

**Chapter Eight p. 217-228, Past Climates (Session 1)**

Class Survey:

- Is the Earth experiencing a warming trend? Yes \_\_\_\_\_
- If so, are humans to blame? No \_\_\_\_\_
- What other natural causes might explain a warming trend?
- Examples of scenarios which might be more of a concern than a warming trend?
  - 1)
  - 2)
  - 3)

Winners of the 2007 Nobel Peace Prize:

- Intergovernmental Panel on Climate Change (IPCC)
- (and) \_\_\_\_\_

Books by Jared Diamond (for those interested in projecting into the future):

GUNS GERMS AND STEEL ( 1997).

COLLAPSE, HOW SOCIETIES CHOOSE TO SUCCEED OR FAIL  
(2005).

Societies that chose to fail:

Easter Island.

What might the person who cut down the last tree on the island  
have used as an argument to justify his/her action?

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Vikings in Greenland.

Rwanda Genocide.

Haiti vs. the Dominican Republic.

Darfur (Lake Chad has evaporated (severe drought)).

What two major industrialized countries have refused to sign on to the old Kyoto Protocol?

What are the two major industries in those countries that feel most threatened by the admission that humans are causing the Earth's atmosphere to heat up?

What part of the world has sustained the greatest impact of global warming over the past few years, causing the greatest number of climate "refugees"?

What is the "enforcement industry" "driving" the refugees out of their former locations?

Lower-48 Climate Change:

2006 warmest in 112 years. 2007 was the 8<sup>th</sup> warmest.

Last 10 years among 25 warmest years on record.

Coal - the US' most abundant fossil fuel. How much of the world's coal does Alaska have?

154 new coal fired plants are planned over the next 25 years.

Currently 50% of all electricity in our country is coal generated.

By 2030 CO<sub>2</sub> emissions from coal could increase by 50%.

Coal produces four times the CO<sub>2</sub> than natural gas. Why?

Carbon Capture might double the cost of producing electricity from coal.

Individual states and cities are taking the lead in limiting greenhouse gasses.

Trading carbon pollution rights.

California suing EPA companies. Why?

### CLIMATES OF THE PAST

1837 Louis Agassiz proposed that Earth had experienced major periods of glaciation in the past.

Pleistocene 1.6 million years (my) ago, up to 10,000 years ago: the glacial ice age

Actual history of glacial advances for the past 2.4 million years.

Last major glacial advance peaked 18,000 years ago.

Evidence for glaciation:

Radiometric age dating.

Ocean Sediments. A few cm accumulates / 1,000 years, with no disruptions.

Fossils of single celled organisms sensitive to temperature variations in surface waters.

Oxygen isotopes

$O_{16}$  and  $O_{18}$

Glacial Ice Cores

Altitheal – 7,000 years ago warmer than today.

Holocene time period: last 10,000 years, an interglacial time period, unusually warm and stable.

### RATES OF CLIMATE CHANGE

Ice Cores - detailed information from Greenland and Antarctica for the past 650,000 years.

Feedback systems:

Positive Feedback - one changed variable forces changes in several other variables - magnifying the change.

Negative Feedback - one changed variable causes other variables to change, counteracting the first change.

Stability is maintained.

Oxygen Isotopes:

What is an isotope?

$O_{16}$  evaporates more easily from oceans than  $O_{18}$ . If evaporation ends up in a glacier, the remaining ocean waters become more  $O_{18}$  rich.

Dendrochronology - tree ring dating.

Palynology - analysis of plant pollen.

Radiocarbonate organics in bogs.

Types of pollen will show the extent and distribution of a plant, and thereby the prevailing climate.

## CAUSES OF CLIMATE CHANGE

Milankovitch Cycles - changes in Earth's orbit.

Eccentricity Cycle - 100,000 years.

Obliquity Cycle - 42,000 year cycle

Earth axis tilt from 22.0° to 24.5°.

How does tilt affect seasonal climate variation?

Precession - 21,000 year cycle.

Determines when Perihelion occurs (when Earth closest to the Sun (now January 3rd). Aphelion occurs on Jan 3rd in 10,500 years, with less insolation in the Northern Hemisphere.

In 20,000 years we are due another full ice age advance.

Changes in the Earth's Atmosphere:

Volcanic eruptions - dust lingers in the atmosphere 1-3 years:

Santorini 1600 BC "Lost Continent of Atlantis". 100 km<sup>3</sup>

Tambora 1815-1816 - the year "without" summer. 50 km<sup>3</sup>

Krakatoa, East of Java 1883. 18 km<sup>3</sup>

Yellowstone 640,000 years ago. When due to erupt again?

Size of a typical eruption?

Greenhouse Gases:

CO<sub>2</sub> - transparent to short wave radiation, but traps long wave radiation.

CO<sub>2</sub> in glacial air bubbles higher in concentration during interglacial periods.

CO<sub>2</sub> now at 370ppm - higher than at any time the past one million years.

CH<sub>4</sub> - methane, 20 times as powerful as a greenhouse gas than CO<sub>2</sub>.  
If frozen gas hydrates in tundra and ocean floors melt, the consequences could be huge.

CFC

N<sub>2</sub>O

(4)

H<sub>2</sub>O

Changes in the Oceans:

Global Ocean Conveyor Belt - density / salinity driven.

Evaporation – saltier.

Land runoff dilutes salty water - especially with increased glacial and floating ice melting.

Changes in the ocean current caused El Nino / Southern Oscillation.

Changes in Land Masses:

Northern hemisphere - continents allow ice accumulation.

Erupting volcanoes.

Isthmus of Panama forms, blocking ocean currents.

Uplift of mountain barriers - Asia, Alaska Range, etc....  
changing albedo patterns.

Climate Change and Its Impact on Coastlines:

20th century seas rose 4-12” (conflicting numbers in the text).

12” increase in elevation next 25 – 50 years (EPA prediction)  
mostly due to thermal expansion.

If all ice melted, seas will rise 263 feet.

If waters rose 33 feet, 25% of US population displaces.

During maximum glaciation seas were down 330 feet.

## FUTURE CLIMATES

Natural variability - need long term patterns.

Causes of Little Ice Age as well as the Medieval Warm Periods?

More weather pattern extremes predicted with warming.

1° to 3.5° C warming predicted in 21<sup>st</sup> century.

+1°C Increased warming since the end of the Little Ice Age.

+2°C Greater than any temperatures the past 10,000 years.

+3°C Hotter than temperatures recorded that past one million years.

Past century increase:  $+0.3^{\circ}\text{C}$  to  $+0.6^{\circ}\text{C}$

Tropical diseases spread poleward.

Opening of the Northwest Passage.

Next major cooling 3000 to 7000 years from now.

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