Biocultural Evolution and the Anthropocene

1

What is the Anthropocene?

Human activity has changed our planet. We live on every continent and have directly affected at least 83% of the planet's viable land surface. Our influence has impacted everything from the makeup of ecosystems to the geochemistry of Earth, from the atmosphere to the oceans. Many scientists define this time in the planet's history by the scale of human influence, and label it as a new geological epoch called the **Anthropocene**.

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2

What is the Anthropocene?

Geological epochs are units used by geologists and paleontologists to separate units of **deep time**.

These units of time are defined by stratigraphic layers that are chemically or biologically distinct. Epochs are defined on a **global level**, and their beginning and end are dated to specific points in time.

Hominins first appear ~6 mya in the **Miocene**, evolve through the **Pliocene**, **Pleistocene**, **Holocene** and now live during the "**Anthropocene**."

Anthropo = human/humanoid, Cene = recent/new

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3

Golden spikes are used by geologists to define major geological time boundaries and large changes in Earth's biota, such as the Ediacaran Biota dated around 635 million to 542 million years old.

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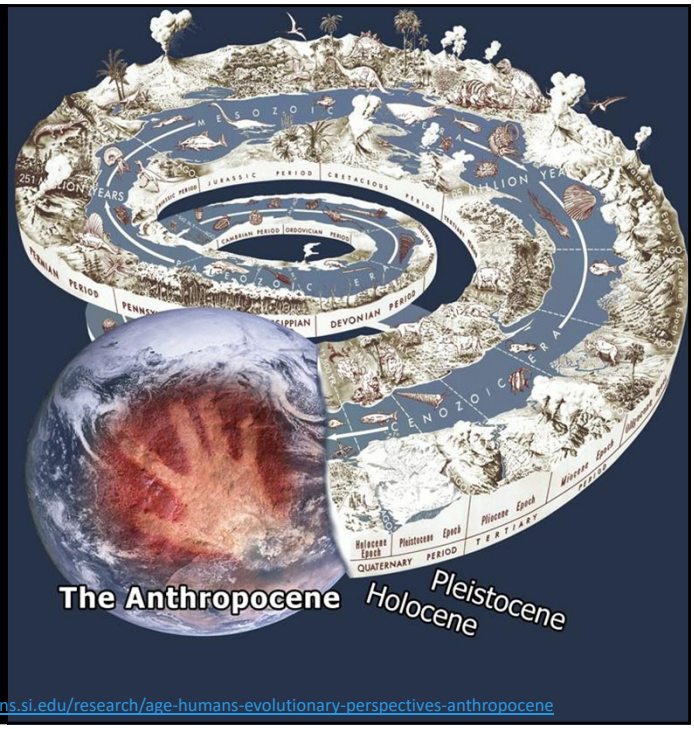
Visual representation of **deep time** (Earth is 4.5 billion years old) with the last three epochs labeled (Pleistocene, Holocene, and "Anthropocene")



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When did the Anthropocene begin?

Answer: Debatable!

The beginning of the Anthropocene is a subject of debate among geologists, climate scientists, anthropologists, and others in the scientific community.

In order for the Anthropocene to become officially recognized as a geological epoch by the **International Commission on Stratigraphy**, a start date must be recognized that is global and can be defined stratigraphically by biological, chemical, or other types of markers.

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When did the Anthropocene begin?

Some geologists argue that this is **impossible to identify** because we are still within the range of variation of any signal that might distinguish recent strata from earlier ones, or because human activity is diverse enough that no single moment universally distinguishes a period of time separating the Anthropocene from the Holocene.

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When did the Anthropocene begin?

