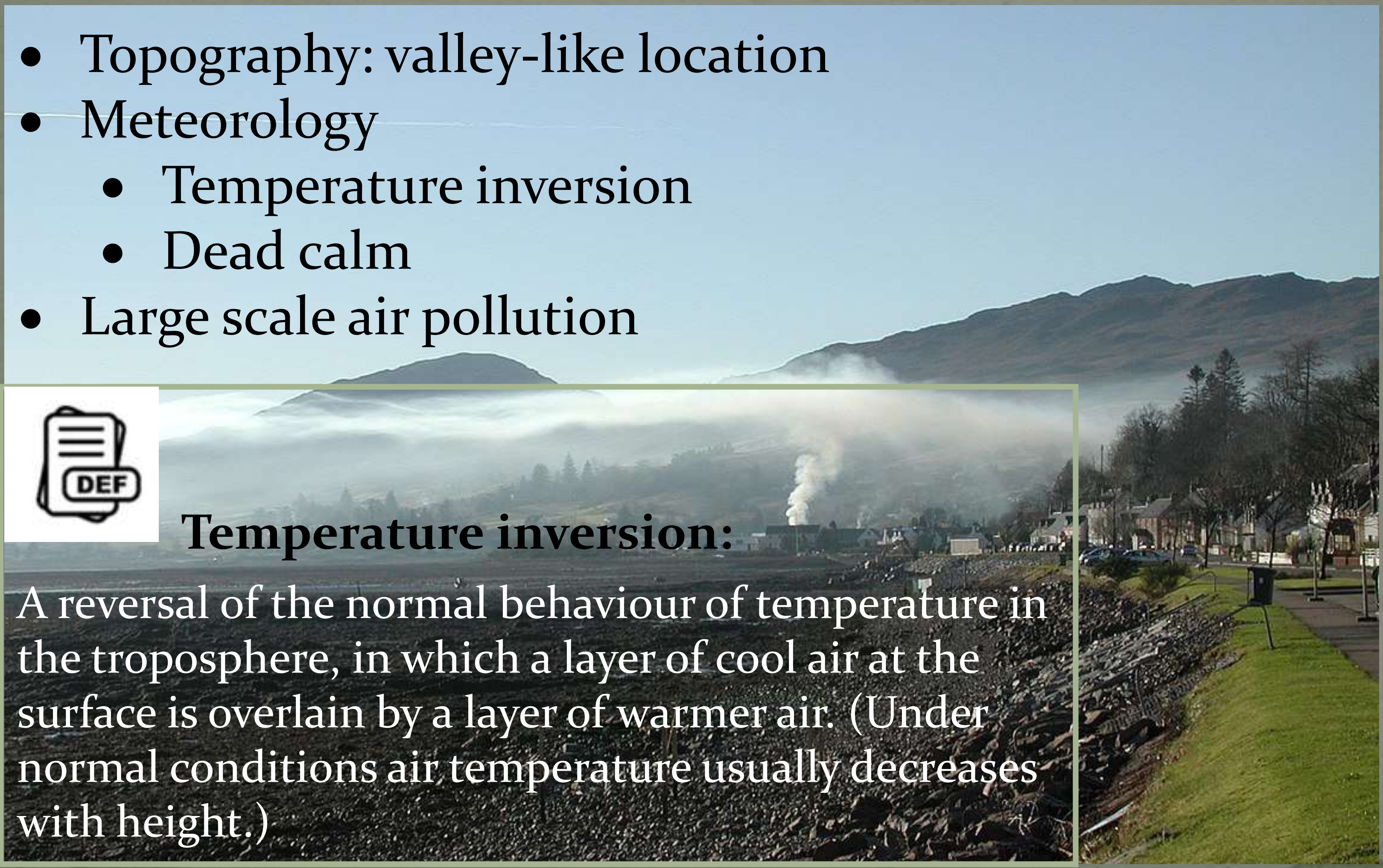
- Utilization of fossil fuels (hard coal, mineral oil, natural gas)
  - → Emission of oxides of carbon, nitrogen and sulfur
    - → Abnormal greenhouse effect (CO_2, N_2O)
    - → Smog (NO_x, SO_2, CO …)
    - → Acid rain (CO_2, NO_x, SO_x)

Sulfurous and Photochemical SMOG


London, 1952


Los Angeles, 1943

Common elements of the formation of sulfurous and photochemical smog



- Topography: valley-like location
- Meteorology
  - Temperature inversion
  - Dead calm
- Large scale air pollution

Temperature inversion:

A reversal of the normal behaviour of temperature in the troposphere, in which a layer of cool air at the surface is overlain by a layer of warmer air. (Under normal conditions air temperature usually decreases with height.)

Properties	Photochemical (Los Angeles)	Sulfurous (London)
Temperature of air	24-32 °C	-1-4 °C
Humidity	< 70 %	85 % (fog)
Temperature inversion	1000 m	< 500 m
Speed of the wind	Calm wind	Calm wind
Visibility	<0.8-1.6 km	< 30 m
Incidence	August-Sept.	Dec. – Jan.
Main reasons	Transport	Heating
Main components	NO, NO_2, CO, O_3	SO_2, H_2SO_4, CO, grime
Types of reactions	Oxidative	Reductive
Daily incidence	During the day	Morning and evening
Primary harmful effects	Irritable eyes	Damage of respiratory system
Effect on built environment	Tire (because of O_3)	Iron, concrete

Source of sulfur dioxide

- Burning of mineral coal
- Metallurgy
- Volcanic activity
- Decomposition of organic materials

Solutions of the problem:

- Desulfurization of fuels
- Substitution of fuels
  (alternative energy sources)
- Remediation of damaged areas

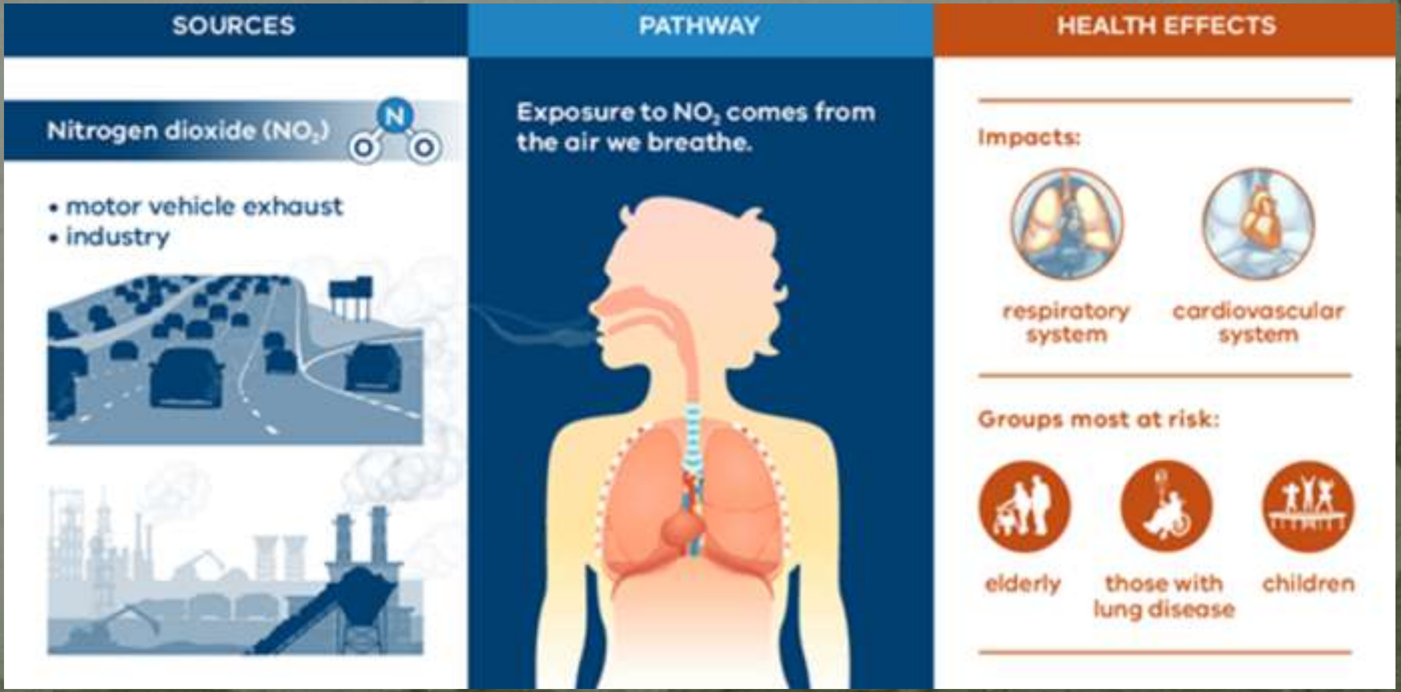
Source of oxides of nitrogen

- Burning of fossil fuels
- Combustion of biomass
- Lightning
- Stratospheric processes
- Oxidation of ammonia
- Emission of soil

70-80 %

Harmful effects of nitrogen oxides

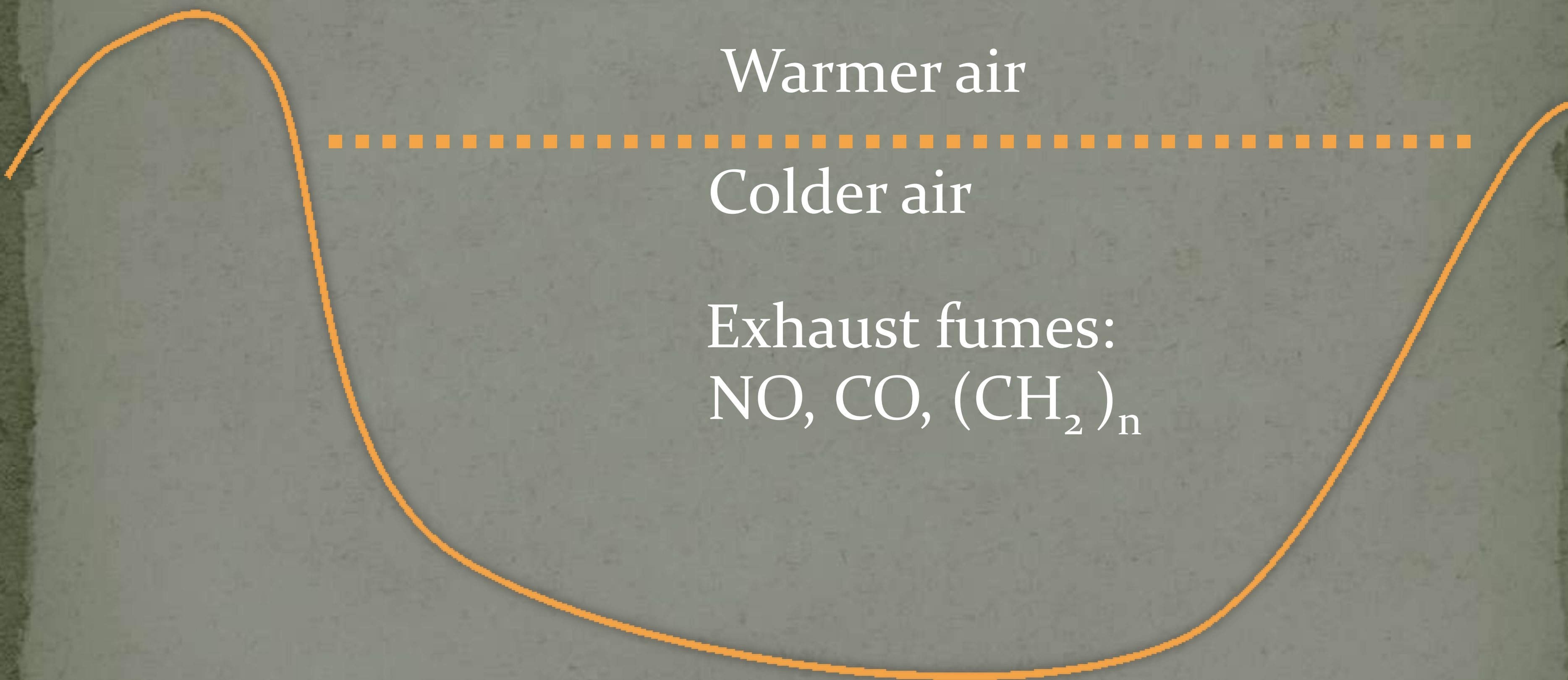
- Irritate the respiratory tract, asthma and chronic bronchitis
- Harmful effects of nitrogen oxides
- NO_2 is harmful in low concentration (300 μg/m^3!)
- Cooking: 470-1880 μg/m^3
- Smoking (one cigarette): 150000-226000 μg/m^3



Formation of Photochemical SMOG

Formation of Photochemical SMOG

Early morning



Inversion prevents the mixing.

Formation of Photochemical SMOG

In the morning

UV radiation

↓↓↓↓↓

$$2NO + O_2 \rightarrow NO_2$$

$$NO_2 + O_2 \rightarrow NO + O_3$$

Formation of Photochemical SMOG

Afternoon

UV radiation

↓↓↓↓↓

$(CH_2)_n + (NO, O_3, NO_2, H_2O)$

→ formation of peroxides, organic nitrates (etc)

Formation of Photochemical SMOG

Night

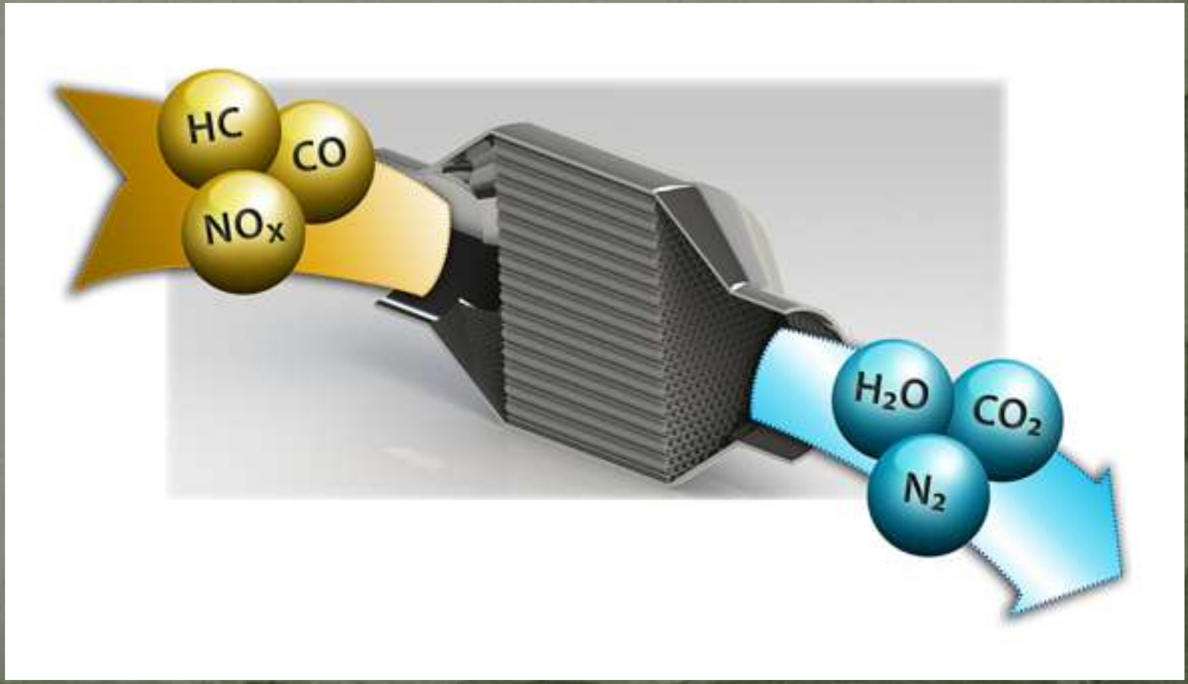
Darkness

In absense of conditions…
it is the end of the reactions.

Smog can appear or moderate.

Solutions of the problem: Reduction of emission (NOx, CO)

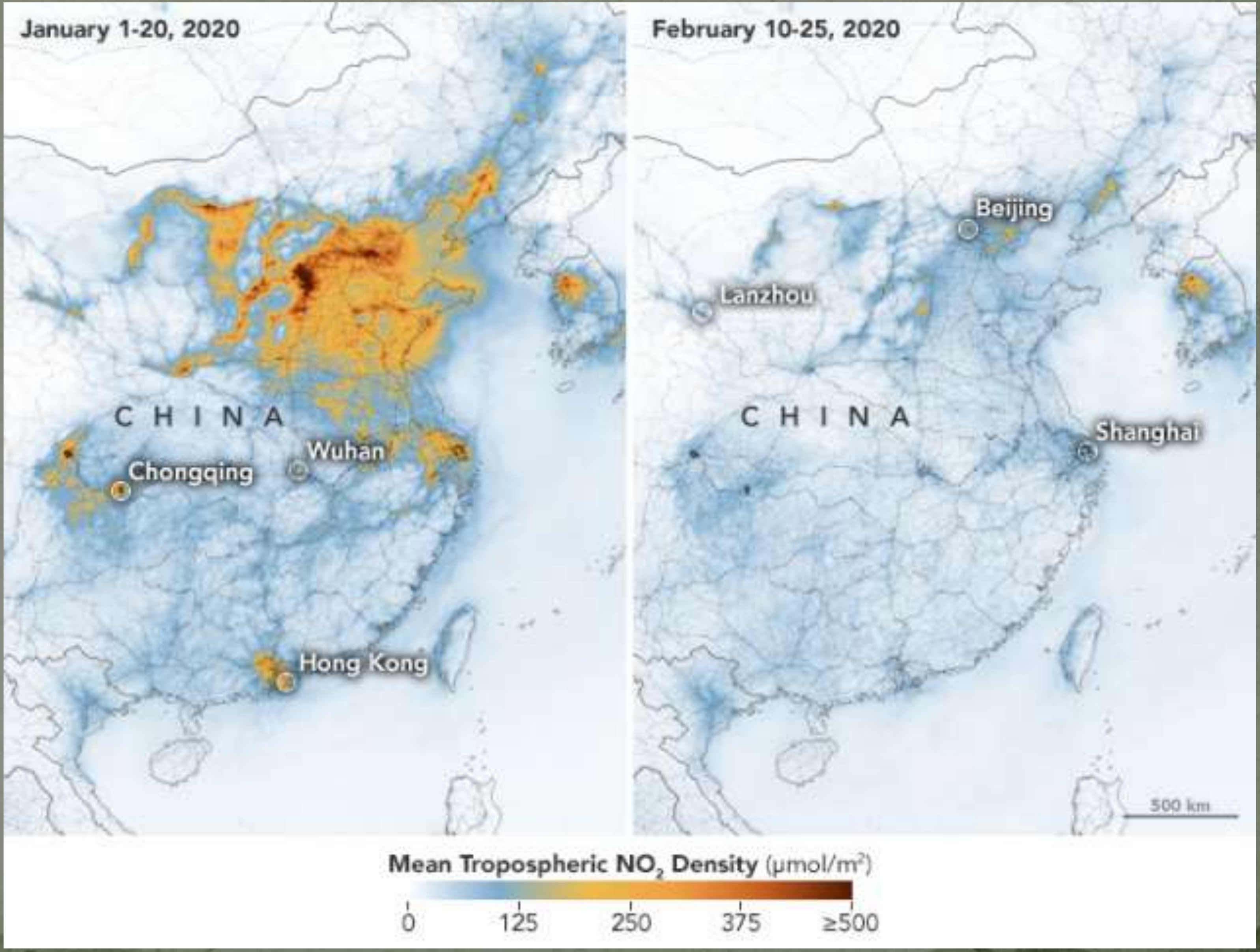
- Catalytic converters in automobiles
- Reduction of traffic
- Reduction of industrial emission



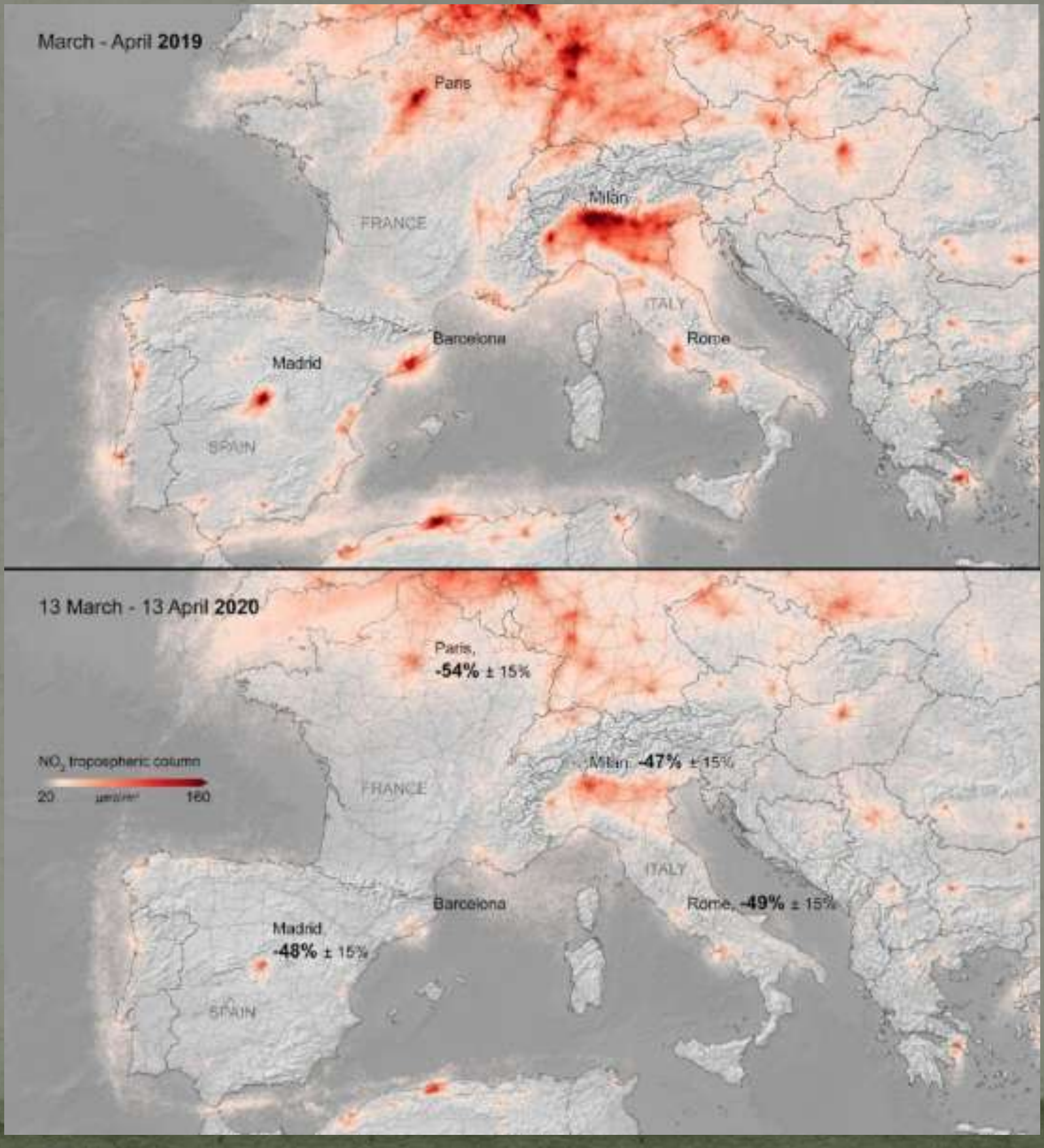
Effects of COVID-19 lockdowns

India 2020:
The Himalayas can be seen for the first time in 'decades,' as the lockdown eases air pollution.

Effects of CoVID-19 lockdowns



Effects of CoVID-19 lockdowns



Global effects

- Utilization of fossil fuels (hard coal, mineral oil, natural gas)
  - → Emission of oxides of carbon, nitrogen and sulfur
    - → Abnormal greenhouse effect (CO_2, N_2O)
    - → Smog (NO_x, SO_2, CO ...)
    - → Acid rain (CO_2, NO_x, SO_x)

Where does acid rain come from?

- Discovery: 1963 - Gene Likens:

Samples of rain ← large-scale pollution

$SO_2 \rightarrow SO_3 \rightarrow H_2SO_4$

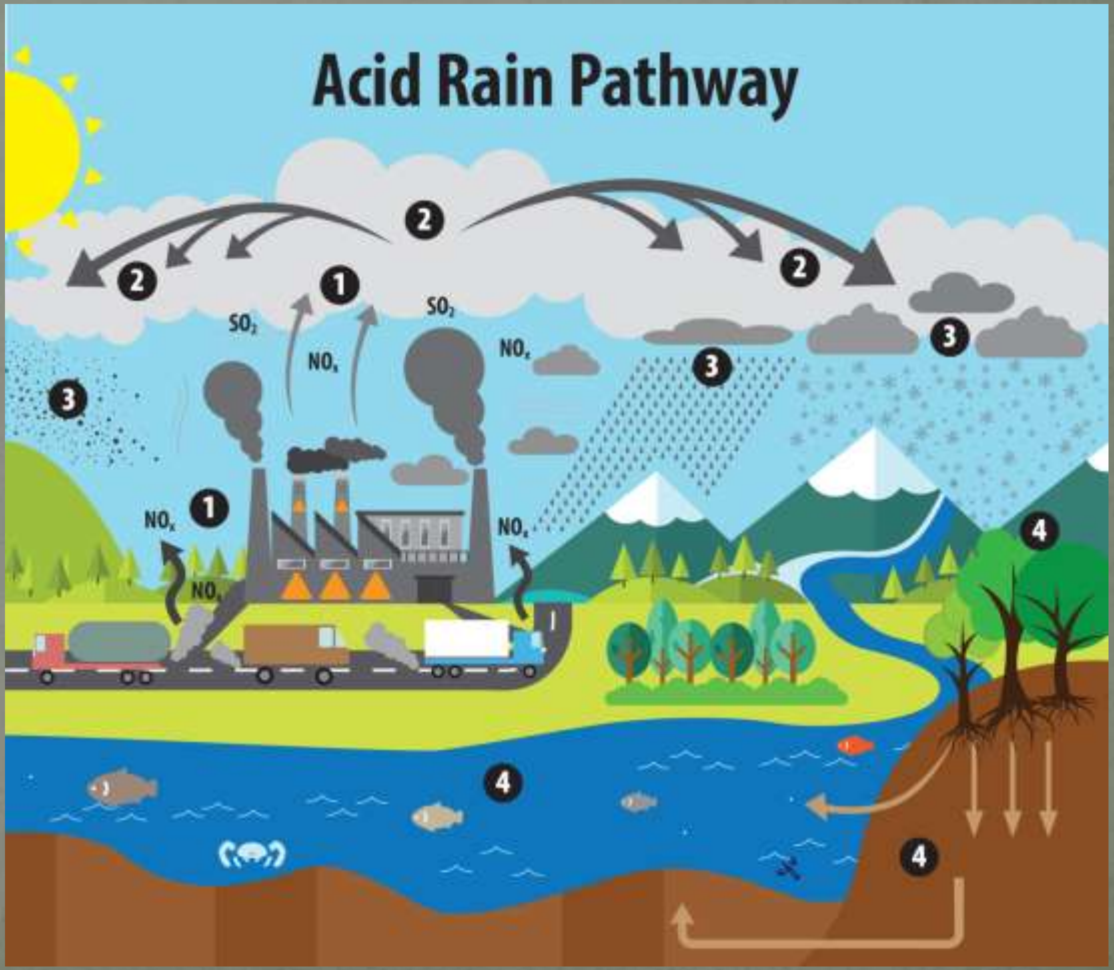
Sulfur dioxide $\rightarrow$ sulfuric acid

$2NO_2 + H_2O = HNO_3 + HNO_2$

Nitrogen dioxide $\rightarrow$ nitric acid + nitrous acid

$CO_2 + H_2O = H_2CO_3$

Carbon dioxide $\rightarrow$ carbonic acid



Concentration of Hydrogen ions compared to distilled water		Examples of solutions at this pH
10,000,000	pH= 0	Battery acid, Strong Hydroflouric Acid
1,000,000	pH = 1	Hydrochloric acid secreted by stomach lining
100,000	pH = 2	Lemon Juice, Gastric Acid Vineger
10,000	pH = 3	Grapefruit, Orange Juice, Soda
1,000	pH = 4	Acid rain Tomato Juice
100	pH = 5	Soft drinking water Black Coffee
10	pH = 6	Urine Saliva
1	pH = 7	"Pure" water
1/10	pH = 8	Sea water
1/100	pH = 9	Baking soda
1/1,000	pH = 10	Great Salt Lake Milk of Magnesia
1/10,000	pH = 11	Ammonia solution
1/100,000	pH = 12	Soapy water
1/1,000,000	pH =13	Bleaches Oven cleaner
1/10,000,000	pH = 14	Liquid drain cleaner

Definition

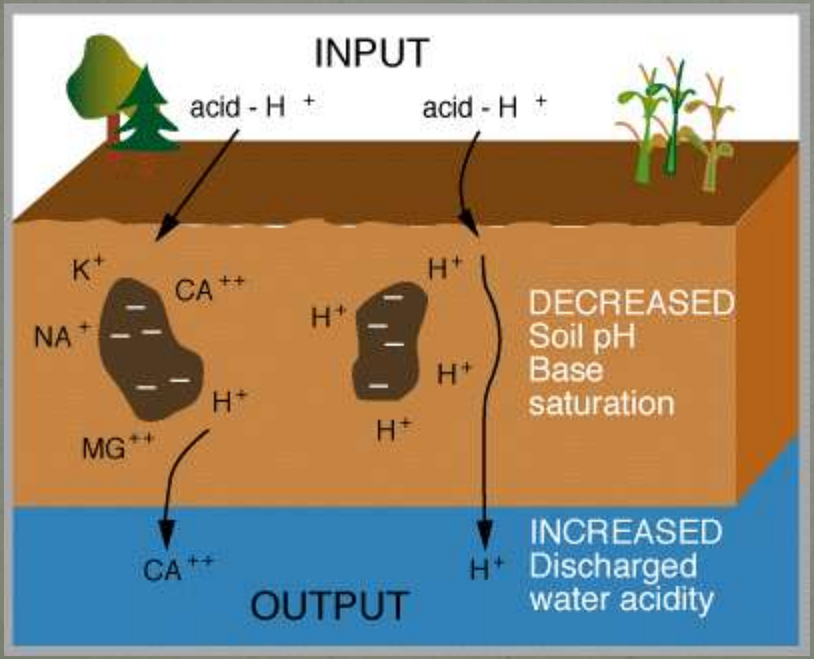
- Normal rain: $5.0 < pH < 6.5$
- Acid rain: $pH < 5.0$
- Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components,

such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.

Regional effects of acid rain

- Decreased pH in soil
  - Rainout of essential metals

  (They would be required for plants)
  - Increased solubility of toxic metals



Regional effects of acid rain

- Direct effect on plant’s metasbolism
- Animals and humans:
  - Respiratory diseases

Regional effects of acid rain

- Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminum from the soil. That aluminum may be harmful to plants as well as animals.
- Acid rain also removes minerals and nutrients from the soil that trees need to grow.
- At high elevations, acidic fog and clouds might strip nutrients from trees' foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

Regional effects of acid rain

- Wetlands (streams, lakes, marshes):
  - the young of most species are more sensitive to environmental conditions than adults (lower pH, high concentration of toxic metals).
  - At pH 5, most fish eggs cannot hatch.
  - At lower pH levels, some adult fish die.
  - (Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not.)

Regional effects of acid rain

- Wetlands (streams, lakes, marshes):
  - „Dead lakes”: blue and clear
  because of absense of plankton

Effects on built environment

- Limestone:

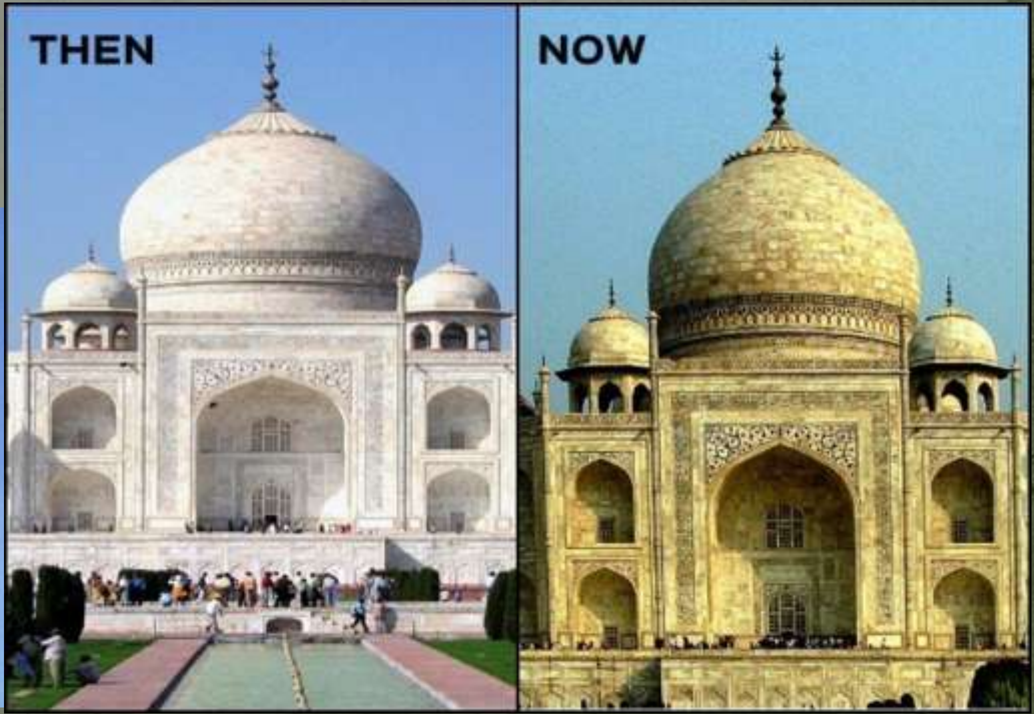
$CaCO_3 + H_2SO_4 \rightarrow Ca^{2+} + SO_4^{2-} + H_2O + CO_2$

- Sandstone:

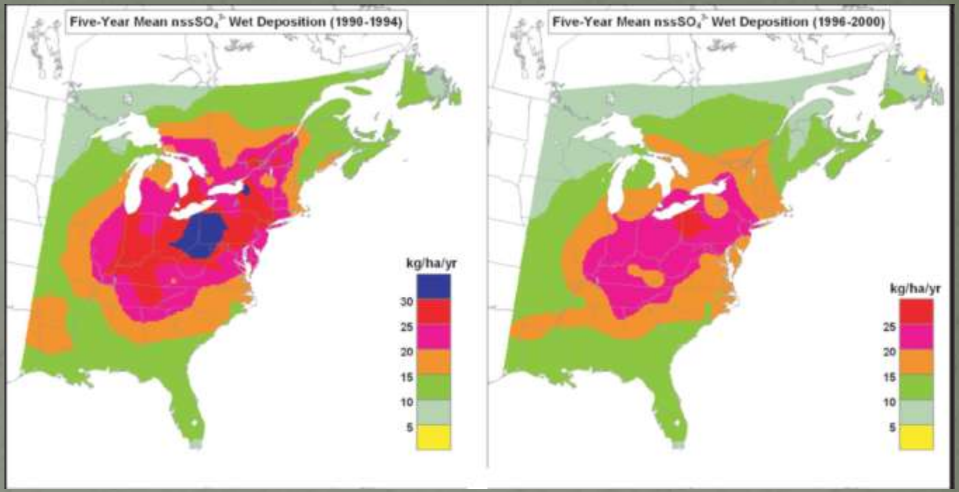
$Fe_2O_3 + 3\ H_2SO_4 \rightarrow 2\ Fe^{3+} + 3\ SO_4^{2-} + 3\ H_2O$

- Metals (corrosive effect):

$Me + 2\ H^+ \rightarrow Me^{2+} + H_2$



Interventions



- North America:
  - Interventions after 27 years after discovery!
  - It was succeeded to stop acid rain!

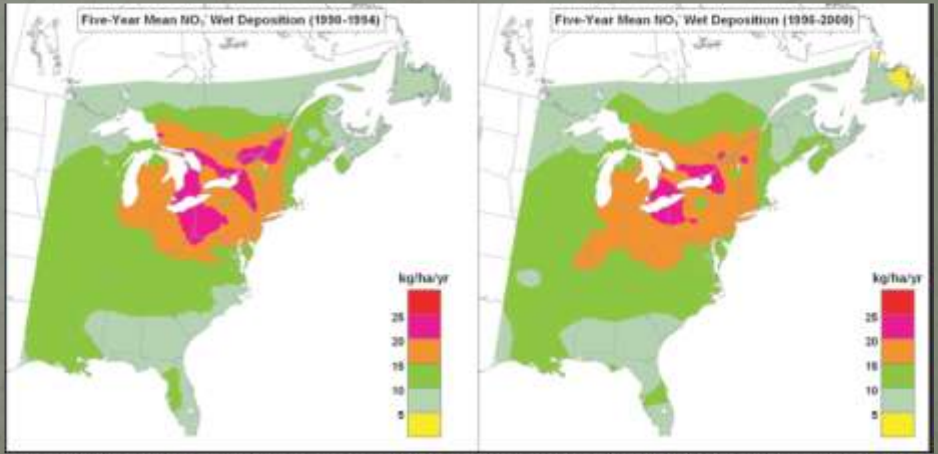
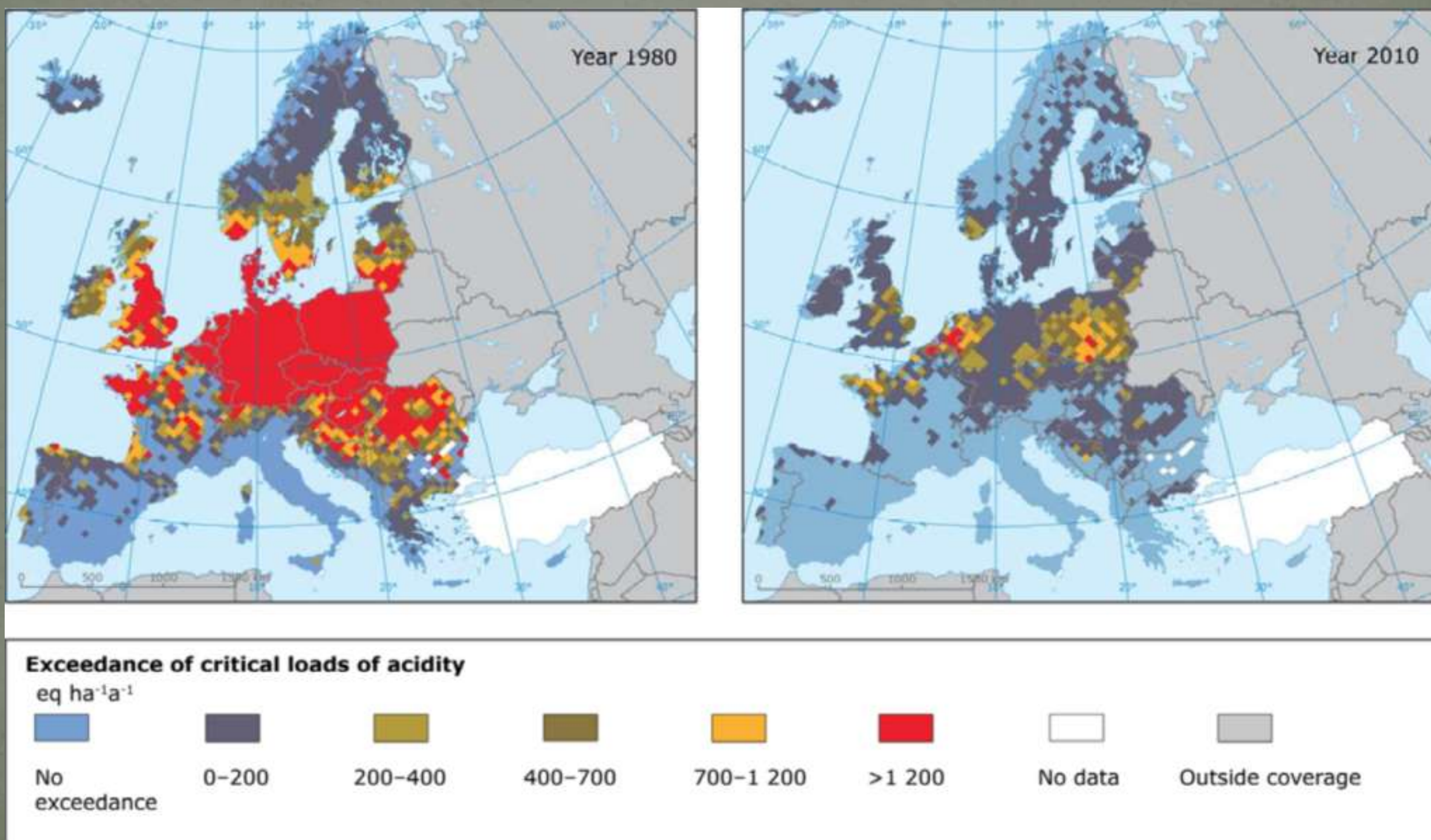


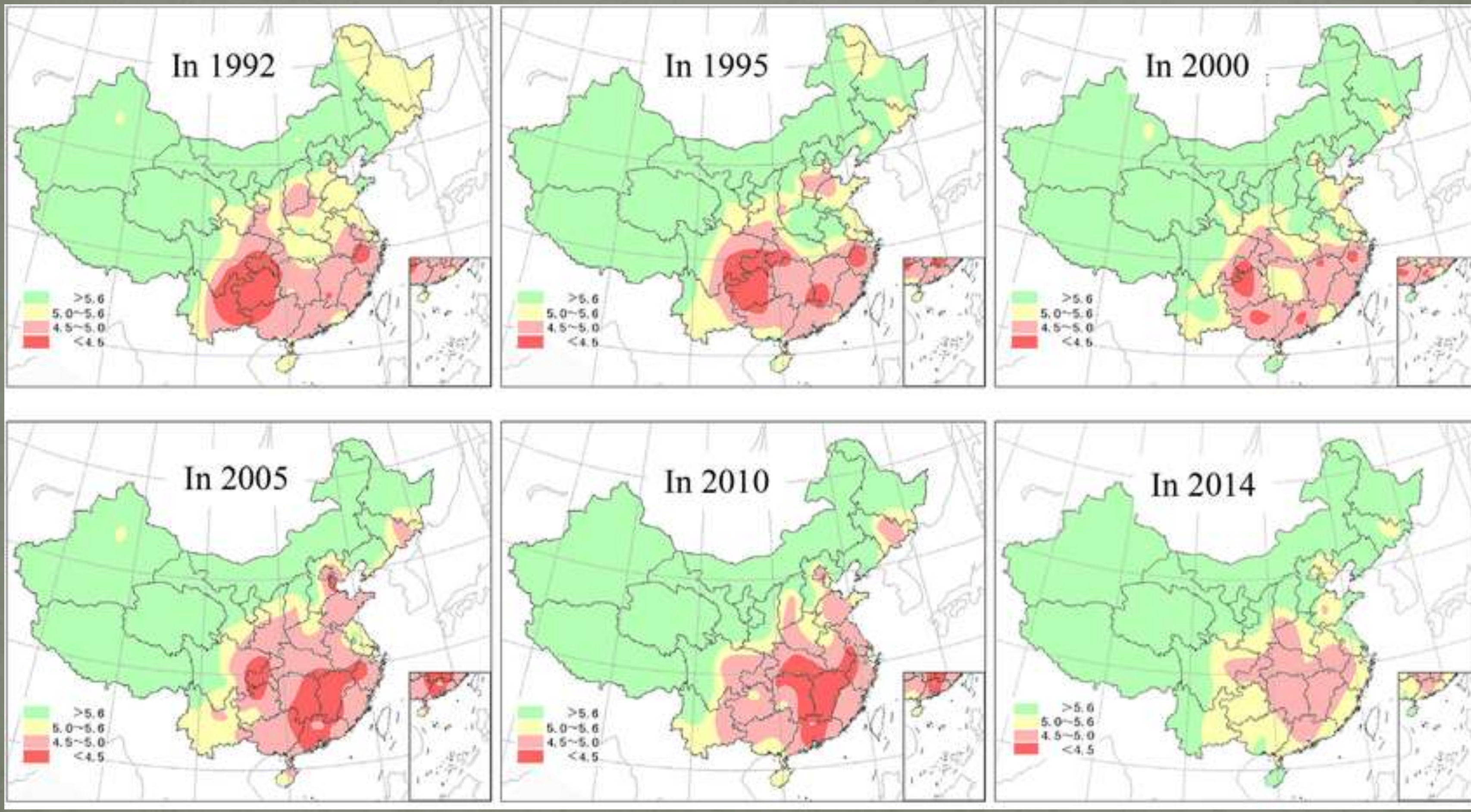
Figure 3. Five-year mean patterns of wet non-sea-salt-sulfate (nssSO$_4^{2-}$) and wet nitrate deposition for the periods 1990-1994 and 1996-2000.

Source: Figures 9 through 12 of Canada - United States Air Quality Agreement: 2002 Progress Report. http://www.epa.gov/airmarkets/progsregs/usca/docs/airus02.pdf, and Jeffries et al. 2003

Acid Rain in Europe



Asia:
Acid rain is a growing problem!



Acid rain → landslide?

Questions

- What was the most important invention of the industrial revolution?
- What was the main energy source after industrial revolution? What were the consequences of its use?
- What are the main roles of the atmosphere?
- What are the differences between sulfurous and photochemical smog?
- What are the global consequences of emission of NO_x?
- How can we reduce this emission?
- Which gases can form acids in the rain?
- What are the effects of acid rain?

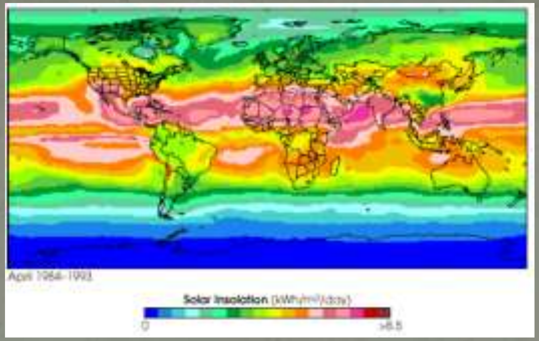
Emission of carbon dioxide and the climate crisis

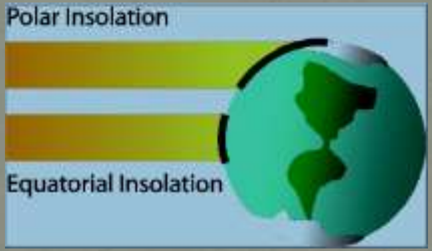
- Weather: describes the short term state of the atmosphere. This includes such conditions as wind, air pressure, precipitation, humidity and temperature.

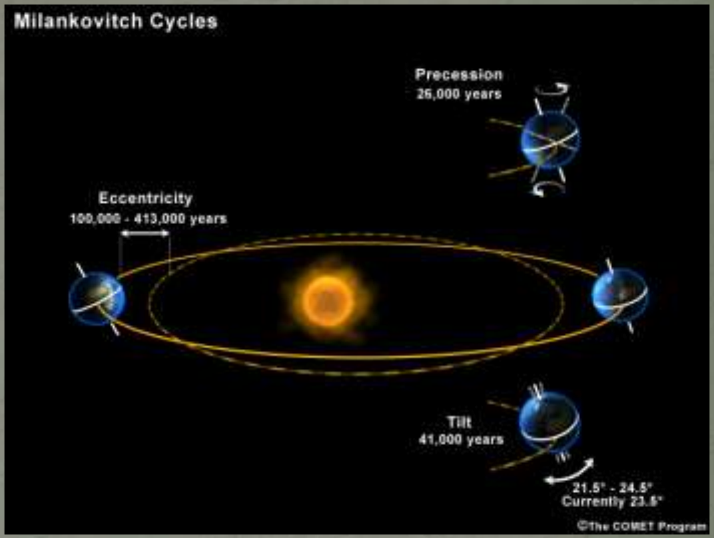
- Climate describes the typical, or average, atmospheric conditions.

What controls the climate?

- Insolation





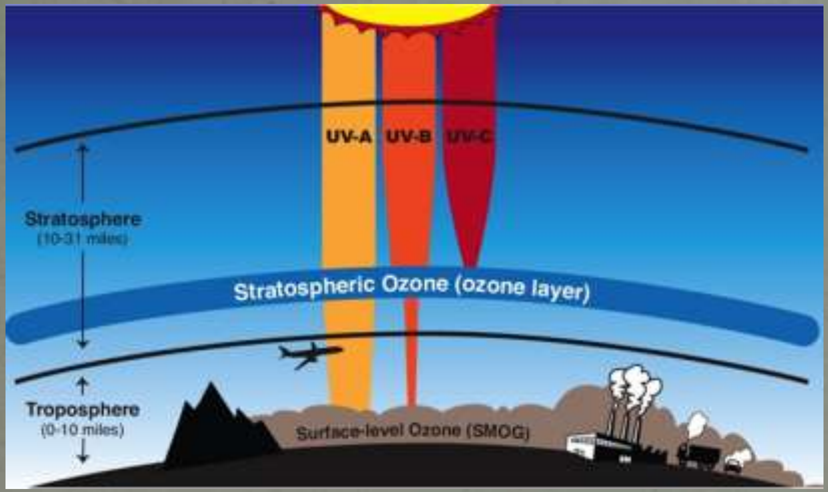


- Albedo

- Greenhouse gases of the atmosphere

The roles of the atmosphere

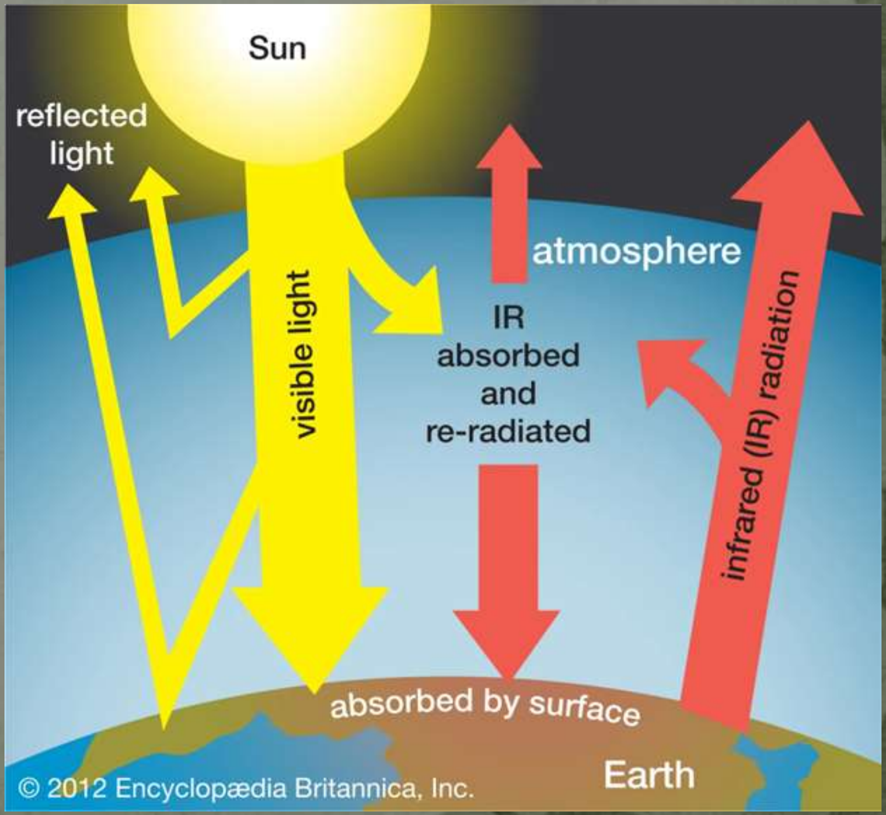
- Ozone layer → Protection from harmful radiation (X-ray, UV)

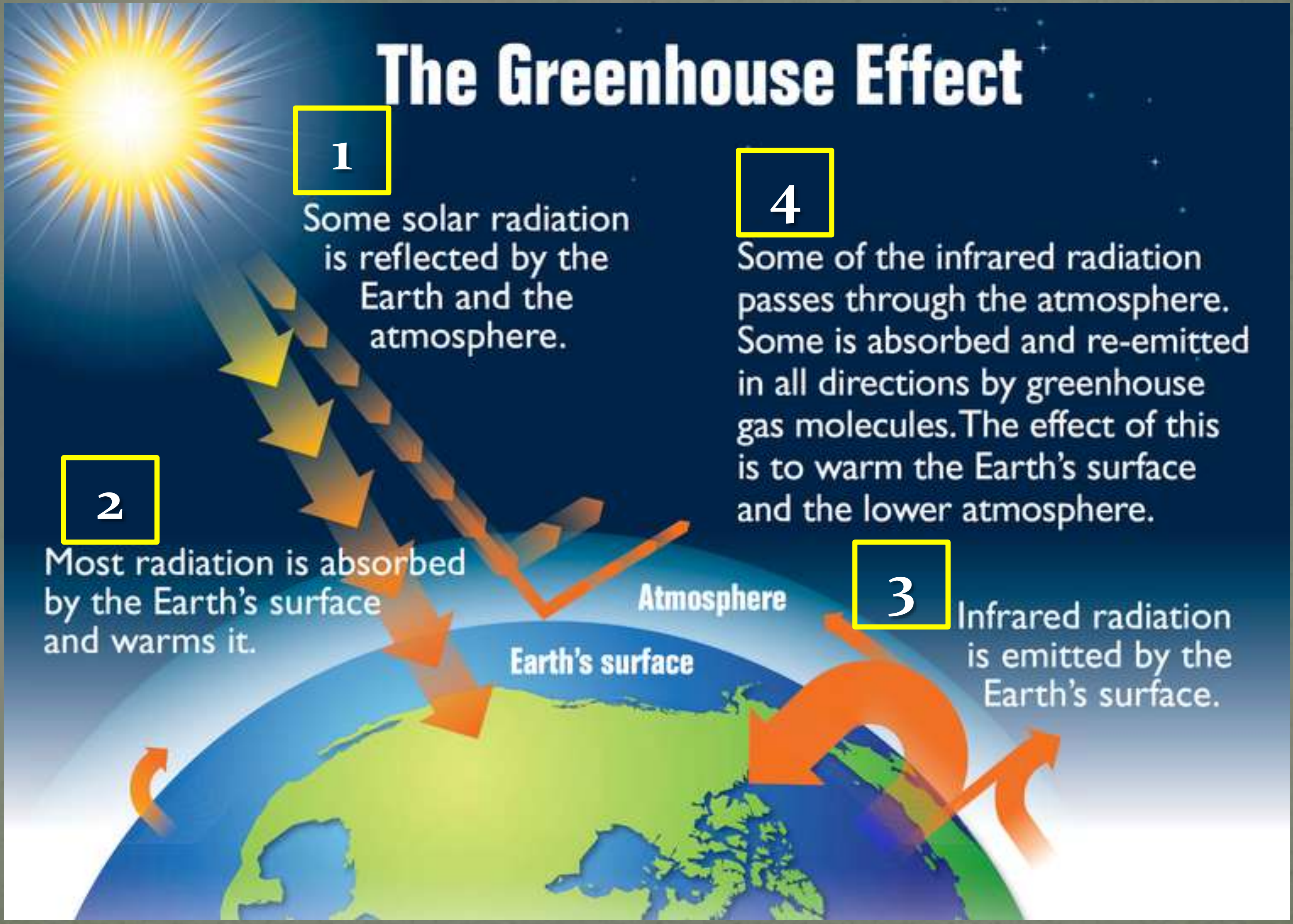


- Greenhouse gases in normal level → Advantageous greenhouse effect

(It warms the planet to its comfortable average of 15 degrees Celsius)

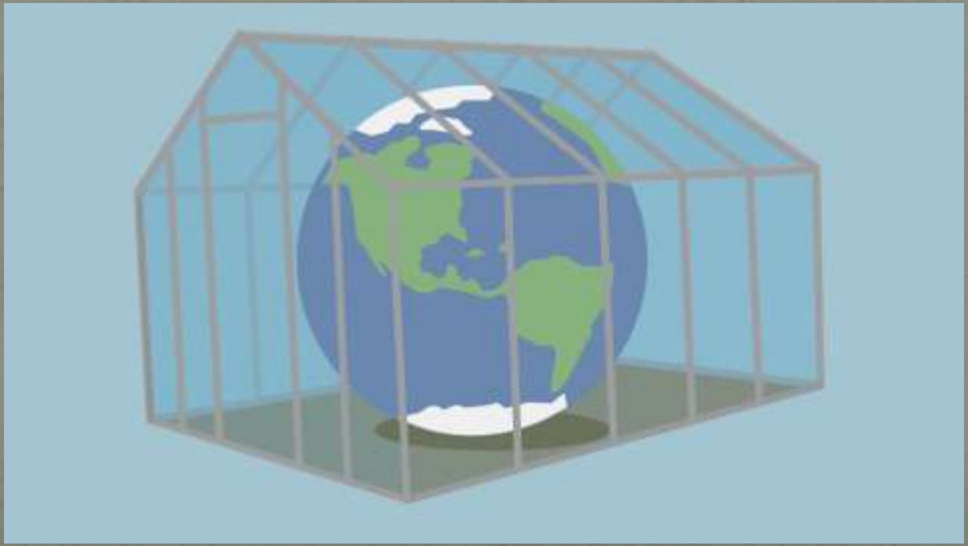
- Oxigen content → Breathing




The Greenhouse Effect
1
Some solar radiation is reflected by the Earth and the atmosphere.
4
Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
2
Most radiation is absorbed by the Earth's surface and warms it.
Atmosphere
3
Infrared radiation is emitted by the Earth's surface.
Earth's surface

Greenhouse Effect

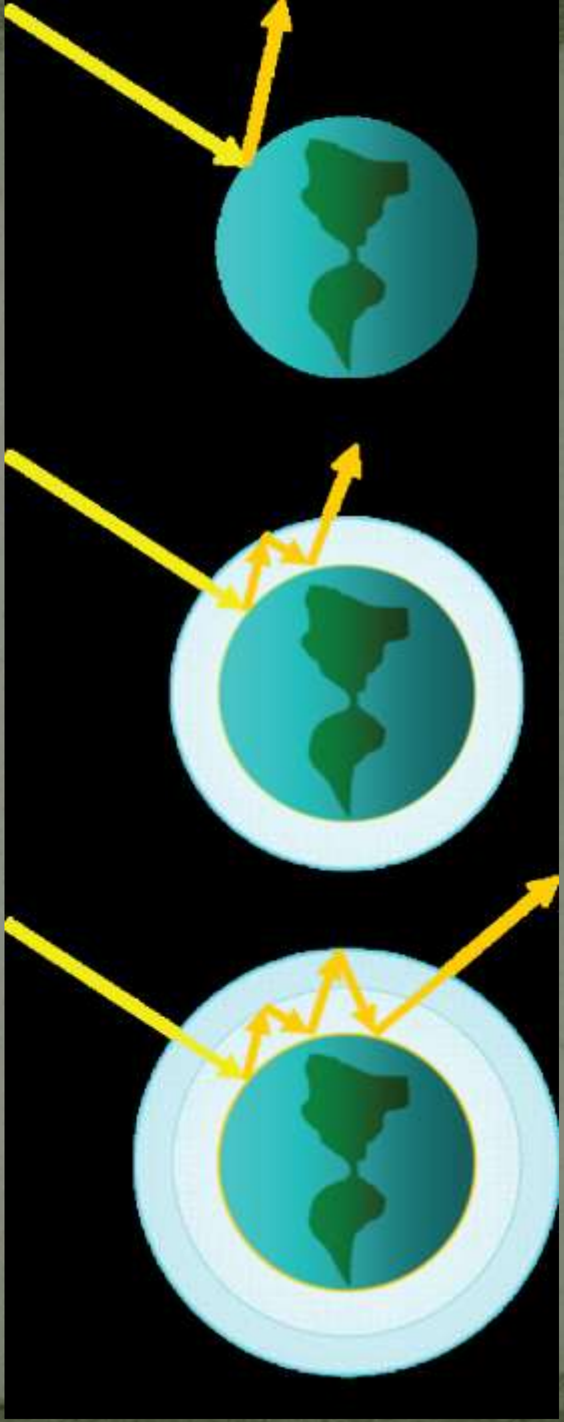
The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat. This process makes Earth much warmer than it would be without an atmosphere. The greenhouse effect is one of the things that makes Earth a comfortable place to live.

