Executive Summary

The US Economic Impacts of Climate Change and the Costs of Inaction

A Review and Assessment by
the Center for Integrative Environmental Research (CIER)
at the University of Maryland

October 2007

CIER
Center for Integrative
Environmental Research

UNIVERSITY OF MARYLAND
18 56

Contributors to the Report

Matthias Ruth
Director, Center for Integrative Environmental Research, and Roy F. Weston Chair for Natural Economics

Dana Coelho
Research Associate, Center for Integrative Environmental Research

Daria Karetnikov
Research Assistant, Center for Integrative Environmental Research

We wish to thank Environmental Defense for support of the research presented in this report.

The Center for Integrative Environmental Research (CIER) at the University of Maryland addresses complex environmental challenges through research that explores the dynamic interactions among environmental, economic and social forces and stimulates active dialogue with stakeholders, researchers and decision makers. Researchers and students at CIER, working at local, regional, national and global scales, are developing strategies and tools to guide policy and investment decisions. For additional information, visit www.cier.umd.edu.

For additional information on this report, please contact:
Matthias Ruth at cier@umd.edu

The full report is available for free download at
http://www.cier.umd.edu/climateadaptation/

Introduction

As science continues to bring clarity to present and future global climate change, policymakers are beginning to respond in earnest and propose policies that aim to curb greenhouse gas emissions and help society adapt to the impending impacts triggered by past emissions. Although these policies are gaining momentum, their importance is not fully understood by many, including Congress, the public and the media. All too frequently, inaction is motivated by the perceived high cost of reducing greenhouse gas emissions. The costs of not taking on the challenges posed by climate change are frequently neglected and typically not calculated.

The range of climatic changes anticipated in the United States – from rising sea levels to stronger and more frequent storms and extreme temperature events – will have real impacts on the natural environment as well as human-made infrastructure and their ability to contribute to economic activity and quality of life. These impacts will vary across regions and sectors of the economy, leaving future governments, the private sector and citizens to face the full spectrum of direct and indirect costs accrued from increasing environmental damage and disruption.

This report presents a review of economic studies for the United States and relates them to predicted impacts of climate change. The summary findings are organized by region and identify the key sectors likely to be affected by climate change, the main impacts to be expected, as well as estimates of costs. The report builds on the 2000 Global Change Research Program National Assessment, using additional regional and local studies, as well as new calculations derived from federal, state and industry data sources. From this review and quantification, five key lessons emerge:

1. Economic impacts of climate change will occur throughout the country.
2. Economic impacts will be unevenly distributed across regions and within the economy and society.
3. Negative climate impacts will outweigh benefits for most sectors that provide essential goods and services to society.
4. Climate change impacts will place immense strains on public sector budgets.
5. Secondary effects of climate impacts can include higher prices, reduced income and job losses.

These lessons are supported in much greater detail in the full report. In their totality, the data and information in this report strongly support a call for action to avoid the most severe impacts of climate change, as well as to prepare for and adapt to those impacts that are unavoidable.

Lesson 1

Economic impacts of climate change will occur throughout the country.

The effects of climate change will be felt by the entire nation:

- all sectors of the economy—most notably agriculture, energy, and transportation—will be affected;
- essential infrastructures that afford us reliable services and high standards of living (such as water supply and water treatment) will be impacted; and
- ecosystems, on which quality of life relies (such as forests, rivers, and lakes), will suffer.

In the West and Northwest, climate change is expected to alter precipitation patterns and snow pack, thereby increasing dry fuel loads and the risk of forest fires. Forest fires cost billions of dollars to suppress, and can result in significant loss of property. The Oakland, California fire of 1991 and the fires in San Diego and San Bernardino Counties in 2003 each cost over $2 billion. Every year for the past four years, over 7 million acres of forests in the National Forest System have burned with annual suppression costs of $1.3 billion or more.

The Great Plains and the Midwest will suffer particularly from increased frequency and severity of flooding and drought events, causing billions of dollars in damages to crops and property. For example, the North Dakota Red River floods in 1997 caused $1 billion in agricultural production losses, and the Midwest floods of 1993 inflicted $6-8 billion in damages to farmers alone.

