

# The Anthropocene

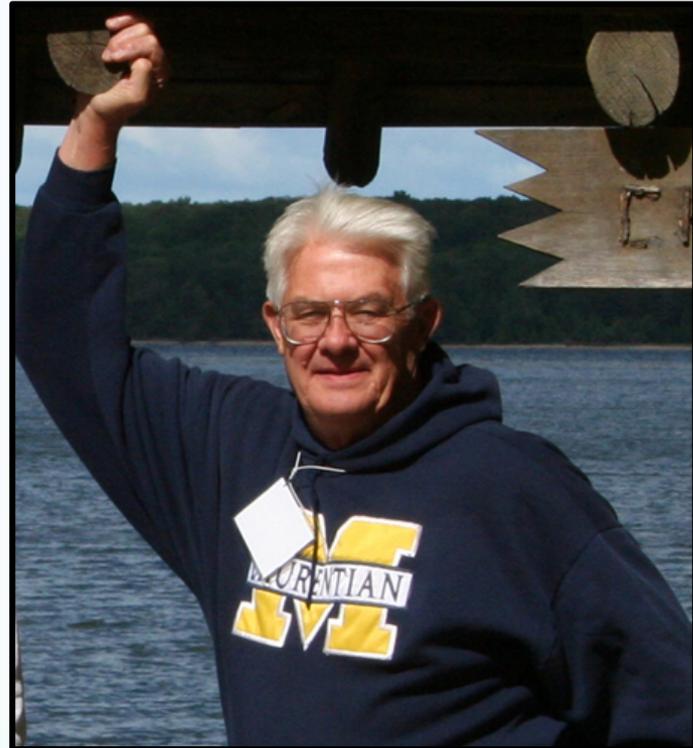
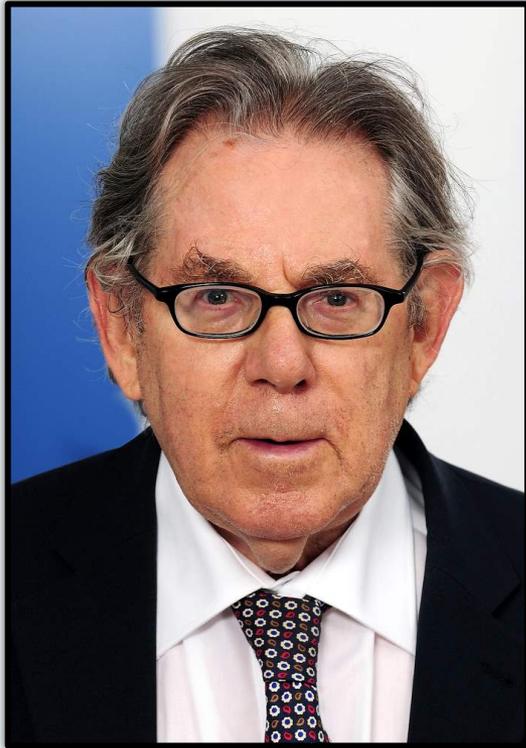
**“The Age of Humanity”**

# The Anthropocene: Causes, Effects, Solutions

- What is it?
- What caused it?
- What are its effects?
- What is/are the solution(s)?



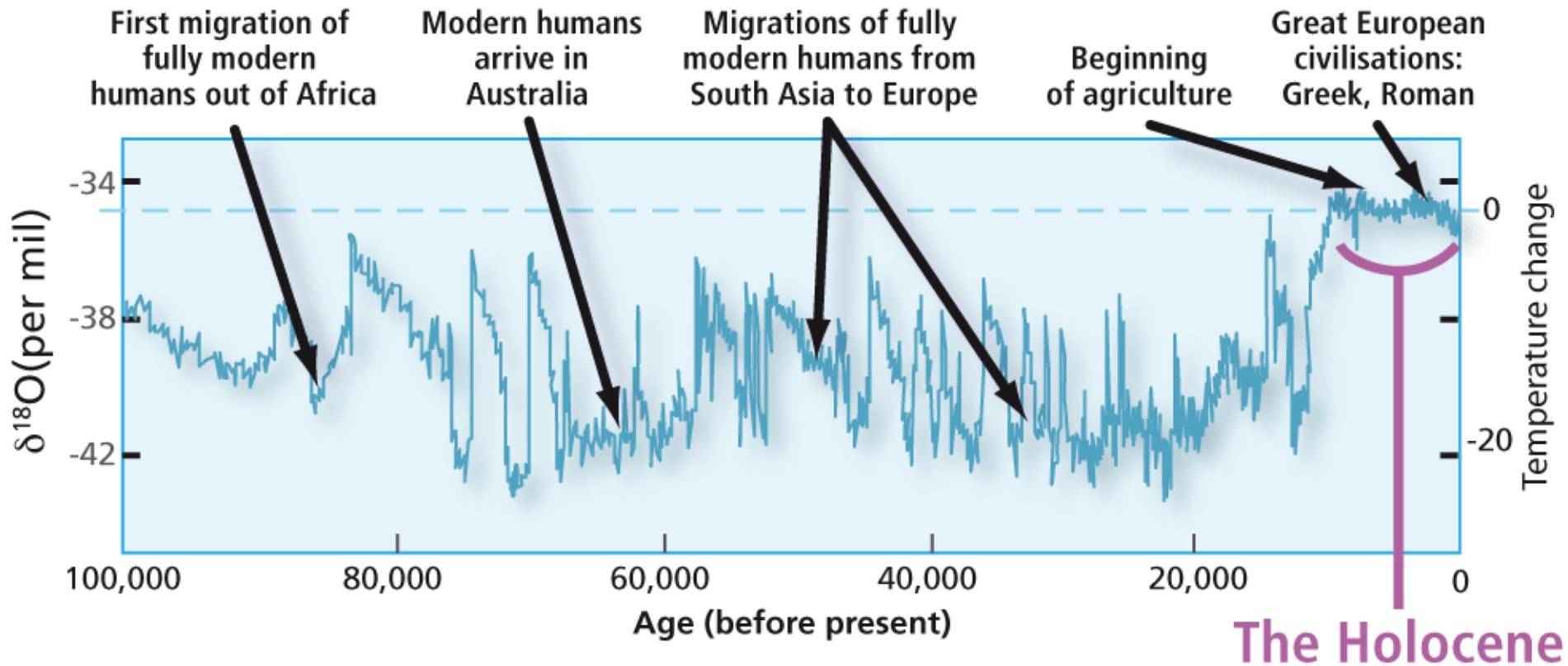
# Paul Crutzen and Eugene Stoermer

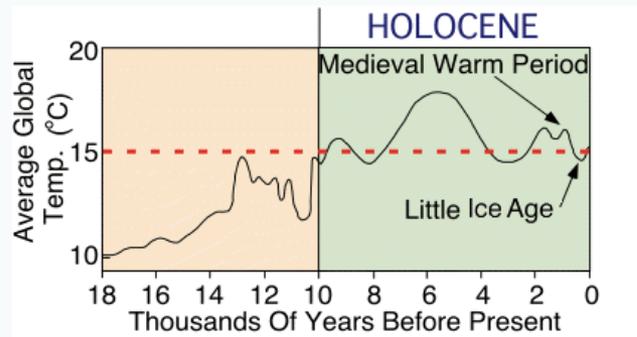


**“The Anthropocene,” IGBP (International Geosphere-Biosphere Programme) Newsletter, 41 (2000): 17.**

- It is “appropriate to emphasize the central role of mankind in geology and ecology by proposing to use the term ‘anthropocene’ for the current geological epoch.” Substantial increase in “greenhouse gases,” especially carbon dioxide.
- For “the onset of the ‘anthropocene’ . . . we propose the latter part of the 18<sup>th</sup> century. . . . Such a starting date also coincides with James Watt’s invention of the steam engine in 1784.”

