

What Goes Around Comes Around: Humankind, the Environmental Crisis, and the Future of Life on Earth...

...Or...How Do We Want To Die ?

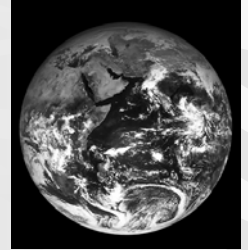
Reminder:
Earth Sciences 083F Final Exam
Saturday, December 9, 2006
9:00 am
Room: TC 348

How Will We Go and When ?

Since microbes began pumping oxygen into Earth's atmosphere in the Archaean, humans are the only other group of organisms that has so profoundly affected the Earth's conditions.

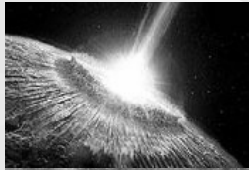
Scientists are becoming increasingly concerned that our consumption of resources and disregard for the consequences of this consumption will bring an end to the age of humans.

Others suggest that humans might be wiped out in a more spectacular way, by natural events over which we have no control.



Events we have minimal control over:

Bolide impact – Taking into account the high mortality rate associated with a large bolide (asteroidal or cometary) impact (remember the "kill curve"), over long time scales, the risk of dying as a result of a bolide impact is about the same as that of dying in an airplane accident.



To cause a serious affect on human civilization, the impactor would have to be 1.5 km or more in diameter. It has been estimated that impacts by objects of this size occur once in a million years (note that the impactor that produced Chicxulub hit Earth 65 million years ago, but the size of that one was about 10.0 km in diameter).

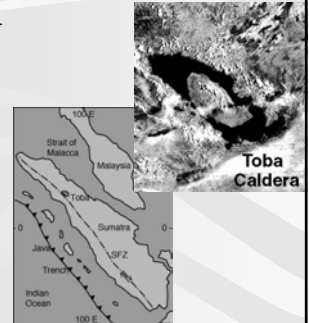


Events we have minimal control over:

Supervolcano – Every 50,000 years or so, a volcanic eruption capable of injecting enough ash and sulphur dioxide into the atmosphere to cause a dramatic effect on global climate for a few years.

The last supereruption occurred about 26,000 years ago in New Zealand

A more severe event occurred about 74,000 years ago when Toba (in Indonesia), erupted enough ash and cooling gases into the atmosphere to dramatically cool Earth's atmosphere. Freezing conditions existed in the tropics for about 5-6 years. Humans teetered at the edge of extinction, and barely made it through.



The crater left by the Toba eruption is about 30 x 100 km in diameter, and amount of ash released was 3,000 times that released by Mt. Helens in 1980.

Events We Have Some Control Over:

A bacterial or viral pandemic – Within the last century humans have witnessed four major flu epidemics, plus HIV and Sars.

The latest concern is the H5 avian flu virus.

The potential impact of a pandemic on humans can be appreciated when one appreciates that the 1918 flu outbreak that caused 20 million deaths in one year (more than all people killed in World War 1, which had just ended)

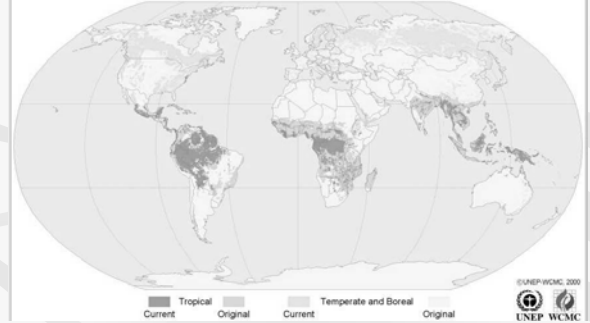
Such a pandemic is unlikely to exterminate humans, but could considerably reduce numbers.

The development of viral vaccines is barely ahead of major virulent viral mutations.



Events We Have Some Control Over:

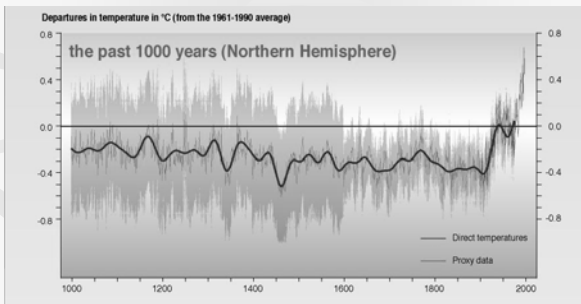
Global Distribution of Original and Remaining Forests



Habitat destruction (forest cover used as a measure here) – destruction of habitat means lower biotic diversity, and in the case of forests, decreased consumption of atmospheric carbon dioxide

Events We Have Some Control Over:

Climate change – This is obviously the biggest, but most complex concern. Average global temperatures have been climbing since at least the mid-1800s with an accelerated increase from 1960 onward.



