

## NORTH DAKOTA

### ASSESSING THE COSTS OF CLIMATE CHANGE

#### CLIMATE TRENDS IN NORTH DAKOTA

The climate in North Dakota can be severe: blizzards, floods, droughts, tornadoes, hail storms, thunderstorms, high winds, severe cold spells, and extreme heat are not uncommon.<sup>1</sup> The state experiences cyclical droughts, with semi-arid conditions prevailing in the western half of the state. The eastern half receives most of the precipitation, primarily as rain in the spring and summer.<sup>2</sup>

During the past 100 years, the average annual temperatures in the northern and central Great Plains have risen by about 2° F. The latest IPCC report predicts the state could experience an increase in temperature of nearly 7° F by 2100.<sup>3</sup> Extreme weather events in North Dakota—including periods of decreased rainfall and severe drought, and more intense rainfall when precipitation occurs—are projected to increase in frequency.<sup>4,5</sup>

These changes in climate are likely to cause economic losses to North Dakota's vital agricultural sector. If drought and climate variability increase as predicted, crop and livestock productivity are likely to decrease. Climate change also may cause losses in the tourism industry and increase the cost of maintaining infrastructure.

#### ECONOMIC IMPACTS<sup>6</sup>

##### *Agriculture*

The agricultural sector is a prominent part of North Dakota's economy, with wheat contributing the most to North Dakota's income—about \$4.5 billion annually.<sup>7</sup> The state also produces flax, seed potatoes, barley, sugar beets, oats, soybeans and sunflowers.<sup>8</sup> In 2006, North Dakota was 11th in the nation in agricultural exports, with an estimated value of \$1.9 billion. The agricultural sector supports about 22,300 jobs, both on the farm and in the food processing, storage and transportation industries.<sup>9</sup>

The state agricultural sector has experienced significant losses due to drought. In 2002, the state lost \$223 million due to crop damage caused by drought.<sup>10</sup> The drought in 2006 cost the livestock industry more than \$32 million, according to economists at North Dakota State University. The losses occurred largely due to an increase in the cost of feed, which rose more than 50 percent in some areas due to smaller harvests. The same 2006 drought inflicted more than \$425 million in damages to crops, resulting in nearly \$309 million in crop insurance indemnity payments.<sup>11</sup> Grazing also

##### OVERVIEW

In the coming decades, a changing climate is likely to affect North Dakota's economy. The most recent climate modeling predicts higher temperatures and worsening droughts for the state. These changes could be more pronounced if global emissions of greenhouse gases are not reduced. Agriculture, water resources and tourism may be affected in a variety of ways and could result in significant losses. Since state economies are directly linked to the economies of neighboring states and regions, policymakers may wish to consider both state and regional policies.



was drastically reduced due to drought conditions, forcing producers to sell livestock as well as land, and many cattle did not survive.<sup>12</sup> Drought conditions cost the state on average an estimated \$228 million annually, resulting in the loss of approximately 360 jobs each year.<sup>13</sup> Droughts also are costly because they increase the probability of fire. During the 2006 drought, approximately 45,000 acres of grassland burned, and 50 percent of counties were under burn bans throughout the summer.<sup>14</sup>

North Dakota's agricultural sector also has seen losses due to an increase in crop pests, which has been attributed to factors such as erratic weather conditions and higher winter temperatures—conditions consistent with the effects of climate change.<sup>15</sup> Agricultural losses from plant diseases exceed \$1 billion annually and reduce business activity in the state, resulting in additional indirect losses. Fusarium head blight in wheat, barley and durum resulted in nearly \$5 billion in losses from 1993 to 2005. Direct losses to farmers' income from the disease during 2005 were estimated at \$171 million, while the overall effect on the state's economy was a loss of more than \$544 million.<sup>16</sup>

Other diseases and insects infect a range of commodities, reducing state revenue by several hundred million dollars annually.<sup>17</sup> A recent report by the Harvard Medical School found that projected climate change impacts—such as droughts, higher temperatures, and more frequent intense weather events—will help spread plant pests and diseases and are likely to create more losses for the agricultural sector.<sup>18</sup>

