National Security Implications of Climate Change

Hearing of

The Permanent Select Committee on Intelligence and the House Select Committee on Energy Independence and Global Warming

By

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Mr. Chairman, members of the Committees, thank you for the opportunity to appear before you today to discuss the issues of climate change and national security. I am Lee Lane, a Resident Fellow at the American Enterprise Institute. AEI is a non-partisan, non-profit organization conducting research and education on public policy issues. AEI does not adopt organizational positions on the issues that it studies, and the views that I express here are my own, not those of the organization.

The committees are to be commended for addressing the issues covered in this morning's hearing. They are clearly of great significance. I regard climate change as one of the most difficult issues facing the world and have worked for the last eight years on developing economically efficient solutions to it. All of us, I think, are concerned with America's security and that of its citizens. So the committees have certainly focused on matters of prime importance to the American people.

Summary

My remarks address three points:

First, climate change poses a serious long-term problem for the U.S. and the world. However, viewing it through the prism of national security may not provide the clearest and most useful perspective from which to think about the difficult trade-offs that it presents. Some have worried that by worsening environmental and resource problems in very poor nations, climate change may pose a risk to U.S. national security. Ecological problems in poor countries are, in fact, troubling for many reasons, but within the next twenty years or so, expected global warming is likely to have only a modest effect on them. Moreover, as many distinguished economists have pointed out, in the near term, efforts targeted at directly alleviating the underlying environmental and poverty problems are likely to be far more cost-effective in reducing problems than attempts to reduce greenhouse gases (GHGs) will be.

Second, from whatever perspective climate policy is viewed, it entails trade-offs. Achieving a balanced policy requires careful consideration of the costs of mitigation as well as its benefits. Greenhouse gas output must be curbed, but hasty, unilateral cuts will impose significant burdens on the American economy. If China and India do not join the effort to curtail emissions, it will yield little environmental benefit. And attempts to use trade sanctions to coerce China, India, and other nations on GHG limits will surely add to international conflict, not alleviate it. Finally, some of the technologies suggested as possible solutions to climate change, themselves, prompt concerns. A large expansion of nuclear power would fuel proliferation worries, and by expanding bio-fuels we may squeeze global food supply. Trade-offs are unavoidable.

Third, new technology is the key to success. Halting climate change requires a zero net emission global economy. Today's technologies are not close to being able to meet this goal at reasonable costs, nor will incremental improvements suffice. But devising transformational technologies and diffusing them globally could easily consume the remainder of this century. As time goes on, the risk grows that high-impact abrupt climate change might appear. It would, therefore, be prudent for government to explore the various novel technologies that many scientists believe might produce significant global cooling in a high-GHG world. At this point, these technologies remain speculative. But having them available might provide a vital margin of safety during the long transition to an emission-free global economy.

Climate change and security

The long-term concern

As a humanitarian and economic problem, climate change deserves serious attention. The harmful effects of climate change will be hit hardest in tropical Third World nations. There, climate change may add to water shortages or degrade quality. They may erode agricultural, forest, or marine productivity. Higher sea levels may restrict the supply of arable land. Higher temperatures may expand the range of tropical diseases.

As political scientist Thomas Homer-Dixon has observed, environmental pressures may prompt immigration or intensify social conflicts. They may worsen international tensions. Ultimately, legal order may collapse within states. Or ecological stress might trigger what Michael Klare has referred to as 'resource wars' over water, oil, land, or other sources of wealth. In principle, by aggravating the existing strains on resources, climate change may add to the levels of strife.

Gradual climate change and national security

Nonetheless, during the next twenty years, climate change is likely to stay of only secondary importance. Climate changes more slowly than do most of the other factors affecting national security. If we think of the next twenty years as the planning horizon for national security, the warming projected by the IPCC seems, in comparison with likely changes in economics and politics, relatively modest.

A backward look may illustrate the point. Compare today's political, economic, and technological environments with those of 1988. The changes are dramatic. To be sure, climate, too, has changed, but by comparison with, say, the fall of the Soviet Union or the rise of China, that change is marginal. Warming may well accelerate slightly during the next two decades. Even if it does, though, its pace will still lag far behind that of other major factors. Homer-Dixon, for example, sees climate change as posing a major threat only after the midpoint of this century or even later. In many poor countries, populations are growing, land is eroding, and water is becoming scarcer much more rapidly than the Earth's temperature is rising. <u>And even if climate change were somehow halted, unless the direct sources of environmental stress are alleviated, the problems will go on worsening</u>.