The Northeast and Mid-Atlantic regions will see increased vulnerability to sea level rise and storms. Depending on the category of the event, evacuation costs for the Northeast region may range, for a single event, between $2 and $6.5 billion. Since 1980, there have been 70 natural weather-caused disasters, with damages to coastal infrastructure exceeding $1 billion per event. Taken together, their combined impact surpassed $560 billion in damages.

Decreased precipitation levels in the South and Southwest will strain water resources for agriculture, industry and households. For the agriculturally productive Central Valley in California alone, the estimated economy-wide loss during the driest years is predicted to be around $6 billion per year. Net agricultural income for the San Antonio Texas Edwards Aquifer region is predicted to decline by 16-29% by 2030 and by 30-45% by 2090 because of competing uses for an increasingly scarce resource—water.

The true economic impact of climate change is fraught with "hidden" costs. Besides the replacement value of infrastructure, for example, there are real costs of re-routing traffic, workdays and productivity lost, provision of temporary shelter and supplies, potential relocation and re-training costs, and others. Likewise, the increased levels of uncertainty and risk brought about by climate change impose new costs on the insurance, banking, and investment industries, as well as complicate the planning processes for the agricultural and manufacturing sectors and public works projects.

Since the early 1990s, and especially during the 21st century, significant progress has been made in understanding the impacts of climate change at national, regional, and local scales. These studies, many of which are discussed in the pages that follow, highlight physical processes that influence

transportation, energy and water supply systems, agriculture and forestry, fisheries, tourism, and other important economic sectors. There is, however, a lack of research that quantifies and compares these impacts, and a deficiency in using what is known about climate impacts to guide adaptation actions from the national level down to the local level. Thus, the full economic costs will likely be much higher than what is reported currently.

Lesson 2

Economic impacts will be unevenly distributed across regions and within the economy and society.

Not all regions of the country or sectors of the economy will be equally affected by climate impacts because of differences in climatic, economic and social conditions whose interplay influences coping capacities. For example, in the Northeast, the maple sugar industry—a $31 million industry—is expected to suffer losses of between 15 and 40% ($5-12 million) in annual revenue due to decreased sap flow. The region can also expect a decrease of 10-20% in skiing days, resulting in a loss of $405-810 million per year. In California, an annual loss of $287-902 million is expected from its $4.1 billion dairy industry. The dairy industry is also highly sensitive to temperature changes, since the dairy cows' productivity starts decreasing above 77°F (25°C). Losses are expected to the $3.2 billion California wine industry as well, since grape quality diminishes with higher temperatures. In each case, these may be considered small niche sectors in their respective economies —accounting for less than one-tenth of gross state product—yet they are an essential element of local employment, history, culture and landscape.

Changes in climate conditions may foster the spread of pests and diseases. For example, spruce bark beetle outbreaks in Alaska could cause a 50% loss of harvestable timber, resulting in a $332 million annual loss (less than one-tenth of gross state product). The recent spread of Southern Pine beetle attributable in part to climate change, has affected sawtimber and pulpwood production in Alabama, Louisiana, Mississippi, Tennessee, Kentucky and the Carolinas. On average, annual losses have reached over 1% of gross state product.

It's hard to imagine another natural catastrophe on the scale of Hurricane Katrina. The economic cost estimates from Katrina range upward of $200 billion, or over 1% of US gross domestic product. Yet climate change may already be affecting the strength and length of tropical storms and hurricanes, and is expected to contribute to an increase in hurricane intensity and duration. With 53 percent of the total population in the US close to major bodies of water, people and infrastructure increasingly lie in harm's way.

