An Overview of Potential Economic Costs to New Mexico of a Business-As-Usual Approach to Climate Change

A Report from
The Program on Climate Economics,
Climate Leadership Initiative,
Institute for a Sustainable Environment,
University of Oregon

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February 17, 2009

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The Program on Climate Economics of the Climate Leadership Initiative (CLI), Institute for a Sustainable Environment, at the University of Oregon, sponsors research on the potential economic consequences and benefits of climate mitigation, preparation and economic development policies. This report is part of that effort. It calculates some of the potential costs that families, businesses, and communities in New Mexico might expect in the next several decades if New Mexico, the U.S., and countries around the world were to continue their activities in a business-as-usual manner, i.e. without effective steps to reign in greenhouse gas emissions (GHGs) or to prepare for and adapt to changes in climate that past and future emissions of GHG will bring about.

The work of the CLI Program on Climate Economics is supported by a steering committee of academic and private economists from across the West and nation. Steering committee members provide overall guidance for the program, may be contracted to produce or contribute to economic assessments, and, serve as peer reviewers. Current members of the Steering Committee are:

This report was prepared by Ernie Niemi, a CLI Fellow and member of the Program on Climate Economics' Steering Committee, along with Mark Buckley, Cleo Neculae, and Sarah Reich of ECONorthwest. We gratefully acknowledge the assistance of Katie Baird, Randall Bluffstone, Gardner Brown, Janie Chermak, Bonnie Colby, Bob Doppelt, Peter Dorman, Kristine Grimsrud, Joel Hamilton, Hart Hodges, Andrew Plantinga, and Michael Scott, for their comments on an earlier version of our manuscript. The assistance from others notwithstanding, ECONorthwest is solely responsible for this report and its content.

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I. INTRODUCTION AND SUMMARY

Extensive research shows that New Mexico and other western states already have experienced noticeable changes in climate and predicts that more change will occur in the future.[1] Much of this change is having and will continue to have negative economic consequences. Some negative effects are readily recognized: warmer stream temperatures during summer stressing fish populations, prolonged drought destroying farmers' crops, and rapidly growing insect populations attacking trees. In response, families, businesses, and communities are considering actions that would reduce the emissions of carbon dioxide and other greenhouse gases (GHGs) that contribute to climate change. Amid all this activity, many have concluded that such actions should not be undertaken because their costs are too great. They reach this conclusion, however, without first seeing what the costs would be of not taking these actions and allowing climate change to continue unabated.

Until now, attempts to describe the costs of climate change have produced results that are too abstract to matter to most citizens. Some have estimated the global costs, but what does this mean to an average family in New Mexico? Others have looked at the costs that will materialize over the next several centuries, but what does that mean to people making decisions today? A few have attempted to describe the net costs of taking this or that action, but undermined their efforts by focusing mostly on describing the action and not providing a full, easily understandable description of the consequences of not taking it.

This report is a first step toward filling the gap. It illustrates some of the potential costs New Mexico's families, businesses, and communities might incur over the next several decades if New Mexico, other states, the U.S., and other countries were to extend a business-as-usual approach to climate change. Under this approach, we assume behaviors do not change and the emissions of carbon dioxide and other greenhouse gases would continue to grow at rates similar to those seen during recent years, leading to increases in global temperature such as those depicted in the high-emission scenarios described by the U.S. Climate Science Program, the Intergovernmental Panel on Climate Change (IPCC), and others.

We take this approach with full recognition that it does not address all the potentially important effects of climate change on New Mexico's economy. Moderate warming might have some positive economic effects for some New Mexicans, by boosting the output of some farmers, for example, or allowing some recreational activities to occur earlier in the spring and later in the autumn. Many of the most serious economic consequences of a business-as-usual approach to climate change will occur elsewhere, or beyond the next several

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[1] *See*, for example, the assessments of climate science and other reports prepared by the U.S. Climate Science Program: http://www.climatescience.gov/, and the reports of the Intergovernmental Panel on Climate Change: http://www.ipcc.ch/

decades, but still are important to today's New Mexicans. As New Mexicans become more familiar with the prospect of changes in climate they likely will take actions to mitigate the harm. All these concerns must be considered to have a complete picture of how climate change will affect New Mexico's economy. This report provides only one piece of the picture: the potential gross costs that might materialize in this state over the next several decades, if societies here and elsewhere fail to address climate change by proceeding in a business-as-usual manner.

To facilitate better understanding of our findings, we place each potential cost in a setting familiar to today's New Mexicans, assuming that families, businesses, and communities will behave in the future essentially the same as they do today and that future prices relative to budgets will be essentially the same as today's. That is, we assume that families, farms, and businesses will continue to go about their activities in a business-as-usual manner. Families will continue with consumption patterns similar to those of today, businesses will continue to produce products similar to their current ones, and communities will follow current behaviors to organize land-use, transportation, and other activities. In short, we provide an estimate of costs that might materialize if climate change is not reined in, not a forecast of how things will actually unfold.

We anticipate that the information in this report will help families, businesses, and communities better understand the nature of the economic threats that climate change poses over the next several decades. We emphasize, however, that the scope of this report is limited. It illustrates only some of the potential costs that might materialize if New Mexico, other states, the U.S., and other countries were to continue to address climate change in a business-as-usual manner. Insufficient data currently exist, however, for us to account for all the potential costs. Hence, we encourage the reader to bear in mind that New Mexicans face substantial, multi-faceted costs in addition to those we describe here, both during the next several decades and beyond.

In Section II, we present a conceptual framework for describing the potential negative economic effects of climate change. In Sections III and IV, we apply the framework and calculate 19 different types of potential costs. We divide these costs into two broad categories: the costs produced by the effects of climate change, and the costs generated by some of the business-as-usual activities that contribute to climate change. In Section V, we discuss the potential implications for New Mexico's households.

The 19 costs we describe are already observable. Over time, they will be exacerbated by potential changes in temperature, precipitation and other climate characteristics, or by climate-related changes in the state's ecosystems. The extent of the anticipated climate change is closely related to increases in the atmospheric concentration of carbon dioxide, which was about 260 to 280 parts per million (ppm) before the Industrial Revolution and has risen to about 385 ppm today. Under our business-as-usual assumptions, the concentration would rise to about 400 ppm by 2020, 500 ppm by 2040, and 800 ppm by 2080.[2] At these concentrations, climate modeling indicates that average global surface temperature could rise by more than 5°C (9°F) above pre-industrial levels by the end of this century (during the past century, the temperature rose 0.74°C (1.33°F), mostly in the past three decades).

Economic costs would arise from undesirable changes in climate, ecosystems, or both. Higher temperatures would increase the incidence of heat-related health problems, for example, and ecosystem changes would reduce summertime stream flows. These and similar changes would impose economic costs on New Mexico's families, businesses, and communities. In addition, New Mexicans would incur costs as they engage in practices that contribute to climate change, such as consuming electricity generated by burning coal and continuing with technologies and practices that waste energy. For each type of cost, we describe the mechanism that produces it, as well as the assumptions, data, and steps we take to calculate it.

Figure 1 summarizes our findings, aggregating the 19 different costs into 10 categories. By 2020, these costs total $3.2 billion per year. The major components of climate-change costs are potential increases in wildland fire costs, with a value of $490 million per year, potential health-related costs of about $421 million per year, and recreation costs of about $286 million. In addition, continuing with the activities that contribute to climate change potentially would cost New Mexicans almost $1.3 billion per year in missed opportunities to implement energy-efficiency programs and about $275 million per year in health costs from burning coal. The combined total annual costs increase with time, to almost six-fold by 2080.

If spread evenly, New Mexico's households, on average, could incur annual costs of $3,430 per year by 2020. Of this amount, $1,650 relate to expenditures on energy, $740 relate to health-related costs, and $520 relate to wildland fire costs. These costs are not negligible. The 2020 average of $3,430 represents more than 8 percent of the current median household income in New Mexico. Analogously, the potential costs in 2040 represent more than 13 percent of median household income and those in 2080 more than 29 percent of the income that half of the households in New Mexico earn in a year.

We recognize that families, businesses, and communities in New Mexico may be able to offset or mitigate some of the potential costs in the near term by taking advantage of the potential economic benefits of climate change, such as increased production of some crops or reduced expenditures on heating, that might

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[2] These increases correspond to the A1FI scenario used by the Intergovernmental Panel on Climate Change (IPCC). The IPCC applies the label, business as usual, to another scenario, A2, but, since its development, it has understated the actual, business-as-usual emissions of greenhouse gases. Hence, we use the A1FI scenario, which we believe more closely represents the trajectory of emissions in a business-as-usual world. *See*, IPCC. 2007. *Fourth Assessment Report.* Retrieved January 22, 2009, from http://www.ipcc.ch/.

Figure 1. Potential Economic Costs in New Mexico Under a Business-as-Usual Approach to Climate Change, 2020, 2040, and 2080 (dollars per year)

Potential Cost	2020	2040	2080
Costs of Climate Change			
Increased Energy-Related Costs	$248 million	$647 million	$2.6 billion
Reduced Trout Populations	$38 million	$46 million	$61 million
Increased Flood and Storm Damage	$88 million	$181 million	$435 million
Reduced Food and Agricultural Production	$73 million	$129 million	$382 million
Increased Wildland Fire Costs	$488 million	$1.0 billion	$2.2 billion
Increased Health-Related Costs	$421 million	$759 million	$1.6 billion
Lost Recreation Opportunities	$286 million	$563 million	$812 million
Reduced Streamflows	$8 million	$11 million	$21 million
Subtotal for Costs of Climate Change	*$1.7 billion*	*$3.4 billion*	*$8.2 billion*
Additional Costs from Business-as-Usual (BAU) Activities that Contribute to Climate Change			
Inefficient Consumption of Energy	$1.3 billion	$2.4 billion	$8.3 billion
Increased Health Costs from Coal-Fired Emissions	$275 million	$527 million	$1.9 billion
Subtotal for Costs from BAU Activities	*$1.5 billion*	*$2.9 billion*	*$10.2 billion*
TOTAL	**$3.2 billion**	**$6.3 billion**	**$18.4 billion**
Average Cost per Household per Year	$3,430	$5,410	$12,000

Source: ECONorthwest.

Notes: These numbers illustrate different types of annual costs New Mexicans potentially would incur if society were to continue with a business-as-usual approach to climate change. There may be overlap between the values for some of the different types of costs. Nonetheless, adding the different types of costs probably seriously understates the total potential cost of climate change because the table excludes many additional types of climate-related costs that New Mexicans would incur under a business-as-usual approach. The numbers do not indicate the net effect of climate change, as they do not represent a forecast of how the economy will respond to the different effects of climate change, or account for potential economic benefits that might materialize from moderate warming and other changes in climate.

accompany moderate climate warming. Our aim, however, is not to describe this potential adjustment but to describe the potential consequences if such adjustments are not realized. Further investigation is required to determine the extent of these opportunities, but current evidence suggests they will not fully offset the costs likely to materialize with large increases in atmospheric concentrations of GHGs.

Similarly, we recognize that there may be some overlap among our cost estimates and, hence, double counting when they are summed. We're confident, however, that the potential costs that are not included in the calculations more than offset the double-counts, if any, and that the total potential costs of a business-as-usual approach to climate change are larger—perhaps far larger—than the amounts shown in Figure 1.

Figure 2. Some Potential Economic Costs in New Mexico Not Incorporated in this Report

Potential Unquantified Cost
Increased cooling costs for commercial and industrial businesses
Increased costs for air conditioning and refrigeration in transportation
Increased costs to cope with greater variability in weather conditions
Increased pumping costs to replace surface water with groundwater for irrigation
Increased regulatory costs for protecting additional threatened and endangered species
Increased management costs for controlling invasive species
Increased costs associated with flood and wind damage from more frequent and intense storms
Reduced value of certain crops, such as tree fruits and nursery stock
Increased costs associated with agricultural pests and diseases related to climate change
Increased costs associated with fish and wildlife diseases related to climate change
Reduced value of certain crops due to water stress
Increased costs for families and businesses that move in response to climate change
Reduced productivity of rangelands
Increased health care costs related to expanded range of tropical and sub-tropical diseases
Increased health care costs related to increased incidence of water- and food-borne diseases
Reduced recreation opportunities due to increased wildland fires
Reduced boating and other recreation opportunities due to decreased streamflows
Increased costs to bring warmer streams into compliance with water-quality standards
Increased insurance costs for storms, fires, floods, and other effects of climate change

Source: ECONorthwest.

Some of these additional costs likely would materialize inside New Mexico over the next several decades. Figure 2 summarizes some of these additional costs, for which we were unable to find adequate documentation to quantify in this report.

Far greater costs might materialize elsewhere or in future centuries, the result of a business-as-usual approach to climate change over the next few decades. If temperatures rise to the maximum levels predicted under the business-as-usual scenario, billions of people in less-developed countries likely would endure increased thirst and starvation, thousands of species would face extinction, sea levels would rise several meters and vast areas of the oceans could become essentially barren. To the extent that these distant effects matter to today's New Mexicans, the potential costs would be far greater than we indicate.