Other factors also complicate efforts to view global warming as a national security threat. For most national security purposes, global mean temperatures matter little. What do matter are regional and local conditions. Yet, the climate models are much less accurate in predicting regional results than they are in predicting global means. Then too, inter-decadal variations in the climate system can easily frustrate attempts to project climate over shorter periods of time. Finally, environmental stress may be less important as a security threat than is sometimes assumed. As a source of international conflict, factors like government corruption or ineffectiveness may be more important than ecological ones. To select a case from the current headlines, there is really no point in trying to boost social order in Zimbabwe by limiting greenhouse gas emissions.

Policy implications

Climate change, of the kind we are discussing here, is potentially troubling primarily because it interacts with other environmental problems in parts of the Third World. These problems already exist. In principle, the rich countries could intervene to ameliorate them. Nobel laureate economist Thomas Schelling has often observed that these interventions would alleviate Third World problems more directly, more swiftly, and far more cost-effectively than a policy of reducing global GHG emissions. It is, for instance, already clear in Schelling's view that economic development is the best single remedy for the ills that climate change may visit on the Third World.

To expand on this point, the latest meeting of the Copenhagen Consensus group identified a series of targeted aid measures that would provide relatively fast and extremely cost-effective relief in many of the nations about which we are worried. These economists suggest that this aid could arrive much more quickly and pay higher dividends in poverty alleviation, and presumably social peace and stability, than emission reductions. If this view is correct, focusing our efforts on climate change would seem to be looking at the problems from the wrong end of the telescope.

Abrupt climate change

The above discussion focuses on gradual and continuous climate change. Faster change cannot, however, be entirely ruled out. In the past, climate has sometimes shifted in the course of a few decades. This has led to at least one effort to identify the national security effects of hypothetical abrupt high impact climate change. The problem with such exercises is that the science is too uncertain to allow for much useful analysis or policy planning. The experience of the 2003 report commissioned by the Pentagon's Office of Net Assessment illustrates the point. In this report, the authors asserted: "Rather than decades or even centuries of gradual warming, recent evidence suggests that a more dire climate scenario may actually be unfolding."

The report proceeded to sketch a series of Dantesque consequences. Of these, perhaps the most startling was that North America and Europe would be plunged into a climatic arid deep freeze. These predictions of imminent doom, however, drew scathing comments from the scientific experts, and the latest IPCC report finds that the consensus of the models is that Europe, far from freezing, is likely to continue warming throughout the 21st Century. It is hard to see how repeating the experience of the 2003 report is going to provide a more useful guide to future policy than emerged from that effort.

Mitigation strategies

Difficulty of global GHG abatement

As Scott Barrett of Johns Hopkins has commented, the task of forging an international agreement to curtail GHG emissions requires costly affirmative efforts by many nations, an especially difficult challenge for the international system. Yet international cooperation is essential for GHG controls to be effective. While the United States is a major source of greenhouse gas emissions, it is not the biggest. China is. China is also the fastest growing source. China, however, flatly refuses to curb emissions in any way that would slow its economic growth. So do other poor, but fast growing, nations.

Emissions from China, India, and similar countries are rising so rapidly that their growth is likely to swamp the effects of whatever America does. Thus, without the active cooperation of the Asian and South American nations, the U.S. and Europe cannot even prevent the continued growth of annual emissions. Yet the fast growing Asian countries have refused to accept the costs of controlling emissions, and at least some economic analysis suggests that they are being economically rational to continue doing so.

Problems raised by attempts to reduce emissions

This impasse has brought some in Congress to the point of considering trade sanctions as part of legislation to control domestic GHG emissions. Such provisions would clamp sanctions on China, India, and other countries that refuse to adopt GHG curbs. Clearly, this step would affect America's relations with the countries it sought to coerce. Whether the resulting conflicts would rise to the level of a national security concern is, I suppose, a matter of judgment. It would certainly put additional strains on the international trade regime. These implications of coercive climate diplomacy are worthy of consideration as part of the larger question.

Similarly, some of the technologies likely to become part of a GHG reduction strategy pose risks of their own. Nuclear power has certainly raised various security concerns. Biofuels now stand accused of worsening the global food crisis. In both cases, attempting to greatly expand the use of these technologies would encounter serious resource constraints. Future technological progress may erase these problems, or at least ease them. That such progress will occur and when is, however, unclear.

My point is not either anti-nuclear or anti-biofuels. I hope that both can play a part in the solution. Many other technologies will also be needed. Both technologies involve some risk. Climate policy is about balancing these risks against those of climate change whether or not we call the risks matters of national security.