Not only are sectors and regions impacted differently, climate change will also take its toll, in varied ways, on the nation's population. For example, temperatures are expected to increase across the country, resulting in an increase of extreme heat events. Events like the Chicago heat wave of 1995, which lasted for five days, could become more frequent. This event resulted in an 85% increase in heat-related mortality and an 11% increase in heat-related hospitalizations. Many of the affected were elderly or poor. Similarly, it is projected that by 2100, temperatures in Boston, MA, will be similar to those of today's Richmond, VA or Atlanta, GA. The number of days above 90°F may rise from the current 13 day average to over 30 days per year within the next 25 years. These are clearly trends that significantly affect local populations and will result in individual- and community-level hardship.

Lesson 3

Negative climate impacts will outweigh benefits for most sectors that provide essential goods and services to society.

For some sectors of the economy and some regions, climate change may temporarily be beneficial. For example, Mid-Atlantic States' agricultural yields are likely to benefit from slightly higher temperatures temporarily. However, additional warming and the movement of agricultural areas mean not only economic losses for farms that lose production. They also add costs to farms that benefit from improved growing conditions because cultivation of new crops and changing farming practices may make prior investments in technology obsolete.

More importantly, although the factors that provide temporary gains to some are the same that cause losses to others, overall, everyone suffers from the introduction of new pests and the spread of existing ones, disruption of the hydrological cycle, and the impacts of severe weather events. For example, New York State's agricultural yield may be reduced by as much as 40%, resulting in $1.2 billion in annual damages. Expected water shortages in California's Central Valley are likely to affect the agricultural sector in the area. The economy-wide annual losses generated are expected to be around $6 billion during particularly dry years. Agriculture around the San Antonio Texas Edwards Aquifer region is likely to suffer a similar fate. The regional impact may reach losses of $3.6-6.5 billion by 2030 and $6.75-10.13 billion by 2090.

Even those farms and regions that temporarily benefit from altered environmental conditions (e.g., carbon fertilization and extended growing season) risk economic losses if temperatures exceed those preferred by the crops they currently produce.

Climate change will also trigger increases in energy demand for cooling and will outpace declines in heating requirements. For example, electricity demand in Massachusetts may increase by 40% in 2030 because of climate change alone, most of which will occur in summer months and require significant investment in peak load capacity and energy efficiency measures. Nationwide, the required investment may exceed $300 billion by the middle of this century. Given the long lead times of capacity expansion in the energy sector, little time remains to act on anticipated warming trends.

Lesson 4

Climate change impacts will place immense strains on public sector budgets.

The effects of climate change will likely place immense strains on public budgets, particularly as the cost of infrastructure maintenance and replacement increases. At the same time, economic losses may translate into lost tax revenues. As a result, public officials may need to raise taxes or cut services. For example, climate change is expected to add $5-10 billion to Alaska's infrastructure maintenance budget through 2080, depending on the climate change scenario under consideration, because of major replacement costs and service disruptions generated by climate change effects. Recent estimates indicate that a sea-level rise of nearly 20 inches (50 cm) by 2100 would cause $23-170 billion in damages to coastal property throughout the US. In Hawaii, sea level rise will require upgrades to the drinking and wastewater infrastructures—at a cost that exceeds $1.9 billion over the next 20 years.

In addition, managed ecosystems and the communities they border will require increased resources for their protection. In 2006, $1.5 billion in federal funds was used to protect over 9.3 million acres of forest land and adjacent communities from wildfires. Climate change-induced warming will mean that Washington State, for instance, will face fire-suppression cost increases of over 50% by 2020 and over 100% by 2040, raising the expenses to $93 and $124 million respectively.

Federal insurance programs' funds are strained because of the increasing trends of adverse weather events. From 1980 to 2005, federal insurance agencies paid out more than $76 billion in claims. The overall risk exposure of the National Flood Insurance Program increased four-fold from 1980 to $1 trillion in 2005, and the Federal Crop Insurance Corporation's exposure reached $44 billion.

Planning and public policies that promote adaptation and occur in anticipation of climate change impacts are essential to reduce strain on budgets. For example, building codes and land use planning typically reflect historical experiences. With future climate conditions quite different from the past, many of those codes and standards are becoming obsolete. Yet, because we continue to build on the basis of these standards, infrastructures that are expected to last many decades may be outdated, requiring retrofits and upgrades shortly after they have been built. Thus, investments assumed to be completed will require additional resources far sooner than planned.