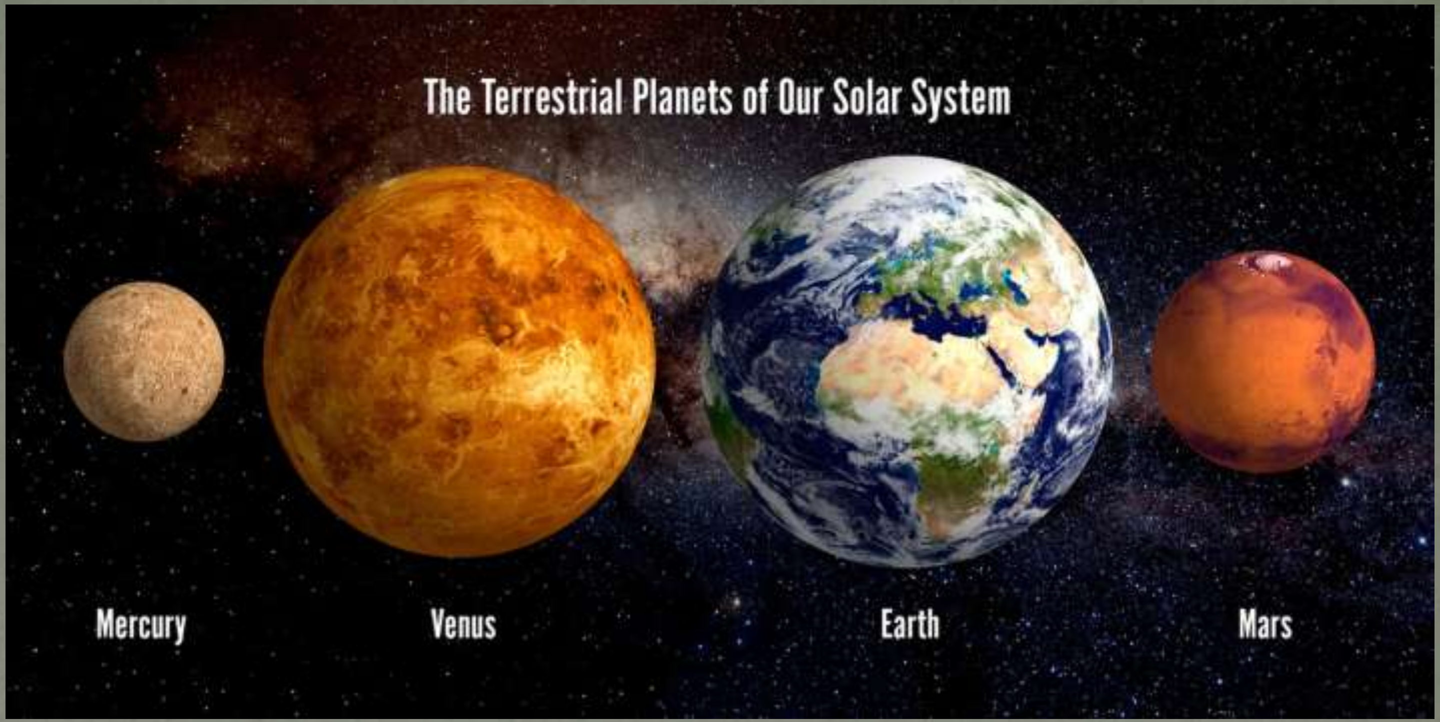


(Top) Visible light radiation emitted by the sun (yellow arrows) strikes the Earth and reflects as infrared radiation (orange arrow)

(middle) an atmosphere reflects some of the infrared radiation back towardthe planet

(bottom) a thickened atmosphere reflects greater amounts of infrared radiation.



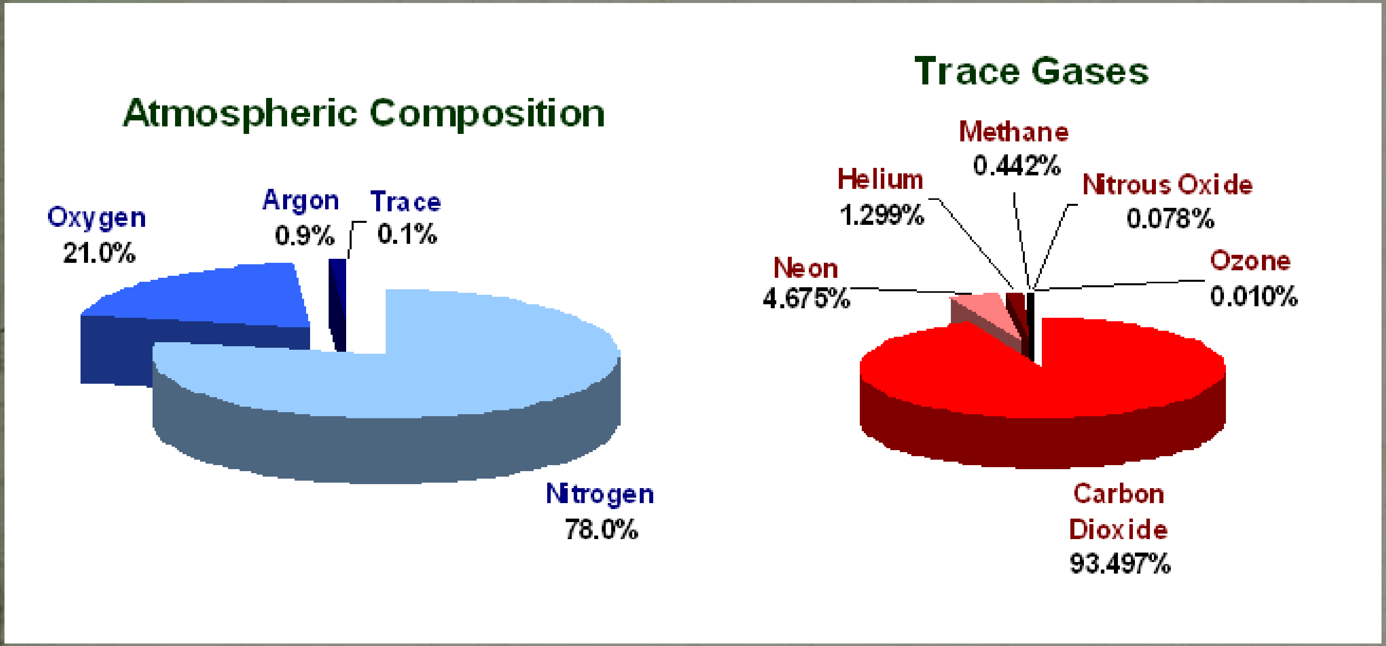


- **Venus ~ 480 °C (large gas content)**
- **Mars: permanent cold (very thin atmosphere)**
- **Earth: ~ 15 °C**

  (without greenhouse gases: -18 °C)

Global problems in the atmosphere

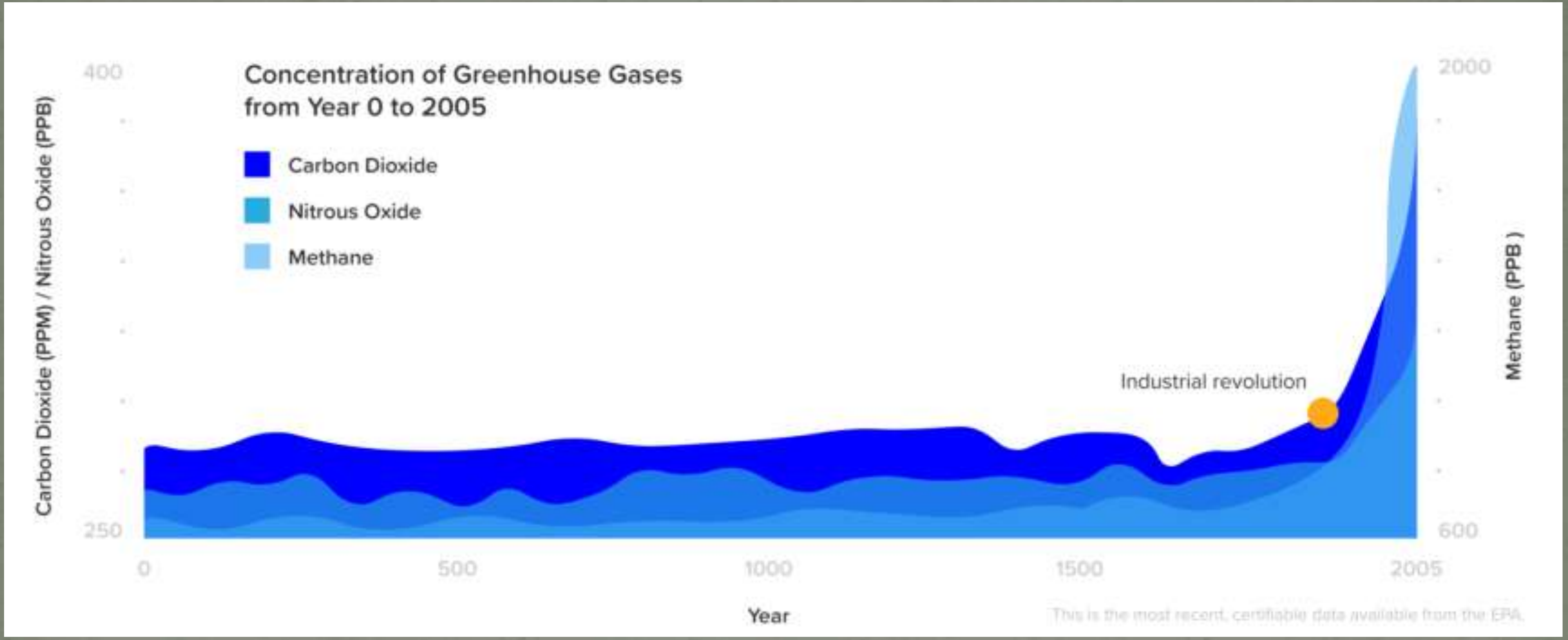
Composition of the atmosphere



Carbon dioxie ↑

- Carbon monoxide ↑
- Oxides of nitrogen ↑
- Halogenated hydrocarbons ↑
- Oxides of sulfur ↑
- Methane ↑

Starting point: Industrial Revolution



Changes of Greenhouse Gases

	CO_2	CH_4	N_2O	CFC-11	CFC-12
Concentration before industrialization	278 ppm	700 ppb	275 ppb	0	0
Current concentration (2022)	>421 ppm	1900 ppb	330 ppb	225 ppt	493 ppt
Efficiency potential	1	25	310	3800	8100
Residence time in the atmosphere (year)	50-200	12	114	45	100

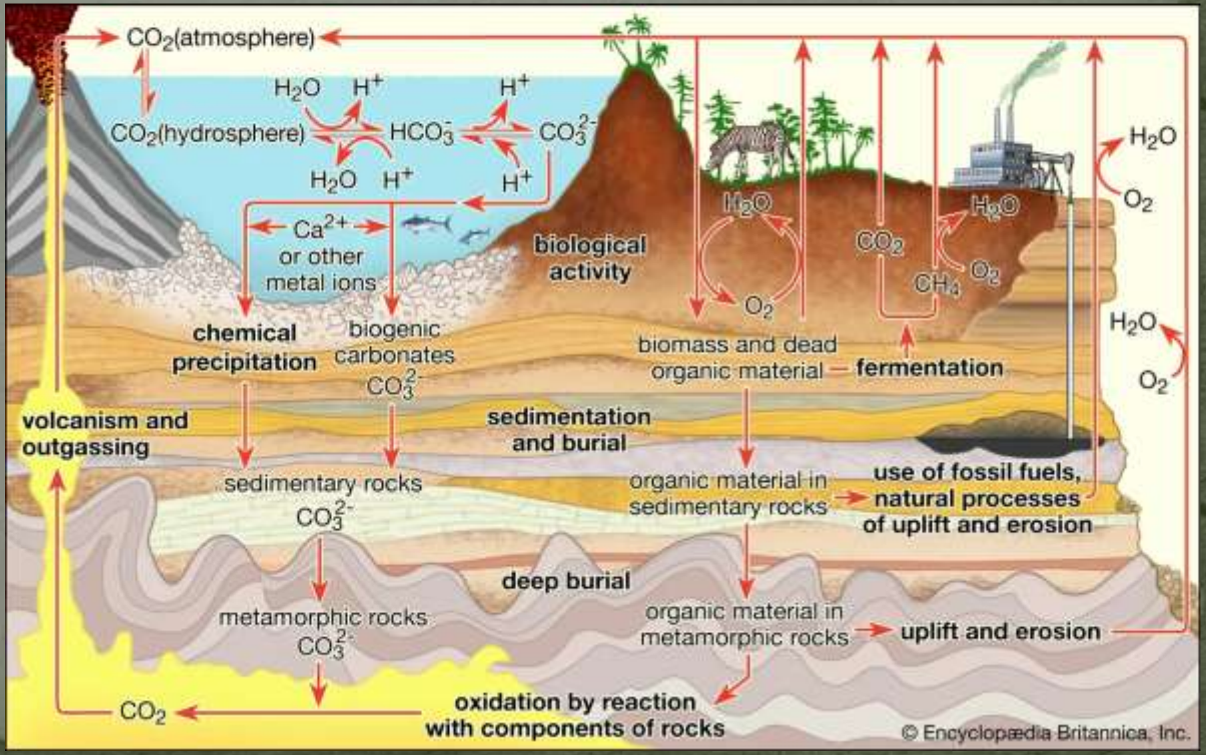
1 ppm = 1000 ppb = 1.000.000 ppt

Greenhouse Gases: Water vapor

- It has a most significant effect (13 trillion tons!)
- Human influence the amount of vapor isn't significant, but we're trying to change it:
  - Transformation of Earth's surface and vegetation
  - Irrigation
  - Decrease of surfaces covered by ice

Greenhouse Gases: carbon dioxide

- Efficiency potential: 1 unit
- Residence time in the atmosphere: 50-200 years!
- Sources:
  - Respiration (natural)
  - Decomposition of organic materials (natural)
  - Human activity (artificial)



Greenhouse Gases: carbon dioxide

- Human activity
  - Burning of fossil fuels (20 billion tons)
  - Burning the forests (4-7 billion tons)
  - Decrease of carbon dioxide fixation because of the missing forests
  - Use of limestone
- Starting point: Industrial Revolution

- Demand for clothing (textile industry)
- Increasing demand in military industry

Discovery of steam engine

Increasing use of hard coal

Machine manufacturing

- Mining
- Metallurgy
- Metalworking

- Agricultural machines
- Vehicles

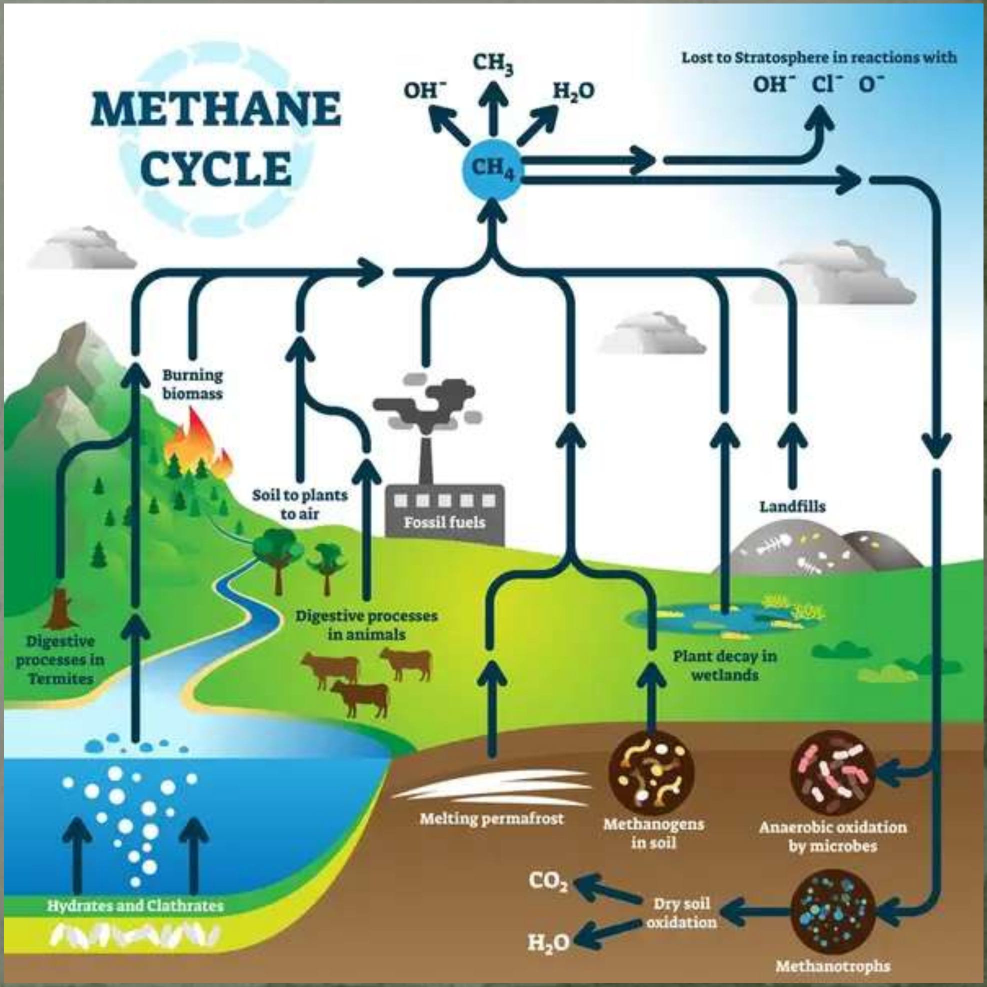
Increasing use of coal after Industrial Revolution

- Major fuel
- Propellant of vehicles
- Raw materials of chemical industry
- Increasing CO_2-emission

STARTING POINT OF GLOBAL AIR POLLUTION

Greenhouse Gases: Methane

- Efficiency potential: 250 unit!
- Residence time in the atmosphere: 12 years
- Sources:
  - Decomposition (natural)
  - Fermentation (natural)
  - Human activities (artificial)



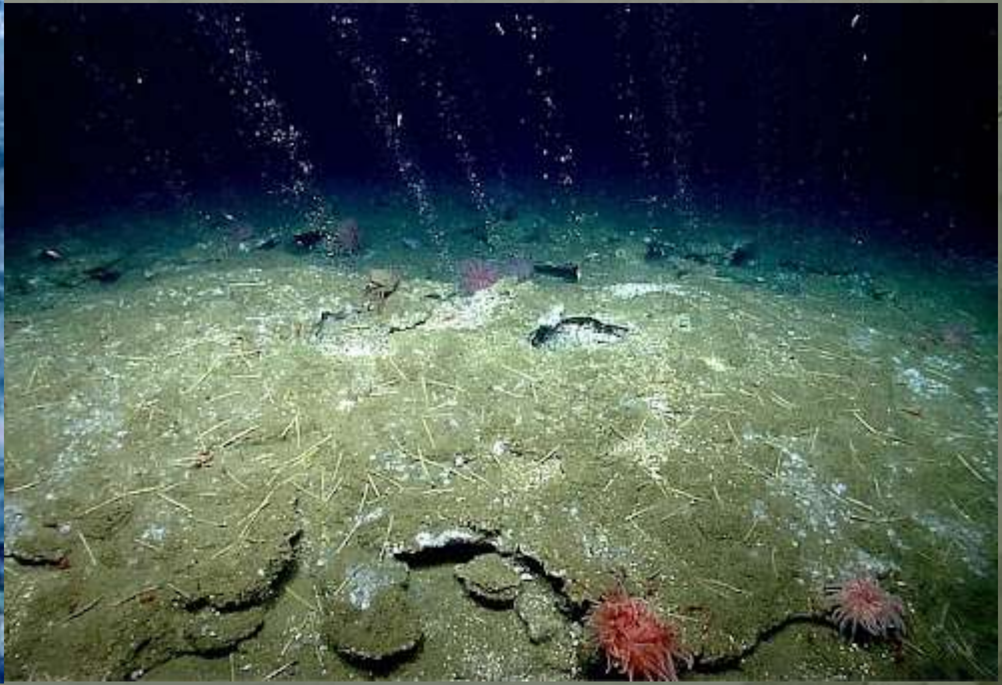
Greenhouse Gases: Methane

- Human activities
  - Rice production
  - Mining
  - Industry
  - Animal husbandry

  (cows 300 litre methane/day)

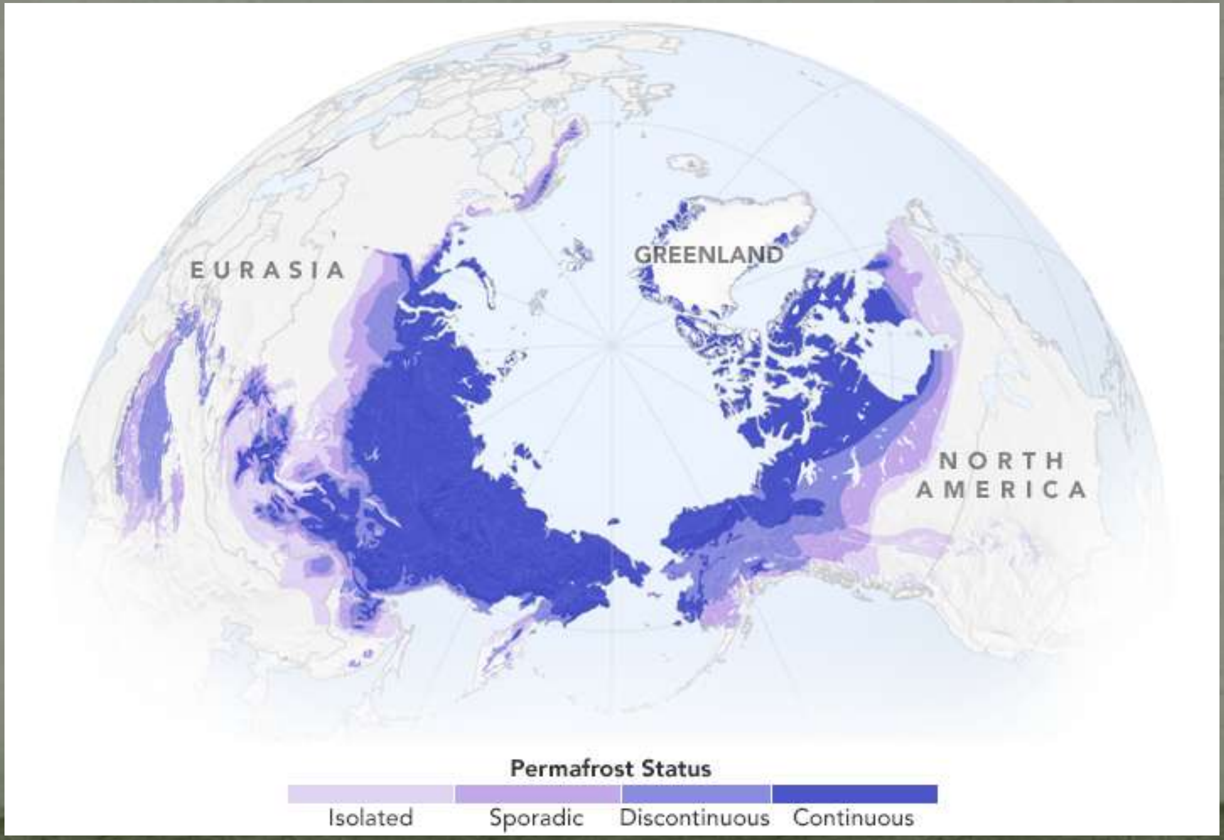
Liberation of methane because of global warming

- From the soil of arctic areas
- From the oceans



Permafrost melting

Permafrost: a thick subsurface layer of soil that remains below freezing point throughout the year, occurring chiefly in polar regions.



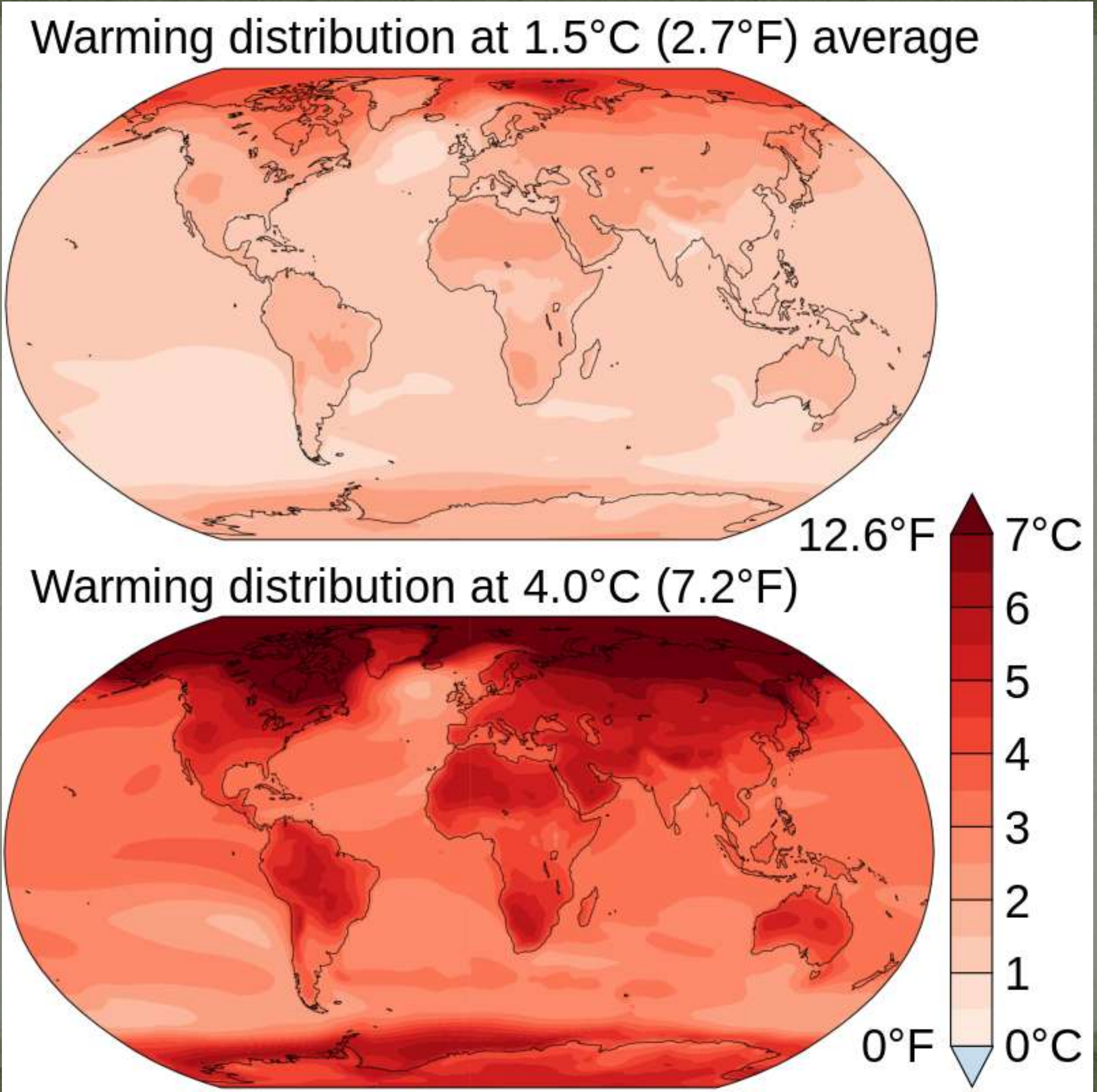
Permafrost melting because of global warming

- „Drunken forests”: Thawing makes trees bend and snap, leading to widespread tree mortality.

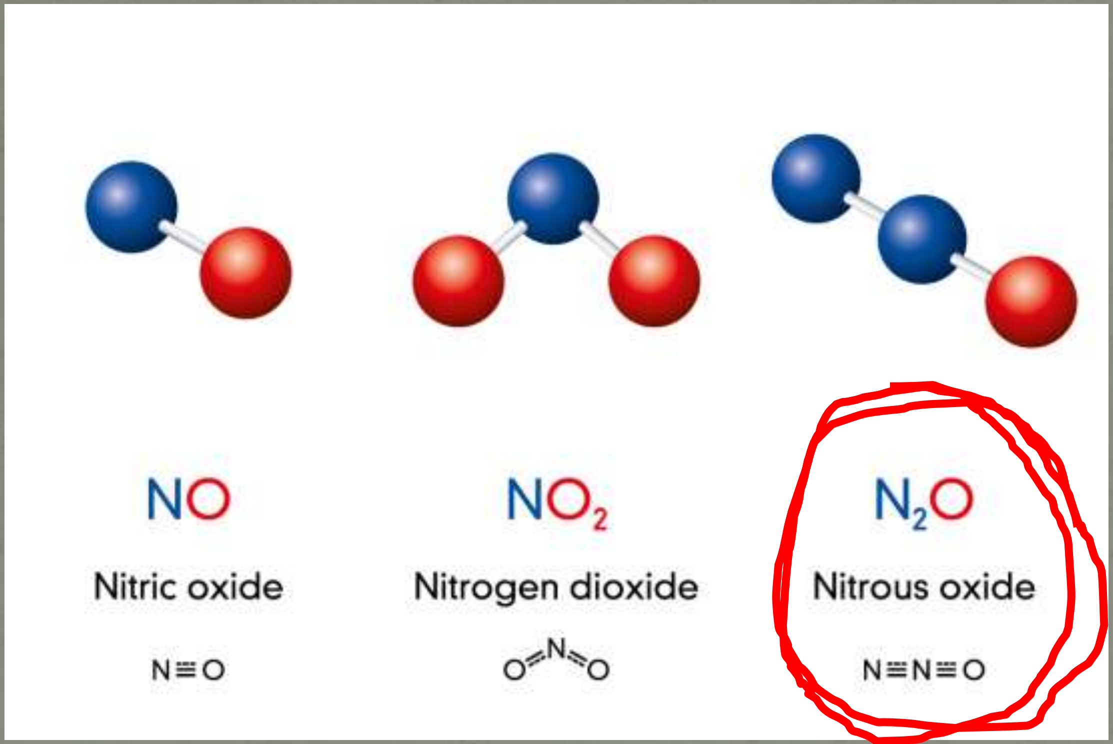
Permafrost melting because of global warming

- **Methane emission** from melted soil:
  - explosions (gas emission craters)
  - thermokarst lakes

- A gas emission crater is recent arctic phenomenon where melting permafrost releases enormous volumes of trapped gas in an explosive event. (wikipedia)


Warming distribution at 1.5°C (2.7°F) average
Warming distribution at 4.0°C (7.2°F)
12.6°F
7°C
6
5
4
3
2
1
0°F
0°C

Greenhouse Gases: nitrous oxide



- Efficiency potential: 310 unit!
- Residence time in the atmosphere: 114 years

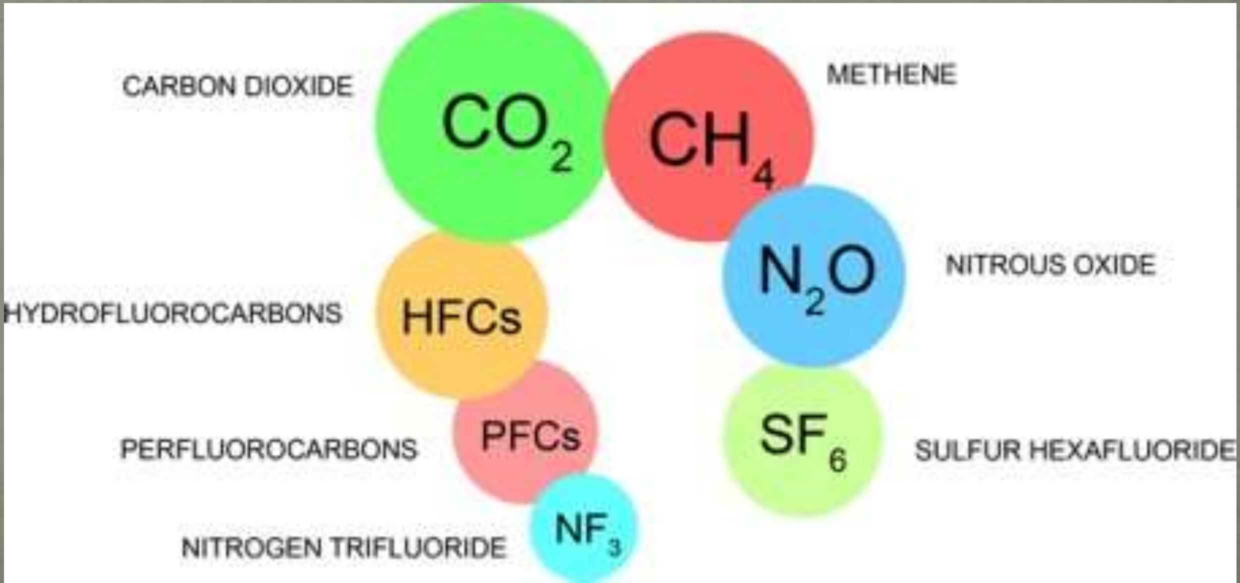
Greenhouse Gases: nitrous oxide

Sources:

- Transport
- Burning of fossil fuels
- Combustion of biomass
- Fertilizers in agriculture

Other greenhouse gases

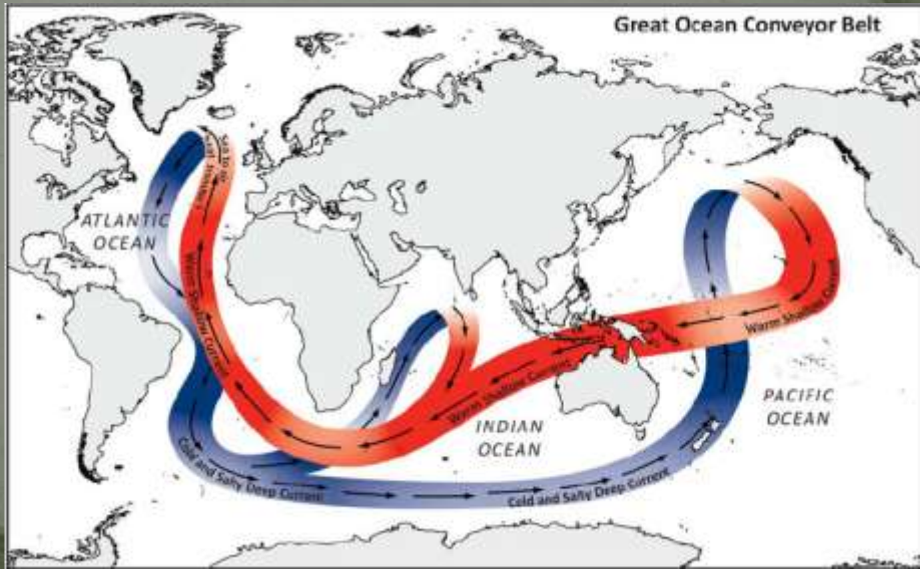
- Halogenated hydrocarbons = CFCs
(e.g. chloro-fluorocarbons, hydrofluorocarbons)
- Sulfur hexafluoride
- Ozone (tropospheric)
- Carbon monoxide



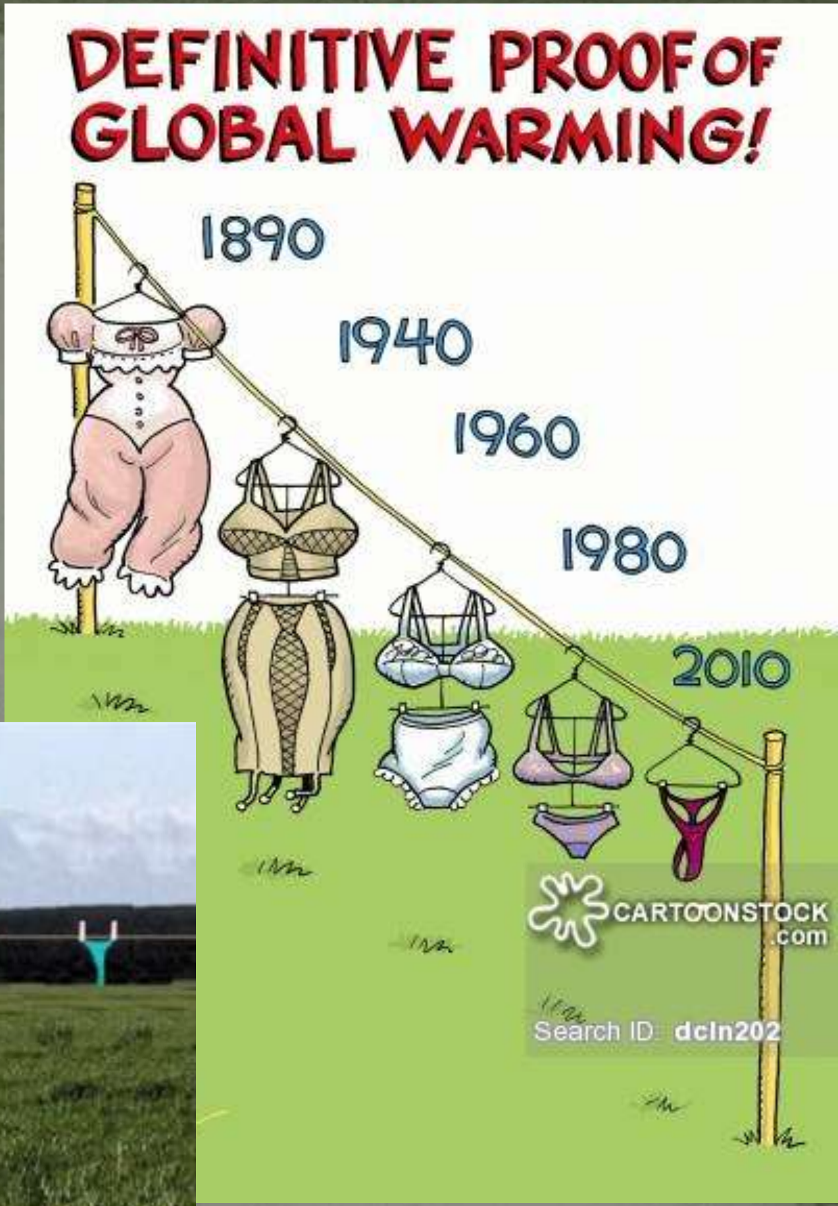
Effects of global warming

- Warming of the atmosphere
- Changes of the surfaces covered by ice
- Desertification
- Extreme weather, more frequent natural disasters
- Weakening of ocean conveyor belt

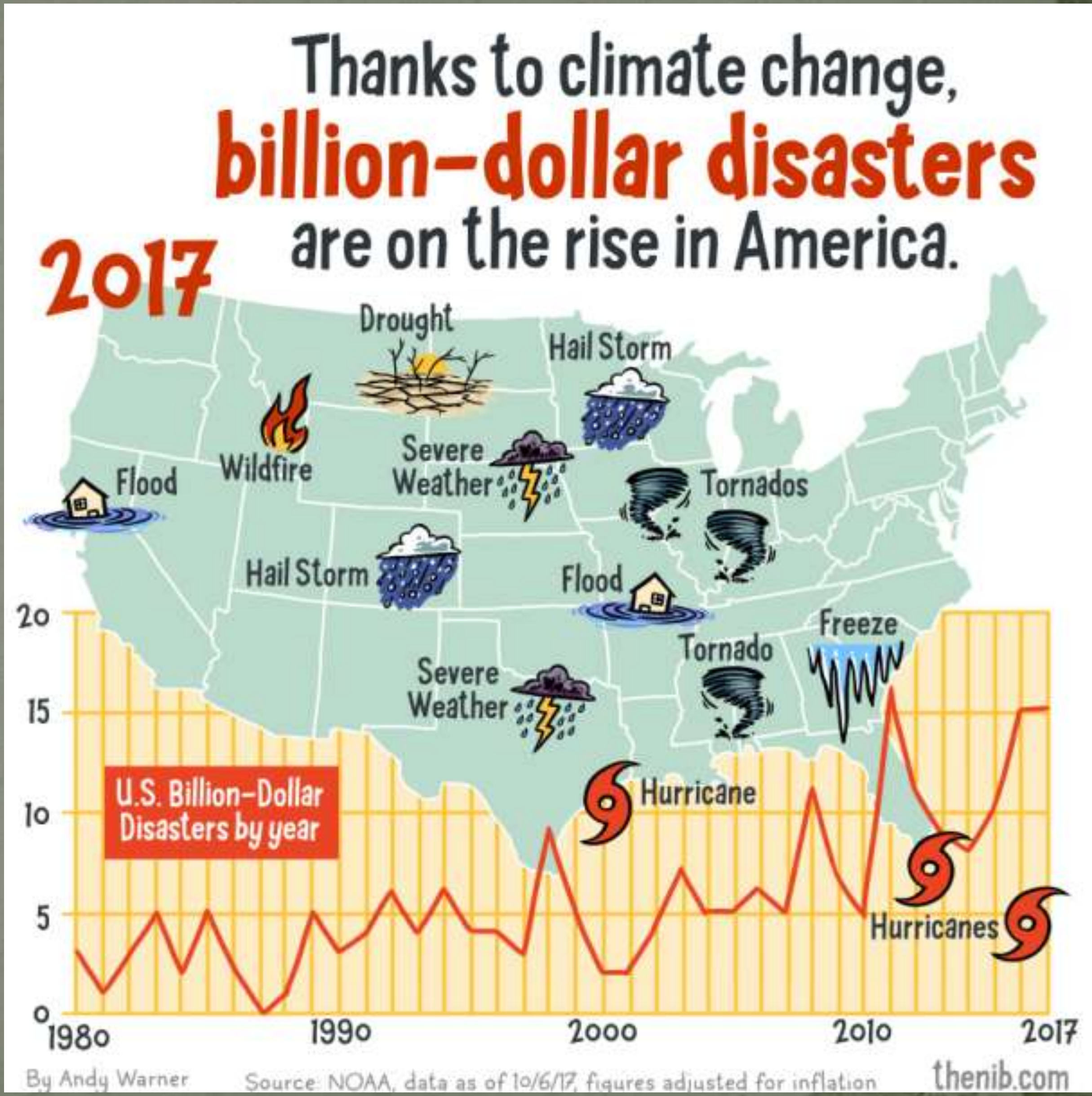
- Climate change



Climate change – is not a joke

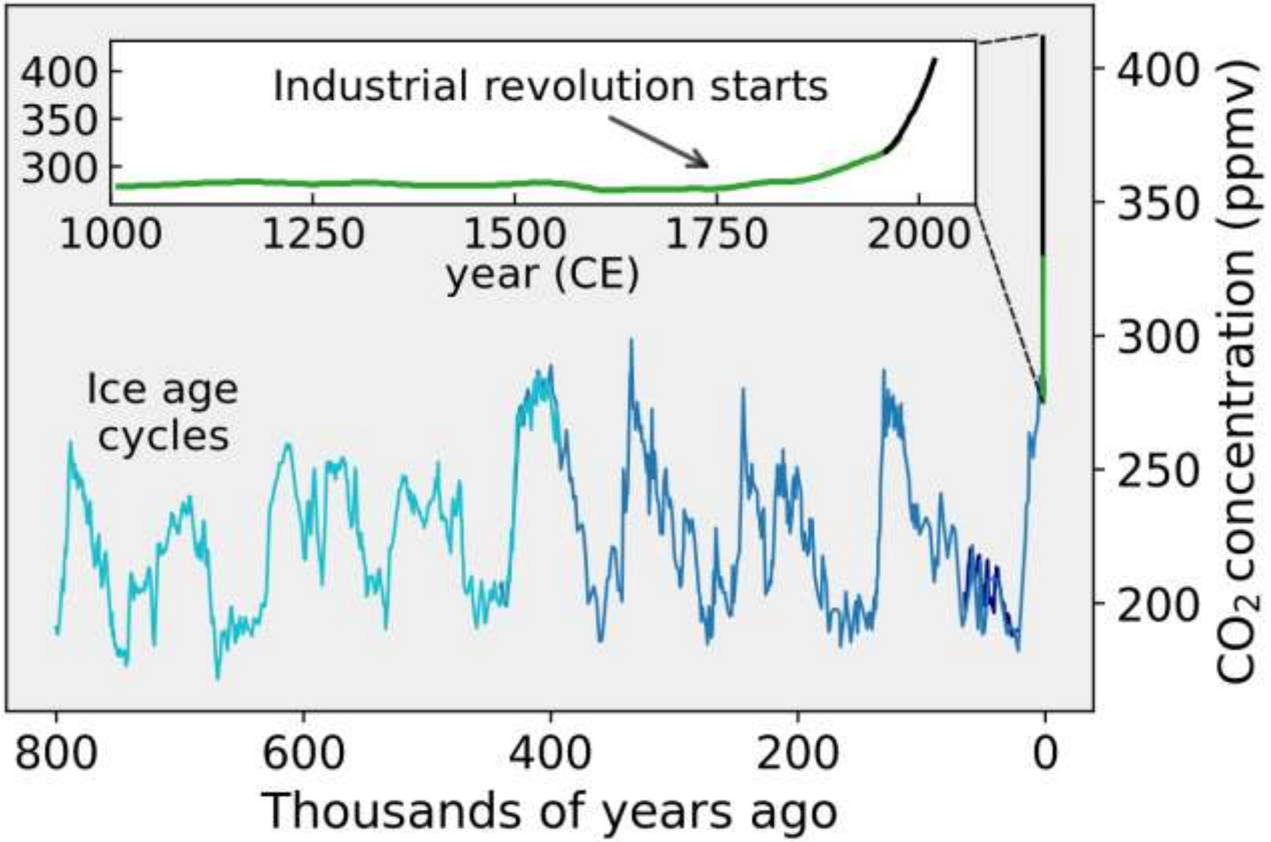


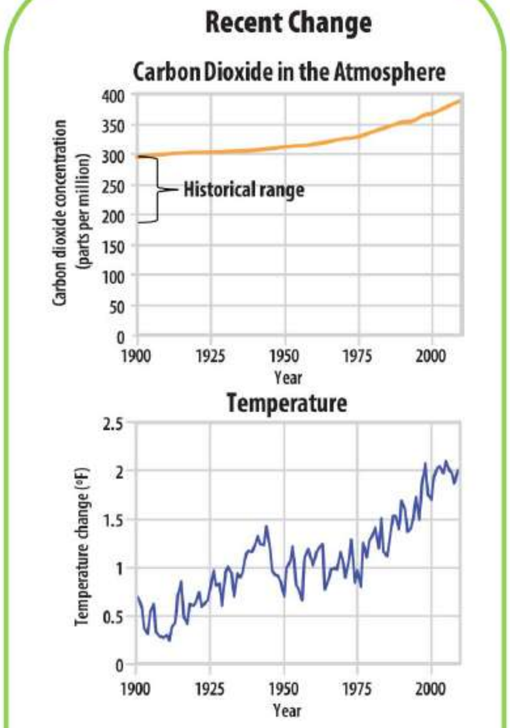
Increasing costs



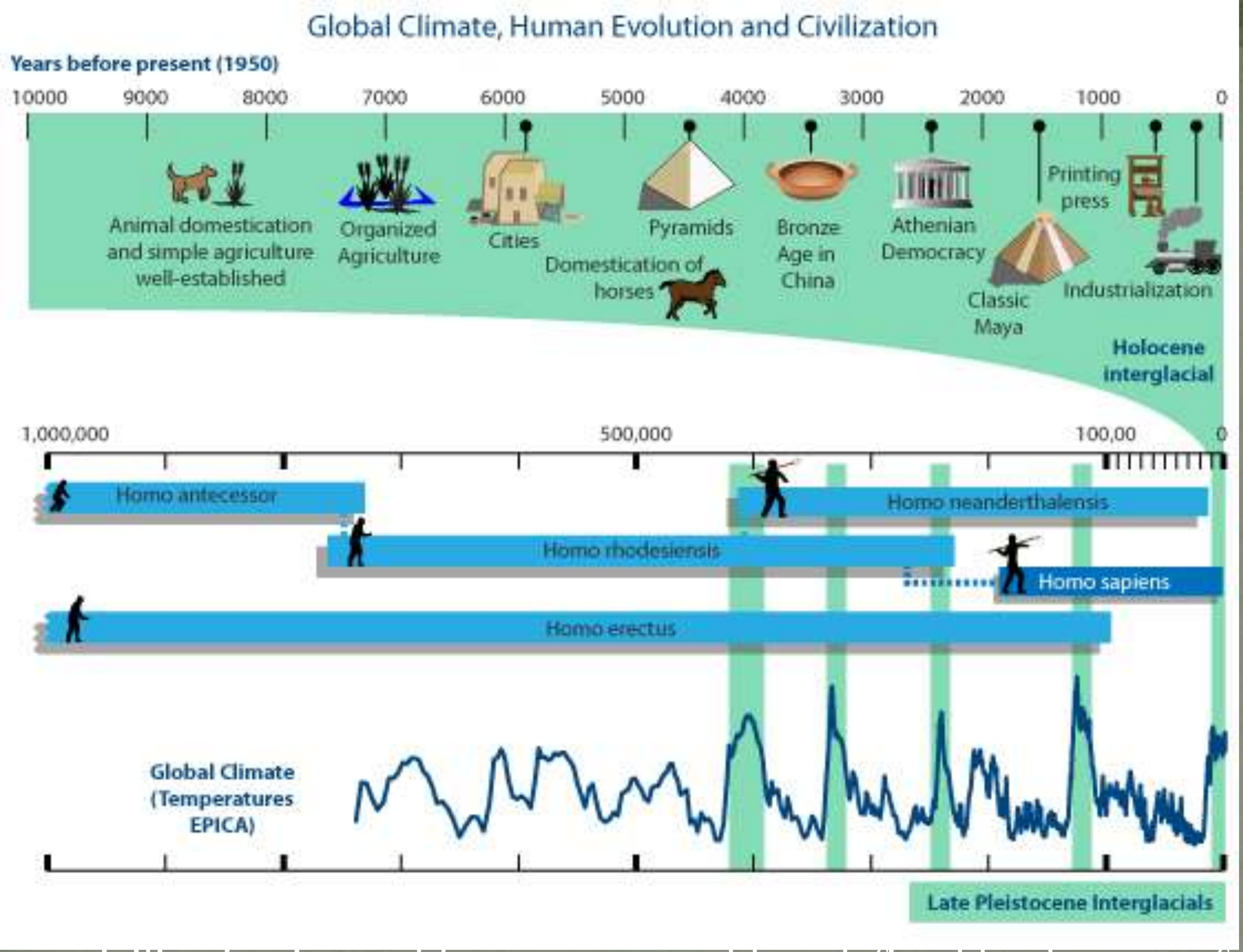
- Ice samples from Antarctica and Greenland > data of concentration of CO_2, CH_4, temperature (ratio of hydrogen/deuterium) let to know the history for 800 000 years!
- Very close relation between level of CO_2, CH_4 and temperature
- In 2022, level of CO_2 reached the 421 ppm!

