Summary Of the Case Study

Polar Bear population in the Antarctic going down because temperatures are going up and melting the caps. Polar bears are losing their habitat, they also can't get their food which is also making it harder for smaller species like the Artic Fox which rely on the carcasses left by Polar Bears. If temperatures continue to rise, then we can only expect the extinction of Polar Bears and the species that rely on them.

Key Ideas

Global change includes changes in the chemistry, biology, and physical properties of the planet. One type of global change is climate change, which refers to changes in the climate of Earth. One aspect of global climate change is global warming, which refers to the warming of oceans, landmasses, and the atmosphere of the earth.

See "Greenhouse effect picture". Natural sources of greenhouse gases include volcanoes, decomposition and digestion and denitrification when oxygen levels are low, and evaporation and evapotranspiration of water. Anthropogenic sources are burning fossil fuels, some agricultural practices, deforestation, landfills, and industries.

CO_2 has increase over the last fifty years by nearly 30%. Major source of CO_2 is from developed and rapidly developing countries.

Positive Feedback loops are bad most of the time. One example is warmer soils increase rates of decomposition and then their emissions of CO_2 increase as well. Negative Feedback loops are good for us and for the environment most of the time. One example is the rate of growth of plant life because of the CO_2 that's increased, which means less CO_2.

Global warming has caused the melting of ice caps, glaciers, and permafrost. It has also cause rising sea levels, and many other things. Future impacts are more heat waves, rarer cold spells, changes in precipitation, disrupted ocean currents, and effects on human health and economics as temperatures rise and it gets harder to adapt.

The Kyoto Protocol is an international agreement to reduce greenhouse gases. Developed countries (the ones who emit the most greenhouse gases) are making the greatest reductions.

Checkpoints

1. Humans are contributing more and more emissions to the atmosphere.
2. In Global change today, there are higher levels of greenhouse gases in the atmosphere than ever before.
3. Climate change is a part of Global Change, but it only includes things dealing with Climate.
4. How the energy of the sun causes the earth to heat. (See Greenhouse Effect Picture)
    a. Incoming solar radiation consists mostly of UV and visible light.
    b. About 1/3 of the radiation is reflected back into space by the atmosphere, clouds, and the surface of the planet.
    c. The remaining solar radiation is absorbed by clouds and the surface of the planet. Both become warmer and then emit infrared radiation.
    d. Much of the emitted infrared radiation from earth is absorbed by greenhouse gases in the atmosphere, the rest is emitted into space
    e. As the greenhouses gases absorb infrared radiation, they warm and emit infrared radiation, with much of it going back toward earth.
5. A greenhouse gas is a gas that holds heat really well. Some of the more common ones are CO_2, water vapor, methane, nitrous oxide, chlorofluorocarbons. See table 19.1
6. What determines the effect of a greenhouse gas is how much a molecule can contribute to global warming over a 100 year period, and how much infrared energy the gas can absorb and how long it stays in the atmosphere.
7. The main anthropogenic sources of greenhouse gases.

   a. Use of fossil fuels
   b. Agricultural practices
   c. Deforestation
   d. Landfills
   e. Industrial production
8. The main natural sources of greenhouse gases.
   a. Volcanic eruptions
   b. Methane
   c. Nitrous Oxide
   d. Water Vapor
9. Developed nations tend to have more CO_2 emissions per capita while developing nations have more CO_2 emissions in millions of metric tons.
10. Ways we can estimate the pollution and temperature of the past.
    a. Sediments in the Ocean
    b. Ice blocks
    c. Tree rings
    d. NASA (for recent history)
11. Climate models are important because they can help us see what changes come in patterns. Like what the earth's cycle is and how long it takes for history to repeat itself. But there are many different variables like humans and emissions that we create and such.
12. Evidence of global warming
    a. Ice caps, glaciers, and permafrost are melting.
    b. Sea levels are rising.
    c. More heat waves and rarer cold spells
    d. Precipitation patterns are changing, some places have more others have less.
    e. Greater storm intensity
13. All of these changes are going to be intensified as temperature continues to rise.
14. We will become more unhealthy because if the temperatures and the emission levels. Also as sea levels rise, people will have to relocate and the economy will suffer because of it. Like tourism will decrease in the Alps because there won't be as much snow to ski on.
15. Kyoto Protocol has called for the reduction in certain emissions from certain countries in certain levels.
16. We are trying to reduce emissions and try and fix the earth. That is why the Kyoto Protocol is called a precautionary principle
17. Developed countries will have to reduce their standard of living and developing countries will have to develop a little slower.

Mostly we just need to work on our emission levels of greenhouse gases because we're polluting and heating the earth.

Kyoto Protocol—calls for reduction in emissions

We are reducing emissions slowly and making small changes to the way we contribute to how much greenhouse gases are in the atmosphere. We are trying to sequester more Co_2 in the ocean and in old oil reservoirs.