# The Holocene





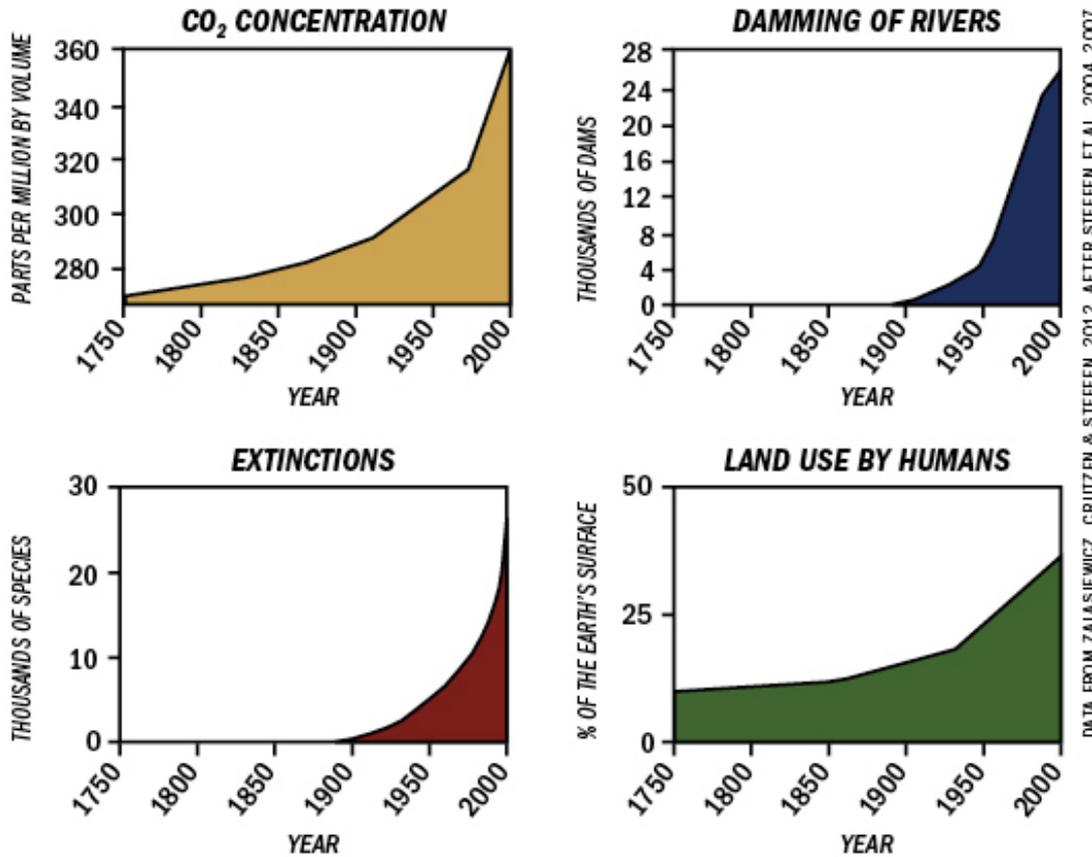
# The Holocene



- “Recent Whole.” Past 12-10,000 years B.P. 5 million people in the world.
- Interglacial warm period.
- Relatively stable climate allows for:
- Crop agriculture. Wheat, oats, barley, rice, sorghum; corn, beans, squash.
- Domestication of animals. Cow, pig, goat, sheep, horse.
- Population growth. 1 CE, 200 million; 1650, 500 million; 1850, 1 billion; 1930, 2 billion; 1999, 6 billion; 2024: 8 billion.

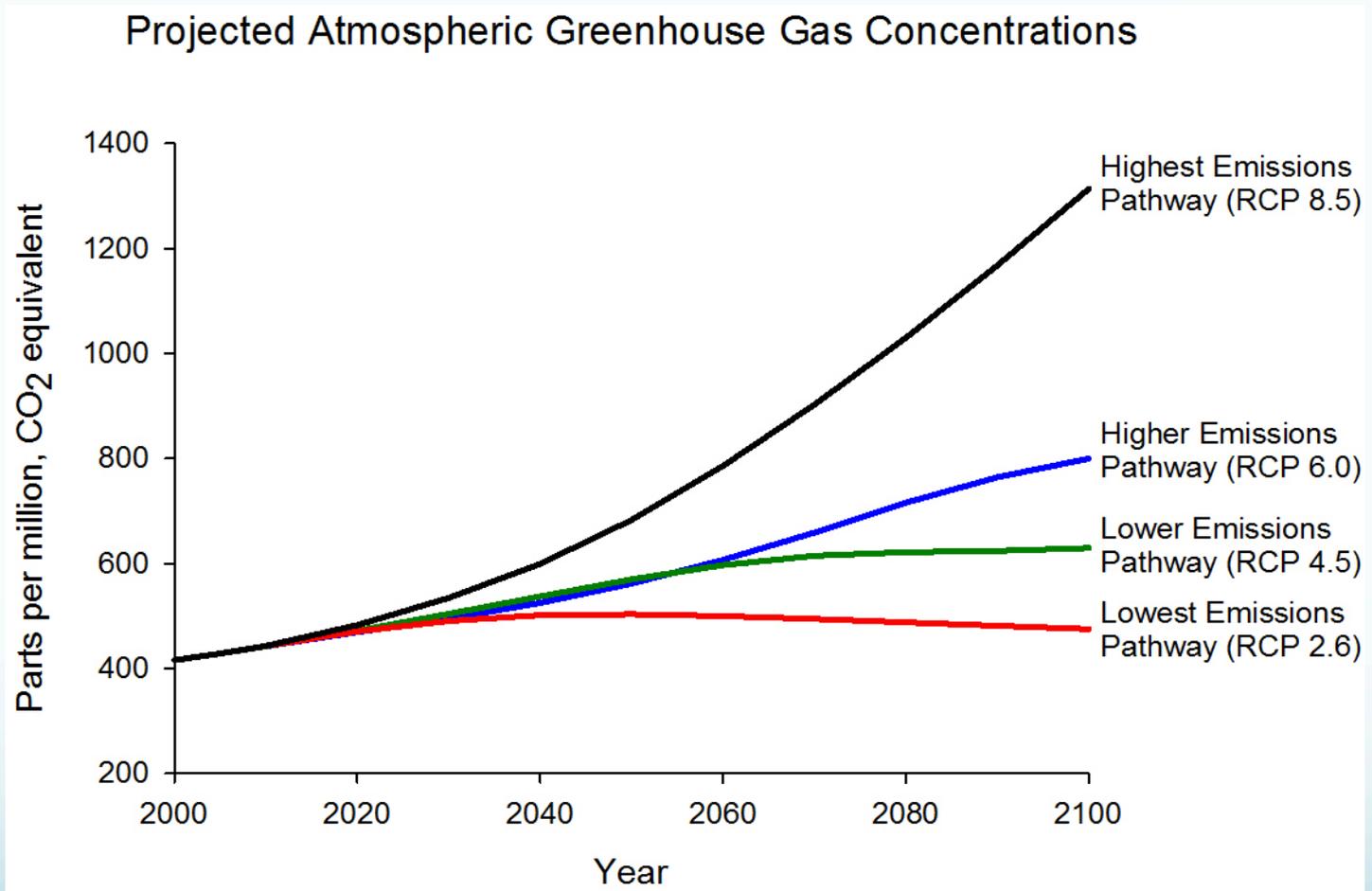
# The Anthropocene

## THE HUMAN FOOTPRINT



- Starts with the Steam Engine, ca. 1784.