II. Conceptual Framework

This analysis is concerned with the climate-related economic costs families, businesses, and communities in New Mexico might incur over the next several decades under a business-as-usual approach to climate change. This approach has two major assumptions. One is that New Mexico, other states, the U.S., and other countries will not take effective actions to rein in emissions of greenhouse gases (GHGs) and continue to engage in actions that drive climate change. We use the A1FI scenario described by the Intergovernmental Panel on Climate Change (IPCC) to represent the future evolution of emissions and atmospheric concentrations for GHGs, as it seems to trace most closely the recent trends in emissions.[3]

The other major assumption we make in this analysis is that New Mexico's households, businesses, and communities will continue to engage in behaviors and adopt technologies similar to those of today. This assumption has several strengths. It reflects the social and economic inertia that arises, for example, insofar as there exists a large amount of residential, commercial-industrial, and public capital built with little or no regard for climate change, and modifying or replacing it likely will take considerable time. It also facilitates both the analysis and the communication of our findings. Limited by time and money, we lacked the ability to construct a scenario of how New Mexicans will behave over the next 10, 30, and 70 years that is both more suitable and understandable than the scenario we used, which assumes that absent major effort to rein in climate change, most families, businesses, and communities will try to continue doing tomorrow what they are doing today.

These assumptions yield illustrations of costs that might materialize if business-as-usual activities continue, but fall far short of a worst-case depiction of what the costs of climate change might be. Numerous recent reports of scientific studies, not represented in the most recent assessment of climate prospects by the IPCC from 2007, signal a growing probability that emissions of GHGs and average surface temperatures might rise faster than previously anticipated. Other studies signal a growing probability that, whatever the increase in emissions and temperatures, the effects of climate change will be more severe. Forests will die more rapidly, oceans will become less productive, ice sheets will melt more rapidly, epidemics of disease and pests will spread more quickly, and more. At the same time, meaningful progress on efforts to rein in the global emissions of GHGs has been slow, and many in the state continue to oppose proposals to rein in GHG emissions here or to prepare for climate changes that cannot be avoided.

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[3] A recent analysis by the MIT Joint Program on the Science and Policy of Global Change confirms our choice of using IPCC's A1FI scenario to represent business-as-usual conditions. Its analysis of uncertainties in emissions, the climate-system's sensitivity to emissions, and the economy predicts a high probability of warming at levels that correspond to the likely range of the A1FI scenario. *See* Sokolov, A.P., P.H. Stone, C.E. Forest, R. Prinn, et al. 2009. *Probabilistic Forecast for 21st Century Climate Based on Uncertainties in Emissions (without Policy) and Climate Parameters.* Report No. 169. January.

In the following sections we first provide an overview of climate-related risks, and then describe ways in which climate change might impose economic harm on New Nexico. We then outline the specific steps we have taken to produce the illustrations of specific types of potential economic harm that we present in Sections III and IV.

A. Overview of Climate-Related Risks

Rapidly accelerating emissions of carbon dioxide, methane, and other GHGs since the beginning of the 20th century have increased the average global temperature by about 0.74°C (1.33°F), and altered precipitation patterns.[4] These changes in climate have had and will continue to have negative effects on the well being of current and future generations of humans.[5] These effects are expected to worsen at an increasing rate as atmospheric concentrations of GHGs increase and global temperatures rise even further.[6] Figure 3 illustrates, briefly and incompletely, the potential impacts of each incremental increase in average global temperature.

Based on this evidence, many have concluded that society should aim to rein in emissions of GHGs so the rise in temperature does not exceed 2°C (3.6°F). There is considerable uncertainty underlying such conclusions, however. As we understand the scientific reports, this uncertainty suggests that the economic risks associated with the smaller increases in temperature (and, hence, with the lower levels of emissions of GHGs) are higher than they first appear, insofar as:

- ***Once set in motion, the processes of climate change cannot easily be reversed, if at all.*** Temperatures will continue to rise in response to GHGs already in the atmosphere, and additional GHG emissions will only reinforce the momentum. There may be no corrective actions available to

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[4] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report.* Retrieved January 22, 2009, from http://www.ipcc.ch/

[5] *See*, for example, Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report.* Retrieved January 22, 2009, from http://www.ipcc.ch/. Some believe climate change is important not only for what it does for humans, but for its effects on the environment, apart from people. They suggest economics should consider those values, and there are good arguments for doing so. There similarly are good reasons for considering spiritual and other measures of the value of climate change that lie outside the direct purview of economics. Here, however, we focus on the economic connections between climate change and people. We do so not just to keep our task from becoming intractable but also because this relationship underlies many, if not most, of the motivation for human actions to restrict emissions of greenhouse gases and to prepare for unavoidable changes in climate. We take a broad view, though, of the ways in which climate change might affect the economic dimensions of human standards of living and quality of life.

[6] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report.* Retrieved January 22, 2009, from http://www.ipcc.ch/; Lynas, M. 2008. *Six Degrees: Our Future on a Hotter Planet.* New York: National Geographic Society; Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge, United Kingdom: Cambridge University Press. Retrieved October 30, 2006, from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm

Figure 3. Potential Impacts of Incremental Increases in Average Global Temperature

1°C (1.8°F)	Increased potential for prolonged drought, converting some parts of the American West to sandy deserts, on a scale much larger than the 1930s Dustbowl.
2°C (3.6°F)	Small mountain glaciers will disappear and mountain snowpack diminish, as will stream flows dependent on snow melt. Large areas of the oceans will become too acidic for organisms with calcium carbonate shells, and for many species of plankton, the basis of the marine food chain. Onset of irreversible melting of the Greenland ice sheet would raise sea levels by about seven meters. Heat waves similar to the most extreme in recent history likely would occur every year in many places. About one-third of all species around the globe may be driven to extinction. Increased risk of hunger for many communities, especially in Africa and Asia.
3°C (5.4°F)	An increase of this magnitude could be a tipping point that causes climate change to become uncontrollable. The middle areas of North America likely would become deserts. Extreme weather, such as hurricanes, may become more intense, doubling damage costs in the U.S. Millions, perhaps billions may face famine from extreme drought, flooding, and insect infestations. Perhaps 50 percent of species face extinction.
4°C (7.2°F)	The West Antarctic ice sheet may collapse and raise sea levels another five meters. Crop yields likely would continue to fall in many regions. Significant shortages of water may affect more than a billion people, as some areas may see runoff increase by one-third. Perhaps 50 percent of species face extinction. Conditions typical of the Sahara Desert probably will materialize across southern Europe.
5°C (9.0°F)	Entire regions of the Earth might see major declines in crop production and ecosystems unable to maintain their current form. Forest fires, droughts, flooding, and heat waves will increase in intensity. Increasing probability of abrupt, large-scale shifts in the climate system, e.g., tropical conditions, may materialize in Arctic regions. Rising sea level threatens major coastal cities.
6°C (10.8°F)	The Earth would experience climate conditions associated with a period, about 250 million years ago, that saw perhaps 95 percent of all species go extinct.

Source: ECONorthwest, adapted from Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report.* Retrieved January 22, 2009, from http://www.ipcc.ch/; Lynas, M. 2008. *Six Degrees: Our Future on a Hotter Planet*. New York: National Geographic Society; and Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge, United Kingdom: Cambridge University Press. Retrieved October 30, 2006, from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_ climate_change/stern_review_report.cfm; and

arrest or reverse some of the processes, and their ecological and economic consequences, once they have been triggered.

- ***Some major impacts of climate change are occurring faster than anticipated.*** Sea ice in the Arctic Ocean is melting at rates unforeseen by the Intergovernmental Panel on Climate Change (IPCC) in its integrated assessment of climate-related research through the early part of 2007.[7] The melting of the sea ice means that solar energy that the ice would reflect now will be absorbed by open water, further accelerating increases in temperature. Some ice structures in the Antarctic Peninsula also are

[7] Stroeve, J., M. Holland, W. Meir, T. et al. 2007. "Arctic Sea Ice Decline: Faster than Forecast." *Geophysical Research Letters* 34: L09501. DOI:10.1029/2007GL029703.

melting faster than expected.[8] The global sea level has been rising faster than expected, and recent analyses conclude that during this century it will rise twice as much as the IPCC predicted in 2007.[9] The processes that enable the oceans and other elements of the global ecosystem to remove GHGs from the atmosphere are slowing down faster than anticipated.[10] Trees in the U.S. and Canada are dying at unforeseen rates, so that some forests, rather than increasing their removal of carbon dioxide from the atmosphere, are contributing this greenhouse gas to the atmosphere.[11]

- ***Recent research suggests that, for a given concentration of GHGs in the atmosphere, the temperature will rise higher than previously anticipated.*** The 2007 report of the IPCC, for example, reported that, if carbon dioxide concentrations were to stabilize in the range of 350 to 400 parts per million (ppm), warming likely would stabilize within the range of 2°C to 2.4°C (3.6°F to 4.3°F), but it warned that larger temperature increases might occur.[12] Research not represented in the IPCC report looks more directly at the possibility that temperatures will increase faster than expected. The authors of one recent paper find that, if carbon dioxide concentrations stabilize at 450 ppm (or higher) there is a substantial probability that the increase in temperature will rise to 6°C (10.8°F).[13]
- ***The atmospheric concentration of GHGs has been rising faster than expected.***[14] The acceleration stems from faster than expected burning of fossil fuels for electricity, transportation and other purposes, but also from other contributing factors, such as a slowing in oceanic absorption of carbon dioxide and unexpected releases of methane, a potent GHG,

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[8] Pritchard, H.D. and D.G. Vaughan. 2007. "Widespread Acceleration of Tidewater Glaciers on the Antarctic Peninsula." *Journal of Geophysical Research* 112: F03S29.

[9] Rahmstorf, S., et al. 2007. "Recent Climate Observations Compared to Projections." *Science* 316(5825): 709; and Rohling, E.J., et al. 2008. "High Rates of Sea-Level Rise During the Last Interglacial Period." *Nature Geoscience* 1: 38-42.

[10] Le Quéré, C., et al. 2007. "Saturation of the Southern Ocean CO_2 Sink Due to Recent Climate Change." *Science* 316(5832): 1735-1738.

[11] Van Mantgem, P.J., N.L. Stephenson, J.C. Byrne, et al. 2009. "Widespread Increase of Tree Mortality Rates in the Western United States." *Science* 323:521-524. January 23.; and Kurz, W.A., C.C. Dymond, G. Stinson, G.J. Rampley, et al. 2009. "Mountain Pine Beetle and Forest Carbon Feedback to Climate Change." *Nature* 452:987-990. April 24.

[12] Solomon, S., D. Qin, M. Manning, M. Marquis, et al. (eds.). 2007. *Climate Change 2007: The Physical Science Basis.* Intergovernmental Panel on Climate Change Working Group I. New York: Cambridge University Press. An average global temperature increase of 2°C to 2.4°C (3.6°F to 4.3°F) would mean higher temperature increases over land. Scientists anticipate that the increase in temperatures over land will be larger than the global average increase, perhaps as great as two times larger, because land absorbs more heat than the oceans.

[13] Hansen, J., et al. 2008. "Target Atmospheric CO_2: Where Should Humanity Aim?" Retrieved January 14, 2009, from http://www.columbia.edu/~jeh1/2008/TargetCO2_ 20080407.pdf

[14] Raupach, M.R., et al. 2007. "Global and Regional Drivers of Accelerating CO_2 Emissions." *Proceedings of the National Academy of Sciences* 104(24): 10288-10293.

trapped in soils.[15] Several authorities have warned of the potential consequences. The authors of one study of past changes in climate concluded, for example, that warmer temperatures likely would accelerate the emission of GHGs into the atmosphere, and "promote warming by an extra 15 to 78 percent on a century scale" relative to the projections presented by the IPCC.[16]

- ***Leading researchers are urgently calling for faster and steeper curtailment of GHG emissions to prevent catastrophic damage from climate change.*** The International Energy Agency has observed that, given the recent rapid increases in the burning of fossil fuels, the average global temperature will rise 6°C (10.8°F) unless there is a quick and rigorous change in policy.[17] The head of Britain's Met Office recently warned that, if emissions keep rising, the average temperature could increase by more than 5°C (9°F) by the end of the century.[18] Some scientists conclude that, to sustain climatic and ecological conditions similar to those that have existed during the development of human civilization, society must do more than just arrest growth in the atmospheric concentration of GHGs, it will have to be reduce them below the current level, with the concentration of carbon dioxide falling to no more than 350 ppm within the next several decades.[19]

Not all of these (and many related) impacts would occur immediately. There is considerable uncertainty about how long it would take for some of the impacts to materialize, but some of the most extreme impacts likely would not materialize for decades or centuries. This delay does not, however, mean that the far-distant impacts have no economic relevance today. Decisions now that affect the

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[15] Park, G.-H., K. Lee, and P. Tishchenko. 2008. "Sudden, Considerable Reduction in Recent Uptake of Anthropogenic CO_2 by the East/Japan Sea." *Geophysical Research Letters* 35: L23611, DOI:10.1029/200GL036118.; Le Quéré, C., M. Raupach, P. Ciais, T. Conway, et al. 2008. *Carbon Budget 2007.* Global Carbon Project. Retrieved January 6, 2009, from http://www.globalcarbonproject.org/carbontrends/index.htm; and Canadell, J.G., C. Le Quéré, M.R. Raupach, C. B. Field, et al. 2007. "Contributions to Accelerating Atmospheric CO_2 Growth from Economic Activity, Carbon Intensity, and Efficiency of Natural Sinks." *Proceedings of the National Academy of Science* 104 (47): 18899-18870. DOI: 10.1073/pnas.0702737104. For additional references, *see* http://www.globalcarbonproject.org/carbontrends/index.htm#References.