But even among those who believe that this beginning date can be pinpointed, there is still considerable disagreement. At least three differing views of when the Anthropocene began:

- **~8,000 ya / agriculture:** Deforestation resulted in increased CO_2 & methane levels.
- **18th century / Industrial Revolution:** Exploitation of fossil fuels increased geologic variability
- **mid-20th century / "Great Acceleration" of the 1940s & 1950s and beyond:** testing/use of atomic weaponry left distinctive radioactive signatures in the sediments of the Earth. (← if the geological governing bodies officially adopt the Anthropocene terminology, it will probably be recognized at this 20th century date)

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The onset of the Anthropocene

Bruce D. Smith *, Melinda A. Zeder

2013 – Journal: *Anthropocene*

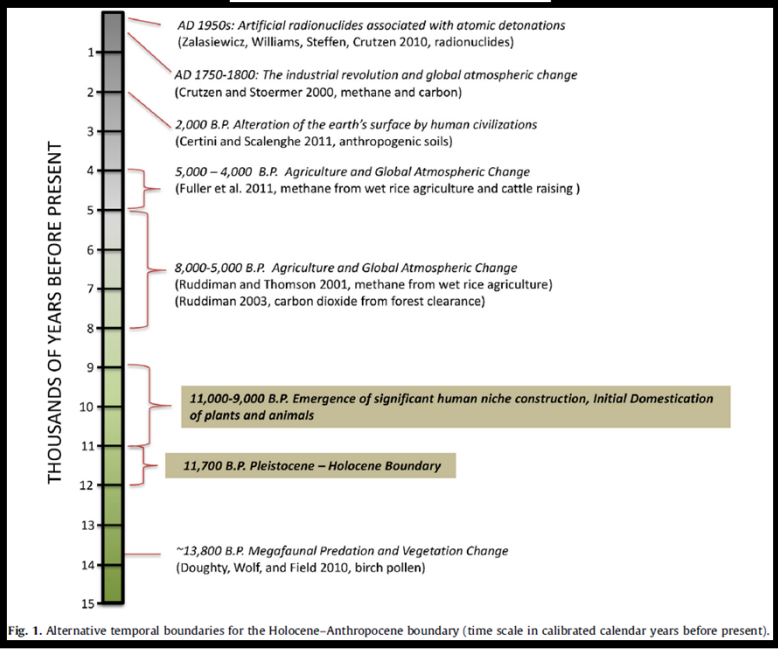

Fig. 1. Alternative temporal boundaries for the Holocene–Anthropocene boundary (time scale in calibrated calendar years before present).

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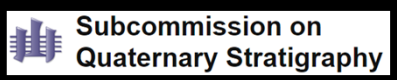
As of today, neither group has officially recognized "Anthropocene" as a recognized subdivision of geologic time



But, in 2016, the Anthropocene Working Group (AWG) of the Subcommission on Quarternary Stratigraphy voted in favor of making a formal recommendation to the above parent institutions. The AWG is working toward finding a location to recommend for a new "golden spike."

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http://quaternary.stratigraphy.org/working-groups/anthropocene/

Subcommission on Quaternary Stratigraphy

Anthropocene Working Group

- Phenomena associated with the **Anthropocene** include: an order-of-magnitude increase in erosion and sediment transport associated with urbanization and agriculture; marked and abrupt anthropogenic perturbations of the cycles of elements such as carbon, nitrogen, phosphorus and various metals together with new chemical compounds; environmental changes generated by these perturbations, including global warming, sea-level rise, ocean acidification and spreading oceanic 'dead zones'; rapid changes in the biosphere both on land and in the sea, as a result of habitat loss, predation, explosion of domestic animal populations and species invasions; and the proliferation and global dispersion of many new 'minerals' and 'rocks' including concrete, fly ash and plastics, and the myriad 'technofossils' produced from these and other materials.

3. Its beginning would be optimally placed in the mid-20th century, coinciding with the array of geological proxy signals preserved within recently accumulated strata and resulting from the 'Great Acceleration' of population growth, industrialization and globalization;
4. The sharpest and most globally synchronous of these signals, that may form a primary marker, is made by the artificial radionuclides spread worldwide by the thermonuclear bomb tests from the early 1950s.

