"A Warm Forecast for the Planet"

Before you begin reading the article, please research these questions:

1. When it comes to Climate Change, who should we listen to? Use the internet to find out more information on the:

   IPCC:

   UN Green Climate Fund:

2. What are we doing as a global society to deal with Climate Change? Nations have met many times. Research the following summits:

   Kyoto Protocol in 1994:

   Copenhagen Climate Summit in 2009:

   Paris Climate Summit in 2015:

Use the article to answer the following questions:

1. How is the share of carbon dioxide emission predicted to change (use the pie chart)?

2. Besides CO2, there are 4 other ANTHROPOGENIC greenhouse gases. Fill in the table below with info on each gas.

GHG	Description from article
Methane	
Nitrous Oxide	
CFCs	
Ozone	

3. What are tropospheric aerosols? What effect do they have on the temerature of the atmosphere?

4. Summarize the 10 effects of climate change bulleted on page 3:

8. What are some ways we can mitigate or offset climate change?

A Warm Forecast for the Planet?

Student Reading

In recent years the fate of our planet's climate has been a source of heated debate. Ten of the hottest years since temperature record-keeping began in 1866 were in the late 1980s and 1990s. Over the past century, the average surface temperature of the Earth has increased 0.5 to 1.1 degrees Fahrenheit (0.3 to 0.6 degrees Centigrade), and the sea level has risen 10 to 25 cm.[1] Scientists, industry and policy makers have been arguing for years about whether human actions are responsible for these changes in the Earth's climate. In 1988, the World Meteorological Organization and the United Nations created an advisory group of 2,500 scientists from over 80 countries to conduct a non-biased analysis of all the available data. In 1995, this group, the Intergovernmental Panel on Climate Change (IPCC), released a report concluding that, in fact, the observed changes are "unlikely to be entirely natural in origin" and that there is "a discernible human influence on global climate."[2] The gases our industrial world has spewed for decades are changing our atmosphere, and scientists are warning that society must take immediate action to avert disastrous consequences.

The Greenhouse Effect

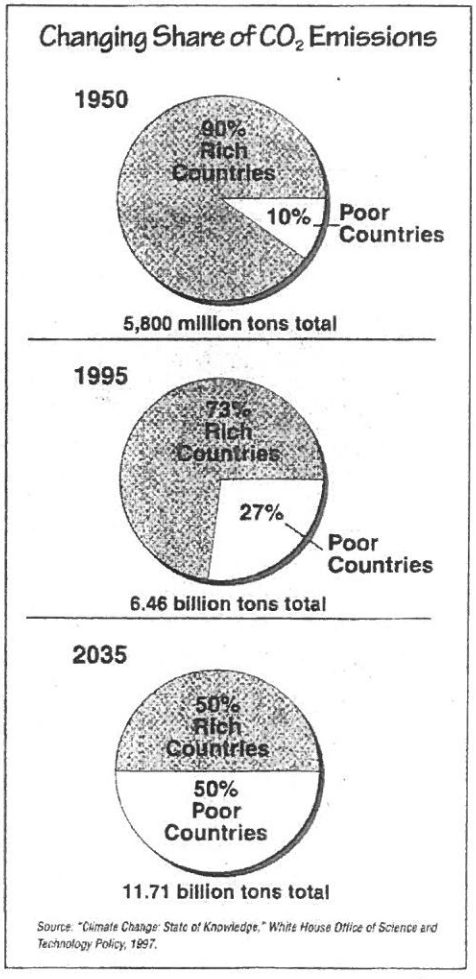
The Earth's atmosphere is a complicated system of gases and energy. It allows energy from the sun to pass through to the Earth and also allows energy from Earth to escape into space. By delicately balancing this exchange of energy, the atmosphere regulates our climate.

The burning of oil, coal and natural gas has increased the concentration of certain gases in our atmosphere.[3] These gases act like a blanket, trapping Earth's heat energy and preventing it from passing through to space. This imbalance in energy exchange, with the Earth's atmosphere taking in more energy than it releases, causes the Earth to get warmer. The process works much the way a greenhouse would, hence its name. Gases which function to keep heat energy from escaping the atmosphere are called **greenhouse gases**.

Turning Up the Heat

For tens of thousands of years, the levels of oxygen, nitrogen and other gases in the Earth's atmosphere remained essentially unchanged. By the beginning of the 19th century, the world's population had grown to one billion and the Industrial Revolution in North America and Europe was starting to clear the land and taint the air with factory smoke. A century later, the population had doubled to two billion and the age of petroleum was dawning. After the Second World War, energy use skyrocketed. Between 1946 and 1968, the use of motor fuel doubled, electricity consumption nearly tripled and the production of petroleum-based plastics increased ten-fold!