[16] Scheffer, M., V. Brovkin, and P.M. Cox. 2006. "Positive Feedback between Global Warming and Atmospheric CO_2 Concentration Inferred from Past Climate Change." *Geophysical Research Letters* 33: L10702. DOI: 10.1029/2005GL025044.

[17] International Energy Agency. 2008. *Energy Technology Perspectives: Scenarios and Strategies to 2050, Executive Summary*. Retrieved January 15, 2009, from http://www.iea.org/Textbase/npsum/ETP2008SUM.pdf

[18] Pope, V. 2008. "Met Office Warn of 'Catastrophic Rise' in Temperature." *(London) Times Online.* December 19. Retrieved January 14, 2009, from http://www.timesonline.co.uk/tol/news/environment/article5371682.ece

[19] Hansen, J., et al. 2008. "Target Atmospheric CO_2: Where Should Humanity Aim?" Retrieved January 14, 2009, from http://www.columbia.edu/~jeh1/2008/TargetCO2_ 20080407.pdf

atmospheric concentration of GHGs may set in motion climate-relate processes that lead to irreversible consequences. Moreover, current New Mexico residents may have strong feelings, and thus realize a marked reduction in their economic well-being, knowing that today's decisions might have catastrophic consequences for future generations.

Having recognized the importance of these more distant and extreme effects, we now set them aside, and focus on the task at hand: describing the business-as-usual potential harm of climate change for families, businesses, and communities in New Mexico over the next several decades. In the next section we describe the general mechanisms through which such harm can materialize in this context.

B. Climate Change and the Economy

Figure 4 illustrates some of the potential changes in climate expected over the next two decades. The top two maps depict the average annual temperature (left) and heat waves (right), and the bottom two maps depict the annual average precipitation (left) and extreme precipitation (right) expected by about 2030, relative to conditions in about 1990, under a middle-of-the-road scenario regarding future emissions of GHGs and their impacts. A technical work group of the New Mexico Climate Change Advisory Group identified some of the other effects associated with climate change, including warmer nighttime temperatures, more episodes of extreme heat and cold, and longer frost-free periods.[20] These anticipated changes point toward some of the ways that climate change can impose harm on the western states. The lower left map in Figure 4, for example, shows that the southwestern region can expect reductions—marked reductions in some areas—in precipitation, while some of the northern parts of the region likely will see precipitation increase. Individually and together, these maps indicate the potential for some or all in the region to realize economic harm through any number of mechanisms: increased droughts and floods, higher air-conditioning costs to cope with higher temperatures, higher incidence of morbidity and mortality for those without access to air conditioning, more frequent wildfires, loss of habitat for important species—the list is perhaps without end.[21] Moreover, under a business-as-usual scenario, the physical changes depicted in Figure 4, and thus the resulting economic impacts, would likely be magnified.

To provide some structure for thinking about the different ways in which climate changes can produce economic harm, Figure 5 identifies different types of change that can generate harm and the different ways in which harm might

[20] New Mexico Climate Change Advisory Group, Agency Technical Work Group. 2005. *Potential Effects of Climate Change on New Mexico.* December 30. Retrieved February 16, 2009, from http://www.nmenv.state.nm.us/aqb/cc/Potential_Effects_Climate_Change_NM.pdf

[21] We understand that the results from the temperature models generally are more robust than the results from the precipitation models. Nonetheless, most models generally support the expectations indicated by the lower left map in Figure 4.

materialize. In some cases, the harm can originate directly from a change in climate itself, through changes in temperature, precipitation, or storms and other extreme events. An increase in heat waves, for example, might increase the incidence of heat-related human illness and death,[22] high temperatures plus reduced precipitation might reduce the productivity of crops that wither under drought conditions,[23] and higher flooding from more severe storms might damage property, disrupt commerce, and take lives.[24]

In other cases, climate change indirectly diminishes well-being by inducing changes in ecosystems or social systems. Warmer temperatures have been associated, for example, with ecosystem changes, such as epidemic outbreaks of insects that kill piñon and ponderosa pine trees and reduce the productivity of the timber industry,[25] or contractions of fish habitat that diminish trout populations and eliminate opportunities for recreational fishing.[26] Climate-related changes in social systems that can diminish economic well-being might arise if families and businesses conclude they must move to avoid the effects of climate change, or if the costs of climate change fall disproportionately on poor families and communities, diminishing their prospects for climbing out of poverty.

The bottom of Figure 5 illustrates that climate-related economic harm can occur in several ways. This summary illustrates each mechanism in greater detail:

- ***Reduction in human health and other constituents of quality of life.***

  Hotter temperatures can increase human mortality; reductions in stream flows can reduce boating, fishing, and other recreational opportunities.

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[22] *See*, for example, Kalkstein, L.S. and J.S. Greene. 2007. *An Analysis of Potential Heat-Related Mortality Increases in U.S. Cities under a Business-as-Usual Climate Change Scenario.* Environment America. September 6. Retrieved January 13, 2008, from http://www.environmentamerica.org/ uploads/Js/tF/ JstFE5oHrsQJi5ifIA931Q/Heat-Mortality_Report_.pdf

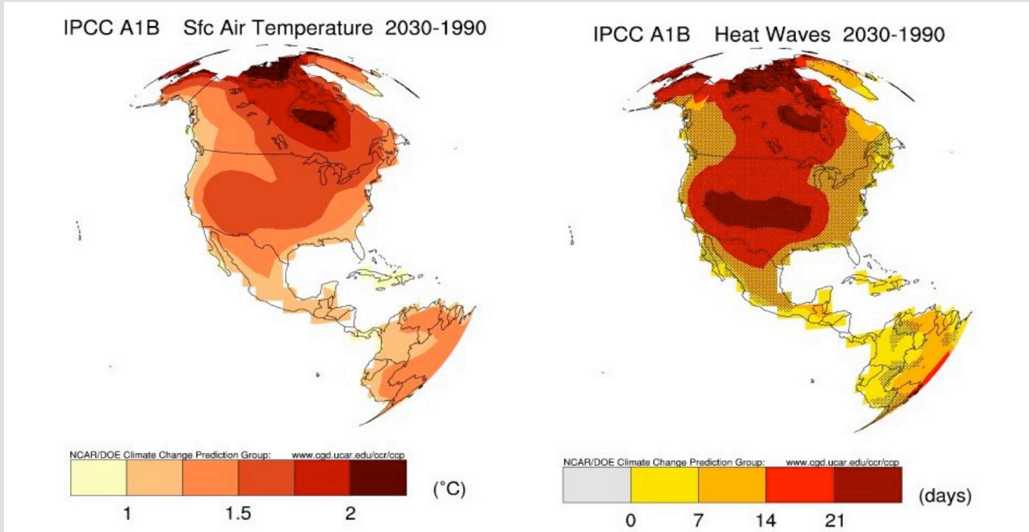
[23] *See*, for example, Hatfield, J., et al. 2008. "Agriculture." *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States.* U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington D.C., USA.

[24] *See,* for example, Munich Re Group. 2008. *Catastrophe Figures for 2008 Confirm that Climate Agreement is Urgently Needed.* December 29. Retrieved January 16, 2009, from http://www.munichre.com/ en/press/press_releases/2008/2008_12_29_press_release.aspx

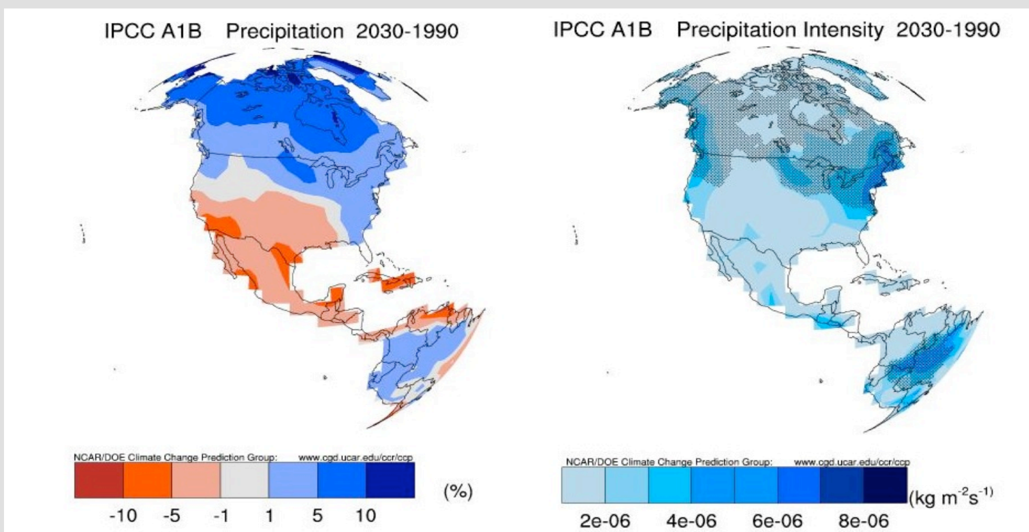
[25] *See*, for example, U.S. Department of Agriculture, Forest Service, Southwestern Region. 2004. *New Mexico Bark Beetle Epidemics.* Retrieved February 11, 2009, from http://www.fs.fed.us/r3/ resources/health/documents/nm_2004_beetle.pdf

[26] *See*, for example, United States Environmental Protection Agency. 1995. *Ecological Impacts from Climate Change: An Economic Analysis of Freshwater Recreational Fishing.* EPA Report No. 220-R-95-004. April.

Figure 4. Expected Changes in Annual Temperature, Heat Waves …



… Annual Precipitation and Extreme Precipitation, 2030 Relative to 1990



Source: Tebaldi, C., K. Hayhoe, J.M. Arblaster, and G.A. Meehl. 2006. "Going to the Extremes; An Intercomparison of Model-Simulated Historical and Future Changes in Extreme Events." *Climatic Change* 79(3-4): 185-211. Adapted by Lawrence Buja and Julie Arblaster. Retrieved January 21, 2009, from http://www.cgd.ucar.edu/ccr/climate_change_gallery_test/

Note: Please refer to the original source for definitions and descriptions of units displayed in each figure.

- ***Reduction in the value of assets or in the level of income.***

  Increased flooding from climate-related storms can reduce the value of exposed properties and disrupt employment for workers at commercial and industrial enterprises in low-lying areas.

- ***Increase in climate-related expenditures and, hence, decrease in income available for other purposes.***

  Households, businesses, and government are likely to increase spending on health-related issues in response to higher temperatures, leaving less money for discretionary household spending, business investment and profits, and government services.

- ***Reduction in the value of goods and services derived from the ecosystem.***

  Changes in climate can diminish an ecosystem's ability to provide valuable goods and services, such as those illustrated in Figure 5. The reduced supply of ecosystem goods and services can reduce the quality of life in a community and increase costs for families, businesses, and governments.

- ***Loss of employment or reduction in employment opportunities.***

  Workers may be harmed when climate-related events, such as floods or wildland fires, cause them to lose their jobs and incomes. The indirect effects of climate change also may lead to similar outcomes, as businesses move away from areas affected by drought to areas with greater availability of water.

- ***Increase in risk or uncertainty about future economic conditions.***

  All else equal, the economic well-being of most families, businesses, and communities is diminished when they experience higher risk, i.e., a higher probability of having bad things happen to them, and greater uncertainty about the probability that such events will occur. The prospect of climate change increases both.

- ***Increase in unprecedented economic conditions.***

  Preparation for and adaptation to new conditions will generate new costs that were not necessary to address similar concerns in the past. Climatic, environmental, and economic variations in the past provide reference for families, businesses and communities to anticipate impacts and adapt their activities. Insofar as climate change generates conditions not experienced in the past, preparation and adaptation will be more costly in terms of requiring new information, institutions, infrastructure, and behaviors.

- ***Undesirable shift in the distribution of wealth, income, and other indicators of economic well-being.***

  Many Americans may experience harm when climate change, or changes in ecosystems and social systems that stem from it, generate economic benefits for one group while imposing costs on another, especially if the latter is poor or otherwise disadvantaged. Similar harm may occur if changes in climate cause the extinction of species or the loss of notable landscapes and other natural resources so they will not be available to future generations.