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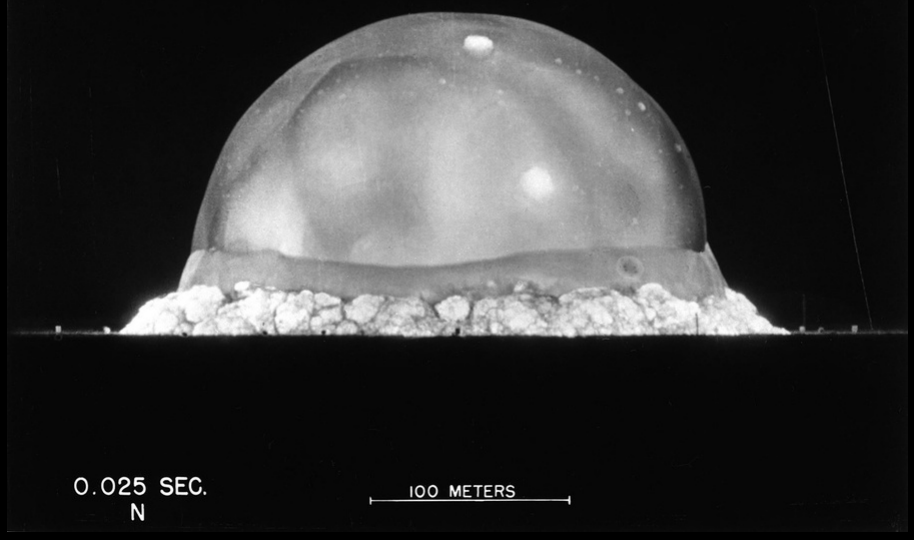
The "Signal"



US Army & Manhattan Project first nuclear test in New Mexico, July 16, 1945

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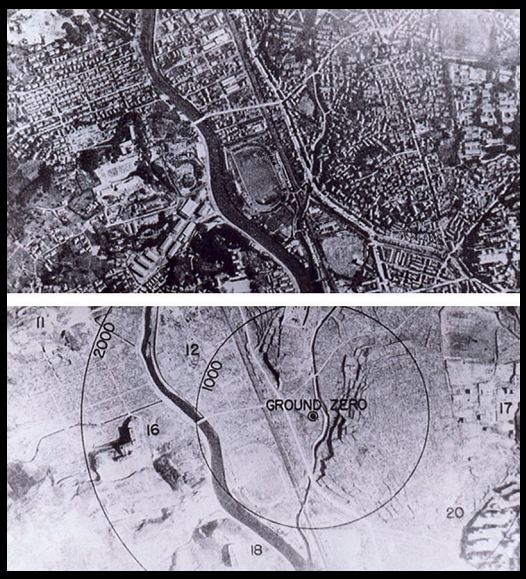
Less than 2 months later –
August 6 & 9, 1945 –
the United States detonated two atomic bombs over Hiroshima and Nagasaki, Japan, effectively ending the Pacific Theater of World War 2.

(a few months earlier in 1945 the Soviet Army had sieged Berlin, Germany, finalizing the defeat of Nazi Germany)



city of Nagasaki, Japan, before and after the US detonated an atomic bomb

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United Nations formed in 1945, the year that the second great imperial war of the 20th century ended

A "tri-polar" world was reached by the mid-20th century…

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The European Union (EU)… [& Brexit]

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North Atlantic Treaty Organization (NATO) summit 2019

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Foraging Society

Average forager produced ~5,000 kcal/cap/day

Farming Society

Average farming society produced ~10,000-30,000 kcal/cap/day

Fossil Fuel Society

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Foraging Society

Average forager produced ~5,000 kcal/cap/day

Farming Society

Average farming society produced ~10,000-30,000 kcal/cap/day

Fossil Fuel Society

2 early innovations/discoveries:

1: 3rd century BC – Egyptians learned that heat could be converted to motion by burning wood to boil water and use steam to power pistons

(supposedly this was used by the "Gods" to magically open temple doors)

2: *around 2000 yrs ago, some humans realized that coal could be burned to release heat

* coal began rivaling wood as a fuel at AD 1000 in China, and AD 1600 in England

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Foraging Society

Average forager produced ~5,000 kcal/cap/day

Farming Society

Average farming society produced ~10,000-30,000 kcal/cap/day

Fossil Fuel Society

Energy capture per capita/day in some Western industrialized societies from 38,000* kcal/cap/day in 1800 to 230,000 by the 1970s.
(obviously, some nations/individuals consume more than others, very particular inequalities were propped up)