Global Climate Change: Worldwide changes in precipitation and temperature.

Multiple Choice Questions

1. What is one anthropogenic source of greenhouse gases?

A. Methane
B. Nitrous Oxide
C. Agricultural Practices
D. Water Vapor
E. Sediments in the Ocean

2. What is an evidence of Global warming?
   A. More cold spells and rarer heat waves
   B. Sea levels rising
   C. Greater storm intensity
   D. A and C
   E. B and C
3. Which sources of data have been used to assess changes in global CO_2 and Temperature?
   i. Air bubbles in ice cores
   ii. Thermometers placed around the globe
   iii. CO_2 sensors placed around the globe

   A. i
   B. i and iii
   C. i, ii, and iii
   D. i and ii
   E. ii and iii

Free Response Question

A. Give 3 proofs of Global warming
B. If the annual rate of CO_2 increase is 1.4 ppm, what concentration of CO_2, what concentration of CO_2 do you predict for the year 2100?
C. What are two ways that we can tell the temperature and amount of CO_2 in the atmosphere100 years ago?
D. Describe both a negative and a positive feedback loop and give one example of each relevant to global change.

DO THE MATH

Projecting Future Increases in CO_2

Since Charles David Keeling and his colleagues began measuring CO_2 in 1958, we have an excellent record of how CO_2 concentrations have changed in the atmosphere over time. From 1960 to 2010, the concentration of CO_2 in the atmosphere increased from 320 to 390 ppm (parts per million).

Based on these two points in time, what has been the average annual increase of CO_2 in the atmosphere?

$$\text{Time} = 2010 - 1960 = 50 \text{ years}$$

$$\text{Increase in } CO_2 = 390 \text{ ppm} - 320 \text{ ppm} = 70 \text{ ppm}$$

Average annual increase in

$$CO_2 = \frac{70 \text{ ppm}}{50 \text{ years}} = 1.4 \text{ ppm/year}$$

Your Turn

1. If the annual rate of CO_2 increase is 1.4 ppm, what concentration of CO_2 do you predict for the year 2100?
2. From 2000 to 2010, the rate of increase was faster than in previous decades, achieving a rate of 1.9 ppm per year. Based on this faster rate, what concentration of CO_2 do you predict for the year 2100?

TABLE 19.1 The major greenhouse gases

The major greenhouse gases differ in their ability to absorb infrared radiation and the duration of time that they stay in the atmosphere. The units "ppm" are parts per million.

Greenhouse gas	Concentration in 2010	Global warming potential (over 100 years)	Duration in the atmosphere
Water vapor	Variable with temperature	<1	9 days
Carbon dioxide	390 ppm	1	Highly variable (ranging from years to hundreds of years)
Methane	1.8 ppm	25	12 years
Nitrous oxide	0.3 ppm	300	114 years
Chlorofluorocarbons	0.9 ppm	1,600 to 13,000	55 to >500 years

Source: Data on concentration are from the National Oceanic and Atmospheric Administration. www.esrl.noaa.gov/gmd/aggi. Data on global warming potential are from the United Nations Framework Convention on Climate Change.