Lesson 5

Secondary effects of climate impacts can include higher prices, reduced income and job loss.

The indirect effects of climate change have rarely been quantified, yet they are likely substantial. Such effects may be present in the form of higher prices for products, because the prices of raw materials and energy, transport, insurance and taxes increase. As the costs for doing business increase, competitiveness of individual firms, entire sectors or regions may decline. With this decline may come a loss of employment and overall economic security. As climate change affects jobs and household income in the United States, and as resources are increasingly diverted to help maintain safety and adequate supply of goods and services, national security may be weakened.

For example, a 1988 Midwest drought cost the region over $49 billion—in part because river-borne commercial shipping routes had to be replaced by more expensive railroad transport due to Mississippi River's reduced water levels. The costs of future droughts are likely to extend beyond requirements to meet public and agricultural water needs, with the region's manufacturing sector incurring economic losses as well. Around 60,000 jobs and $3 billion annually depend on the movement of goods within the Great Lakes-St. Lawrence route. Drought could lower water levels in the Great Lakes, requiring additional dredging of sediments at an annual cost of between $85 and $142 million, simply to maintain shipping lanes; and overall decreases in connectivity flow are estimated to cost the manufacturing sector $850 million per year.

Damages from severe hurricanes can span many economic sectors. Hurricane Katrina, for example, damaged not only hundreds of thousands of housing units and other urban infrastructure, but it also affected as many as 2,100 oil platforms and damaged over 15,000 miles of pipelines. Lost revenues due to these damages amounted to nearly $11 billion.