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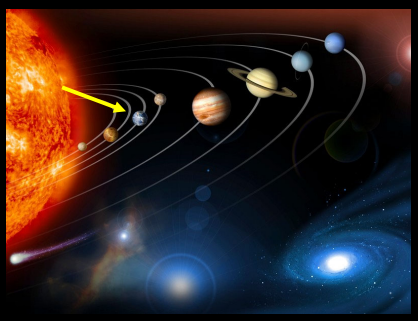

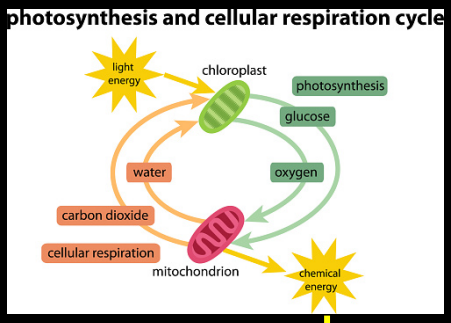

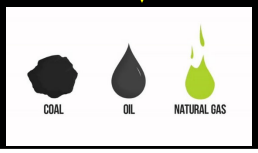

Fossil Fuels – new human method of energy capture

Fossil fuels store energy in the bonds between the atoms that make up their molecules. Burning the fuels breaks apart those bonds. This releases the energy that originally came from the sun. Green plants had locked up that solar energy within their leaves using photosynthesis, millions of years ago. Animals ate some of those plants, moving that energy up the food web. Others plants just died and decayed.

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A composite image of Earth at night. The lights include city lights, gas flares, and wildfires. (NASA/GSFC)

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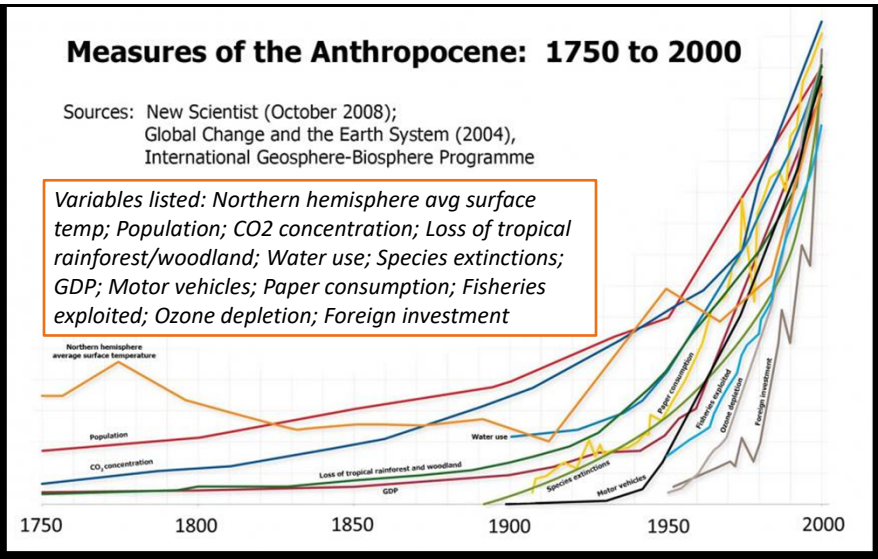

Industrial Revolution

The sharp upward spike in all of the trends displayed on this graph show how human activity has increased since the **Great Acceleration**.

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Paul Crutzen, 2000: set Anthropocene to Industrial Revolution

the key indicator of the onset of the Anthropocene: "This is the period when data retrieved from glacial ice cores show the beginning of a growth in the atmospheric concentrations of several "greenhouse gases", in particular CO_2 and CH_4. . .Such a starting date also coincides with James Watt's invention of the steam engine" (Crutzen and Stoermer, 2000, p. 17).

Watt steam engine was developed by 1775

Coal – fossil fuel (carbon)

23

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Coal – fossil fuel (carbon)

- **1869** – The First Transcontinental Railroad completed in North America, successfully bridging Pacific and central United States.