1.5. ábra. Antarktiszi jégfuratminta a Dome C kutatóállomásról. (Fotó: Laurent Augusti CNRS/LGGE, Grenoble, France)





Source: U.S. EPA. *A Student's Guide to Global Climate Change.* http://www.epa.gov/climatechange/students.

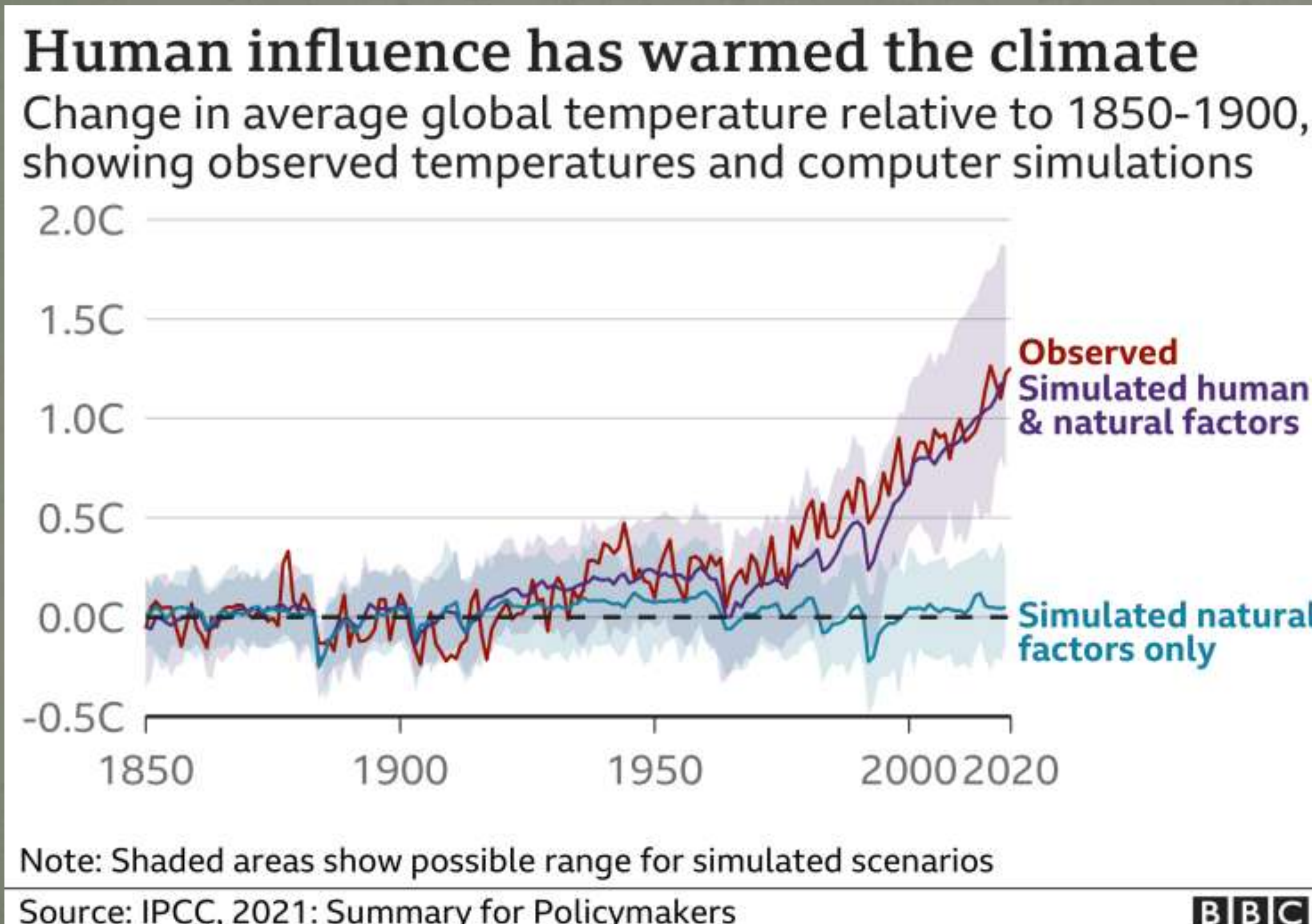


Human civilization is roughly 12,000 years old, as defined by the start of permanent settlements and agriculture.

Agriculture became established as the glaciers retreated from the last ice age.

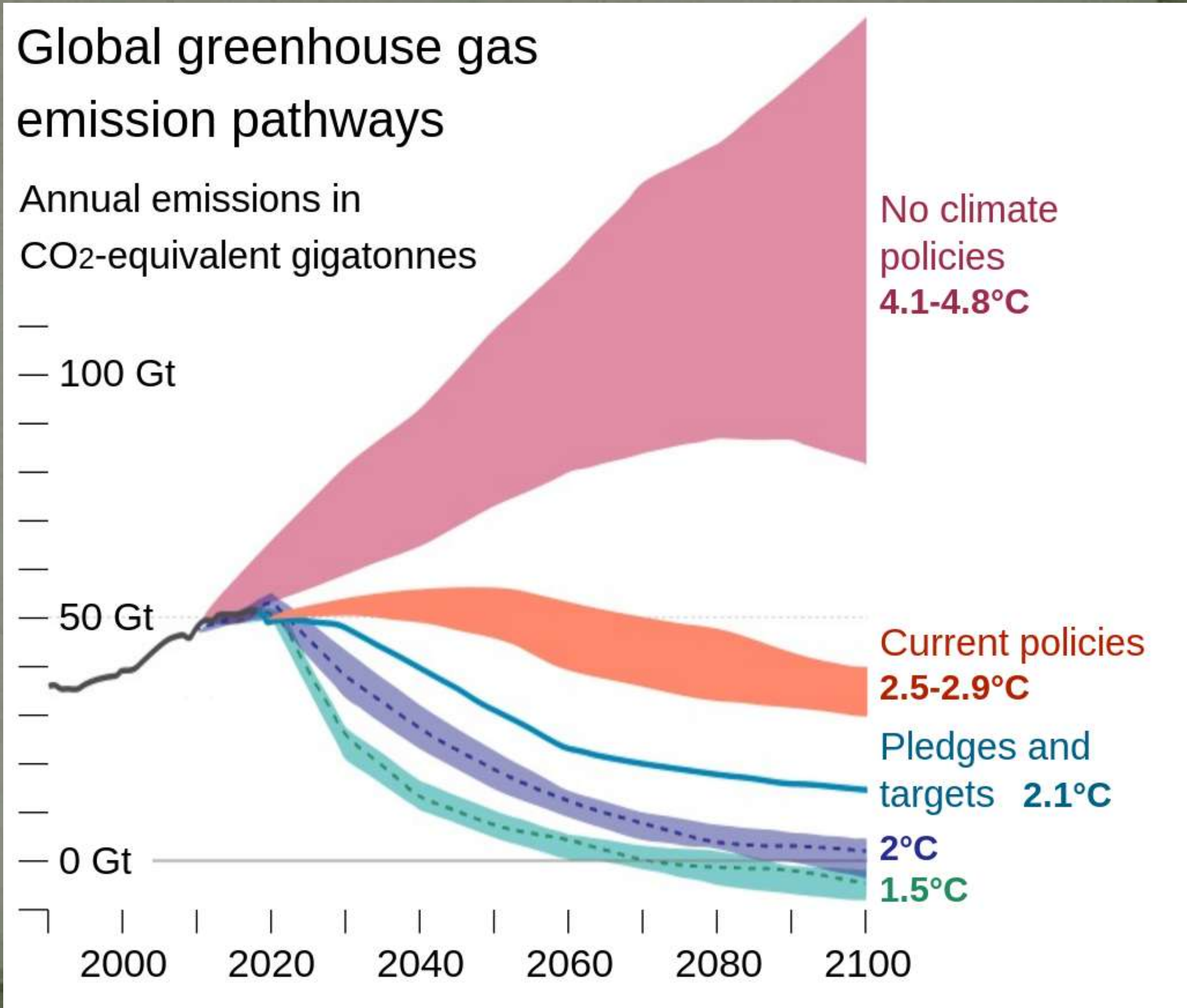
Modern society has developed entirely in our current geological epoch, the Holocene. **Global temperatures haven't varied by more than ±1 °C since**.

1. Warming of the atmosphere



IPCC The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations. Its job is to advance scientific knowledge about climate change caused by human activities

scenarios



1. Warming of the atmosphere

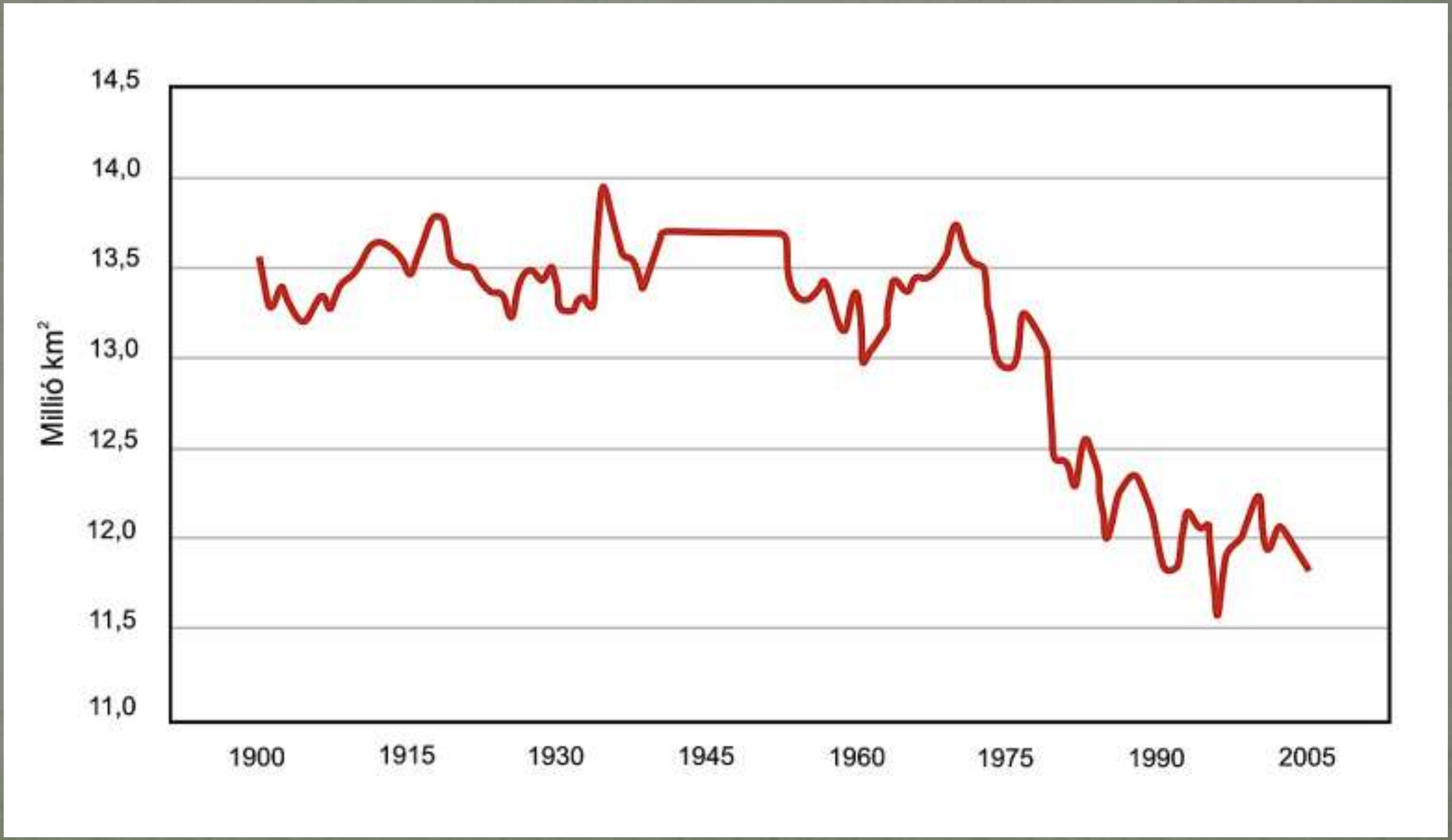
Risks and impacts of global warming are the higher the more the climate warms up.

Change in extreme weather events that cause damage from pre-industrial times 1850–1900

	present +1.1 °C	+1.5 °C	+2 °C	+4 °C
Temperature Temperature of the hottest day in a decade increases (+°C)	+1.2 °C	+1.9 °C	+2.6 °C	+5.1 °C
Drought Drought occurring once in a decade happens **x** times more frequently	2 × more frequent	2.4 ×	3.1 ×	5.1 ×
Precipitation What used to be the wettest day in a decade now occurs **x** times more frequently	1.3 × more frequent	1.5 ×	1.8 ×	2.8 ×
Tropical cyclones Proportion of intense tropical cyclones increases (%)		+10 %	+13 %	+30 %

2. Changes of the surfaces covered by ice

- North Pole



Is Northwest Passage viable?

New York Times, Aug. 19, 2000:
Ages-Old Icecap at North Pole Is Now Liquid, Scientists Find

„The North Pole is melting.
The thick ice that has for ages covered the Arctic Ocean at the pole has turned to water, recent visitors there reported yesterday. At least for the time being, an ice-free patch of ocean about a mile wide has opened at the very top of the world, something that has presumably never before been seen by humans and is more evidence that global warming may be real and already affecting climate.
The last time scientists can be certain the pole was awash in water was more than 50 million years ago.”

New York Times, Aug. 19, 2000:
Ages-Old Icecap at North Pole Is Now Liquid, Scientists Find

"It was totally unexpected," said Dr. James J. McCarthy, an oceanographer, director of the Museum of Comparative Zoology at Harvard University and the co-leader of a group working for the Intergovernmental Panel on Climate Change, which is sponsored by the United Nations. The panel is studying the potential environmental and economic consequences of marked climate change.

Dr. McCarthy was a lecturer on a tourist cruise in the Arctic aboard a Russian icebreaker earlier this month. On a similar cruise six years ago, he recalled, the icebreaker plowed through an icecap six to nine feet thick at the North Pole.

This time, ice was generally so thin that sunlight could penetrate and support concentrations of plankton growing under the ice. Dr. McCarthy said the icebreaker's Russian captain, who has made the voyage 10 times in recent years, said he had never before encountered open water at the pole.

New York Times, Aug. 19, 2000:
Ages-Old Icecap at North Pole Is Now Liquid, Scientists Find

„Another lecturer, Dr. Malcolm C. McKenna, a paleontologist at the American Museum of Natural History, said the ship, the Yamal, crunched through miles of unusually thin ice and intermittent open water on the approach from Spitsbergen, Norway, to the pole. When the ship reached the pole -- which Dr. McKenna and his wife, Priscilla, confirmed with a handheld Global Positioning System navigation device -- water lapped its bow.

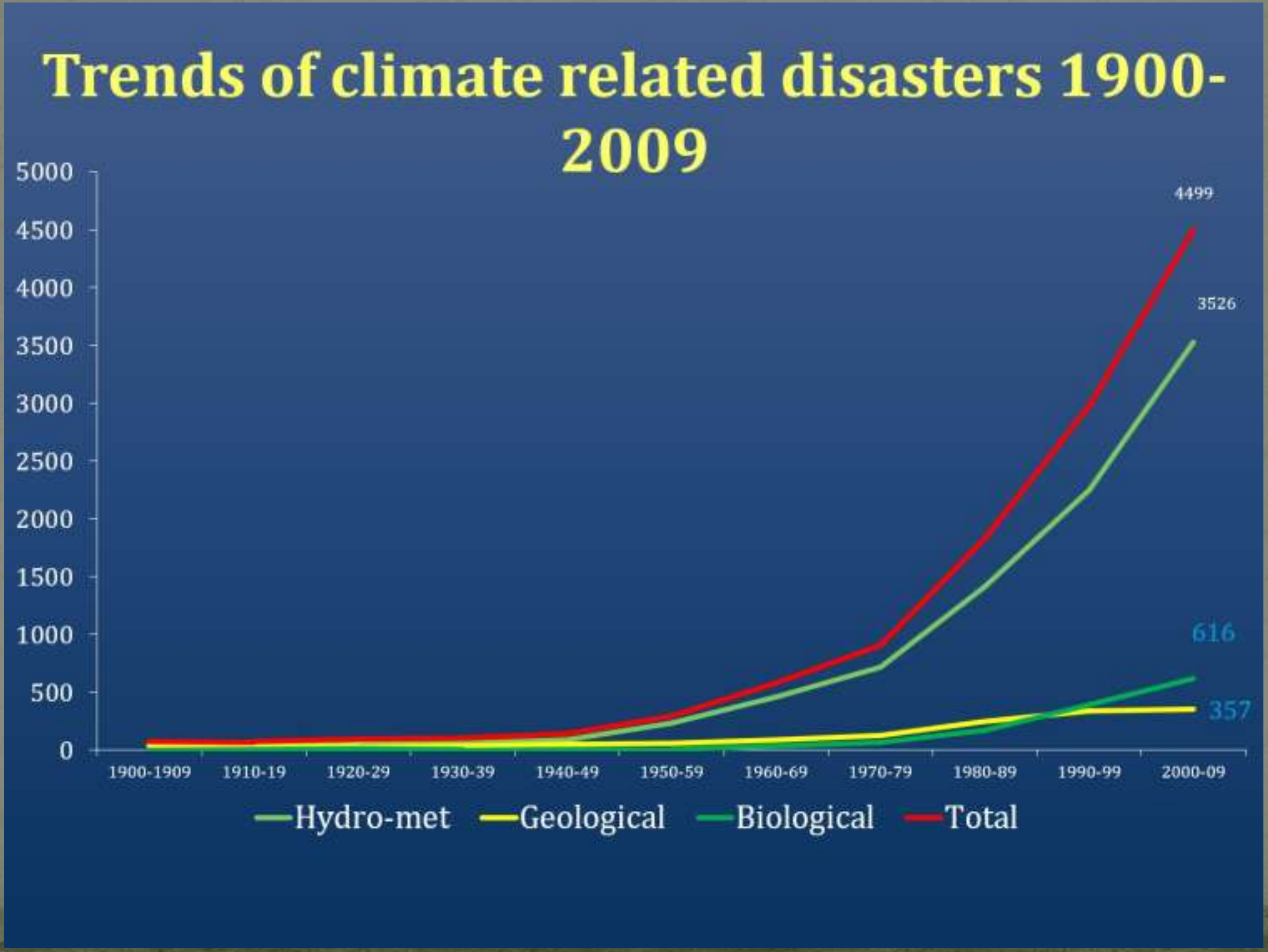
"I don't know if anybody in history ever got to 90 degrees north to be greeted by water, not ice," Dr. McKenna said in an interview. He instantly snapped pictures to document the phenomenon in photographs.

The Yamal eventually had to steam six miles away to find ice thick enough for the 100 passengers to get out and be able to say they had stood on the North Pole, or close to it. They saw ivory gulls flying overhead, the first time ornithologists said they had ever been sighted at the pole."

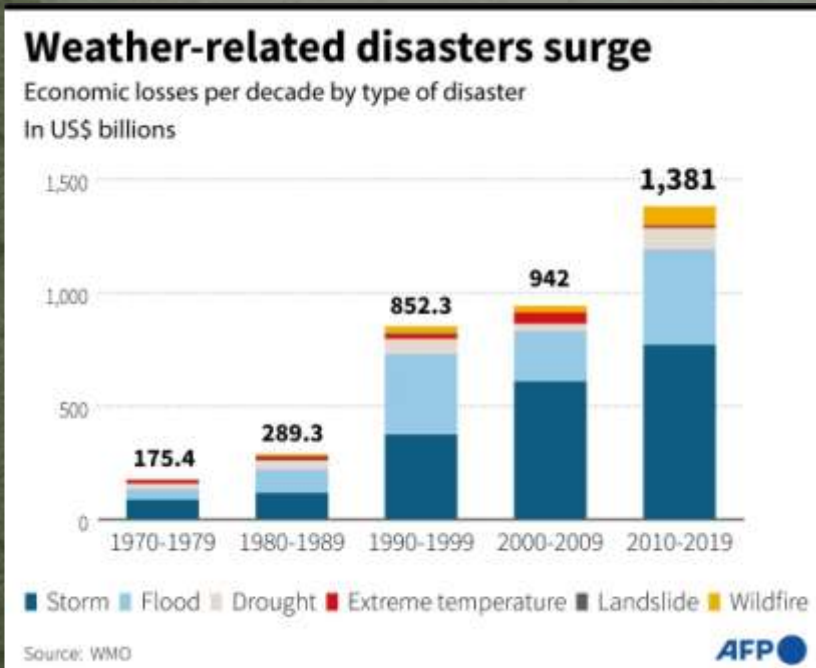
3. Desertification

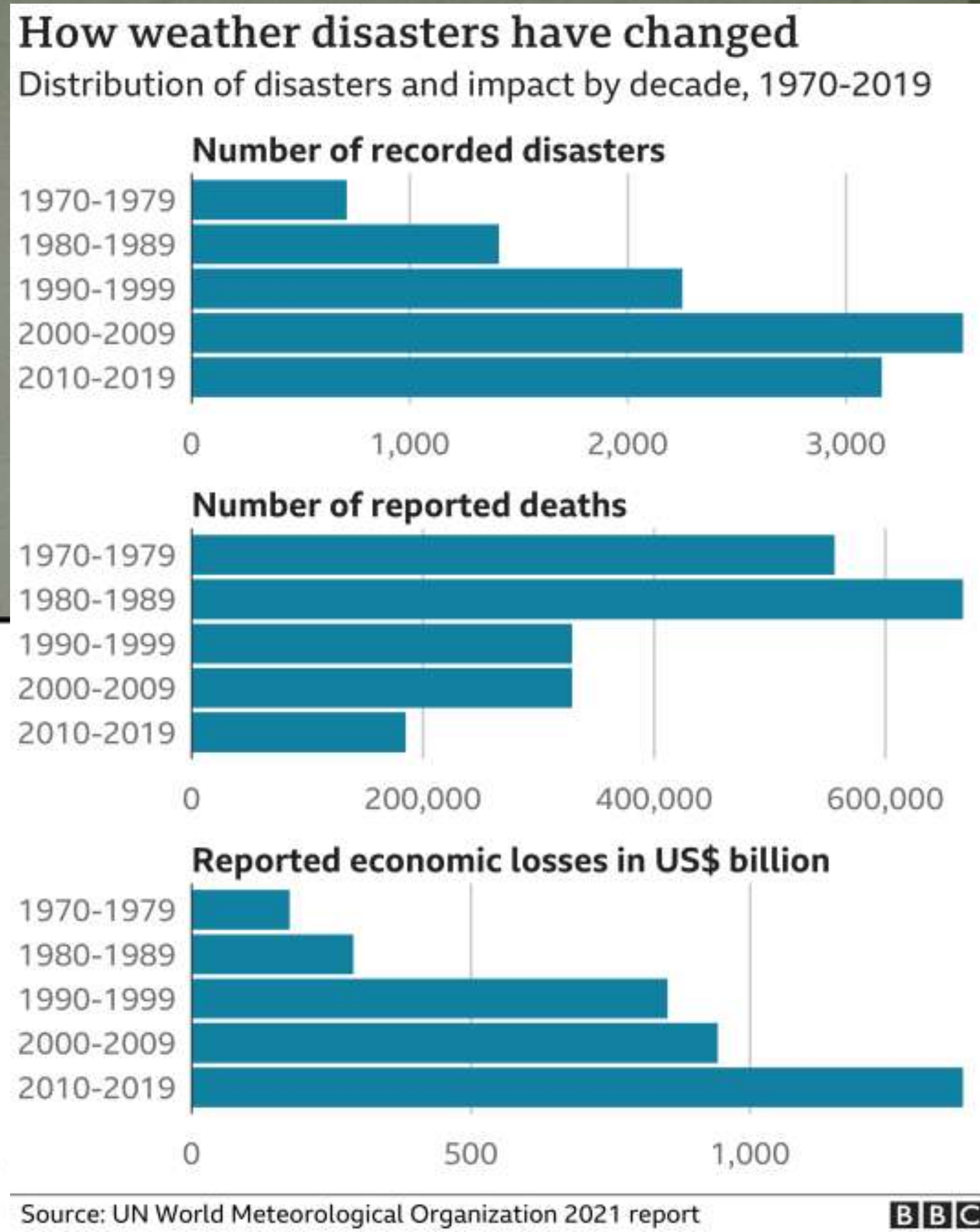
- Less precipitation
- Warming of the atmosphere
- Poor vegetation, ecological instability
- Human activities
  - Growth of population
  - Demand of food ↑
  - Live-stock ↑ (overgrazing)
  - Erosion
  - Deforestation
  - Wars
  - Escalating use of water

4. More frequent natural disasters



4. More frequent natural disasters





Increasing tension in human societies – increase of migration

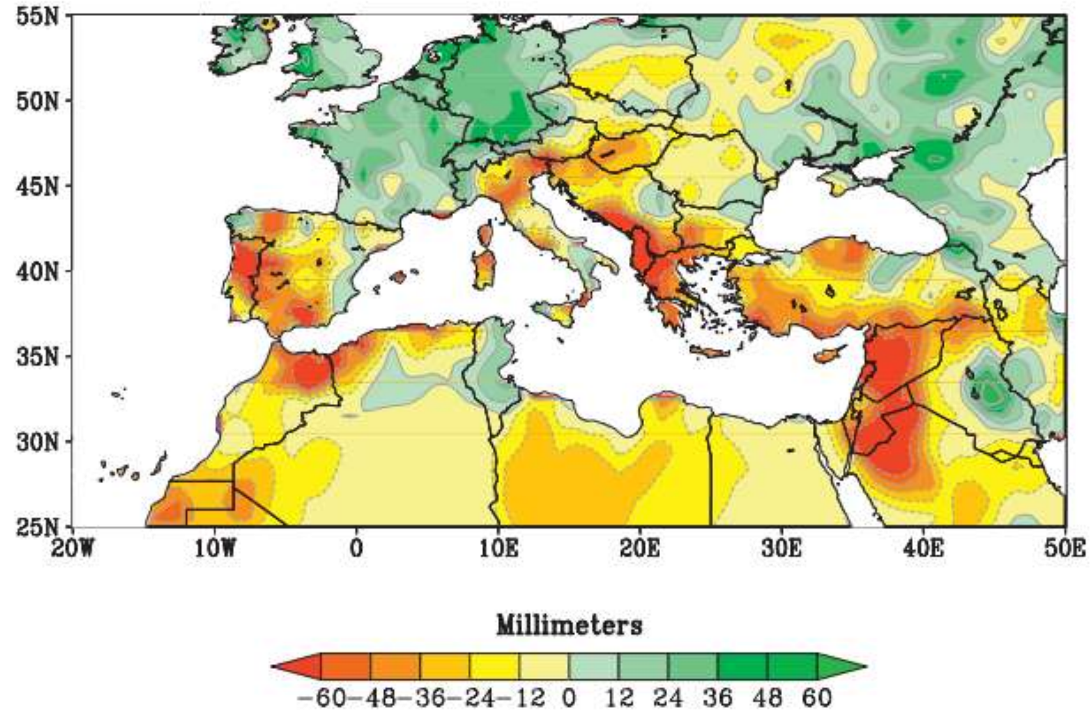
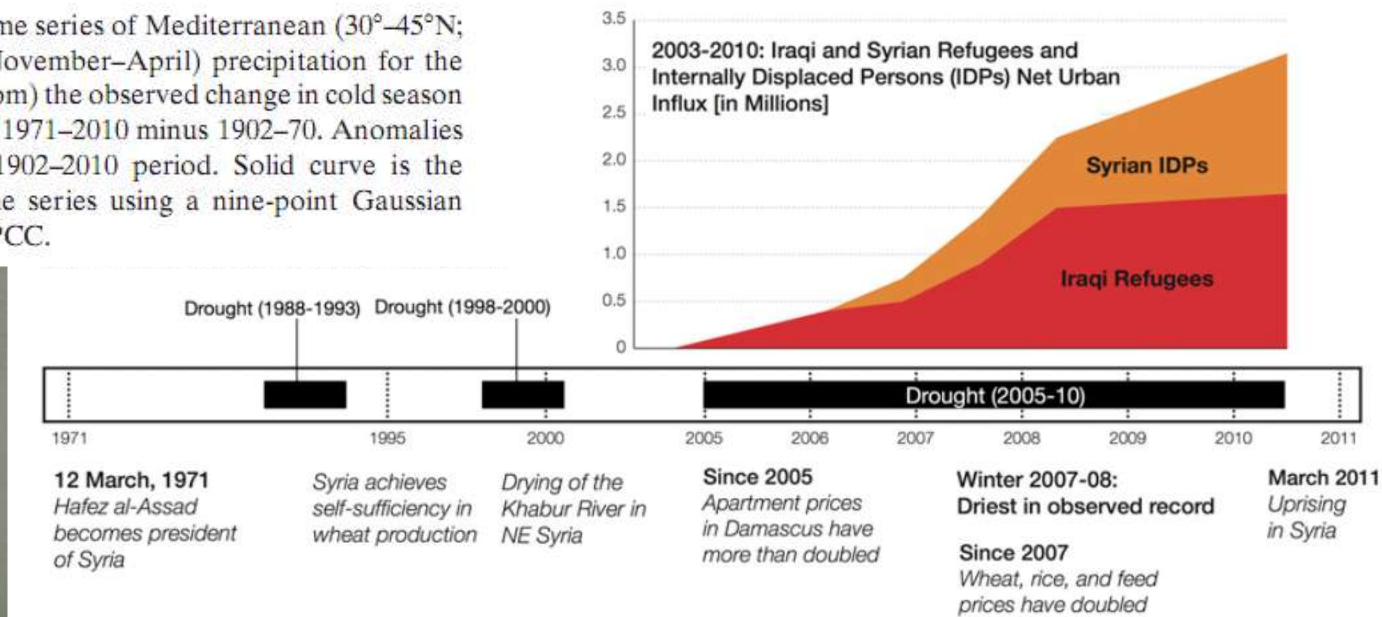


FIG. 1. (top) Observed time series of Mediterranean (30°–45°N; 10°W–40°E) cold season (November–April) precipitation for the period 1902–2010 and (bottom) the observed change in cold season precipitation for the period 1971–2010 minus 1902–70. Anomalies (mm) are relative to the 1902–2010 period. Solid curve is the smoothed precipitation time series using a nine-point Gaussian filter. Data are from the GPCC.



Questions

- What is the consequence of the presence of greenhouse gases?
- What was the starting point of the emission of greenhouse gases?
- What are the main causatives of abnormal greenhouse effect?
- What are the differences between greenhouse gases?
- What are the sources of greenhosue gases?
- What are the effects of global warming?

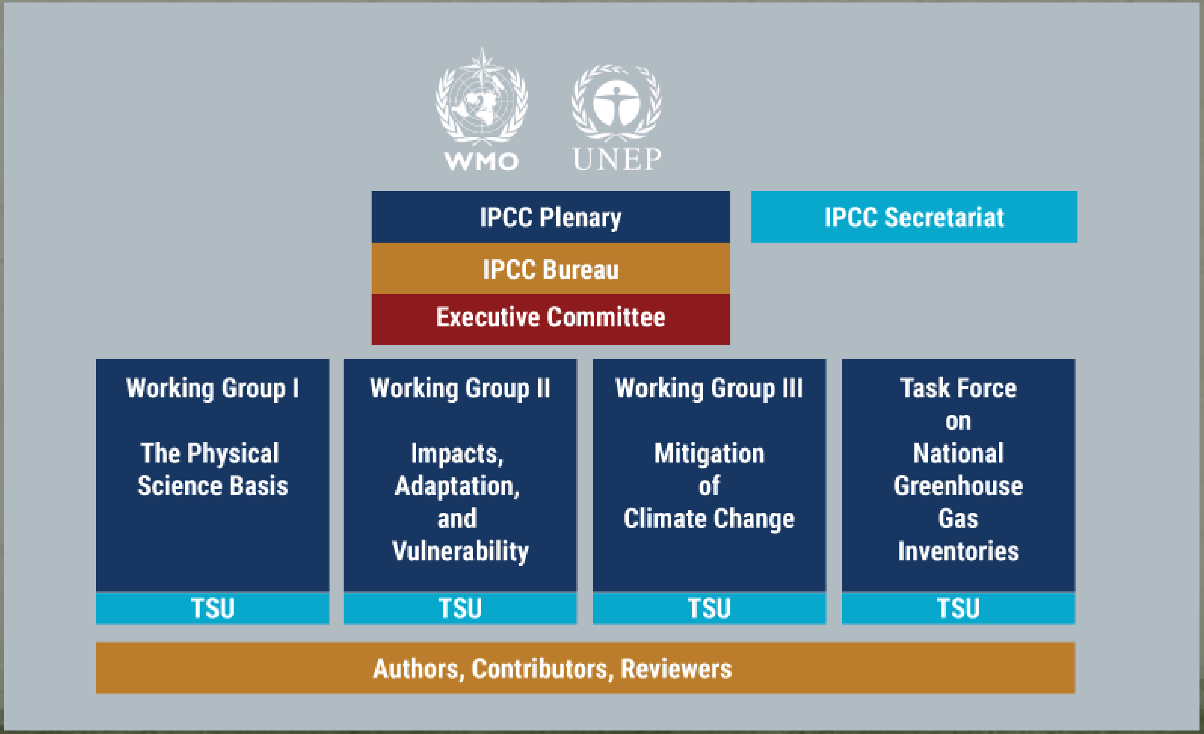
Climate Protection and Renewable Energy Sources

- Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP)
- The IPCC is an organization of governments that are members of the United Nations or WMO. The IPCC currently has 195 members.

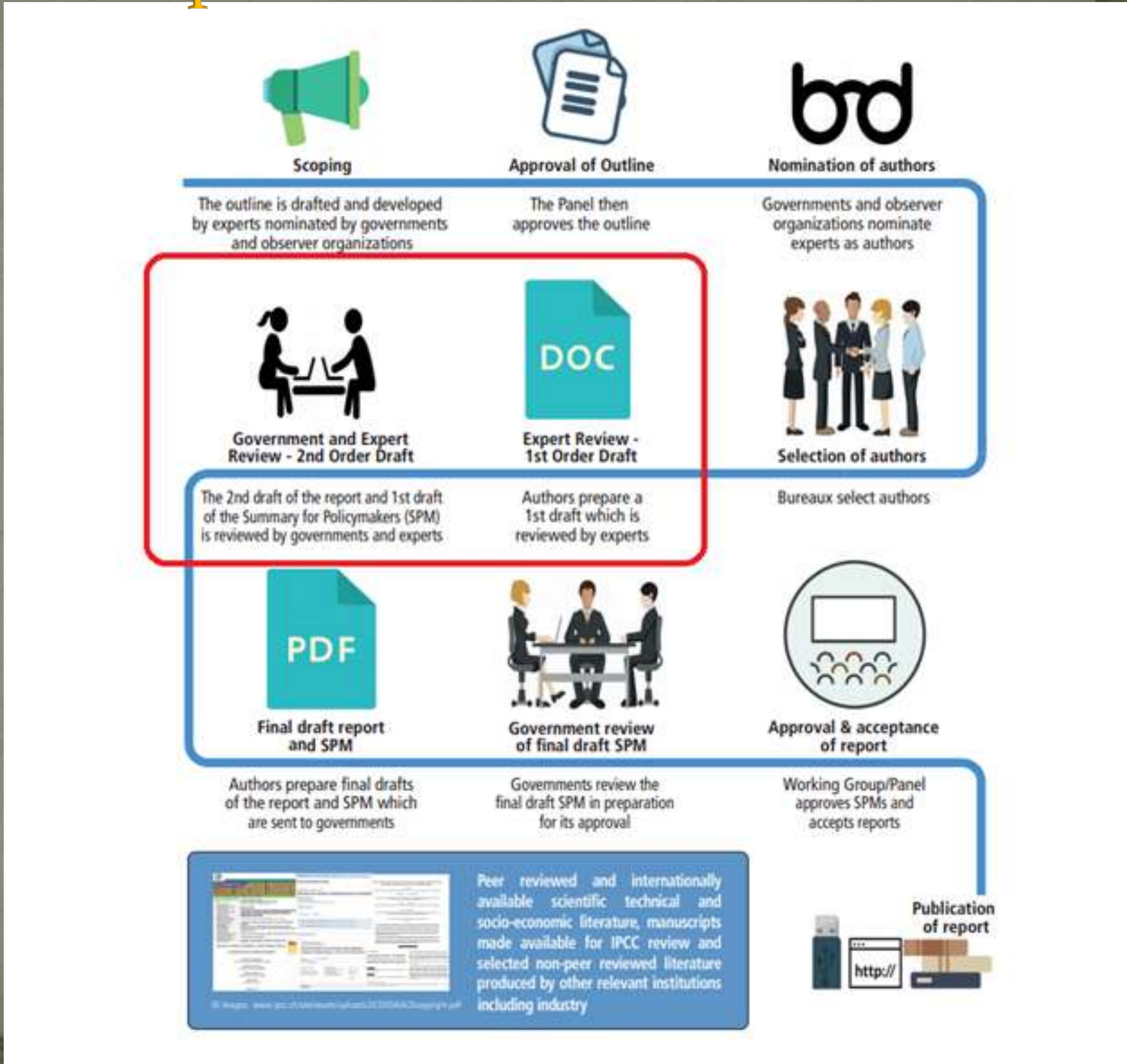
IPCC INTERGOVERNMENTAL PANEL ON climate change WMO UNEP

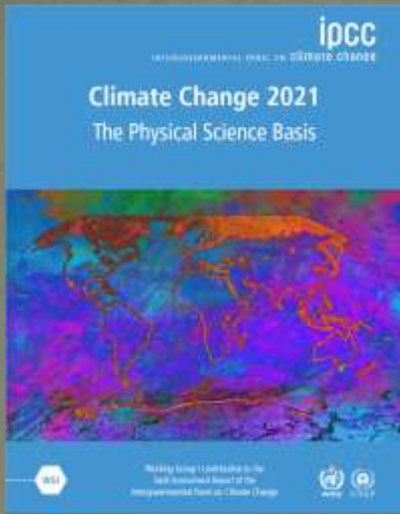
- The objective of the IPCC is …
  - …to provide governments at all levels with scientific information that they can use to develop climate policies.
  - …to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks.

- **Working Groups**
  - Working Group I deals with The Physical Science Basis of Climate Change,
  - Working Group II with Climate Change Impacts, Adaptation and Vulnerability
  - and Working Group III with Mitigation of Climate Change.
- **Task Forces:** The main objective of the Task Force on National Greenhouse Gas Inventories is to develop and refine a methodology for the calculation and reporting of national greenhouse gas emissions and removals.
- **Technical Support Units**
- **Bureau**
- **Panel**



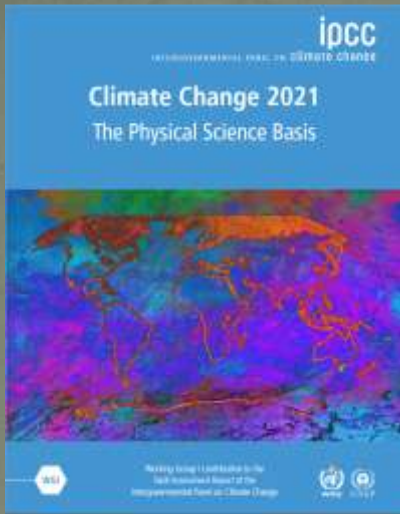
IPCC Report Preparation Process





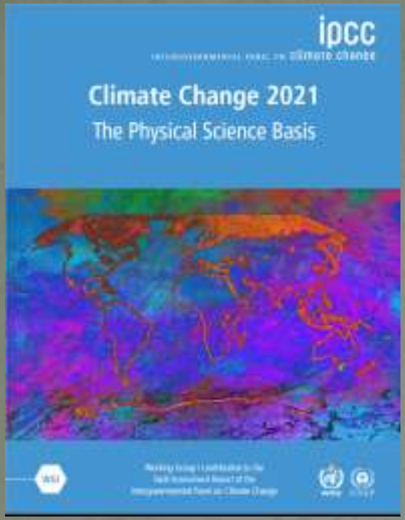
The Sixth Assessment Report (2021)

- **A.1** Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020. Global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and among individuals.



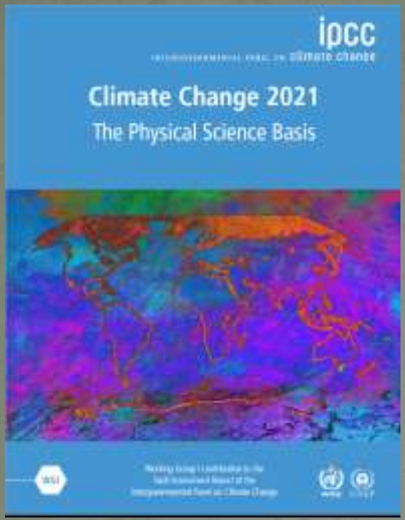
The Sixth Assessment Report (2021)

- **A.2** Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to widespread adverse impacts and related losses and damages to nature and people (high confidence). Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected.



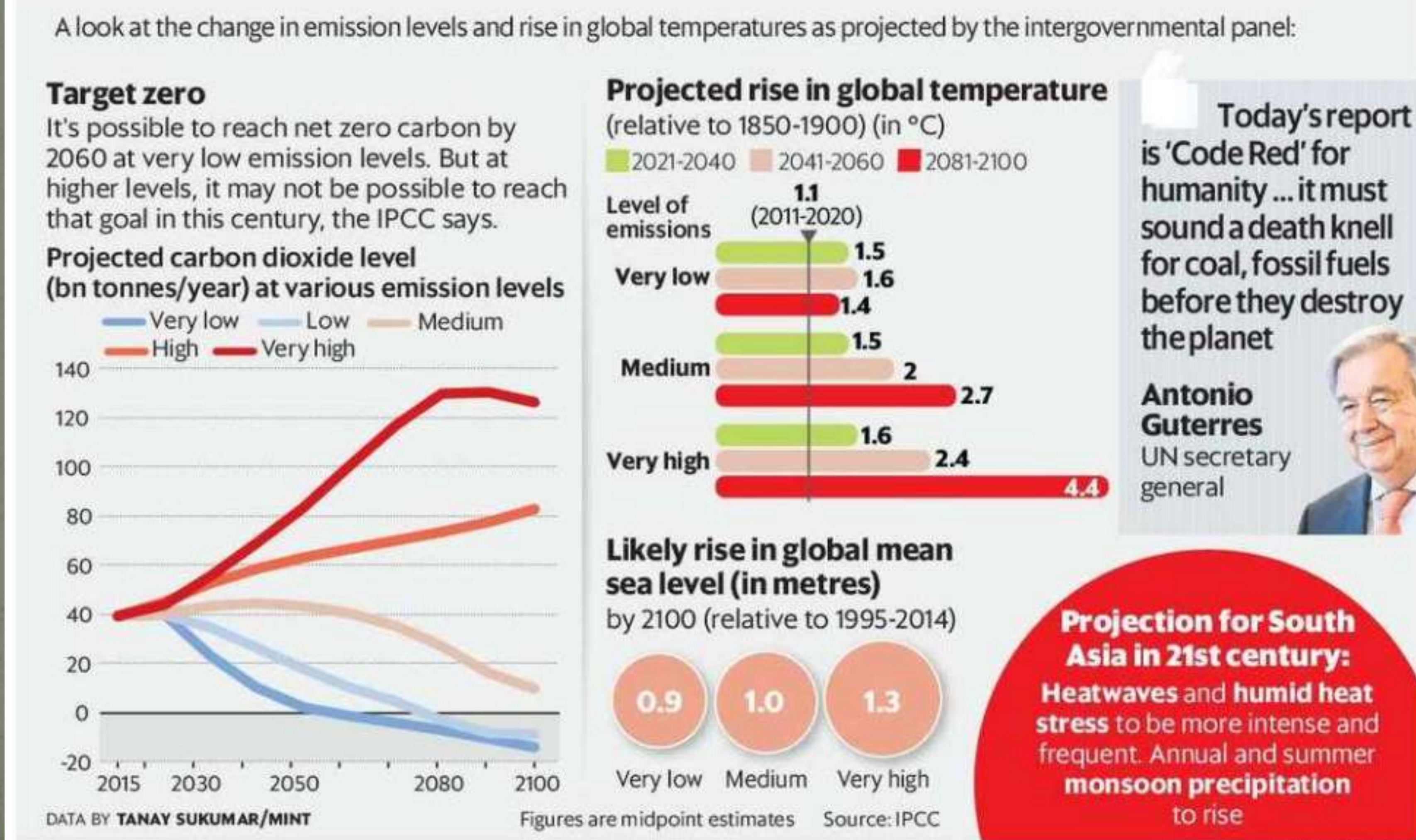
The Sixth Assessment Report (2021)

- **A.4** Policies and laws addressing mitigation have consistently expanded since „Assessment Report 5”. „Global Greenhouse Gas emissions” in 2030 implied by nationally determined contributions (NDCs) announced by October 2021 make it likely that warming will exceed 1.5°C during the 21st century and make it harder to limit warming below 2°C. There are gaps between projected emissions from implemented policies and those from NDCs and finance flows fall short of the levels needed to meet climate goals across all sectors and regions.



The Sixth Assessment Report (2021)

- **A.5** Limiting human-caused global warming requires net zero CO_2 emissions. Cumulative carbon emissions until the time of reaching net-zero CO_2 emissions and the level of greenhouse gas emission reductions this decade largely determine whether warming can be limited to 1.5°C or 2°C. Projected CO_2 emissions from existing fossil fuel infrastructure without additional abatement would exceed the remaining carbon budget for 1.5°C (50%).



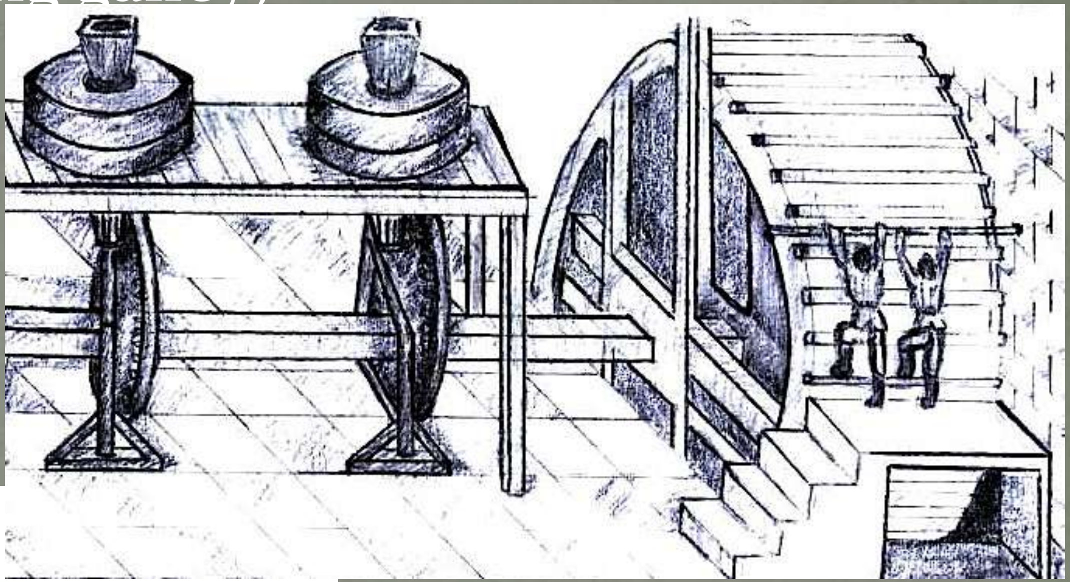
A look at the change in emission levels and rise in global temperatures as projected by the intergovernmental panel:
Target zero
It's possible to reach net zero carbon by 2060 at very low emission levels. But at higher levels, it may not be possible to reach that goal in this century, the IPCC says.
Projected carbon dioxide level (bn tonnes/year) at various emission levels
Very low
Low
Medium
High
Very high
140
120
100
80
60
40
20
0
-20
2015
2030
2050
2080
2100
DATA BY TANAY SUKUMAR/MINT
Projected rise in global temperature
(relative to 1850-1900) (in °C)
2021-2040
2041-2060
2081-2100
Level of emissions
1.1 (2011-2020)
Very low
1.5
1.6
1.4
Medium
1.5
2
2.7
Very high
1.6
2.4
4.4
Likely rise in global mean sea level (in metres)
by 2100 (relative to 1995-2014)
0.9
1.0
1.3
Very low
Medium
Very high
Figures are midpoint estimates
Source: IPCC
Today's report is 'Code Red' for humanity ... it must sound a death knell for coal, fossil fuels before they destroy the planet
Antonio Guterres
UN secretary general
Projection for South Asia in 21st century:
Heatwaves and humid heat stress to be more intense and frequent. Annual and summer monsoon precipitation to rise

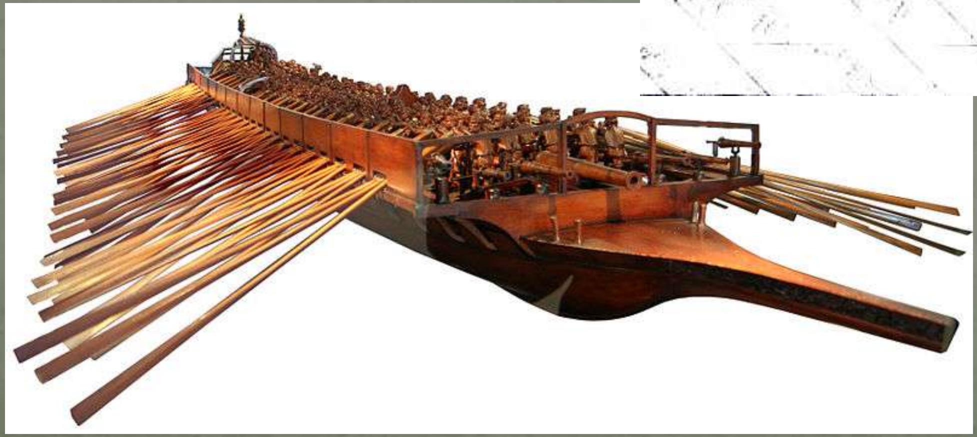
Net Zero
Carbon Emission by 2050?

Renewable Energy Sources

Antecedents in Ancient Times

- Force of muscles / animal or human
  (treadmills, rowing galley)

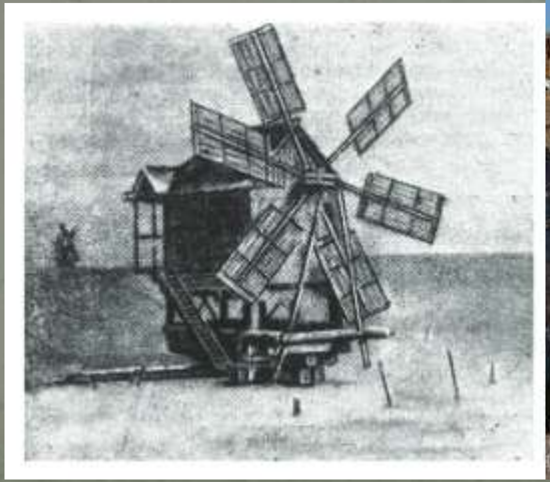




Energy Sources in Ancient Times

- Wind power
  - Sailing boats
  - Wind mills

  (from Egypt, BC 1200)
  - Wind wheels



Ancient wind mills in Nashtifan,Iran

Antecedents in Medieval Era

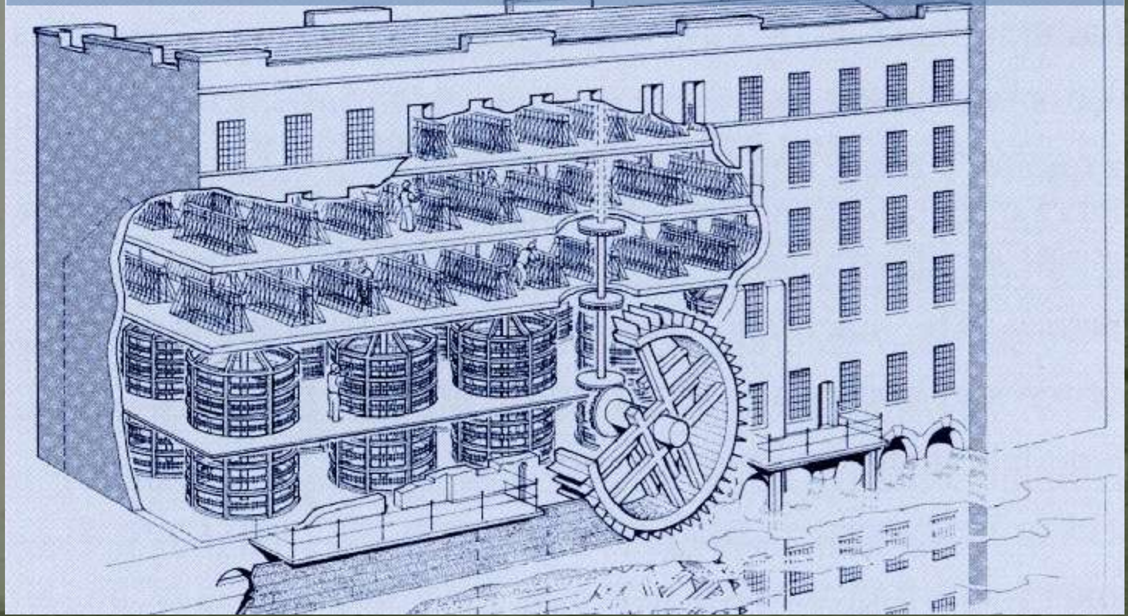
- Hydropower
  - Water wheels
  (ancient Greek invention)
  - Water mills
  - Ebb/flow force power,
    tidal mills (7th century)

Dürer: The Wire-drawing mill

Albertini: Medieval sawmill with hydraulic power

Medieval paper mill
in Vetrní

Water driven silk throwing mill at Tring
(19th century)

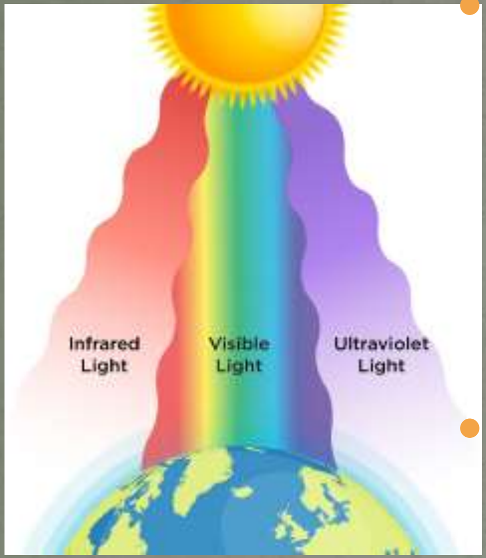


Renewable Energy Sources in our days

Solar Energy

- Solar energy is any type of energy generated by the sun.
- Solar energy is created by nuclear fusion that takes place in the sun. Fusion occurs when protons of hydrogen atoms violently collide in the sun's core and fuse to create a helium atom.
- Solar energy is constantly flowing away from the sun and throughout the solar system. Solar energy warms the Earth, causes wind and weather, and sustains plant and animal life.

