

GLOBAL WARMING AND SEA LEVEL RISE

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I. Variations in Climate

Throughout the four billion years of geological history the climate of the world has undergone many changes, long and short, have come and gone, and the seas have invaded the land and in time retreated. Continuous change has been the essence of the planetary tectonic and climatic systems.

Recently we have been able to correlate world climatic change with variations in the luminosity of the sun. The sun's luminosity varies cyclically with sun spot cycles of approximately 11 years, luminosity also varies with the changing distance of the earth from the sun and also according to the angle at which the sun's rays strike the earth (which changes according to the elevation of the sun relative to the tilt of the earth's axis) and as part of the natural evolutionary process of stars, the sun's luminosity has increased over time.

The net effect of the forces which influence the impact of solar energy on the earth and the internal mechanism by which heat from the sun is dispersed around the planet and through its atmosphere and oceans constitute what we call climate. Therefore, we may define climate as the average state of the atmosphere at a point in time.

II. The Problem at Hand

The question that this and other conferences seek to understand is: given the complexity of the natural basis of climate and climatic change, has the intrusion of human activity altered this system in the direction of warming the planet? And, at the same time, has human interaction with global processes increased the variability of climate - a dimension of equal importance as the question of warming.

There is a reasonable consensus among atmospheric scientists that over the last 140 years a warming has taken place. There is less agreement over the two questions noted above, whether or not the variability of climate has increased and whether or not man is primarily responsible for the warming. Thus, at the heart of the problem of current climatic change are crucial questions about our ability to understand the forces determining climatic change.

A similar set of measurement questions surround the associated problem of the level of the oceans. Historically, continental drift (plate tectonics) has changed the size of ocean basins, the land has risen and subsided, the oceans have been affected by the size of the ice caps, etc. so that, what is true of climate is also true of sea level change. We must try to extract the exact state of affairs from conflicting signals about the causes of observed changes.

Everyone should appreciate that our gaining greater understanding of these global processes involving climate and the level of the oceans is of crucial importance. Here we can only hint at the vast economic, political and social significance of any substantive rise in sea level associated with climatic change. A significant portion of the world's population and major cities are at or near tidewater. The investment in ports and port facilities represents a crucial link in world trade. In addition there are specific areas of the world that would be flooded by any significant rise in sea level, e.g., Venice, Bangladesh, and South Florida.

However, before we assume "the sky may fall" we must consider the time horizon over which changes in climate and oceans occur. Let us offer for discussion two scenarios. The first imagines rapid changes in climate and sea level; the second a more gradual, extended set of processes.

Case A

Assume, as a result of human activity, the global mean temperature, which appears to have risen by about 0.5°C centigrade since 1900, continues to rise at an accelerated rate. If this warming trend continues, it will have significant climatic effects.

One effect is on the polar ice caps. The warming would melt the ice caps. Particularly vulnerable is the West Antarctic ice sheet which is

believed to be in unstable equilibrium. If this ice sheet should slide into the ocean and rapidly melt (in a few years), the combination of the retreat of the ice caps and the destruction of the West Antarctic ice sheet will raise sea level and tidal surges to destructive heights.

The rise in sea level would create an economic catastrophe in coastal areas. Ports would be destroyed, urban flooding would take place, there would be a loss of facilities for both commerce and recreation on the shore. These changes would represent extensive capital losses plus losses in employment and they would impose problems in the relocation of human activity.

Another disastrous effect of the warming trend is the "greenhouse" effect which would impinge upon all human activity. In the United States summers in the South, Southwest and Midwest would become hotter. Agriculture would have to move northward as increased heat and desertification cause crop yields to fall. This in turn would reduce agricultural productivity and output. Water resources already in short supply would increase in cost, forcing readjustments in irrigation of agriculture and imposing constraints on urban development. These changes would in turn evoke significant political problems involving the allocation of water resources, the decline in agricultural output, etc. At the same time the agricultural outlook in Central Canada would improve as the growing season was extended in the North.

Case B

This scenario is essentially the same as in Case A but the changes would occur over an extended time horizon. Further, in this case, the changes could be anticipated as society came to understand and, to a small degree, was able to gain control over the forces making for climatic change. A modest rate of rise in sea level would allow for new investment to proceed at a reasonable pace, the retaining of workers and the planned relocation of economic activity. While climatic shifts would create economic and political "winners and losers", if these changes occurred slowly then human society could adjust with a minimum of cost to people and nations.

The implications of these two brief scenarios, the issue suggested for discussion, is how can we gain the time required to adjust to climatic change?

The requirements are:

1. a greater understanding of the forces, including human activity, behind climatic change,
2. a greater understanding of the linkage between climate and sea level,
3. a beginning of strenuous efforts to control on a global basis those human activities which may contribute to the warming of the planet.

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