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Paul Crutzen, 2000: set Anthropocene to Industrial Revolution

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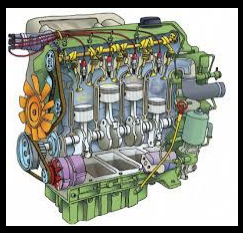
Internal combustion engine



oil – fossil fuel (carbon)

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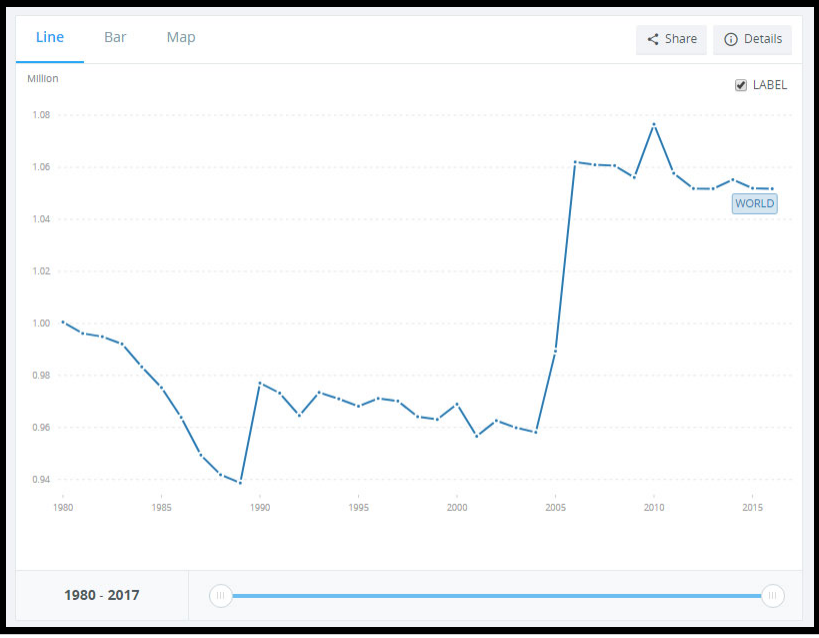
Global Railroad lines – ~1.07 million km (~665,000 miles -- 26+ times around Earth's equator)



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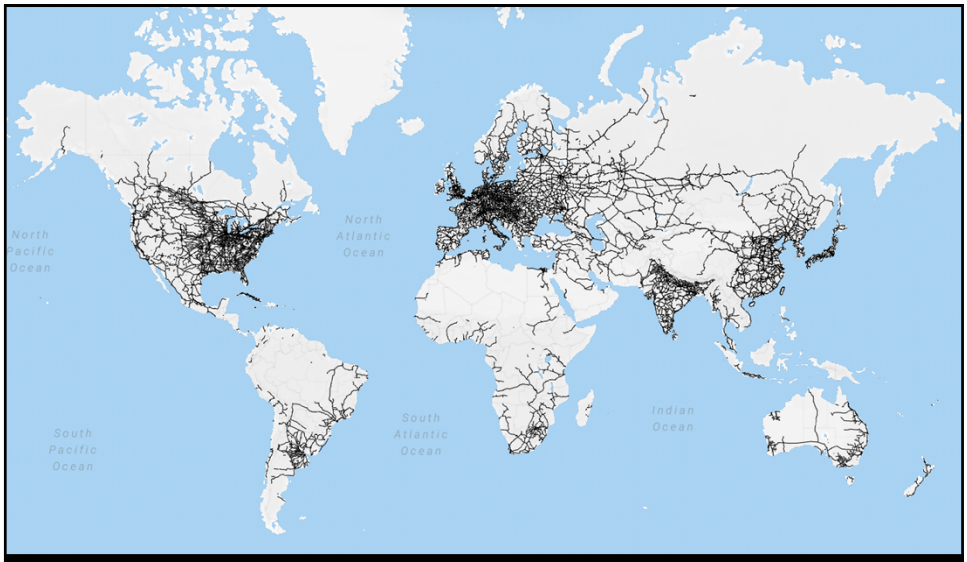

Global Railroad lines

27

A composite image of Earth at night. The lights include city lights, gas flares, and wildfires. (NASA/GSFC)