Solar Energy



- The Sun is an extremely powerful energy source, and sunlight is by far the largest source of energy received by Earth, but its intensity at Earth's surface is actually quite low. This is essentially because of the enormous radial spreading of radiation from the distant Sun.
- A relatively minor additional loss is due to Earth's atmosphere and clouds, which absorb or scatter as much as 54 percent of the incoming sunlight.
- The sunlight that reaches the ground consists of nearly 50 percent visible light, 45 percent infrared radiation, and smaller amounts of ultraviolet and other forms of electromagnetic radiation.

Types of Solar Energy

- **Passive Solar Technology:** It is often involved in the design of a building. For example, in the planning stage of construction, the engineer or architect may align the building with the sun's daily path to receive desirable amounts of sunlight. This method takes into account the latitude, altitude, and typical cloud cover of a specific area.

Types of Solar Energy

- **Active Solar Technologies:**
  - **Concentrated Solar Energy / CSE:** A solar collector is a device that collects and/or concentrates solar radiation from the Sun. These devices are primarily used for active solar heating and allow for the heating of water for personal use.
  - **Photovoltatics / PV :** A photovoltaic system is composed of one or more solar panels combined with an inverter and other electrical and mechanical hardware that use energy from the Sun to generate electricity.

Advantages of Solar Energy

- **Renewable:** Solar energy is a fully renewable energy resource
- **No Fuel Costs:** There are no fuel costs associated with solar energy, which will save money
- **Environmentally Friendly:** Unlike with other energy sources, such as fossil fuels, solar energy doesn’t release any harmful natural gases or hazardous by-products

Advantages of Solar Energy

- **Lifetime:** 15-20 years
- On-time investment
- Minimal operating expense
- Economic energy source for off-grid consumers in remote locations

Disadvantages of Solar Energy

- **Reliability:** Solar energy is dependent on the weather and how many hours of sunlight there are. This means that it is better suited to some parts of the world than others.
- **Cost:** Although the costs are reducing, solar energy technology such as solar panels can be expensive to install.

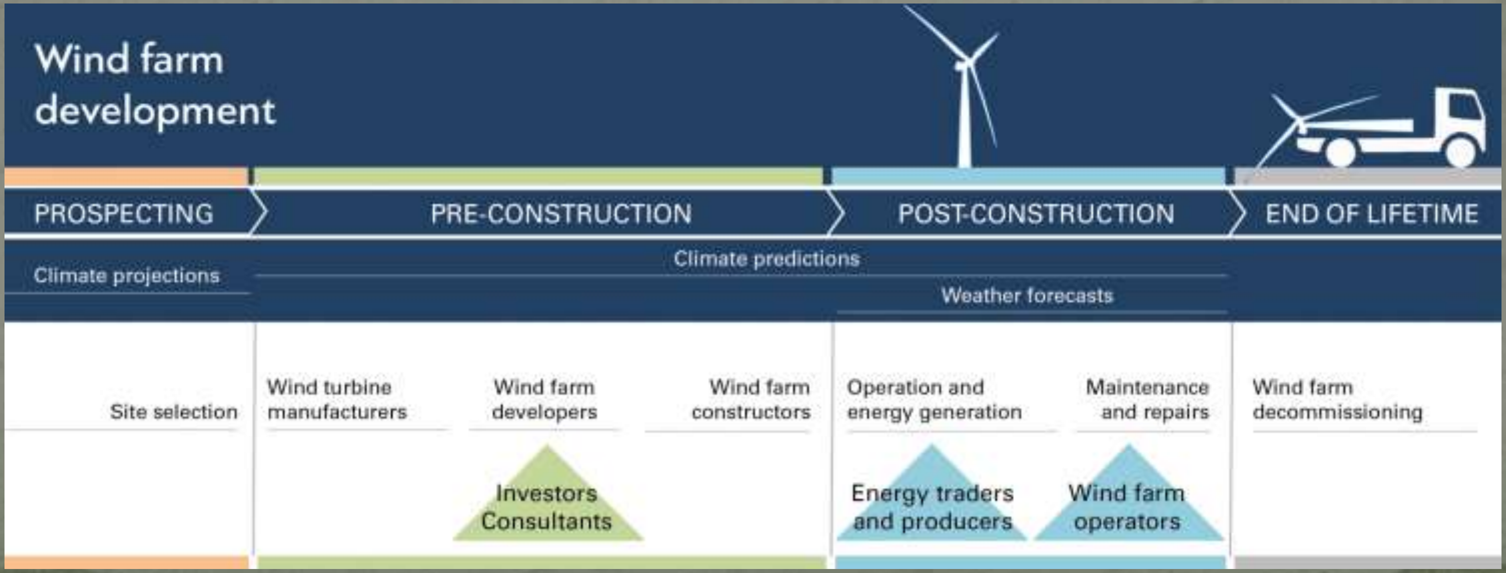
Wind Power

- Wind power or wind energy describes the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water), or can be converted into electricity by a generator.

Wind turbin installation

Before starting the process, wind turbine installers must conduct a detailed study. The study includes:

- Measuring wind speeds for at least three months to determine the project's feasibility.
- Analyzing the topography of the terrain.
- Assessing accessibility.
- Evaluating typical weather conditions.



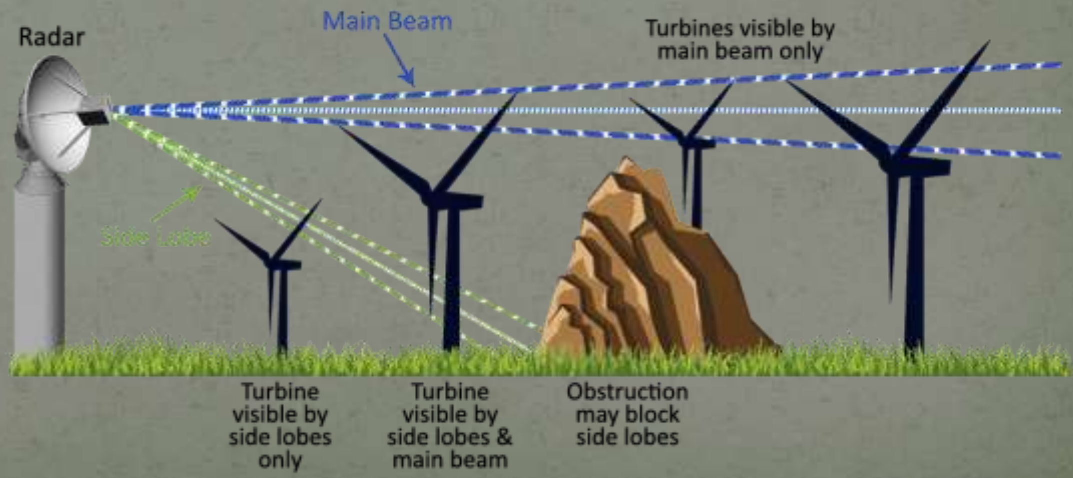
Wind turbin installation

The 'size' of a wind turbine is made up of two key elements:

- **the hub-height:** High hub-heights are preferred because this exposes the turbine to higher average wind speeds.
- **the rotor diameter:** Larger rotors are preferred because they capture more wind.

There are a couple of reasons for opting for shorter towers/smaller rotors:

- to avoid microwave transmission links
- or aviation radar interference
- to reduce visual impact



Utilizatition of Wind Power

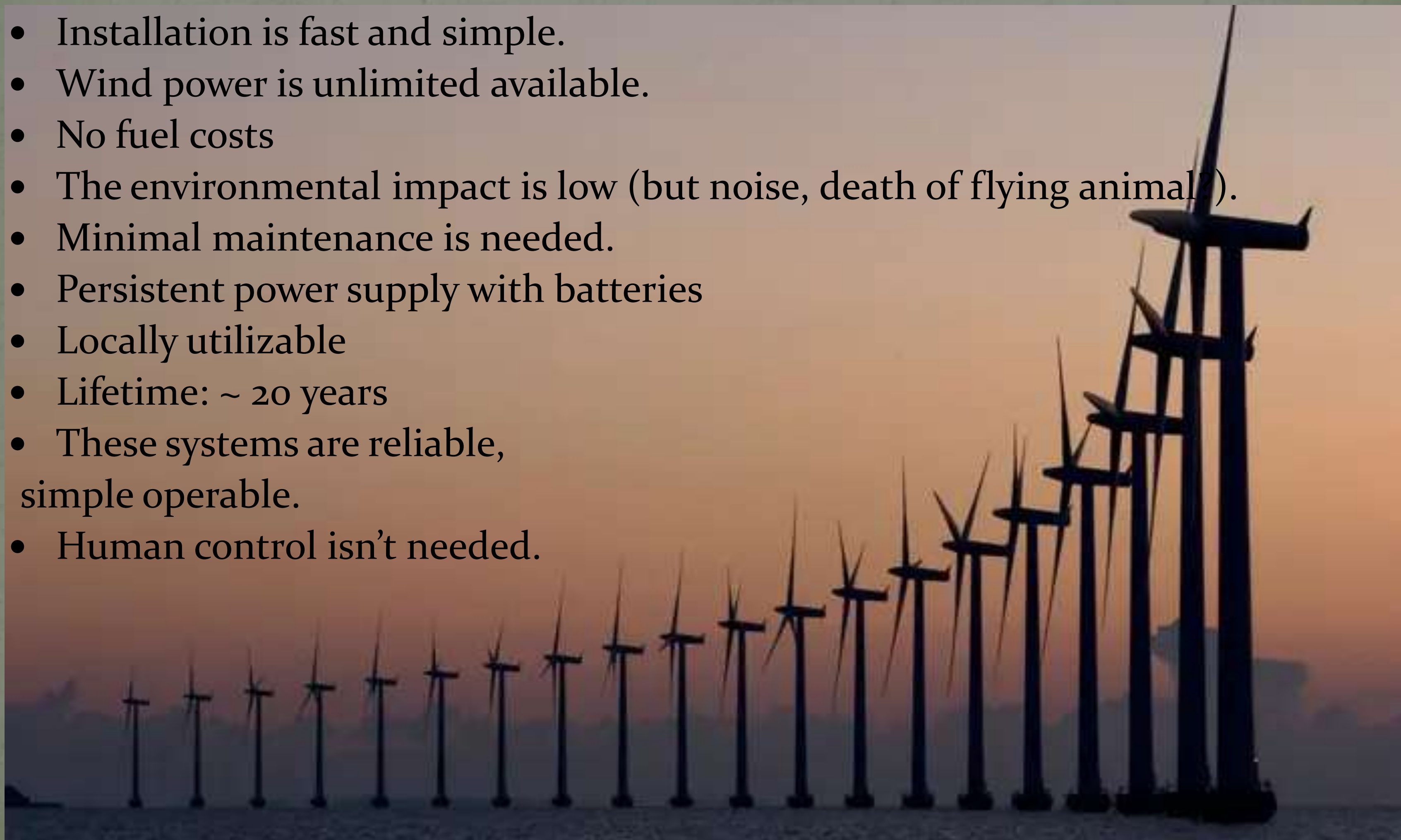
- **Converting to electricity:** The wind blows the blades of the turbine, which are attached to a rotor. The rotor then spins a generator to create electricity. There are two types of wind turbines: the horizontal-axis wind turbines (HAWTs) and vertical-axis wind turbines (VAWTs).
- **Pumping water:** A typical wind water pumping system includes: the wind rotor, a tower, a mechanical pump, mechanical linkage, a well full of water (or other such water source), and piping to deliver the pumped water. Also there maybe some form of water storage: a large water tank, pond, or reservoirs depending on the application.

- **Aeration for wastewater treatment:** Aeration provides oxygen to bacteria for treating and stabilizing the wastewater. Wind power is an attractive option for driving aerators at suitable sites.


Advantages of Wind Power

- Installation is fast and simple.
- Wind power is unlimited available.
- No fuel costs
- The environmental impact is low (but noise, death of flying animals).
- Minimal maintenance is needed.
- Persistent power supply with batteries
- Locally utilizable
- Lifetime: ~ 20 years
- These systems are reliable,

simple operable.
- Human control isn't needed.



Wind Solar Hybrid Projects

A Wind Solar hybrid plant generates power in a continuous pattern:

- with much less variability than a standalone solar plant (generates only during daylight hours)
- or standalone wind plant

(generates mainly

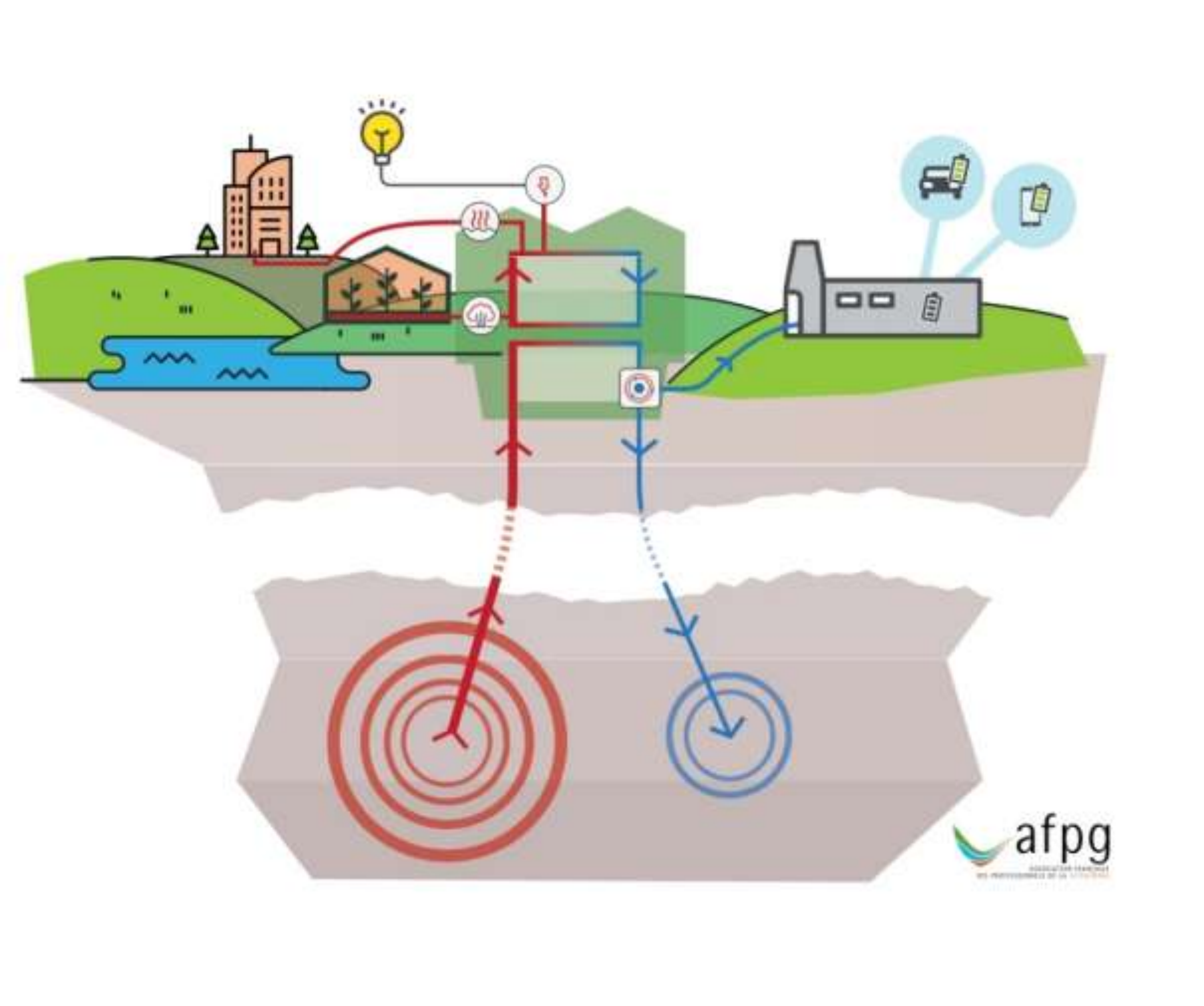
during evening/night).

Geothermal energy

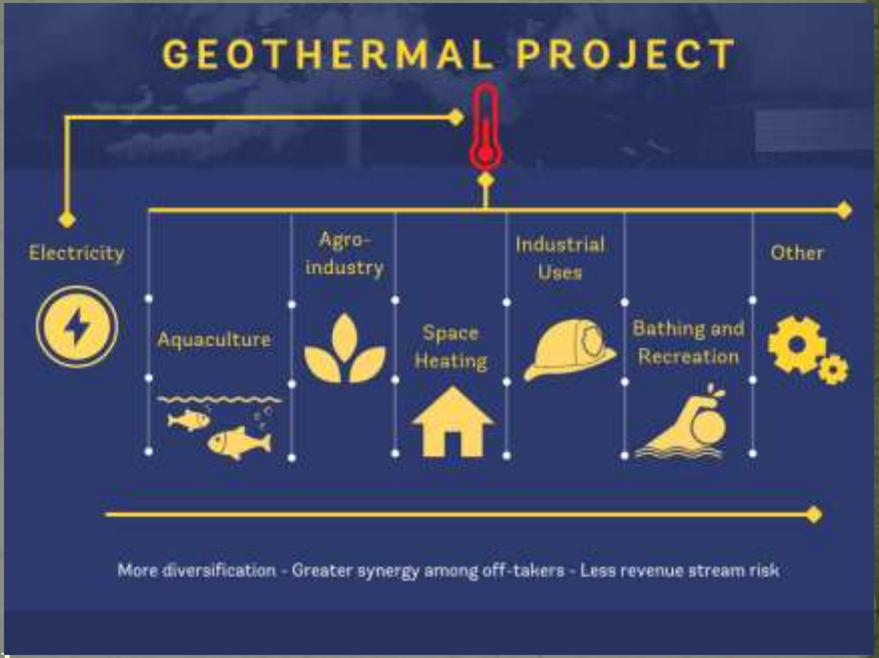
- It comes from heat generated during the original formation of the planet and the radioactive decay of materials.
- This thermal energy is stored in rocks and fluids in the centre of the earth.
- Geothermal resources are reservoirs of hot water that exist or are human made at varying temperatures and depths below the Earth's surface.

Utilization of geothermal energy

- Heating
- Balneology
- Generating electricity



Utilization of geo-thermal energy



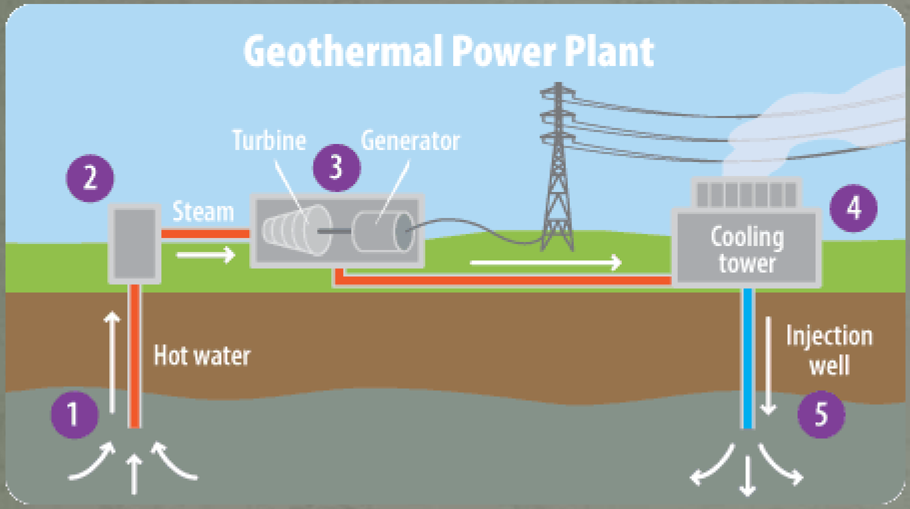
- Heating
  - Heating buildings
  - District heating
  - Warming water
    for personal use
  - Heating of public baths
  - Heating of greenhouses / polytunnels
  - Drying of crops, fodder and fruits
  - Raising of mushrooms
  - Warming of irrigation water
  - Heating systems of livestock production
  - Temperament of water in fish-farming
  - Industrial/technological warm water demand

Utilization of geo-thermal energy

- Balneology
  - Therapies
  - Health Spa

Utilization of geo-thermal energy

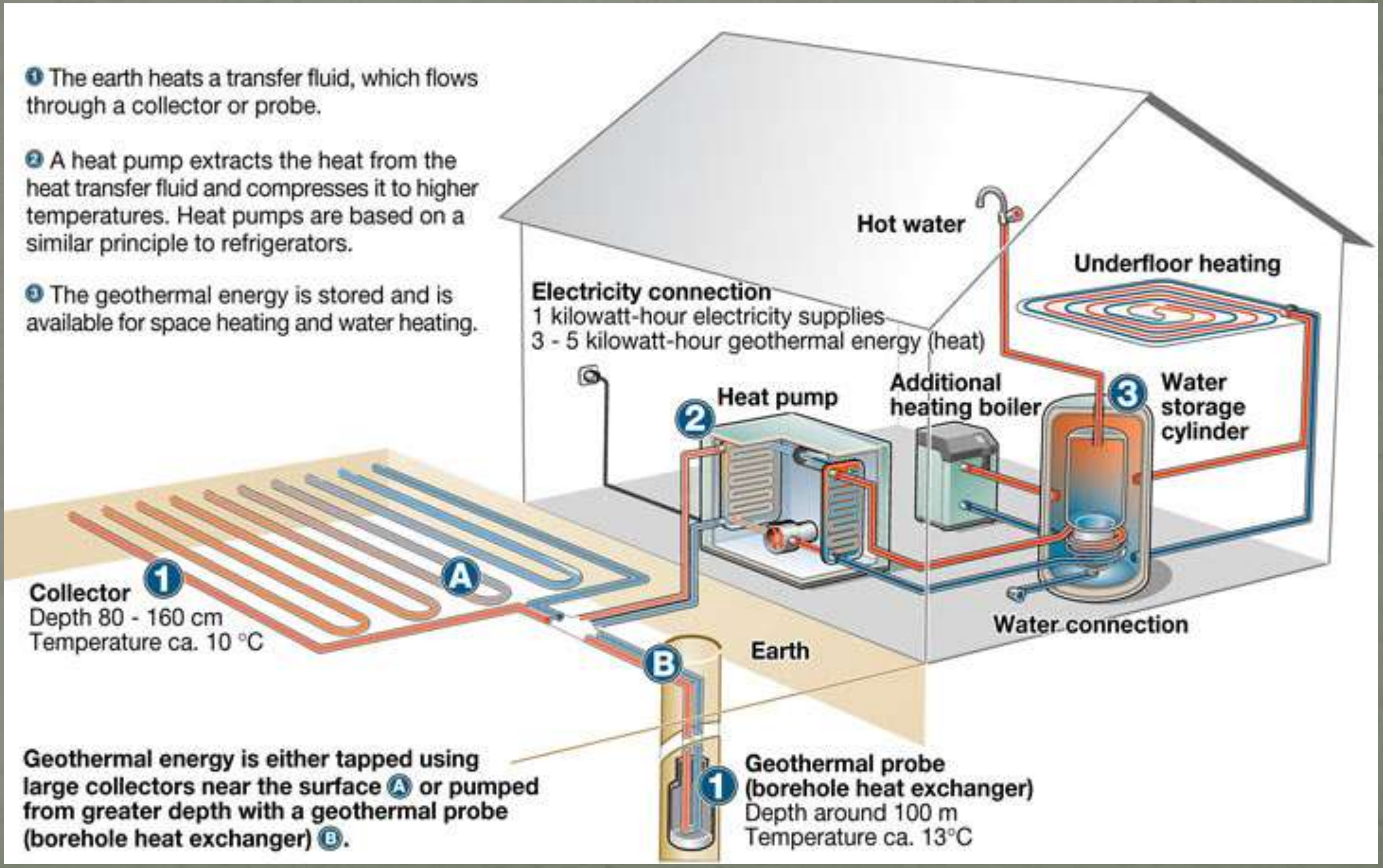
- Generating electricity



1. Hot water is pumped from deep underground through a well under high pressure.
2. When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. The steam cools off in a cooling tower and condenses back to water.
5. The cooled water is pumped back into the Earth to begin the process again. (epa.gov)

Utilization of geo-thermal energy

- Technologies: Geothermal Probe



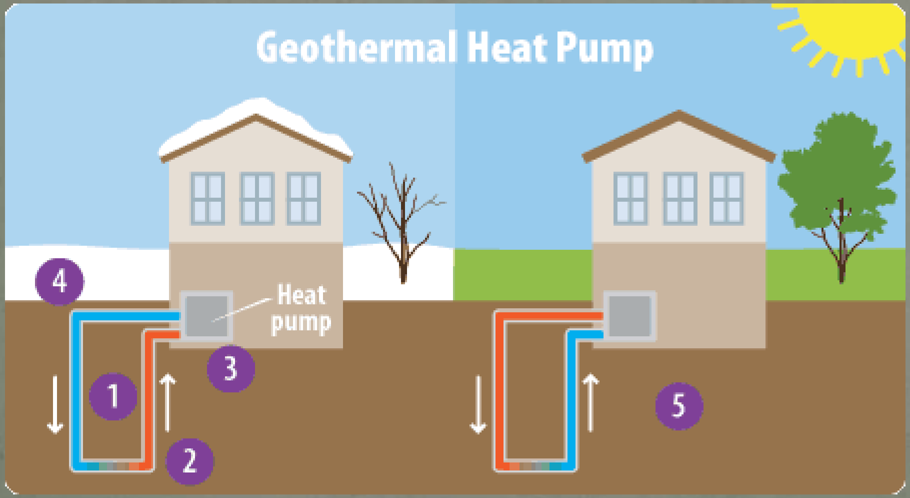
Utilization of geo-thermal energy

- Technologies:

Geothermal Heat Pumps

- Its electricity consumption is low.
- Its investment cost is high.
- Multipurpose:

Heating / Cooling / Warming water



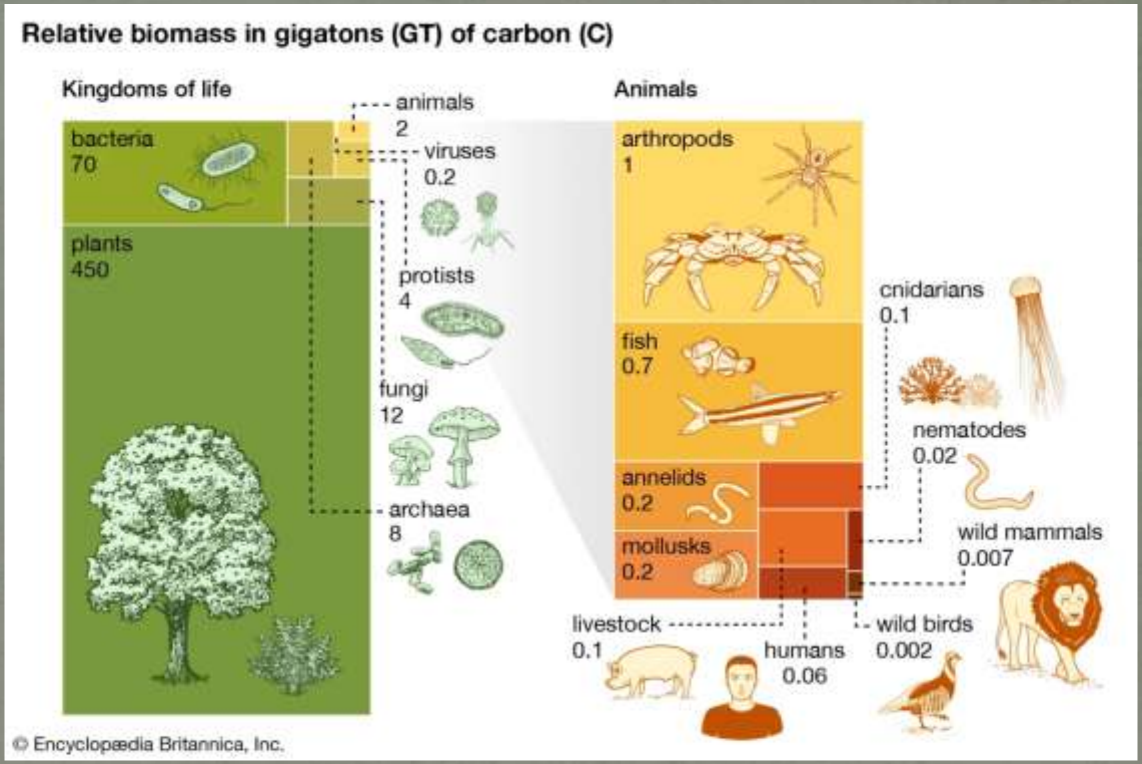
1. Water or a refrigerant moves through a loop of pipes.
2. When the weather is cold, the water or refrigerant heats up as it travels through the part of the loop that's buried underground.
3. Once it gets back above ground, the warmed water or refrigerant transfers heat into the building.
4. The water or refrigerant cools down after its heat is transferred. It is pumped back underground where it heats up once more, starting the process again.
5. On a hot day, the system can run in reverse. The water or refrigerant cools the building and then is pumped underground where extra heat is transferred to the ground around the pipes. (epa.gov)

Advantages of Geothermal Energy

- Persistent availability
- Independent of the weather
- Locally utilizable
- Local air pollution
  is decreased.
- Protection of local
  drinking water sources
- The environmental impact
  is low (if water pumped back) .

Biomass
as renewable energy source

- „The total quantity or weight of organisms in a given area or volume."



- „Organic matter used as a fuel, especially in a power station for the generation of electricity."

Utilization of Biomass

- Direct utilization: combustion
  - Without pretreatment
  - With pretreatment

- Solid Biomass:
  - Firewood
  - Wood chips
  - Straw
  - Herbs

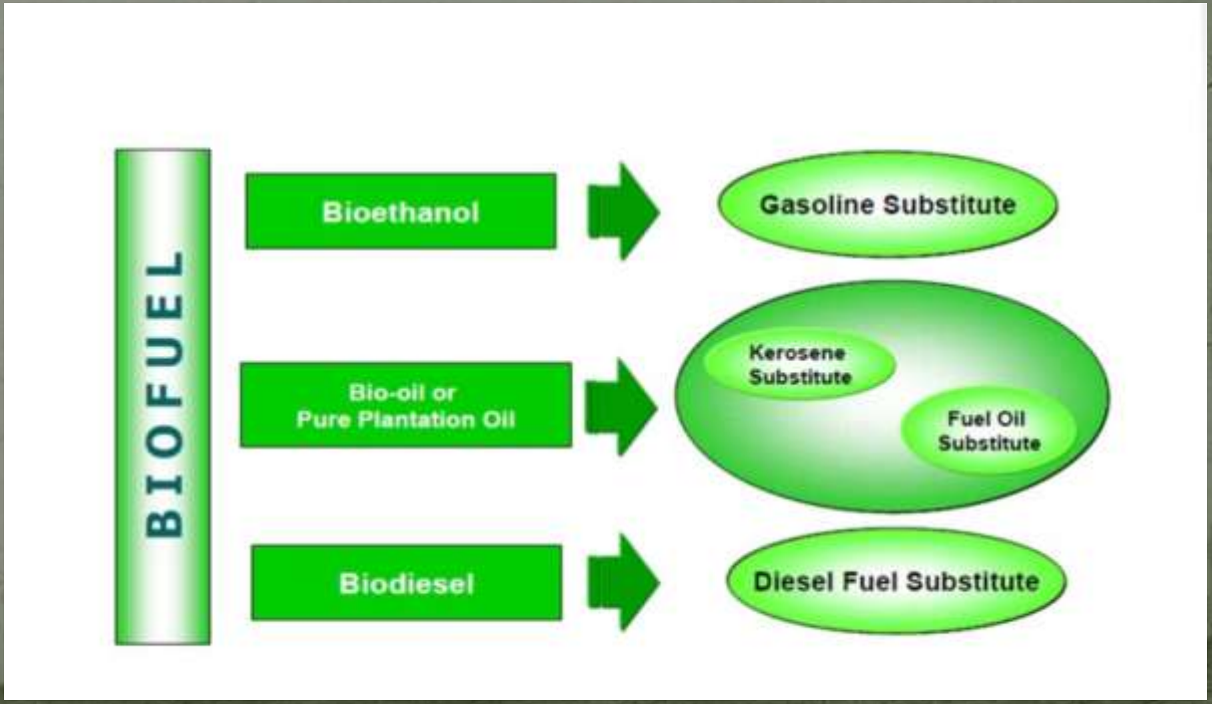
  (e.g. switchgrass, reeds)
  - Pellet

  (a compressed feedstock material with or without additives)
  - Bio-Briquette

  (compact solid composites of different sizes with the application of pressure)

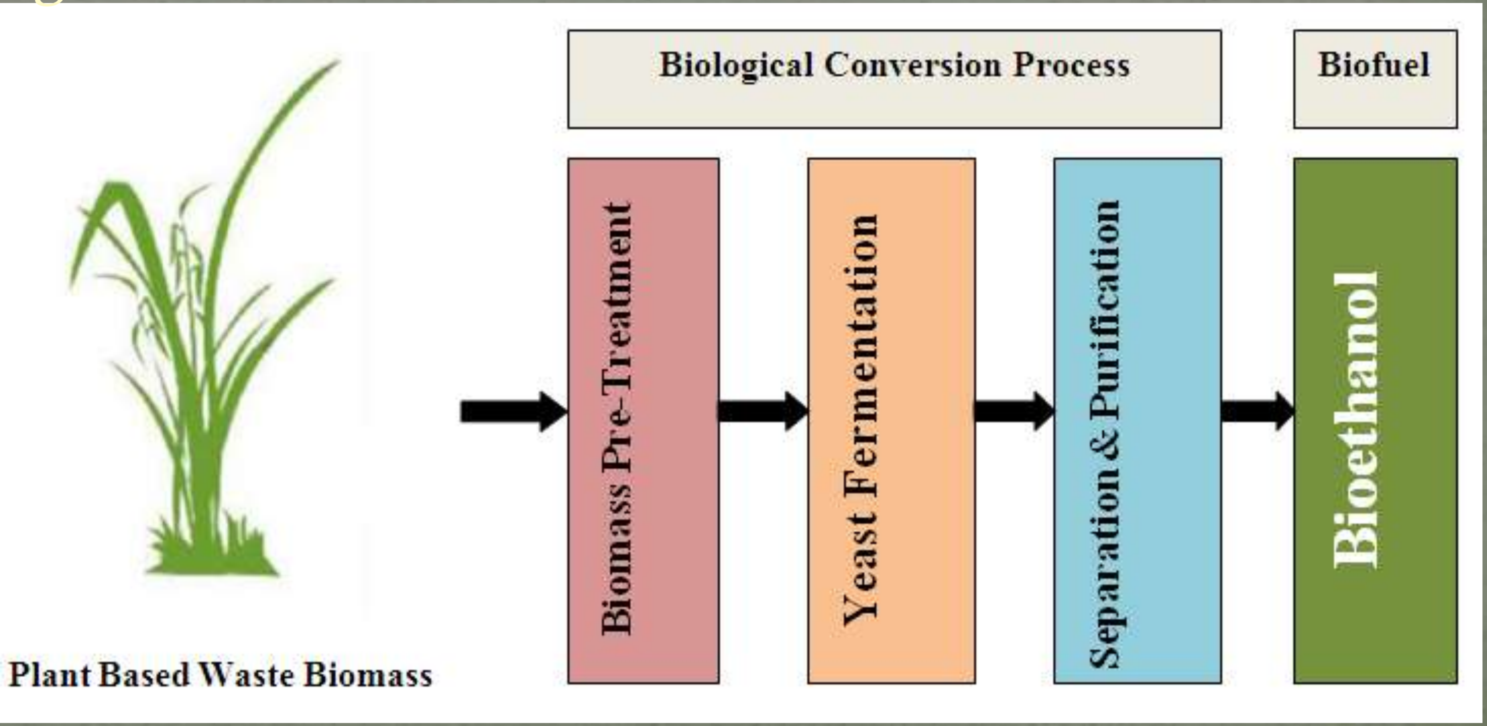
Utilization of Biomass

- Indirect utilization:
  - Chemical modification
    - Liquefaction → liquid fuel
    - Gassing → combustible gas
  - Fermentation → alcohol (as fuel)
  - Esterification of vegetable oils → biodiesel
  - Anaerobic fermentation → biogas

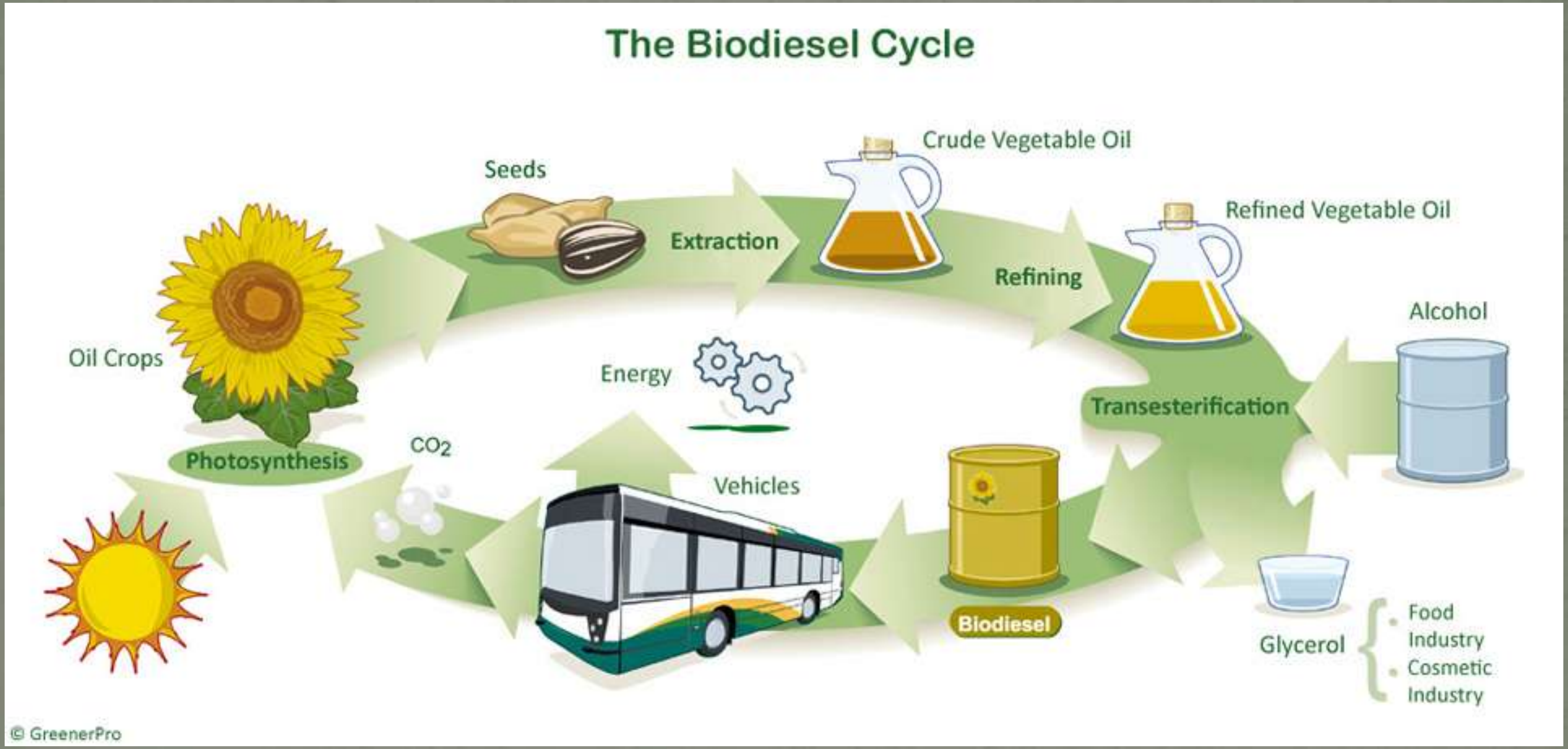


Utilization of Biomass

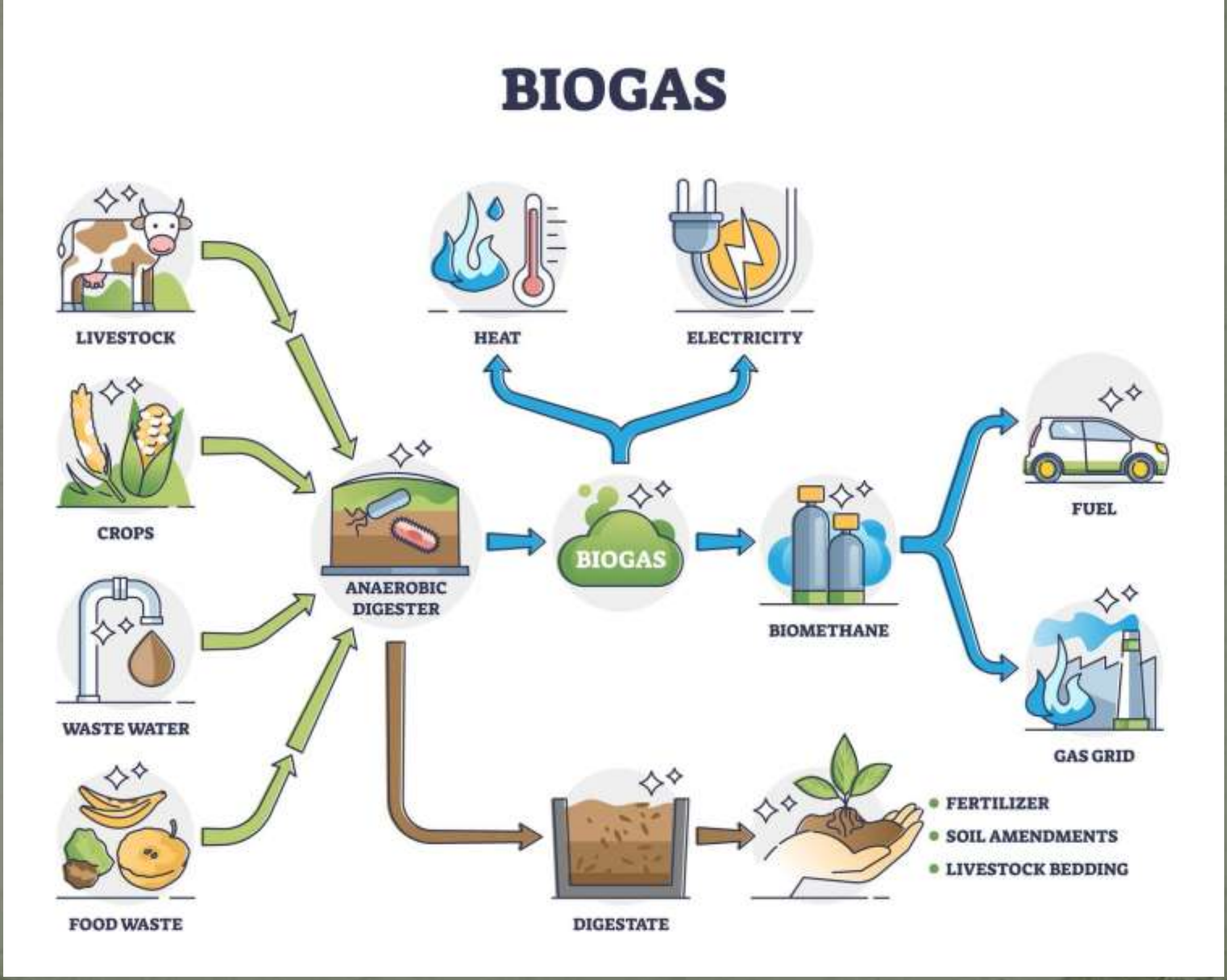
- Liquid Biomass Fuels
  - Bioethanol
  - Biodiesel
- Gaseous Biomass
  - Biogas



Utilization of Biomass



Utilization of Biomass



Energetic Utilization of Biomass

- Generating electricity
- Utilization of agricultural and municipal waste
- Heating (individual or district heating)
- Incineration of hazardous waste
- Fuel production
- Heat production

Advantages of Biomass Energy

- Regrowth is relatively short
- Saving the reserves of mineral resources
- Unused agricultural lands can be used for production of energy herbs
- Rural development

and job creation

- Incineration

of byproducts and waste

Disadvantages of Biomass Energy

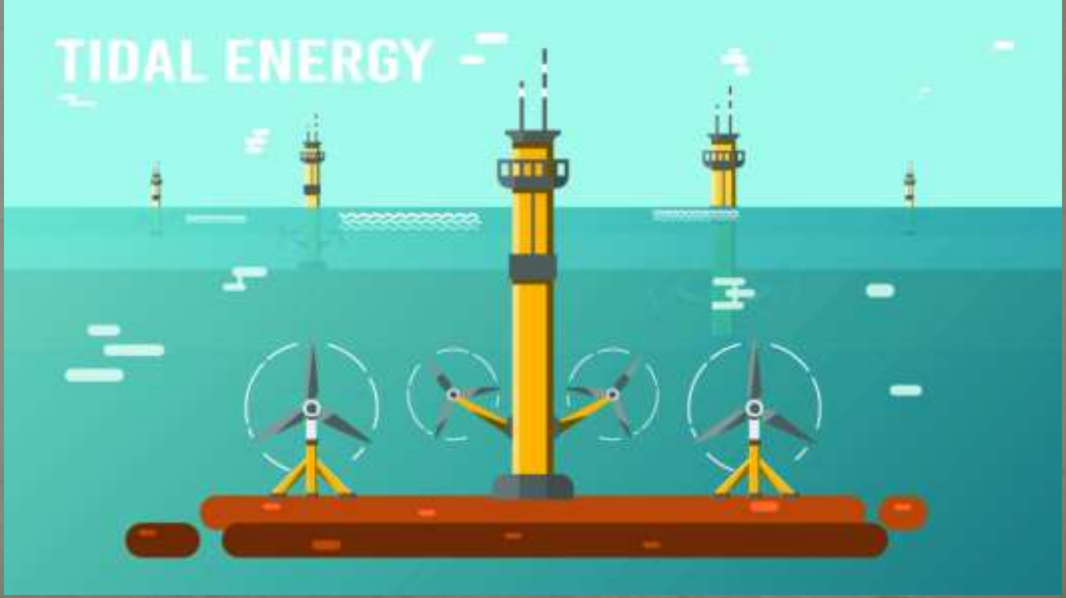
- Environmental impact, such as deforestation and air pollution
- Large-scale cultivation of energy crops for biomass production can lead to land conversion, deforestation, and habitat loss, which can threaten biodiversity and disrupt ecosystems. See: e.g. Oil Palm and Orangutan
- If agricultural land is diverted from food production to growing biomass feedstocks, it could potentially affect food prices by reducing the supply of food crops.

Hydropower

- Electricity produced from generators driven by turbines that convert the potential energy of falling or fast-flowing water into mechanical energy.
  - Water catchments
  - Damned reservoirs
  - Diversions
  - Pumped-storage

Tidal energy

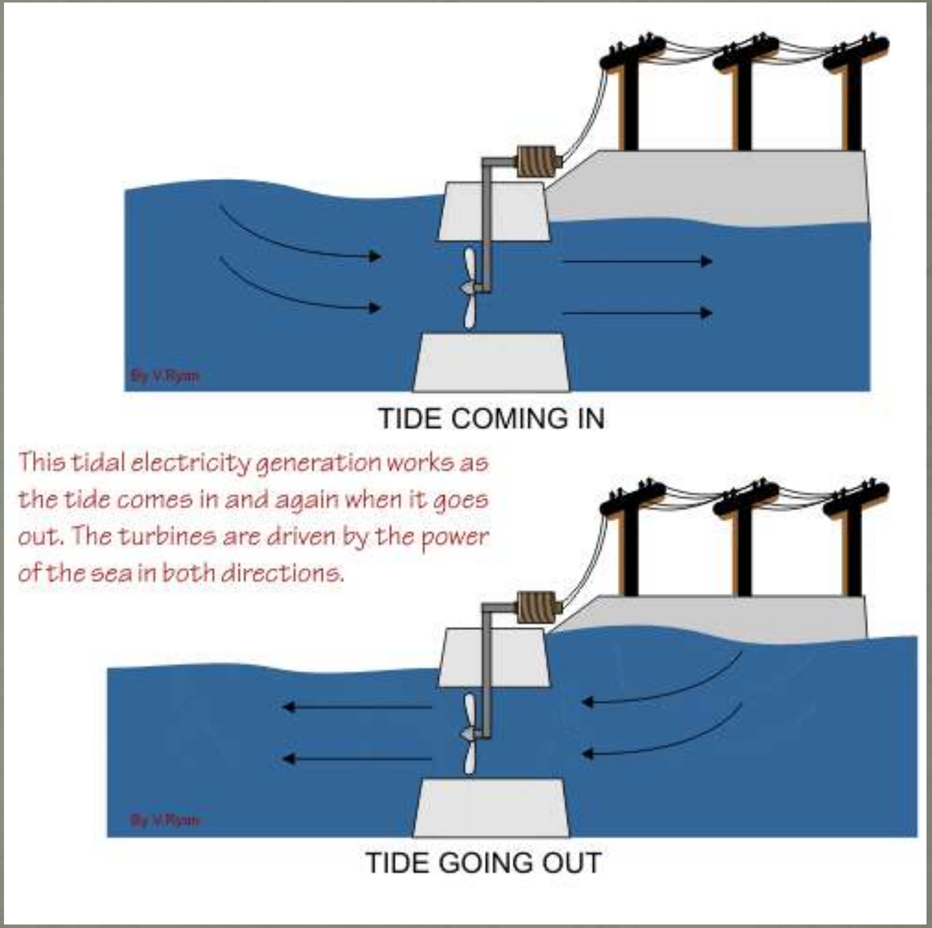
- Tidal energy is a renewable energy powered by the natural rise and fall of ocean tides and currents. (nationalgeographic) Tides are generated due to gravitational pull of the moon and the Sun.



Utilization of Hydro Power

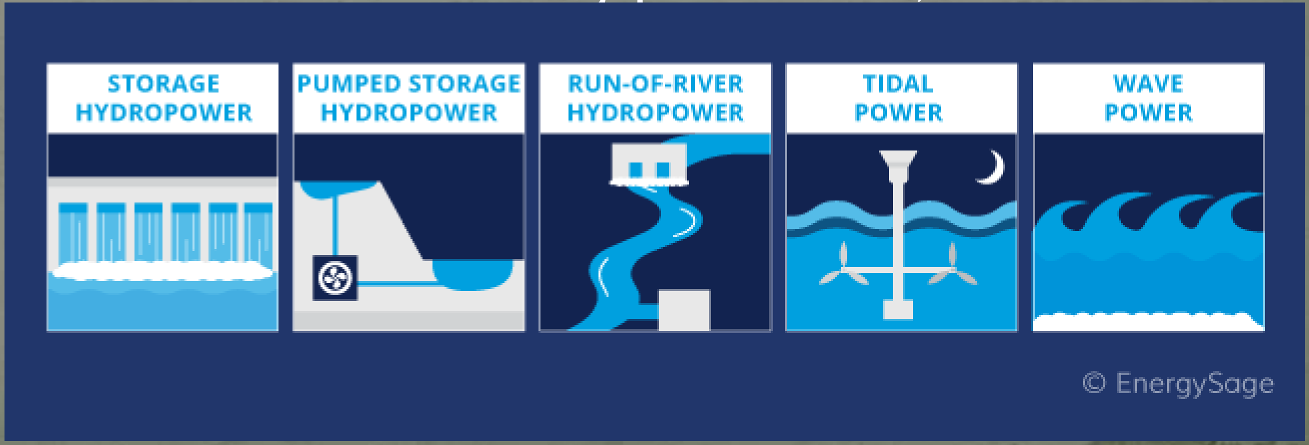
- Hydro Power Plants
  - Generating electricity
- Tidal power Stations
  - Generating electricity

- Barrage
  - Water management
  - Irrigation
  - Shipping
  - Fishing
  - Flood protection
  - Sports, recreation



Advantages of Hydro Power

- Long lifetime (50-100 years)
- Reliable technology
- Emission of greenhouse gases is minimal.
- Flood protection
- Minimal operating expense
- Sustainable
- Water can be stored (contorolled and persistent electricity production)



Disadvantages of Hydro Power

- Environmental impact: Large-scale hydropower projects can disrupt river ecosystems, alter natural water flow patterns, and lead to habitat destruction. This can negatively affect fish migration, aquatic biodiversity, and water quality.

- Displacement of communities: The construction of dams and reservoirs for hydropower projects often requires the relocation of communities living in the affected areas. This displacement can lead to social and economic disruptions for local populations, including loss of livelihoods and cultural heritage.

- Risk of dam failure

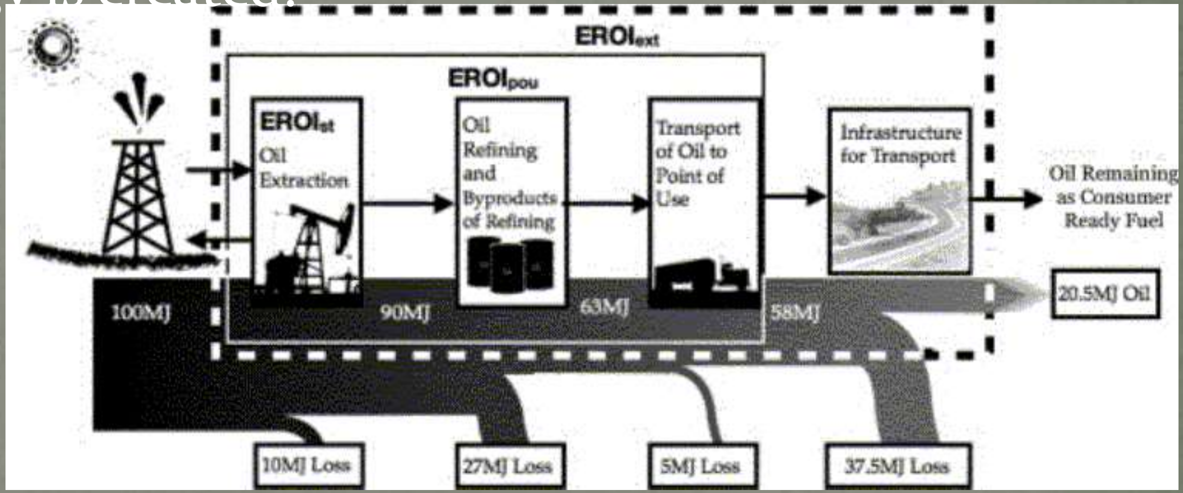
- Sedimentation: Dams trap sediment flowing in rivers, leading to sedimentation in reservoirs. Over time, this reduces the storage capacity of reservoirs and affects downstream ecosystems, riverbed stability, and water quality.

