



UCL

The Anthropocene

GEOG0170



The Anthropocene

New epoch where human-induced changes to earth system rival natural influences.



Negative
(pollution) and
positive (repair)
changes

Image source:
<https://tinyurl.com/vzd3czsr>

Term credited to the atmospheric chemist and Nobel Laureate Paul Crutzen

The Anthropocene

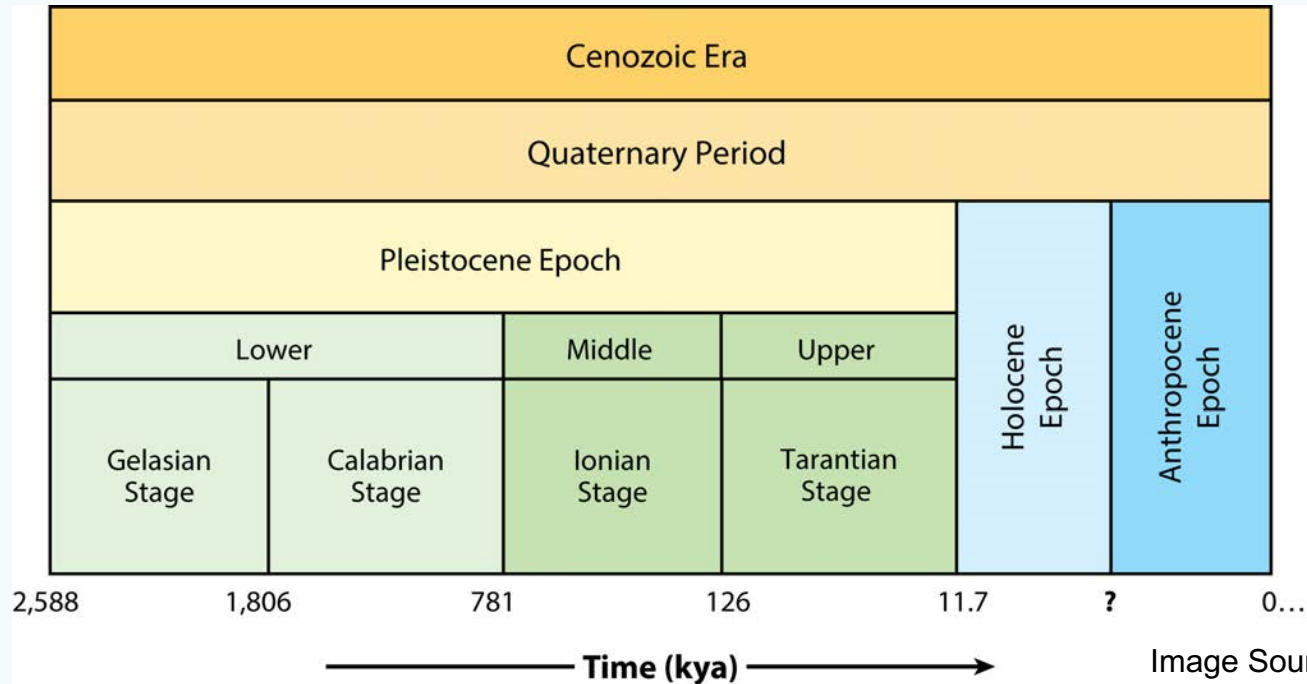
First proposed to start with the Industrial Era (1800-1945), followed by acceleration (1945-2015), and now awareness of problem (humans as Stewards of the Earth)



Image source:
https://en.wikipedia.org/wiki/Black_Country

The Anthropocene

Now acknowledged to be a colonial/technocentric view. Greater human than natural influence on environment may have started earlier

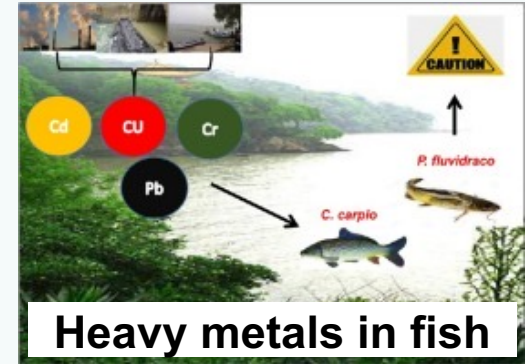
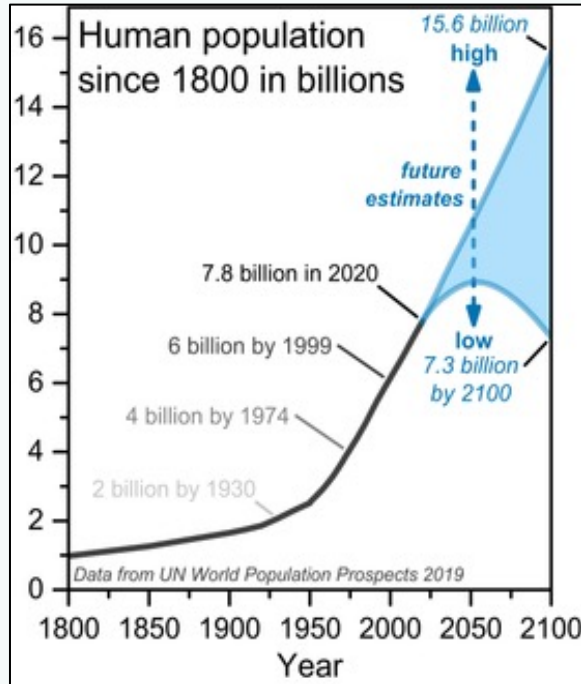


kya: kilo (1000) years ago

Image Source:
<https://doi.org/10.1146/annu-rev-environ-102016-060854>

The Anthropocene

How did we get here?



Hunter Gatherers

200,00-10,000 years ago

Archaeological evidence of hunter gatherer communities (tools, art)

Paleolithic Hand Axes, East Africa



Image Source: Goudie (2013)

Linton Panel, Rock Art Gallery, South Africa



Image Source: <https://tinyurl.com/utc8652n>

Large roaming land required to sustain omnivorous diet of wild animals and plants.