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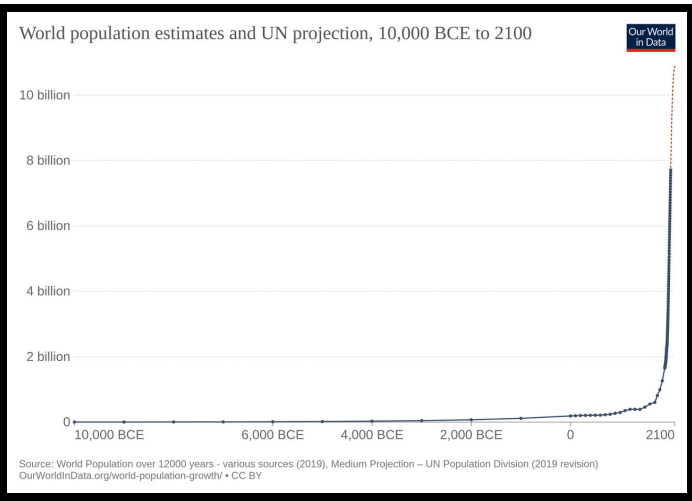

*on the cusp of the Agricultural/Neolithic Revolution, just a few million people globally (maybe less than 1 million)
*1800 – just under 1 billion people worldwide
*1900 – 1.6 billion
*2000 – 6 billion
*last year during this same lecture (December 2021) – 7.8 billion
* A couple weeks ago (November 2022) – 8 billion

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JOURNAL ARTICLE

Population Bottlenecks and Pleistocene Human Evolution

John Hawks, Keith Hunley, Sang-Hee Lee, Milford Wolpoff

Molecular Biology and Evolution, Volume 17, Issue 1, January 2000, Pages 2–22,
https://doi.org/10.1093/oxfordjournals.molbev.a026233
Published: 01 January 2000 **Article history** ▾

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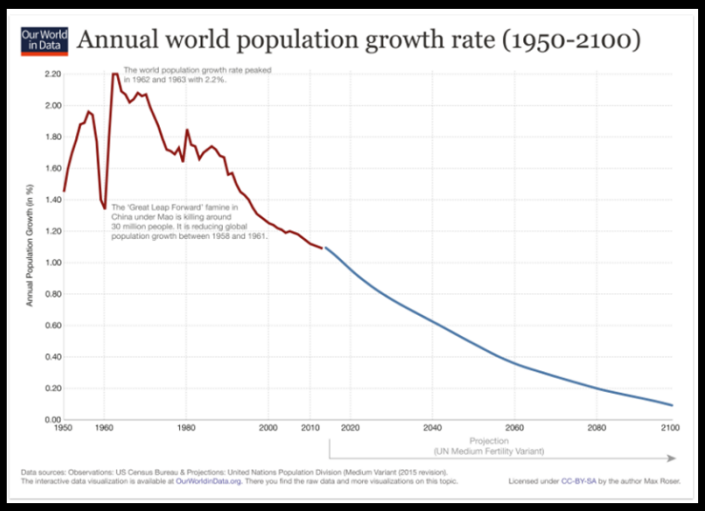
- Industrial Demographic Transition
- Global average birth rate (#kids per female) has halved since 1960s



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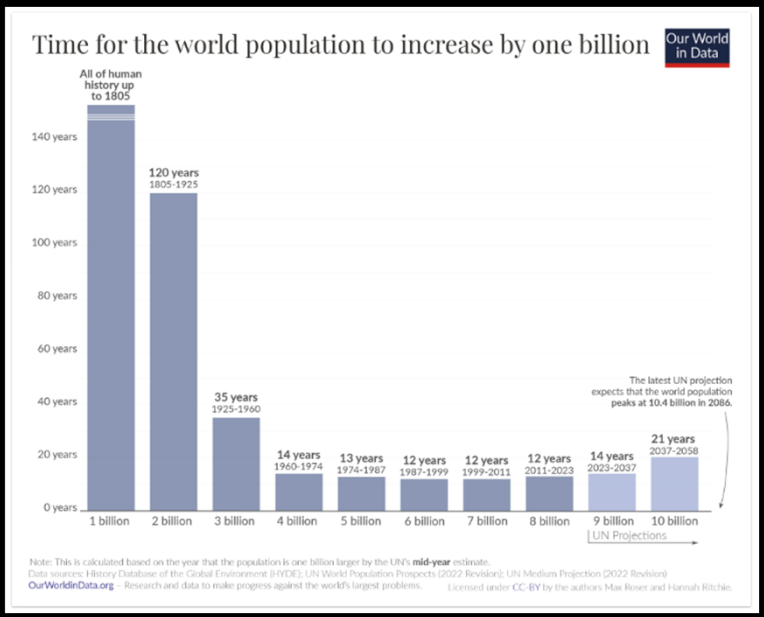