- Methane emissions: Decomposing organic matter in reservoirs can produce methane, a potent greenhouse gas that contributes to climate change. Large reservoirs created by hydropower projects can be significant sources of methane emissions.

- High initial investment: The construction of hydropower infrastructure, including dams, reservoirs, and power plants, requires substantial upfront investment. This can make hydropower projects economically challenging compared to other energy sources, especially in regions with less developed infrastructure.

Energy Return of Investment (EROI)

- EROI is a ratio for describing a measure of energy produced in relation to the energy used to create it. EROI = Energy Output : Energy Input
- For instance the ratio would illustrate how much energy is used to locate, extract, deliver, and refine crude oil relative to how much useable energy is created.
- EROI of crude oil is changed from 100:1 to 20:1 (1920→2021).



The fossil fuel industry is pushing into resources that are harder to extract.

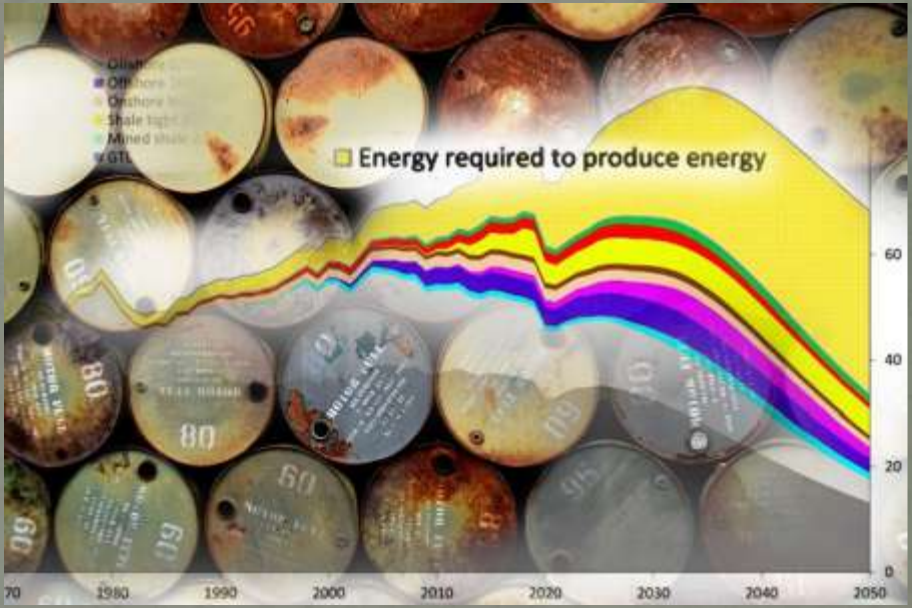
Energy Return of Investment (EROI)

Energy	Average	Optimistic estimation	Pessimistic estimation
Crude oil	19:1		5:1
Hard coal		85:1	50:1
Natural gas	10:1		
Hydro power		267:1	11:1
Nuclear energy		15:1	1.1:1
Wind power (land-based)		58:1	34:1
Wind power (marine)		17.7:1	16.7:1
Photovoltatics		34:1	5:1
Biodiesel (from rapeseed oil)		2.6:1	1.1:1
Oil from tar sand	5:1		
Wave power plants	15:1		
Tidal power stations	6:1		

Energy Return of Investment (EROI)

- Sustainability of industrial civilization:

  EROI should be around 5:1



- Energy Trap:

  Configuration of renewable energy sources is energy-intensive. This energy demand can be satisfied by fossil fuels.

Global Energy Transformation

- Difficulty of Global Energy Transformation
  - Energy Trap
  - Availability of rare metals below a treshold level

  (Importance of recycling in Solar Power Industry)
  - Increased space requirement
  - Landscape Modification

- Global Energy Transformation is a prime necessity
  - In spite of disadvantages
  - Because of Global Warming / Climate Change
  - („Target Zero")

Net Zero
Carbon Emission by 2050

The Meadow's law. The example of the ozone depletion

The Club of Rome (since 1968)

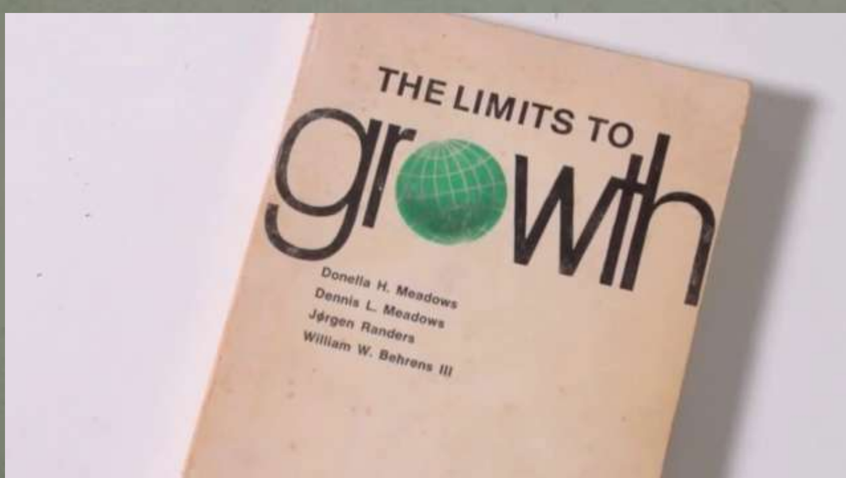
THE CLUB OF ROME

- 1972 – The Limits to Growth

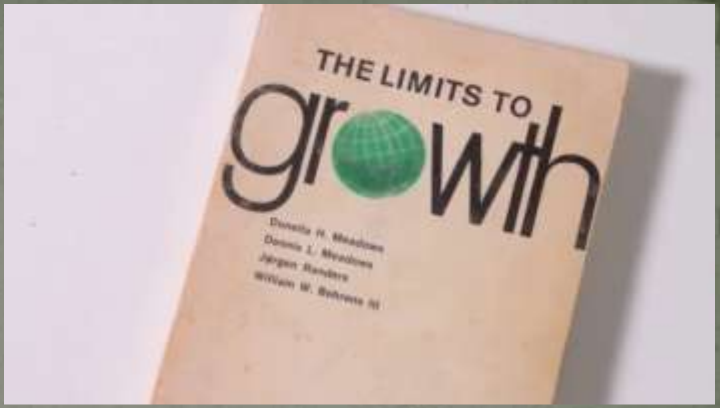
LTG is a 1972 report that discussed the possibility of exponential economic and population growth with finite supply of resources, studied by computer simulation.

- 1972 – The report's authors are

  Donella H. Meadows,
  Dennis L. Meadows,
  Jørgen Randers,
  and William W. Behrens III,
  representing a team
  of 17 researchers.



The Limits to Growth (1972)



In commissioning the research team to undertake the project that resulted in LTG, the Club of Rome had three objectives:

1. Gain insights into the limits of our world system and the constraints it puts on human numbers and activity.
2. Identify and study the dominant elements, and their interactions, that influence the long-term behavior of world systems.
3. To warn of the likely outcome of contemporary economic and industrial policies, with a view to influencing changes to a sustainable lifestyle.

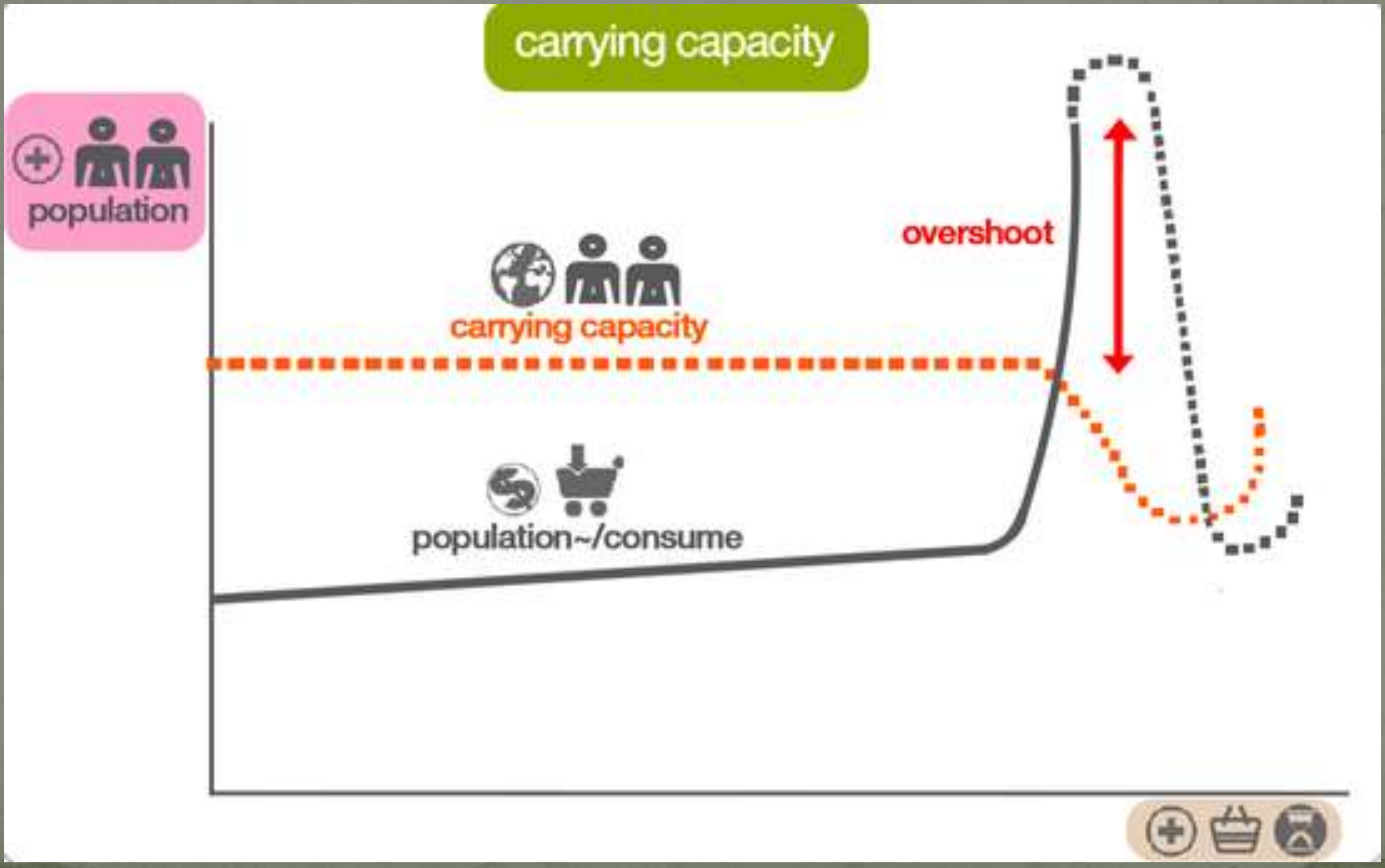
The Limits to Growth (1972)

After reviewing their computer simulations, the research team came to the following conclusions:

1. If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years.[b] The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity.
2. It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential.
3. If the world's people decide to strive for this second outcome rather than the first, the sooner they begin working to attain it, the greater will be their chances of success.

(Limits to Growth,Introduction)

Connection between population/ consumption and Earth's carrying capacity (a catastrophic model)



Meadows law

- „…the sooner they begin working to attain it, the greater will be their chances of success.” (LTG)

→ It isn’t sure that an overdue intevention

lives up to expectations!

The example of ACID RAIN

What is Acid Rain?

- https://youtu.be/1PDjVDIrFec

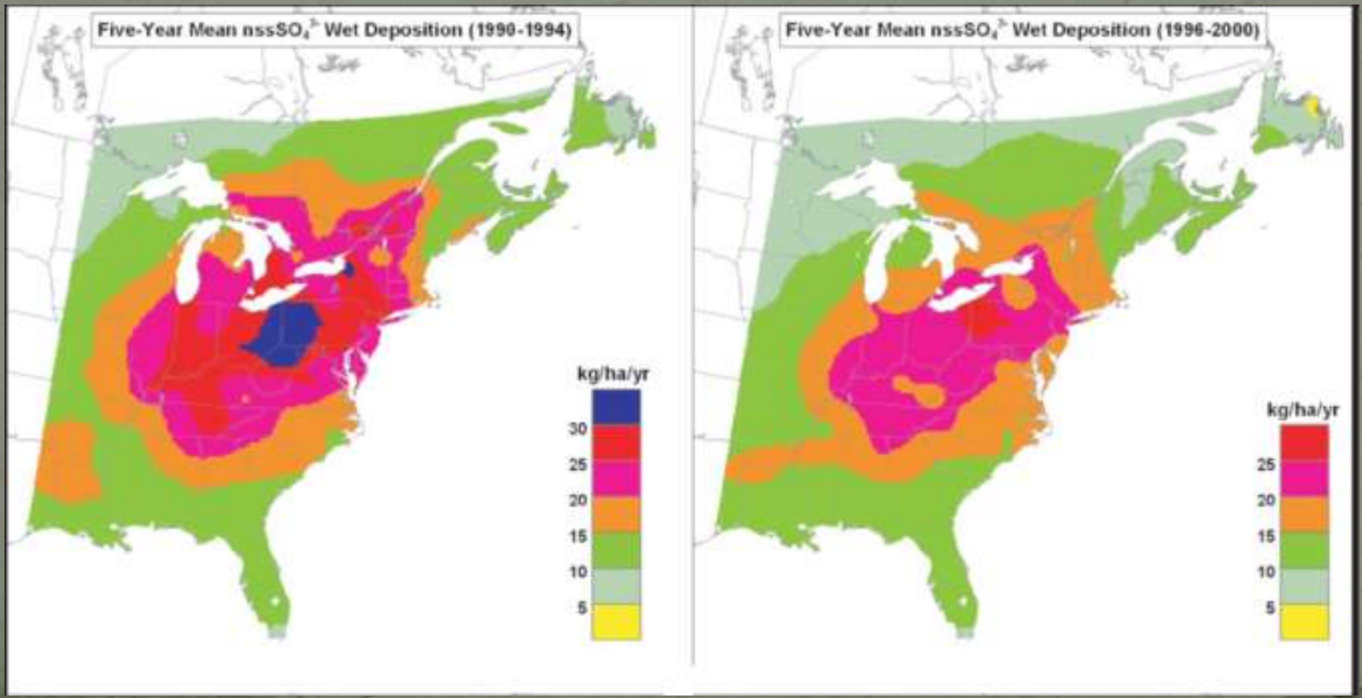
Where does acid rain come from?

- Discovery: 1963 - Gene Likens:

Samples of rain ← large-scale pollution

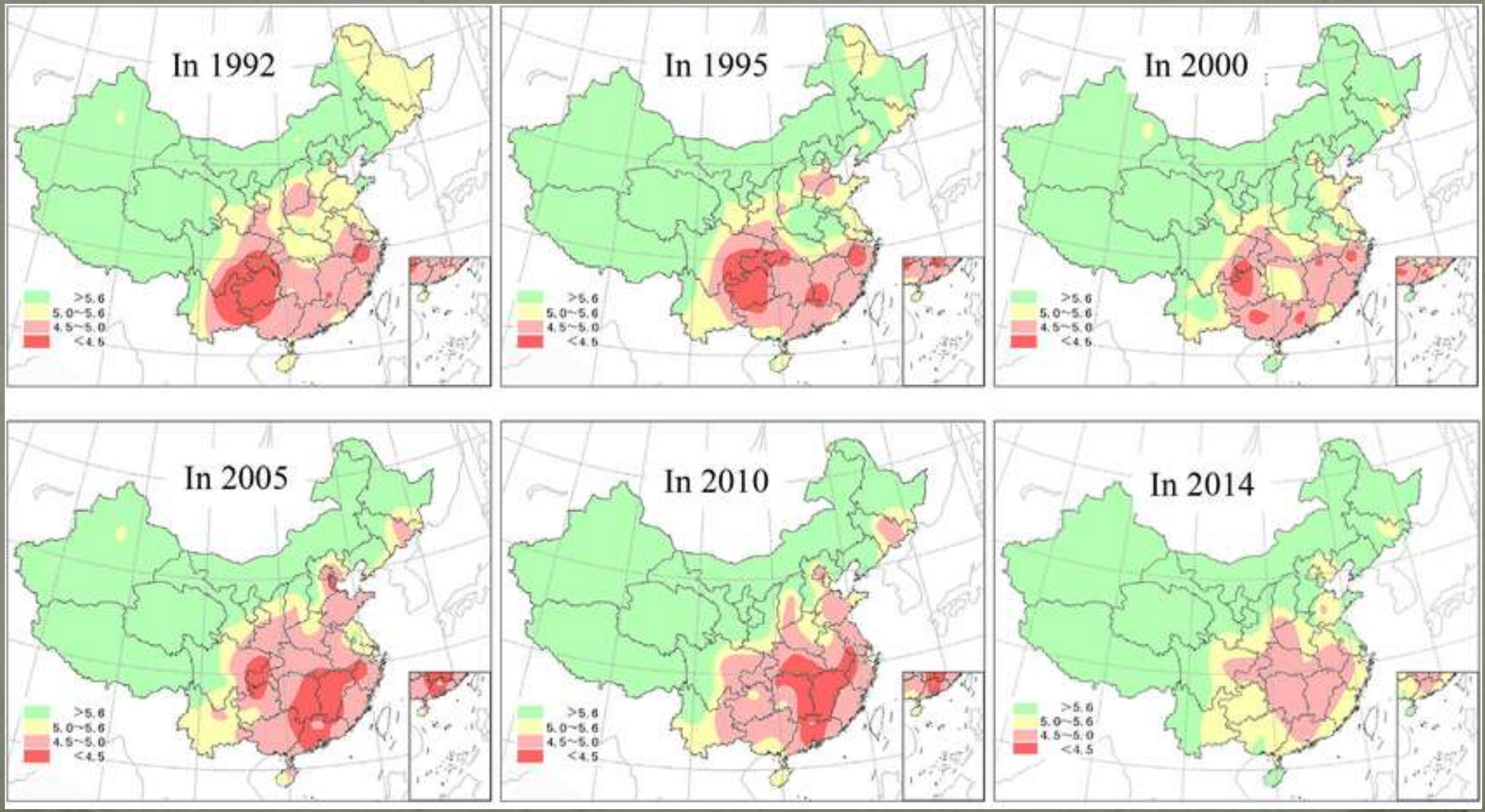
Interventions → Expectations

- North America:
  - Interventions after 27 years after discovery!
  - It's succeeded to stop acid rain!
  - Successful remediation of damaged areas



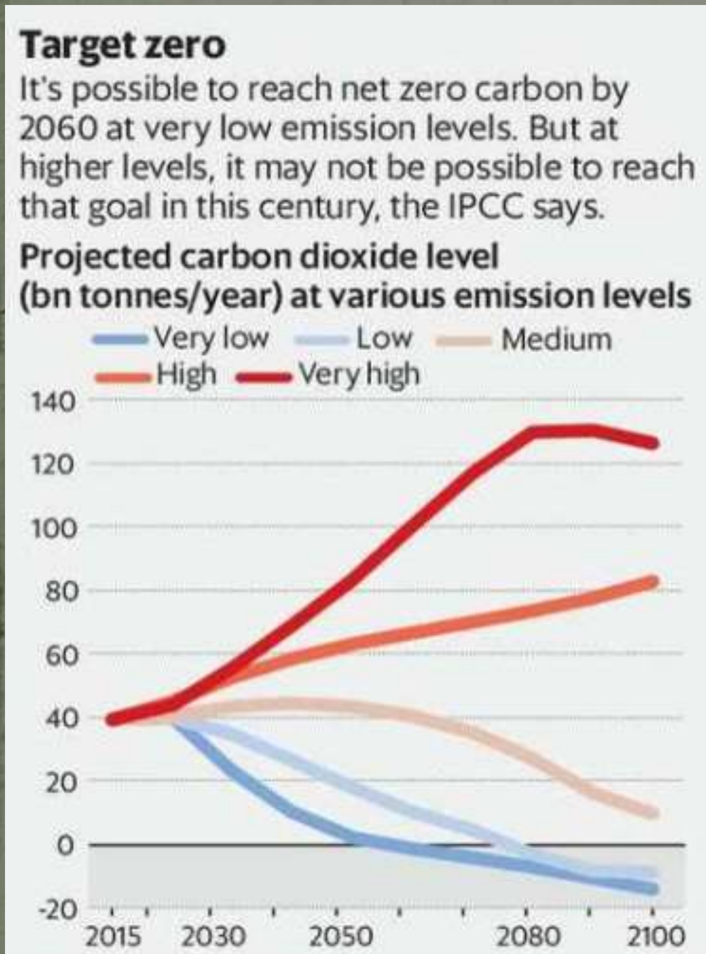
Interventions → Expectations

- Asia:
  - Acid rain is a growing problem
  - Without interventions



The example of abnormal GREENHOUSE EFFECT

Interventions → Expectations



Liberation of methane because of global warming

- From the soil of arctic areas
- From the soil of permafrost
- From the oceans

Abnormal greenhouse effect

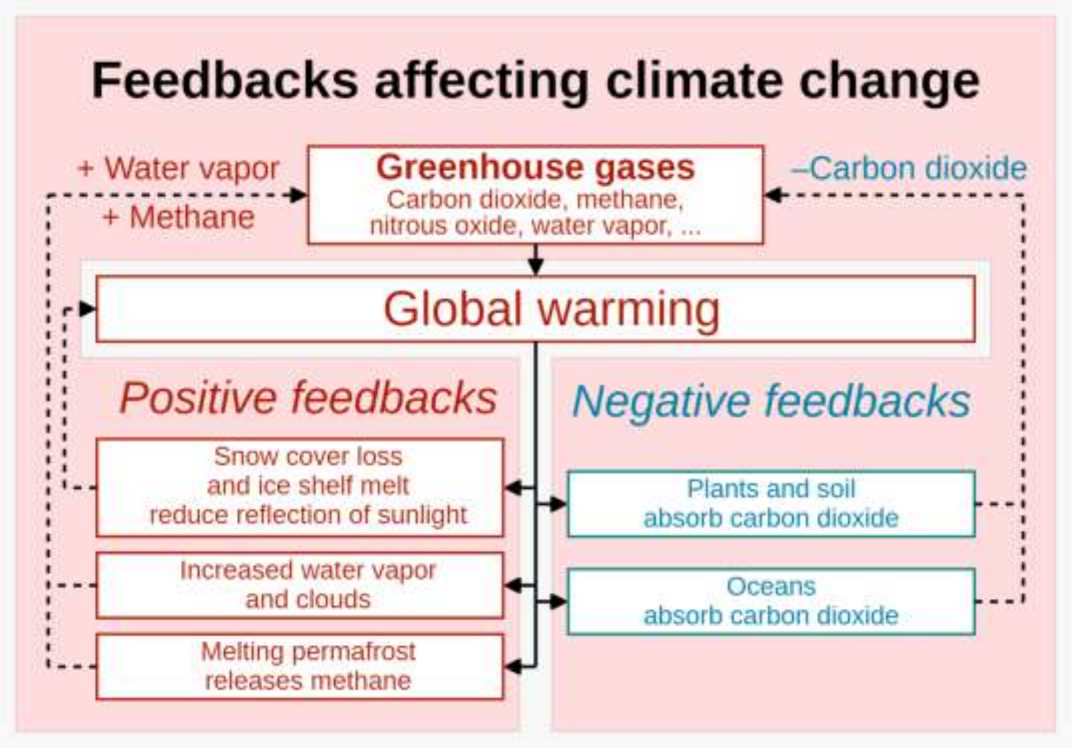
Warming of the atmosphere,
Melting of ice cover
and permafrost

Increasing methane emission

Meadows law

It isn't sure that an overdue intevention lives up to expectations!

It isn't sure that the radical reduction of emission of green-house gases will stop the global warming because of the accelerating positive feedback loops!

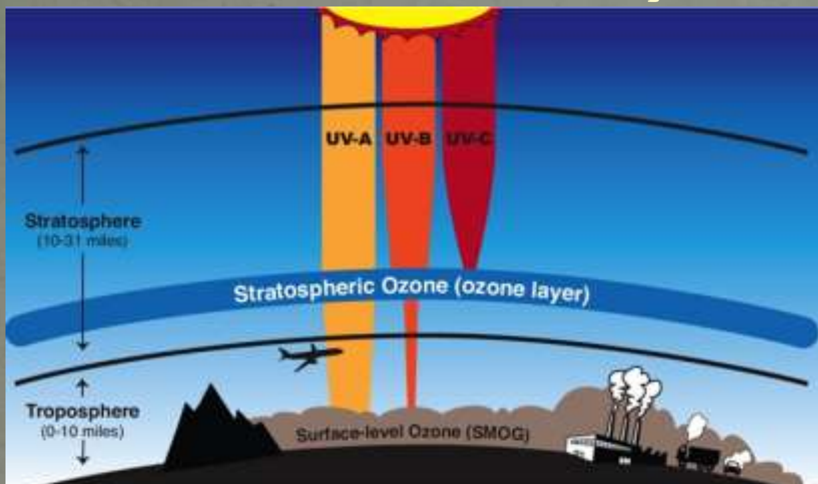


The example of Ozone depletion

https://en.wikipedia.org/wiki/Ozone_depletion

The roles of the atmosphere

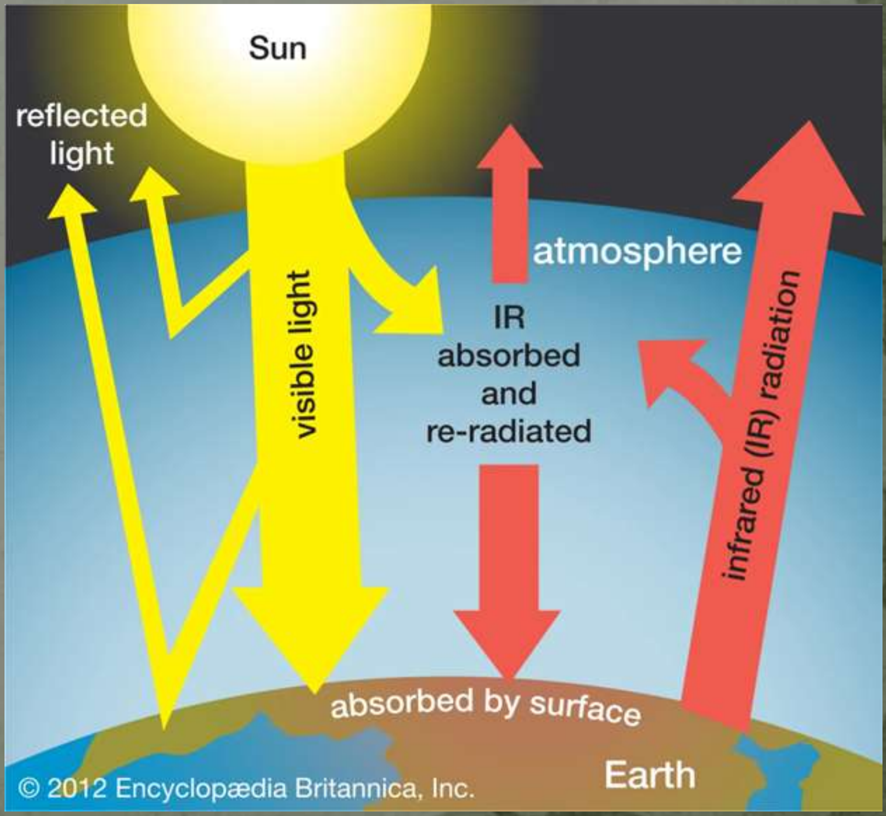
- Ozone layer → Protection from harmful radiation (X-ray, UV)



- Greenhouse gases in normal level → Advantageous greenhouse effect

(It warms the planet to its comfortable average of 15 degrees Celsius)

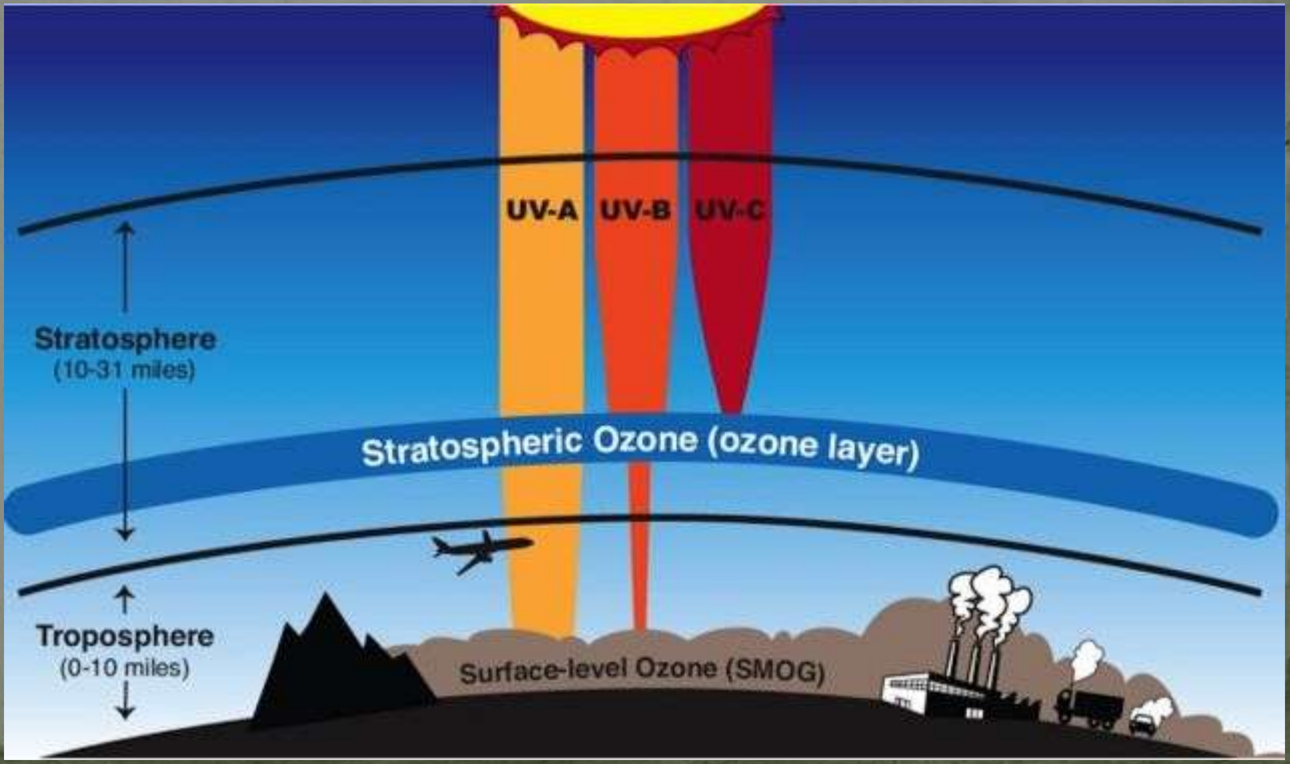
- Oxigen content → Breathing



The role of ozone layer

- It filters out the harmful UV-C radiation totally.
- It decreases UV-B radiation significantly.

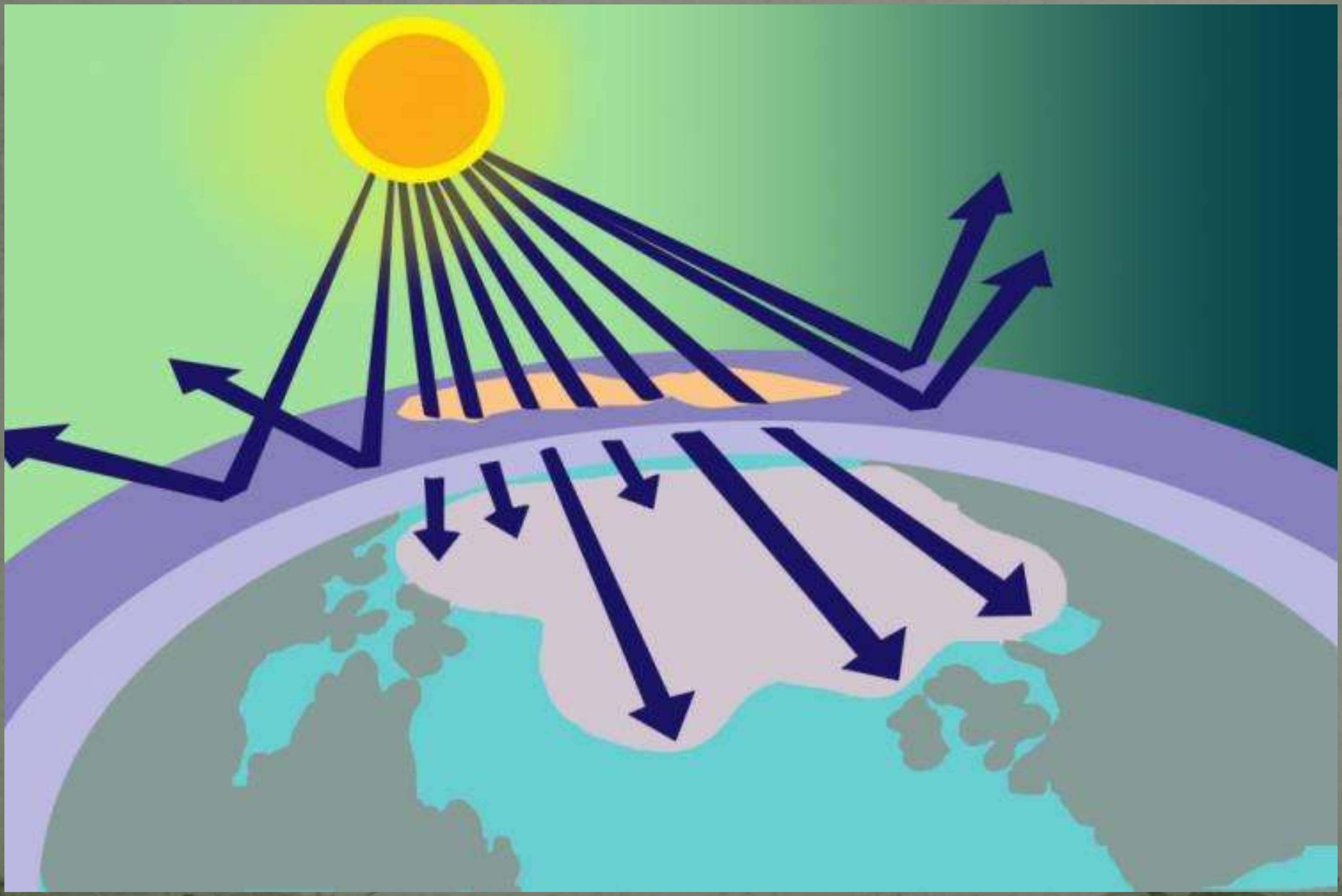
UV-A	UV-B	UV-C
320-400 nm	290-320 nm	<290 nm



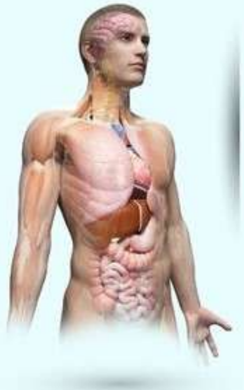
Global effects

- Gas phase ozone decomposition catalysts (Halogenated hydrocarbons)
  - → Concentration of ozone ↓
  - → Harmful UV-radiation ↑
- Utilization of fossil fuels (hard coal, mineral oil, natural gas)
  - → Emission of oxides of carbon, nitrogen and sulfur
    - → Abnormal greenhouse effect (CO_2, N_2O)
    - → Smog (NOx, SO_2, CO ...)
    - → Acid rain (CO_2, NOx, SOx)
- Emission of greenhouse gases ↑ → abnormal greenhouse effect
  - → global warming,
    climate change

Gap in the shield

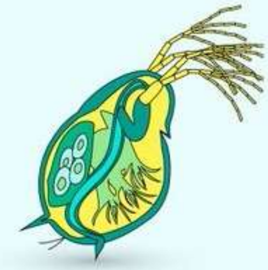


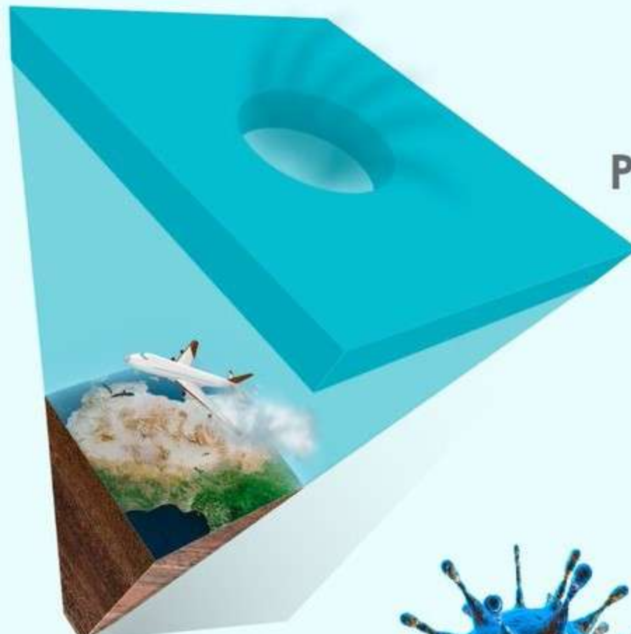
O3 HARMFUL EFFECTS OF OZONE LAYER DEPLETION



HUMAN HEALTH

Increased Ultraviolet Radiations reach the Earth Surface that are harmful for human health



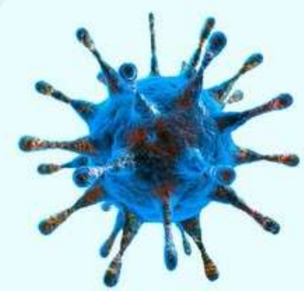


PHYTOPLANKTON GROWTH

UV radiations inhibit the reproductive cycle of phytoplankton, single-celled organisms that make up the bottom of the food chain

CROPS GROWTH

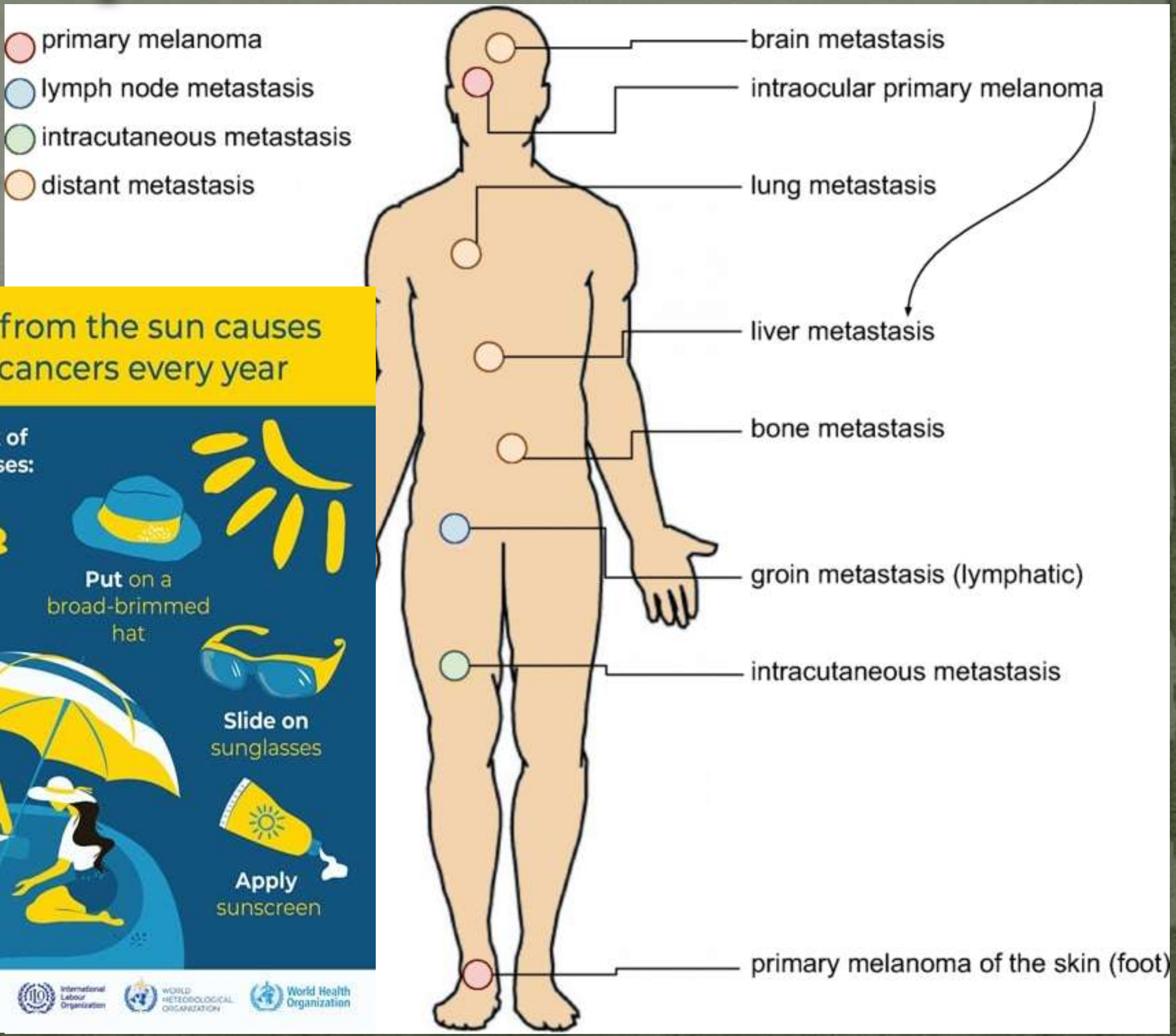
UV radiations also effect on the growth of crops, especially rice



INCREASED DISEASES

Increased risk of skin cancer, infectious diseases and eye related problems

Health impacts



The main cause: Discovery of new non-toxic non-flammable gas (1928)

CFCs = Chloro-fluorocarbons (FREON)

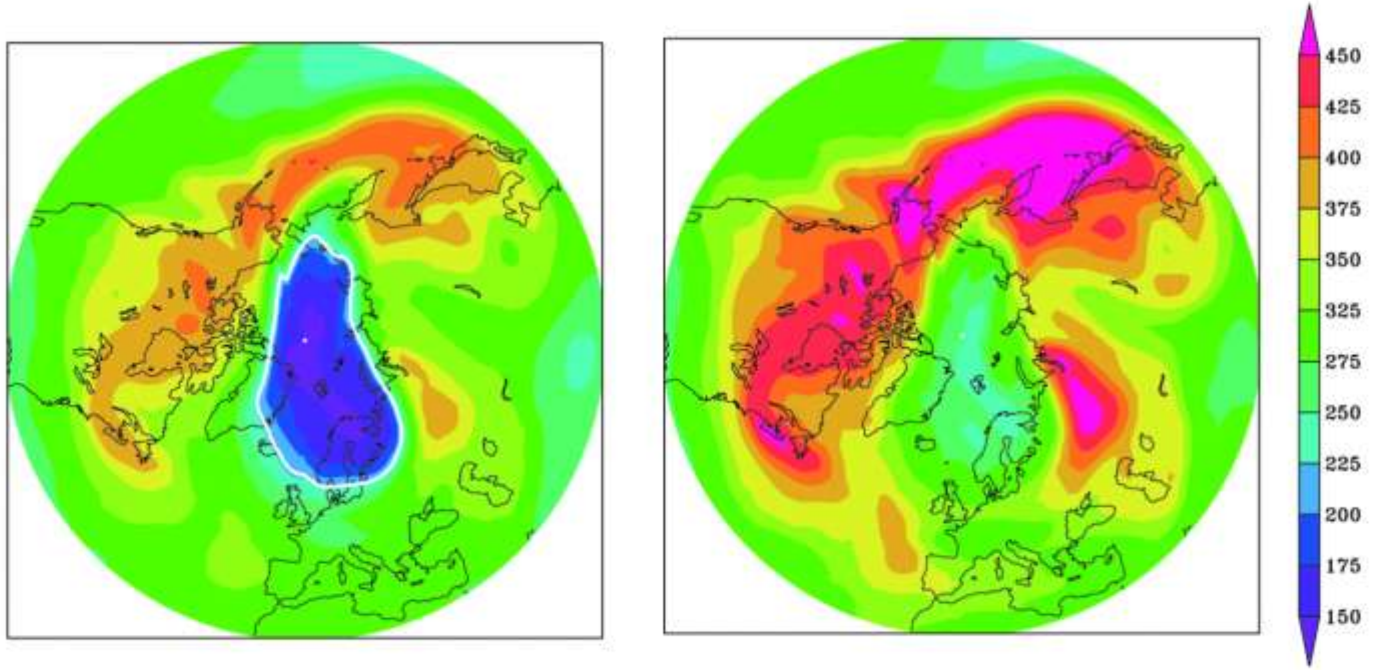
- Synthetic compounds (They haven’t natural sources.)
- Very low reactivity, slow decomposition
- Accumulation in Polar Stratospheric Clouds (PSCs)
  /Antarctica, winter season/
- Liberation in spring
- Temporary decomposition of CFC because of UV-radiation
- Decomposition products of CFC

catalyze the decomposition of ozone

- After catalysis CFCs are re-formed.
- CFCs have greenhouse effect!

Interventions

- Montreal Protocol 1987
- Minimize of production
- Except little amount of these gases, which is indispensable in specific applications
- Recycling of the existing amount of CFC's



Forecasted situation for 2011 without Montreal Protocol and the real situation.

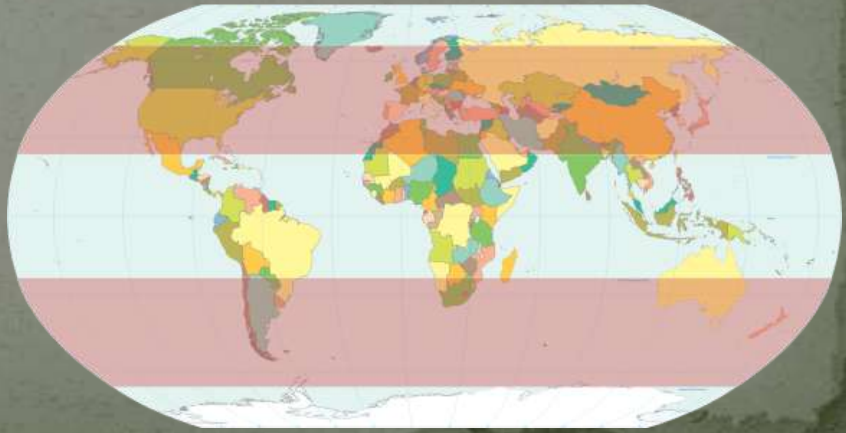
Without the Protocol:

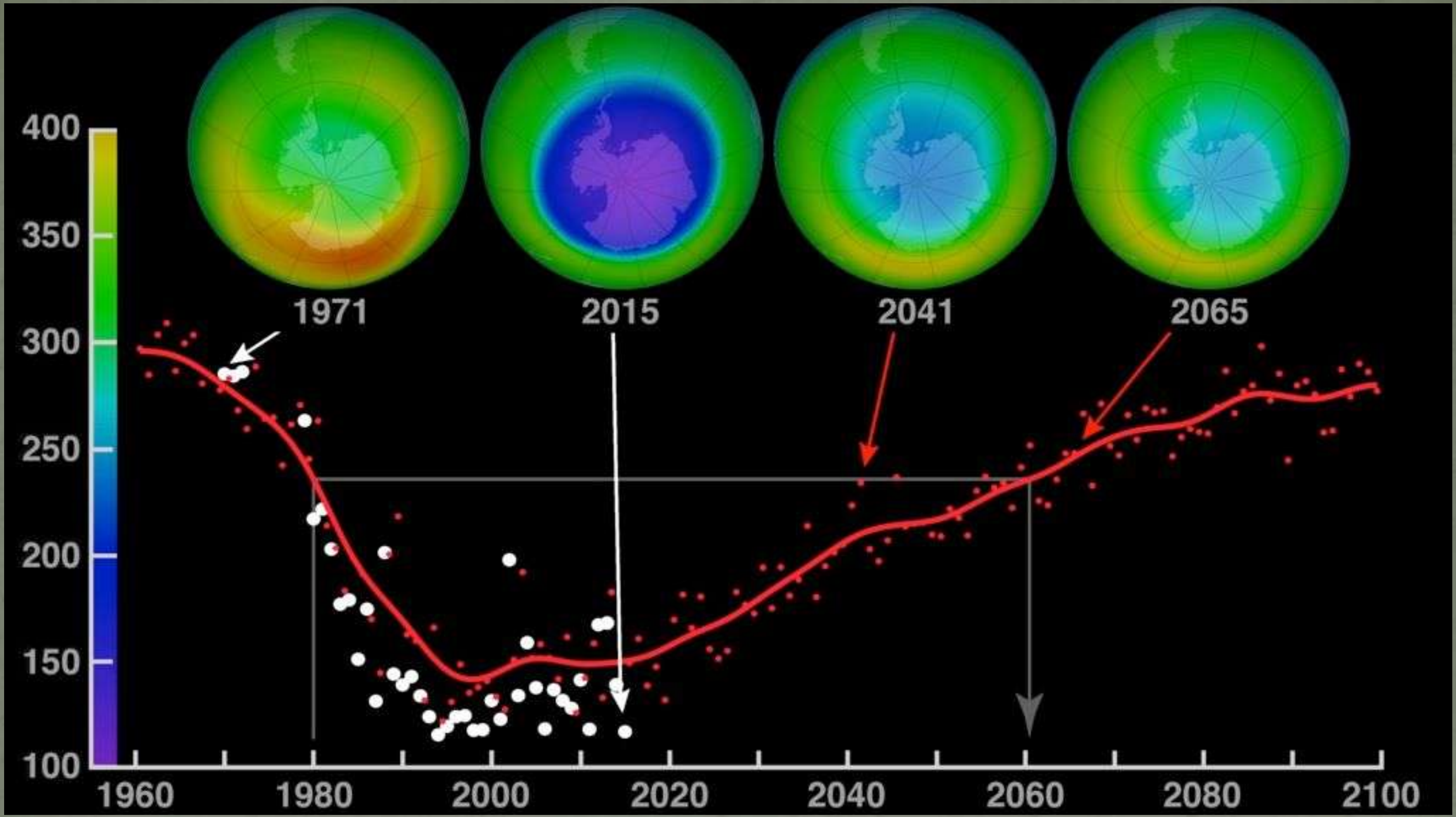
- 2050, Nothern Hemisphere,

Middle Latitude:

50% of UV-protection disappears

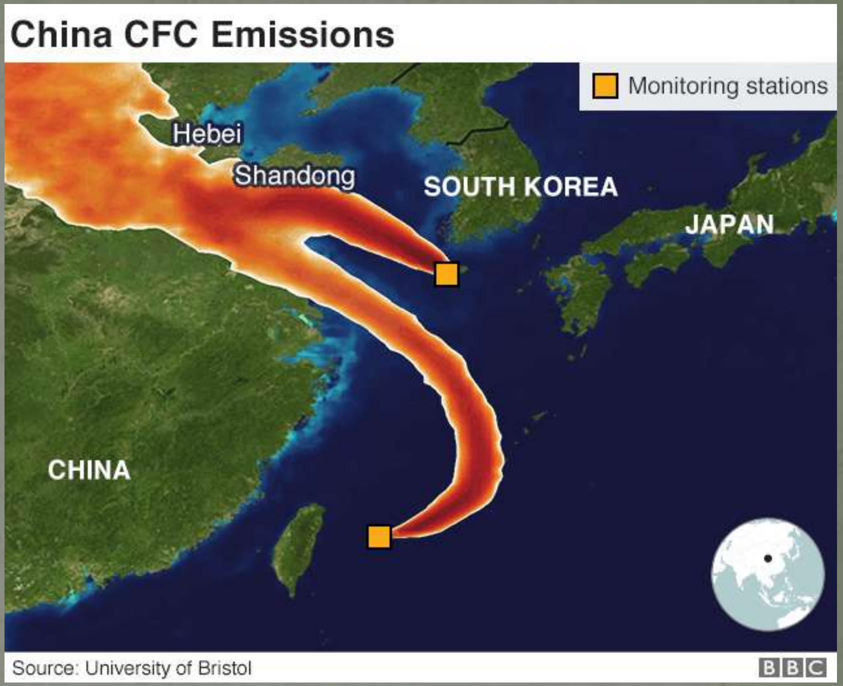
- Southern Hemisphere: -70%!





- Restriction of CFC's use (Montreal Protocol 1987)
- The ozone layer could be fully healed by 2060
- Illegal production of CFC'S in the third world (China)

- Since 2012 reduction of CFC's concentration was 50% slower
- Leakage? Causalty synthesis? Secundary product? NO!



- July 2019: Emission from China (CFC-11 is the cheapest and best blowing agent in foamed plastic production /polyurethane/ → lagging of doors)

Protect yourself from UV!!

Questions

- How can you describe positive feedback loops of global warming?
- What is the role of the ozone layer?
- What are the harmful effects of UV radiation?
- What are the advantageous and disadvantageous properties of CFCs?

Fundamental Ideas of Sustainability

„When man of old appeared upon the earth,
He found a larder stocked with plenteous food;
He needed but to stretch his hand and take,
To satisfy his every want and use.
He thus consumed unthinkingly, apace,
As maggots in a cheese, and warm and fed,
Had time to seek adventure, poesy,
In wondrous visions of his idle thought.