The need for new technology

Without new technologies that lower the costs of cutting emissions, it seems hard to believe that a global consensus on reducing emissions is likely to form. Fortunately, the long run outlook for new technology is fairly bright. Past funding for research in sciences that are potentially relevant to greenhouse gas reductions may mean that many new discoveries are already, "in the pipeline." And analysis done for the U.S. Department of Energy has shown that speculative, but plausible, progress on some key technologies could reduce the costs of stabilizing greenhouse gas concentrations by, literally, trillions of dollars.

A closer look, though, also suggests caution and patience. The technological solutions to climbing levels of greenhouse gases may be slower than we would hope and less than perfect when they arrive. It is worth examining four important reasons for believing that patience will be required.

First, solutions will require new scientific knowledge, not just new gadgets. The widely cited Hoffert *et al* 2002 *Science* article, observed that existing technologies and the expected extensions of them were wholly inadequate to the task of stabilizing greenhouse gas concentrations. The article also argued that nothing less than multiple large breakthroughs in basic science could create the revolutionary new technologies that were needed. However, *ex ante*, the outcome of R&D is notoriously uncertain. Will the progress envisioned by Edmonds materialize? If it does, when? There is far more doubt than would be the case were we considering the simple extension of existing technologies.

Second, a long lag often occurs between the discovery of new scientific knowledge and its first use in new processes or products. Another lag is common before the latter succeed in an engineering and economic sense. And the perfected innovation may take a long while to diffuse through the economy. Economist Nathan Rosenberg has explained very clearly why the process is so time consuming, but the upshot is that the full economic payoff of discoveries in basic science is often realized only after several decades.

Third, in the case of climate, the lags are likely to be especially long because the innovations must diffuse across most of the globe. Innovations made in America or Japan may not fit market and institutional conditions in China and India until they have been adapted to local conditions. Those conditions may differ widely from those prevailing where the invention originated. In climate technology, therefore, we might expect the diffusion process to be unusually long. An approach like carbon capture and storage, the use of which depends completely on government policy, may have an especially hard time in countries like China and India, where governments are most unlikely to foster it.

Fourth, at this point, we do not know what technologies are likely to meet the need. It may be space-based solar power. It may be nuclear with fuel recycling. It may be microbes that produce fuel. Or, to cite Jae Edmonds again, it may be something of which we cannot conceive until a future breakthrough in basic science opens our eyes to its possibility. One implication is that the problem here is quite different from that involved in the Apollo or Manhattan Projects. There, the scientists had a relatively clear concept of what they were looking for. Here, our vision of the goal is much cloudier.

However, many of the innovations needed to solve the climate problem depend on new discoveries in basic science. The economic rewards of such discoveries, although they can be very large for society as a whole, are notoriously difficult to capture for the organization that makes the discovery. As a result, a large gap develops between the level of private R&D investments and the level that would be optimal for society as a whole. Patents, tax credits, and subsidies are designed to remedy the resulting R&D shortfall, but apparently they are only partly successful. The gap between actual R&D investment and the optimal level appears to be large. In the U.S., for example, R&D investment is, according to some estimates, only about a quarter of the optimal level.

A possible additional approach

These considerations suggest that the technological means of low cost GHG emission cuts could be long in coming. As time goes on, the risk grows that high-impact abrupt climate change might appear—although the size of that risk remains highly uncertain. However, another family of technologies might provide an added margin of safety during the transition. The idea behind them is simple. When sunlight strikes the Earth's surface, greenhouse gases in the atmosphere trap some of the heat that is generated. A slight decrease in the amount of sunlight reaching the Earth's surface could, in principle, offset the warming. Scientists estimate that deflecting into space only 2 percent of the total sunlight that strikes the Earth would be enough to cancel out the warming effect of doubling the pre-industrial levels of greenhouse gases.

Scattering this amount of sunlight may be relatively easy. Past volcanic eruptions have shown that injecting relatively small volumes of matter into the upper atmosphere can scatter enough sunlight back into space to cause discernable cooling. The 1991 eruption of Mt. Pinatubo reduced global mean temperature by about .5 degree Celsius. These temperature reductions were apparent in just a few months and persisted for about three years.

Some scientists propose, therefore, to use modern technology to create a carefully engineered analogue to this effect. Proposals to seriously study geoengineering are gaining adherents among climate policy experts. In late 2006, NASA and the Carnegie Institution jointly sponsored a high level expert workshop on the subject. The workshop report observed that such distinguished scientists as Ralph Cicerone, Paul Crutzen, and Tom Wigley, have suggested further study, and it noted, "Prominent economists such as William Nordhaus and Thomas Schelling have long argued that the concept warranted further exploration as well."