An economic analysis by researchers at Towson University estimated that, due to pest outbreaks, 2,500 people lose their jobs each year, while the economic impact tops \$1.5 billion dollars annually.<sup>19</sup>

### *Water Supplies and Infrastructure*

Droughts and rainfall events also affect infrastructure and water supply. The worst drought in North Dakota's history lasted from 2000 to mid-2006, straining public water supplies throughout the period. On August 23, 2006, the U.S. Army Corps of Engineers was forced to increase flows from Garrison Dam in North Dakota to supplement the low water levels of the downstream Oahe Reservoir along the Missouri River. Lake Oahe was at a record low of 1,571.3 feet above sea level (compared to a typical average of 1,610 feet).<sup>20</sup> The drought directly affected hydropower production and contributed to the worst fire season on record.<sup>21</sup>



Drought also has affected North Dakota's transportation infrastructure. In Fargo, the clay beneath the city has shrunk from lack

of moisture, leading to cracked sidewalks, driveways and streets.<sup>22</sup>

Heavy rains may cause problems for the water system and infrastructure. Drought-like conditions inhibit soil absorption of rainwater, resulting in an increase in runoff and the likelihood of flash floods following heavy rain. In 2002, the state experienced \$2.35 million in flood damages to roads, streets, bridges and water drainage systems in rural areas.<sup>23</sup> In 2004, 679 housing units were damaged due to floods along the Red River Basin.<sup>24</sup> Since climate change models project more extreme weather events coupled with drier conditions, North Dakota will likely experience further damage to its infrastructure, disrupting critical services and inflicting economic losses.

## OTHER ECONOMIC IMPACTS

### *Hunting and Fishing*

In 2006, nearly 400,000 sports enthusiasts spent \$260 million on hunting and fishing in North Dakota, providing about 5,000 jobs.<sup>25</sup> Rainbow trout anglers—who spend more than \$1 million on retail items each year—may reduce their fishing excursions, since fish populations are expected to suffer from higher temperatures and lower stream flows.<sup>26</sup>

Lower water levels in Lake Sakakawea, one of the largest man-made lakes in the country, will affect the cold-water habitat necessary to sustain the forage fish species that serve as the food base for bigger game fish.<sup>27</sup> As water levels have decreased, reducing shoreline access for anglers' boats, local business income has declined. Continued changes in the water levels and temperatures will likely undermine this economically important recreational activity.

Hunting is likely to be affected by climate change as well. North Dakota's prairie potholes—the most productive waterfowl nesting grounds in the nation—currently provide nesting grounds for waterfowl that produce more than 3.8 million offspring each year.<sup>28</sup> Waterfowl hunting is a profitable industry in the state; trip and equipment expenditures topped \$44 million in 2001.<sup>29</sup> By 2080, climate change could reduce wetlands in the Prairie Pothole Region and areas of the northern Great Plains by 91 percent.<sup>30</sup> This could drastically reduce duck populations, not only in North Dakota but along the entire Mississippi flyway. Populations of other bird species such as the greater prairie chicken are likely to decline due to loss of habitat. Reduced hunting activity due to declining bird populations could cause losses for small businesses in the region of more than \$7 million because of decreased expenditures on food, lodging, transportation and equipment.<sup>31</sup>

Changes in the location and range of habitats are likely to affect bird watchers. In 2006, wildlife enthusiasts spent approximately \$23 million in North Dakota.<sup>32</sup> Nearly 35 bird species found in North Dakota today are predicted to move their summer habitat out of North Dakota, and habitat for some 20 bird species is expected to shrink.<sup>33</sup> Birds are an extremely important link in ecosystems, providing pollination, seed dispersion and insect control for agricultural production. The economic effects on the agricultural industry from reduced bird numbers may be significant.