Oil, coal and natural gas power our automobiles, heat our homes, provide electricity for our appliances and allow us to enjoy a standard of living unprecedented in history. However, when burned (combusted), these carbon-based, fossil fuels combine with oxygen to form **carbon dioxide** (CO_2). CO_2 is the primary greenhouse gas, responsible for more than 60 percent of all the global warming due to greenhouse gases. As a result of increased industrialization and combustion of these fuels, more and more carbon has been emitted into the atmosphere, and the concentration of CO_2 in the atmosphere has increased by 30 percent since the mid-19th century. CO_2 levels are now at their highest point in 150,000 years.[4] The levels of carbon emissions have quadrupled since the 1950's, and in 1996, a new record of 6.25 billion tons of carbon were emitted.[5] Trees and other photosynthetic organisms can take in CO_2, but not more than about three or four billion



Source: "Climate Change: State of Knowledge," White House Office of Science and Technology Policy, 1997.

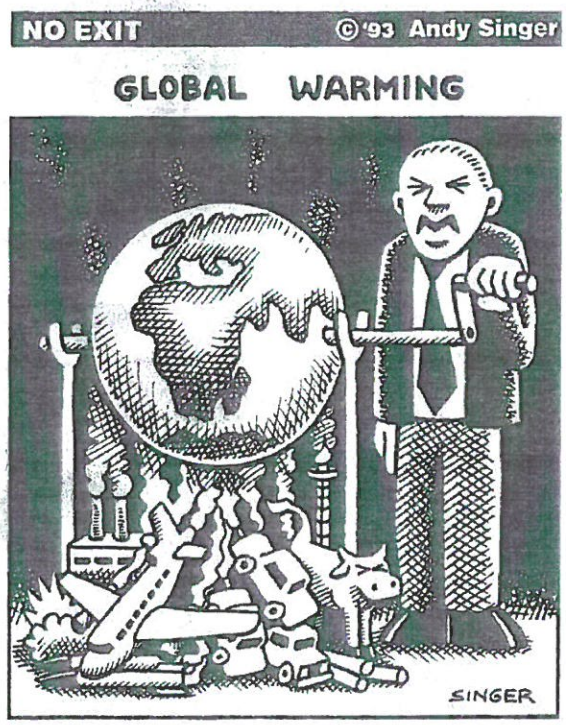
A Warm Forecast for the Planet?

Student Reading

tons worldwide. As deforestation continues, the Earth will be able to absorb less and less.

The United States emits more tons of carbon than any other country, both in raw numbers and per capita. In 1996, the United States and Canada, though just five percent of the world's population, were responsible for producing 26 percent of world's carbon emissions.[6]

However, as industrialization escalates in Asia, Africa and Latin America, carbon emissions in the developing world are increasing rapidly. China is now the world's second largest carbon emitter, at 14 percent of the global total. Even with their rapid increases, China's carbon emissions per capita are still less than one-seventh those of the United States. It is also important to point out that the vast majority of greenhouse gases already put into the atmosphere by human activities are a result of emissions from industrialized countries, and some of these gases can remain in the atmosphere for centuries.



Singer ©1993. Reprinted with permission of the artist. www.andysinger.com

Other Gases

Human activity is also directly related to the production of **methane** (CH_4), another greenhouse gas. Methane is released by natural gas leaks, coal mining, oil and gas drilling, the burning of wood and garbage and the decomposition of organic matter in rice paddies and in the intestines of cattle, sheep and termites. The atmospheric concentration of methane has increased 145 percent since pre-industrial days, and currently accounts for about 15 percent of all the global warming due to greenhouse gases.[7]

Worldwide production of methane is expected to increase as more cattle are raised and more rice is cultivated to feed increasing numbers of people. Although methane accounts for a smaller part of the greenhouse gas volume than does CO_2, it is more potent. Each methane molecule is 30 to 40 times more efficient at trapping heat than a CO_2 molecule. Further, methane remains in the atmosphere five to ten years, and levels are rising up to one percent annually.

Nitrous oxide (N_2O), also known as "laughing gas," is a byproduct of fossil fuel combustion, bacterial reactions in soil and the breakdown of widely used fertilizers. Its atmospheric concentration has increased 15 percent over pre-industrial levels, and it accounts for about five percent of the total warming due to greenhouse gases.

