THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

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Community Development, 2120 Fyffe Road, Columbus, OH 43210-1010

Global Climate Change

Thomas W. Blaine
District Specialist, Northeast District
Community Development

The study of global climate incorporates a number of variables which include temperature and precipitation, as well as the distribution of these over space and time. In recent years concern has emerged over the possibility that human activities may change global climate. Most climatologists agree that if there is any global climate change over the next 50–100 years, it will be a direct result of the more specific problem of global warming, the causes and implications of which are discussed in this fact sheet.

The Greenhouse Effect

The earth orbits the sun at an average distance of nearly 93 million miles. When the radiation from the sun reaches the earth, a portion is absorbed as heat on the surface, but most is radiated back toward space. Due to the nature of the atmosphere, however, much of the escaping heat is trapped, where it contributes to the warming of the planet. This phenomenon is known as the greenhouse effect. It is an extremely important and natural phenomenon, and if it did not exist, the earth would be far too cold to support life as we know it. The specific gases that occur naturally in the atmosphere to sustain the greenhouse effect include water vapor, carbon dioxide (CO_2), methane (CH_4), ozone (O_3), and nitrous oxide (N_2O). These are often referred to as "greenhouse gases."

It is widely agreed that concentrations of greenhouse gases present in the atmosphere (particularly carbon dioxide and methane) have varied tremendously over the period of the earth's existence, and there is considerable agreement that these changes correlate with temperature change. However, until recently in the earth's history, human activities have not been significant enough to influence the concentrations of these gases. That began to change about two hundred years ago.

Since the time of the Industrial Revolution in the 1700's humans have released nearly 1 trillion tons of carbon dioxide into the atmosphere by burning fossil fuels. A significant portion of this has been taken up by absorption in the oceans and by the terrestrial ecosystem. The net effect, however, has been to increase atmospheric concentrations of carbon dioxide from roughly 280 parts per million (ppm) to the current level of about 360 ppm. Moreover, annual emissions are expected, at a minimum, to double in the next 50–100 years.

Over the same period, the production and use of coal, oil, and natural gas, along with expanded agricultural enterprises (particularly cattle and wetland rice production) have led to greatly increased methane emissions. Atmospheric concentrations of methane have increased from 0.80 ppm in 1800 to 1.75 ppm in 1995.

In addition to naturally occurring gases such as carbon dioxide and methane, whose levels in the atmosphere are enhanced by human activities, chloroflourocarbons (CFC's—primarily used as refrigerants), which are uniquely manmade, also contribute to the greenhouse effect. However, the production of CFC's has been restricted due to other environmental concerns. Emissions of CFC's are expected to decline substantially in the future.

Temperature Trends

Climate models are basically computer programs that replicate the earth's climate and/or attempt to predict climate conditions on the basis of selected variables or factors which might bring about climate change. According to most current climate models, the combined amounts of greenhouse gases emitted by activities for which humans are responsible to date have been sufficient to raise the average temperature of the earth by 2 degrees Fahrenheit.

Modern methods of measuring and recording temperatures began around 1860. Most analyses of the data show that since that time, a statistically significant increase in temperature has occurred. This trend has accounted for a roughly 1 degree Fahrenheit increase in global temperature, about half what would be predicted on the basis of the concentration of greenhouse gases. A closer look at the data reveals that temperatures were relatively stable between 1860 and 1920, when an upward trend developed which lasted until the late 1940's. A downward trend prevailed until the mid 1970's, when a warming trend continued into the early 1990's.

The question arises as to the place of these trends in historical context. Archeological analyses reveal that the earth's temperature has varied greatly over time. It was about 18 degrees F warmer than at present about 100 million years ago when the dinosaurs roamed the earth. It is estimated that at the other extreme, the earth was more than 10 degrees F cooler than at present during the last ice age, which ended about 10 thousand years ago.

The specter that alarms those who fear global warming is that many climate models that assume a doubling of carbon dioxide emissions over the next 50–100 years forecast a 3–7 degree F increase in global temperature, an increase that is unprecedented in such a short period of time.

