

## ***Teacher Background Information: The Potential Effects of Climate Change***

***Introduction:*** Landscapes, mountains and seascapes appear to many individuals to be eternal ecosystems. In reality, they are not, as evidenced by the many changes evidenced in Earth's history. The great ice sheets that once covered parts of North America and Eurasia have long since melted and left behind rocks and soils alien to the area where they remained. Wind and water erosion constantly expose bare rock to chemical and physical change, and in many areas of the world, fires act as an important natural change factor. Floods, blowing sand and volcanic eruptions may destroy the vegetation of an area leaving the ground bare or creating entirely new land.

Climate is an additional change factor that may, over hundreds or thousands of years, affect the biotic and abiotic components of any ecosystem. If it grows colder or drier, some animals may die or move elsewhere; other animals may find the area more hospitable than it was earlier. The selective affect of the organism depends upon what adaptations the plant or animal possesses. The adaptations may be to climatic factors, or at the same time, the animals may be adapted to certain plants that are in turn adapted to a certain climate. In that case, a change in climate could affect animals indirectly through changes in the plant life of the area. The genetic variation present in any natural population means that some individuals by chance, prove to be well suited to change in the environment. Such individuals are, in effect, pre-adapted to the new environment. Over many years, one biotic or abiotic factor in an ecosystem may change, causing a second factor to change, which in turn changes a third factor, very much like a change reaction. Over long periods of time, the entire ecosystem may be quite different than it was originally.

Climate change means much more than a simple rise in average global temperatures. Researchers predict that even a simple change, such as the doubling of carbon dioxide concentrations in the atmosphere, could cause changes in rainfall patterns, cloud cover and seasonal temperatures across the globe. These changes in turn may result in a restructuring of the Earth's entire biosphere. Since the Earth's plants, animals, atmosphere and oceans are interdependent, changes in one part of the system will affect other parts of the system. These changes are not easily predicted for any given region, but experiments and computer simulations provide evidence that an increase in the average global temperature of only 5 degrees F would result in the following changes:

- **Ice Caps and Glaciers:** Substantial melting of the Southern Polar ice cap and of the mountain glaciers around the world will raise sea levels. Melting of the North Polar ice cap will not raise sea level, since the polar ice there floats in water. It is also predicted that reduction in the size of the white, highly reflective glaciers and ice caps around the world (the Earth's *albedo*) will

mean that more of the Sun's energy will be absorbed by the Earth, contributing to further warming.

- **The Oceans:** Since water expands when heated, a rise in average sea water temperatures would cause sea levels to rise even further. Over the past century, sea level has already risen 4-8 inches. The reason for this increase may be due to the 1 degree F warming during this period, or a variety of other causes. It is very difficult to estimate how much further the sea level will rise if global temperature increases 5 degrees F; estimates range from one foot to 3 feet.
- **Coastal Areas:** Images of the Statue of Liberty up to her neck in water are misleading. Sea levels will probably not rise that dramatically. However, an increase of 2-3 feet will be disastrous for low-lying coastal areas. For example, Louisiana has 40% of the nation's wetlands, and could lose up to 85% of that area to the expanding ocean. Likewise, Florida will also lose much of its valuable coastline and much of Everglades National Park. In California, farmland in the Sacramento River Delta will be threatened by incursions of salt water, as will other low-lying coastal areas. Around the world, rising sea levels will have a major impact on ports, harbors, and low-lying residential, industrial and farm lands. Among the hardest hit will be island nations that may be totally inundated by a sea level rise of just a few meters.
- **Agricultural Patterns:** Changes in climate will result changes in the worldwide pattern of rainfall and soil moisture. In some areas rainfall and snow are likely to increase, while in other areas precipitation will probably decrease. For example, according to some computer models, the central region of the United States, which now produces most of the country's wheat and corn, is likely to suffer increasing drought conditions in summer. At the same time, Canadian agriculture may benefit from increased rainfall and a longer growing season.
- **Clouds:** An increase in the Earth's average global temperature will seriously affect the Earth's water cycle. Warmer temperatures will increase evaporation from the oceans. How this will affect further global warming is unclear. In one view, higher evaporation will cause more clouds to form and acting as a negative feedback, decrease global warming by reflecting more solar energy back into space. However, water vapor itself is a greenhouse gas and readily absorbs infrared radiation. At night, when the Earth cools by emitting infrared energy from its surface, increased water vapor will prevent some of the heat from escaping by absorbing the infrared energy and emitting some of it back to Earth.
- **Water Resources:** Overall precipitation is likely to increase, due to the increased evaporation and cloud cover. However, due to changes in precipitation patterns, some regions that currently enjoy abundant rainfall might experience

droughts. Droughts have detrimental effects on agriculture, on river transportation systems, and on hydroelectric power. In addition to lower rainfall, if there are more hot days, soil evaporation will increase exacerbating the effects of droughts. With generally warmer weather, some place will have rain instead of snow, increasing the chance of winter floods and reducing the amount of stored water for the spring and summer. IN other areas, there may be an increased snow pack, resulting in spring floods as the snow melts. People who live in coastal areas and on islands that depend on well may find them contaminated, as salt water from rising sea levels seeps into the fresh groundwater.

- **Forests:** The composition and location of forests is likely to change as trees that grow better in increased carbon dioxide atmospheres replace those that do not. With warmer temperatures, there are likely to be more hot days, drier conditions and more extensive forests fires. The increased frequency of fires will also change vegetation patterns and locations, as will changes in rainfall, cloud cover and extremes in temperature.
- **Biological diversity:** The plant and animal species that now inhabit the Earth evolved in response to changing environmental conditions over millions of years. Fossil evidence shows that during the transitions between glacial and interglacial periods, which took thousands of years, many species migrated to new regions or evolved into new forms; many others became extinct, unable to adapt to the speed of the changing climate. However, global warming due to an enhanced greenhouse effect has the potential to cause significant changes in less than 100 years, about one human lifetime. As habitats change, the availability of food, water and shelter will change. While some species may be able to migrate with the changes, or change their behaviors, many species will not be able to find new niches, or adapt to the rapidly changing conditions. Significant global warming could result in an acceleration of the already fast rate of species extinction (now estimated to be up to 30 species per day).
- **Human Health:** In a warmer world, we are likely to experience a greater number of hot days. While hot days may be welcome at the beach, they are periods of stress for many people, especially those with respiratory diseases and the elderly. Changing air circulation patterns may exacerbate problems due to pollution. Insect pests may increase in certain areas, along with the diseases they transmit. In areas with higher summer temperatures, or more hot days, the demand for air conditioning is likely to increase, which in turn will increase the demand for electricity. If this is generated by burning fossil fuels, more carbon dioxide will be added to the atmosphere.

Scientists do not yet have a complete understanding of the Earth system and the predicted climatic changes that could be in place within the next century as a consequence of planetary forcing not much beyond what it is today. Of

specific importance is the degree of nonlinearity of many Earth system processes and whether thresholds for sudden change are present. The Earth's climate does not generally respond to forcing in a smooth and gradual way, but rather in sharp jumps. The concern is that increases to the concentrations of carbon dioxide and other greenhouse gases will jolt the ocean-atmosphere system out of its current mode and into one more appropriate to Earth's altered temperature state and less appropriate to the well-being of Earth's present population or portions thereof. Scientists have little basis for answering questions regarding the impact of such changes on the inhabitants of the biosphere, but most likely, surprises, probably disagreeable ones, appear more likely than not.