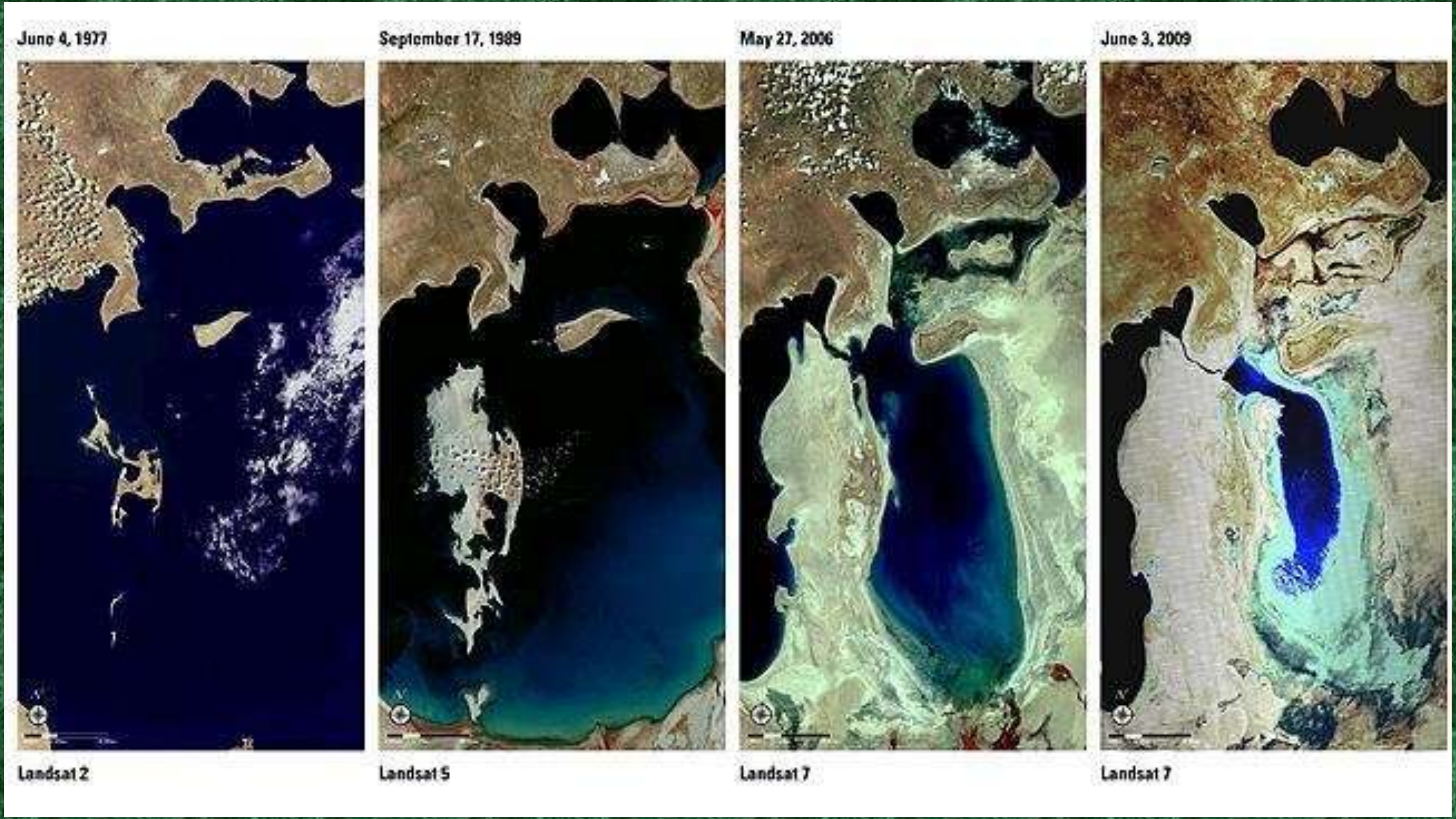
But when the final morsel now we reach,
We must be sparing, since we long have known
The cheese is nearly spent and we must starve."
(The Tragedy of Man, Scene XII)

Endless hunting grounds?

Endless forests?
(e.g. Easter Island)

Endless forests?
(e.g. Ephesos,
a port without seaside)

Endless seas? (e.g. Aral Sea)



Endless seas? (e.g. Aral Sea)

What was the original size of the Aral Sea?

- The Aral Sea was the fourth largest lake in the world and covered around 68,000 square kilometres. It is the worst environmental disaster prompted by human interference, which destroyed the region's ecosystem, economy and livelihood of thousands of people.

Endless seas? (e.g. Aral Sea)

When Why did the Aral Sea dry up?

- The Aral Sea dried up as the waters of its source rivers were diverted for irrigation. The waters of two main rivers, the Syr Darya and the Amu Darya, were used for cotton cultivation, decreasing the sea's water level over the years.

Endless seas? (e.g. Aral Sea)

When did the Aral Sea start shrinking?

- Aral Sea's eastern basin began shrinking in the 1960s. In 2000, Asia's the Aral Sea had already shrunk to a fraction of its 1960 extent.
  - Extensive irrigation
  - and dry weather

  caused her eastern lobe to completely dry in 2014, for the time in 600 years.

The Birth of Environmental Movement: DDT

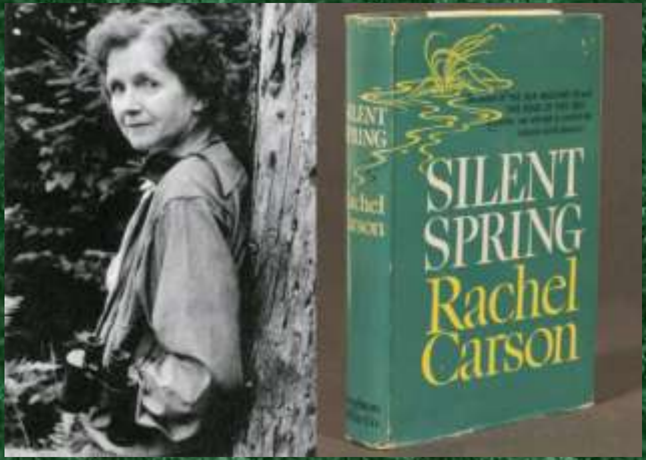
- DDT was first made in 1874 by Othmaar Ziedler.
- Its insecticidal properties were discovered in 1939 by a Swiss chemist, Paul Hermann Müller.
- During and after World War II, DDT was found to be effective against lice, fleas, and mosquitoes (the carriers of typhus, of plague, and of malaria and yellow fever, respectively) as well as the Colorado potato beetle, the spongy moth, and other insects that attack valuable crops. The chemical was widely used, though many species of insects rapidly developed resistant populations.

The Birth of Environmental Movement: DDT

- Paul Hermann Müller received the Nobel Prize for Physiology or Medicine in 1948 for discovering the potent toxic effects on insects of DDT. (britannica)

- As a result of repeated sprayings, DDT accumulated in soils in surprisingly large amounts (10–112 kilograms per hectare [10–100 pounds per acre]).
- Its effects on wildlife greatly increased as it became associated with food chains.
- The stability of DDT led to its bioaccumulation in the bodily tissues of insects that constitute the diet of other animals higher up the food chain, with toxic effects on the latter.
- Songbirds and birds of prey, such as eagles, hawks, and falcons, were usually most severely affected, and serious declines in their populations have been traced to the effects of DDT.

The Birth of Environmental Movement: „Silent Spring”



- Use of DDT began to be restricted in the 1960s, thanks in part to the public awareness raised by Rachel Carson's Silent Spring (1962). DDT was banned outright in the 1970s in many countries. The chemical is still used in some places, particularly as an indoor pesticide for mosquitoes in areas where malaria remains a major public health concern.

First steps

- Adlai Stevenson (US)

UN Economic and Social Council

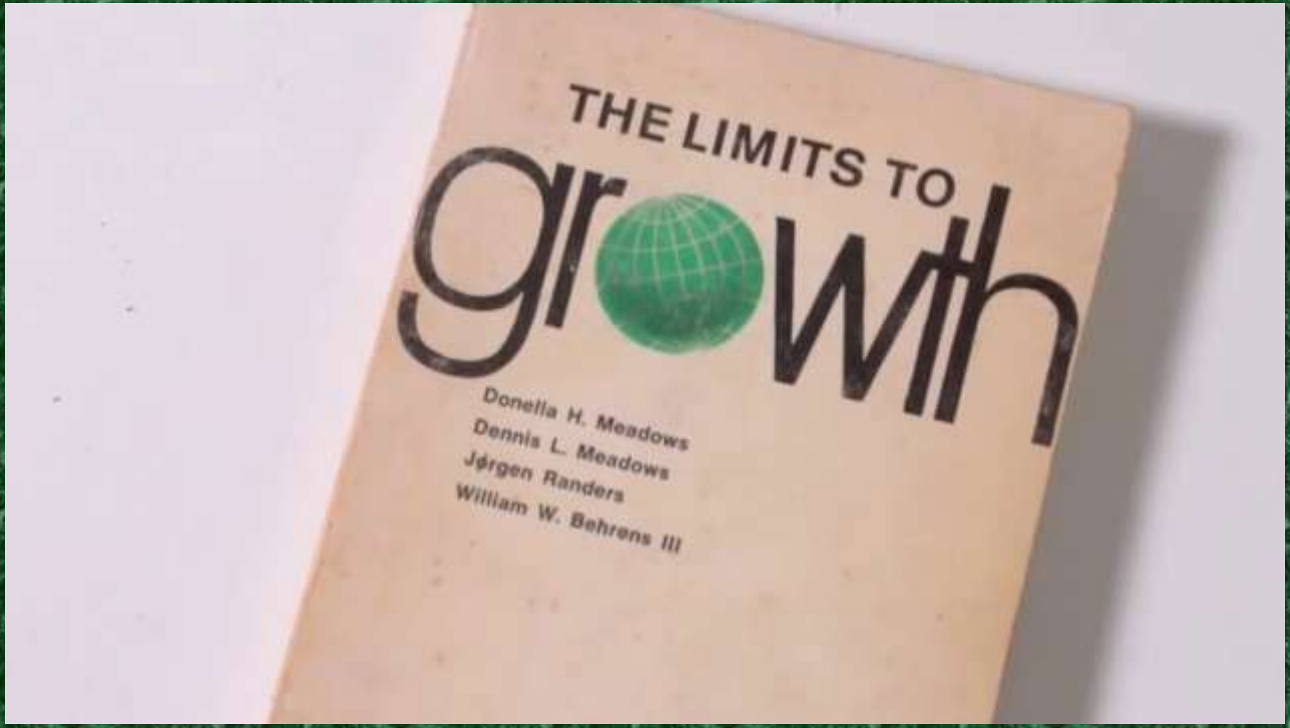
July 9, 1965, Genf

„We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil; all committed, for our safety, to its security and peace; preserved from annihilation only by care, the work and the love we give our fragile craft."

First steps

- 1968 – The Club of Rome
- 1972 – Te Limits to Growth

THE CLUB OF ROME



First steps

1968 - The first international conference on global biosphere protection, UNESCO's **Intergovernmental Conference for Rational Use and Conservation of the Biosphere**, took place in Paris.

- The conference was a turning point in the establishment of international environmental politics.
- As one result of the conference,

in 1970 UNESCO launched its "Man and the Biosphere Program" (MAB) to protect areas representing the central ecosystems of the planet as "biosphere reserves."

First steps

1969 - The UN Secretary-General U Thant delivers a report, **Activities of United Nations Organizations and Programmes Relevant to the Human Environment**, which issues a stark warning:

"If current trends continue,
life on Earth could be endangered."

- This report called for the convening of the **UN Conference on the Human Environment** → 1972

(unep.org)

First steps

1972 - The United Nations Conference on the Human Environment

- Held in Stockholm, Sweden,
- in June 1972,…

- …this landmark conference places the environment on the global agenda and leads to **the formation of UNEP (United Nations Environment Programme).**
- The event's declaration resulted in what is often seen as the **first step toward the development of international environmental law and the recognition of the importance of a healthy environment for people.**

The United Nations Environment Programme (UNEP) is the leading environmental authority in the United Nations system.

- UNEP uses its expertise to strengthen environmental standards and practices while helping implement environmental obligations at the country, regional and global levels.
- UNEP’s mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UN environment programme

50 1972-2022

SIX AREAS OF CONCENTRATION:

- 1. CLIMATE CHANGE
- 2. POST-CONFLICT AND DISASTER
- 3. ECOSYSTEM MANAGEMENT
- 4. ENVIRONMENTAL GOVERNANCE
- 5. HARMFUL SUBSTANCES
- 6. RESOURCE EFFICIENCY/SUSTAINABLE CONSUMPTION AND PRODUCTION

Further Outcomes

- **Convention for the Prevention of Pollution from Ships (London, 1973)**

→Strict rules on the shipping industry, helping to prevent spills and pollution from routine operations.

- **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Washington, 1973)**

→ A cornerstone of international conservation efforts

- **CONFERENCE ON SECURITY AND CO-OPERATION IN EUROPE (Helsinki, 1975)**

→About Long-range Transboundary Air and Water Pollution

Meanwhile in Italy…

1976 - „The north Italian town of Seveso has been the scene of an ecological disaster that sounds the alarm about mankind's fatally laggard approach to the problems of chemical contamination. Seveso's troubles began early this summer when a chemical plant process went awry. Temperatures and pressures soared, and a valve released a white cloud of smoke.

That white cloud contained, among other compounds a chemical called dioxin, a highly toxic substance which, even in minute quantities, can produce deformations in human fetuses. No comparable release of dioxin into the general environment had ever occurred, and it took a week before the deaths of animals and plants and the development of skin ailments in children led to full recognition of the disaster. Since then the population has been evacuated, and some pregnant women living in the area have had abortions."

Meanwhile in Italy…

1976 - „The magnitude of the problem posed by this dioxin contamination is indicated by plans now being drawn up to remove all vegetation and the earth itself to a depth of one foot from the directly affected areas and process them in special incinerators capable of producing temperatures high enough to disintegrate this persistent chemical. Houses in the area nearest to the chemical plant are to be demolished, while structures left standing must be decontaminated."

Meanwhile in Italy…

- Seveso Directive of European Comission (1982)
  - A contribution to Technological Disaster Risk Reduction

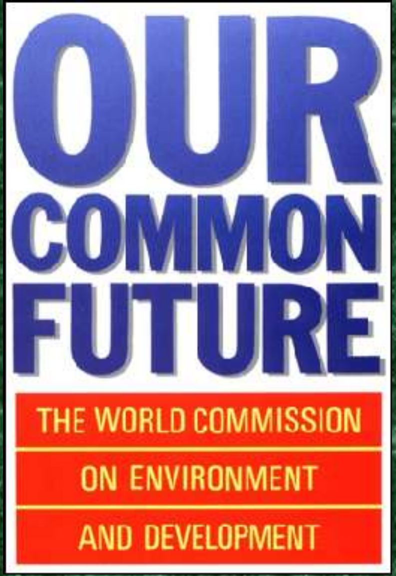
Further Outcomes

- **Helsinki Protocol** on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (1985)
- **Vienna Convention** for the Protection of the Ozone Layer (1985)
- **Montreal Protocol** on Substances that Deplete the Ozone Layer (1987)
- **Sofia Protocol** (1988) – Protocol concerning the Control of Emissions of Nitrogen Oxides
- **Basel Convention** (1989) – Strict rules on the movement and disposal of hazardous waste.

The World Commission on Environment and Development

- ...also known as the Brundtland Commission after its chairman, Gro Harlem Brundtland...
- ...was convened by the United Nations in 1983 to address growing concern "**about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development.**"

The World Commission on Environment and Development



- „**Our Common Future**” **report** (1987):
  - "Re-examine the critical issues of environment and development and to formulate innovative, concrete, and realistic action proposals to deal with them;
  - Strengthen international cooperation on environment and development and to assess and propose new forms of cooperation that can break out of existing patterns and influence policies and events in the direction of needed change; and
  - Raise the level of understanding and commitment to action on the part of individuals, voluntary organizations, businesses, institutes, and governments. The Commission focused its attention in the areas of population, food security, the loss of species and genetic resources, energy, industry, and human settlements - realizing that all of these are connected and cannot be treated in isolation one from another."

Sustainable Development

- 1987 – **Sustainable Development:**

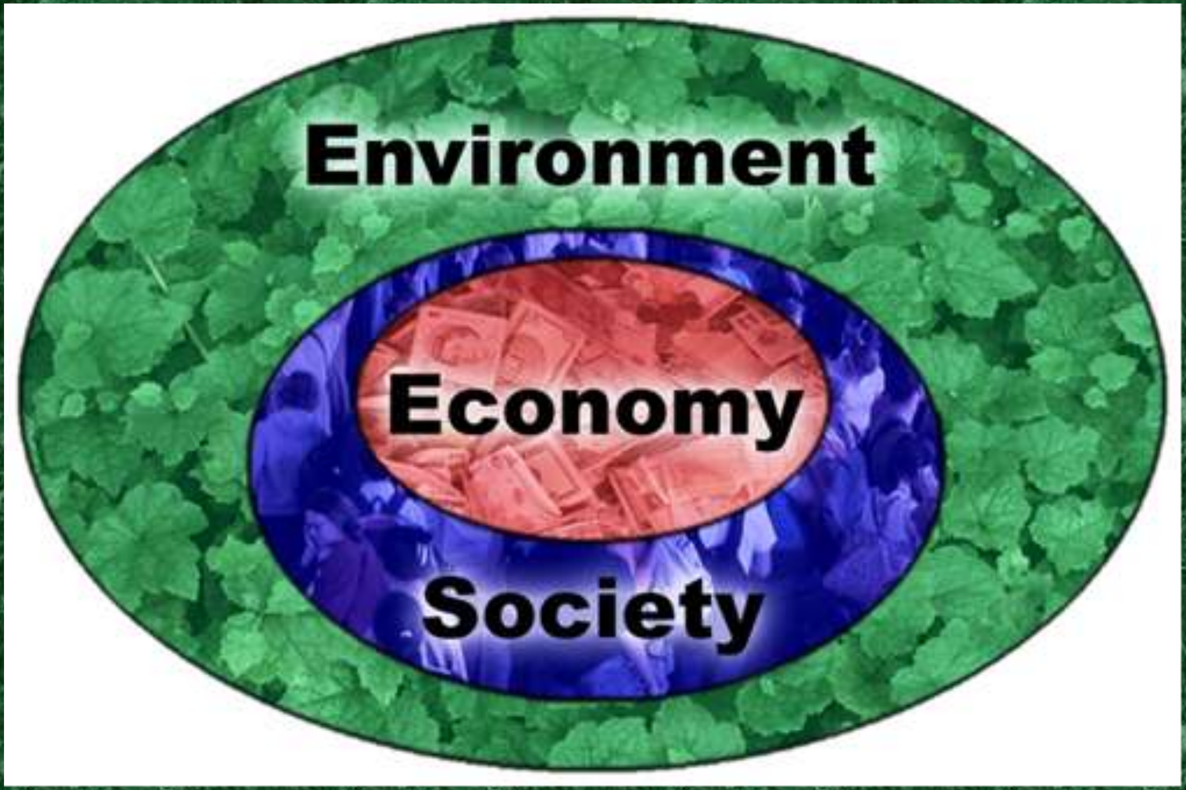
"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- 1992 - The Rio de Janeiro conference highlighted
  - how different social,
  - economic
  - and environmental factors

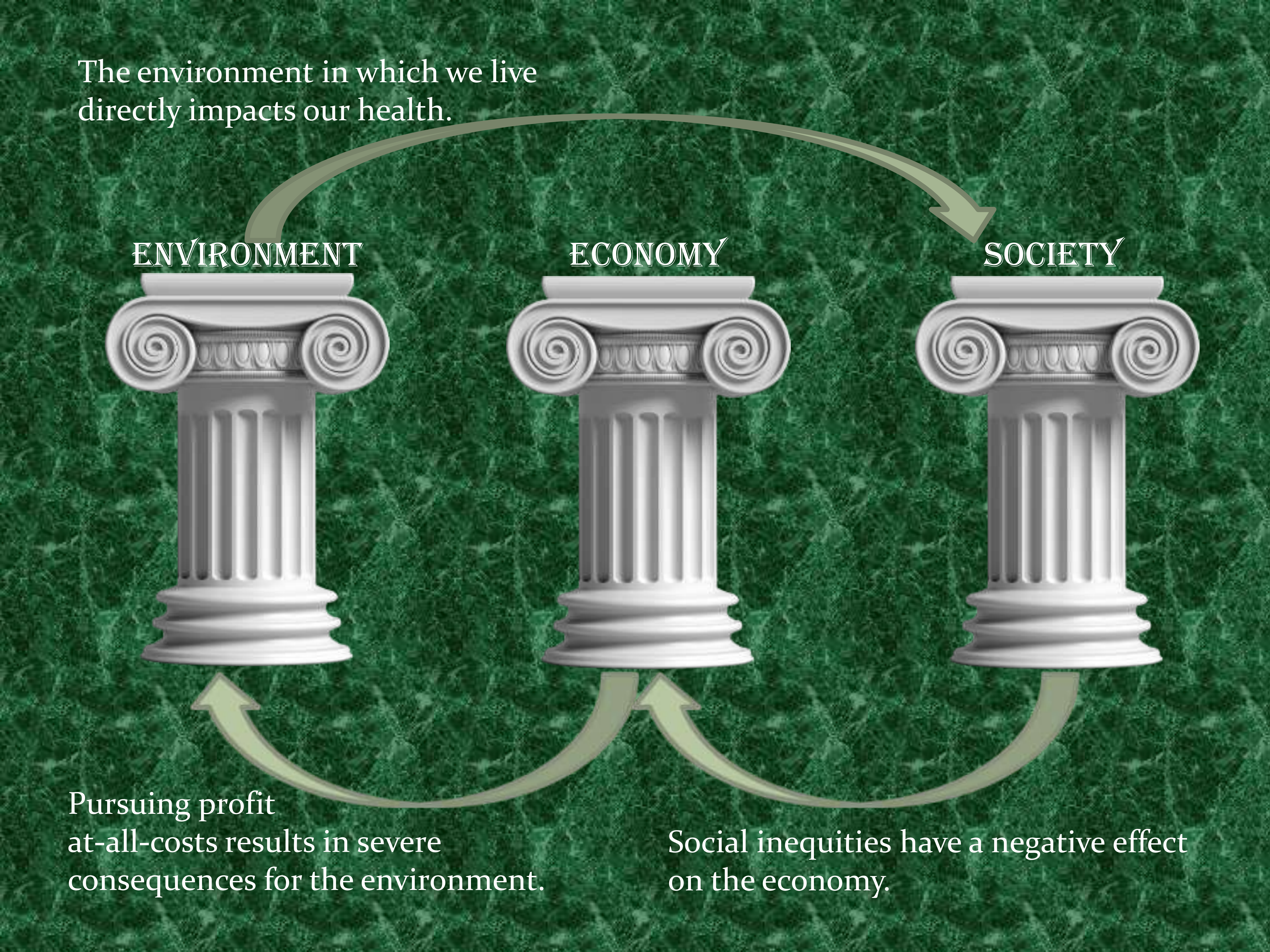
  are interdependent
  and evolve together,
  and how success in one sector
  requires action in other sectors
  to be sustained over time.

„...needs of future generations...”

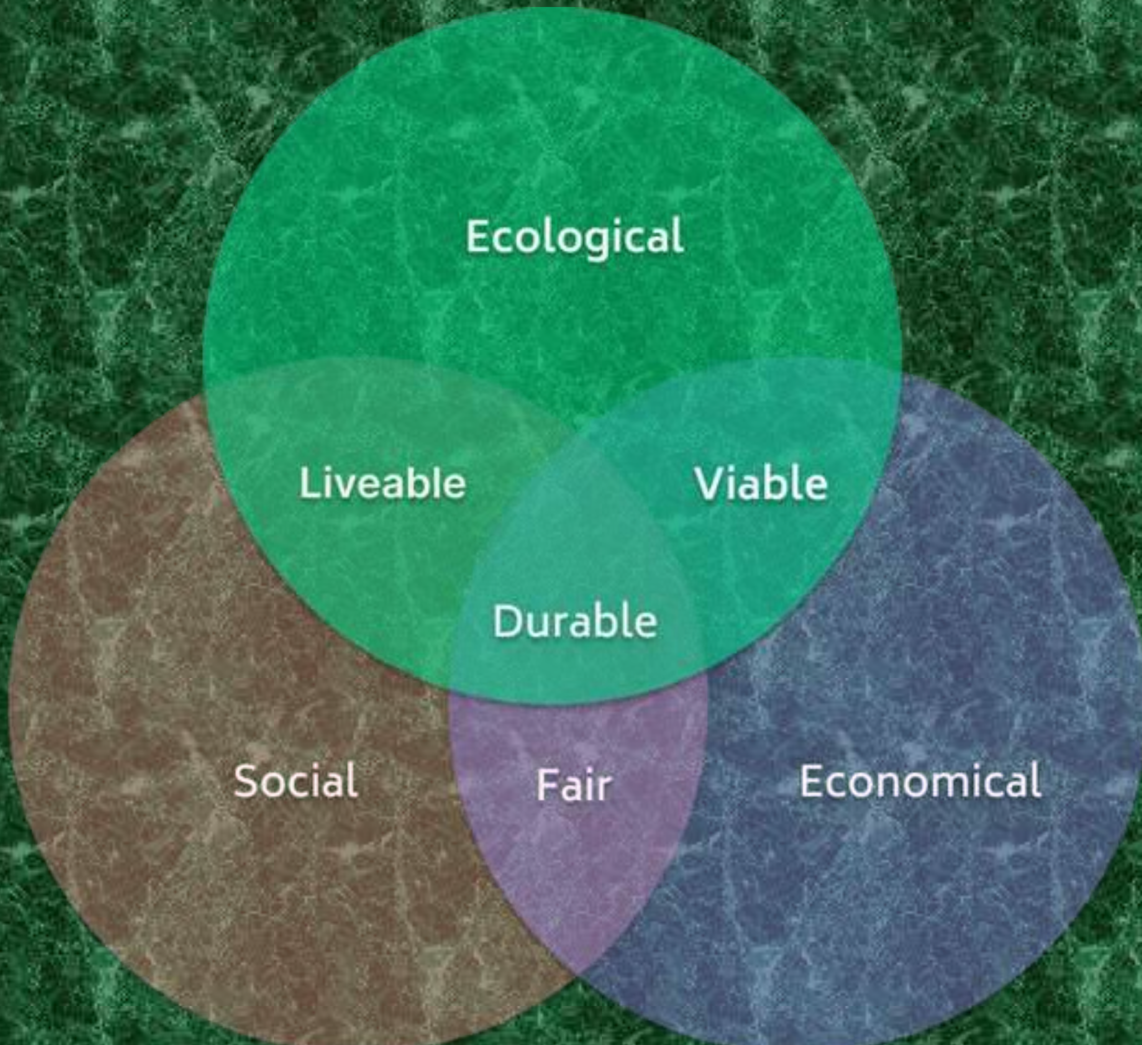
Key Areas of Sustainable Development



The economic,
social and
environmental pillars
of sustainable development
are not independent of one another…


The environment in which we live
directly impacts our health.
ENVIRONMENT
ECONOMY
SOCIETY
Pursuing profit
at-all-costs results in severe
consequences for the environment.
Social inequities have a negative effect
on the economy.

Key Areas of Sustainable Development



Key Areas of Sustainable Development

- **Environmental pillar of sustainability:**

It involves ensuring that the natural environment, including natural resources / air / land / ecosystems are healthy, protected, and restored (if necessary).

- Ecosystem services
- Green engineering and chemistry
- Air quality
- Water quality
- Stressors
- Resource integrity

Key Areas of Sustainable Development

- **Environmental sustainability:**

Ecological integrity is maintained, all of earth's environmental systems are kept in balance while natural resources within them are consumed by humans at a rate where they are able to replenish themselves.


4 Pillars of Sustainability
ENVIRONMENTAL
SUSTAINABILITY
• Consider the environment in the business strategy
• Switch to renewable energy
• Choose local suppliers
• Be more efficient by leveraging Digital Transformation
• Pursue eco-friendly design and production

Key Areas of Sustainable Development

- **Economic pillar of sustainability:**

It involves supporting the economic growth and financial stability of communities and individuals without compromising on their social, environmental, and cultural aspects.

- Jobs
- Incentives
- Supply and demand
- Natural resource accounting
- Costs
- Prices

Key Areas of Sustainable Development

- **Economic Sustainability:**

Human communities across the globe are able to maintain their independence and have access to the resources that they require, financial and other, to meet their needs. Economic systems are intact and activities are available to everyone, such as secure sources of livelihood.


ECONOMIC
Sustainability
• A business needs to be profitable to survive.
• Making a profit is an indication that the business is delivering something valuable.
• But the pursuit of profit should not come by neglecting environmental and social issues.

Key Areas of Sustainable Development

- **Social pillar of sustainability:**

It includes that all members of society throughout the world have fair access to resources and opportunities. In addition to this, it also involves the full participation of everyone in a healthy social life and culture. All in all, it’s centered around liveability and viability.

- Environmental justice
- Human health
- Participation
- Education
- Resource security
- Sustainable communities

Key Areas of Sustainable Development

- **Social Sustainability:**

Universal human rights and basic necessities are attainable by all people, who have access to enough resources in order to keep their families and communities healthy and secure. Healthy communities have just leaders who ensure personal, labour and cultural rights are respected and all people are protected from discrimination.

SOCIAL

SUSTAINABILITY

Social sustainability aims at:

- social well-being,
- social cohesion
- equality
- development of a thriving society
- Valuing relationships

Approval and support of society is an asset for the long term sustainability

The 2030 Agenda for Sustainable Development (2015)

The 2030 Agenda for Sustainable Development (2015)

- NO POVERTY: End poverty in all it forms everywhere
- ZERO HUNGER: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- GOOD HEALTH AND WELL-BEING: Ensure healthy life and promote well-being for all at all ages.


Poverty is not just about food
Education
Social justice
Health
Climate change
Gender equality
Decent work opportunities
To sustainably end poverty we must tackle all of these.
The Hunger Project.
UNITED KINGDOM
World Food Day and World Poverty Day
16th and 17th October
www.thehungerproject.org.uk

The 2030 Agenda for Sustainable Development (2015)

- QUALITY EDUCATION:

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

- GENDER EQUALITY:

Achieve gender equality and empower all women and girls.


Promoting and fostering gender equality throughout education paths is an important step towards more sustainable, peaceful and democratic societies.

The 2030 Agenda for Sustainable Development (2015)

- CLEAN WATER AND SANITATION:

Ensure availability and sustainable management of water and sanitation for all.

- AFFORDABLE AND CLEAN ENERGY:

Ensure access to affordable, reliable, sustainable and modern energy for all.

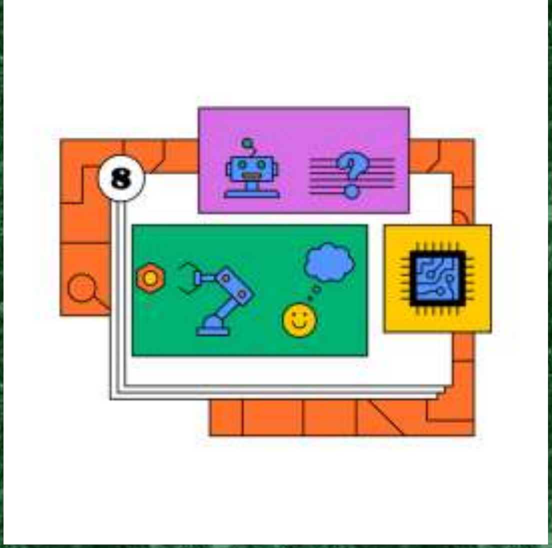
The 2030 Agenda for Sustainable Development (2015)

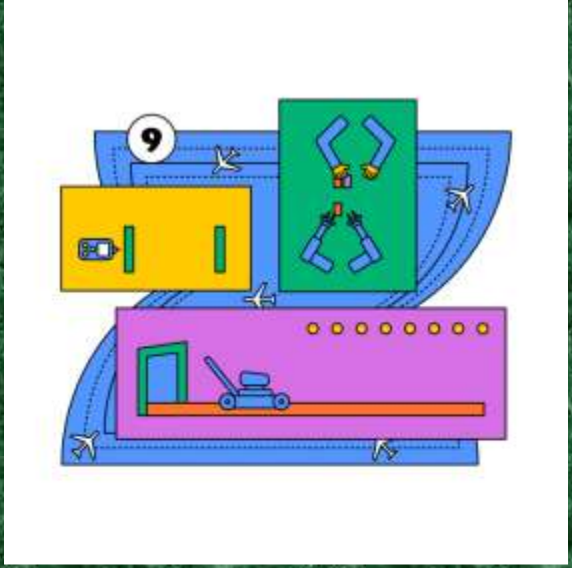
- DECENT WORK AND ECONOMIC GROWTH:

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

- INDUSTRY, INNOVATION AND INFRASTRUCTURE:

Built resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.





The 2030 Agenda for Sustainable Development (2015)

- REDUCED INEQUALITIES:

Reduce inequalities within and among countries.

- SUSTAINABLE CITIES AND COMMUNITIES: Make cities and human settlements inclusive, safe, resilient and sustainable.

The 2030 Agenda for Sustainable Development (2015)

- RESPONSIBLE CONSUMPTION AND PRODUCTION:

Ensure sustainable consumption and production patterns.

- CLIMATE ACTION: Take urgent action to combat climate change and its impacts.
- LIFE BELOW WATER: Conserve and sustainably use of oceans, seas and marine resources for sustainable development.
- LIFE ON LAND: Protect, restore and promote sustainable use of

terrestrial ecosystems, sustainably managed forests, combat desertification, and halt and reserve land degradation and halt biodiversity loss.

The 2030 Agenda for Sustainable Development (2015)

- PEACE, JUSTICE AND STRONG INSTITUTIONS:

Promote peaceful and inclusive societies, for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

- PARTNERSHIPS FOR THE GOALS: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

Implementation

- Development of new technologies
- Reorganization of economy
- New trends in consumer behavior

Global Sustainable Development Report (2023)

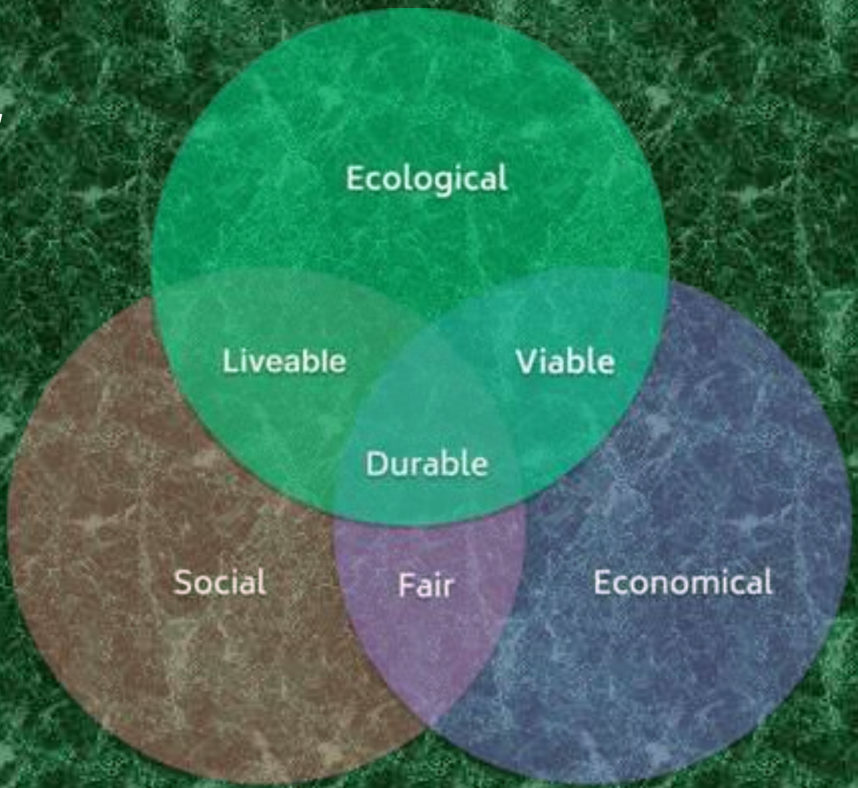
- The 2023 Global Sustainable Development Report will be launched as the world approaches the half-way point of the 2030 Agenda and struggles to rebuild in the aftermath (or in the midst) of the COVID-19 pandemic.
- In this context, practical solutions that can accelerate progress on the SDGs will be urgently needed.
- The 2023 Report will build on the 2019 Report providing evidence that can help decision-makers to accelerate action and overcome impediments that stand in the way of progress on sustainable development.
- The focus will be on accelerating transformation through important entry points and enabling science to support this acceleration.


The Future
NEXT EXIT

Indicators of Sustainable Development

Sustainability Measurement

- Sustainability is measured
by assessing performance of
  - Social,
  - Environmental,
  - and Economic principles.

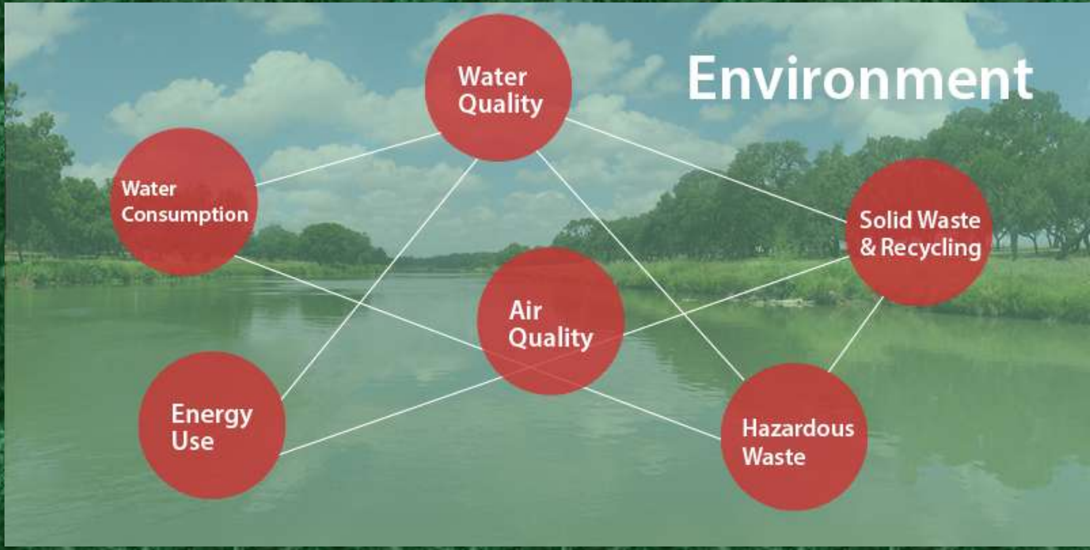


- While a balanced treatment of all three is an ideal goal, it is not always achievable.

Environmental Sustainability Indicators

- Global warming potential
- Acidification potential
- Ozone depletion potential
- Aerosol optical depth
- Eutrophication potential
- Ionization
radiation potential

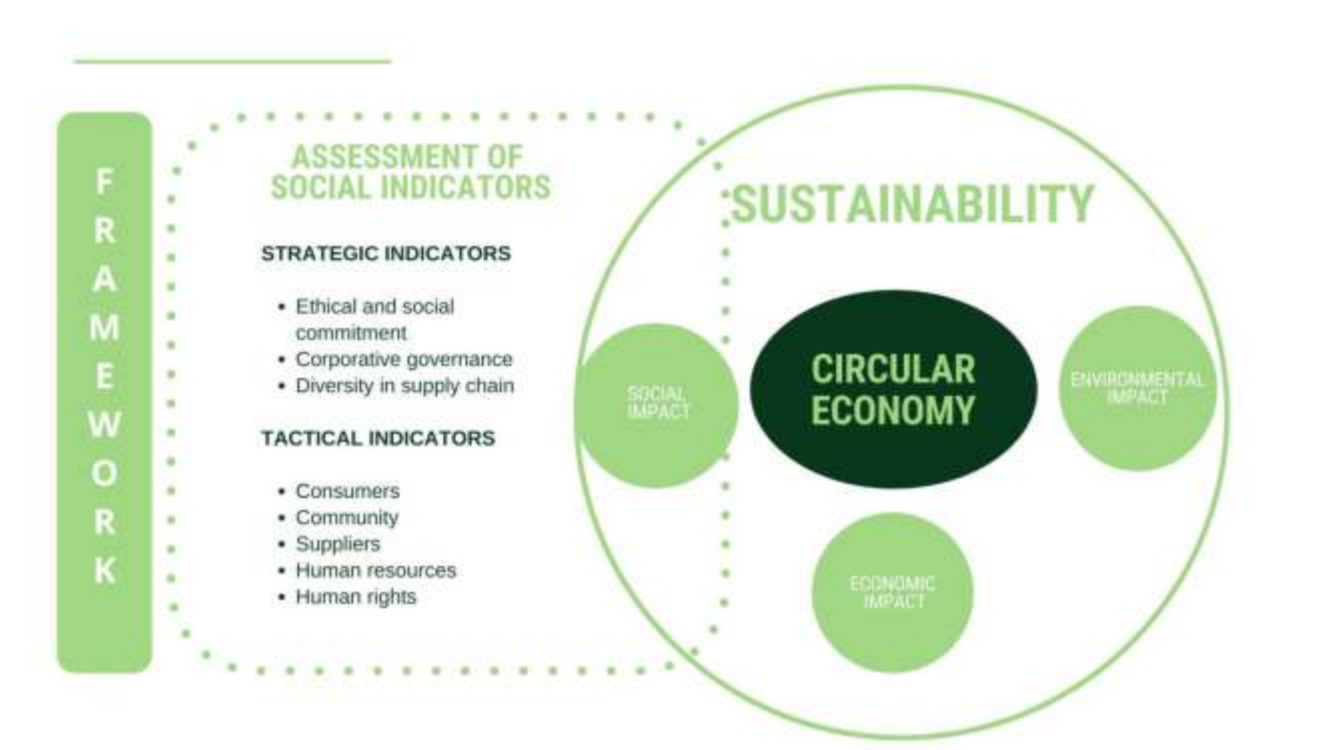
- Photochemical ozone potential
- Waste treatment
- Freshwater use
- Energy resources use
- Level of Biodiversity



Social Sustainability Indicators

- Employment generated
- Equity
- Health and safety
- Education

- Housing/living conditions
- Community cohesion
- Social security



Economic Sustainability Indicators

- Gross Domestic Product
- Trade balance
- Local government income
- Profit, value and tax
- Investments

Sustainability Indices

- **Environment, Social and Corporate Governance:**
  - **ESG** is a framework used to assess an organization's business practices and performance on various sustainability and ethical issues.
  - **ESG** also provides a way to measure business risks and opportunities in those areas.

Some investors use ESG criteria to evaluate companies and help determine their investment plans.

Sustainability Indices

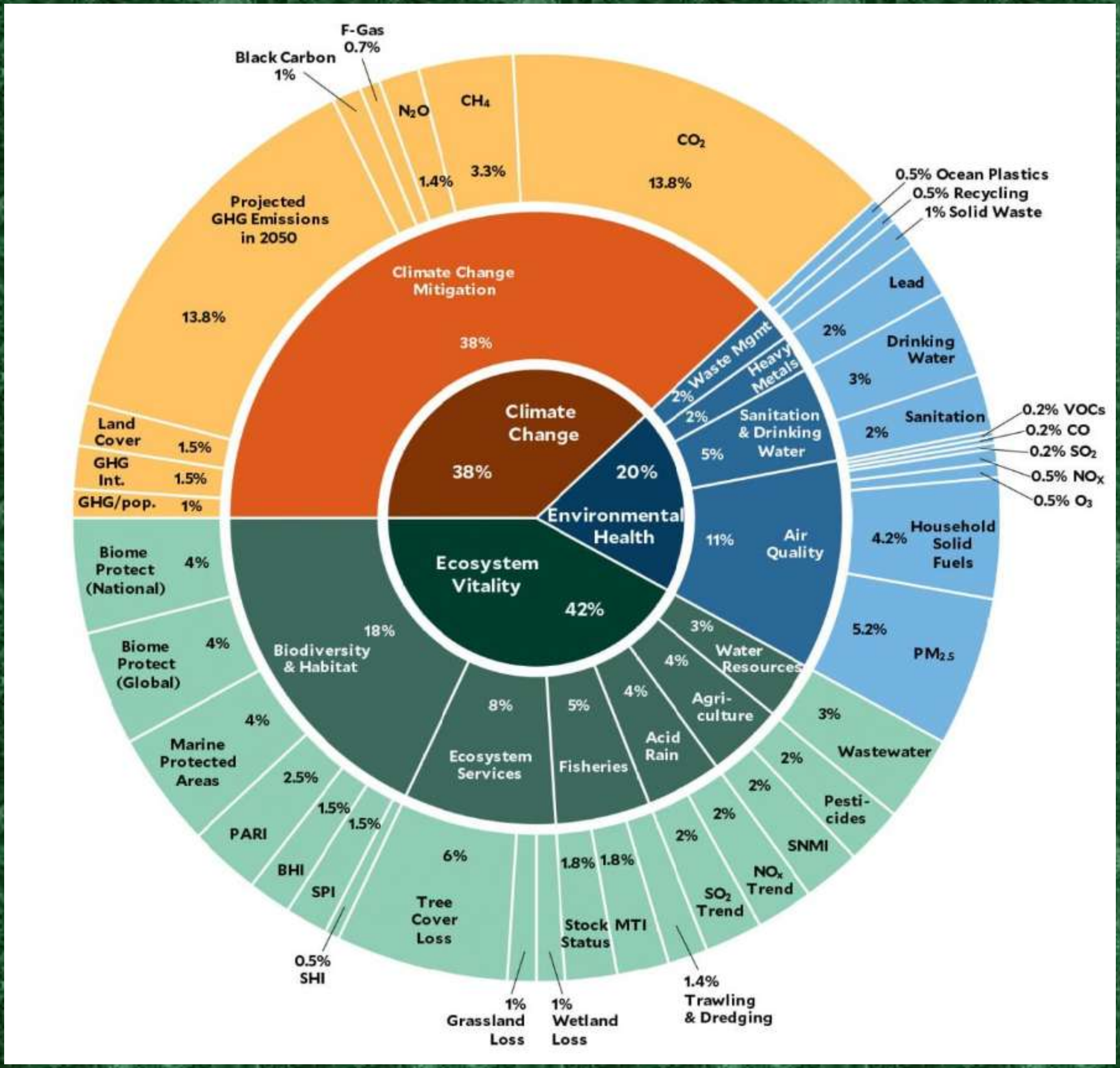
- **Environment, Social and Corporate Governance**

Sustainability Indices

- **Environmental Performance Index :**
  - **EPI** provides a data-driven summary of the state of sustainability around the world.
  - **EPI** ranks 180 countries

on climate change performance,
environmental health,
and ecosystem vitality
→ National Scale of Countries

https://epi.yale.edu/



Climate Change
38%
Environmental Health
20%
Ecosystem Vitality
42%
Climate Change Mitigation
38%
Projected GHG Emissions in 2050
13.8%
Black Carbon 1%
F-Gas 0.7%
N2O
1.4%
CH4
3.3%
CO2
13.8%
Land Cover 1.5%
GHG Int. 1.5%
GHG/pop. 1%
Waste Mgmt
2%
Heavy Metals
2%
Sanitation & Drinking Water
5%
Air Quality
11%
0.5% Ocean Plastics
0.5% Recycling
1% Solid Waste
Lead
2%
Drinking Water
3%
Sanitation
2%
0.2% VOCs
0.2% CO
0.2% SO2
0.5% NOX
0.5% O3
Household Solid Fuels
4.2%
PM2.5
5.2%
Biodiversity & Habitat
18%
Ecosystem Services
8%
Fisheries
5%
Acid Rain
4%
Agri-culture
4%
Water Resources
3%
Biome Protect (National) 4%
Biome Protect (Global) 4%
Marine Protected Areas 4%
PARI 2.5%
BHI 1.5%
SPI 1.5%
0.5% SHI
Tree Cover Loss 6%
1% Grassland Loss
1% Wetland Loss
Stock Status 1.8%
MTI 1.8%
1.4% Trawling & Dredging
SO2 Trend 2%
NOx Trend 2%
SNMI 2%
Pesti-cides 2%
Wastewater 3%

COUNTRY	RANK	EPI SCORE	10-YEAR CHANGE
FILTER BY REGION: ALL REGIONS			
Denmark	1	77.90	14.90
United Kingdom	2	77.70	23.00
Finland	3	76.50	21.00
Malta	4	75.20	25.40
Sweden	5	72.70	15.80
Luxembourg	6	72.30	13.50
Slovenia	7	67.30	8.60
Austria	8	66.50	7.20
Switzerland	9	65.90	8.20
Iceland	10	62.80	4.40

Hungary

Region	Eastern Europe
GDP	302.32 [PPP 2011$ billions]
GDP per capita	31007.77 [$]
Population	9.75 [millions]
Land Area	92922.39 [sq. km]

Country Scorecard

COMPONENT	RANK	EPI SCORE	10-YEAR CHANGE
FILTER: ALL CATEGORIES			
EPI	33	55.10	2.00

ENVIRONMENTAL PROTECTION INDEX	
New Zealand	56.7
Spain	56.6
Bahamas	56.2
Greece	56.2
Romania	56
Lithuania	55.9
Seychelles	55.6
Hungary	**55.1**
North Macedonia	54.3
Botswana	54

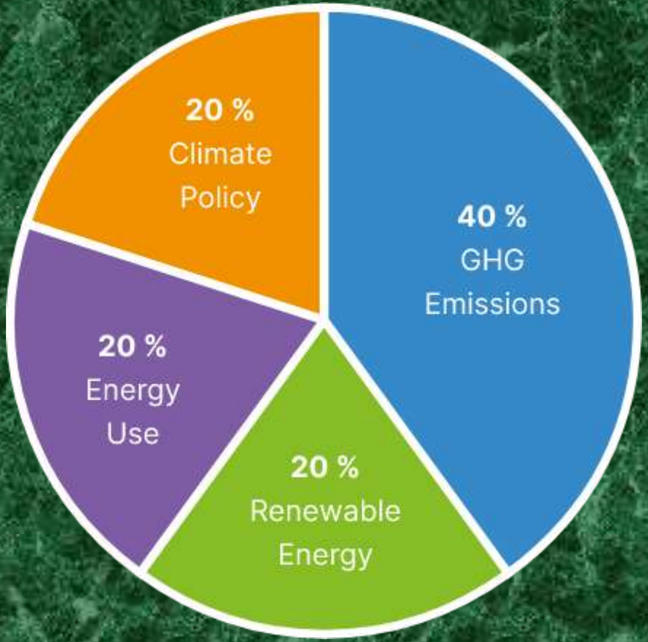
GDP PER CAPITA	
Latvia	61.1
Slovakia	60
Cyprus	58
Bahamas	56.2
Greece	56.2
Romania	56
Hungary	**55.1**
Poland	50.6
Portugal	50.4
Turkey	26.3

ISSUE PERFORMANCE	
Croatia	60.2
Slovakia	60
Lithuania	55.9
Hungary	**55.1**
Bulgaria	51.9
Poland	50.6
Ukraine	49.6
Belarus	48.5
Mexico	45.5
Brazil	43.6

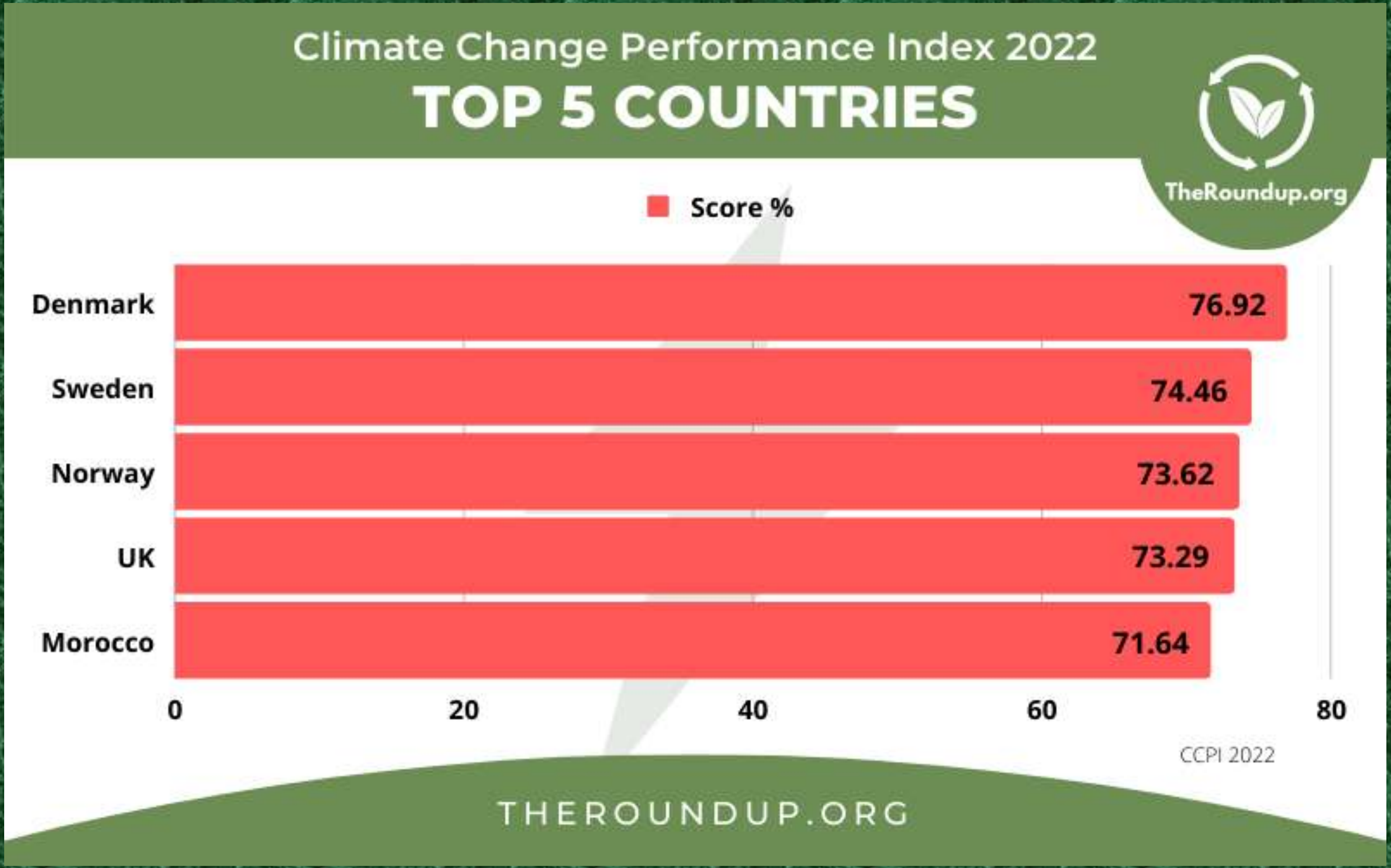
Sustainability Indices

- **Climate Change Performance Index :**
  - **CCPI** is an instrument to enable transparency in national and international climate politics.
  - **CCPI** uses a standardized framework to compare the climate performance of 59 countries and the EU, which together account for 92% of global greenhouse gas emissions.
  - **CCPI** is assessed in four categories:
    - GHG Emissions,
    - Renewable Energy,
    - Energy Use
    - and Climate Policy.

  https://ccpi.org/



Which country is doing the most for climate change?



Sustainability Indices

- **Happy Planet Index :**
  - **HPI** is a measure of sustainable wellbeing, ranking countries by how efficiently they deliver long, happy lives using our limited environmental resources.
    - Wellbeing
    - Life Expectancy
    - Ecological footprint
- https://happyplanetindex.org/

Sustainability Indices

Too often governments prioritise accelerated economic growth above all other concerns. They lose sight of what truly matters – long, happy, sustainable lives for people around the world.

In reality, GDP growth on its own does not mean a better life for everyone, particularly in countries that are already wealthy. It doesn't take into account inequality, the things that really matter to people like social relations, health, or how they spend their free time, and crucially, the planetary limits we are up against.