Implications of Warming

Most climate models predict that if global warming occurs, it will not produce globally uniform effects. Most places will become warmer, but some will actually cool down. Global precipitation will increase due to increased evaporation from the oceans, but some areas will receive substantially less rainfall than today. It is expected that temperatures will rise more near the poles and less in tropical regions. Nights and winters are expected to warm more than daytime and summer temperatures. Thus in general, warming will tend to occur at the lower ends of current temperature ranges. This has led some to argue that global warming will be generally beneficial to mankind, potentially opening new areas in the upper temperate zones to agricultural enterprises that are not practical today due to the cold climate. Also, increased concentrations of carbon dioxide would have a fertilizing effect on crops and other vegetation, stimulating growth.

Current climatological models indicate that a 3–7 degree F increase in global average temperature would cause a melting of substantial portions of polar ice, which when combined with thermal expansion of the oceans would result in a global sea level rise of between one and three feet. Many low lying coastal areas would be jeopardized, such as the country of Bangladesh, where many of the lands adjacent to the ocean are at or below sea level. In the United States numerous barrier islands, primarily on the Atlantic and Gulf coasts would be adversely influenced. Some coastal marshes and wetlands would be inundated. This might have a mitigating effect on warming, since these types of environments are one of the leading natural sources of methane. However, the loss of these ecosystems would probably have far-reaching consequences, and in any case, marsh like environments might possibly "migrate" inland. Several major urban areas such as New Orleans, Miami, and New York City would also be threatened. Projects built to keep the waters out are feasible, but would come at a substantial expense.

Another consequence of warming would be an increase in the number of tropical cyclones. Currently, an average of ten named storms (which include tropical storms and hurricanes) develop in the Atlantic/Gulf/Caribbean waters off the south/east coasts of the U.S. during hurricane season (June 1–November 30). About half of these actually strike the U.S. coast. Conditions that are required for the development of such systems include warm ocean water (79 degrees F or greater). Global warming would increase the length of the season, and also would expand the area of ocean over which these storms could develop. Since these storms typically produce very large amounts of precipitation after making landfall, they would partially offset tendencies for drought which might otherwise be expected to result from warming in the eastern U.S. While these types of showers would be hit and miss, and therefore not very reliable for unirrigated areas, they could certainly play a role in replenishing aquifers and reservoirs which could be tapped for irrigation. Even with the most severe types of warming forecast, however, the west coast of the U.S. would still remain unaffected by tropical cyclones, since the temperatures of the adjacent Pacific surface would tend to remain well below 79 degrees F.

As for implications for Ohio, most climate models predict substantially warmer winters and slightly hotter summers. Some indicate that summers would also be drier than at present. Thus, agriculture would be faced with a longer and drier growing season. Adaptations might include the introduction of crops (such as cotton) that are not possible given the current climate. The reduction of the number and severity of winter storms would unquestionably benefit farmers, but the increasing likelihood of summer droughts could present a real challenge for agriculture. In contrast with rising sea levels, the levels of the Great Lakes, including Lake Erie, are expected to drop by an average of 7–8 feet, primarily because of reduced rainfall and increased use of irrigation.

Need for Further Study

Numerous questions remain. For example, why has there been only a 1 degree F increase in global temperature, when climate models predict it should have been twice that amount, given current greenhouse gas emissions? What other factors are influencing global climate? Have the oceans been responsible for moderating warming by absorbing excessive greenhouse gases? What is their capacity to absorb still further increases? Do current climate models tend to exaggerate the effects of increased greenhouse gas emissions?

It seems very unlikely at this point that humans will take the types of action necessary to prevent carbon dioxide and methane emissions from increasing enough to cause a predicted increase of global temperatures in the 3–7 degree F range over the next 50–100 years. Even if the high income countries are able, through environmental regulations, to control emissions of carbon dioxide, most developing countries, where living standards present a constant daily struggle, will almost certainly opt to follow paths which will lead to higher emissions. Under this scenario, we should be taking steps to understand better the determinants of global climate change and how we can best cope with the consequences.

Suggested Reading

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