The analysis we present in Section III focuses on the potential economic costs of changes in climate, ecosystems, and social systems. New Mexicans potentially

Figure 5. Changes in Climate Can Have Negative Effects on the Economy Over the Next Several Decades

Changes in Climate…

Higher Temperatures
Increases in short- and long-run temperatures.

Changes in Precipitation
Decreases or increases in snow or rain, and shifts in seasonal precipitation patterns.

Increases in Extreme Events
More frequent or more severe storms, droughts, heat waves.

Climate-Related Changes in Ecosystems
Losses of habitat for species of concern, increases in undesired species (diseases and pests), reductions in ecosystems' ability to produce desired goods and services.

Climate-Related Changes in Social Systems
Increases in climate-related expenditures, behaviors, and institutions, including migrations of population and economic activity away from areas facing high climate-related risks.

…can lead to… Economic Harm

Economic Costs
Reductions in the value of goods and services available to society.

Negative Economic Impacts
Reductions in jobs, income, and related variables.

Increases in Risk and Uncertainty
Risk: Higher probability that harmful events will materialize in the future, or that harmful events will become more severe, or both.

Uncertainty: Diminished ability to anticipate the future.

Increases in Unprecedented Economic Conditions
Information costs, adaptation costs, and increased economic impacts.

Increases in Undesirable Distribution of Economic Well-Being
The effects of climate change accrue in a manner people consider to be unfair and inappropriate.

will incur additional costs not as a result of changes in climate but from activities that contribute to climate change. We examine two of these in Section IV. One is the cost households and businesses would incur by continuing with technologies and behaviors that inefficiently use energy, even though more-efficient alternatives are available at little or no cost. The other is the health-related cost individuals and families would incur by being exposed to harmful pollutants produced by burning coal to produce electricity. In the following section, we describe our analytical approach to quantifying these costs.

C. Calculating the Business-As-Usual Potential Economic Harm

Our objective is to illustrate the potential economic harm to families, business, and communities in New Mexico over the next several decades under conditions likely to materialize if society continues to conduct its affairs without an effective program to rein in GHGs. We call this the business-as-usual potential economic harm.

The reasoning underlying our calculations is straightforward. We begin with a credible, quantitative estimate of a climate-related potential worsening in some factor (public health, agricultural production, energy costs, etc.) that contributes to the economic well being of families, businesses, or communities in New Mexico. We then multiply this times a credible estimate of the per-unit value of the factor. The product is an initial estimate of the potential harm per year.

We complete the calculation by adjusting the initial estimate to represent business-as-usual expectations for three target years: 2020, 2040, and 2080. This adjustment may have three steps. First, if the literature provides estimates of the quantitative impact of climate change for years other than a target year (2020, 2040, or 2080), we linearly interpolate to get a value for a target year when it falls between two values available from the literature, or linearly extrapolate when it falls outside them. For example, the maps in Figure 3 show expected changes in climate from 1990 to 2030. If we were to use the underlying data for our calculation, we would interpolate to find expected change in 2020, and extrapolate to find the expected change in 2040, and 2080. The values would be 70, 125, and 225 percent of the 1990 to 2030 change. We anticipate that linear interpolative and extrapolative adjustments likely understate and overstate the impact in the target year, respectively, as the underlying climate relationships apparently are nonlinear.

Second, we adjust the initial estimate to account for business-as-usual conditions. This adjustment is required because most of the studies that offer a quantitative estimate of the impact of future climate change employ a scenario of emissions, temperature, and climate that assumes business-as-usual behaviors will not continue (i.e., society begins to act to rein in emissions). Other studies employ middle-of-the-road assumptions about the sensitivity of temperature and climate to GHG emissions, and thus potentially underestimate the potential effects of climate change. Accordingly, we adjust our initial estimate of the potential harm to reflect more closely what it would be under a business-as-usual scenario, based on differences among scenario assumptions of CO_2 concentrations in a given time period. For this exercise, we employ Scenario A1FI, as represented by the IPCC.[27] We anticipate that using this scenario may still understate the potential harm under business-as-usual conditions, as actual emissions in recent

[27] IPCC, Data distribution Centre. 2008. "Carbon Dioxide: Projected Emissions and Concentrations." December 5. Retrieved January 22, 2009, from http://www.ipcc-data.org/ddc_co2.html

Figure 6. Adjustment Factors for Estimating the Business-As-Usual Impacts of Climate Change from Initial Estimates Based on Other Scenarios

Adjustment to A1FI from…	2020	2040	2080
A1B	0.9929	1.0265	1.2311
A2	1.0000	1.0286	1.1447
B1	1.0121	1.0886	1.4879
B2	1.0221	1.1126	1.4293
IS92a	1.0048	1.0611	1.2825

Source: ECONorthwest, with data from IPCC. 2008. *Carbon Dioxide: Projected Emissions and Concentrations.* Retrieved on January 16, 2009, from http://www.ipcc-data.org/ddc_co2.html

years have exceeded the level embedded in the scenario, and recent research suggests the climate and ecosystems may be more sensitive than previously anticipated to increases in greenhouse gases. Figure 6 lists the adjustment factors applicable to the calculations we present in Section III. As Figure 6 shows, the differences between A1FI and the other emission scenarios are fairly small for 2020 and 2040 but they increase substantially by 2080.

Third, we adjust for anticipated changes in population. This adjustment is appropriate, for example, when a study estimates the future impact of higher temperatures on human morbidity, expressed as a change in the death rate per hundred-thousand population. We adjust the population of New Mexico, assuming it will experience population growth at the rates estimated by the state through 2035,[28] and for the nation as a whole by the Bureau of Census after 2035.[29]

The product of these steps is a representation of the potential future cost in New Mexico over the next several decades if the global society should extend a business-as-usual approach to addressing issues associated with climate change. We anticipate that our results will provide a useful introduction to the potential economic consequences of climate change, at a spatial and temporal scale that is useful for many New Mexicans. We also anticipate that our results will provide a

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[28] Bureau of Business and Economic Research, University of New Mexico. 2008. *New Mexico County Population Projections July 1, 2005 to July 1, 2035.* August. Retrieved on January 12, 2009, from http://www.unm.edu/~bber/demo/table1.xls. This is the most recent population forecast we could find. Older forecasts have predicted different changes, even declines in population. *See*, U.S. Census Bureau. 2004. *State Interim Population Projections by Age and Sex: 2004-2030. Table A1: The Total Population.* Retrieved January 6, 2009, from http://www.census.gov/population/projections/SummaryTabA1.pdf.

[29] U.S. Department of Commerce, Census Bureau, Population Division. 2000. *Annual Projections of the Total Resident Population as of July 1: Middle, Lowest, Highest, and Zero International Migration Series, 1999 to 2100.* February 14. Retrieved January 16, 2009, from http://www.census.gov/population/projections/nation/summary/np-t1.txt

useful basis for future investigations to describe these other facets of the economic consequences of climate change:

- A full assessment of all the potential near-term costs in this region, encompassing the many costs that are too poorly understood to describe today.
- An assessment of the potential costs that might materialize outside this region and beyond the next several decades.
- An estimate of the present expected value of the overall potential cost of climate change, reflecting the many alternative ways in which climate change might play out and the probability that each will occur.
- A comparison of the potential costs and benefits associated with different levels of GHG emissions, actions to rein in emissions, or actions to prepare for and adjust to changes in climate that cannot be avoided.
- A forecast of what the economy will look like in the future. Such a product would require information about all the potential costs and benefits of climate change, the climate-related actions society might take, and the probabilities associated with different potential outcomes.
- An estimate of the costs associated with continued dependence on foreign oil, including payments to foreign countries.

Some of the potential costs, called market costs, would materialize as reductions in cash: lower disposable incomes for households, net revenues for businesses, and financial resources for communities. Increased expenditures to cope with climate-related illness, for example, would lower household incomes, while reductions in workers' productivity could also reduce business earnings and public tax revenues. Other potential costs, called non-market costs, would not have an immediate cash effect on incomes, earnings, and public finance. Much of the cost associated with potential reductions in trout populations, for example, reflects the public's desire to ensure that trout will be available for future generations to enjoy. Both market and non-market costs are important.

This analysis does not capture all likely costs of climate change for New Mexico. Insufficient data are available to provide estimates for all of the potential effects scientists have identified, not to mention other effects not yet identified. In addition, New Mexicans likely will experience costs that materialize beyond the state's border: as climate change leads to damage from heat waves, droughts, and storms elsewhere in the country and the world, for example, tax dollars and voluntary contributions will flow out of the state to provide assistance. Today's New Mexicans also will incur some costs from manifestations of climate change that would occur beyond this century. Many New Mexicans strongly want to pass to future generations the forests, trout populations, and skiing opportunities that exist today, for example, and will experience reductions in economic well-being should climate change make this unlikely, if not impossible. For all these reasons, we are confident that the actual potential costs of climate change in New Mexico are larger than the amounts we have calculated.

III. The Potential Economic Costs Associated with the Effects of Climate Change

In this section we present our illustrative calculations of the business-as-usual, potential economic costs to families, businesses, and families in New Mexico of climate change over the next several decades. In Section IV, we present another set of costs resulting from activities associated with the business-as-usual pathway that contribute to climate change. For each type of cost in this section and in Section IV, we present this information:

Description: We provide a short description of the potential cost, and the change(s) in climate, ecosystems, or social systems that likely will generate it. To facilitate the presentation, we organize the potential costs into these categories:

A. Energy
B. Fish and Wildlife
C. Flood and Storm Damage
D. Food and Agricultural Prod.
E. Forest and Range Production
F. Recreation
G. Public Health
H. Water Supplies

Assumptions, Data, and Calculation: We describe our assumptions, identify the information we use to quantify the business-as-usual potential cost and estimate its economic value, and demonstrate how we make the calculation.

Results: We report each business-as-usual potential annual cost in 2020, 2040, and 2080. Our findings represent the costs, expressed in today's dollars, that New Mexicans potentially would bear if they, in concert with others around the world, do not take meaningful action and climate change occurs as represented by the A1FI scenario from the IPCC.

We anticipate that our results generally understate the potential economic costs climate change would impose on New Mexicans if they and the residents of other states and nations continue in a business-as-usual manner. The degree of understatement increases the further one looks into the future. As atmospheric concentrations of GHGs increase, it becomes increasingly likely that higher temperatures will trigger processes that bring about even faster change in climate and initiate irreversible changes in ecosystems and social systems.

We recognize that families, businesses, and communities in New Mexico may be able to offset or mitigate some of the potential costs in the near term by taking advantage of the potential economic benefits of climate change, such as increased production of some crops or reduced expenditures on heating, that might accompany moderate climate warming. Our aim, however, is not to describe this potential adjustment but to describe the potential consequences if such adjustments are not realized. Further investigation is required to determine the extent of these opportunities, but current evidence suggests they will not fully offset the costs likely to materialize with large increases in atmospheric concentrations of GHGs. Similarly, adaptation opportunities may not offset the costs of small increases, or even the costs of increases that already have occurred. In sum, our results do not represent a forecast of what will happen, but a description of what might happen. We do not present a forecast because doing so would inject into the calculations many variables about which little is known, at odds with our objective to provide results that are defensible, comprehensible, and useful.

A. Energy

1. Increased Energy Consumption for Residential Indoor Air Cooling

Description

Higher temperatures during summer months will induce residential consumers to spend more money on cooling (air-conditioners, swamp-coolers, etc.) decreasing the amount they can spend on other things.

Assumptions, Data, and Calculation

A scientific assessment of the effects of climate change on the U.S. found that summer temperatures in New Mexico will increase by 5-7ºC (9-12.6ºF) by 2080-2099, compared to those between 1980-1999.[a] We use these findings to interpolate increases in temperatures for the months of June, July, and August in the years 2020, 2040, and 2080. Assuming the 2005 rate of energy consumption per average degree days in New Mexico[b] extends into the future, we estimate that the additional average demand will be about 1.8 million MW-hours in 2020, 4.6 million MW-hours by 2040, and 14.3 million MW-hours by 2080. We use the average monthly residential prices in New Mexico between 1990 and 2008 for the three summer months to estimate consumers' additional cooling costs.[c]

Results

Potential Value of Increased Energy Costs for Air Cooling

2020	2040	2080
$209 million	$519 million	$1.6 billion

Source: ECONorthwest

This calculation does not include additional expenditures for commercial or industrial consumers, which we expect to be small relative to the potential increase in New Mexicans' home electricity bills. Additionally, we are confident these values underestimate future costs since the hot season spans the months of May through September. Because we do not have immediate access to data that show future temperature increases for the months of May and September we limit our impact calculation to the months of June, July, and August.

