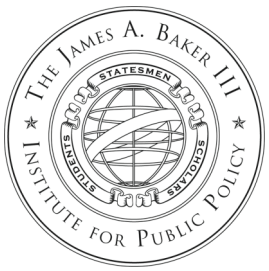

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Frequently Asked Questions: Climate Change

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Sass, whose research interests include wetland sources of biogenic radiatively active atmospheric trace gases, was a co-convener of the International Geosphere-Biosphere Programme focus group on exchange of methane and other trace gases in rice cultivation. He also consulted for the Environmental Protection Agency and advised the United Nations Development Programme's interregional research on methane emission from rice fields in Asia. His work with the Intergovernmental Panel on Climate Change helped establish guidelines and values for national greenhouse gas inventories throughout the world.

Below, he addresses some frequently asked questions about climate change.

Is global climate change really happening?

Yes. Since 1905, global average surface temperatures have increased 1.4° F (0.78° C), with about 1.1° F (0.61° C) of the increase occurring since the mid 1970s. Nine of the 10 warmest years ever recorded occurred during the past decade. The average increase in sea surface temperatures has been about half that of air temperatures.

Rain and snow patterns have also shifted during the past century, with precipitation increasing in eastern parts of North and South America, northern Europe and central Asia and declining in the Mediterranean, parts of Africa and southern Asia. There is good evidence for an increased intensity of tropical cyclonic storms in the North Atlantic.

At the same time, a decrease in the extent of polar ice and snow is evident. Late summer Arctic sea ice is shrinking at the rate of about 8 percent per year and may result in an ice clear summer Arctic Ocean in 20 to 30 years. NASA satellite data shows the melting rate of Greenland's ice sheet has accelerated to about 239 cubic kilometers (57.3 cubic miles) per year. Glacier withdrawal is also taking place in the Alps. The melting ice is contributing to higher sea levels, which have been rising about 1 to 2 centimeters per decade.

Who and what are the real causes of climate change?

Both natural and human factors drive climate change.

The ice ages, which tend to occur in 100,000-year cycles, are one example of climate change occurring independent of humans. Transient natural events, such as volcanic eruptions, and cyclic effects, such as small changes in solar energy, also can cause both positive and negative temporary changes in the surface temperature. Greenhouse gases also are a part of nature.

But there's no doubt that the recent acceleration in climate change is attributable to human factors and an unnatural rise in greenhouse gases. We have seen that the world's climate is changing in part, at least, because of man-made emissions of greenhouse gases, primarily carbon dioxide from fossil fuel — created as we burn coal, oil and other fuels to power our cars, aircraft, electricity and industry.

Carbon dioxide and other byproducts of human activities (e.g. deforestation, agricultural gases from rice fields and cows), as well as industrial nitrous oxide and chlorofluorocarbons, added significant concentrations of greenhouse gases to the atmosphere. By 1990, more than 7 billion tons of carbon (equivalent to 26 tons of carbon dioxide) were being emitted into the atmosphere every year. Similar to the action of the naturally existing greenhouse gases, any additional greenhouse gases would lead to an increase in the surface temperature of the globe.

Other man-made changes may be forcing climate change. Increases in near-surface ozone from internal combustion engines and aerosols, such as carbon black, mineral dust and aviation-induced exhaust, are acting to raise the surface temperature. Sulfate aerosols, however, reflect sunlight and thus act to lower the surface temperature. The reduction of ozone in the stratosphere, production of sulfate, biomass burning and land-use changes are all acting to change the surface temperature.

What changes in the future climate might be expected?

The current atmospheric carbon dioxide concentration is about 385 parts per million (ppm). The world will be very fortunate if mitigation efforts can control emissions sufficiently that the 2050 level will not exceed 550 ppm. An atmospheric carbon dioxide concentration of 450 ppm, corresponding to a temperature rise of 1º to 3°C, would result in the worldwide disappearance of mountain glaciers, threatening water supplies to several areas; and some increase in the intensity of storms, forest fires, droughts and flooding.

A concentration of 550 ppm, corresponding to a temperature rise of 2º to 4° C, would lead to failing crop yields in many developing regions; changes in water availability for more than a billion people by 2080; the possible onset of the collapse of the Amazon rainforest; and the possible extinction of many species.

Concentrations beyond 650 ppm, corresponding to a temperature rise of 4° C or more, could result in major declines in crop yields in entire regions; a sea level rise that could threaten major world cities, including New York, Los Angeles, London, Tokyo and Hong Kong; extremely intense natural climate events such as forest fires and hurricanes; and increasing risk of abrupt, large-scale shifts in the climate system that could result in extreme cooling of northern Europe and North America.

What, if anything, can be done about climate change?

Humans have a choice that must be made soon; we will either mitigate the problems of climate change by a massive reduction of greenhouse gas emissions or adapt by changing our lifestyle.

Mitigation is the stabilization of the climate by the removal of some or of all the fossil fuel derived atmospheric carbon dioxide from the energy equation. Adaptation is action taken to cope with increased rainfall, higher temperatures, scarce water and more frequent storms. Adaptation may be needed to tackle present problems or to anticipate changes in the future, aiming to reduce

risk and damage cost-effectively, and perhaps even exploiting potential benefits. Somewhere in the middle of these two alternatives we will find an optimal path.

Some of the ways that we can reduce our emissions of fossil fuel carbon dioxide and mitigate climate change follow.

Immediately implementable strategies with several tangible benefits:

- Increase the efficiency of vehicles and reduce the use of these vehicles.
- Build more energy-efficient buildings and equip them with energy-efficient appliances.

Available technologies with some added costs:

- Increase the efficiency of coal and gas power plants — for example, by combining the production and use of both heat and power.
- Use governmental incentives to improve the efficiency of existing technologies and to develop new clean energy technologies.
- Establish policies such as a carbon tax or carbon cap and trade legislation to reduce and eventually stop the emission of atmospheric carbon dioxide.

Available technologies with some lead time required:

- Develop wind, photovoltaic and geothermal power as well as fuel from biomass and other newer technologies.

Potential technologies with decadal or multi-decadal time lines:

- Develop and construct new and safe nuclear power plants.
- Continue to develop the technology to capture and sequester carbon in order to continue to use fossil fuel until the above-mentioned sources of renewable energy are developed.
- Encourage the development of new and as yet unthought of technologies to provide efficient and environmentally neutral energy sources.

Additional Readings

The most complete scientific source is probably the Intergovernmental Panel on Climate Change. A complete set of links to their publications and instructions for downloading them can be found online at http://www.ipcc.ch/.

Other helpful Web sites are:

National Academy of Science at http://www.nasonline.org
Lawrence Berkeley National Laboratory http://insurance.lbl.gov