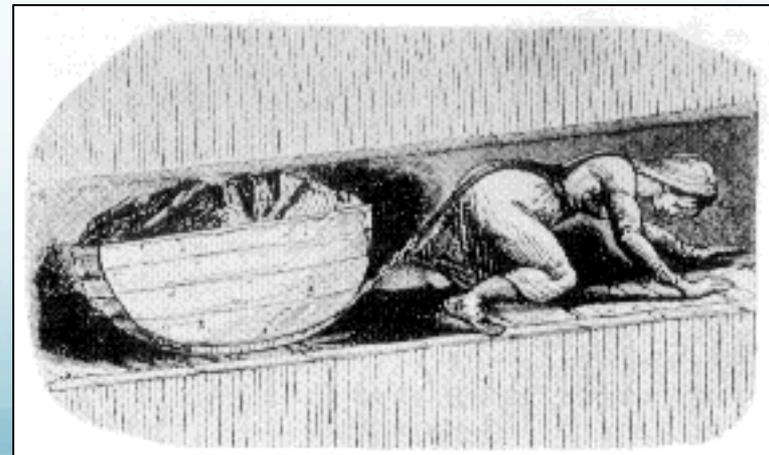
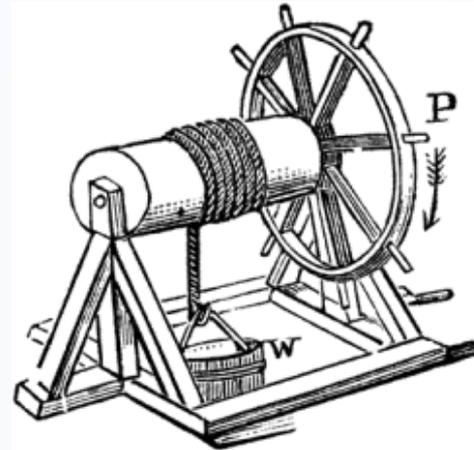
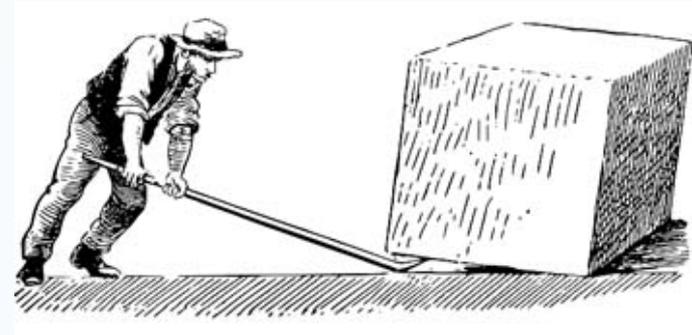
# The Anthropocene



**Source: Environmental Protection Agency, January, 2017.  
Representative Concentration Pathways (RCP)**

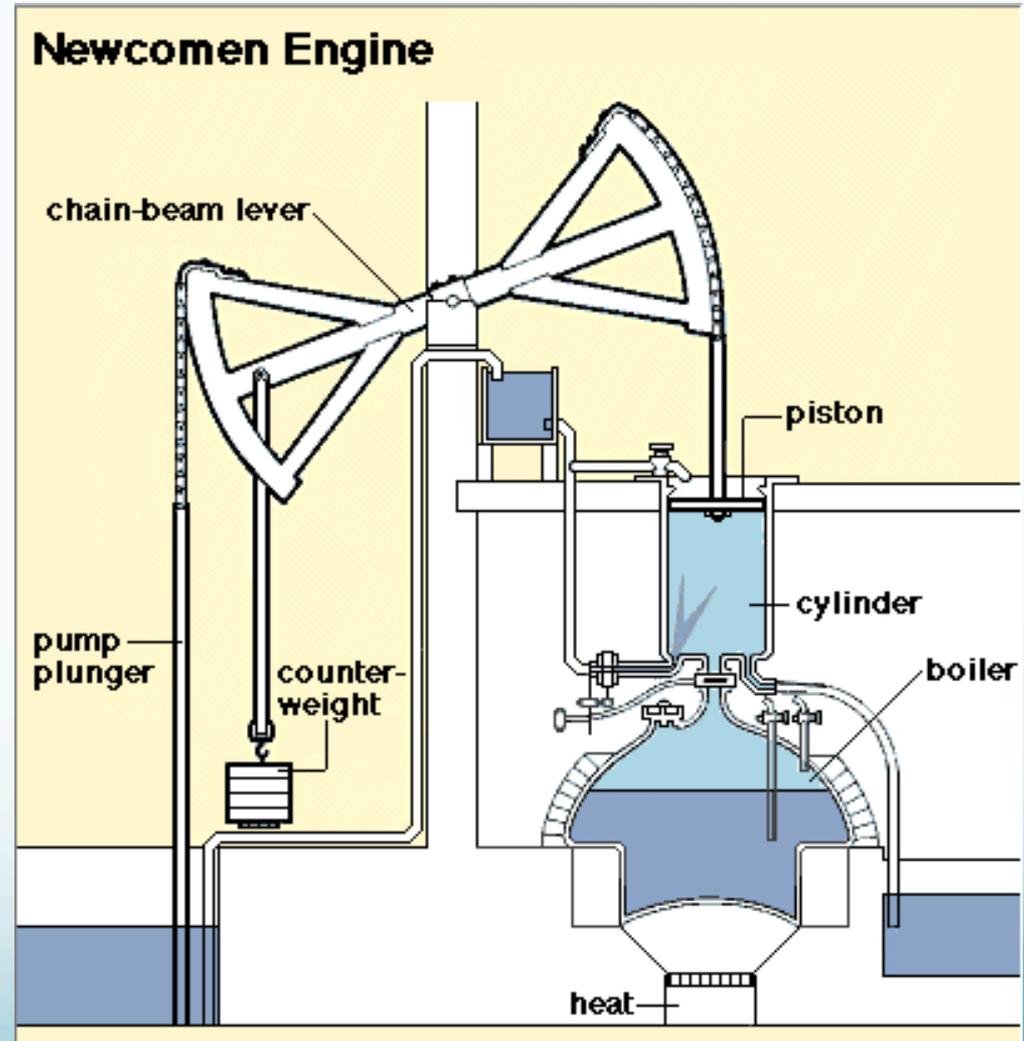
# Why the Steam Engine Changes Everything

- Moving objects is an age old problem
- Human or animal lifting, pushing, pulling.
- Horses and mules.
- Greeks: 5 simple machines: lever, pulley, wheel, inclined plane, wedge.
- Watermills; windmills.
- Biggest Problem: Pumping water and lifting coal from mines.



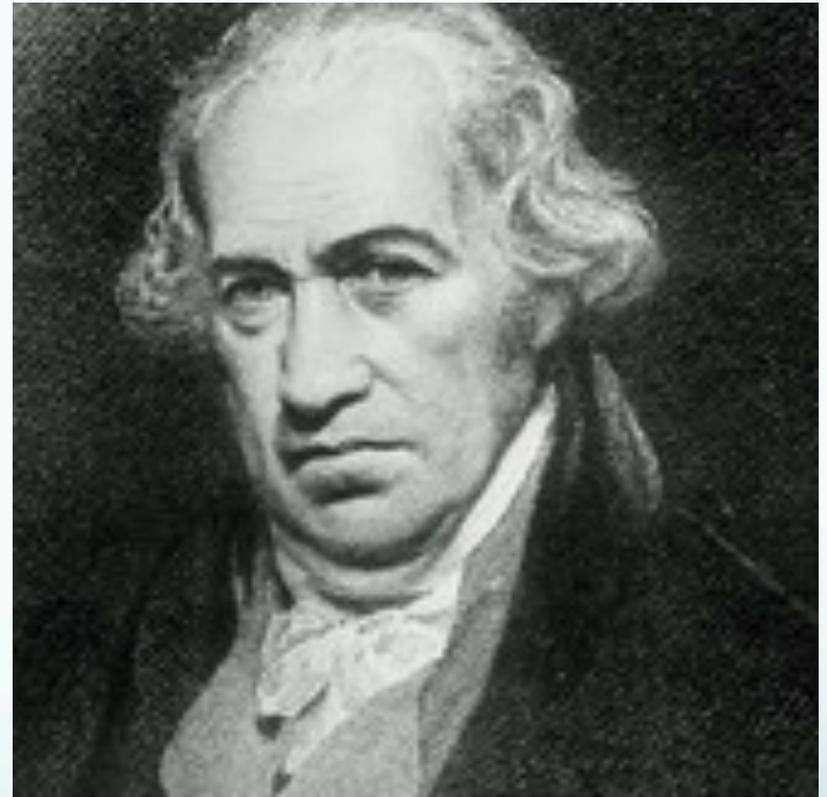
# Newcomen Engine

- Newcomen Engine, 1712
- Cylinder is filled with steam from boiler.
- Expands to push the piston upwards.
- Then cold water is sprayed into the cylinder creating a vacuum.
- External air pressure pushes the piston down, pulling the rocker arm up.
- Problem: Loss of energy from heating and cooling on every cycle.