References and Notes

[a] Committee on Environment and Natural Resources, National Science and Technology Council. 2008. *Scientific Assessment of the Effects of Global Change on the United States.* May. Retrieved on January 14, 2009, from http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf

b U.S. Department of Energy, Energy Efficiency and Renewable Energy. *EERE State Activities and Partnerships: Energy Consumption in New Mexico Homes.* Retrieved January 15, 2009, from http://apps1.eere.energy.gov/states/residential.cfm/state=NM

[c] Energy Information Administration. 2008. *Current and Historical Monthly Retail Sales, Revenue and Average per Kilowatthour by State and by Sector* (Form EIA-826). Retrieved January 15, 2009, from http://www.eia.doe.gov/cneaf/electricity/page/sales_ revenue.xls.

2. Increased Energy Loss During Transmission

Description

Higher temperatures during climate-related heat waves will increase the amount of energy lost during electricity-transmission lines. During heat waves, the resistance of overloaded transmission lines increases, causing the grid to convert more electricity into heat, which wastes energy.[a]

Assumptions, Data, and Calculation

We assume summertime consumption of electricity in 2008 will increase in accord with the rate projected by the Energy Information Administration for New Mexico.[b] We apply a middle-of-the-road estimate of the potential growth in heat-wave days from 1990 to 2030;[c] linearly interpolate and extrapolate to estimate the number of additional days in 2020, 2040, and 2080; and adjust the numbers to estimate what the impact would be under a business-as-usual approach to climate change. If the additional transmission-line losses during a heat-wave day equal one-quarter of the electricity being transmitted,[a] the annual losses would total 430,000 MW-hours by 2020, 1.4 million MW-hours by 2040, and 11 million MW-hours by 2080. We assume the average summertime wholesale price of electricity, $92 per MW-hour in 2008 dollars, will apply in the future.[d]

Results

Potential Value of Energy Lost in Transmission During Heat Waves

2020	2040	2080
$39 million	$128 million	$1.0 billion

Source: ECONorthwest

References and Notes

[a] Ackerman, F. and E.A. Stanton. 2008. *The Cost of Climate Change: What We'll Pay If Global Warming Continues Unchecked*. Natural Resources Defense Council. May. Retrieved January 20, 2009, from http://www.nrdc.org/globalwarming/cost/cost.pdf

[b] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *EERE State Activities and Partnerships: Electric Power and Renewable Energy in New Mexico*. Retrieved January 15, 2009, from http://apps1.eere.energy.gov/states/electricity.cfm/state=NM

[c] Tebaldi, C., K. Hayhoe, J.M. Arblaster, and G.A. Meehl. 2006. "Going to the Extremes; An Intercomparison of Model-Simulated Historical and Future Changes in Extreme Events." *Climatic Change* 79(3-4): 185-211. Adapted by Lawrence Buja and Julie Arblaster. Retrieved January 21, 2009, from http://www.cgd.ucar.edu/ccr/climate_change_ gallery_test/

[d] Energy Information Administration. 2008. *Current and Historical Monthly Retail Sales, Revenue and Average per Kilowatthour by State and by Sector* (Form EIA-826). Retrieved January 15, 2009, from http://www.eia.doe.gov/cneaf/electricity/page/sales_ revenue.xls

3. Other Potential Costs of Climate Change Related to Energy

Description

Climate change undoubtedly will affect other parts of New Mexico's energy system but there is little research to substantiate the magnitude of these impacts. For instance, a recent report showed that industry may increase its energy consumption on days with high temperatures, people may consume higher amounts of gasoline due to increased use of air conditioning in their cars, and trucks that transport perishables may increase their fuel use to refrigerate their cargoes. Equally uncertain is how much farmers' energy demand will increase on hot days when they ramp up irrigation to maintain soil moisture.[a] Other potential costs include damages to electricity-transmission equipment during floods and storms, which are expected to become more frequent and intense because of climate change.[b]

A study by researchers at Los Alamos National Laboratory found that an increase in air temperature of 1.5°C (2.7°F) would increase the probability of a blackout occurring from 1 time per year to 8-10 times per year. The researchers estimated economic loss associated with this increased probability at 1 percent of gross state product.[c]

References and Notes

[a] Scott, M.J. and Y.J. Huang. 2007. "Effects of Climate Change in Energy Use in the United States." In Wilbanks, T.J., V. Bhatt, D.E. Bilello (eds.). *Effects of Climate Change on Energy Production and Use in the United States.* A Report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research.

[b] Bull, S.R., D.E. Bilello, J. Eckmann, et al. 2007. "Effects of Climate Change on Energy Production and Distribution in the United States." In Wilbanks, T.J., V. Bhatt, D.E. Bilello (eds.). *Effects of Climate Change on Energy Production and Use in the United States.* A Report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research.

[c] Personal communication with Gary Geernaert, Director, Institute of Geophysics and Planetary Physics, Los Alamos National Laboratory. February 6, 2009.

B. Fish and Wildlife

1. Reduced Trout Habitat and Populations

Description

Warmer stream temperatures resulting from increased global temperatures reduce the amount of habitat that can viably support cold-water fish, reducing native trout populations.

Assumptions, Data, and Calculation

We assume trout populations will decline proportionate to expected losses of aquatic habitat. An assessment of stream temperatures under a middle-of-the-road emissions scenario indicates increased warming might reduce cold-water habitat by up to 100 percent by 2050.[a] We interpolate and adjust the percentages to reflect the A1FI scenario, to estimate the reductions in trout populations in 2020, 2040, and 2080. We value the losses based on New Mexican households' willingness-to-pay at $40 per year[b] to protect another endangered fish species, the silvery minnow. We use this value because similar data are not available for cutthroat trout populations, but we have no reason to believe that the value New Mexicans would place on avoiding the loss of the cutthroat trout population would be dramatically different. The loss represents the population reduction times households' willingness to pay to protect the species, adjusted for population growth in 2020, 2040, and 2080.

Results

Potential Value of Reduced Trout Populations

2020	2040	2080
$37.6 million	$46.3 million	$61 million

Source: ECONorthwest

References and Notes

[a] Michaels, G., K. O'Neal, J. Humphrey, K. Bell, R. Camacho, and R. Funk. 1995. *Ecological Impacts from Climate Change: An Economic Analysis of Freshwater Recreational Fishing.* Abt Associates, Inc. and the U.S. Environmental Protection Agency. Report No. EPA-230-R-95-004.; and O'Neal, K. 2002. *Effects of Global Warming on Trout and Salmon in U.S. Streams.* Defenders of Wildlife and Natural Resources Defense Council. May.

[b] Berrens, R.P., P. Ganderton, and C. Silva. 1996. "Valuing the Protection of Minimum Instream Flows in New Mexico." *Journal of Agricultural and Resource Economics* 21 (2): 294-309.

2. Other Potential Costs Related to Impacts of Climate Change on Fish and Wildlife

Description

Increased temperatures and changes in precipitation are likely to impact many species, other than trout in New Mexico. Scientists have found evidence that climate change can result in changes in species' range, abundance, phenology (timing of an event, such as migration), morphology and physiology, and community composition, biotic interactions and behavior.[a] Many of these impacts on populations and ecosystems would potentially result in economic harm. For example, many of New Mexico's species rely on the narrow bands of riparian habitat surrounding its rivers. As these habitats become stressed as climate change reduces water availability, the species that depend on them, such as the endangered Mexican spotted owl and the southwester willow flycatcher, may face greater challenges to their continued survival.[b] Disruptions in these ecosystems could also adversely affect New Mexico's recreation industry.

Temperature increases also are likely to disrupt montane ecosystems, particularly those associated with glaciers and snowpack. In general, temperature increases are likely to push species to higher elevations and higher latitudes. For species where New Mexico represents the southern extent of their range, they are more likely to disappear from the state entirely. Some invasive species and pests, which have historically been limited by temperature or moisture, may be able to expand their range and pose new threats to native populations of fish and wildlife.[c] Data are not available, however, to allow us to estimate the costs associated with these and other potential fish and wildlife-related impacts.

References and Notes

[a] Root, T.L. and S.H. Schneider. 2002. "Climate Change: Overview and Implications for Wildlife." In S.H. Schneider and T.L. Root (eds.). *Wildlife Responses to Climate Change: North American Case Studies.* Island Press: Washington D.C.

[b] Enquist, C.A.F., E.H. Girvvetz, and D.F. Gori. *Conservation Implications of Emerging Moisture Stress Due to Recent Climate Changes in New Mexico.* A Climate Change Vulnerability Assessment for Biodiversity in New Mexico, Part II. The Nature Conservancy, University of Washington, and the Wildlife Conservation Society. December. Retrieved February 5, 2009, from http://nmconservation.org/dl/CC_report2_final.pdf

[c] Janetos, A.C. 2008. "Chapter 5: Biodiversity." In Backlund, P., A. Janetos, and D. Schimel. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. Synthesis and Assessment Product 4.3. U.S. Climate Change Science Program and the Subcommittee on Global Change Research. May.

C. Flood and Storm Damage

1. Costs Related to Extreme Weather Events

Description

Climate change is expected to increase storm severity, and the frequency of extreme storm events, including high winds, flooding, lightning and fire. Storm events will have direct property-damage effects, as well as increased storm-related injuries and fatalities.[a]

Assumptions, Data, and Calculation

The National Oceanic and Atmospheric Administration's National Weather Service and National Climatic Data Center collect information on fatalities, injuries, property damage, and crop damage resulting from extreme weather events, including weather-influenced wildfires.[b] The U.S. Climate Change Science Program provides rough estimates for increases in extreme weather events, including an increase in frequency of extreme precipitation events by 2.5 times under A1B by 2100. Wildfire forecasts for the west follow similar increases rates with two to five times the acreage burned at the end of the 20th century by late in the 21st century.[c] Using the average total property and crop damage estimates from 1996 to 2007, we linearly interpolate an increase in these impacts 2.5 times by 2100 for 2020, 2040 and 2080, and adjust for the A1FI scenario. We do not monetize fatalities and injuries, but the increase by 2080 would be 9 fatalities and 29 injuries due to extreme weather events. These include heat-related effects that are further described and valued in the *Public Health* section.

Results

Potential Value of Property and Crop Damage from Extreme Weather Events

2020	2040	2080
$88 million	$181 million	$435 million

Source: ECONorthwest

References and Notes

[a] U.S. Climate Change Science Program. 2008. "Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands." In Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple and W.L. Murray (eds.). *Weather and Climate Extremes in a Changing Climate.* Synthesis and Assessment Product 3.3. Washington, DC.

[b] Consistent damage cost estimates are available from 1996-2007. National Weather Service and National Climatic Data Center. 1996-2008. "Summary of Hazardous Weather Fatalities, Injuries and Damage Costs by State." *Natural Hazard Statistics.* Accessed February 3, 2009 from http://www.weather.gov/os/hazstats.shtml#. Adjusted to 2008 dollars.

[c] Mckenzie, D., Z. Gedalof, D. Peterson, and P. Mote. 2004. "Climatic Change, Wildfire, and Conservation." *Conservation Biology* 18: 890-902.

2. Other Potential Costs from Climate-Related Extreme Weather

Description

The combined impact of multiple storm and ocean effects from climate change is likely to be greater than the sum of the individual impacts, as interactions increase severity. Similarly, damages from storm events tend to increase relative to storm severity more than linearly.[a] Thresholds exist in current infrastructure designed to protect property and people from storm impacts.

Extreme weather events will impact natural structures and functions and the resulting ecosystem services communities rely upon. Storm events increase erosion, create landslides, damage forests and habitat, and injure wildlife.

References and Notes

[a] U.S. Climate Change Science Program. 2008. "Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands." In Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple and W.L. Murray (eds.). *Weather and Climate Extremes in a Changing Climate.* Synthesis and Assessment Product 3.3. Washington, DC.

D. Food and Agricultural Production

1. Reduced Beef Production

Description

Higher temperatures slow the rate of growth for beef cattle and reduce the production and sales of ranches and feedlots.

Assumptions, Data, and Calculation

We assume ranchers and feedlot operators will continue the practices of 2007 and that prices will remain at 2007 levels, which produced sales of $955 million.[a] We also assume that the temperature increases accompanying a doubling of carbon dioxide emissions would increase the time required for a cow to reach finished weight in a feedlot in the southwestern United States by 1.4 percent; a tripling might increase the time by 8.2 percent.[b] The potential harm equals the value of annual beef production times the percentage loss of production from climate change, adjusted to reflect potential doubling of carbon dioxide emissions by 2040 and tripling by 2080, under scenario A1FI.

Results

Potential Value of Reduced Beef Production

2020	2040	2080
$8.4 million	$13.4 million	$78.3 million

Source: ECONorthwest

Potential losses would be greater if ranchers tried to expand their production, so that higher temperatures would affect the maturation of a larger number of animals. Also, additional beef production losses, especially for range-fed cattle, may occur as range productivity declines with increasing temperatures and reduced water availability during summer months.[c]

References and Notes

[a] United States Department of Agriculture, National Agricultural Statistics Service. 2008. *Meat Animals Production, Disposition, and Income: 2007 Summary*. April.

[b] Frank, K.L. 2001. *Potential Effects of Climate Change on Warm Season Voluntary Feed Intake and Associated Production of Confined Livestock in the United States*. Masters of Science Thesis. Kansas State University, Manhattan. As cited in Backlund, P., A. Janetos, and D. Schimel. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. Synthesis and Assessment Product 4.3. U.S. Climate Change Science Program and the Subcommittee on Global Change Research. May.