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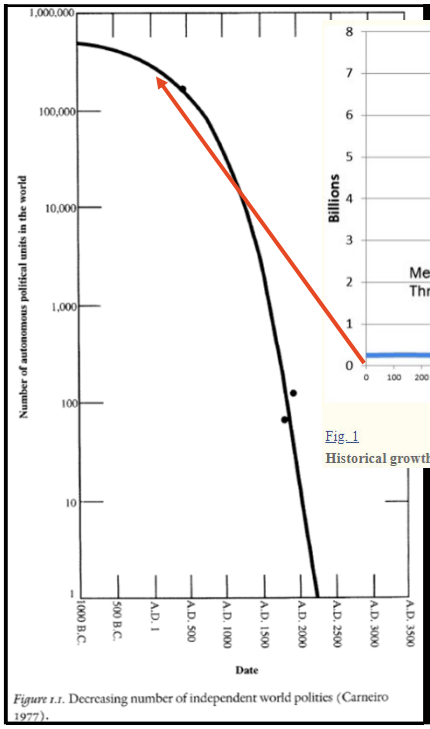

Figure 1.1. Decreasing number of independent world polities (Carneiro 1977).

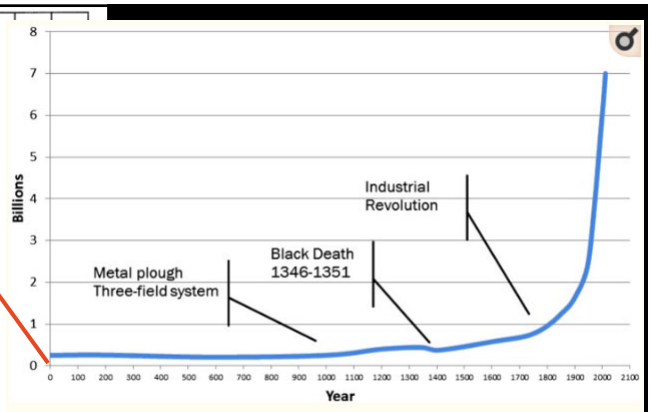

Fig. 1
Historical growth of the world population since year 0

World population in Billions, since AD 1

independent political units (polities/societies) in the same era

Today there are 195 nation-states (?? changing)

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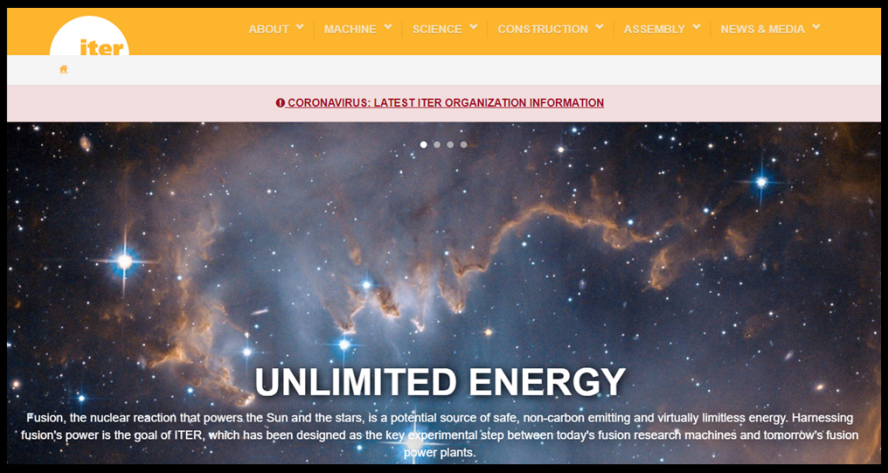
Anthropologist Leslie White (1931) – "Internationalism, or world consolidation… is the next stage of political evolution." ???