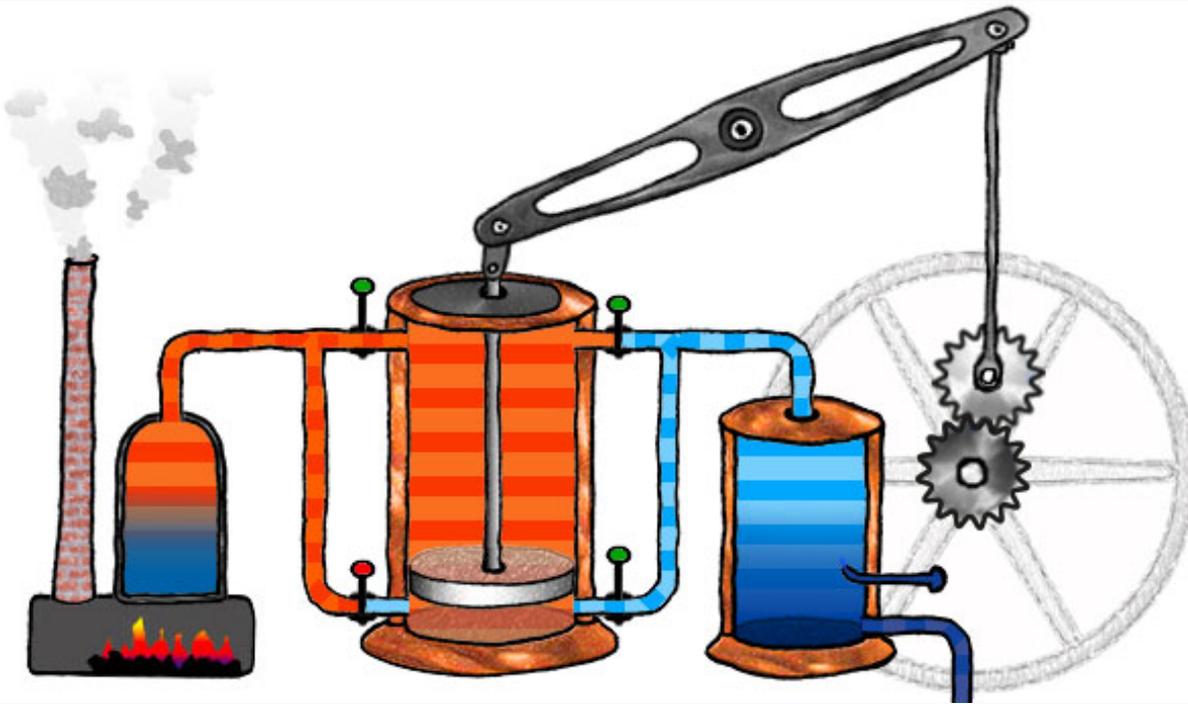
# James Watt

- **Watt's Steam Engine—  
Improved efficiency.**
- **1765. Steam could be condensed in a separate chamber (condenser) from the piston chamber.**
- **Watt moved the condensation process out of the cylinder and into an external condenser.**
- **Result: the cylinder remains hot and does not require constant reheating.**
- **He also surrounded the cylinder with a blanket of steam, which reduced the heat loss.**



**James Watt, 1736-1819  
Glasgow University  
Scotland**

# Watt's Steam Engine: Separate Condenser (right)



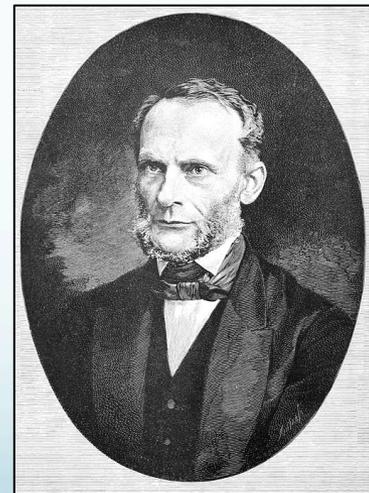
- Steam is generated by fire heating water in a boiler (left) and channelled to a cylinder (middle). Separate condenser (right).
- The piston in the cylinder (middle) is alternately driven on either side by the force of the expanding steam and sub-atmospheric pressure created in a condenser (right)
- Open stopcocks (top red) push steam in and draw steam out (bottom blue) .
- The lower than atmospheric pressure is created by spraying water into the steam escaping from the cylinder, causing it to cool and contract to a smaller volume.
- Because steam and low pressure act on the piston from both sides, the piston performs work on the upstroke and downstroke.

# Carnot and Clausius

- **Problem: How to improve the amount of mechanical work obtained from a steam engine. (Efficiency is only about 3%)**
- **Find that efficiency of the steam engine depends only on the temperatures of the 2 heat reservoirs (cylinder and condenser). Carnot**
- **Ideal engine is frictionless and independent of the fluid used. Carnot**
- **But can never have a perfect engine with no loss of heat. Carnot**
- **Second Law of Thermodynamics. Energy available for work (moving an object through space) is always decreasing. Entropy (energy unavailable for work) is always increasing in closed isolated systems. Clausius**
- **Universe is running down. Order goes to disorder. People grow older; rocks crumble; ultimate heat death.**

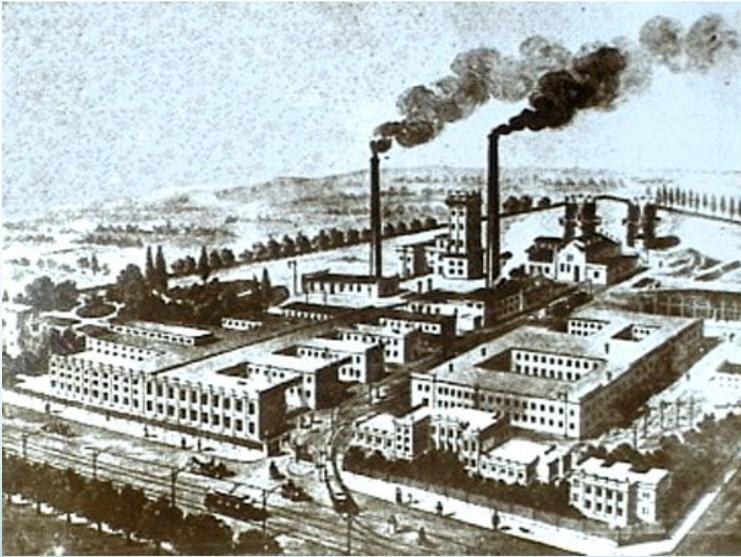
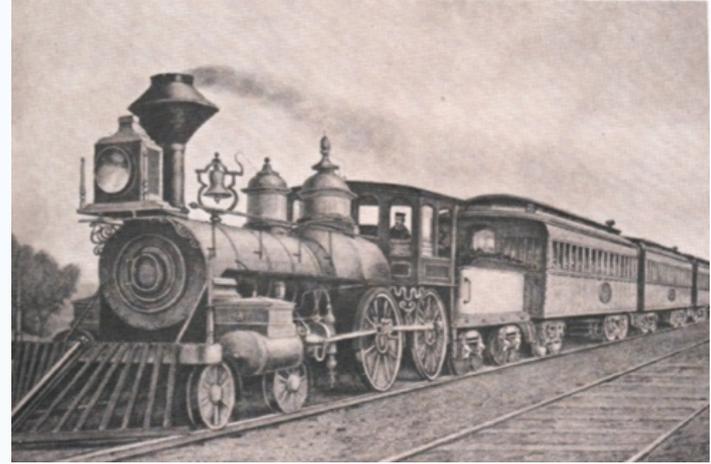
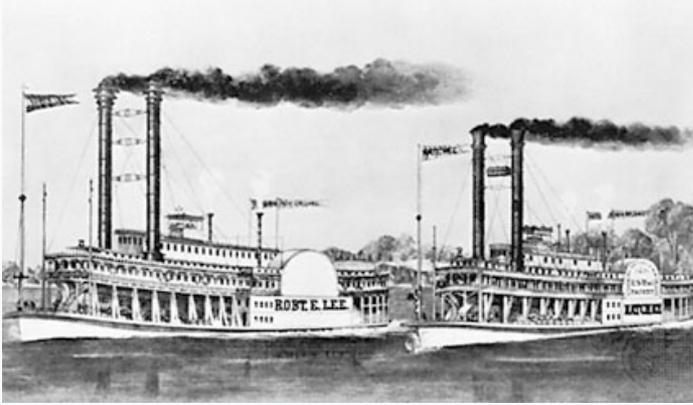