### Hydroelectric Dams

Although electricity generation in North Dakota is dominated by coal, hydroelectric power represents an important alternative energy source, accounting for 4 percent of the state's total electricity production.<sup>34</sup> In future years, however, maintaining and expanding this level of production might be compromised due to climate change. Climate models suggest drier conditions, which will lower water levels in crucial reservoirs and undermine hydroelectric energy production.

Garrison Dam on the Missouri River, the fifth largest dam in the United States, forms Lake Sakakawea. The dam, the fifth largest electricity generation plant by capacity in the state,<sup>35</sup> also is used for flood control and irrigation and is vital for recreation, fish and wildlife.

Figure 1. Missouri River



Source: USGS, 2008 *Dams and Reservoirs of the Upper Missouri River*; [nd.water.usgs.gov/lewisandclark/dams.html](http://nd.water.usgs.gov/lewisandclark/dams.html).

Lake Oahe, the fourth largest manmade reservoir in the United States, spans both North Dakota and South Dakota. The dam that created the lake provides hydroelectric power and flood control; regulates downstream flows for navigation, recreation, fish and wildlife; and provides water for drinking and irrigation.<sup>36</sup> The

fishery in Lake Oahe yielded \$27.64 million per year in revenue in the mid-1990s. This declined to approximately \$11.25 million per year by 2004 due to lower water levels caused by drought and water allocation decisions.<sup>37</sup>

The potential electricity production from both dams may be greatly diminished in the future as water levels decrease.

Lower water levels also are likely to affect the public water supply and recreational activities associated with the reservoirs.

### CONCLUSION

Climate is predicted to increase the likelihood of drought, which could impose considerable costs on North Dakota farmers. To gain a better picture of how these changes could affect farmers, improved assessments of how climate change may alter the state's supply of water for agriculture are needed. These assessments can help during the development of water management plans that can ensure crop productivity during periods when water is scarce. Policymakers may wish to encourage research that helps create state-specific assessments of how changes in temperature and precipitation may affect agriculture. Promoting research into adaptation options—such as the potential for farming drought-tolerant crops and using water-conserving tillage practices—may help avoid serious loss if droughts become more common.

Since water availability also will affect residential, business and power sectors, policies that promote the collaboration of all sectors may be necessary. Better research on the effects of drought and of increased flooding on these sectors will help policymakers and stakeholders evaluate water security and develop plans for water conservation and drought response. Planning for reduced electricity contribution from hydropower, possibly by substituting alternatives such as wind, is likely to prevent income losses and the potential power shortages that could be caused by loss of hydropower.

Since climate change is likely to bring changes for wildlife populations and their habitat, thereby affecting tourism income, policymakers may wish to promote more research on how a changing climate could affect North Dakota's ecological resources and investigate preservation approaches that increase the odds that wildlife will be able to adapt to a changing climate. Creating large, inter-connected wildlife preserves with varied ecosystems may improve animals' ability to adapt to climate change.

#### MISSING INFORMATION AND DATA GAPS

General climate predictions relating to the entire state of North Dakota must be made cautiously due to its variable topography. Many possible scenarios could result from climate change, which makes the prediction of economic impacts challenging. Better assessments on how climate change will affect North Dakota's variable climate are needed.