Symbiotic relationship between environment and humans (adapt to environment)

Controlled use of Fire

Controlled use of fire for hunting, cooking (more varied diet), agriculture (land clearing, fertilization)

1 million years ago

Evidence of controlled use of fire from archaeological objects and charcoal in soils and lake sediments

Charred remains of animals found in a cave in Israel



Image Source:
https://commons.wikimedia.org/wiki/File:Qesem_Cave_burned_animal_bones.jpg

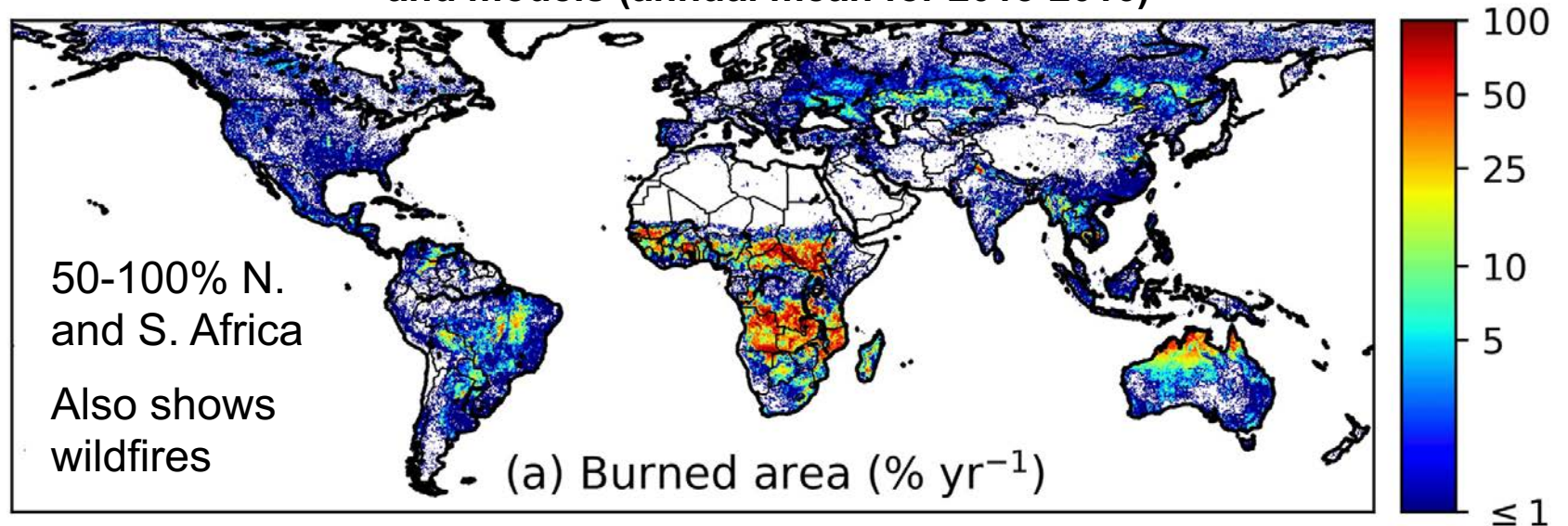
Fire key to future environmental damage (combustion that powers our energy system and industrial processes, agricultural practices still used today)

Controlled use of Fire

Fire still widely used in agriculture. Banned and enforced in most of Europe.

Africa is the burning hotspot of the world.

Percent area burned according to a product developed with satellite images and models (annual mean for 2013-2016)



Cultivation and Domestication

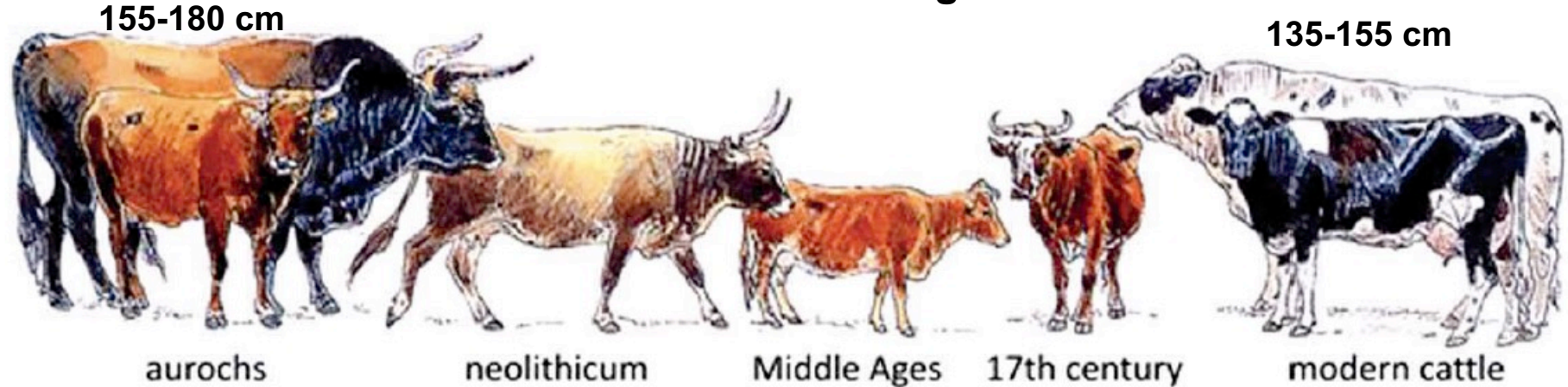


9,000 years ago

Shift from hunt and gather to animal domestication (pastoralism) and plant cultivation

No longer need a wide range of land to survive. Shift from nomadic to permanence.
Deliberately transform environment.

Domestication of aurochs leading to modern cattle



Exercise

Can you name the region (present name) where records suggest these animals were first domesticated?