I have included as Attachment A the Executive Summary of the NASA workshop. The promising although untried state of geoengineering strongly suggests that the federal government should do the R&D needed to explore this concept. Big questions persist, and experts continue to differ on the balance between the possible benefits and risks. Only research can resolve the outstanding uncertainties. In light of the long delays that may occur before significant progress on mitigation, an R&D investment in geoengineering seems prudent.

ATTACHMENT A

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Workshop Report on Managing Solar Radiation

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Executive Summary

In November of 2006 the NASA Ames Research Center and the Carnegie Institution of Washington, Department of Global Ecology at Stanford University sponsored an expert workshop on the use of solar radiation management as a strategy for coping with the challenge of climate change.

The basic concept of managing Earth's radiation budget is to reduce the amount of incoming solar radiation absorbed by the Earth so as to counterbalance the heating of the Earth that would otherwise result from the accumulation of greenhouse gases.

The workshop did not seek to decide whether or under what circumstances solar radiation management should be deployed or which strategies or technologies might be best, if it were deployed. Rather, the workshop focused on defining what kinds of information might be most valuable in allowing policy makers more knowledgeably to address the various options for solar radiation management. The report concludes with an appendix that describes important environmental science, engineering, and policy research issues.

Solar radiation management concepts

The volcanic eruptions of El Chichón and Pinatubo injected enough sulfate aerosol into the stratosphere to decrease temperatures in the Northern Hemisphere for 1 to 3 years by several tenths of a degree Celsius. Repeating the aerosol injections and optimizing them for cooling could amplify the impacts on global temperatures. Further research could assess whether this approach could safely counter the significant increases in temperature that could occur by 2100 if anthropogenic greenhouse gas emissions continue unabated. Research could determine, for example, whether injections of sulfates or other materials into the stratosphere could diminish cooling in the Arctic region, an area of seemingly high vulnerability to climate change.

Workshop participants also considered other approaches to solar radiation management, such as a plan to raise the reflectivity of low altitude marine clouds. Work has begun on designing seagoing hardware capable of producing the upward directed spray of mixed air and seawater intended to increase cloud reflectivity. Another proposed approach was to block some sunlight with an orbiting space sunshade. The inner Lagrange point L1 point is in an orbit with the same one-year period as the Earth, in-line with the sun at a distance where the penumbra shadow covers, and thus cools, the entire planet. A presentation on this concept proposed several approaches for overcoming the various engineering and economic challenges a sunshade presented although those challenges remain daunting.

These concepts have been the subject of some preliminary theoretical analysis, but none have been tested in the field under controlled experimental conditions.

Solar radiation management as climate policy

Research into solar radiation management approaches could develop information related to effectiveness and unintended consequences. Research could proceed in a carefully graduated series of theoretical studies and experiments. If the deployment of such technologies were ever to come under consideration, having generated detailed knowledge about the consequences of each option could be extremely valuable. On the other hand, research may show that solar radiation management strategies would not be feasible for any of a number of reasons.

Although the workshop did not address the issue of the circumstances under which solar radiation management should be deployed, participants' views on this matter appeared to span the gamut including (i) never, (ii) only in the event of an imminent climate catastrophe, (iii) as part of a transition to a low-carbon-emission economy, and (iv) in lieu of strong reductions in greenhouse gas emissions. More importantly, the discussion illuminated important differences in the economic and political implications of solar radiation management depending on whether deployment occurred in the face imminent climate emergency or was implemented preemptively well in advance of crisis conditions. Thus the circumstances under which solar radiation management might be deployed could have major implications for its economic and policy implications.

Possible risks, uncertainties, and objections

One major focus of the workshop was to identify the factors that might militate against research or deployment of solar radiation management technology. Participants noted several such potential objections. These included:

- Solar radiation management systems are unlikely to perfectly reverse all climate consequences of greenhouse gases and could introduce new changes in regional or seasonal climate, so some climate change might be expected even with the deployment of such systems.
- Modeling indicates that if a solar radiation management system were shut down suddenly after prolonged operation the climate system could warm very rapidly.
- Injecting sulfur into the stratosphere would likely diminish spring Northern Hemisphere stratospheric polar ozone levels, although the amount of diminution is currently uncertain and extreme Antarctic-style depletion is unlikely.
- Solar radiation management will neither reverse nor exacerbate non-climate effects of CO_2 including fertilization of the land biosphere and acidification of the ocean.

The workshop scope focused on preliminary characterization of some elements of a possible solar radiation management research program. Research into solar radiation management could have implications for other approaches to addressing climate change and could have various political consequences, both domestically and internationally. These considerations may be important, but were beyond the scope of our workshop.