[c] Backlund, P., A. Janetos, and D. Schimel. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. Synthesis and Assessment Product 4.3. U.S. Climate Change Science Program and the Subcommittee on Global Change Research. May.

2. Reduced Milk Production

Description

Higher temperatures slow the rate of milk production for dairy cows and reduce the sales of dairies.

Assumptions, Data, and Calculation

We assume dairy operators will continue the practices of 2007 and that prices will remain at 2007 levels, which produced sales of $1.37 billion.[a] We also assume that the temperature increases accompanying a doubling of carbon dioxide emissions would reduce milk production per cow in the southwestern United States by 4 percent; a tripling might reduce the production by 11 percent.[b] The potential harm equals the value of annual beef production times the percentage loss of production from climate change, adjusted to reflect potential doubling of carbon dioxide emissions by 2040 and tripling by 2080, under scenario A1FI.

Results

Potential Value of Reduced Milk Production

2020	2040	2080
$34.3 million	$54.9 million	$151 million

Source: ECONorthwest

References and Notes

[a] United States Department of Agriculture, National Agricultural Statistics Service. 2008. *Milk Production, Disposition, and Income 2007 Summary*. April. Retrieved January 13, 2009, from http://usda.mannlib.cornell.edu/usda/current/MilkProdDi/MilkProdDi-04-25-2008.pdf

[b] Frank, K.L. 2001. *Potential Effects of Climate Change on Warm Season Voluntary Feed Intake and Associated Production of Confined Livestock in the United States.* Masters of Science Thesis. Kansas State University, Manhattan. As cited in Backlund, P., A. Janetos, and D. Schimel. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States.* Synthesis and Assessment Product 4.3. U.S. Climate Change Science Program and the Subcommittee on Global Change Research. May.

3. Reduced Cotton Production

Description

Temperatures above a certain threshold reduce the yields of cotton production.

Assumptions, Data, and Calculation

Cotton is a minor but important crop for which there exist data regarding the potential effects of changes in climate. We assume farmers will continue with the practices that produced the 2007 crop and that prices will remain at 2007 levels, which produced a crop worth about $37.7 million.[a] We apply the results of a study that indicates cotton production in New Mexico will decline by approximately 20 percent by 2049 and 50 percent by 2099 under the A1FI scenario.[b] We interpolate this finding to estimate the potential reduction in production in 2020, 2040, and 2080. The potential harm equals the value of the potential reduction in cotton production.

Results

Potential Value of Reduced Cotton Production

2020	2040	2080
$2.6 million	$6 million	$14.7 million

Source: ECONorthwest

References and Notes

[a] U.S. Department of Agriculture, National Agricultural Statistics Service. 2008. *U.S. & All States Data – Cotton* [2007, Value of Production, All Cotton, New Mexico].

[b] Schlenker, W. and M. Roberts. 2008. *Estimating the Impact of Climate Change on Crop Yields: The Importance of Nonlinear Temperature Effects.* National Bureau of Economic Research. Working Paper No. 13799.

4. Reduced Wheat Production

Description

Temperatures above 5°C (9°F) reduce the yields of winter wheat production.

Assumptions, Data, and Calculation

We assume farmers will continue with the practices that produced the 2007 crop and that prices will remain at 2007 levels, which produced a crop worth about $42.9 million.[a] We apply the results of a study that indicates wheat production in New Mexico will decline by approximately 33 percent with a 5°C (9°F) increase in global mean temperature, and an atmospheric carbon-dioxide concentration of 365 ppm.[b] We extrapolate and adjust this finding to estimate the potential reduction in production under the A1FI scenario in 2080, the only one of our target years that would experience a temperature increase of at least 5°C (9°F). The potential harm equals the value of the potential reduction in wheat production.

Results

Potential Value of Reduced Wheat Production

2020	2040	2080
--	--	$14.2 million

Source: ECONorthwest

We do not include costs for 2020 and 2040, because reduced wheat production does not occur until temperatures reach approximately 5°C (9°F). This magnitude of temperature increase is not expected to occur in the A1FI scenario until the later part of the 21st century.

References and Notes

[a] U.S. Department of Agriculture, National Agricultural Statistics Service. 2008. *U.S. & All States Data – Winter Wheat* [2007, Value of Production, All Winter Wheat, New Mexico].

[b] Brown, R.A. and N.J. Rosenberg. 1999. "Climate Change Impacts on the Potential Productivity of Corn and Winter Wheat in their Primary United States Growing Regions." *Climatic Change* 41: 73-107. Although the authors hold carbon dioxide concentrations constant to control for any so-called fertilization effect, in which higher concentrations of CO_2 accelerate plant growth, they conclude that even at concentrations of carbon dioxide at 750 ppm, a 5°C (9°F) increase in temperature causes wheat yields to decline.

5. Reduced Agricultural Production in the Rio Grande Valley

Description

Changes in temperature and precipitation will reduce the water supply available for growing crops in the Rio Grande Vally, reducing the direct economic output of the agricultural sector in the Valley.

Assumptions, Data, and Calculation

We rely on the results of a study that coupled a climate model with a hydroeconomic model of the Rio Grande watershed.[a] The study found that under an A1B scenario and dry conditions the direct economic output of the agricultural sector in 2030 would fall by $41.2 million, and in 2080 would fall by $100.7 million in 2008 dollars. We adjust these results to the A1FI scenario and interpolate to find values for 2020 and 2040.

Results

Potential Value of Reduced Economic Output of the Agricultural Sector

2020	2040	2080
$27.7 million	$54.7 million	$123.9 million

Source: ECONorthwest

These values potentially double-count the costs associated with loss of production in specific agricultural commodities discussed in the previous pages. We are confident, however, that the additional costs associated with the loss of agricultural production that we were not able to quantify more than compensate for any double-counting here.

References and Notes

[a] Hurd, B.H. and J. Coonrod. 2007. *Climate Change and its Implications for New Mexico's Water Resources and Economic Opportunities.* New Mexico State University, Department of Agricultural Economics and Agricultural Business and University of New Mexico, Department of Civil Engineering. July.

6. Other Potential Costs from the Effects of Climate Change on Food Production

Description

Changes in precipitation and temperature are likely to impact New Mexico's agricultural industry in ways other than those reported above. For example, higher temperatures may reduce the yield or cease production altogether in some regions of some additional crops, such as pecans, corn, and alfalfa. Changes in temperature may also increase the occurrence of pests and plant diseases, requiring famers to expend more resources on pest and disease management.[a] Increased evaptranspiration and reduced availability water supplies, which we discuss in more detail below in the section on *Water Supply*, may lead to reductions in yield for a variety of crops due to water stress. Insufficient data are available, however, to allow us to estimate the costs associated with these and other potential impacts related to agricultural production.

References and Notes

[a] Hatfield, J.L. 2008. "Chapter 2: Agriculture." In Backlund, P., A. Janetos, and D. Schimel. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. Synthesis and Assessment Product 4.3. U.S. Climate Change Science Program and the Subcommittee on Global Change Research. May.

E. Forest and Range Production

1. Lost Forest Assets from Wildland Fires

Description

Wildland fires become more frequent and severe as climate change increases temperatures and aridity, and accelerates tree mortality from insects and disease. When forests burn, they lose their ability to produce many goods and services, but data are available only to estimate the loss assuming the forest would be managed to produce timber.

Assumptions, Data, and Calculation

Projections for climate-related changes in temperature and precipitation suggest that, relative to the 20th century, wildfires in New Mexico will burn annually on average four times more acreage by 2040.[a] On average, 189,000 acres of public and private land burned annually from 1990 to 1999.[b] A 400 percent increase by 2040 would be a marginal increase of 756,000 acres per year. We assume the value of lost goods and services when a forest burns is at least $1,000 per acre, a general estimate for the value of lost timber.[c] We use linear interpolation and extrapolation for 2020 and 2080. The projected increase in burn rates are for the A2 scenario, which we linearly extrapolate for A1FI.

Results

Potential Value of Lost Forest Assets from Increased Forest Fires

2020	2040	2080
$378 million	$778 million	$1.73 billion

Source: ECONorthwest

These results do not include the value of ecosystem services distinct from the production of timber that would be lost with increased forest fires. The loss of structures to fire is included under extreme weather events because the data are collected by the National Weather Service and aggregated with other weather-related structural losses.

References and Notes

[a] Mckenzie, D. Z. Gedalof, D. Peterson, and P. Mote. 2004. "Climatic Change, Wildfire, and Conservation." *Conservation Biology* 18: 890-902.

[b] Southwest Coordination Center. 2008. *Southwest Area Fires and Acres by State.* http://gacc.nifc.gov/swcc/predictive/intelligence/ytd_historical_data/historical/suppression/average/average_per_year_suppression.pdf.

[c] Titus, J.G. 1992. "The Costs of Climate Change to the United States." In: Majumdar, S.K., L.S. Kalkstein, B. Yarnal, E.W. Miller, and L.M. Rosenfeld (eds). *Global Climate Change: Implications, Challenges, and Mitigation Measure*s. Pennsylvania Academy of Sciences.

2. Increased Control Expenditures Related to Wildland Fire

Description

Wildfires become more frequent and severe as climate change increases temperatures and aridity, and accelerates tree mortality from insects and disease. As wildland fires become more widespread New Mexicans will incur additional fire-control costs.

Assumptions, Data, and Calculation

Projections for forests in New Mexico based on temperature and precipitation suggest that wildland fires will impact four times more acreage than during the 20th century by 2040.[a] Our estimates for total increased acreage burned in New Mexico are described under *Lost Forest Assets*. For suppression costs, we use the average of aggregate suppression and control costs per acre burned by the U.S. Forest Service for 2006 and 2007, $291 per acre.[b] We assume suppression costs will increase proportional to acres burned, fire suppression costs will increase as well, or alternatively.[b] We base our calculation on these rates and historical expenditures.[c]

Results

Potential Value of Increased Control Expenditures for Wildland Fires

2020	2040	2080
$110 million	$227 million	$504 million

Source: ECONorthwest

References and Notes

[a] Mckenzie, D. Z. Gedalof, D. Peterson, and P. Mote. 2004. "Climatic Change, Wildfire, and Conservation." *Conservation Biology* 18: 890-902.

[b] Independent Large Wildfire Cost Panel. 2007. *Towards a Collaborative Cost Management Strategy. 2006 U.S. Forest Service Large Wildfire Cost Review Recommendations.* U.S. Department of Agriculture. May 15. http://www.fs.fed.us/fire/publications/ilwc-panel/BR6988-1.PDF.

[c] Independent Large Wildfire Cost Panel. 2008. *2007 U.S. Forest Service & Department of Interior Large Wildfire Cost Review. Assessing Progress Towards an Integrated Risk and Cost Fire Management Strategy.* U.S. Department of Agriculture. April 24. http://www.fs.fed.us/fire/publications/ilwc-panel/report-2007.pdf.

3. Other Potential Costs from the Effects of Climate Change on Forests and Range

Description

Numerous studies based on climate forecasts as well as impacts already occurring indicate that climate change is likely to increase the forest damages resulting from disease and pests such as the mountain pine beetle. Mountain pine beetle populations are historically held in check by cold winters. As the frequency of cold winters decreases, the mountain pine beetle's exponential growth rate goes unfettered and leads to rapid and widespread tree mortality, as seen throughout the western United States and Canada.[a] The mountain pine beetle is now beginning to show a potential to jump to non-pine species after locally exhausting the supply of pines. Mountain pine beetles could conceivably impact the majority of remaining forest in New Mexico. Mountain pine beetles can interact with other effects that stress forests in New Mexico such as increased temperatures and decreased soil moisture to hasten tree mortality.[b]

Lost forest will lead to lost ecosystem services for New Mexicans, such as water filtration, water storage and air filtration. We do not make an estimate of the total value of ecosystem services lost with forest loss because there currently are not equivalent identifications of demand for the state as a whole.

References and Notes

[a] Carroll, A.L., J. Régnière, J.A. Logan et al. 2006. *Impacts of Climate Change on Range Expansion by the Mountain Pine Beetle*. Working Paper No. 2006-14. Canadian Forest Service, Natural Resources Canada, Pacific Forestry Centre. Retrieved May 18, 2007, from http://mpb.cfs.nrcan.gc.ca/research/projects/1-02_e.html

[b] van Mantgem, P.J., N.L. Stephenson, J.C. Byrne, et al. 2009. "Widespread Increase of Tree Mortality Rates in the Western United States." *Science* 323: 5913.

