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Book Review of *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. A Report of the National Assessment Synthesis Team, US Global Change Research Program*

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Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. A Report of the National Assessment Synthesis Team, US Global Change Research Program. Cambridge: Cambridge University Press, 2001. 612 pp. Tables, graphs, photographs, appendixes. \$50.00 paper.

Addressing the potential consequences of climate variability and change can be best summarized in terms of tradeoffs: tradeoffs between short-term and long-term impacts; tradeoffs among sectors and regions; and tradeoffs among national-level versus more regional-level impacts. Evidence of these tradeoffs is presented in this comprehensive report by the National Assessment Synthesis Team (NAST) for the US Global Research Program. Its findings are based on analysis of historical data, model projections, and scientific research. A key assumption in the report is the absence of major interventions to reduce continued growth of greenhouse gas (GHG) emissions.

The report makes three major and somewhat unique contributions to the analysis of climate change impacts. First, it provides a national-scale assessment as well as comprehensive regional analyses. Second, it integrates the need for biophysical and economic analyses to address the potential impacts of climate change, making the case for the clear partnership that must be formed between the natural and social sciences and between private and public sectors. And third, the NAST report articulates and illustrates the nature of the tradeoffs in both spatial and temporal dimensions.

Various policy and measurement issues hinge on regional and national assessments such as quantifying progress toward meeting the Bush Administration's

slower growth trajectory for greenhouse gas emissions, as well as determining the potential winners and losers associated with target incentives and other policies to offset emissions. Although this report does not address mitigation efforts per se, determining the least-cost policy of reducing GHG emissions hinges on a comparison of the expected impacts of the changing climate, both with and without alternative policy intervention. The information on a national scale provides a foundation for further focus on regional and selected sectional analyses, providing decision-makers with a simple and widely-accessible reading of aggregate potential impacts. National-level assessments are often called for in public policy debates and used as a first benchmark for addressing the severity of the problems for different sectors. For example, the report correctly concludes that natural ecosystems, wherever located, appear to be the most vulnerable to the harmful effects of climate change, and major alterations to natural ecosystems due to climate change could possibly have negative consequences for the US economy, which depends in part on the sustained bounty of the nation's lands, waters, and native plant and animal communities. At the national scale, the report also suggests the likelihood of unanticipated changes due to unforeseen biophysical elements as well as economic and political priorities. These elements of uncertainty, and the impacts they can have on lifestyles and economic well-being, have been all too clearly brought home over the last two years.

The regional assessments highlight both important commonalities and differences in the climate-related issues in nine spatially-differentiated regions, including the homelands of Native Americans. The process for determining key regional climate-change issues included a series of workshops to identify possible impacts and potential adaptation strategies, followed up with recommendations for needed research on the feasibility and potential economic implications of these strategies. The report does an excellent job in sizing up and explaining the factors that will lead to different regional impacts, including biophysical features such as dependence on vegetation cover, distribution of plant communities, and variations in heat and moisture indexes, as well as the demographics of the US population and growth trends through the mid-twenty-first century. Regional impacts are treated in a series of separate sections, each highlighting the primary issues for the region as well as observed and probable climate trends. The clarity and consistency of the discussions across all regions makes this section particularly well suited for policy leaders, lay audiences, and as a text in courses on environmental and resource issues. As an inhabitant of the northern Great Plains and Rocky Mountain front, I turned to the regional assessments covering this area and quickly discerned the input from local stakeholders. Many of the central issues, such as invasive species and concerns over the availability of water for agriculture, are ones that the region's

land-grant universities are constantly dealing with as part of their basic research and outreach programs.

The report's second contribution is its clear and prominent message about integration of biophysical and economic and social science disciplines. The composition of the NAST itself reflects this interdisciplinary imperative. But simply asserting the need for integration begs a serious follow-up question: how does one truly integrate biophysical and economic models? Just as biophysical models alone cannot predict the spatial distribution of land use, economic models alone cannot predict the spatial distribution of biophysical change such as climate change. For example, a limitation of using reduced-form economic models is their inability to incorporate the possible effects of CO₂ fertilization on cropland productivity. Agronomic research shows that there is on average a +30 percent yield response of C₃ crops to doubled CO₂ concentrations. Our research into the impacts of climate change in the northern Great Plains shows that without CO₂ fertilization, crop yields could be reduced by up to 50 percent. However, when we use an ecosystem model loosely coupled to an economic land-use model, we are able to account for the positive effects of CO₂ fertilization that largely offset the negative effects of climate change. Thus, without linkages between the biophysical and economic models, predictions of the potential impacts of climate change are significantly biased.

Its third contribution illustrates the quality and, finally, the usefulness of the NAST report. The focus is on tradeoffs, which go by many terms including multiple stresses, likelihood of various impacts, and time-dependent impacts. Included here is the notion that the ultimate impacts of climate change can depend upon the extent to which people and ecosystems can respond or adapt, and the opportunity and cost of doing so. Our research on the impacts of climate change in the northern Great Plains shows the crucial role that adaptation plays in understanding the biophysical effects of external biophysical drivers. Ecosystem models used to simulate the effects of climate change on carbon levels in agricultural soils indicate that there could be significant losses of soil carbon, assuming that land-use patterns are fixed. However, when the ecosystem/biophysical models are coupled with an economic model that predicts land-use changes in response to climate change, the analysis shows that land-use changes could significantly offset, and in some cases reverse, the loss of soil carbon predicted by the ecosystem model alone. Such is the power of using integrated assessments to understand tradeoffs.

This NAST report also affords an excellent introduction to the basics of climate change impacts. Discussions of what is meant by the greenhouse effect as well as the historical data on temperature, CO₂ concentrations, and carbon emissions set the stage for understanding the tools the report employs for its analysis, all of which are explained in non-technical terms.

Finally, in its concluding “Research Pathways” section, the NAST report takes future research needs seriously, offering six concrete research recommendations that include developing better methods for integrating biophysical and economic analysis at the regional and sector level, dealing with uncertainty, improving data sets, and developing baseline indicators and measures of environmental conditions. What we have here is a blueprint for setting up a federally funded research program on climate change analysis.

Climate Change Impacts on the United States does a solid job of explaining and synthesizing the central issues of the climate change debate, information that can be less efficiently found in well over five hundred reports and publications (by my last count). Along with the United Nations Intergovernmental Panel on Climate Change (IPCC) reports, this comprehensive study by the National Assessment Synthesis Team ought to be the takeoff point of any continuing debate on climate change mitigation processes. It should be at the top of the syllabus for interdisciplinary courses dealing with environmental and resource issues affecting our world in the twenty-first century and, perhaps most importantly, a useful guide to those of us who get caught up in the details of a particular region, sector, or discipline and fail to place our research in the context needed for political action to occur. Perhaps the only limitation to this report is its exclusive focus on the United States, a limitation noted by the NAST at the outset. Nevertheless, this report (which can be downloaded from the following web site: <<http://earth.usgcrp.gov/usgcrp/Library/nationalassessment/overview.htm>>) should prove useful for those with a specific geographical interest as well as a more national-scale perspective. In short, this is a required read for the climate change crew. **Susan M. Capalbo**, *Department of Agricultural Economics and Economics, Montana State University*.