Direct effects of global warming:

Melting of polar ice caps and raising of sea level (affecting highly populated coastal regions)

Unstable weather patterns (mostly due to a decrease in temperature contrasts between polar and tropical regions).

Loss of now-productive agricultural regions due to desertification.

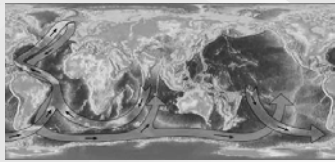


A major difficulty in dealing with climate change is the large number of potential secondary effects that come with it:

Melting of frozen methane hydrates in permafrost and deep sea (methane is more potent than carbon dioxide as a greenhouse gas), leading to further warming.



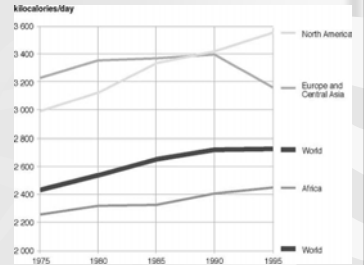
On the long term, shutting off major ocean currents, that transfer heat to and from the tropics to the polar areas leading to cooling of temperate regions.



Overpopulation and competition for resources - humans have a very high demand for food and energy.

The human carrying capacity is still up for debate.

But...the biggest potential problem lies in the inequality in resource use.



Calorie consumption per capita

Resource Supply and Demand

Current estimates for the total amount of conventionally recoverable oil on the planet is around 2 trillion barrels.

We have consumed almost 1 trillion of this - so roughly half the oil is gone.

The rest will last another 40 years at current consumption rates.

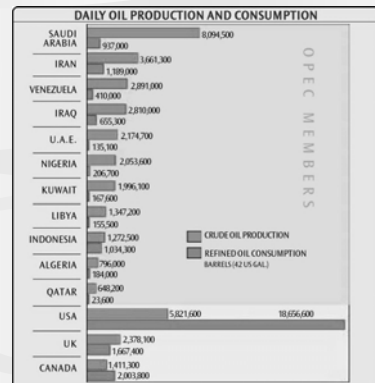
But demands for oil will not stay at current rates.

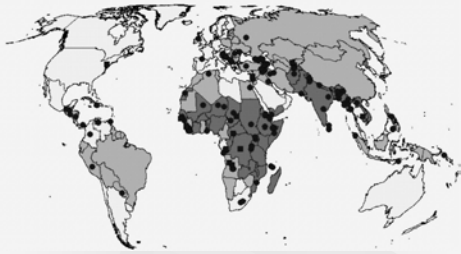
It continues to rise steadily - from 54m barrels a day in 1986 to 82m barrels today.



Killer Inside

People start fighting for resources – how bad will this get ?





Note: blue symbols indicate locations of internal or international conflict since the end of the Cold War.

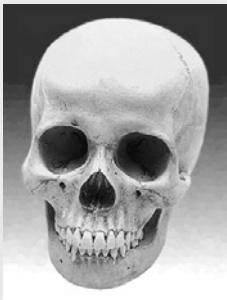
The darker the shade in each country, the poorer that nation is (as indicated by GNP)

Can the unthinkable happen due to competition for resources ?



...when somebody gets desperate enough to send a message ?

And then, there are the inherent sociological aspects of human populations...



Homo sapiens: "wise man"

...Our *perception* of time

From a sociological perspective, there are a few more points that might favour our demise:

Our limited appreciation of time (after all, few of us live beyond 100 years to appreciate longer term changes)



...Division of classes

The rich get richer, the poor get poorer.

Prosperity = more stuff = more demand on resources

Many of our resources come from underdeveloped countries where work is cheap and environmental monitoring is lax.



Toronto suburb

A Guatamalan "suburb"

...Lack of awareness about the rest of the world

The warning signs of ecological degradation are already becoming apparent. Unfortunately, areas that tend to be most ecologically sensitive to global change are "out of sight, out of mind."



Acid mine drainage
(dissolves and carries metals such as lead and mercury into natural environment)

Rainforest clearcutting
(strips away diverse flora and associated fauna and renders nutrient-poor soils useless for farming)

...and apathy

Some profound political statements by George W. Bush:

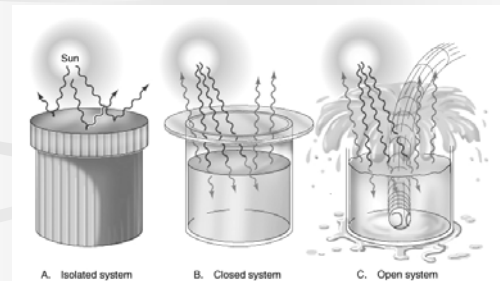
"Had we joined the Kyoto Treaty it would have cost America a lot of jobs."