**Sadi Carnot, 1796-1832**



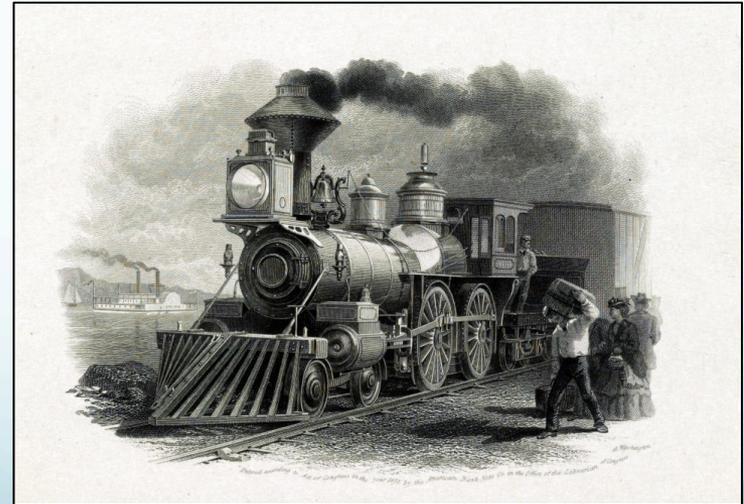
**Rudolf Clausius, 1823-1888**

# Industrialization



- 19<sup>th</sup> century steamboats, trains, factories, cars.

# Steam Engines and Pollution



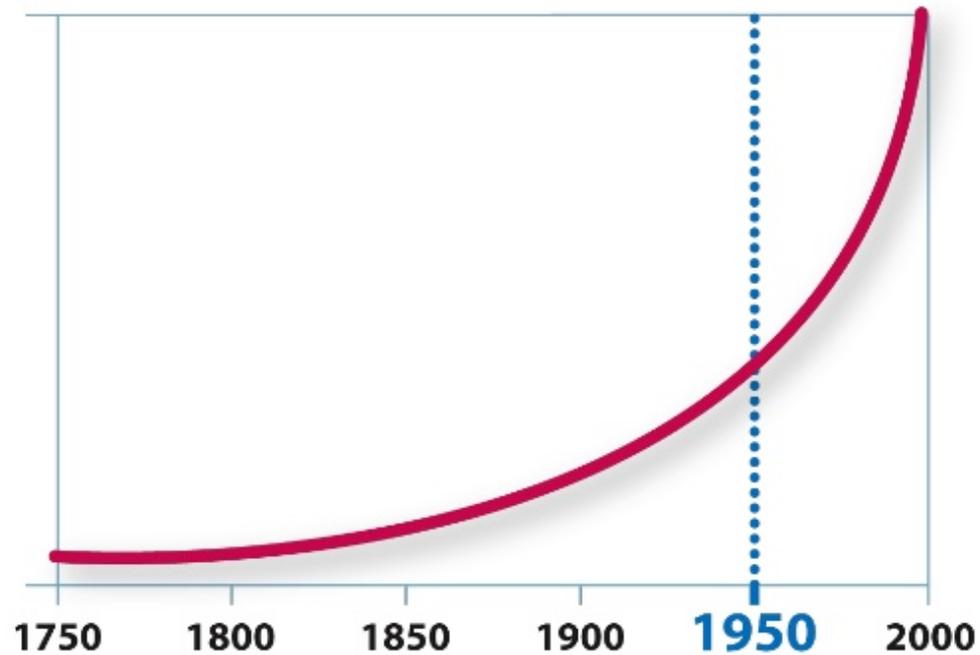
- **Black smoke wherever steam engines are located.**

# Great Acceleration

GLOBAL  
IGBP  
CHANGE



## Great acceleration



IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

- 1950 Acceleration of the Anthropocene

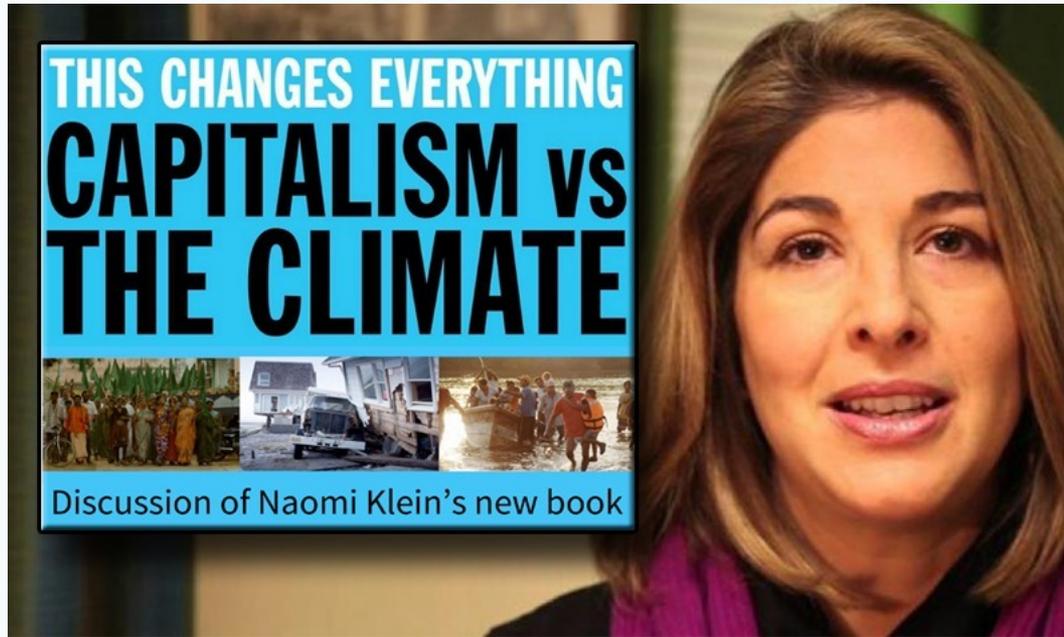
# Dipesh Chakrabarty

- **“The Climate of History: Four Theses”  
Critical Inquiry (2009).**
- **1. Collapse of humanist distinction  
between natural history and human  
history. Now have Environmental History.**
- **2. Humans as new geological force.  
Changes 18<sup>th</sup> century humanist histories  
of “freedom from oppression” to a  
“planet of slums.”**
- **3. Global histories of capital  
(capitalocene) in conversation with  
species history of humans  
(anthropocene).**
- **4. Probing the limits of historical  
understanding. We are now a geological  
agent threatening our very own  
existence.**



