

■ report on reports

Climate Change 1995

Impacts, Adaptations, and Mitigation

Reviewed by Robert W. Kates

In this, the longest of the three scientific and technical analyses that make up the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report, 119 scientists from 32 countries assess the current state of knowledge about the impacts of human-induced climate change and possible strategies for responding to that change.¹ Until the third assessment is done in 2000, this analysis will be the "source of first consult"—the authoritative scientific consensus on both the impacts of climate change and mitigation strategies. By the same token, the relatively small amount of attention given to adaptation and the belief systems that influence mitigation strategies highlight the need for more work in these areas.

Major Impacts

This volume considers the impacts of the climate change projected by Working Group I² on nine natural ecosystems and ten managed systems (e.g., agriculture and financial services) that provide water, food, fiber, and other goods and services to humans. It summarizes each system's general status and function, its sensitivity to climate change (and other environmental and human-induced changes), its

adaptability to actual or projected climate change, and its overall vulnerability (a function of both sensitivity and adaptability). Some chapters are more comprehensive than others—and the degree of confidence that the authors place in their conclusions also varies somewhat—but the volume's editors have striven to maintain a sense of coherence and comparability throughout.

The volume's overall conclusion is that most natural ecological systems, socioeconomic systems, and human health are sensitive to human-induced climate change of the magnitude and rate envisaged (i.e., a 1° to 3.5°C increase in mean global temperature and a 15 to 95 centimeter rise in sea level by 2100) and that such change will put the most stress on those systems that are already affected by pollution, increasing resource demands, and nonsustainable management practices. The potential impacts are difficult to quantify, however, because regional climate change

projections remain very uncertain and the connections between climate change and system impacts are poorly understood because of the numerous climate- and non-climate related stresses involved.

Most studies have only considered the changes in climate that would result from an (arbitrary) doubling of the con-

centration of carbon dioxide in the atmosphere. They have not examined the interim effects or those that would result from a higher concentration (a possibility that seems likely in the long run). Furthermore, the computer models used to make these projections are better at predicting temperature than precipitation—and even then they vary greatly in their ability to forecast the temperature increase (or decrease) for particular places.

While climate is clearly important to ecosystems—and temperature and precipitation combined do predict the global distribution of vegetation fairly well—ecosystem dynamics continue to surprise us. Adding to this uncertainty are the multiple impacts that humans have on natural systems. For example, higher concentrations of carbon dioxide in the atmosphere lead to global warming through the greenhouse effect, but they also increase plant growth and reduce the water demand of many plant varieties. And while aerosols or the small particulates that cause acid rain may harm particular species, they also cool the Earth by reflecting incoming radiation back into space and may provide nutrients that increase overall biomass.

In the face of such uncertainty (which those who would have us worry less about climate change constantly allude to³), the strength and scientific validity of some of this volume's conclusions are quite impressive. The fact that the various summaries state the degree of confidence (high, medium, or low) that the authors place in their major conclusions is an especially nice touch. Based on such information, for instance, I am convinced that there are four areas in which vulnerability to climate change is significant: forests, coastal zones and small islands, human health, and agriculture. Let the volume's authors speak for themselves on each of these issues:

Forests

As a consequence of possible changes in temperature and water availability under doubled equivalent CO₂-equilibrium conditions, a substantial fraction (a global average of one-third, varying by region from one-seventh to two-thirds) of the existing forested area of the world will undergo major changes in broad vegetation types—with the greatest changes occurring in high latitudes.

Climate change is expected to occur rapidly relative to the speed at which forest species grow, reproduce, and reestablish themselves. For mid-latitude regions, an average global warming of 1–3.5°C over the next 100 years would be equivalent to shifting

isotherms poleward approximately 150–550 km. . . . This compares to past tree species migration rates on the order of 4–200 km per century. Entire forest types may disappear, and new ecosystems may take their places.⁴

Coastal Zones and Small Islands

Climate change clearly will increase the vulnerability of some coastal populations to flooding and erosional land loss. Estimates put about 46 million people per year currently at risk of flooding due to storm surges. . . . In the absence of adaptation measures, a 50-cm rise in sea-level would increase this number to about 92 million; a 1-m sea-level rise would raise it to 118 million. If one incorporates anticipated population growth, the estimates increase substantially.