F. Public Health

1. Increased Low-Altitude Ozone

Description

Increased temperatures favor the production of low-altitude ozone, which negatively impacts the health of humans that live in urban areas and creates costs associated with increased rates of morbidity, premature mortality, and lost worker productivity.[a]

Assumptions, Data, and Calculation of Mortality

We apply findings from an assessment of the A2 scenario, which indicate elevated ozone levels related to climate change could increase nonaccidental mortality by 0.27 percent by 2050.[b] We linearly interpolate and extrapolate to estimate the effect in 2020, 2040, and 2080, then adjust for higher temperatures expected in the A1FI scenario. We assume that, absent climate change, nonaccidental mortality would rise proportional to future increases in the state's metropolitan population and estimate that the higher ozone concentrations would increase annual mortality by 17 deaths in 2020, 37 in 2040, and more than 98 in 2080.[c] We estimate the value of the additional premature deaths using EPA's current estimate of the value of a statistical life.[d]

To calculate the potential costs of increased morbidity we rely on the results of an employee survey, that estimated expenditures associated with conditions, such as allergies, asthma, and other respiratory affections, incurred by employees, including those who do not suffer from the particular condition.[e] Using these results, we first estimate what the costs would be absent climate change by assuming that current costs of hospitalization for conditions related to ozone in metropolitan areas will increase proportionate to expected growth in New Mexico's labor force. We then apply the results from a study that concluded current hospitalization costs related to high ozone concentrations in California might triple under the A2 scenario,[f] and make adjustments to reflect the higher temperatures expected under the A1FI scenario. The results represent the potential increases in medical costs for 2020, 2040, and 2080.

To estimate the value of increases in lost productivity as more workers become ill from climate-related increases in ozone concentrations, we rely on the findings of the same employee survey[e] and first assume that, absent climate change, current levels of lost productivity in metropolitan areas would grow proportional to expected growth in New Mexico's labor force. We then apply the results of a study that estimated the productivity losses in California related to ozone could increase 62 percent under the A2 scenario,[f] and make adjustments to reflect the higher temperatures expected under the A1FI scenario. The results represent the potential increases in workers' lost productivity for 2020, 2040, and 2080.

Results

Potential Health-Related Costs from Increased Low-Altitude Ozone		
2020	**2040**	**2080**
Value of Premature Deaths		
$119 million	$256 million	$675 million
Value of Increased Morbidity		
$16 million	$21 million	$30 million
Value of Lost Productivity		
$170 million	$215 million	$316 million
TOTAL		
$305 million	$492 million	$1.0 billion

Source: ECONorthwest

The calculation of increased morbidity costs does not account for costs that would occur outside a hospital (in-patient or emergency room) or for the effects of higher ozone concentrations on all sensitive groups, like children and elderly.

EPA's value of statistical life represents the value that people, on average, are willing to pay to avoid premature mortality from exposure to harm, be it pollution, accidents, etc. Researchers have argued that a more appropriate measure to value a life is the willingness to accept fatal consequences of exposure to harm. This value is usually higher than the willingness to pay.[g] This means that the total value of increased mortality from high ozone concentrations, that we estimate above, understate the actual value society places on deaths froom climate change.

References and Notes

[a] Ebi, K.L., J. Balbus, P.L. Kinney et al. 2008. "Effects of Global Change on Human Health." In J.L. Gamble, ed., *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems.* Washington, D.C.: U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency. Retrieved December 23, 2008, from http://www.climatescience.gov/Library/sap/sap4-6/final-report/sap4-6-final-all.pdf.

[b] Bell, M.L., R. Goldberg, C. Hogrefe et al. 2007. "Climate Change, Ambient Ozone, and Health in 50 U.S. Cities." *Climatic Change* 82: 61-76.

[c] The Henry J. Kaiser Family Foundation. 2008. *New Mexico: Number of Deaths per 100,000 Population, 2006.* Retrieved January 6, 2009, from http://www.statehealthfacts.org/profileind.jsp?ind=58&cat=2&rgn=33; Bureau of Business and Economic Research, University of New Mexico. 2008. *New Mexico County Population Projections July 1, 2005 to July 1, 2035.* August. Retrieved on January 12, 2009, from http://www.unm.edu/~bber/demo/table1.xls; and Bureau of Business and Economic Research, University of New Mexico. 2008. *New Mexico Metropolitan Statistical Areas.* March 27. Retrieved on January 13, 2009, from http://www.unm.edu/~bber/demo/msapopest.xls

[d] Borenstein, S. 2008. *American Life Worth Less Today.* July 10. Associated Press. Retrieved on December 23, 2008, from http://www.huffingtonpost.com/2008/07/10/american-life-worth-less_n_112030.html

[e] Goetzel, R.Z., S.R. Long, R.J. Ozminkowski et al. 2004. “Health, Absence, Disability, and Presenteeism Cost Estimates of Certain Physical and Mental Health Conditions Affecting U.S. Employers.” *Journal of Occupational and Environmental Medicine* 46: 398-412.

[f] Kahrl, F. and D. Roland-Holst. 2008. *California Climate Risk and Response*. Department of Agricultural and Resource Economics, University of California Berkeley. November. Retrieved January 7, 2009, from http://are.berkeley.edu/~dwrh/CERES_Web/Docs/California%20Climate%20Risk%20and%20Response.pdf.

[g] *See*, for example, Guria, J., J. Leung, M. Jones-Lee, and G. Loomes. 2005. “The Willingness to Accept Value of Statistical Life Relative to the Willingness to Pay Value: Evidence and Policy Implications.” *Environmental and Resource Economics* 32: 113-127.

2. Increased Heat Waves

Description

Additional heat waves (days with temperatures consistently above a threshold specific to different geographic areas) are expected to increase mortality rates and medical costs of those already suffering from cardiovascular, cerebrovascular, and respiratory diseases.[a] They also will reduce work productivity, household productivity, and the value of leisure time.

Assumptions, Data, and Calculation

We apply to the entire state the results of a recent study, which estimated climate-related heat waves would cause an additional 20 deaths in Albuquerque by 2055 under the A2 scenario,[b] and make adjustments to estimate the number of additional deaths in 2020, 2040, and 2080 under the A1FI scenario. We estimate the value of the additional premature deaths using EPA's current estimate of the value of a statistical life.[c]

To calculate additional medical and other costs, we multiplied New Mexico's expected future populations times the per capita daily costs for hospitalization, emergency-room visits, and follow-up medical costs during the 2006 heat wave in California.[d] We estimate the additional climate-related costs by applying the results of a study that projected New Mexico would experience an additional 21 heat-wave days by 2030 under the A1B scenario[e] and making adjustments to estimate the number of additional deaths in 2020, 2040, and 4080 under the A1FI scenario.

Results

Potential Value of Health-Related and Other Costs of Heat Waves

2020	2040	2080
Value of Premature Deaths		
$108 million	$250 million	$587 million
Value of Increased-Medical Care Costs		
$7 million	$16 million	$44 million
Value of Other Costs		
$1 million	$1.4 million	$4 million
TOTAL		
$116 million	$267 million	$635 million

Source: ECONorthwest

Heat-wave statistics show they cause more deaths than all other natural disasters in the US. Death certificates systematically fail to represent high temperatures as the death cause during heat waves, however, and a full accounting would increase the mortality numbers, perhaps by 54 percent.[f]

EPA's value of statistical life represents the value that people, on average, are willing to pay to avoid premature mortality from exposure to harm, be it pollution, accidents, etc. Researchers have argued that a more appropriate measure to value a life is the willingness to accept fatal consequences of exposure to harm. This value is usually higher than the willingness to pay.[g] This means that the total value of increased mortality from high ozone concentrations, that we estimate above, understate the actual value society places on deaths froom climate change.

References and Notes

[a] Knowlton, K., M. Rotkin-Ellman, G. King et al. 2009. "The 2006 California Heat Waves: Impacts on Hospitalizations and Emergency Department Visits." *Environmental Health Perspectives* 117: 61-67.

[b] Kalkstein, L.S. and J.S. Greene. 2007. *An Analysis of Potential Heat-Related Mortality Increases in U.S. Cities under a Business-as-Usual Climate Change Scenario.* Environment America. September 6. Retrieved January 13, 2008, from http://www.environmentamerica.org/uploads/Js/tF/JstFE5oHrsQJi5ifIA931Q/Heat-Mortality_Report_.pdf.

[c] Borenstein, S. 2008. *American Life Worth Less Today.* July 10. Associated Press. Retrieved on December 23, 3008, from http://www.huffingtonpost.com/2008/07/10/american-life-worth-less_n_112030.html

[d] Srinivasan, T. 2008. *Cost of Excess Hospitalization and Emergency Department Visits for the 2006 California Heat Wave.* Natural Resources Defense Council. August 28. Retrieved January 11, 2009, from http://docs.nrdc.org/health/files/hea_08082601a.pdf.

[e] Tebaldi, C., K. Hayhoe, J.M. Arblaster, and G.A. Meehl. 2006. "Going to the Extremes; An Intercomparison of Model-Simulated Historical and Future Changes in Extreme Events." *Climatic Change* 79(3-4): 185-211. Adapted by Lawrence Buja and Julie Arblaster. Retrieved January 21, 2009, from http://www.cgd.ucar.edu/ccr/climate_change_gallery_test/.

[f] Luber, G.E. and C.A. Sanchez. 2006. "Heat-Related Deaths--United States, 1999-2003." *Morbidity and Mortality Weekly Report* 55 (29): 796-798. Retrieved January 13, 2009, from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5529a2.htm

[g] *See*, for example, Guria, J., J. Leung, M. Jones-Lee, and G. Loomes. 2005. "The Willingness to Accept Value of Statistical Life Relative to the Willingness to Pay Value: Evidence and Policy Implications." *Environmental and Resource Economics* 32: 113-127.

3. Other Potential Costs from the Efffects of Climate Change on Human Health

Description

Impacts of climate change on human health are not restricted to those caused by high levels of ozone or heat. Studies have shown that climate change will make wider areas hospitable to vectors that produce diseases, such as the West Nile virus, encephalitis, and Lyme disease. At the same time, water- and food-borne diseases likely will increase in incidence and cases of *Giardia*, *salmonellosis, E. coli* will become more frequent.[a]

We have found no data to quantify these future impacts associated with climate change but the lack of quantifiable information does not mean that the value is zero.

References and Notes

[a] Ebi, K.L., J. Balbus, P.L. Kinney et al. 2008. "Effects of Global Change on Human Health." In J.L. Gamble, ed., *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems.* Washington, D.C.: U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency. Retrieved December 23, 2008, from http://www.climatescience.gov/Library/sap/sap4-6/final-report/sap4-6-final-all.pdf.

G. Recreation

1. Reduced Opportunities for Downhill Skiing

Description

Higher temperatures reduce snowfall and accumulation, shortening the ski season, degrading skiing conditions, and reducing the value of skiing.

Assumptions, Data, and Calculation

We assume that, absent climate change, downhill skiing participation would grow from the 2007-2008 ski season level, 716,477 skier-days,[a] at the same rate as the general population is expected to grow, and that the average expenditures and consumer surplus per skier day would remain at $80[b] and $28[c] per day, respectively. We assume that the ski season will shrink 36 percent by 2020, 52 percent by 2040, and 85 percent in 2080, based on the rate at which snowpack is expected to decline over the next century in the southern Rocky Mountains.[d] We assume the number of user-days, expenditures, and consumer surplus shrinks proportionately. The potential harm equals the number of user days times the expenditures and consumer surplus per day times the percentage loss of recreation opportunity from climate change.

Results

Potential Value of Reduced Downhill Skiing Recreation

2020	2040	2080
$50 million	$78 million	$168.7 million

Source: ECONorthwest

Industry officials suggest that once the snow-recreation season is shortened to the extent indicated for 2080, snow-related recreation businesses, downhill ski businesses in particular, likely would not be viable and would close.[d]

References and Notes

[a] Ski New Mexico. 2008. "The 2007-2008 Season Has Just Wrapped up a Banner Year." *News Letter III*. April 25. Retrieved January 19, 2009, from http://www.skinewmexico.com/membership/fromthedirector.php

[b] Berry, M. 2008. *Overview of the U.S. Ski Industry.* National Ski Areas Association. June 27.

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2. Reduced Opportunities for Cold-Water Angling

Description

Increased stream temperatures reduce the amount of habitat that can viably support trout, reducing the contribution of cold-water angling to the economy.

Assumptions, Data, and Calculation

We assume the value of cold-water angling will decline proportionate to expected losses of cold-water habitat. An assessment of stream temperatures under a middle-of-the-road emissions scenario indicates increased warming might reduce cold-water habitat by up to 100 percent by 2050.[a] We interpolate and adjust the percentage to reflect the A1FI scenario, and apply it to 1,434,000[b] the number of stream-based angling days in 2006, to estimate the reductions in angling in 2020, 2040, and 2080. We adjust for population growth in 2020, 2040, and 2080 and value the reductions applying the estimated consumer surplus and expenditures per trout-angler per day: $96[c] and $115,[b] respectively.