Chlorofluorocarbons (CFCs), unlike CO_2, methane and nitrous oxide, are completely human-made chemicals. They are used as refrigerator and air conditioner coolants, as chemical cleaners and in the manufacture of foam and in aerosol spray cans. Although CFCs cause only about ten percent of total atmospheric warming, ounce for ounce, they are the strongest insulators of the greenhouse gases. They are 10,000 to 20,000 times more effective at trapping heat than CO_2, and are likely to remain in the atmosphere 75 to 400 years.

Some of the warming effect of CFCs is slightly offset by the fact that they also deplete **ozone** in the upper atmosphere, which allows energy to leave the Earth more easily and has a net cooling effect. Depletion of the ozone layer carries its own set of severe consequences. The

A Warm Forecast for the Planet?

Student Reading

decrease in ozone lets in more of the sun's harmful ultraviolet light, which is known to cause skin cancer and eye disease, damage crops and destroy the phytoplankton that support the marine food chain.[8]

As a result of the Montreal Protocol in 1987, in which participating countries agreed to phase out the production of CFCs, CFC production has been falling consistently since its peak in 1988. Nonetheless, because it takes CFCs three to five years to reach the upper atmosphere, the ozone will continue to suffer their effects for years to come.

Humans are also responsible for increases in **tropospheric aerosols**, which are tiny particles suspended in the air. Aerosols cool the atmosphere but their effects tend to be short-lived and localized. While they may counteract the warming effect of greenhouse gases, aerosols can have other climate effects, such as altering rain patterns.[9]

All of the gases added to the atmosphere by energy use are responsible for over half of the increase in global temperatures. The trends point to increased energy consumption in the future, particularly in the developing world, where the population is expected to double in just 40 years. Daniel J. Evans, as Chairman of the National Academy of Sciences panel on global warming, stated in 1991 that population growth "is the biggest single driver of atmospheric pollution."

A Price for Progress

The IPCC's "best estimate" forecasts an increase in the average global temperature by the year 2100 of 3.6 degrees Fahrenheit (2 degrees Centigrade) accompanied by a rise in the average sea level of about 19.7 inches (50 cm). Does an increase of only a few degrees really make that big an impact? In the last 10,000 years, the Earth's average temperature has not changed either way by more than 1.8 degrees F (1 degree C).[10] So small differences in average temperature can make a huge difference in the Earth's climate. The following are some of the potential consequences of global warming.

- Sea levels may rise 15 to 95 cm, putting 92 million people at risk of flooding. Low-lying islands and countries such as Bangladesh would be at particularly high risk.
- Amount, frequency and intensity of rainfall may change. Floods and violent storms such as monsoons and hurricanes would become more likely.
- Droughts may occur more often and with greater severity, turning larger areas of cropland into desert.
- Tropical diseases and pests may spread, with devastating effects upon stressed crops and malnourished populations. For example, the percent of the population living in a zone of potential malaria transmission could increase from about 45 percent today to as much as 60 percent.
- Climate change will affect crop yields differently in different regions. Overall production could remain the same, with decreased productivity in the tropics, and increased productivity closer to the poles.
- A decrease in biodiversity and in the goods and services that ecosystems provide is likely as individual species respond to a changing climate.
- Deserts are expected to become hotter, but not significantly wetter, threatening more heat-sensitive species.
- Species composition of forests is likely to change. Some old forest types may disappear while others develop.
- As the climate warms, species are expected to shift upward in altitude. Species limited to mountain tops may become extinct due to disappearance of habitat.
- Geographical locations of wetlands are also expected to change in response to changes in climate and rainfall.

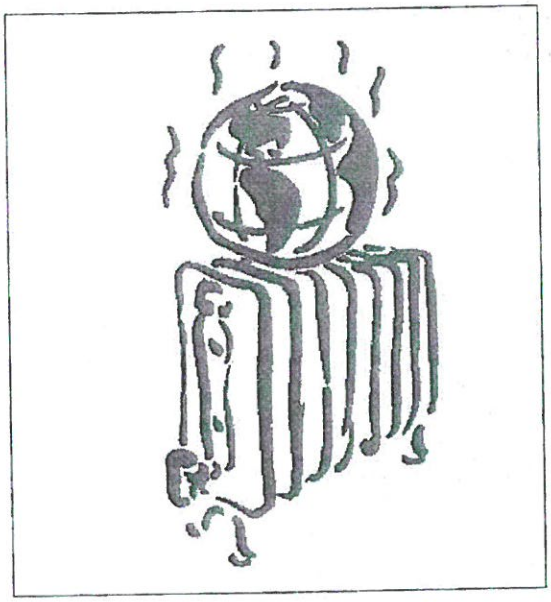
(All possible consequences come from the IPCC Second Assessment Report.*)*

Cool It!