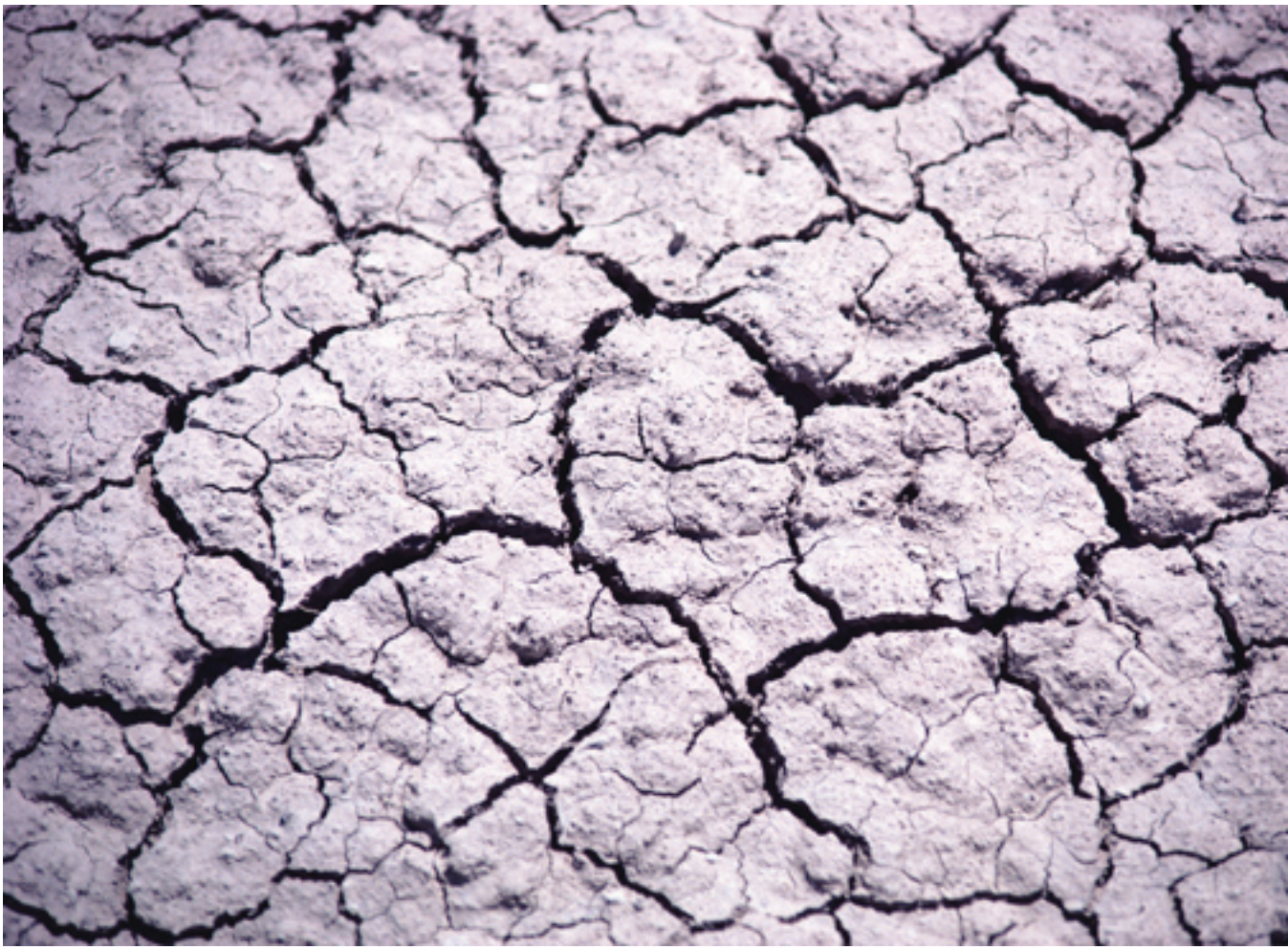
Conclusions and Recommendations

Scientific evidence is mounting that climate change will directly or indirectly affect all economic sectors and regions of the country, though not all equally. Although there may be temporary benefits from a changing climate, the costs of climate change rapidly exceed benefits and place major strains on public sector budgets, personal income and job security. Because of the economic costs of climate change, we conclude that delayed action (or inaction) on global climate change will likely be the most expensive policy option. **A national policy for immediate action to mitigate emissions coupled with efforts to adapt to unavoidable impacts will significantly reduce the overall costs of continued climate change.**

Climate change will pose major challenges for the country as a whole. At the same time, the very nature of climate impacts and adaptation options requires focus on issues at regional and sectoral scales. The number, breadth and sophistication of case studies estimating economic costs of impacts are increasing. Yet, coverage continues to be limited to some of the main sectors of the economy and discrete regions or even single states, with little attention to their interdependencies. Furthermore, most estimates of the economic cost of climate impacts are for direct impacts, and few consider indirect and induced impacts. By virtue of neglecting the adverse economic ripple effects throughout the regional and national economy, many of the direct impacts listed here may be low estimates of total impacts.

The dominant methodology to judge adaptation options is to calculate the benefits associated with incremental expansion of adaptation actions and suggest that an optimum level of adaptation is reached once these benefits are equal to the marginal cost of adaptation. Many of the adaptation studies on which this report is based employ such a marginalist approach. A more adequate methodology would treat adaptation actions as bulky investments in natural, human-made and social capital, with the goal of maintaining or enhancing the services they provide. A methodological approach consistent with that viewpoint will need to rest in portfolio choice theory (i.e., how rational investors will use diversification to optimize their portfolios, and how a risky asset should be priced or valued) and needs to include methods and tools from the theory of investment and finance under risk and uncertainty. Here lies a methodological frontier to be explored in future research.

Because improved understanding of climate impacts, and the costs and benefits of these impacts, is in the national interest, **the federal government should organize and finance a set of region- and sector-specific studies that help guide climate policy and investments, using appropriate methodologies.** A wide range of resources should be brought to bear on the problem—it should be a multi-agency effort that mobilizes universities, research centers and national laboratories. Although Congressional oversight of such studies would be necessary, the intellectual power of the nation's universities and labs should be set free to do cutting-edge, original research and help to inform policy and investment decision making while we can still avoid the high cost of inaction.



Center for Integrative Environmental Research
University of Maryland
2101 Van Munching Hall
College Park, Maryland 20742
email: cier@umd.edu
www.cier.umd.edu