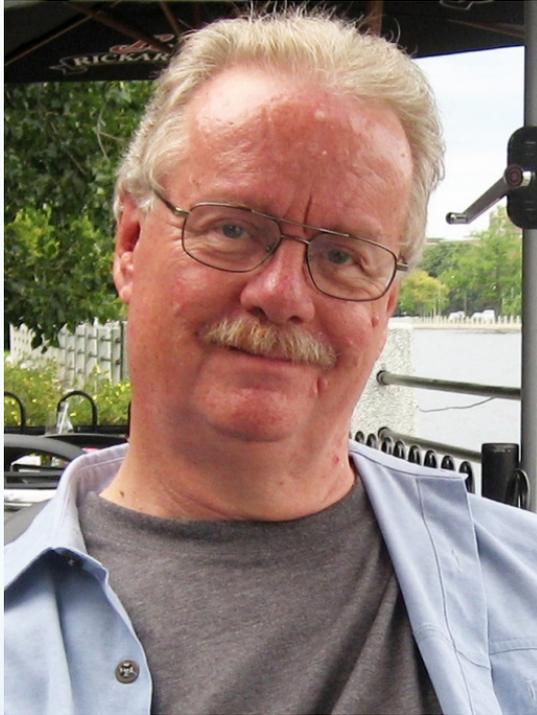
**Institute for Advanced  
Study, Princeton**

# Naomi Klein



- **Author, This Changes Everything: Capitalism vs. The Climate (2014).**
- **“Radical Guide to the Anthropocene” (2015).**
- **Capitalism is the culprit. Not human nature. Sacrifice zones. Tied to racial injustice.**
- **Americans consume 500 times more energy than Ethiopians. But also US inequities.**
- **Need to document non-capitalist ways of relating to nature. Grassroots movements.**

# Ian Angus



**Editor, Climate and Capitalism; Canadian Socialist; Socialist History Project.**

**Author: The Global Fight for Climate Justice (2009); Does Anthropocene Science Blame All Humanity? (2015)**

- **Facing the Anthropocene: Fossil Capitalism and the Crisis of the Earth System (2016).**
- **Fossil Capitalism: The wealthy countries account for 80% of CO<sub>2</sub> emissions since 1751; the poorest countries less than 1%.**
- **Updated graphs by the IGBP (Int. Geosphere-Biosphere Programme) now highlight global inequities.**
- **Not a Malthusian “people are the problem” approach (i.e. population growth is the cause).**

# Amerindian Ontologies

- **Eduardo Viveiros de Castro, Federal University of Rio de Janeiro. “Exchanging Perspectives.”**
- **Original non-differentiation between humans and animals. Human and animal attributes are mixed.**
- **Animals lost their human qualities. Animals are humans disguised by animal forms.**
- **The worlds that animals perceive are different worlds from our own. Perspectivist animism.**
- **Only shamans can communicate between human and animal worlds.**



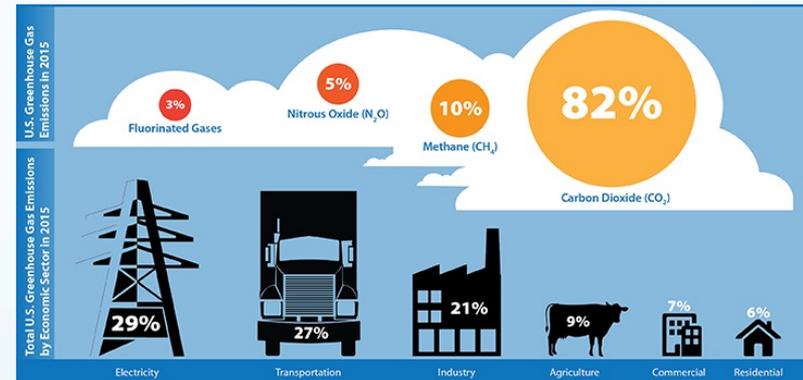
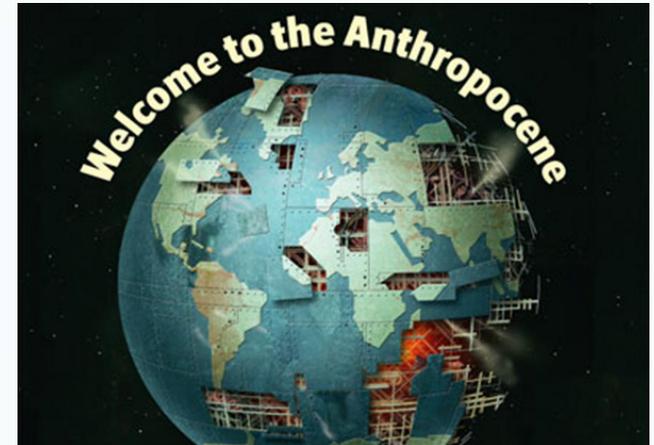
# The Capitalocene

- **Jason W. Moore, Binghamton University, Binghamton, NY.**
- **“The Capitalocene: On the Nature and Origins of our Ecological Crisis.”**
- **Anthropocene or Capitalocene? Edited book.**
- **We are living, not in the Anthropocene, but the Capitalocene.**
- **It begins not with the steam engine in 1874, but in 1450 with the the rise of capitalist civilization, global conquest, and the relations of power, knowledge, and capital. The “long 16<sup>th</sup> century.”**
- **Shut down a coal plant and slow global warming. But shut down the relations that made the coal plant and stop global warming for good.**



# How to Resolve the Differences

- Domination of nature via science and technology by humans ⇔ domination of humans by nature.
- Humans of all genders (LGBTQ), races, and ethnicities have the brain power to do science and mathematics and to construct machines and digital devices (although ability and education vary)  
Anthropos = Humanity: Anthropocene.
- Capitalism organizes economic and social relations; creates profits, power, inequalities, and oppression: Capitalocene.
- Humans have created the problem; but different inputs by different countries, different effects: rich vs. poor.





# Anthropocene is



# implemented by Capitalocene

- **Thermodynamics (science) and steam engine (technology) are necessary for the Anthropocene.**
- **Capital and labor are necessary for the Capitalocene. Preindustrial capitalism and colonial expansion of Europe create the preconditions for 19th century industrial capitalism.**
- **Capital and labor are consolidated into corporations. Fossil capital + cheap labor (slaves, immigrants, poor).**
- **Steam engine triggers transportation of goods and movement of manufacturing into cities.**
- **Nature and humanity exist in interactive, dialectical, process-oriented relationships. Nature ↔ Humanity.**

# The Anthropocene subsumes the Capitalocene



- Domination of nature by humans made possible by science and technology (steam engine). Anthropocene.
- Control over fossilized coal, oil, gas. Capitalocene.
- Control over labor (race/gender) as tools for capitalist expansion. Slave and immigrant labor. Capitalocene.
- What problems are caused by the Anthropocene?



- Greenhouse gases begin to fill the atmosphere.
- Smoke and steam as symbols of human dominance.
- Alarm and ambivalence over effects of smoke on humans and nature. But effects are unequal.
- Graphic images and descriptions in art and literature.

# First Passenger Railways



- 1825. George Stephenson. Stockton Darlington Railway. Rocket.
- 1830. Manchester-Liverpool Railway.
- 1831. Letter to Leeds Intelligencer, January 13, 1831.
- “ On the very line of this railway, I have built a comfortable house; it enjoys a pleasing view of the country. Now judge, my friend, of my mortification, whilst I am sitting comfortably at breakfast with my family, enjoying the purity of the summer air, in a moment my dwelling, once consecrated to peace and retirement, is filled with dense smoke of foetid gas; my homely, though cleanly, table covered with dirt; and the features of my wife and family almost obscured by a polluted atmosphere. Nothing is heard but the clanking iron, the blasphemous song, or the appalling curses of the directors of these infernal machines.”
- Contamination of rural landscape. “Railway with tail of smoke curling across the countryside.” W.T. Jackman, historian, p. 497.