1. Llama
2. Horse
3. Chicken



Image Source:

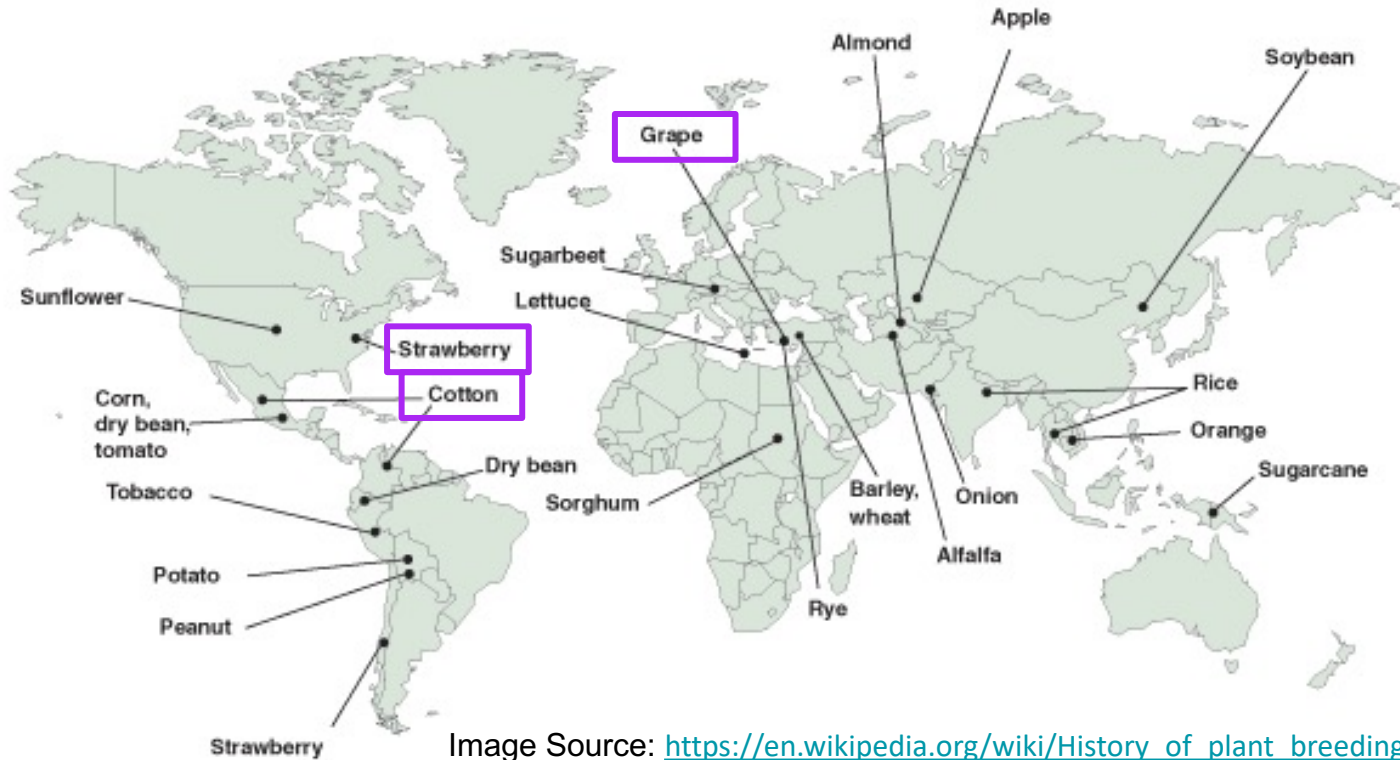
<https://www.frontiersin.org/articles/10.3389/fevo.2020.00103/full>

Exercise

Can you name the region (present name) where records suggest these plants were first cultivated?

1. Grape
2. Strawberry
3. Cotton

Centers of origin of selected crops



Important to recognize that the location and date of the origin of cultivated crops and domesticated animals is altered frequently by new discoveries

Settlements and Towns

Cultivation and domestication allowed settlements and towns to establish.

9,500 years ago

Issues like refuse/waste disposal, hygiene, social conflict arise

Excavated foundations of Çatalhöyük, Turkey (oldest city, 9 kya, 10,000 people)

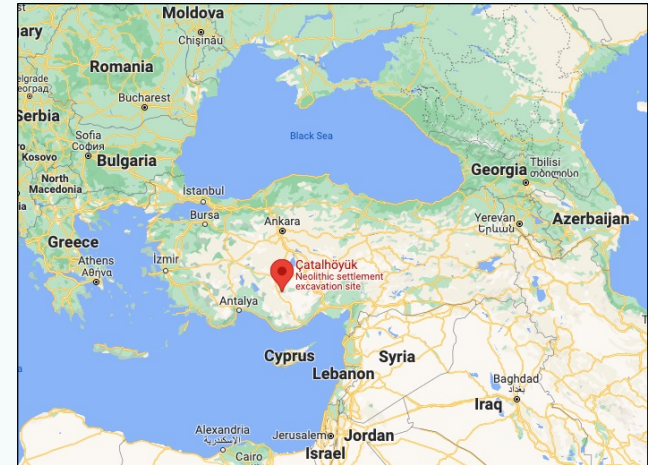


Image Source: https://en.wikipedia.org/wiki/History_of_the_city

Irrigation

8,000 years ago

Important development for agriculture.

Allowed farmers to control river by preventing flooding and storing water.

First developed in Egypt using system of canals and basins

Conceptual diagram of basin irrigation in Egypt

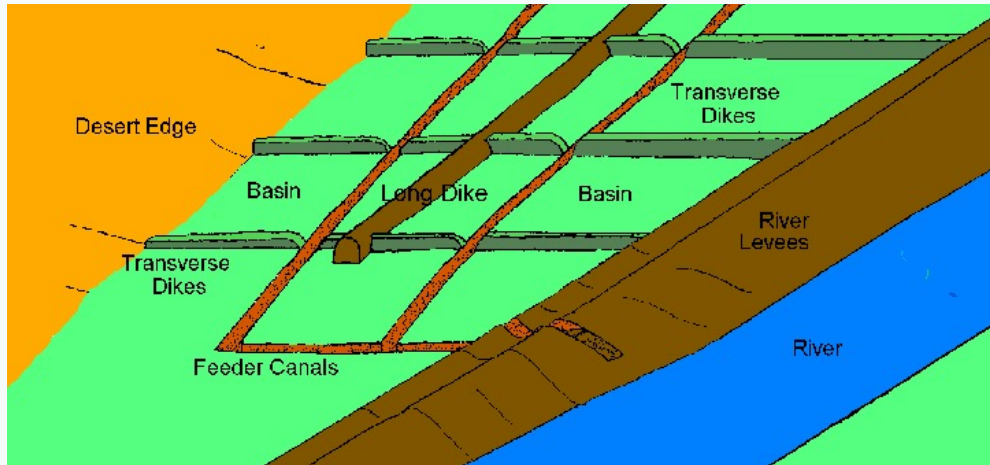


Image Source: <https://condor.depaul.edu/~sbucking/basinirr2.gif>



Image Source:

<http://www.waterencyclopedia.com/Hy-La/Irrigation-Systems-Ancient.html>

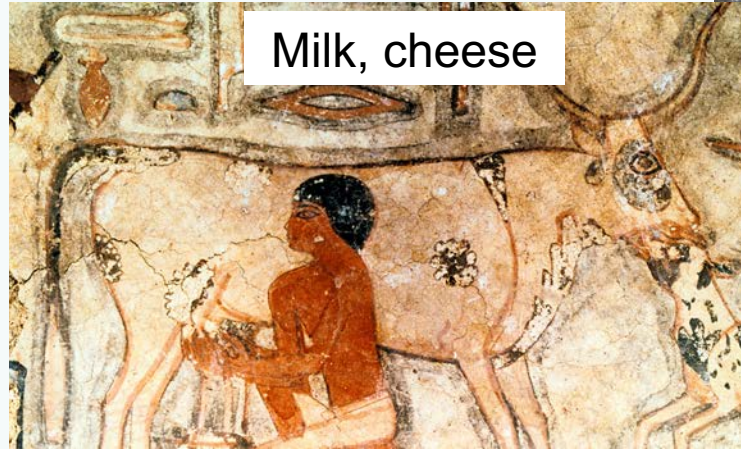
Secondary Agricultural Products

Harness additional power from domesticated animals

Ploughs, carts, animal fibres, milk, cheese

Leads to increased intensification of farming and transport

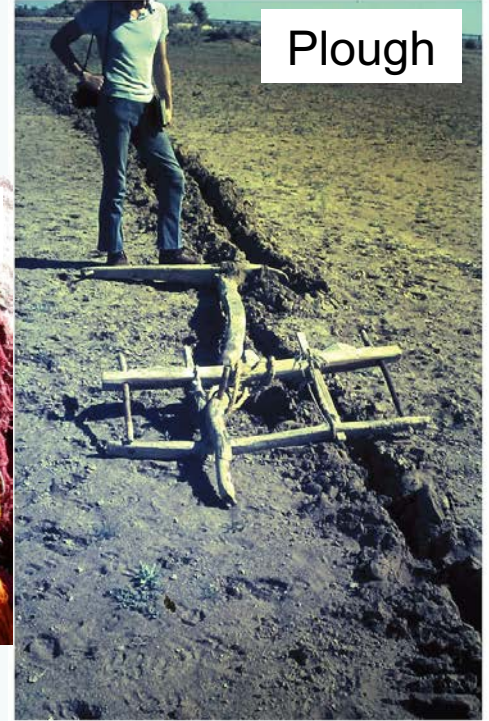
8,000 years ago



Milk, cheese



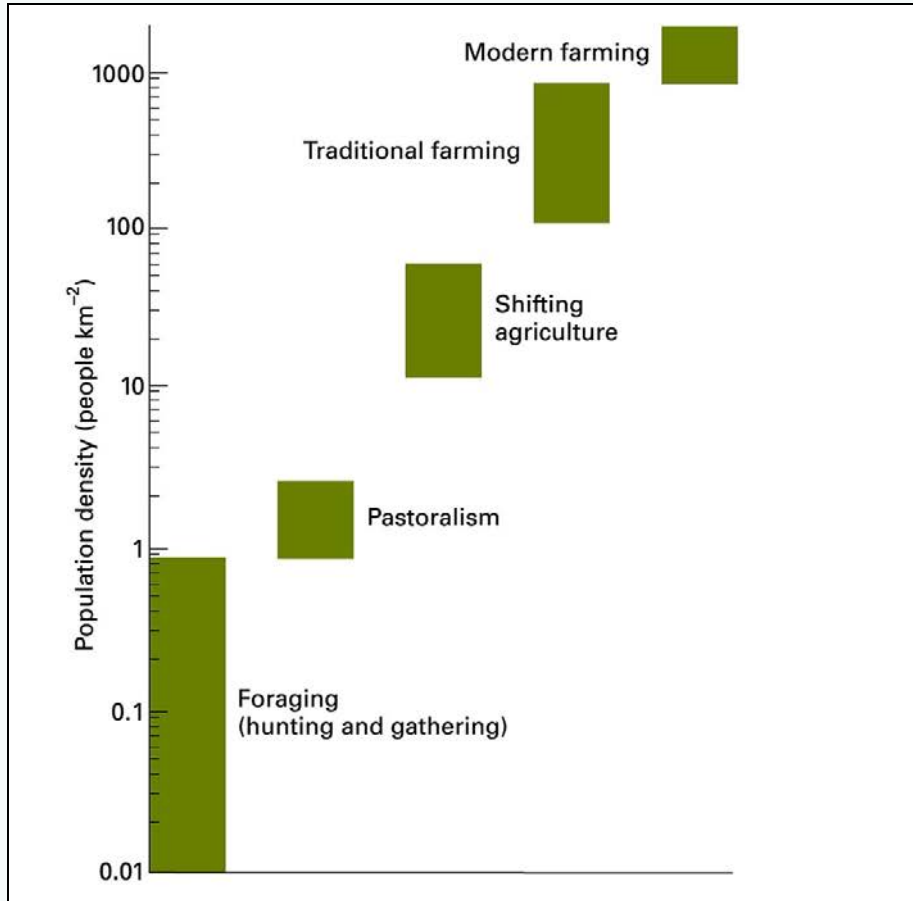
Animal fibres



Plough

Also took to the seas. Fishing intensity increased (date unclear)

Influence of Agriculture on ...