Studies using this 1-m projection show a particular risk for small islands and deltas. Given the present state of protection systems, estimated land losses range from 0.05% for Uruguay, 1% for Egypt, 6% for the Netherlands, and 17.5% for Bangladesh, up to about 80% for the Majuro Atoll in the Marshall Islands. Large numbers of people are also affected—for example, about 70 million each in China and Bangladesh. Many nations face lost capital value in excess of 10% of GDP.⁵

Human Health

Climate change is likely to have wide-ranging and mostly adverse impacts on human health with significant loss of life.

Direct health effects include increases in (predominantly cardiorespiratory) mortality and illness due to an anticipated increase in the intensity and duration of heat waves. Temperature increases in colder regions should result in fewer cold-related deaths. An increase in extreme weather would cause a higher incidence of death, injury, psychological disorders, and exposure to contaminated water supplies.

Indirect effects of climate change include increases in the potential transmission of vector-borne infectious diseases (e.g., malaria, dengue, yellow fever, and some viral encephalitis) resulting from extensions of the geographical range and season for vector organisms. Projections by models (that entail necessary simplifying assumptions) indicate . . . potential increases in malaria incidence on the order of 50–80 million additional annual cases, relative to an assumed global background total of 500 million cases.⁶

Agriculture

Recent studies support evidence in the 1990 assessment that, on the whole, global agricultural production could be maintained relative to baseline production in the face of climate change. . . .

However, more important than global food production—in terms of the potential for hunger, malnutrition, and famine—is the access to and availability of food for specific local and regional populations. . . At broader regional scales, subtropical and tropical climate areas—home to many of the world's poorest people—show negative consequences more often than temperate areas. People dependent on isolated agricultural systems in semi-arid and arid regions face the greatest risk of increased hunger due to climate change.⁷

Thorough and impressive as these assessments seem to be, they do not completely fulfill the assignment that the United Nations Framework Convention on Climate Change implicitly gave IPCC, namely to identify

a level [of greenhouse gas concentrations] that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.⁸

The situation, then, is potentially dangerous. But how dangerous? My conclusion, at this reading, is that climate change poses no more dangers than the numerous other environmental changes that are already under way and that are likely to escalate rapidly over the next three or four decades. My personal worry beads have to do with bugs (including microbes), coastal areas, floods, forests, and the inevitable surprises that will occur. Moreover, I have an overwhelming sense that the impacts of climate change, though regionally and socially unpredictable at present, will add to the many inequities separating the poorest peoples from everybody else.

Adaptation

As the first volume of the IPCC report indicates, most scientists believe that a modest degree of human-induced climate change is already under way. What impacts this change will have, how fast they will occur, and most importantly, where they will occur are still subject to debate, however. The scientific community has identified some broad patterns (notably that temperatures will increase more at high latitudes and that while there will be more precipitation overall, drought is likely in many places), but much remains uncertain. Even so, this volume clearly shows that the potential impacts of climate change are quite large, particularly for forests, coastal areas, human health, and agriculture. Major climate change will also place additional stress on natural and resource systems that are already under tremendous pressure from human activity.

As environments change, all forms of life adjust, adapt, and evolve in ways that reduce their vulnerability. Humanity responds to environmental changes in both conscious and unconscious ways and can even anticipate those changes in a distinctive fashion. For this reason, the notion of adaptation figures prominently in the second volume's title and section headings, but, alas, it does not play a major role in the content. The volume's subtitle, "Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses," is a misnomer where adaptation is concerned. Of its 728 pages of substantive text (the remaining 150 pages are summaries, background pieces, and appendices), almost two-thirds are devoted to the impacts of climate change, one-third to mitigation strategies, and only 32 pages (less than 4 percent of the total) to adaptation. These 32 pages are spread throughout 18 chapters dealing with impacts on biomes and socioeconomic sectors.

Because IPCC saw overall vulnerability to climate change as a function of both sensitivity and adaptability, it instructed the authors of this volume to assess the impacts of such change and adaptation options

jointly. These authors had a rich tradition of natural and human adaptation studies to draw on. In fact, a technical appendix describes six well-known strategies for adapting to climate change that seem to come from standard studies of natural hazards: reducing susceptibility to impacts by various anticipatory actions; absorbing losses that are acceptable; spreading losses widely among the affected population; modifying activities to reduce sensitivity to change or to take advantage of new opportunities; relocating activities to less vulnerable areas; and restoring an affected system to its original condition.