"We need an energy bill that encourages consumption"

"We have enough coal to last for 250 years, yet coal also prevents an environmental challenge."

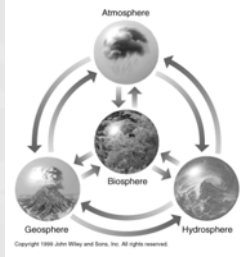
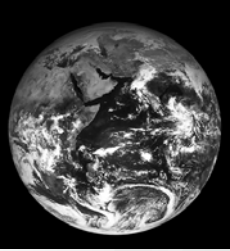
"I know the human being and fish can coexist peacefully."

Again...Earth as a closed system



Closed system: exchange of energy but negligible exchange of matter with surroundings

Again...Earth's four spheres



Due to the degree to which "Earth's Four Spheres" are interconnected, effects of environmental change may be more severe and/or more complex than one might think.

What would survive the next mass extinction ?

Depends on how it happens

– as an extreme example, consider nuclear war

Almost undoubtedly:

Rodents



Insects



But all bets are off for anything else.

So...we've got a closed system

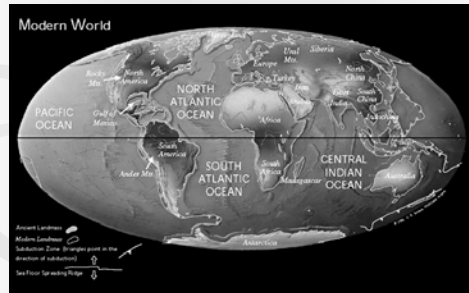
...made of interacting components (the geosphere, biosphere, atmosphere, hydrosphere).

So...we can bring the course together and say:

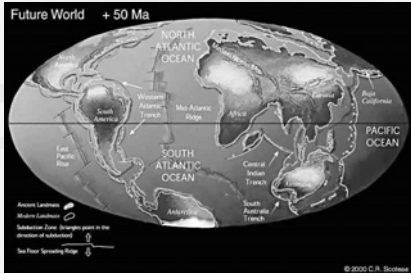
1. We're stuck with what we've got (unless we master colonization of other planets), so we'd better take care of it.
2. Do we face the same selective pressures as other animals ?
 - Competition for resources
 - Competition of "exotic" populations with indigenous populations
 - Changing environmental conditions
 - Thinning out of populations by disease
 - The dangers of overspecialization and overpopulation
 - Reduction of variability within our species

The world will go on – with or without us
(let's look again at plate tectonics)

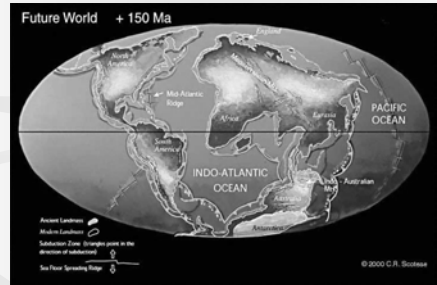
Present Day



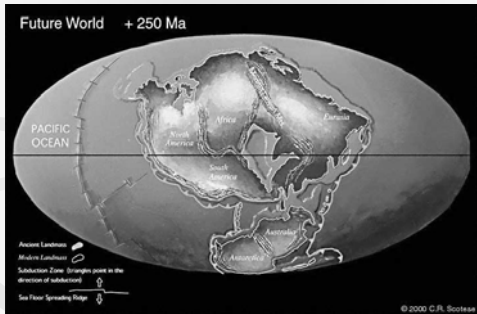
50 million years in the future



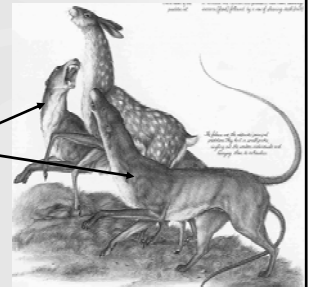
150 million years in the future



250 million years in the future



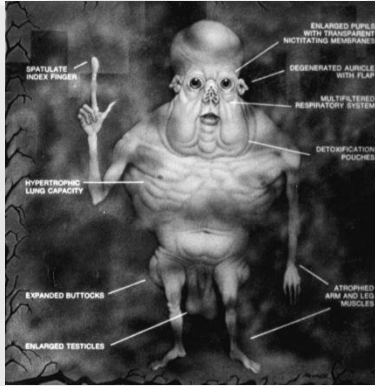
And whoever survives will lead the next revolution in Earth's biological history



The future of humans ?

And if we are smart enough to avoid killing ourselves off, will natural selection still hold for humans ?

If it does, maybe this will be what your great, great, great, great, great grandchild will look like.



Natural history repeats itself

We have much to gain, and nothing to lose in learning from the past.

What are we gonna do about it ?

END OF LECTURE