Carrying capacity
(population density)

Increases from <1
person km⁻² to > 1000
people km⁻²

(further increases from
improved sanitation,
plumbing, health care)

Mining and Smelting

Steps: extract → concentrate → smelt/refine

7,000 years ago

Mining challenges included lighting, ventilation, and water

Gold, copper, precious stones mine in Egypt



Image: <https://www.arabnews.com/node/1223766/offbeat>

Smelting: refine ore into useable metal

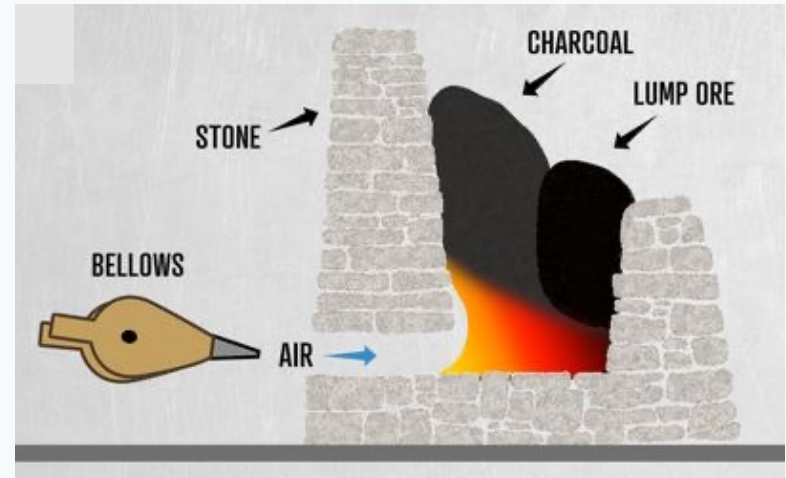


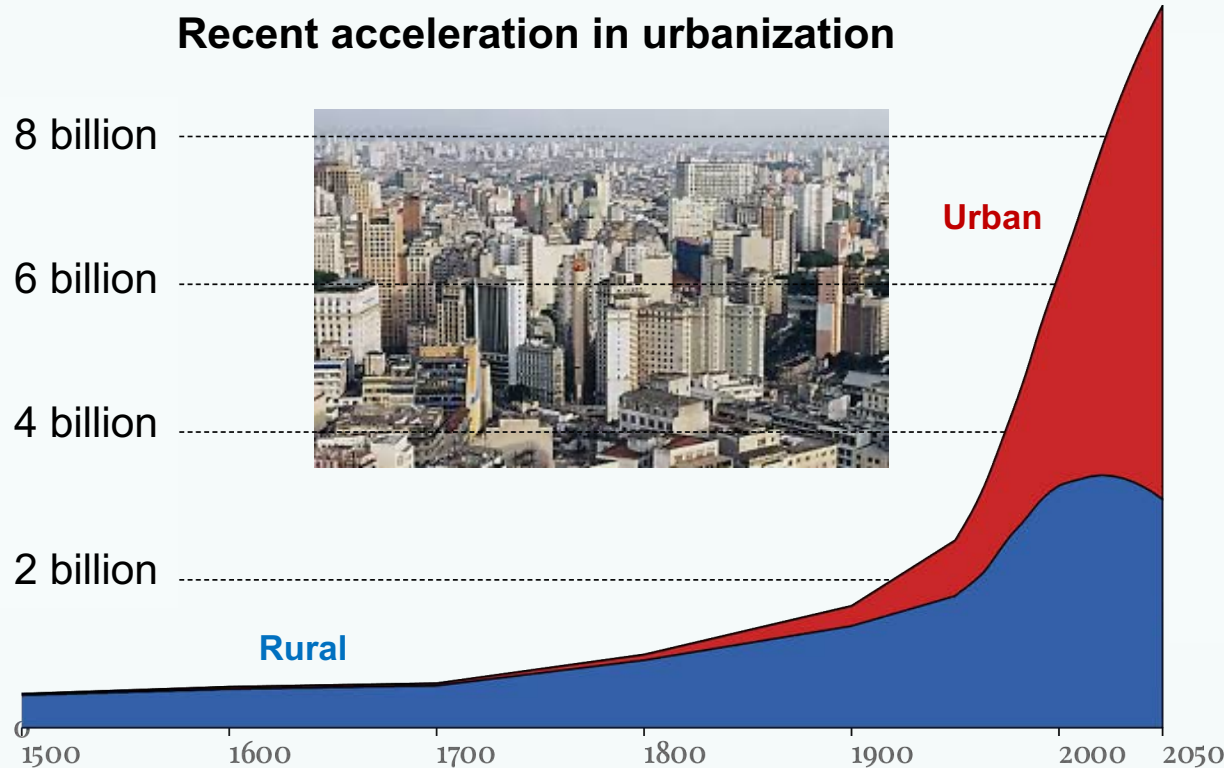
Image: <https://tinyurl.com/2p98ce73>

Mining generated large quantities of waste and acidified water bodies

Smelting iron and copper required large amounts of wood: deforestation, air pollution

Cities and Urbanization

Recent acceleration in urbanization



9,000-7,000 years ago

First large ancient cities had 700,000 to 1 million people.

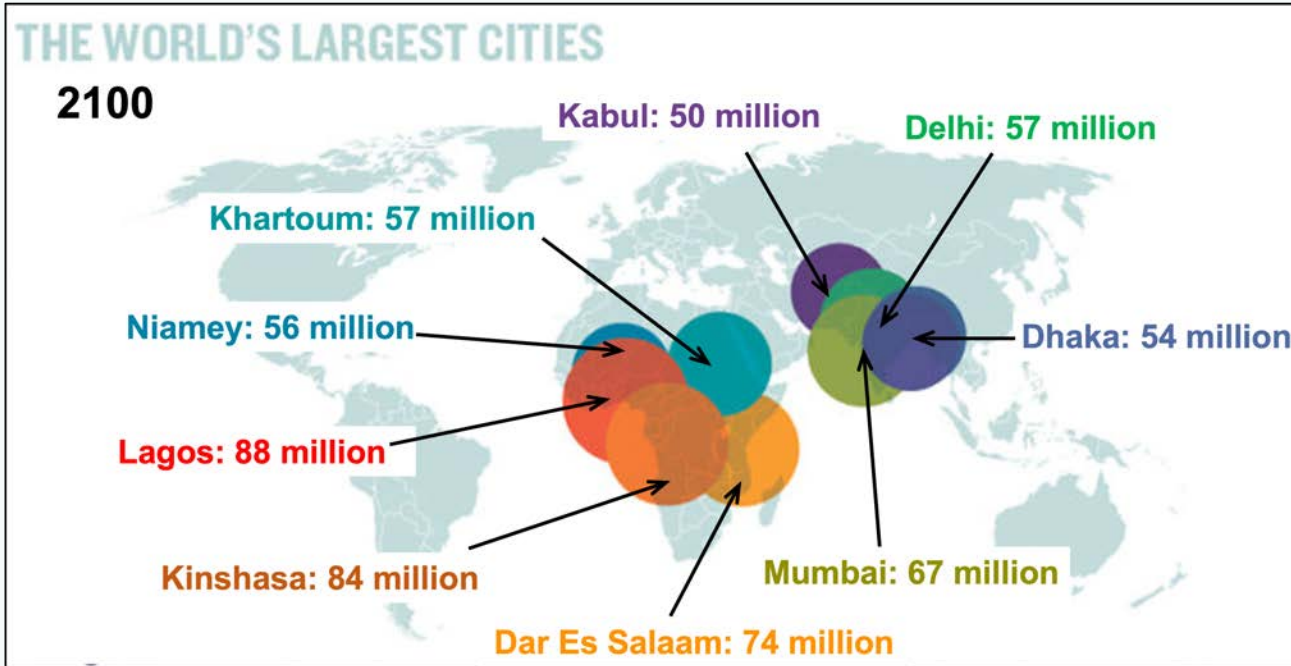
Large industries allowed cities to grow larger