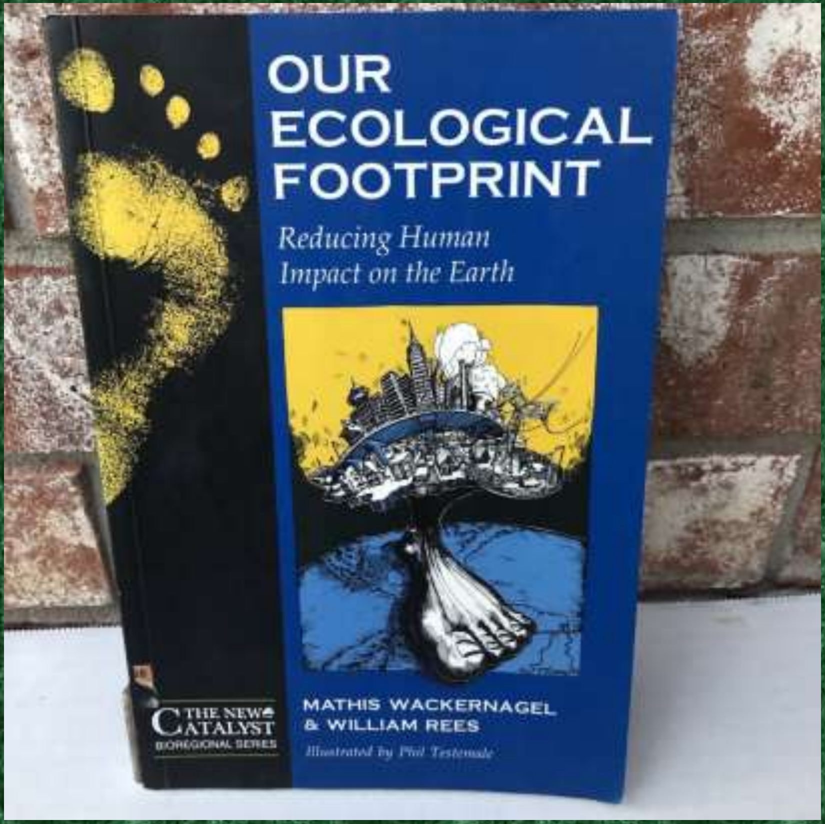
Research suggests that in most reasonably developed countries, material circumstances such as wealth and possessions play only a small role in determining levels of wellbeing (some psychologists say it's only 10 percent).

The Five Ways to Wellbeing are:

Connect, Be Active, Take Notice, Keep Learning, Give

Ecological Footprint

The Ecological Footprint represents the area of land on earth that provides for resources consumed and that assimilates the waste produced by a given entity or region.

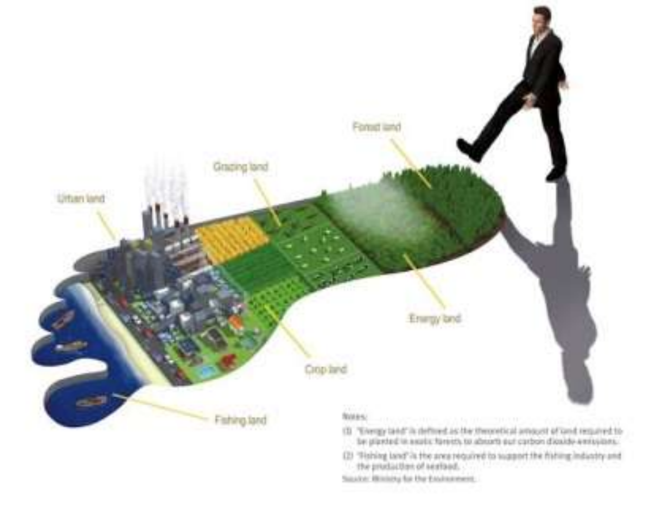


Ecological Footprint

It measures the requirements for productive areas:

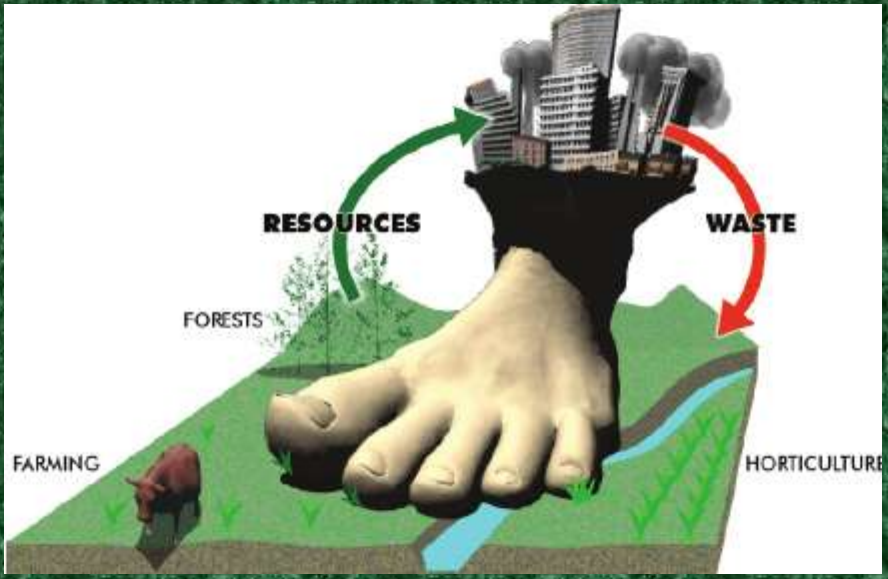
- croplands,
- grazing lands for animal products,
- forested areas to produce wood products,
- marine areas for fisheries,
- built-up land for housing and infrastructure,
- and forested land needed to absorb carbon dioxide emissions from energy consumption.

https://www.footprintnetwork.org/



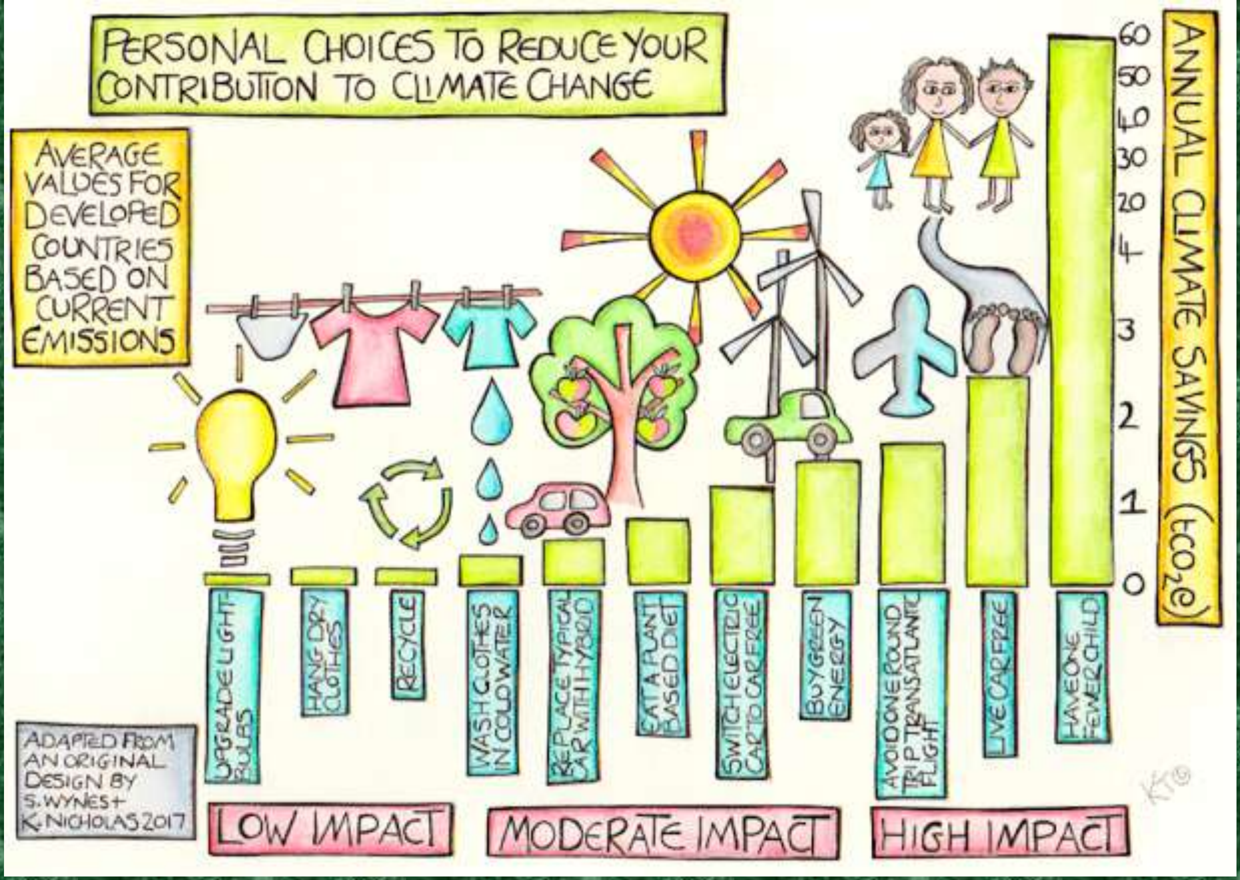
Ecological Footprint

One can estimate the EF, measured in “global hectares” (gha), at various scales
—for individuals, regions, countries,
and humanity as a whole.
The resulting figures can also be compared with how much productive area—or biocapacity—is available.



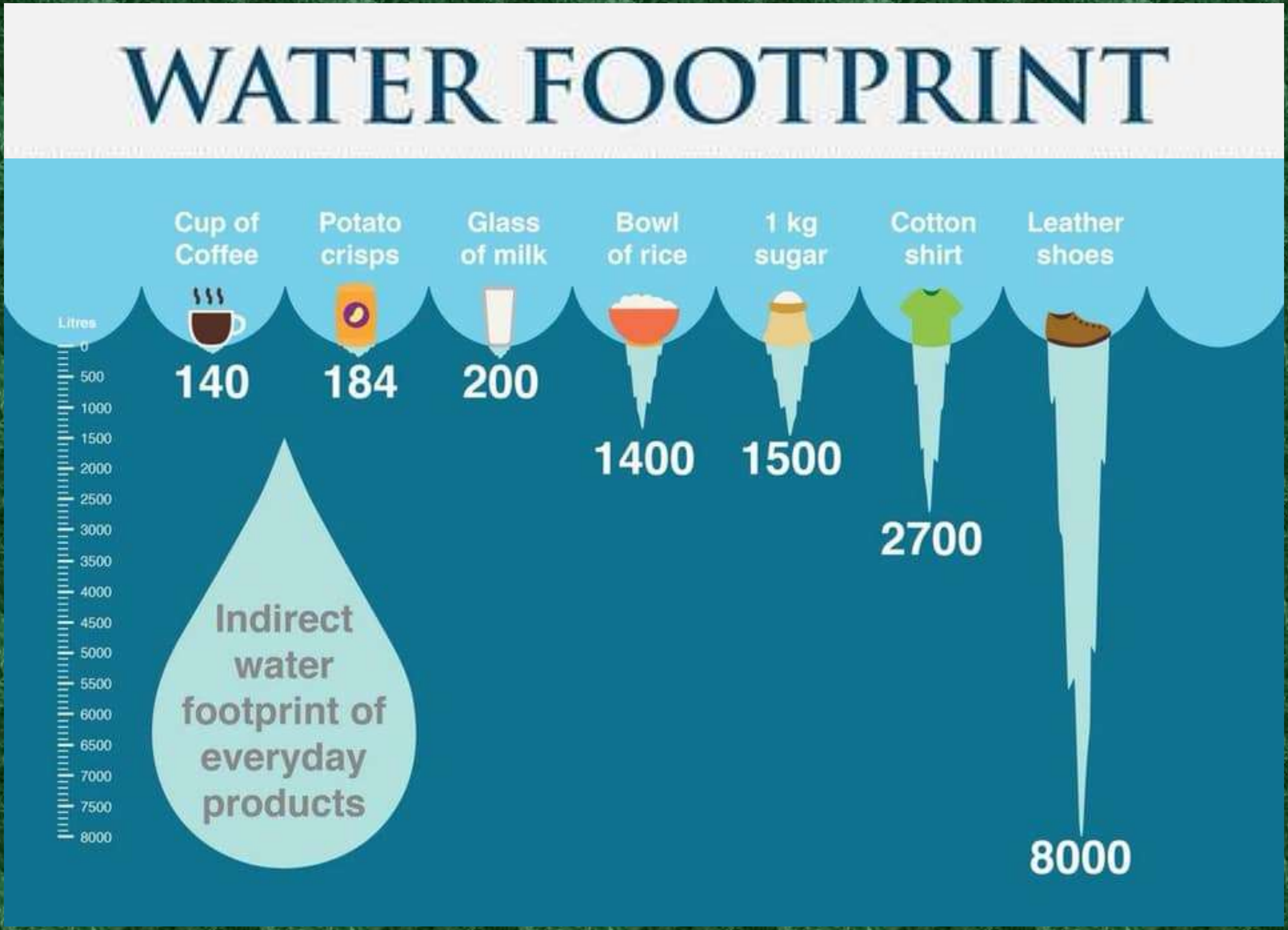
Advantages of *EF*:

- EF enhances the individual sense of responsibility.
- We can realize the limits of the Earth.



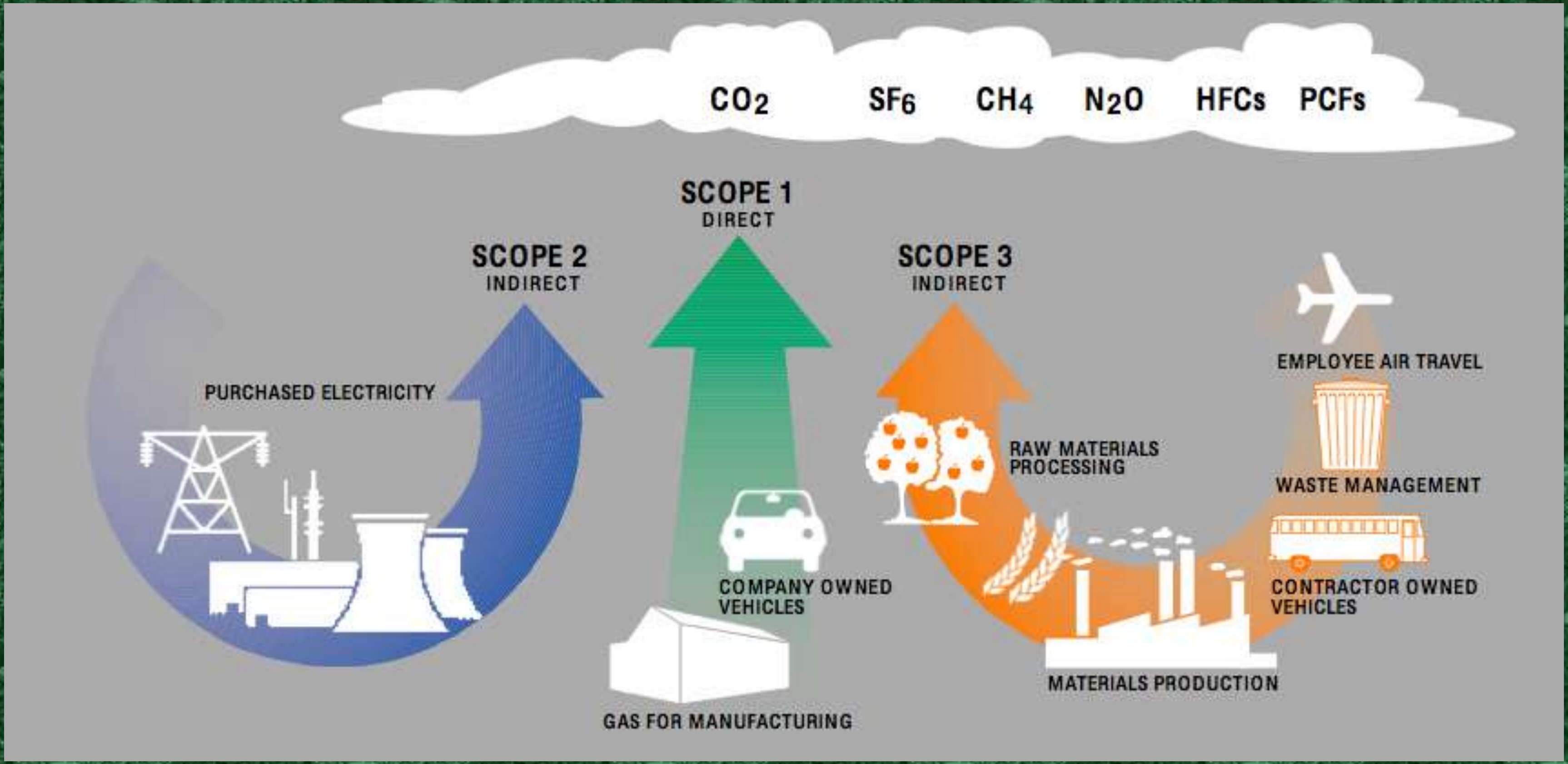
Further supplements?

- Nuclear footprint?
- Water footprint?
- Carbon footprint?
- ... ?


WATER FOOTPRINT
Cup of Coffee
Potato crisps
Glass of milk
Bowl of rice
1 kg sugar
Cotton shirt
Leather shoes
Litres
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
140
184
200
1400
1500
2700
8000
Indirect water footprint of everyday products

Carbon footprint

A Corporate Carbon Footprint

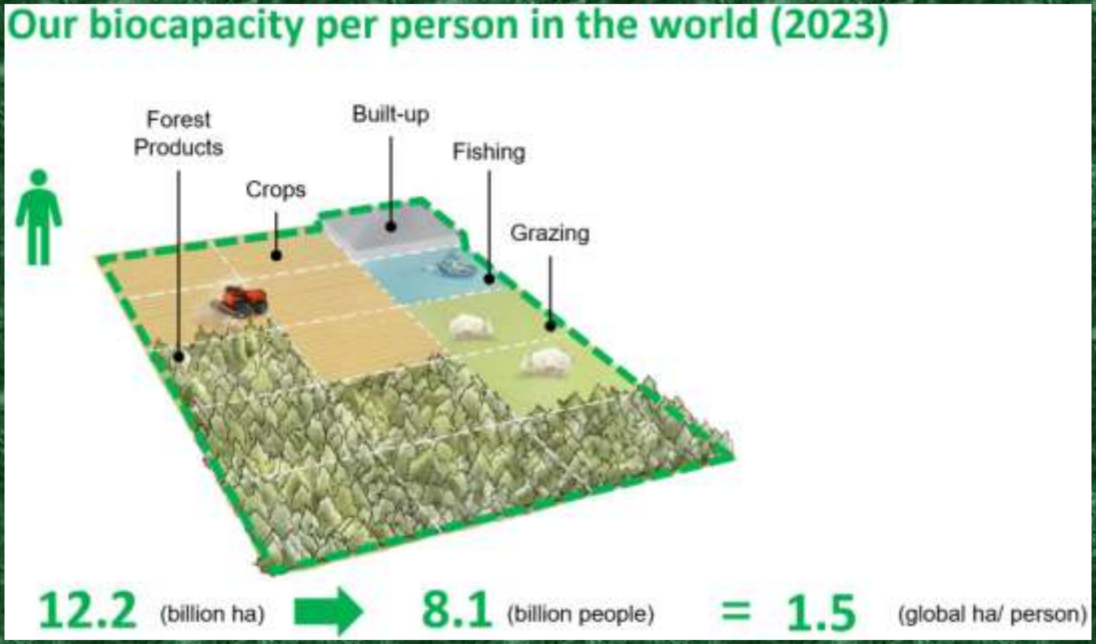


Biological Capacity (BioCapacity)

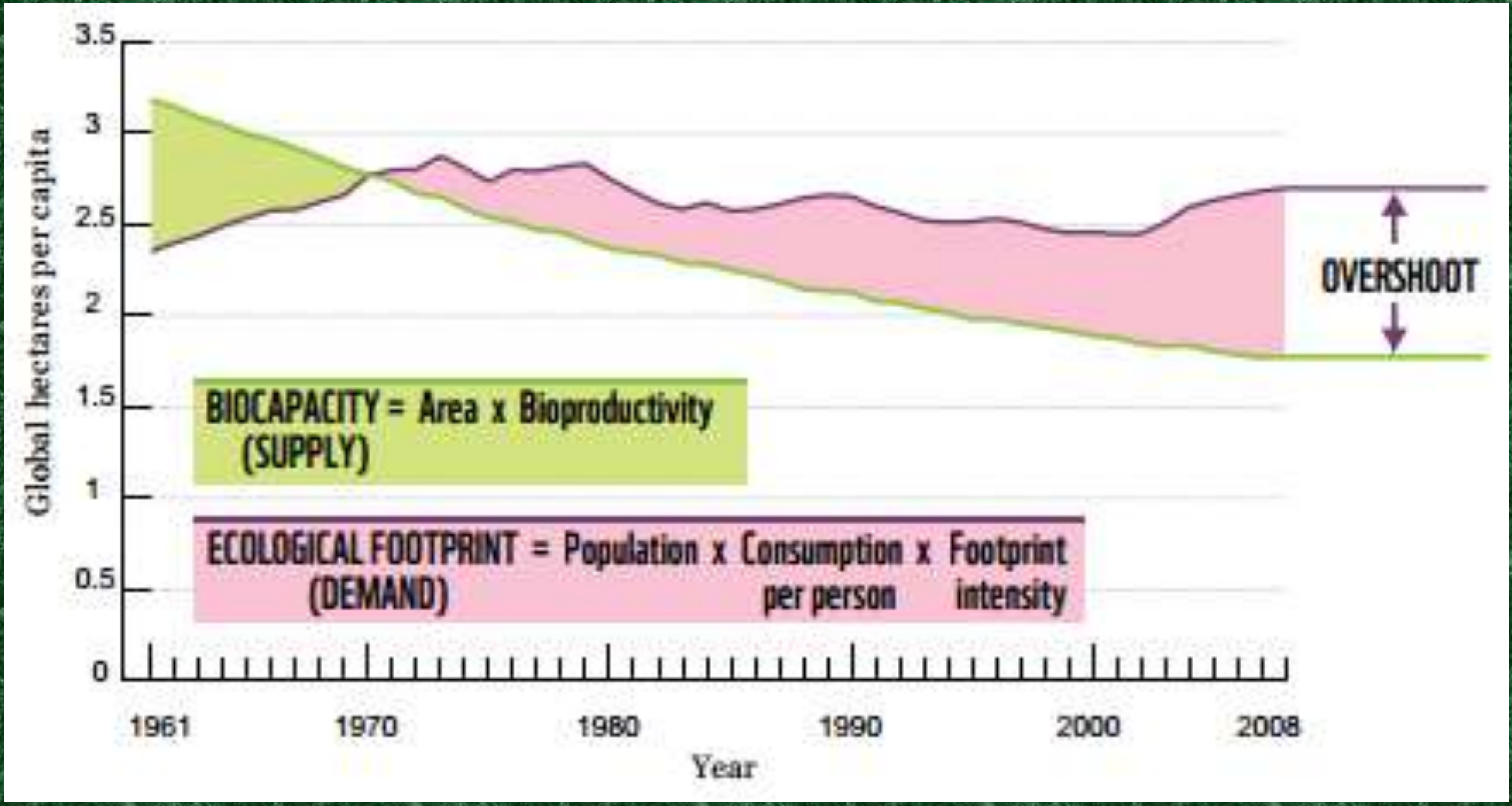
- Biocapacity is the ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies.
- Biocapacity can change from year to year due to climate, management, and also what portions are considered useful inputs to the human economy.

Biological Capacity (BioCapacity)

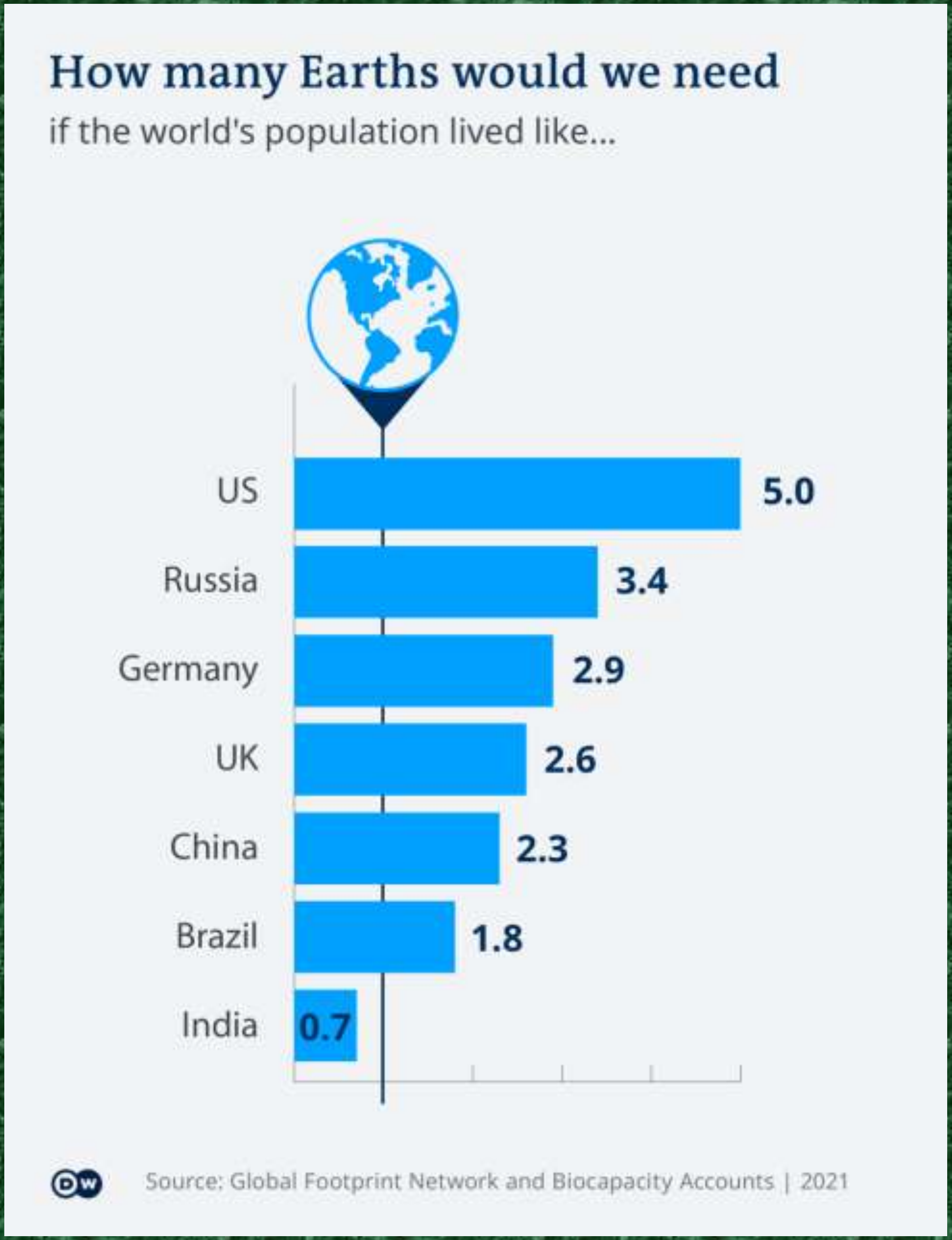
- Biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor.
- Biocapacity is usually expressed in global hectares.



Biocapacity *vs.* Ecological footprint

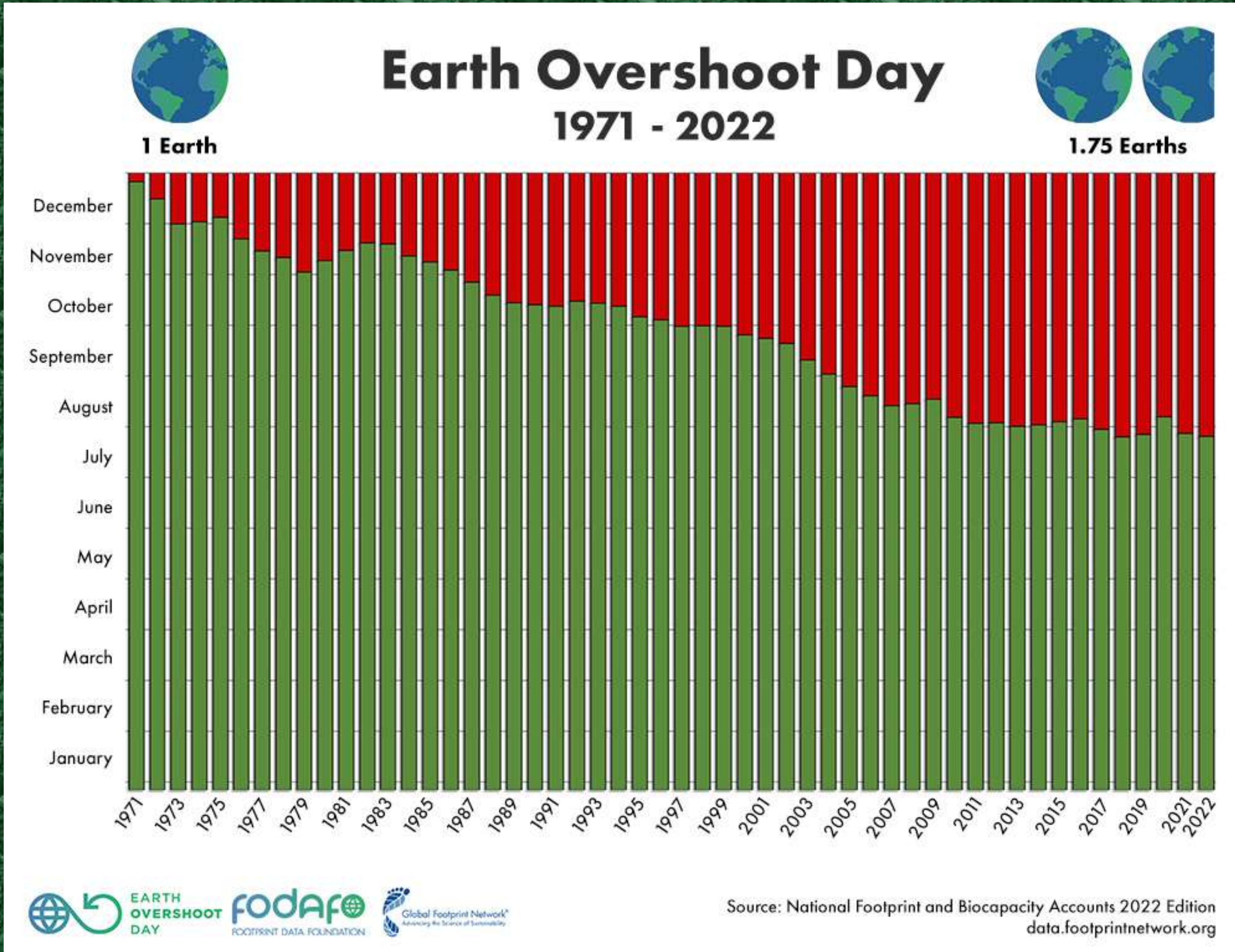



#8BillionStrong
The global population
is expected to reach
8 billion
on 15 November 2022.
UNFPA


How many Earths would we need
if the world's population lived like...
US
5.0
Russia
3.4
Germany
2.9
UK
2.6
China
2.3
Brazil
1.8
India
0.7
DW
Source: Global Footprint Network and Biocapacity Accounts | 2021

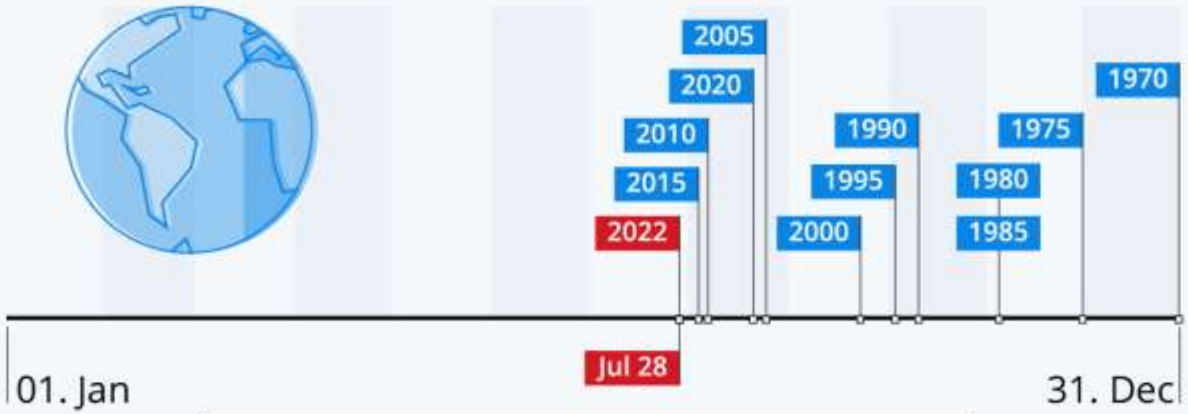
Earth Oversshoot Day

- Earth Overshoot Day marks the date when humanity has exhausted nature's budget for the year. For the rest of the year, we are maintaining our ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere.


Earth Overshoot Day
1971 - 2022
1 Earth
1.75 Earths
December
November
October
September
August
July
June
May
April
March
February
January
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2022
EARTH OVERSHOOT DAY
FODAFO
FOOTPRINT DATA FOUNDATION
Global Footprint Network
Source: National Footprint and Biocapacity Accounts 2022 Edition
data.footprintnetwork.org

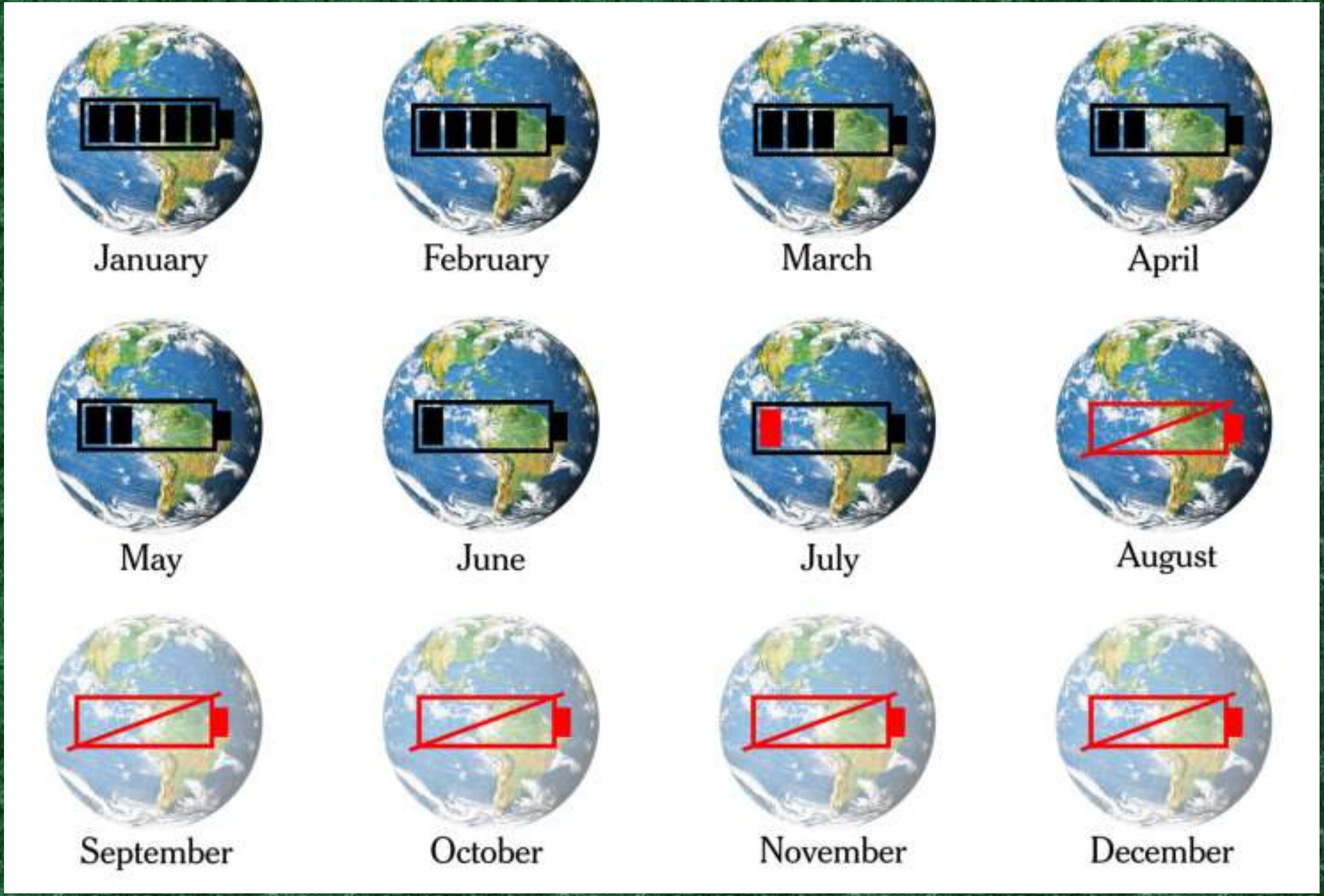
Earth Overshoot Day Is Coming Sooner and Sooner

Historical dates of Earth Overshoot Day



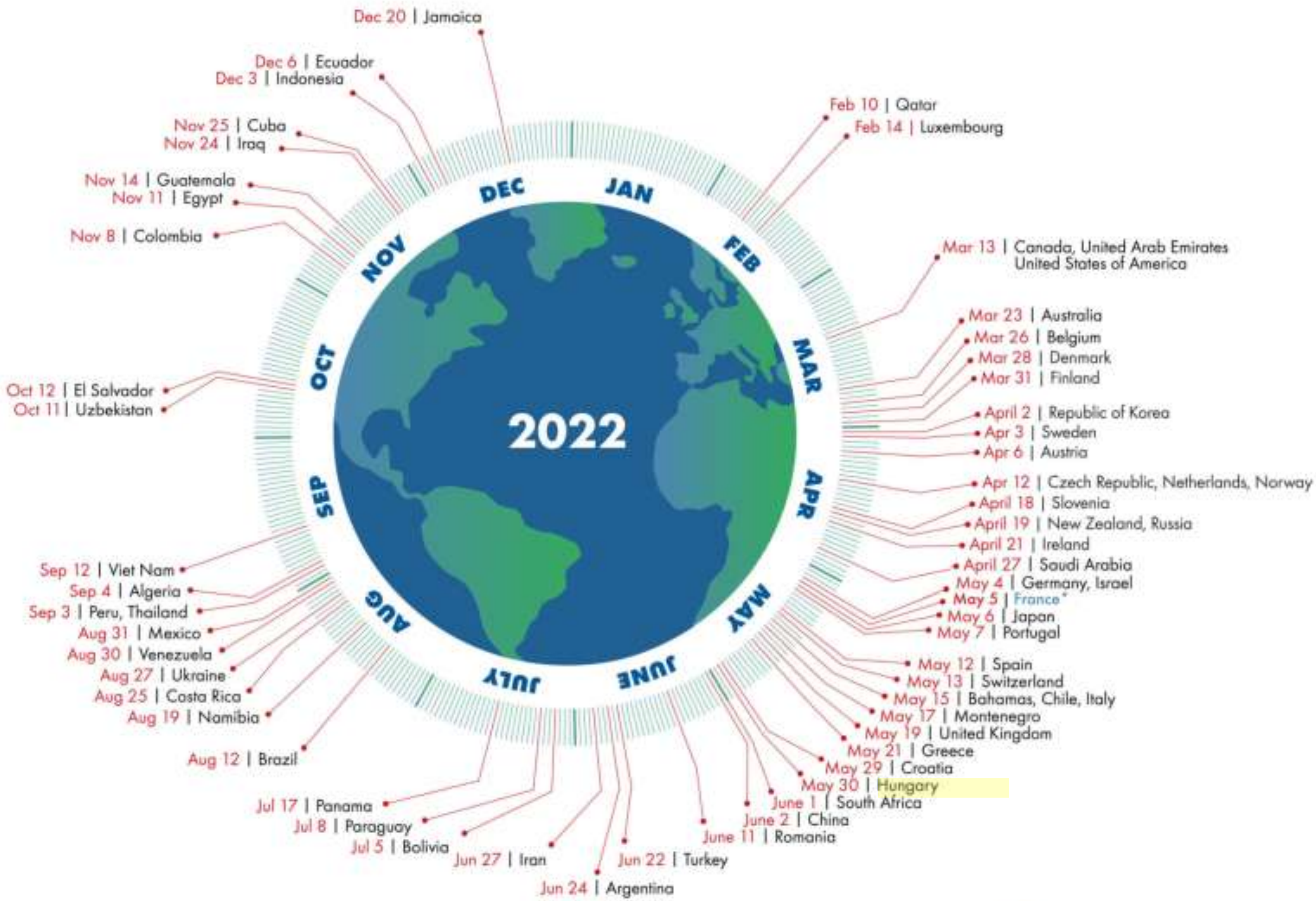
Earth Overshoot Day marks the date when humanity's demand for ecological resources in a given year exceeds what Earth can regenerate in that year.

Source: Global Footprint Network


January
February
March
April
May
June
July
August
September
October
November
December

Country Overshoot Days 2022

When would Earth Overshoot Day land if the world's population lived like...



For a full list of countries, visit overshootday.org/country-overshoot-days.

*France Overshoot Day updated April 20, 2022 based on nowcasted data. See overshootday.org/france.

Source: National Footprint and Biocapacity Accounts, 2022 Edition

data.footprintnetwork.org

EARTH OVERSHOOT DAY

Global Footprint Network
Advancing the Science of Sustainability


#MoveTheDate
ENERGY
How we power ourselves
CITIES
How we design and manage cities
FOOD
How we feed ourselves
PLANET
How we help nature thrive
#Move the Date
POPULATION
How many of us there are
EARTH OVERSHOOT DAY
overshootday.org/solutions


The Future
NEXT EXIT

Sustainable Cities

Ancient villages, cities, city-states

- Enormous water demand ← Channelling
- Sewage drain
- Waste production

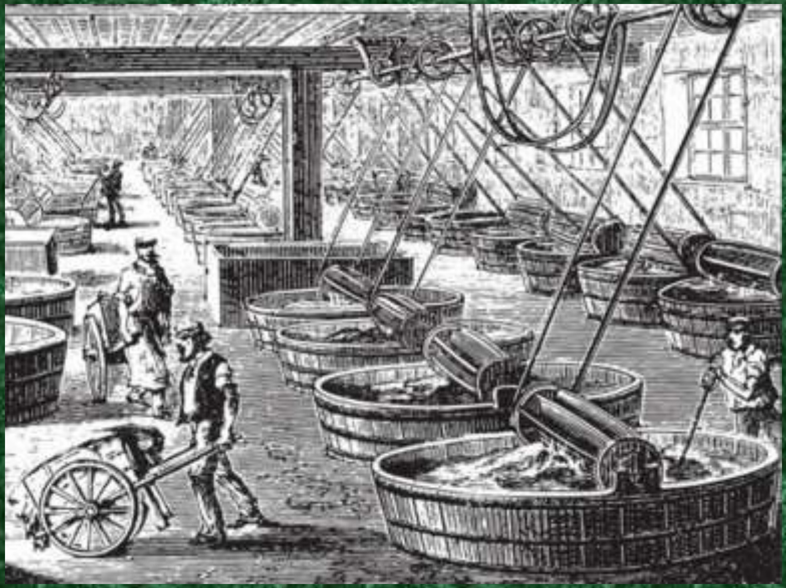
Channelling
- Irrigation of agricultural areas
- Water supply in the cities

Medieval
water pollution and waste

- Water demand and the problem of sewage
  - Not enough drinking water
  - Continuous smell
  - Chemical and biological pollutions in rivers

  e. g. from tanneries and butcheries
  - Saturation of digestive pits

  → Pollution of surface waters



Medieval water pollution and waste

- Accumulation of urban waste

was a continuous problem.

  - Waste on the street
  - Waste was washed away by the rain

  to channels and rivers

  - Rudimentary actions,

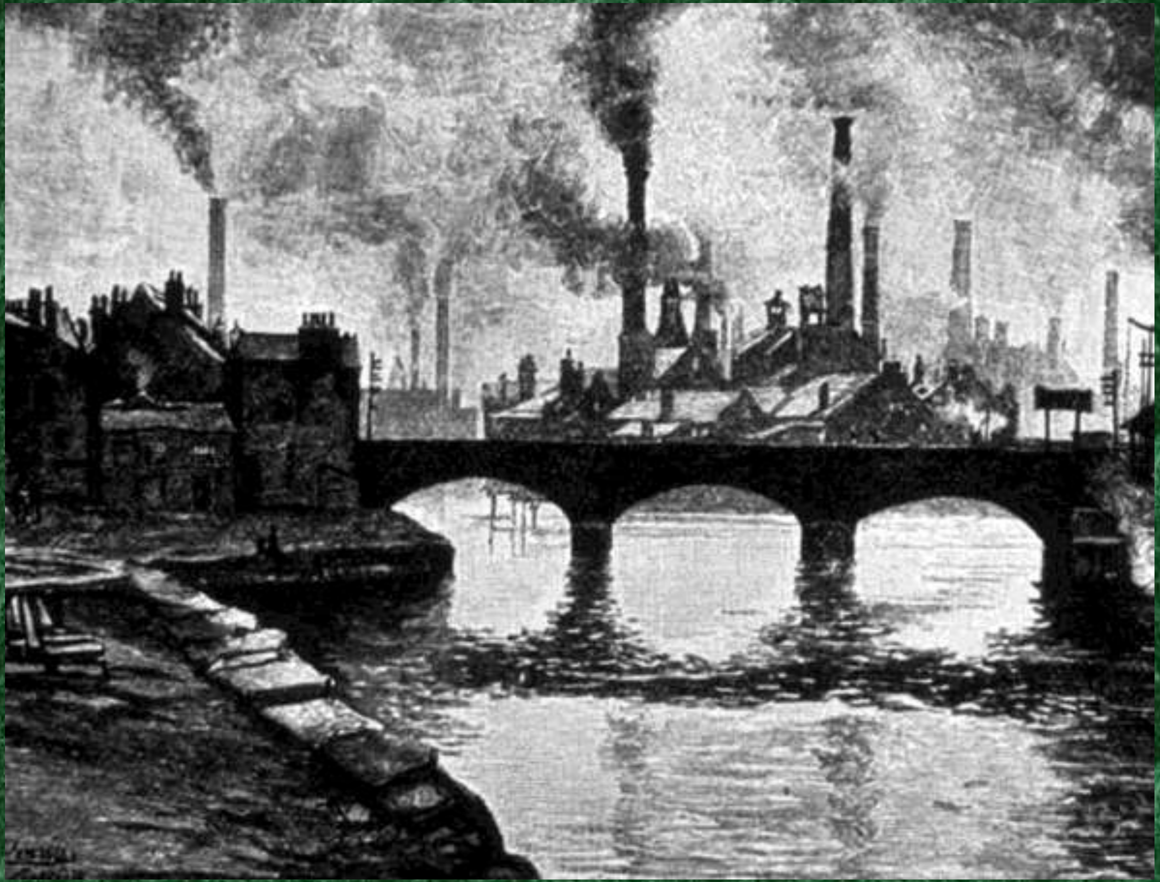
    e.g. scavengers

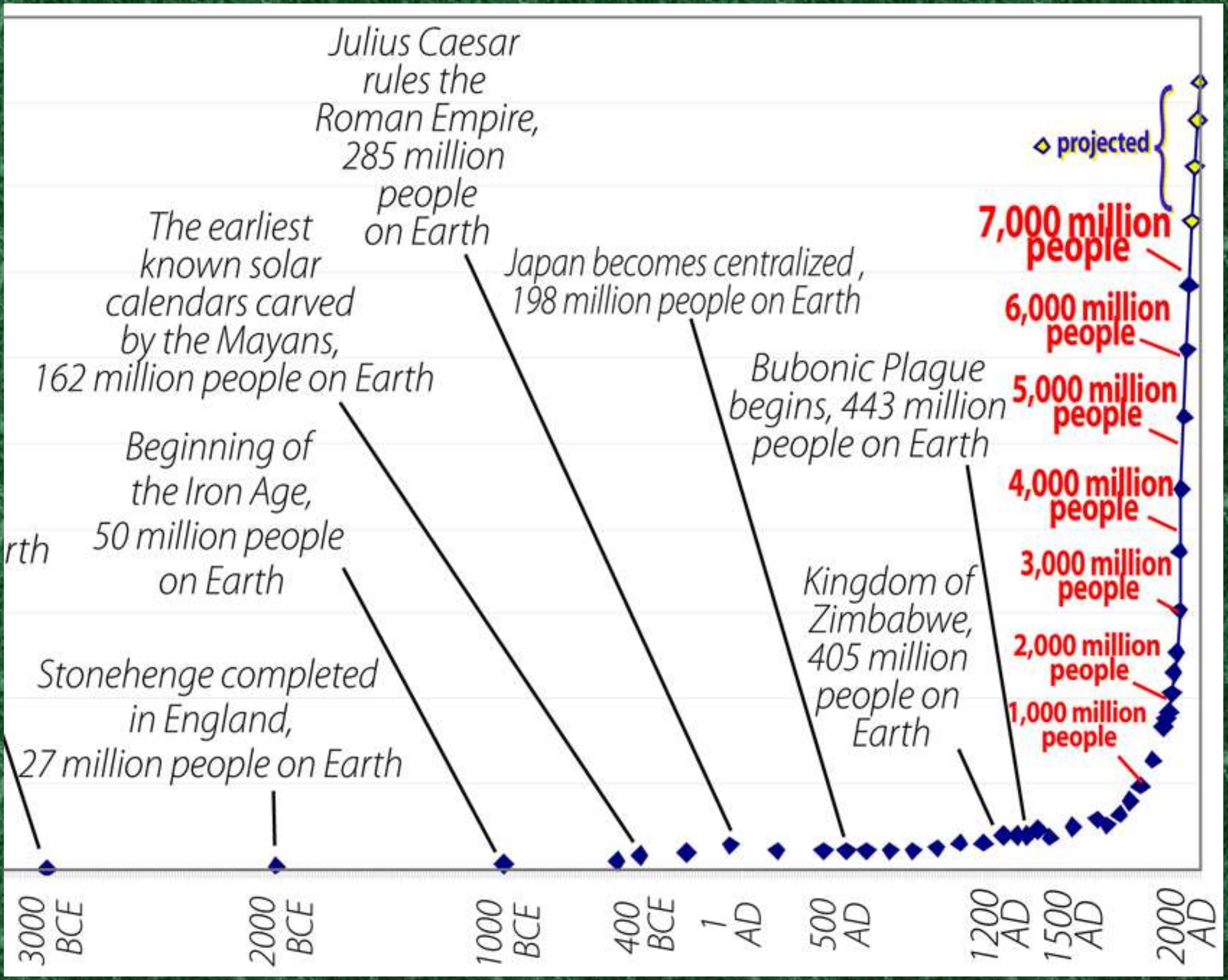
Effects of Industrial Revolution

- Population ↑
- Urbanization!
- Pollution ↑
- Deteriorating health conditions

↓

Typhus
Tuberculosis
Cholera





Julius Caesar rules the Roman Empire, 285 million people on Earth
The earliest known solar calendars carved by the Mayans, 162 million people on Earth
Japan becomes centralized , 198 million people on Earth
Bubonic Plague begins, 443 million people on Earth
Beginning of the Iron Age, 50 million people on Earth
rth
Kingdom of Zimbabwe, 405 million people on Earth
Stonehenge completed in England, 27 million people on Earth
projected
7,000 million people
6,000 million people
5,000 million people
4,000 million people
3,000 million people
2,000 million people
1,000 million people
3000 BCE
2000 BCE
1000 BCE
400 BCE
1 AD
500 AD
1200 AD
1500 AD
2000 AD