Why, then, does this exceptional analysis deal so poorly with adaptation? In my view, the answer lies in the biases (some subtle, some blatant) that even good scientists are prone to. These biases can be seen in the emergence of two distinct schools of thought about climate change, namely the "preventionist" and "adaptationist" schools. Preventionists argue that the accumulation of greenhouse gases may have a catastrophic impact on nature and humankind and that action is needed now to drastically reduce the rate of climate change. Adaptationists, on the other hand, argue that the projected changes in climate will be slow enough that both nature and human society can surely adapt to them. In the case of nature, they cite the rapid recovery of ecosystems altered by such factors as fire and volcanic eruptions as well as the resilience of many species in the face of decade- and

century-long climate fluctuations. In the case of humans, they cite the facts that human settlement has occurred in all climates, that the changes in climate people have encountered in the course of migration exceed any of those forecast for the future, and that humans continue to make progress in cultivating desired plants far from their original ranges.

Ironically, both of these views discourage research on adaptation. The preventionists fear that such work will weaken society's willingness to reduce greenhouse gas emissions and thus play into the hands of those who argue that any action is premature. Many adaptationists, on the other hand, see no need to study adaptation in a systematic way because they trust the invisible hand of either natural selection or market forces to bring it about. Many adaptationists are also blind to the often high social costs of adaptation. An added drawback is that both the preventionist and adaptationist views are rooted in studies from the industrialized world and tend to ignore developing countries' inability either to prevent or to adapt to climate change.

Agriculture offers perhaps the best example of the differences among countries in this regard. Many analysts, particularly those from industrialized countries, are optimistic about agriculture's ability to cope with climate change. This confidence stems from the historically observed increases in crop yields, the spread of many crops far beyond their traditional agroecological boundaries, and the inherent flexibility of the international trade system. These analysts point to studies like the state-of-the-art simulation in this volume of the IPCC report that shows how cereal grain production would change by 2060 under 12 different climate change scenarios.⁹ With a moderate degree of adaptation, overall world production would decline less than 3 percent (averaging the results of the three models used for the analysis); with more extensive adaptation, overall production might even increase slightly. However, these broad trends mask sharp differences between developed and developing countries. In all the scenarios examined, climate change leads to substantial net declines in cereal production in the developing world (which are offset by increases in the developed world only when there is extensive adaptation). In all the simulations, world market prices rise at the same time developing countries are forced to import more cereals. As a

result, the number of malnourished people increases in 11 of the scenarios examined. The number of people affected ranges from several hundred million to 2 billion, depending on the particular assumptions made.

This study confirms that adjustment, even by the invisible hand of the market, is not cost free and does not produce the same benefits for everyone. To evaluate the impacts of environmental change, we must consider the full social costs of adjustment, including the secondary effects of the adaptations themselves and the losses suffered by those who are bypassed or marginalized in the process.

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Mitigation

In contrast to its relative silence on adaptation, this volume is upbeat on the prospects for mitigation—that is, reducing emissions of greenhouse gases or creating additional “sinks” for those gases. The authors believe that it is both technologically and economically feasible to substantially reduce harmful emissions and that government policies can induce such reductions. Many of these same policies, they feel, offer the additional benefit of promoting sustainable development.

During the next century, the capital equipment used to produce and distribute energy will be replaced twice over. With the right policies, we could both lower energy costs and reduce greenhouse gas emissions. Such a result might entail a gradual shift from fuels with a high carbon content (such as coal) to fuels with a relatively low carbon content (such as oil and natural gas or biomass fuels that add no net carbon to the atmosphere) and finally to nuclear power or renewable energy sources with no carbon content (such as the sun, wind, and water). With improved technology, we could raise the efficiency with which fossil fuels are converted into electricity from the current 30 percent to 60 percent. In the same vein, the best technologies now available could reduce total energy use 30 percent in the short run and from 50 to 60 percent in the long run.¹⁰ All told, the proper policies, conservation, improvements in efficiency, and a shift to low- or no-carbon energy sources could reduce annual carbon dioxide emissions one-third by 2050 and two-thirds by 2100. Ten to 20 years' worth of our current carbon emissions could either be prevented or sequestered in various forests, rangelands, or croplands. In this way, we could put off the doubling of car-

bon dioxide levels—the de facto standard for assessing impacts—for another century!