# Problems with Steam Engines

- London and Birmingham Railroad, 1825.
- Sheep's wool will be ruined by smoke.
- Will the fox runs through the fields be damaged?
- Will the cows' grazing fields be affected?
- Will hens be able to lay eggs?



# William Wordsworth



1770-1850

- **Opposition to Steam Engine, 1814.**
- **Kendal and Windermere railroad line threatens the Lakes District.**
- **Steam engine is a threat to nature: “the smoke of unremitting fires.”**
- **Suffocation.**
- **Fear that progress will take over the world.**

# Joseph Turner, 1775-1851

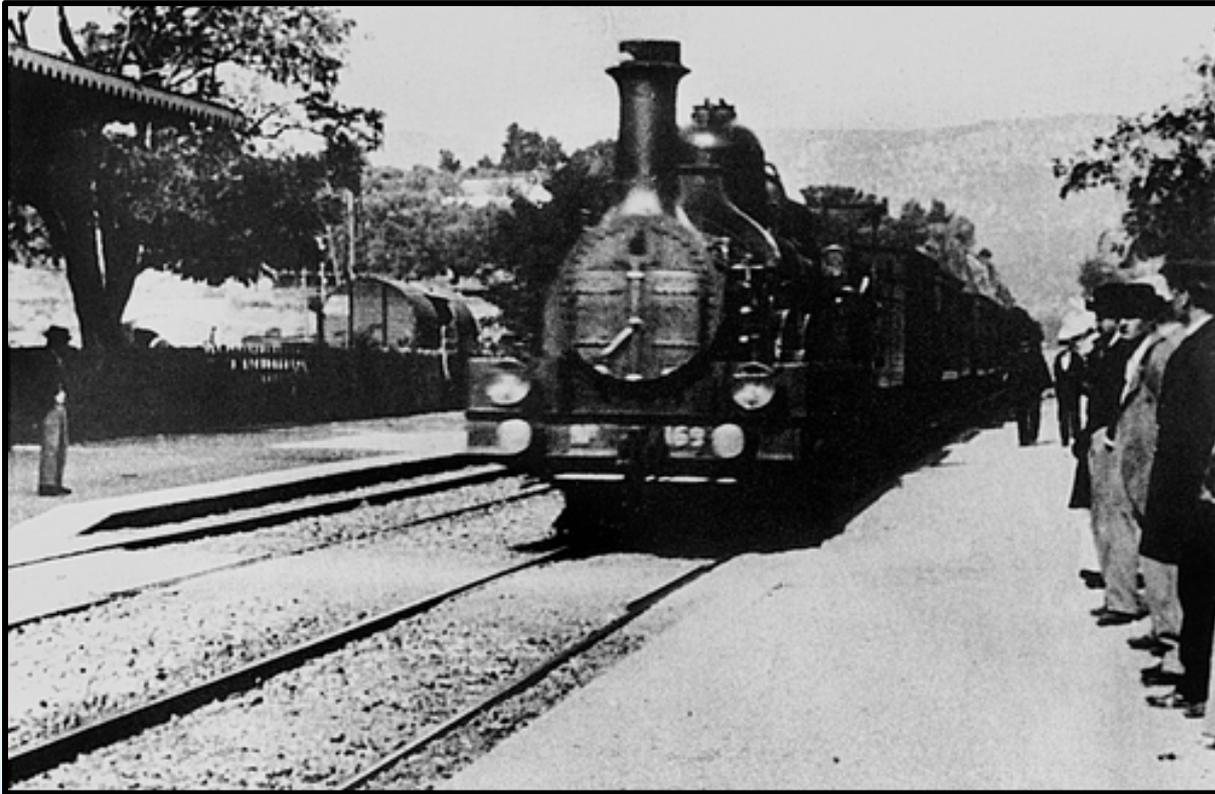


Self Portrait, c. 1799



- **“Fighting Temeraire Being Tugged to Her Last Berth,” 1838. “Raw mechanical energy of the flaming and smoking steam tug.”**
- **“Rain, Steam, and Speed: The Great Western Railway,” 1844. “A train rushes across a bridge and is bearing down on a hare that’s running over the washed-brown bed of a railway track.” Utter terror of the unrelenting speed of the train. Can the hare escape? Can anyone escape? Can humanity escape?**
- **“Speed of the new coal train and appreciation for technology” for travel and transport. “The progressive threat that humans pose toward the earth.” “What should we fear more, the awe of the wild, or the annihilation of it?”**

# First Movie of Train Barreling Down into Station



- “The Arrival of a Train at La Ciotat Station,” S.E. France, 1895. Said to have caused panic in the theater with people running for the exits. Produced by Auguste and Louis Lumière, shown January, 1896.

# Henry David Thoreau



- **Walden, 1854, near Concord, outside Boston..**
- **Harvard University, 1837.**
- **Denounces "the commercial spirit."**
- **Retreats to Walden, 1845.**
- **Train runs along edge of Walden Pond.**

# Walden Train Station



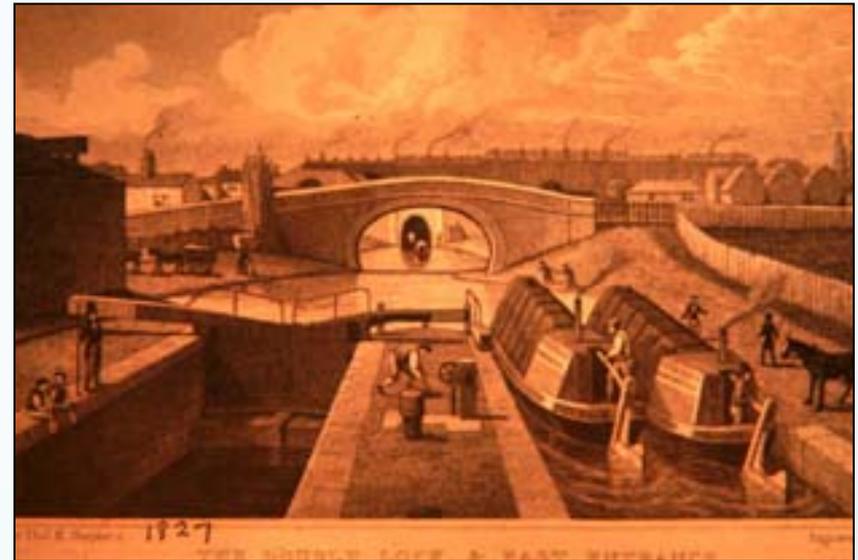
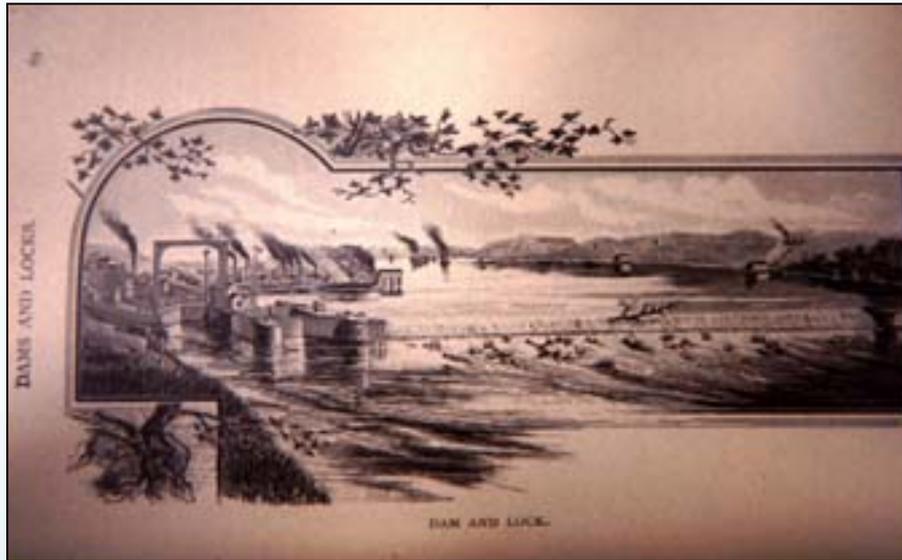
- **Train as symbol of the market; whistle pierces the air like a hawk; rattle of the rails; but railroad brings resources and commodities from around the world.**

# Steam Power and Cities

- **Steam power makes it possible for manufacturing to move into cities.**
- **1811. First stationary steam engine built for the Middletown Woollen Manufacturing Company of Connecticut.**
- **1838. 317 Steam engines operating in New England. Mills, steam boats, locomotives.**



# Canals, Steamboats, Locks link Factories to Markets



- Middlesex Canal, 1803; Erie Canal, 1825; Blackstone Canal, 1828; Gt. Lakes to Ohio & Mississippi, 1830s. Keelboats replaced by steamboats.
- Black smoke from factories and steamboats in the background.