Cities an increasing contribution to environmental damage, but also a refuge for plants and animals

Future Megacities

Largest cities forecast to reach > 40 million inhabitants

2100



Largest cities in 2020
(population in millions):

1. Tokyo (38)
2. Delhi (29)
3. Shanghai (26)
4. Sao Paulo (22)
5. Mexico City (22)
6. Cairo (20)
7. Mumbai (20)
8. Beijing (20)
9. Dhaka (20)
10. Osaka (19)

Adapted Image: <https://medium.com/ensia/here-come-the-megacities-1b0f8a2287f2>

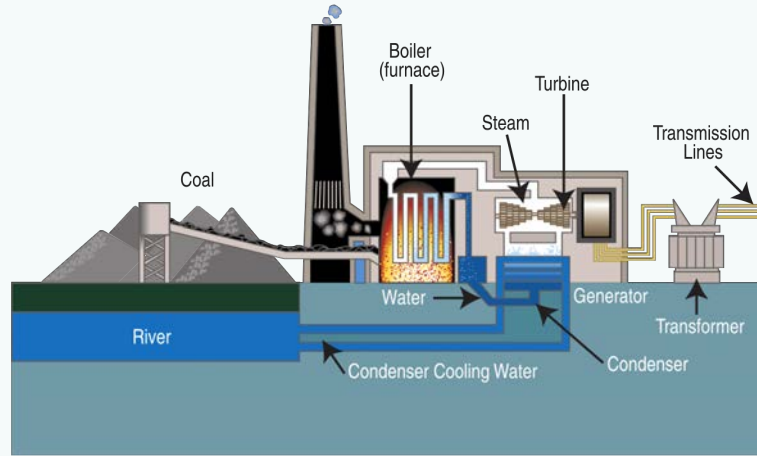
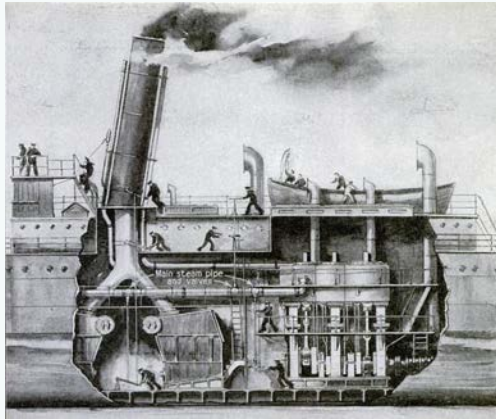
Projections: <https://journals.sagepub.com/doi/full/10.1177/0956247816663557>

Steam Engine

18th century

Energy from combustion of coal ($C + O_2 \rightarrow CO_2 + \text{🔥}$)

Large locomotives (trains, ships), electric power (power plants)



Fueled the industrial revolution

Degraded air quality, caused acid rain, increased abundance of the greenhouse gas CO_2 and bioavailable nitrogen ($N_2 + O_2 \rightarrow 2NO$)

Internal Combustion Engine (ICE)

19th century

Used in cars, boats, ships, airplanes, trains

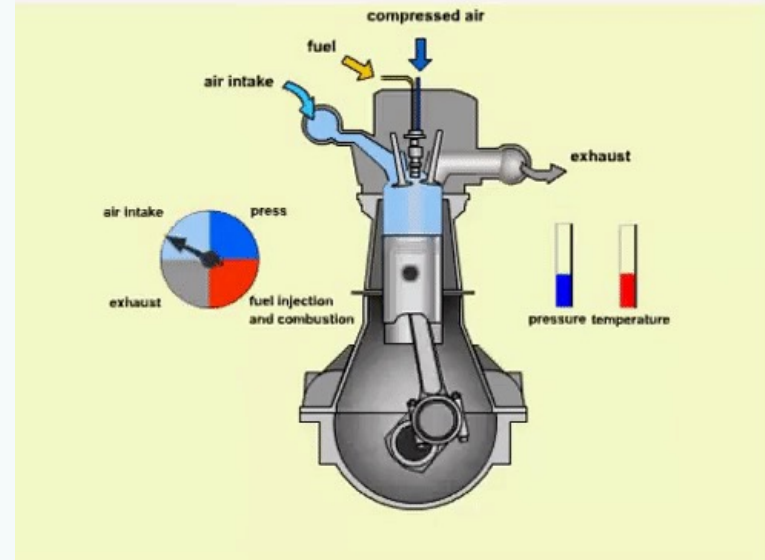
Also draws energy from combustion ($C + O_2 \rightarrow CO_2 + \text{fire}$), so also emits air pollution and the greenhouse gas CO_2

ICE draws more power than steam engine

ICE combustion inside cylinder;
steam engine outside it.

ICE lighter and more compact
(move faster, carry more)

ICE operates at higher temperatures and
pressures, so special materials (alloys) required.