#8BillionStrong
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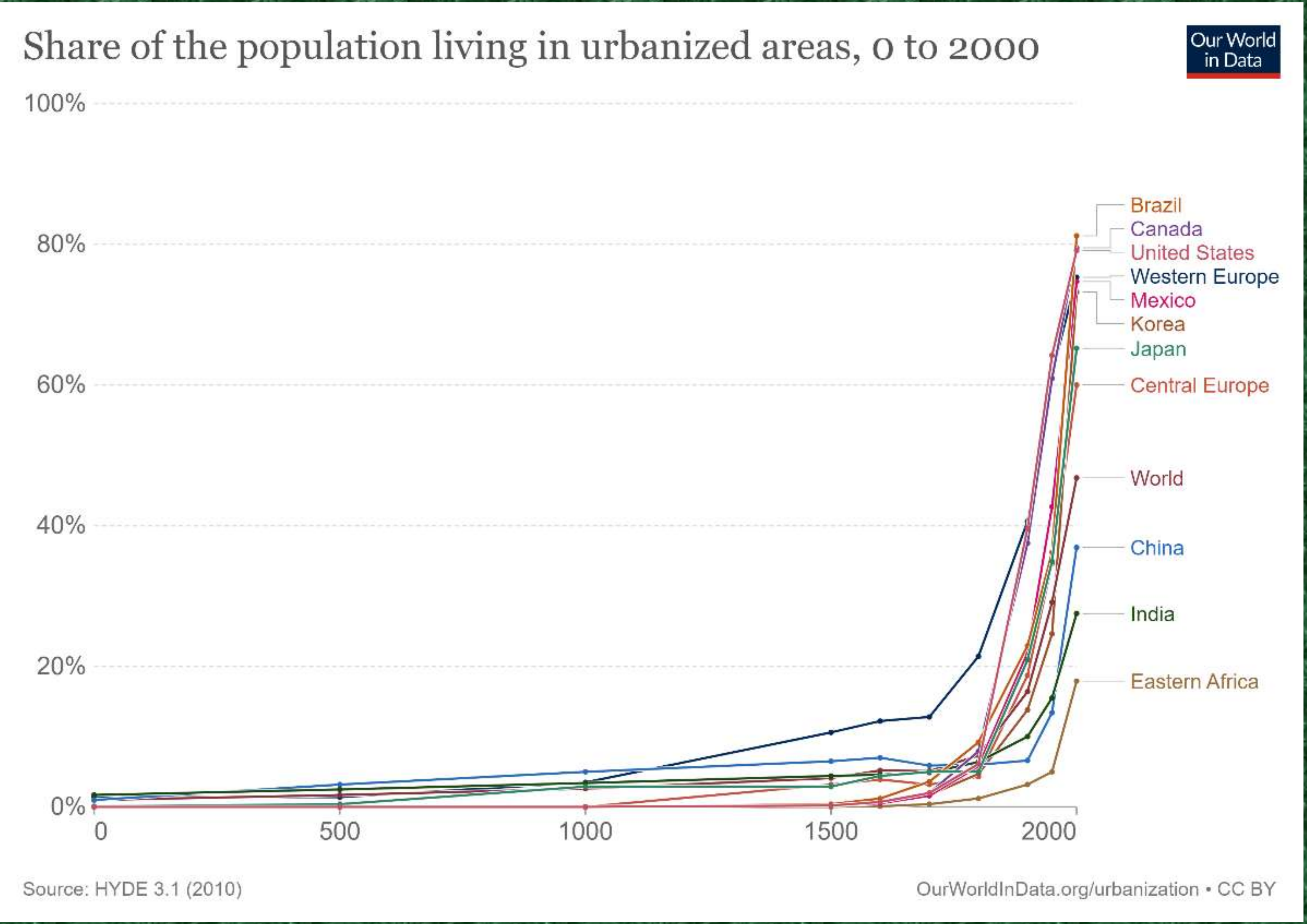
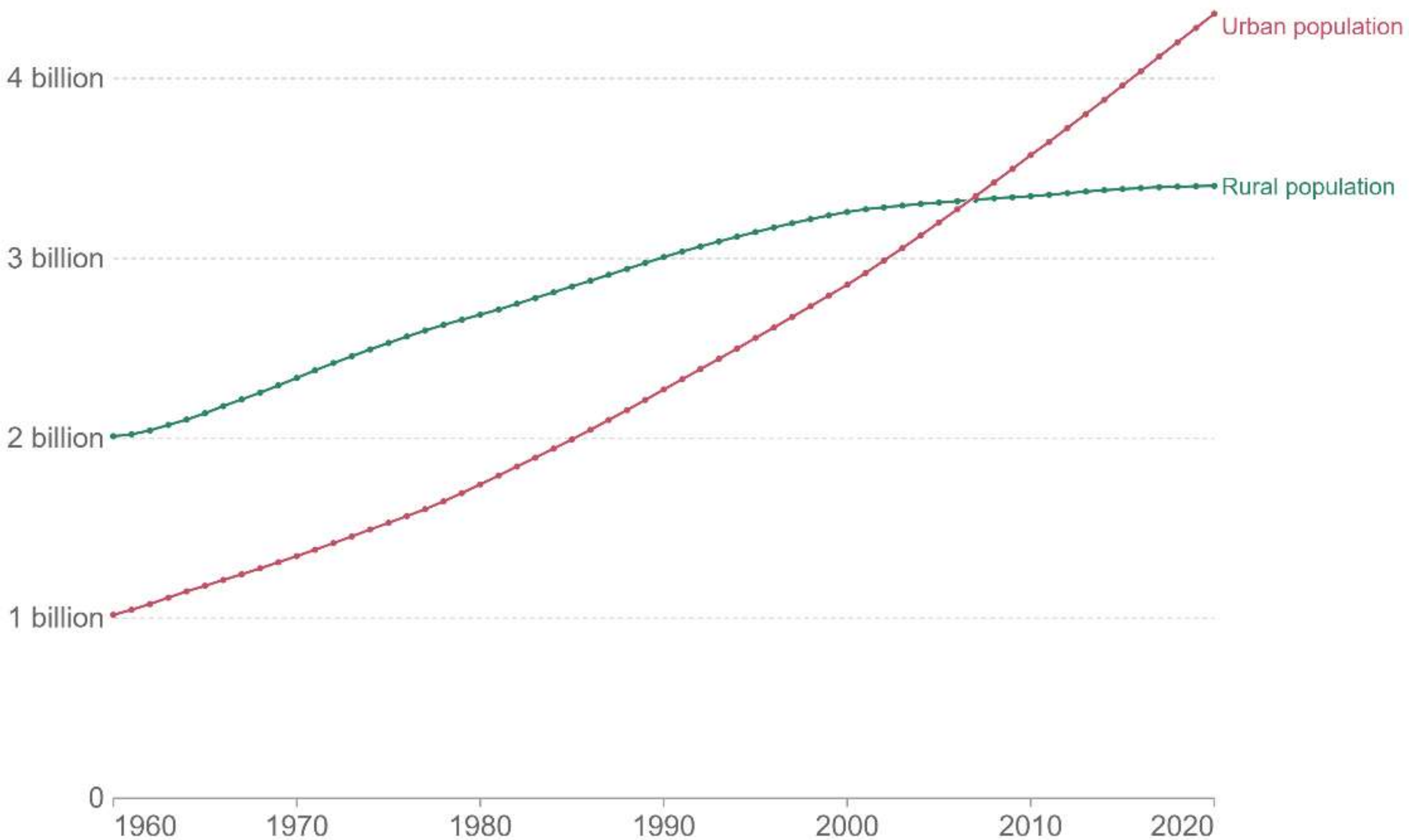


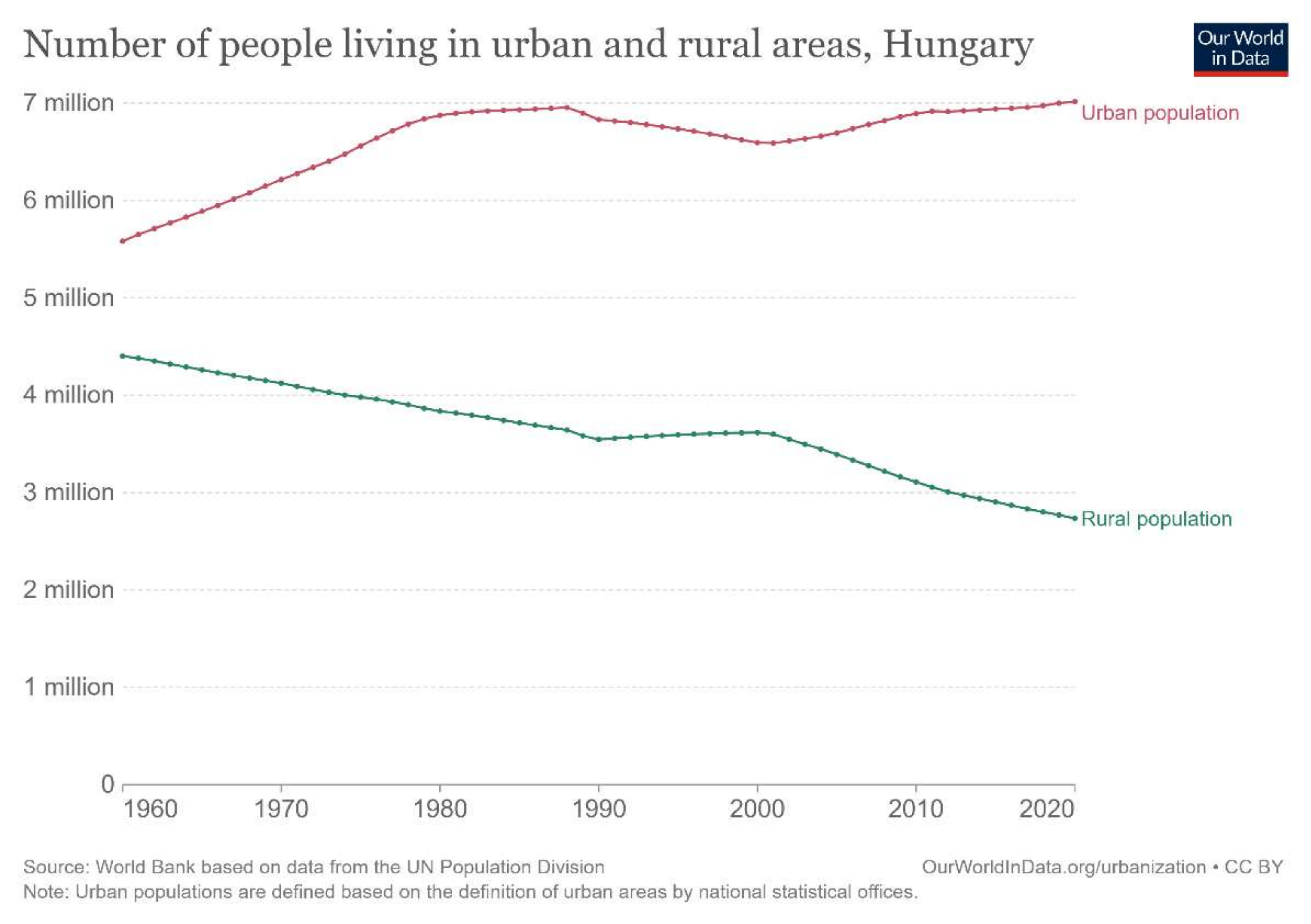
Share of the population living in urbanized areas, 0 to 2000
Our World in Data
100%
80%
60%
40%
20%
0%
0
500
1000
1500
2000
Brazil
Canada
United States
Western Europe
Mexico
Korea
Japan
Central Europe
World
China
India
Eastern Africa
Source: HYDE 3.1 (2010)
OurWorldInData.org/urbanization • CC BY

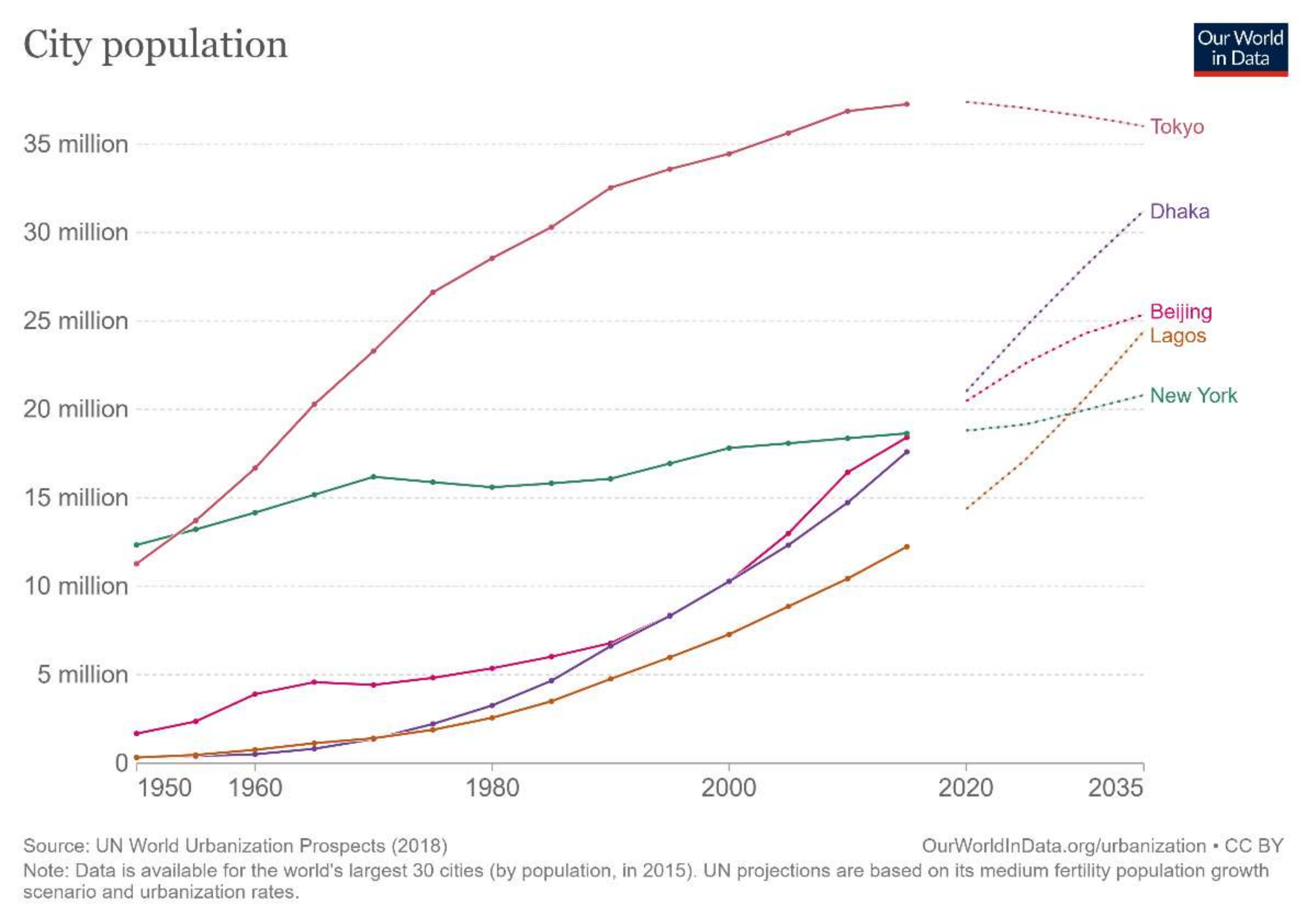
Number of people living in urban and rural areas, World

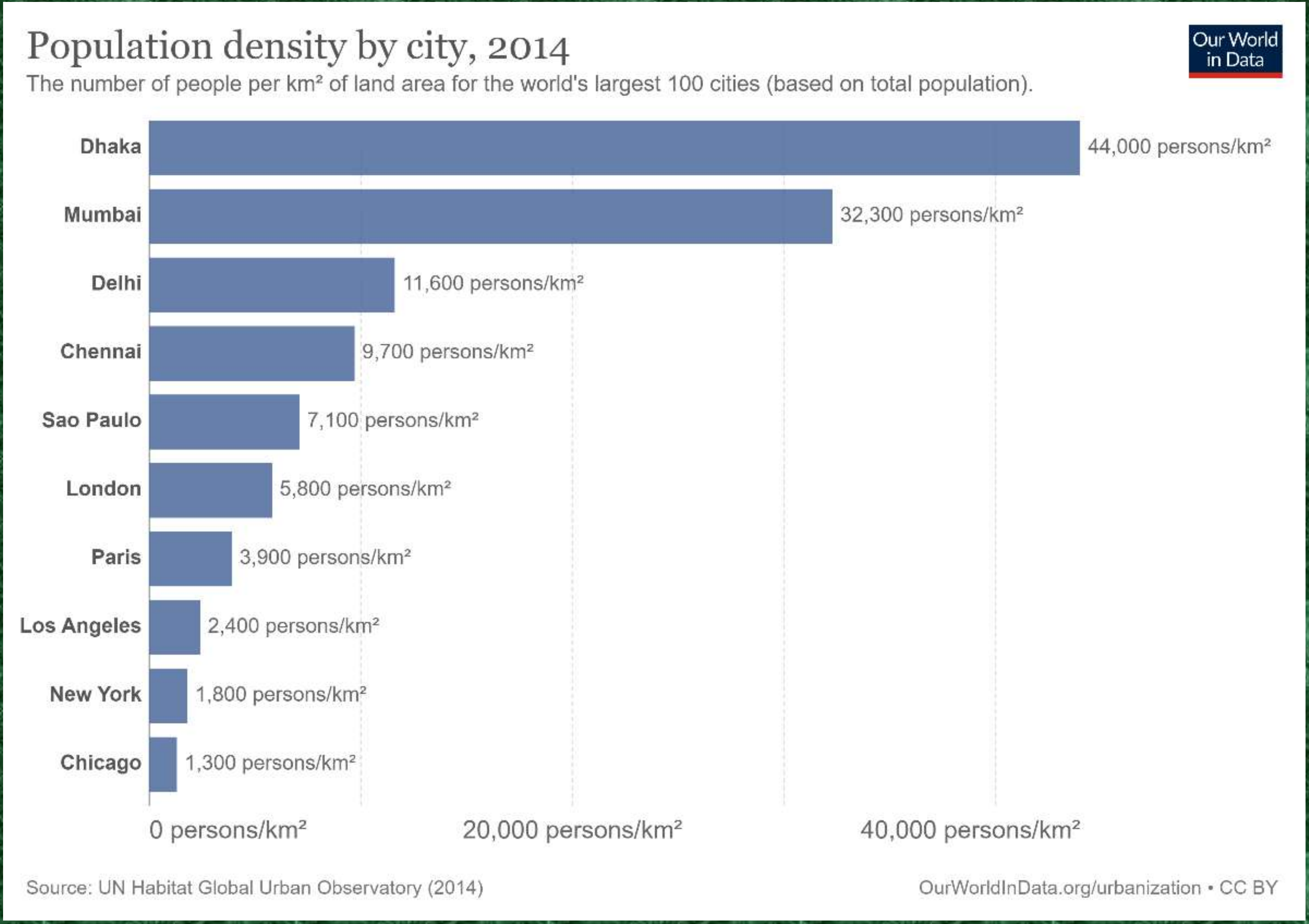


Source: World Bank based on data from the UN Population Division

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.


Number of people living in urban and rural areas, Hungary
Our World in Data
7 million
6 million
5 million
4 million
3 million
2 million
1 million
0
1960
1970
1980
1990
2000
2010
2020
Urban population
Rural population
Source: World Bank based on data from the UN Population Division
OurWorldInData.org/urbanization • CC BY
Note: Urban populations are defined based on the definition of urban areas by national statistical offices.


City population
Our World in Data
35 million
30 million
25 million
20 million
15 million
10 million
5 million
0
1950
1960
1980
2000
2020
2035
Tokyo
Dhaka
Beijing
Lagos
New York
Source: UN World Urbanization Prospects (2018)
OurWorldInData.org/urbanization • CC BY
Note: Data is available for the world's largest 30 cities (by population, in 2015). UN projections are based on its medium fertility population growth scenario and urbanization rates.


Population density by city, 2014
The number of people per km² of land area for the world's largest 100 cities (based on total population).
Our World in Data
Dhaka
44,000 persons/km²
Mumbai
32,300 persons/km²
Delhi
11,600 persons/km²
Chennai
9,700 persons/km²
Sao Paulo
7,100 persons/km²
London
5,800 persons/km²
Paris
3,900 persons/km²
Los Angeles
2,400 persons/km²
New York
1,800 persons/km²
Chicago
1,300 persons/km²
0 persons/km²
20,000 persons/km²
40,000 persons/km²
Source: UN Habitat Global Urban Observatory (2014)
OurWorldInData.org/urbanization • CC BY

Environmental Antecedents of COVID-19 in ASIA

- An unprecedented shift in human population
- Rapid urbanization: Deforestation and habitat loss

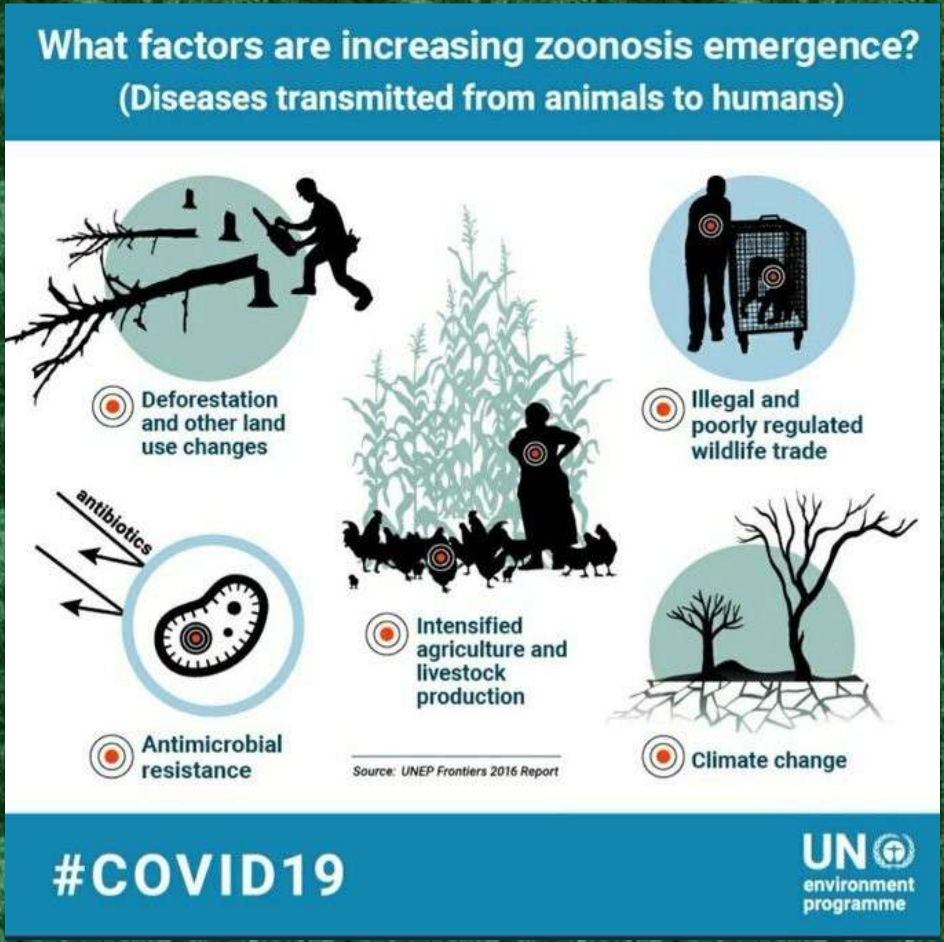
  → Wild animals, forced to move closer to cities and towns, inevitably encounter domestic animals and the human population.

Environmental Antecedents of COVID-19 in Asia

- **Extreme urbanization becomes a vicious cycle:**
  More people bring more deforestation, and human expansion and the loss of habitat ultimately kills off predators, including those that feed off rodents. With the predators gone – or at least with their numbers sharply diminished – the rodent population explodes…
  → the risk of zoonotic disease ↑

Environmental Antecedents of COVID-19 in ASIA

- Limited disease control of livestock
- Live animal markets
- Illegal wildlife trade



First steps

1992 - **The UN Conference on Environment and Development (UNCED) = THE (Rio) EARTH SUMMIT**

- The creation of new institutions for sustainable development, including the United Nations Commission on Sustainable Development;
- The signing of two new environmental treaties:
  - the United Nations Framework Convention on Climate Change
  - the Convention on Biological Diversity.
- The adoption of
  - the Rio Declaration on Environment and Development,
  - **Agenda 21**,
  - and the Statement of Forest Principles.

First steps

1992 - **The AGENDA 21**

- Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which human impacts on the environment.
- It were adopted by more than 178 Governments at the (UNCED) held in Rio de Janeiro, Brazil, 3 to 14 June 1992. *(un.org)*
- One major objective of the Agenda 21

initiative is that **every local government should draw its own local Agenda 21.**

- Its aim initially was to achieve

global sustainable development by 2000, with the "21" in Agenda 21 referring to **the original target of the 21st century.**

First steps

1994 - The Aalborg Charter

- The Charter is an urban sustainability initiative approved by the participants at the first **European Conference on Sustainable Cities & Towns** in Aalborg, Denmark. It is inspired by the Rio Earth Summit's Local Agenda 21 plan.
- The Charter is based on the consensus of
  - individuals,
  - municipalities,
  - NGOs,
  - national
  - and international organisations,
  - and scientific bodies.
- More than 3,000 local authorities from more than 40 countries have signed the Charter. This has resulted in the largest European movement of its type and started the European Sustainable Cities and Towns Campaign.

EUROPEAN CONFERENCE ON SUSTAINABLE CITIES & TOWNS

First steps

1994 - **The Aalborg Charter**

The Charter of European Cities & Towns Towards Sustainability

- The Role of European Cities and Towns
- The Notion and Principles of Sustainability
- Local Strategies Towards Sustainability
- Sustainability as a Creative, Local, Balance-Seeking Process
- Resolving Problems by Negotiating Outwards
- Urban Economy Towards Sustainability
- Social Equity for Urban Sustainability
- Sustainable **Land-Use** Patterns
- Sustainable **Urban Mobility** Patterns
- Responsibility for the **Global Climate**
- Prevention of **Ecosystems Toxification**
- Local Self-Governance as a Pre-Condition
- **Citizens as Key Actors** and the Involvement of the Community
- Instruments and Tools for Urban Management Towards Sustainability

UN Environment focuses on:

Resource efficient cities

	Approaches
• Resource Augmentation	Promotion of principles Circular Economy and 3R's approaches (reduce, reuse and recycle)
• Material and Energy Intensity Management	Development of lifecycle analyses
• Smart and Intelligent Cities	Promotion of resource efficient smart city solutions

Clean Cities

• Pollution and Waste Prevention	Promotion of Sustainable Consumption and Production practices to prevent unsustainable accumulation of pollution and waste
• Pollution and Waste Management	Promotion of the Polluter Pay Principle and Extended Producer Responsibility schemes

Green and Healthy Cities

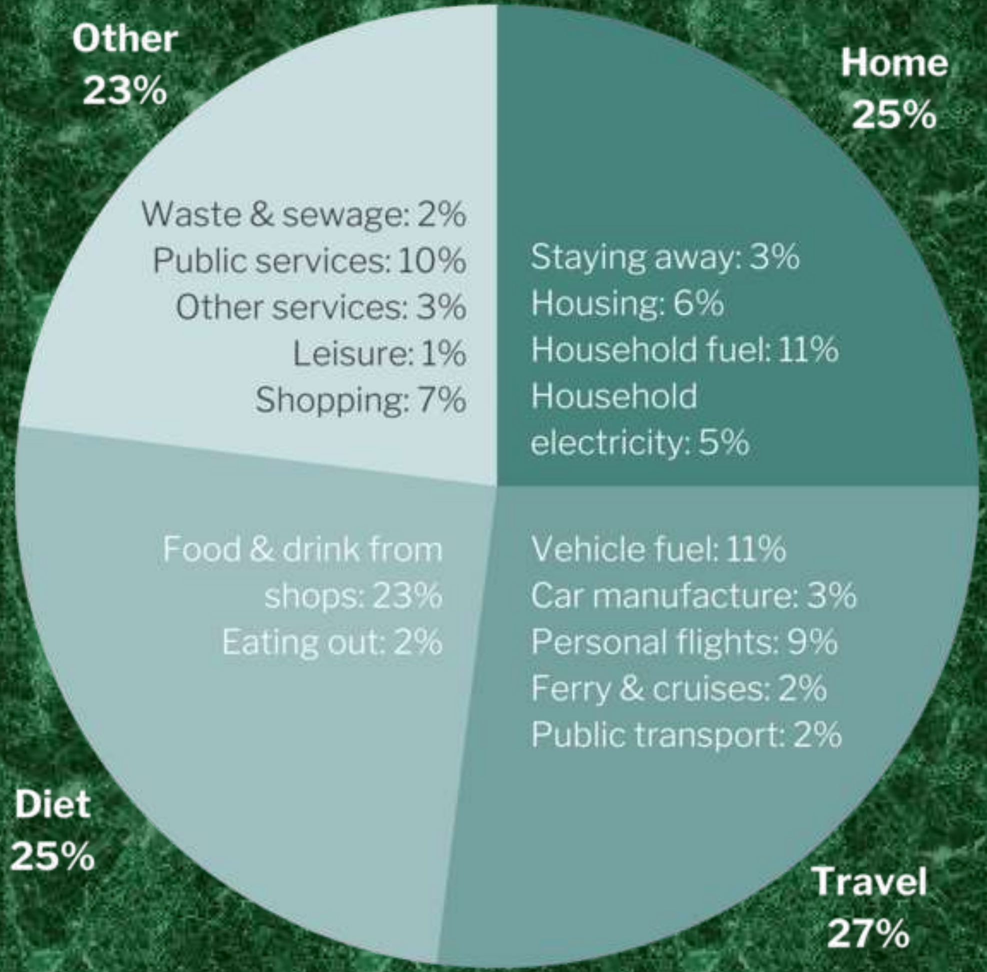
• Land-use planning for Urban Ecosystem	Measuring and analyzing resource use in cities
• Mobility Management	Promotion of transport planning aims to improve mobility, while reducing environmental and social impacts. This includes Just-in-Time and Intermodal Transport schemes
• Socioeconomic Equity	Social Cents, Economic Parity, Affordability to Pay

Smart and Intelligent Cities

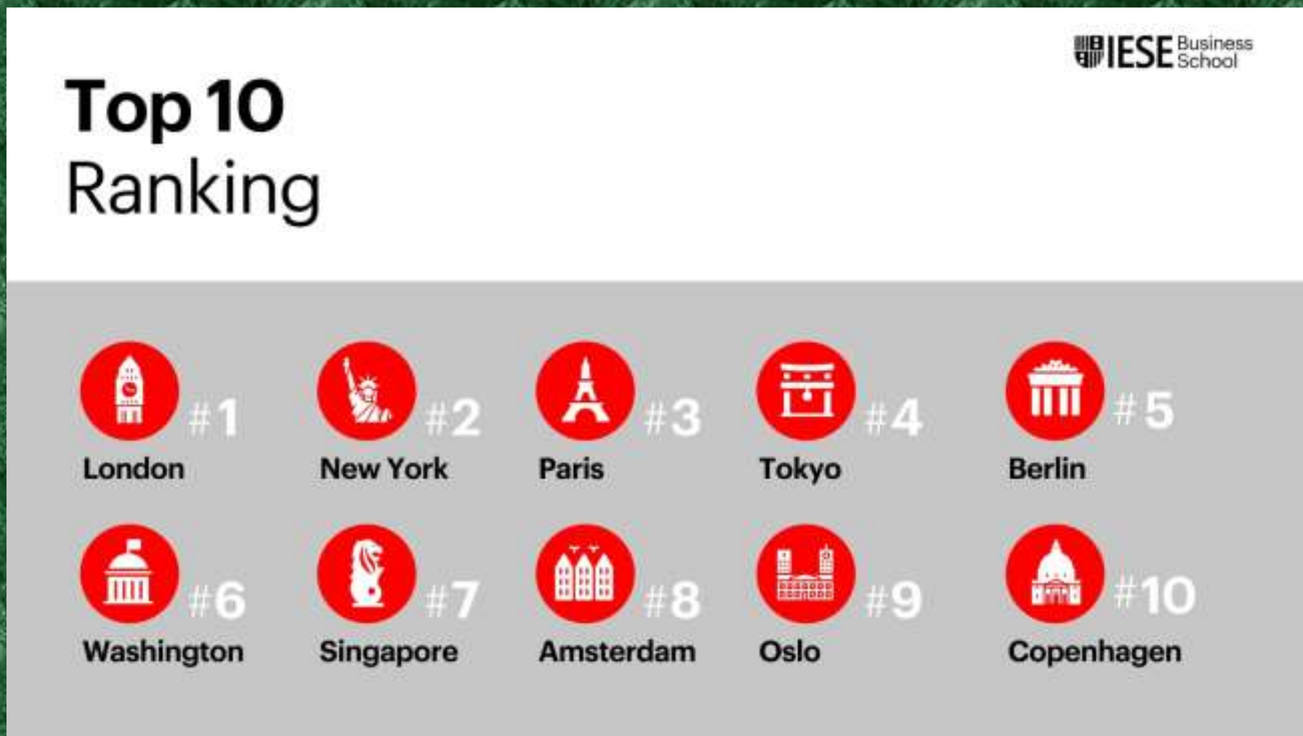
Ecological footprint in the city

- Nutrition
- Travel
- Housing
- Lifestyle

(Goods and Services)



The smartest and most sustainable cities



IESE Business School

Cities are evaluated in 9 dimensions

Human capital #1 London	**Social** cohesion #1 Taipei	**Economy** #1 New York
Governance #1 Bern	**Environment** #1 Reykjavik	**Mobility** and transport #1 New York
Urban planning #1 London	**International** projection #1 London	**Technology** #1 Hong Kong

2023's most sustainable cities in the US

Overall Rank (1=Best)	City	State	Overall Score	Policy Rank	Sustainable Development Rank	Pollution Rank	Transportation Rank	Food Productio Rank
1	San Francisco	CA	77.205	5	1	77	2	16
2	Boston	MA	71.567	7	6	92	3	1
3	New York	NY	70.684	1	11	164	1	89
4	Oakland	CA	69.363	4	8	57	14	39
5	San Diego	CA	66.561	18	2	104	19	56
6	San Jose	CA	66.204	23	10	37	12	63
7	Seattle	WA	66.174	47	9	44	7	11
8	Baltimore	MD	65.479	2	51	35	39	14
9	Sacramento	CA	65.128	9	4	141	29	26
10	Los Angeles	CA	64.804	10	5	175	9	37


SAN FRANCISCO CLIMATE ACTION
0
50
100
ROOTS
Zero Waste
Send nothing to landfill.
50% Clean Transportation
Take half your trips by bus or bike.
100% Renewable Energy
Choose power from renewable resources.
Roots
Heal the planet.

Environment-friendly Houses

- Powerhouse Battorkaia (Trondheim, Norway)
  - An energy-positive building
  - This building will produce more energy than was used during its entire life cycle, from production of building materials to construction, operation and demolition.

Environment-friendly Houses

- Powerhouse Battorkaia (Trondheim, Norway)
  - 2 000 m^2 of solar panels on the roof, 500 m^2 of solar panels on the facade, and a seawater heat pump located in the Trondheims-fjord.
  - It generates twice as much electricity as it uses, and has received a special permit for a microgrid to distribute electricity to neighbouring buildings, electric buses, cars and boats, as well as to the national grid.

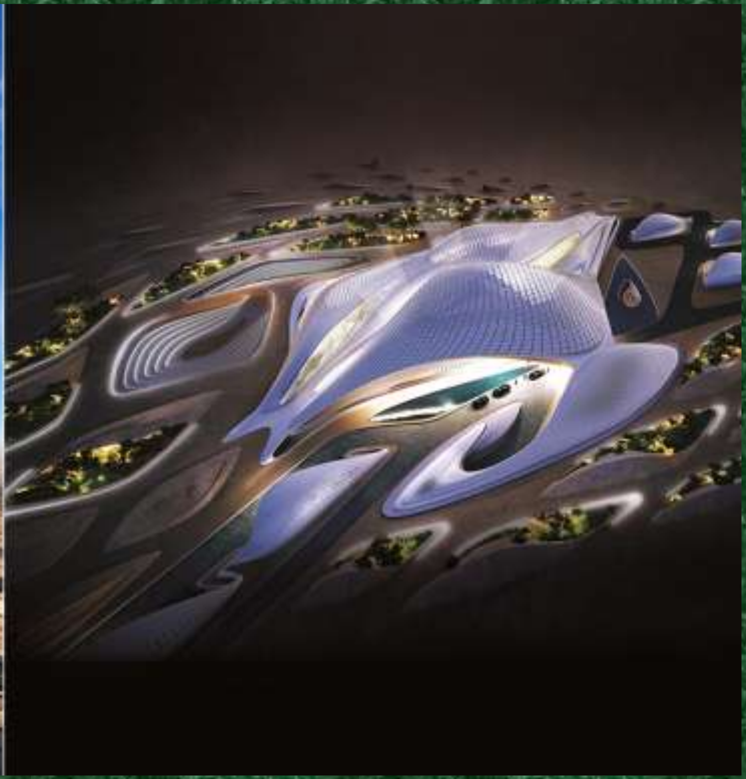

Photo: Ivar Kvaal

Environment-friendly Houses

- BEEAH Headquarters in Sharjah,
  United Arab Emirates (UAE)
  - A net zero energy building
  - This is the first fully **AI**-integrated building in the region.

Environment-friendly Houses

- BEEAH Headquarters in Sharjah, United Arab Emirates (UAE).
  - Featuring intelligent edge systems and software designed to optimize energy efficiency…
  - An artificial intelligence-based solution to power personalized recommendations for efficiency, enable friction-free access and security; and to unify building management, and employee service systems. (johnsoncontrols.com)

Environment-friendly Houses

- MOL CAMPUS (Budapest)
  - BREAM excellent rating and LEED Platinum certification
  - 900 m2 solar panel system
  - geothermal heating and cooling system
  - graywater recycling

Environment-friendly Houses

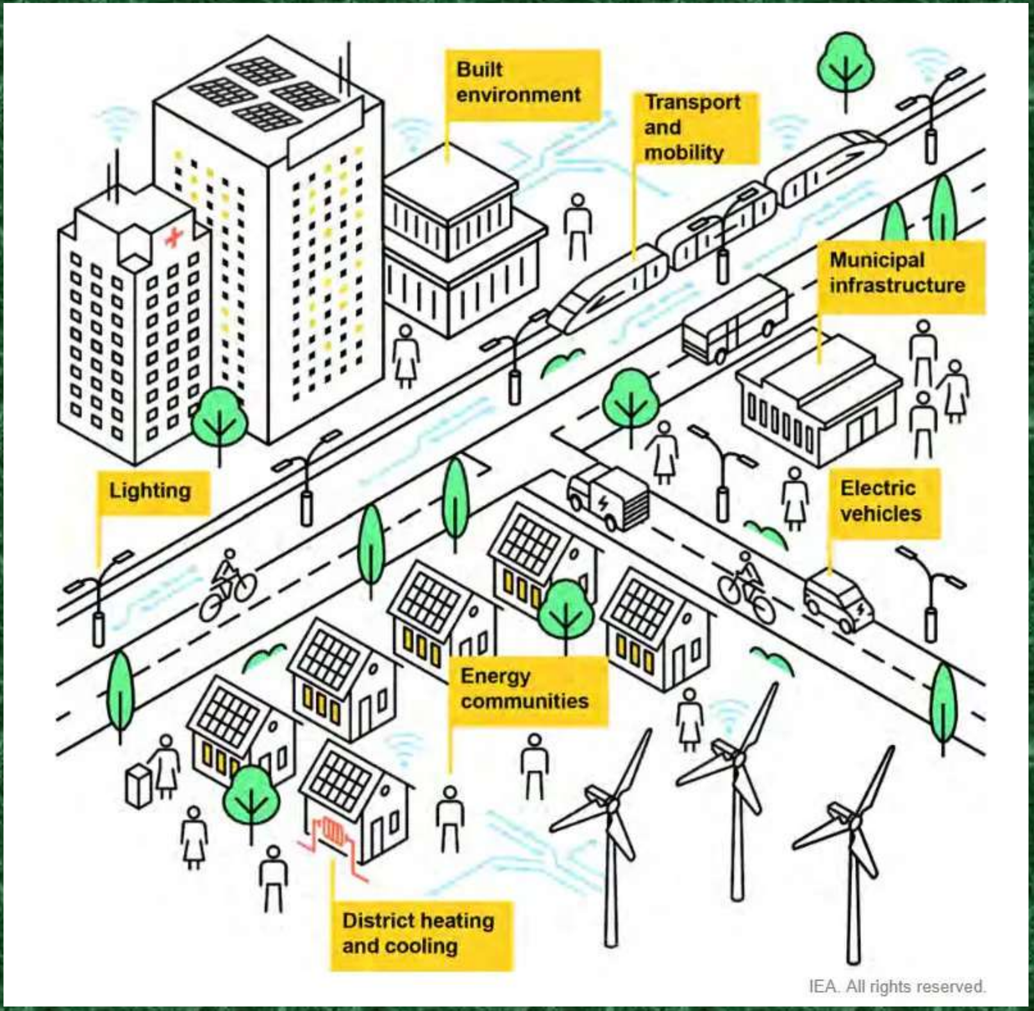
- **MOL CAMPUS (Budapest)**
  - Selective collection of 5 different types of waste
  - 50 outdoor bike storage for our visitors, 160 indoor bike storage and changing rooms for colleagues
  - 47 electric car charging stations for MOL Company cars in the garage levels
  - Individually and centrally controllable shading system
  - Solar panel system on the top of the Podium
  - 86% of the workstations is lit by natural light
  - Integrated building management system ensures high comfort
  - Low water consumption sanitary facilities
  - Energy efficient devices
  - Accessible building
  - Rain and grey water use for irrigation and flushing
  - Bird roosts, bat houses and bee hives

Environment-friendly Houses

- **MOL CAMPUS (Budapest)**

Net Zero Energy Districts

- Extended bikeways
- Stores and workplaces
next to safe sidewalks
- Public transport
- Limited Traffic Zones
- Renewable
energy sources
- Local producers
- Selective
waste collection



Smart Green Cities

- **PARIS**
  - **New Bike Plan (until 2026):** 180 kilometers of new permanent segregated bike lanes. The number of bike parking spots will more than triple. („**100% Cycable**”)
  - More car-free pedestrian zones (**Car-free city in 2024?**)
  - New tram lines

Smart Green Cities

- **LONDON**: The Mayor's Transport Strategy, published in March 2018, outlines the Mayor's vision for transport in London. The overarching aim of the Mayor's Transport Strategy is to **reduce Londoners' dependency on cars** and to increase the active, efficient and sustainable **(walking, cycling and public transport)** mode share of trips in London to an ambitious 80 per cent by 2041.
  - Healthy Streets and healthy people
    - Active: London's streets will be healthy, and more Londoners will travel actively
    - Safe: London's streets will be safe and also secure
    - Efficient: London's streets will be used more efficiently and have less traffic travelling on them
    - Green: London's streets will be clean and also green

Smart Green Cities

- **LONDON**: The Mayor's Transport Strategy
  - A good public transport experience
    - Connected: The public transport network will meet the needs of a growing London
    - Accessible: Public transport will be safe, affordable and accessible to all
    - Quality: Journeys by public transport will be pleasant, fast and reliable

Smart Green Cities

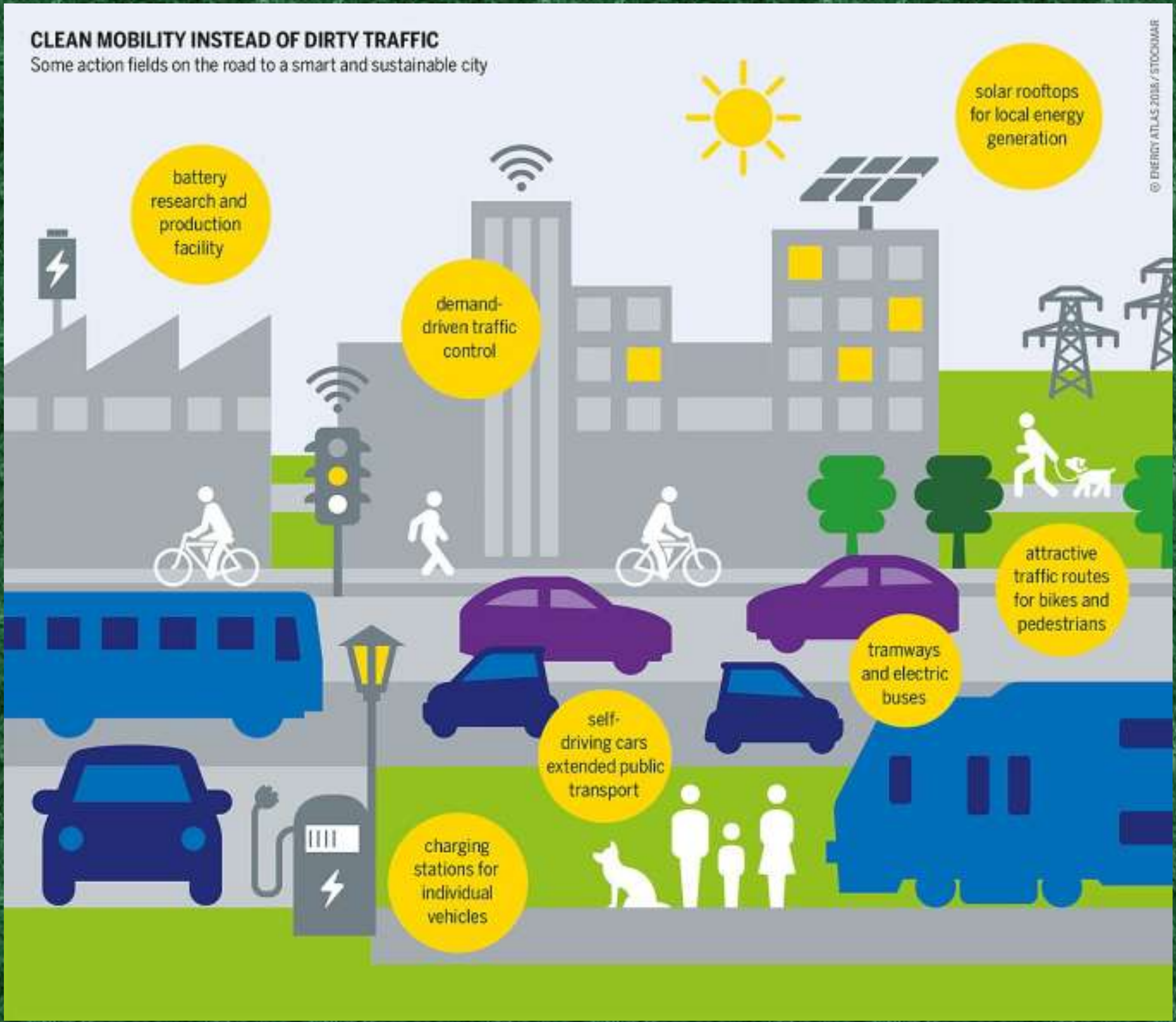
- **LONDON**: The Mayor's Transport Strategy
  - New homes and Jobs
    - Sustainable: Active, efficient and sustainable travel will be the best option in new developments.
    - Unlocking: Transport investment will unlock the delivery of new homes and new jobs.

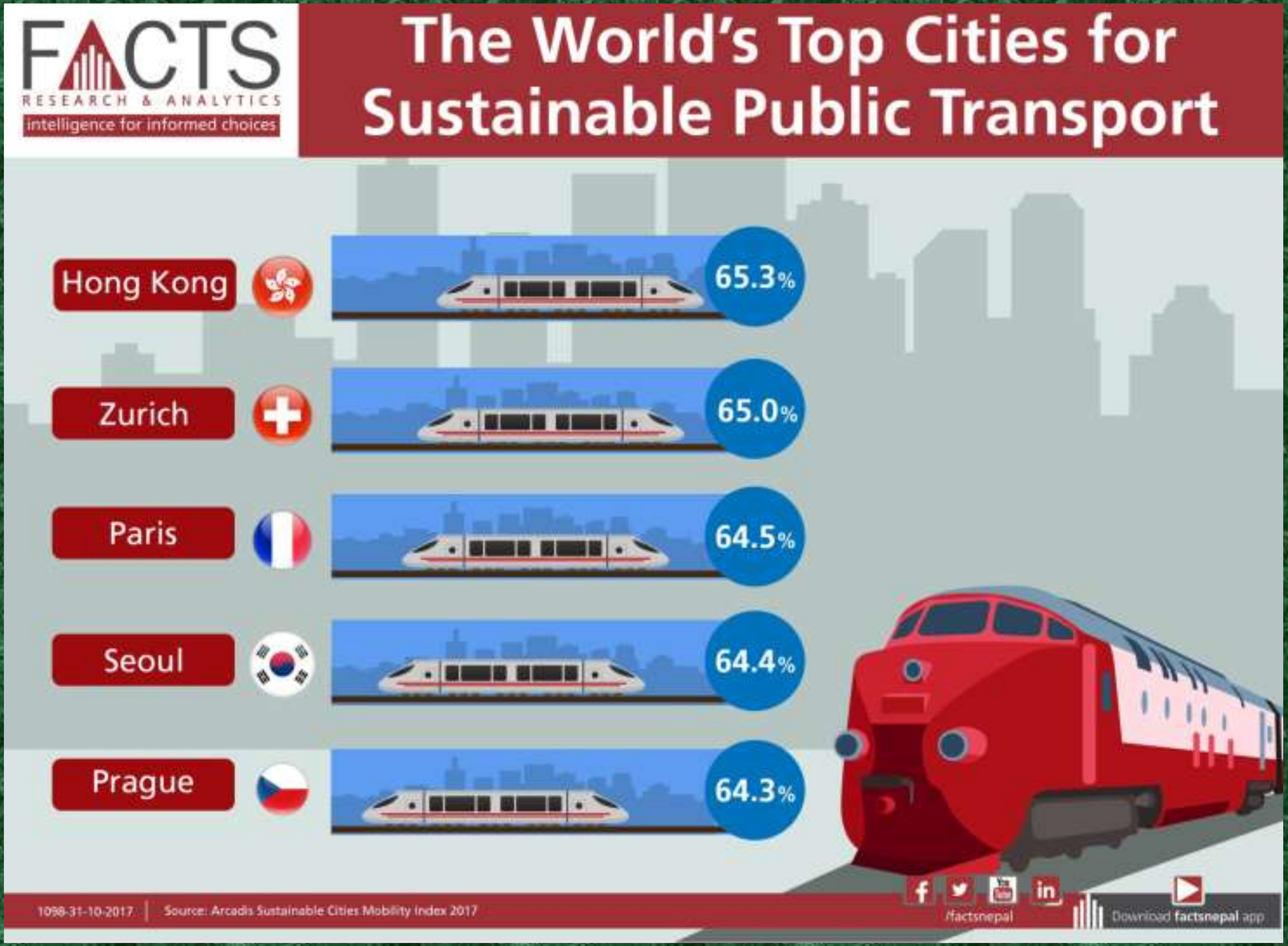
Source: Lucy Saunders

Smart Green Cities

- **ZURICH**: Thanks to the e-bikes long distances and climbs can be covered in no time and without effort. (zuerich.com)

- **BOGOTÁ:** Bogotá attracted worldwide attention for being one of the first cities to install temporary bike lanes to promote socially distanced transportation. The city even went a step further and integrated 28 km of the 84 km temporary bike lane system into their rapidly growing permanent system.


CLEAN MOBILITY INSTEAD OF DIRTY TRAFFIC
Some action fields on the road to a smart and sustainable city
© ENERGY ATLAS 2018 / STOCKMAR
solar rooftops for local energy generation
battery research and production facility
demand-driven traffic control
attractive traffic routes for bikes and pedestrians
tramways and electric buses
self-driving cars extended public transport
charging stations for individual vehicles


FACTS
RESEARCH & ANALYTICS
intelligence for informed choices
The World's Top Cities for Sustainable Public Transport
Hong Kong
65.3%
Zurich
65.0%
Paris
64.5%
Seoul
64.4%
Prague
64.3%
1098-31-10-2017
Source: Arcadis Sustainable Cities Mobility Index 2017
/factsnepal
Download factsnepal app

Slow Cities

- Slowing transport in cities could provide immense benefits for the health of people, economies and the planet.
- Speed can take a profound toll on our lives, with high city speeds causing an increase in road deaths and energy demands.

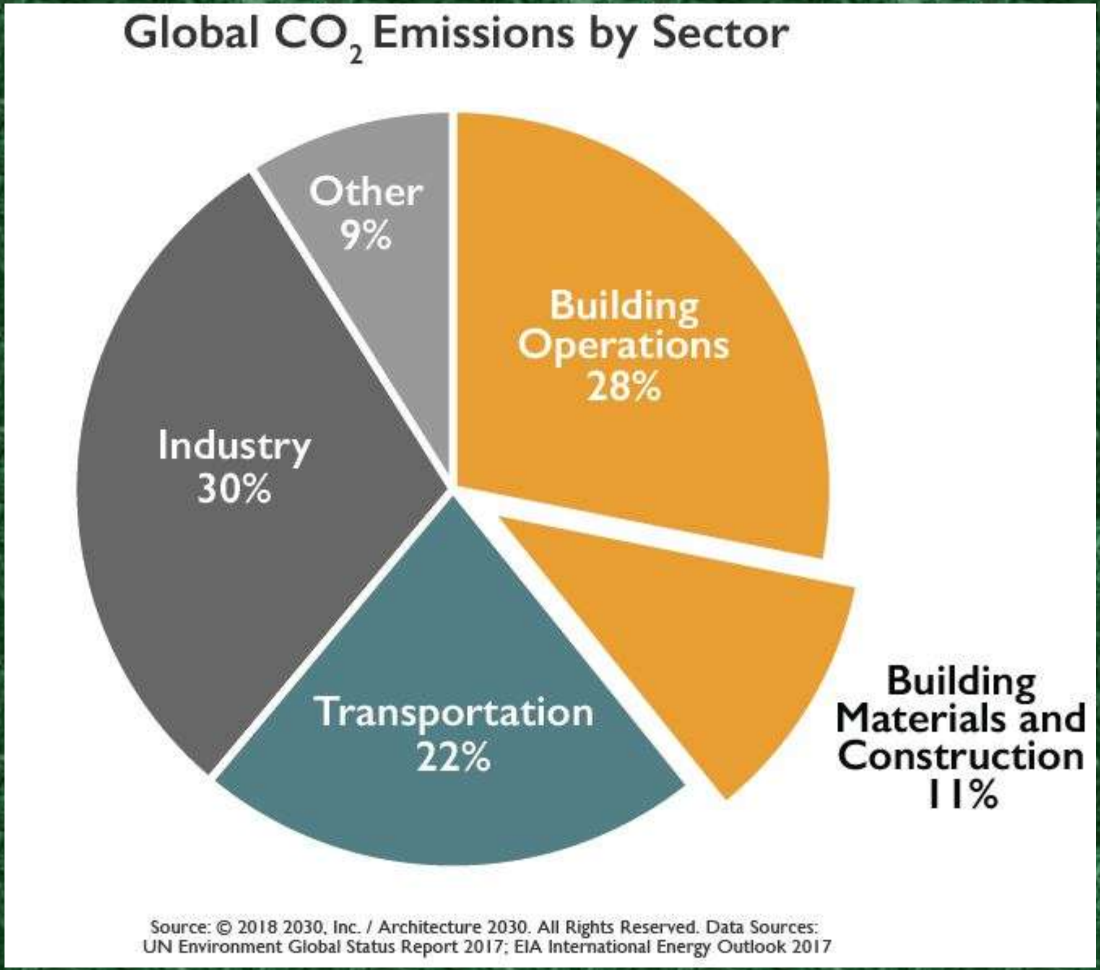
Slow Cities

- **PONTEVEDRA (Spain):**

This city demonstrates how slowing transport across an entire city benefits all types of health. After the city reduced speed limits to 30km/h:

- Physical activity and social connection improved as more people walked.
- From 2011 to 2018, there was not a single traffic death.
- CO_2 emissions fell by 70%.
- 30% increase in business revenues in the city centre presents a strong economic case for slow cities.

The role of building materials and constructions



Advantages of 3D printed houses

- **It reduces waste** because builders can print only what they need for particular projects.
- **It can cut emissions** by reducing or eliminating instances requiring heavy construction equipment or trucks to bring supplies to building sites.
- **Cost-efficient and affordable, highly customizable**
- **Construction time reduces** drastically (fewer costs)
- Solution of housing shortage crisis (e.g. in the US)


3D Printed Houses
In Numbers
Time
2-3 days VS 8 weeks
3D printing vs traditional building methods
Cost
£20,000 VS £146,000
3D printing vs current building costs of UK houses[5]
Safety
Construction has one of the highest injury rates for industry in the UK[6]
Strength
A 3D printed house in China can withstand a 8.0 Richter scale earthquake[7]
20 Millions Tonnes
Construction waste sent to UK landfills every year[8]
Team
2 VS 40
Workers needed
Less Waste
59%
of the UK's total waste is generated by the construction industry[9]
Lower Repair Costs
Print your own repairs!

CARBON IMPACTS OF CONCRETE

Alternative building materials

- Concrete causes about 8% of global carbon dioxide emissions.
- Sustainable alternatives:
  - Low carbon concrete
  - Hempcrete

  (a net-carbon-negative material from hemp)
  - Recycled glass as sand substitute
  - Recycled plastics
  - Pellets made

  from agricultural waste
  - Recycled single-

  use medical plastics

The "world's first" habitable 3D printed houses

- Eindhoven (Netherland)

The "world's first" habitable 3D printed houses

- Eindhoven (Netherland)
  - 100 m2
  - 24 pieces of concrete elements
  - 120 hours
  - Without cradling

Germany's first 3D printed house

- Beckum (Germany)
  - 160 m2
  - 8 months

World's First Neighborhood of Zero-Net Energy 3D Printed Homes

- Coachella-valley (US)
  - 82 houses
  - 24 hours /house

Carbon neutral resort?

- Bucuti and Tara Resort (Aruba)

Have a nice Summer!

Tragedy of the Commons

['tra-jə-dē ōv 'thē 'kä-məns]

A social and political problem in which each individual is incentivized to act in a way that will ultimately be harmful to all individuals.

https://www.youtube.com/watch?v=CxC161GvMPc&t=1s

https://www.youtube.com/watch?v=30gmz49PDY8&t=1s