# John Kane, 1860-1934

- Monongahela Valley, 1931



**Steam Boats and Steam Trains  
Link Factories and Farms**

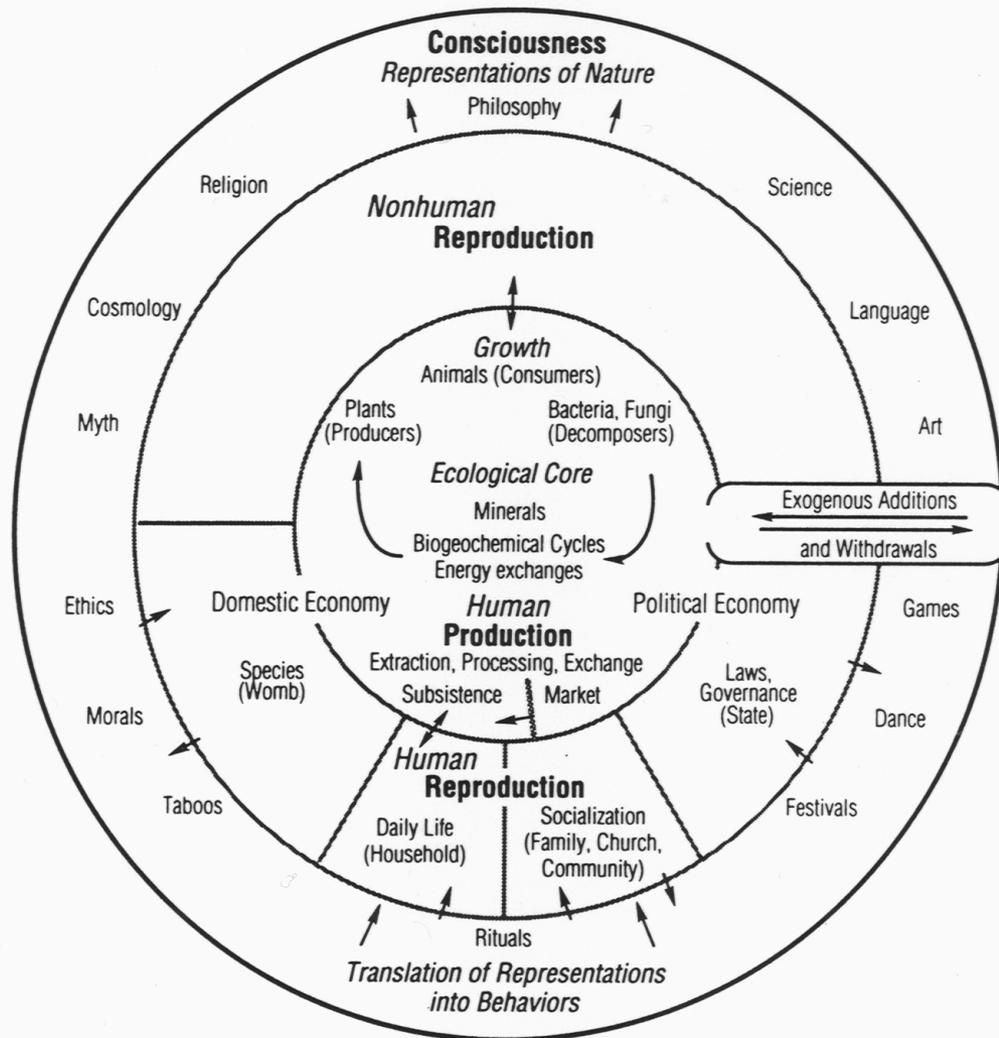
# Railroads: Central Pacific and Union Pacific Meet, 1869



- Steam engines as transportation power industrialization.
- Promontory Point, Utah; Built by Chinese labor.
- Transportation system converts U.S. into one vast, unified market.
- Sectional specialization in staples and manufactured products.
- South; Northwest; Northeast; Middle Atlantic; Great West.

**FIGURE I.1**  
**ECOLOGICAL REVOLUTIONS**

# The Global Ecological Crisis leads to Global Ecological Revolution 1970-2050



Source: Carolyn Merchant, *Ecological Revolutions: Nature, Gender, and Science in New England*. The University of North Carolina Press, Chapel Hill and London, 1989; pp. 6-7, reprinted by permission.

# Solutions: From Fossil Fuels to Renewable Energy



- Mark Jacobson, et al, Stanford. PNAS, Dec. 8, 2015.
- From coal, oil, and gas (COG) to wind, and water, and solar (WWS). (Includes 1.2% geothermal, tidal, and wave energy.)
- WWS is expanding rapidly because it is sustainable, clean, safe, and widely available. Problem is grid reliability.
- How to supply WWS power (no natural gas, biofuels, or nuclear power) at a reasonable cost and no grid overloads.
- How to provide time-dependent load reliability at low cost combined with storage and demand response.
- A 100% WWS world could exist by 2050.

# TheSolutionsProject.org

<https://twitter.com/mzjacobson>



- **139 countries could transition to 100% renewable energy under the new plan.**
- **82% of 26,000 respondents in 13 countries want 100% renewables; only 18% don't.**
- **A total of 50 cities and towns across the United States have now committed to transition to 100% clean, renewable sources of energy, such as wind and solar power.**
- **Google is officially 100% sun and wind powered — 3.0 gigawatts worth.**
- **The power grid in South Australia now includes a huge Tesla battery tied to a wind farm, allowing the system to supply electricity around the clock.**

# Solutions: Need Nuclear and Bioenergy



- Christopher Clack, et al, PNAS, Jun 27, '17.
- Need diverse portfolio of clean energy technologies that is broader than WWS alone.
- Goal: Decarbonized reliable energy system.
- Nuclear and bioenergy sources should not be excluded. Can be coupled with carbon capture storage.
- But need continental, high-voltage transmission grid. Max. that can be achieved is 80%. Problem industries: aviation, cement, etc., difficult to convert to electric.

## Summary

# Anthropocene Components



- Anthropos: Brains, science, technologies, inventions, solutions, modeling.



- Capitalos: Power, economic and social organization, capital plus cheap labor.

- Politicos: Policies, politics, democracy, negotiation, discussion.



- Natura: Living and non-living beings, ecological relations. Nature as active, alive.

- Dialectica: Process, interaction, humans within nature.





# Conclusion



- **We need a new story, a new ethic, new technologies, new policies.**
- **Replace the Anthropocene with:**
- **The “Age of Sustainability.”**
- **An Ethic of Partnership.**
- **Renewable energy: solar, wind, hydro, geo, tidal.**
- **\*Solar panels on every roof, bicycles in every garage, vegetables in every backyard.\***
- **Limited use of non-renewable resources. Reduce, Reuse, Recycle.**
- **Policies and incentives that promote change at all levels from the state down to the individual.**



**The End**