Synthetic Fertilizers and pesticides

20th century

More productive crops to sustain large population

Haber-Bosch ammonia production process

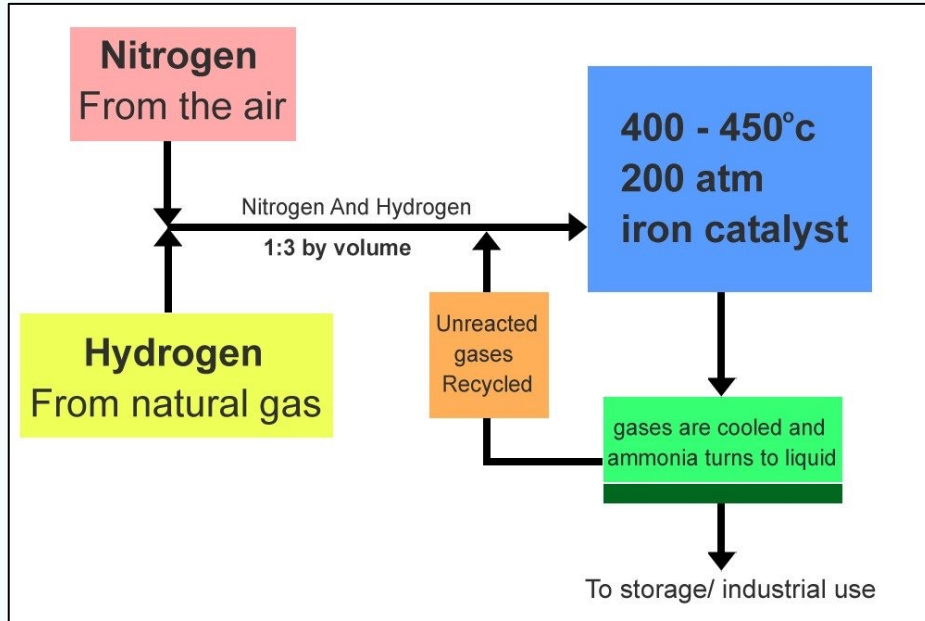


Image Source: <https://tinyurl.com/yc3eyk9r>

- Converts stable, unreactive nitrogen (N_2) to bioavailable nitrogen as ammonia (NH_3)
- Natural processes too slow
- **Adv:** Increase agricultural productivity, feed more people
- **Disadv:** offsets nitrogen balance in the environment (eutrophication). Contributes to air pollution.

Selective breeding of crops around the same time also increased crop yields

How We've Altered the Environment



Exercise

What proportion of all mammals are wild?

What are the 4 most common crops globally?

Exercise

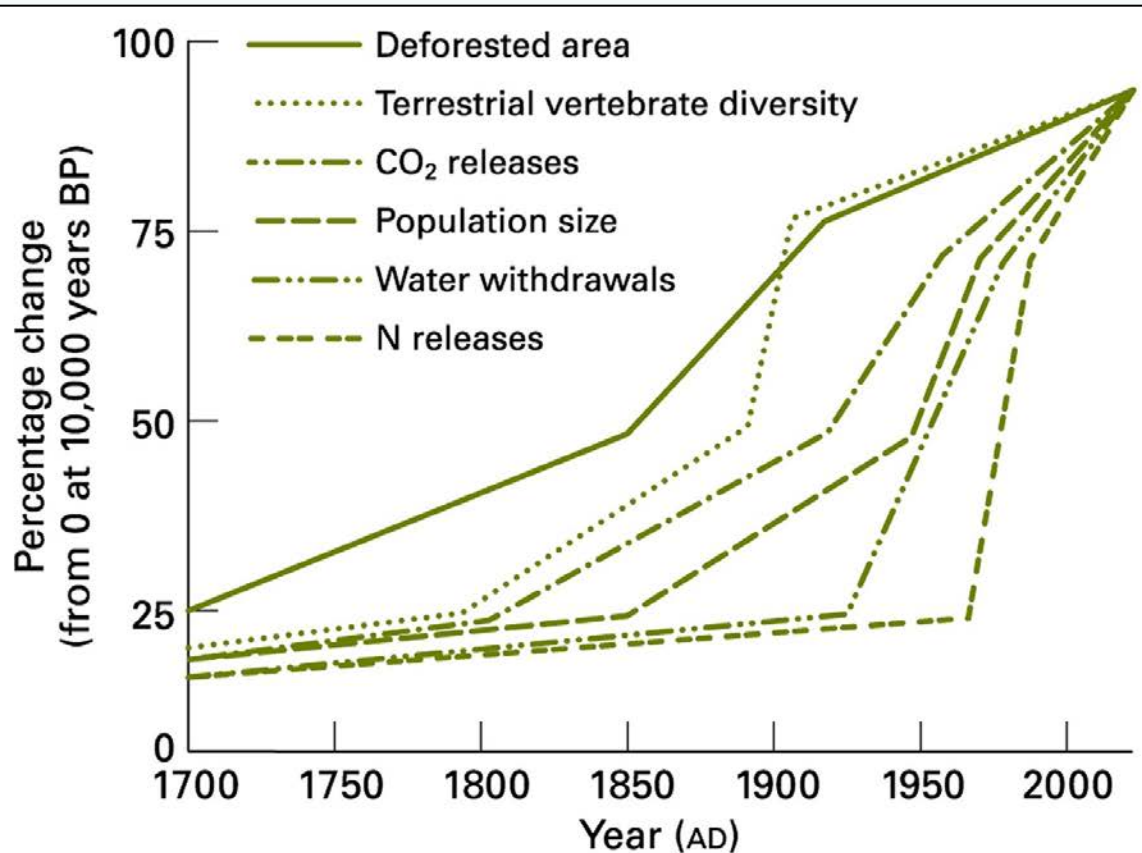
What proportion of all mammals are wild?

4% of mammals are wild (<https://www.pnas.org/content/115/25/6506>)

What are the 4 most common crops globally?