A degree of uncertainty remains about the severity of global warming and the impact of human activity. However, many scientists and policymakers alike point out that if we wait until we are absolutely certain about climate change, it may be too late to take the most effective and simplest measures to combat it. The IPCC stresses: "Uncertainty does not mean

A Warm Forecast for the Planet?

Student Reading



that a nation or the world community cannot position itself better to cope with the broad range of possible climate changes or protect against potentially costly future outcomes."[11]

The primary precautionary measure to take against global warming is the reduction of greenhouse gas emissions. The IPCC estimates that in order to stabilize greenhouse gas concentrations at present day levels, CO_2 emissions need to be cut by 50 to 70 percent worldwide; methane emissions need to be reduced by eight percent and nitrous oxide emissions by 50 percent. At the Earth Summit in Rio de Janeiro in 1992, 166 nations signed the U.N. Framework Conference on Climate Change and agreed to reduce and stabilize emissions to 1990 levels by the year 2000; however, at the current rate, no countries, outside of a few in the European Union, are expected to meet this target.

Why are countries having a hard time cutting their greenhouse gas emissions? Because people are concerned that efforts to stabilize emissions, such as taxes placed on use of fossil fuels or changes in how factories work to make them more efficient and pollute less, can hurt economic growth. However, the IPCC Second Assessment Report and many economic studies argue that there are several ways to make emissions cuts both technically possible and economically feasible.

Altering our wasteful consumption patterns by using more energy-efficient technology in industry, recycling and using materials which produce fewer greenhouse gas emissions, driving more fuel-efficient cars, and using alternative fuels and renewable sources of energy, such as solar and wind, are essential to reducing the amount of greenhouse gas emissions. Reducing deforestation, while planting and cultivating new forests, would absorb CO_2 and preserve the biological richness of our planet. In addition, successful efforts to slow population growth would allow nations to cut CO_2 emissions more easily. Stabilizing global population is a crucial step to reducing greenhouse gas emissions, but it is not the only step. Many experts believe that a program with any chance of success must be aimed at both resource consumption and population stabilization.

In December of 1997, 160 nations met in Kyoto, Japan, to write the first-ever legally binding treaty on greenhouse gas emissions. The document produced from this conference, called the "Kyoto Protocol," requires that the industrialized nations reduce their greenhouse gas emissions by an average of 5.2 percent below 1990 levels between 2008 and 2012. The protocol, which sets legally binding limits on six greenhouse gases, is the first small step in the process of changing the fossil-fuel driven world economy to one which uses more sustainable sources of energy such as solar, wind and hydroelectric. Much work still lies ahead in to prevent potentially dangerous changes in the Earth's climate.

Endnotes

[1] *Summary for Policymakers: The Science of Climate Change*—IPCC Working Group I. The United Nations, 1995.

[2] *Climate Change 1995: The IPCC Second Assessment Report*. The United Nations, 1995.

[3] Seth Dunn. 1997. "Global Temperature Down Slightly." *Vital Signs 1997*. Washington, DC: Worldwatch Institute.

[4] Seth Dunn. 1997. "Carbon Emissions Set New Record." *Vital Signs 1997*. Washington, DC: Worldwatch Institute.

[5] Ibid.

[6] *Annual Energy Review 1996*. Washington, DC: Energy Information Agency, U.S. Department of Energy, 1997. Table 11.21. U.S.: 4.5 percent of the population, 23.5 percent of carbon emissions. Canada: 0 percent of the population, 2.2 percent of carbon emissions. For Canada data, see also: *Canada and Climate Change: Responding to Challenges and Opportunities*, A submission to Canada's Provincial and Federal Ministers of Energy and Environment. Joint project of the Canadian Global Change program and the Canadian Climate Program Board, November 1996.

[7] Op. cit. note 1.

[8] Anjali Acharya. "CFC Production Drop Continues." *Vital Signs 1996*. Washington, DC: Worldwatch Institute.

[9] Op. cit. note 1.

[10] Op. cit. note 2.

[11] *Summary for Policymakers: Scientific-Technical Analyses of Impacts, Adaptations and Mitigation of Climate Change*—IPCC Working Group II. United Nations, 1995.