Cosmic Evolution

From Big Bang to Humankind

The arrow of time, from the origin of the Universe to the present and beyond, spans several major epochs throughout all of history. Cosmic evolution is the study of the many varied changes in the assembly and composition of energy, matter and life in the thinning and cooling Universe.

Billions of Years

CULTURAL

BIOLOGICAL

CHEMICAL

PLANETARY

STELLAR

GALACTIC

PARTICULATE

Site Summary
Introductory Movie
View an Epoch

Wright Center for Science Education
Tufts University

Co-sponsored by Foundation for the Future

Harvard Course Syllabus
Foundation For the Future
Bellevue, Washington USA

---

**THE POPULATION SPIKE**

- Global population now increases as much every 3 days as it did in a whole century for most of the thousand centuries we've been on Earth.

- The US Congress withdraws American financial support for international family planning—taking away an essential tool of population stabilization.

- "Population momentum" builds. As the base gets larger, stabilization becomes more difficult. A low fertility rate with the large base population of the late twentieth century produces more increase than a high rate did decades earlier, when the base was smaller.

- Life expectancies increase in most countries, including countries where birth rates remain high.

- Thomas Malthus writes *An Essay on the Principle of Population*, warning that population can expand geometrically, but food supply cannot.

- With the Age of Exploration, more of the world is colonized; human dominance of the environment now covers the globe.

- After about 90 millennia of hunting and gathering, the advent of farming and herding allows for accumulation of food surpluses and the capacities of communities to support more people. Population growth begins to gain momentum.
THE CONSUMPTION SPIKE

Trillions of Dollars of Gross World Product or Purchasing Equivalent (1997 dollars)

1. The amount of money spent on advertising and marketing in 1997 (close to $1 trillion) exceeds the total GDP of the world just a little more than a century earlier.

2. The average individual in a German, Dutch, or American household uses up 45 to 85 tons of natural resources per year—the equivalent of 300 shopping bags per week. Much of it ends up as industrial waste or pollution.

3. The global economy expands as much in each year now as it did in any century prior to 1900.

4. In the 1980s and 1990s, Americans shift from keeping up with the Joneses to keeping up with the wealthy. The rest of the world tries to keep up with the Americans.

5. Explosion of global media and advertising drives up per-capita demand faster. Number of TVs in the world leaps from under 5 million in 1950 to 900 million in the mid-1990s.

6. Americans strive to “keep up with the Joneses” in the 1950s; in 1958, John Kenneth Galbraith’s The Affluent Society is published.

7. As human population begins to spike, consumption follows—at first in parallel, then even steeper, as industrialization spreads and increases per-capita demand.
THE CARBON DIOXIDE SPIKE

Concentration of CO₂ Gas in the Atmosphere (Parts Per Million, Volume)

- Attempts to seriously stem emissions are sabotaged by the Global Climate Coalition. Loopholes in the Kyoto climate treaty allow most industries to continue increasing emissions more or less at will.

- Despite warnings about global warming, world coal use reaches new record highs four consecutive years in the late 1990s. World Bank, while professing deep concern about global environment, finances 20 major new coal-fired power plants between 1990 and 1997.

- Climate scientists issue first IPCC report warning of urgent need to reduce emissions.

- In the 1950s, most people consider air conditioning a luxury (shade trees, fans, slow pacing, and physiological acclimatization help make heat tolerable); by 1990s, a majority of Americans consider air conditioning a "necessity"—and use of fossil fuels to produce power for it soars.

- The first cars appear; their numbers pass 500 million by 1996, each car producing over 2 tons of CO₂ per year.

- The Industrial Revolution begins. The prime source of work energy shifts from food and firewood used only as it is grown, to fossil fuels using 100 centuries of plant growth each year.
The Extinction Spike

Number of Species Eliminated, Worldwide, Per Year

1. Biologists surveyed by the Museum of Natural History in New York say we have entered the fastest mass extinction in Earth's history— even faster than when the dinosaurs died.

2. Global warming drives temperature to highest worldwide average in human history; many species are now unable to migrate fast enough to higher latitudes or altitudes and begin to die off.

3. Over 100,000 slash-and-burn fires are set each year in the Amazon, Indonesia, Malaysia, and Mexico; world's tropical forests decline by an area equal to one football field per second. Every hour, three more species are eliminated.

4. Human development and domination grow ever more rapidly accelerating habitat destruction, breaking down natural barriers between ecosystems, and opening the way to bioinvasions.

5. Green Revolution imposes widespread monoculture, killing off crop diversity in agriculture and destroying many of the wild pollinators and soil microbes essential to healthy ecosystems.

6. Millions of birds, seals, and porpoises are slaughtered by European hunters during the Age of Exploration; hundreds of species are extinguished.

7. About half of the original forest cover of the Earth—habitat for millions of species—is destroyed after the Agricultural Revolution starts serious clearing of forests for crops.
Our Changing Planet
The View From Space
Las Vegas Growth Over 33 Years

May 1973 pop. 358,000
June 1991 pop. 937,000
May 2000 pop. 1,563,000
Feb 2006 pop. 2,013,000
Bolivian Deforestation and Farming
1975 and 2000
Argentina Deforestation and Urbanization

30 Year Change - Space Images from 1973 and 2003
Disappearance of Lake Hamoun, Iran/Afghanistan

25 Years – 1976 and 2001
Population Growth in Dhaka, Bangladesh

From 1977 to 2000, Dhaka grew from 2.5 to 10.0 million
By 2015 Dhaka will have a population of 21.5 million
Urban Growth of Santiago, Chile

25 Years – 1975 to 2000
Urban Growth of Mexico City

6 million in 1973; 20 million in 2007
Looking Back on the Limits of Growth

Forty years after the release of the groundbreaking study, were the concerns about overpopulation and the environment correct?

By Mark Strauss
Smithsonian magazine, April 2012, Subscribe

Historical Trend
Trend Predicted by 1972 Study
Observed Trend 1970-2000

2030 Population declines following economic collapse

Stock Check
Estimated remaining world supplies of non-renewable resources

- Ecosystems
- Fossil fuels
- Minerals

2012
Brazilian rainforest gone

2030
Arctic ice-free in summer

2050
Third of land plant and animal species extinct due to climate change

2060
Dangerous 2 °C warming threshold likely reached

Sources: UN, TEDC, US Geological Survey, BIP, Winer et al (2006), London Metal Exchange. Figures are worldwide. Living natural resources data are worst case based on published estimates. Minerals and fossil fuel data based on known reserves currently economical to extract, assuming 5% increase in usage per year. No provision made for changes in demand caused by new technologies, discoveries of new reserves or market forces.

Agricultural land means land suitable for rainfed cultivation not of forest land cover. Thirty year historic agricultural expansion rates are applied.

IIBstudio