Wheat, rice, potatoes, maize. *Account for more mass produced than the sum of the next 26 crops combined. Shows that our diet has become less varied.*

How We've Altered the Environment



Changes from 1700 to 2010:

- Population increased from 1.5 to 6 billion (7.8 billion in 2021)
- 13- to 14-times increase in energy use
- 9-times increase in freshwater use
- 5-times increase in irrigated areas

Image source: Goudie (2013)

How We've Altered the Environment

Anthropogenic creation of reactive nitrogen (Nr)

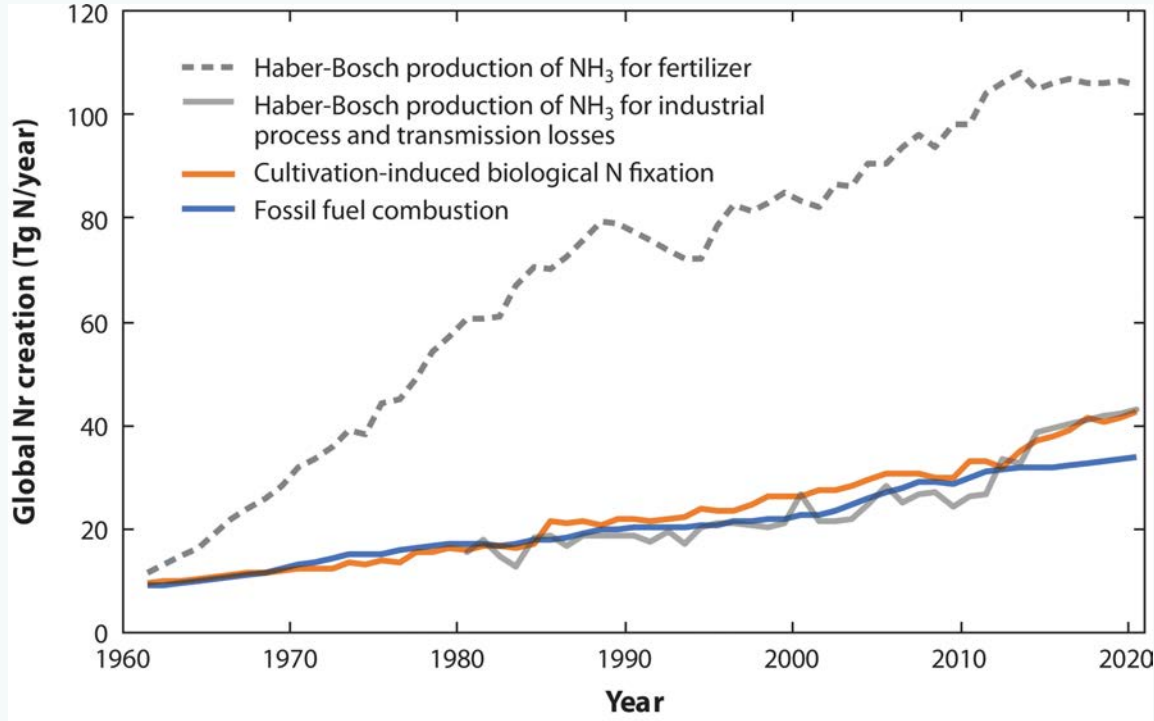


Image source:
<https://www.annualreviews.org/doi/full/10.1146/annurev-environ-012420-045120?intcmp=trendmd>

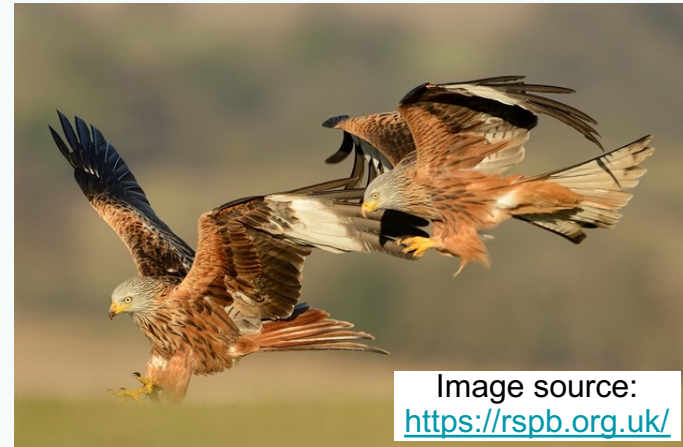
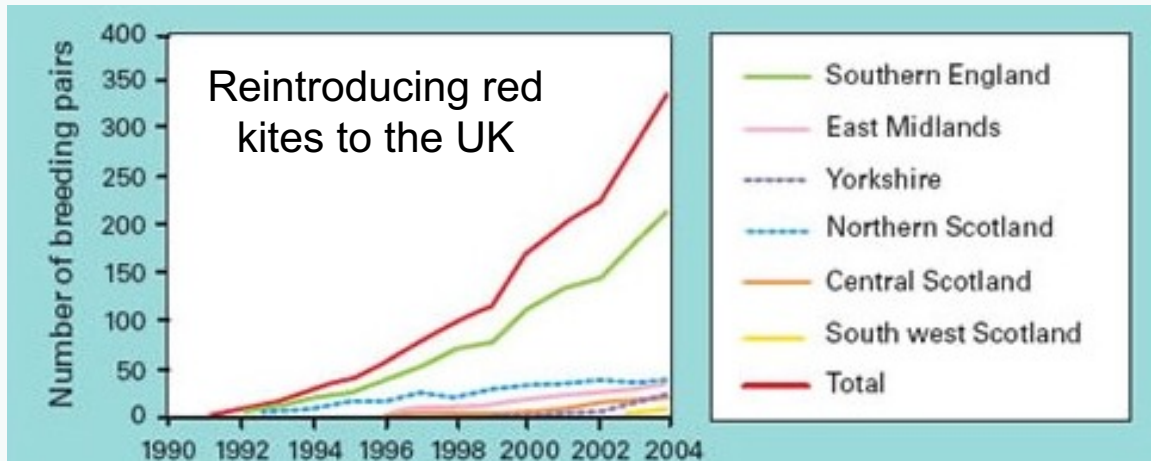
Dominated by Haber-Bosch production of ammonia (NH_3) fertilizers

Seminar Activity for Week 2



Discussion Roundtable: It's not all gloom and doom!!!

Share an example of a good news story where humans have had a positive effect on the environment.



Possible sources: primary literature, reputable news agency, environmental reports, policy documents, environment agency websites, National Geographic

Further Resources



The Concept of the Anthropocene:

<https://www.annualreviews.org/doi/10.1146/annurev-environ-102016-060854>

Nitrogen fixation trends: <https://www.annualreviews.org/doi/full/10.1146/annurev-environ-012420-045120?intcmp=trendmd>

UCL Lunch Hour Lecture on the environmental impacts of space tourism:

<https://www.ucl.ac.uk/events/events/2022/feb/billionaire-space-tourism-race-could-be-one-giant-leap-air-pollution>

Next Lecture: Air Pollution UCL