ITER ("The Way" in Latin) – 35 nation-states in long-term collaborative project
Primary members: China, EU, India, Japan, Korea, Russia, United States



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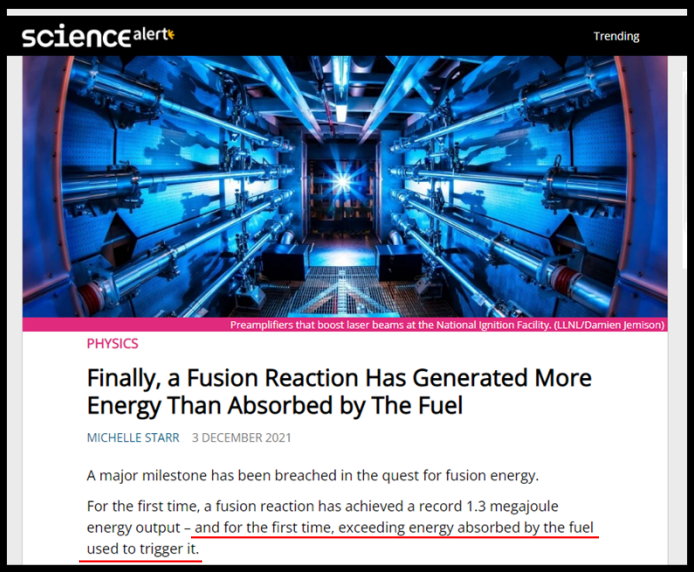
Is the human species now crossing a new Rubicon? – we have created and have started controlling our own "suns"



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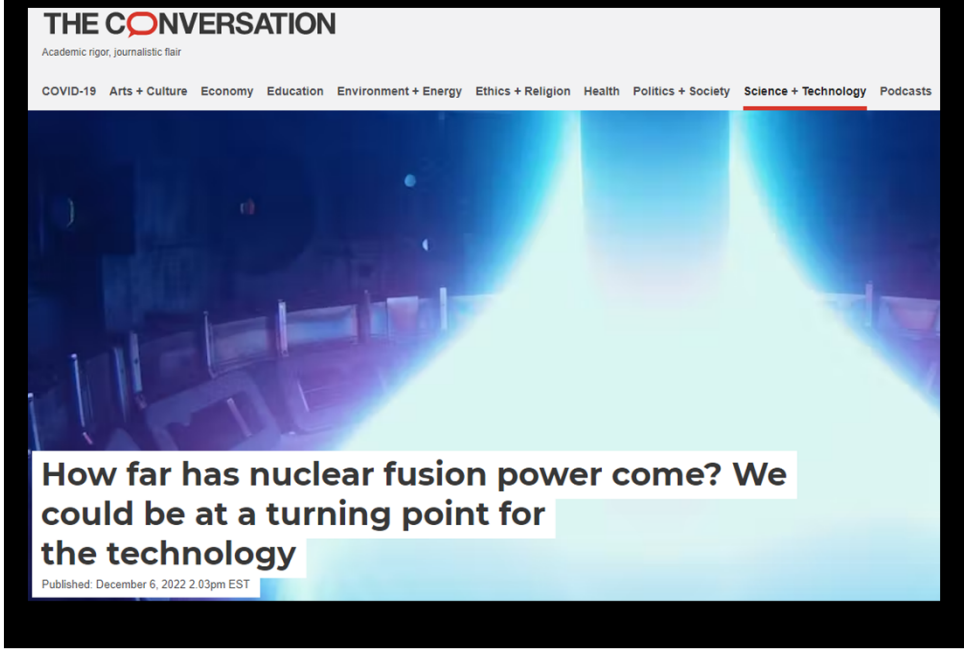

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Foraging Society

Farming Society

Fossil Fuel Society

?

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Introduction to Anthropology: Biological Anthropology and Anthropological Archaeology

ANTH B101

Fall 2022

Thank you for going on this 7-million-year journey with us!
Our collective future remains to be created…

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