Results

Potential Value of Reduced Cold-Water Angling

2020	2040	2080
$234 million	$480 million	$634 million

Source: ECONorthwest

References and Notes

[a] Michaels, G., K. O'Neal, J. Humphrey, et al. 1995. *Ecological Impacts from Climate Change: An Economic Analysis of Freshwater Recreational Fishing.* Abt Associates, Inc. and the U.S. Environmental Protection Agency. Report No. EPA-230-R-95-004.; and O'Neal, K. 2002. *Effects of Global Warming on Trout and Salmon in U.S. Streams.* Defenders of Wildlife and Natural Resources Defense Council. May.

[b] U.S. Fish and Wildlife Service. 2008. *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: New Mexico.* Report No. FHW/06-NM. April.

[c] Loomis, J. 2005. *The Economic Value of Recreational Fishing & Boating to Visitors & Communities Along the Upper Snake River.* May. Henry's Fork Foundation and Trout Unlimited.

3. Reduced Economic Output from the Reservoir Recreation Sector

Description

Changes in temperature and precipitation will reduce the water levels in reservoirs, reducing reservoir-recreation opportunities, and thus output from the reservoir-recreation sector in the Rio Grande Vally.

Assumptions, Data, and Calculation

We rely on the results of a study that coupled a climate model with a hydroeconomic model of the Rio Grande watershed.[a] The study found that under an A1B scenario and dry conditions the direct economic output of the reservoir recreation sector in 2030 would fall by $3.7 million, and in 2080 would fall by $7.4 million in 2008 dollars. We adjust these results to the A1FI scenario and interpolate to find values for 2020 and 2040.

Results

Potential Value of Reduced Reservoir Recreation

2020	2040	2080
$2.4 million	$5 million	$9.1 million

Source: ECONorthwest

References and Notes

[a] Hurd, B.H. and J. Coonrod. 2007. *Climate Change and its Implications for New Mexico's Water Resources and Economic Opportunities.* New Mexico State University, Department of Agricultural Economics and Agricultural Business and University of New Mexico, Department of Civil Engineering. July.

4. Other Potential Costs from the Effects of Climate Change on Recreation

Description

Increased wildland fires will potentially reduce recreation opportunities during summer months. Forest closures during wildland fire events and exceptionally dry, high-risk fire seasons may limit the area, and thus opportunities, available for activities, such as hiking, mountain biking, wildlife watching, and scenic driving. For example, in 2002, extreme fire conditions closed five of New Mexico's forests to all recreational uses for up to 40 percent of the summer recreation season. Researchers found that the potential loss to the regional economy associated with such a closure could amount to $480 million of lost economic output.[a] This kind of closure would become more likely in any given year with climate change. In addition, post-fire landscapes may provide more limited or lower-quality recreation experiences.[b]

Low water levels in streams, especially in late summer, may also reduce some water-related recreation opportunities, such as river rafting and kayaking. As peak flows shift earlier in the season due to earlier snowmelt, they may not longer overlap with the summer season in which many people enjoy river recreation. Lower flows during peak summer months may limit boating on certain stretches of river and lower the quality of the recreation experience.[c]

Though insufficient data are available to quantify these impacts, research suggests that they have the potential to reduce the value (expenditures and consumer surplus) of forest-based and water-related recreation in New Mexico.

References and Notes

[a] Starbuck, C.M., R.P. Berrens, and M. McKee. 2006. "Simulating Changes in Forest Recreation Demand and Associated Economic Impacts Due to Fire and Fuels Management Activities." *Forest Policy and Economics* 8: 52-66.

[b] Scott, D., G. Wall, and G. McBoyle. 2005. "Chapter 7: Climate Change and Tourism and Recreation in North America: Exploring Regional Risks and Opportunities." In C. M. Hall and J. Higham (eds.) *Tourism, Recreation and Climate Change. Aspects of Tourism.* Clevedon: Channel View Publications.

[c] Mickelson, K.E., and A.F. Hamlet. 2008. "Effects of Climate Change on White-Water Recreation on the Salmon River, Idaho." American Geophysical Union, Fall Meeting.

H. Water Resources

Description

Increased temperatures from climate change will diminish the supply of water to meet ecological, municipal-industrial, irrigation, and other demands by reducing mountain snowpack[a] and, hence, snowmelt runoff, and by increasing evapotranspiration.[b]

Assumptions, Data, and Calculation

We employ the results of a study that found stream flows in the Southwest might decrease by 10 percent by 2060 under the A1B scenario.[c] We linearly interpolate and extrapolate to estimate the reductions for 2020, 2040, and 2080, and make adjustments so the estimates reflect the A1FI scenario. We apply the estimates to average stream flows that originated in New Mexico in recent years[d] to arrive at annual flow reductions that range from 250,000 acre-feet by 2020 to 670,000 acre-feet by 2080. We calculate the value of the streamflow reductions using as proxy an estimate of American farmers' willingness to pay for an incremental increase in water availability, $31 per acre-foot.[e]

Results

Potential Value of Reduced Streamflows

2020	2040	2080
$8 million	$11 million	$21 million

Source: ECONorthwest

These results understate the potential harm insofar as increased scarcity of water would increase the value of water above current levels. They understate (overstate) the potential harm to the extent that the incremental value of water to satisfy other demands would be greater than (less than) irrigators' willingness to pay. Population growth could increase demand for water in the future, increasing the price, and increasing the value of these losses.

References and Notes

[a] Nolin, A.W. and C. Daly. 2006. "Mapping 'At Risk' Snow in the Pacific Northwest." *Journal of Hydrometeorology* 7: 1164-1171.

[b] Christensen, N.S. and D.P. Lettenmaier. 2007. "A Mutimodel Ensemble Approach to Assessment of Climate Change Impacts on the Hydrogeology and Water Resources of the Colorado River Basin." *Hydrology and Earth System Sciences* 11: 1417-1434.

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[d] Brown, T.C., M.T. Hobbins, and J.A. Ramierz. 2008. "Spatial Distribution of Water Supply in the Coterminous United States." *Journal of the American Water Resources Association* 44 (6): 1474-1487.

[e] Young, R.A. 2005. *Determining the Economic Value of Water*. Washington, D.C.: Resources for the Future.

IV. The Potential Economic Costs Associated with Activities that Contribute to Climate Change

In this section, we describe costs that are produced by activities associated with the business-as-usual pathway that contribute to climate change. Although these are not costs resulting directly from the effects of climate change *per se*, they represent important sources of economic harm society incurs by proceeding with business-as-usual activities.

A. Wasteful Use of Energy

Description

Consumers incur costs by using technologies and behaviors that are less efficient than available substitutes in their use of energy.

Assumptions, Data, and Calculation

We assume New Mexico's consumption of electricity and natural gas in 2007[a] will increase at rates estimated by the Energy Information Administration[b] for New Mexico and use percentages reported by several studies[c] to estimate the amount of energy New Mexicans will waste by not implementing cost-effective programs and technologies to increase energy efficiency. We estimate the value of the expenditures on wasted energy using recent average prices.[d]

Results

Potential Value of Wasted Electricity and Natural Gas

2020	2040	2080
$1.30 billion	$2.38 billion	$8.31 billion

Source: ECONorthwest

References and Notes

[a] Energy Information Administration. 2008. *Current and Historical Monthly Retail Sales, Revenue and Average per Kilowatthour by State and by Sector (Form EIA-826)*. Retrieved January 15, 2009, from http://www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls; and Energy Information Administration. 2008. *New Mexico Natural Gas Consumption by End Use: 2002-2007*. Retrieved January 22, 2009, from http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm

[b] Energy Information Administration. 2008. *EERE State Activities and Partnerships: Electric Power and Renewable Energy in New Mexico*. Retrieved January 23, 2009, from http://apps1.eere.energy.gov/states/electricity.cfm/state=NM

[c] Nadel, S., A. Shipley, R.N. Elliott. 2004. *The Technical, Economic and Achievable Potential for Energy Efficiency in the U.S.-A Meta Analysis of Different Studies*. American Council for an Energy-Efficient Economy.

[d] Energy Information Administration. 2008. *Current and Historical Monthly Retail Sales, Revenue and Average per Kilowatthour by State and by Sector (Form EIA-826)*. Retrieved January 15, 2009, from http://www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls; and Energy Information Administration. 2008. *New Mexico Natural Gas Prices: 2002-2007*. Retrieved from http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm

B. Emissions from the Generation of Coal-Fired Electricity

Description

Burning coal to generate electricity in New Mexico will impose health-related spillover costs on New Mexicans, i.e., costs not reflected in the price of the electricity.

Assumptions, Data, and Calculation

Coal-fired power plants in New Mexico emitted 28,275 metric tons of sulfur dioxide and 68,012 metric tons of nitrogen oxide in 2006.[a] The health-related externality costs associated with these pollutants are $2,556 per ton for sulfur dioxide and $1,505 per ton for nitrogen oxides.[b] We assume that, in a business-as-usual future, emissions would continue at these rates and that coal-fired electricity generation in New Mexico would grow at the expected rate for total electricity consumption, 3.3 percent per year.[c] The potential harm is the sum of the cost of the health-related spillover costs for the three pollutants.

Results

Potential Value of Health-Related Spillover Costs of Coal-Fired Electricity

2020	2040	2080
$275 million	$527 million	$1.87 billion

Source: ECONorthwest

These results likely underestimate the total health-related spillover costs associated with coal-fired electricity generation, insofar as they do not include other harmful pollutants, such as mercury, volatile organic compounds, and carbon monoxide.

References and Notes

[a] Energy Information Administration. 2008. *U.S. Electric Power Industry Estimated Emissions (EIA-767 and EIA 906).* Retrieved January 23, 2009, from http://tonto.eia.doe.gov/state/SEP_MoreEnviron.cfm.

[b] Matthews, H.S. and L.B. Lave. 2000. "Applications of Environmental Valuation for Determining Externality Costs." *Environmental Science and Technology.* 34 (8) 1390-1395. Values converted to equivalent 2008 dollars.

[c] U.S. Department of Energy, Energy Efficiency and Renewable Energy. 2008. *Electricity Power and Renewable Energy in New Mexico.* Retrieved January 23, 2009, from http://apps1.eere.energy.gov/states/electricity.cfm/state=NM

V. Potential Economic Costs Per Household

The preceding sections illustrate some specific types of potential economic costs New Mexicans as a whole would face if New Mexico, other states, the U.S., and other nations adopt a business-as-usual approach to climate change. Here, we scale down our findings to illustrate the potential costs per household.

In 2005, New Mexico had 727,000 households.[30] We assume this number will grow at the same rates projected for New Mexico's population through 2035 and at the rates projected for the U.S. population from 2035 until 2080, reaching 940,000 in 2020, 1.16 million in 2040, and 1.53 million in 2080. Dividing these numbers into the estimates of statewide potential costs from the preceding section for each of these years yields the per-household costs shown in Figure 7. These costs are not negligible; based on the median income of a household in New Mexico in the 2005-2007 period,[31] these costs represent 8 percent of household earnings in 2020, 13 percent in 2040, and 29 percent in 2080.

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[30] U.S. Census Bureau. 2006. "Selected Social Characteristics: New Mexico." *2005 American Community Survey*. Retrieved February 6, 2009, from http://www.census.gov/acs/www/Area%20Sheets/Area%20Sheet%20NM.doc

[31] U.S. Census Bureau. No date. "New Mexico-Fact Sheet—American FactFinder." *2005-2007 American Community Survey*. Retrieved January 26, 2009, from http://factfinder.census.gov/

Figure 7. Potential Economic Costs Per Household in New Mexico Under a Business-As-Usual Approach to Climate Change, 2020, 2040, and 2080 (Dollars per Year)

Potential Cost	2020	2040	2080
Costs of Climate Change			
Increased Energy-Related Costs	$264	$558	$1,701
Reduced Trout Populations	$40	$40	$40
Increased Flood and Storm Damage	$94	$156	$285
Reduced Food and Agricultural Production	$78	$111	$250
Increased Wildland Fire Costs	$519	$867	$1,461
Increased Health-Related Costs	$448	$655	$1,069
Lost Recreation Opportunities	$304	$486	$531
Reduced Streamflows	$9	$9	$14
Subtotal for Costs of Climate Change	*$1,755*	*$2,883*	*$5,350*
Additional Costs from Business-as-Usual (BAU) Activities that Contribute to Climate Change			
Inefficient Consumption of Energy	$1,383	$2,071	$5,429
Increased Health Costs from Coal-Fired Emissions	$293	$455	$1,243
Subtotal for Costs from BAU Activities	*$1,675*	*$2,526*	*$6,671*
Average Cost per Household per Year	**$3,430**	**$5,409**	**$12,022**

Source: ECONorthwest.

Notes: These numbers illustrate different types of annual cost New Mexicans potentially would incur if society were to continue with a business-as-usual approach to climate change. There may be overlap between the values for some of the different types of cost. Nonetheless, adding the different types of costs probably seriously understates the total potential cost of climate change because the table excludes many additional types of climate-related costs that New Mexicans would incur under a business-as-usual approach. The numbers do not indicate the net effect of climate change, as they do not represent a forecast of how the economy will respond to the different effects of climate change, or account for potential economic benefits that might materialize from moderate warming and other changes in climate.