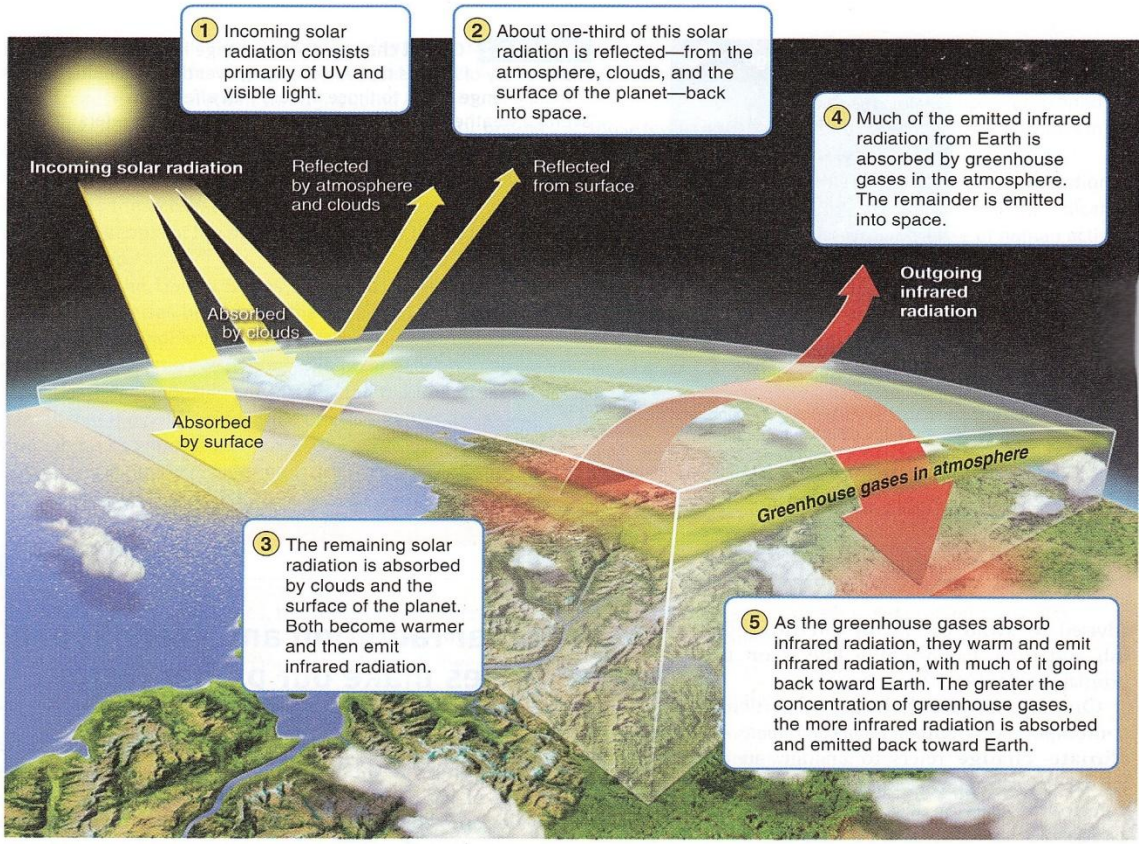

FIGURE 19.2 The greenhouse effect. When the high-energy radiation from the Sun strikes the atmosphere, about one-third is reflected from the atmosphere, clouds, and the surface of the planet. Much of the high-energy ultraviolet radiation is absorbed by the ozone layer, where it is converted to low-energy infrared radiation. The remaining ultraviolet radiation and visible light strike the land and water of Earth where they are also converted into low-energy infrared radiation. The infrared radiation radiates back toward the atmosphere, where it is absorbed by greenhouse gases that radiate much of it back toward the surface of Earth. Collectively, these processes cause warming on the planet.

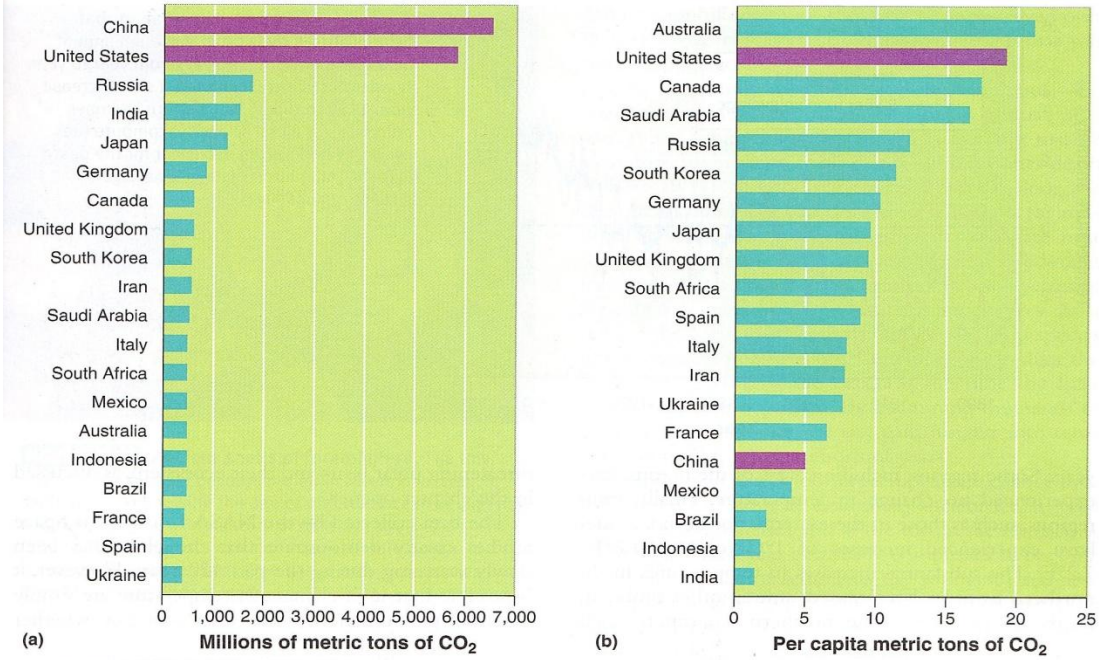

FIGURE 19.8 **CO_2 emissions by country.** (a) When we consider the total amount of CO_2 produced by a country, we see that the largest contributors are the developed and rapidly developing countries of the world. (b) On a per capita basis, some major CO_2 emitters have relatively low per capita CO_2 emissions. [Data from http://www.ucsusa.org/global_warming/science_and_impacts/science/each-countrys-share-of-co2.html.]