While the section on mitigation is persuasive as to the technological potential to reduce emissions, it is less convincing on the actions required to implement this technology. According to the report, implementation

depends on successful research and development, the existence of the right market and institutional conditions, and timely market penetration, as well as the adoption of new technologies and practices by firms and individuals. Government policies are an important element in the creation of appropriate market conditions and incentive structures.¹¹

In one sense, the developed countries have been reducing their dependence on fossil fuels for a long time. In these countries, for instance, the amount of carbon emitted per unit of gross domestic product has been dropping an average of 1.3 percent per year for more than 100 years. At the same time, however, the economies of these countries have grown an average of 3 percent per year—thereby raising carbon emissions 1.7 percent per year.¹² Clearly, business as usual cannot change the current emissions trajectory or achieve the “safe” level of greenhouse gas emissions envisioned by the United Nations Framework Convention on Climate Change.

What can? The willingness to make the heroic efforts required to reverse this trajectory and to implement the many technological possibilities will ultimately depend on the behaviors, attitudes, belief systems, and ideologies of the world’s peoples. Unfortunately, these matters warrant scarcely a word in this report.

There is, however, a growing body of data regarding attitudes and belief systems. For example, in a recent survey of 1,200 registered voters in the United States, 34 percent of the respondents said that the threat of climate change was “very serious,” while 37 percent called it “somewhat serious.” Only 49 percent thought the United States should sign an international protocol to reduce emissions, however. Forty-one percent opposed such action when given contrasting statements such as that the United States “as the source of the largest percentage of these emissions, should be a leader in this area and sign this agreement” and “that the agreement could hurt the U.S. economy by reducing our ability to compete with some nations that would not have the same restrictions.”¹³

The gap between U.S. decarbonization and emissions rates will not change substantially until the public bridges the gap between what they view as dangerous and what they are willing to do about it. For this reason, the forthcoming assessment in the year 2000 will need to address ideology as well as technology.

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NOTES

1. R. T. Watson, M. C. Zinyowera, and R. H. Moss, eds., *Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change—Scientific-Technical Analyses*, Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 1996).

2. J. T. Houghton et al., eds., *Climate Change 1995: The Science of Climate Change*, Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 1996).

3. See Rep. G. E. Brown Jr., “Environmental Science under Siege in the U.S. Congress,” *Environment*, March 1997, 12; and the commentaries by Patrick J. Michaels and S. Fred Singer in the May 1997 issue of *Environment*.

4. See Watson et al., note 1 above, page 26.

5. Ibid., page 36.

6. Ibid., pages 11–12.

7. Ibid., page 33.

8. Ibid., page 3.

9. Ibid., pages 451–52. The different scenarios are based on two different levels of adaptation (moderate and extensive) as well as the presence or absence of carbon dioxide enrichment (which increases crop growth).

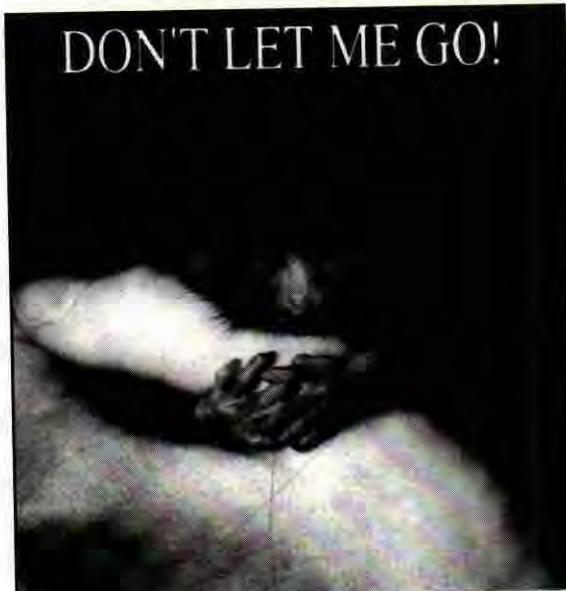
10. Ibid., page 41.

11. Ibid., page 90.

12. Ibid., page 85.

13. Bureau of National Affairs, “Environment Poll Demonstrates Public Concern about Climate Change, Support for Treaty,” press release (Washington, D.C., December 1996). For more on the formation of environmental attitudes, see the article by Willett Kempton on page 12 of this issue.

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