## NOTES

1. U.S. Global Change Research Program, *Climate Change Impacts on the United States; The Potential Consequences of Climate Variability and Change, "Overview: Great Plains"* (Washington, D.C.: USGCRP, 2000); [www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewgreatplains.htm](http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewgreatplains.htm).
2. *The Columbia Electronic Encyclopedia*, "North Dakota Geography," 6th ed. (New York, N.Y.: Columbia University Press, 2007); [www.infoplease.com/ce6/us/A0860034.html](http://www.infoplease.com/ce6/us/A0860034.html).
3. R.K. Pacharui et al., *Climate Change 2007: Synthesis Report, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva, Switzerland: United Nations Intergovernmental Panel on Climate Change, 2007): 104; [www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4\\_syr\\_frontmatter.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_frontmatter.pdf).
4. Brian Handwerk, "Plains Drought Cycle Has Long History, Ominous Future," *National Geographic News* (2005); [news.nationalgeographic.com/news/2005/06/0614\\_050614\\_drought.html](http://news.nationalgeographic.com/news/2005/06/0614_050614_drought.html).
5. U.S. Global Change Research Program, *Climate Change Impacts on the United States*.
6. All dollar figures are adjusted to 2007 dollars. Job creation and other economic figures are taken directly from the source documents. Inflation figures are drawn from the Bureau of Labor Statistics' Consumer Price Index calculator: <http://data.bls.gov/cgi-bin/cpicalc.pl>.
7. North Dakota Wheat Commission, *Report to the 2007 North Dakota Legislative Assembly: Economic Importance of Wheat* (Bismarck, N.D.: NDWC, 2007); [www.ndwheat.com/uploads%5Cresources%5C614%5C07legreport.pdf](http://www.ndwheat.com/uploads%5Cresources%5C614%5C07legreport.pdf).
8. *The Columbia Electronic Encyclopedia*, "North Dakota Geography."
9. U.S. Department of Agriculture, Foreign Agricultural Service, *Fact Sheet: U.S.-Colombia Trade Promotion Agreement – North Dakota Farmers Will Benefit* (Washington, D.C.: USDA FAS, 2008); [www.fas.usda.gov/info/factsheets/Colombia/nd\\_Colombia.asp](http://www.fas.usda.gov/info/factsheets/Colombia/nd_Colombia.asp).
10. Frank Jossi, "Drought is hell," *Fedgazette* (2002); [www.minneapolisfed.org/pubs/fedgaz/02-11/drought.cfm](http://www.minneapolisfed.org/pubs/fedgaz/02-11/drought.cfm).
11. North Dakota Department of Agriculture, *Testimony of Roger Johnson, Agriculture Commissioner, House Concurrent Resolution 3005* (Bismarck, N.D.: ND DOA, 2007); [www.agdepartment.com/Testimony/2007LegTestimony/HCR3005-AgDisasterReliefPkg.pdf](http://www.agdepartment.com/Testimony/2007LegTestimony/HCR3005-AgDisasterReliefPkg.pdf).
12. North Dakota Department of Environmental Services, *Situation Report No. 2 Incident No. 2006-032* (Bismarck, N.D.: ND DES, 2006); [www.nd.gov/des/reports/docs/sitrep/2006/2006-032-02.pdf](http://www.nd.gov/des/reports/docs/sitrep/2006/2006-032-02.pdf).
13. RESI, Calculations using modified IMPLANTM economic model from the Regional Economic Studies Institute (RESI) of Towson University (Towson, Md.: RESI, 2008).
14. North Dakota Department of Environmental Services, *Situation Report No. 2 Incident No. 2006-032*.
15. Cynthia Rosenzweig, *Climate Change and U.S. Agriculture: The Impacts of Warming and Extreme Weather Events on Productivity, Plant Disease, and Pests* (Cambridge, Mass.: Harvard Medical School, Center for Health and the Global Environment, 2000); [www.eesi.org/briefings/publications/05.25.00ccag.pdf](http://www.eesi.org/briefings/publications/05.25.00ccag.pdf).
16. North Dakota State University, Agricultural Experiment Station, *Enhancing North Dakota's Economy Through Agriculture 2007-09 Investment Proposals* (Fargo, N.D.: NDSU, 2007); [www.ag.ndsu.nodak.edu/ag-vp/grow21-investment.htm](http://www.ag.ndsu.nodak.edu/ag-vp/grow21-investment.htm).
17. Ibid.
18. Cynthia Rosenzweig, *Climate Change and U.S. Agriculture: The Impacts of Warming and Extreme Weather Events on Productivity, Plant Disease, and Pests*.
19. RESI, Calculations using modified IMPLANTM economic model from the Regional Economic Studies Institute (RESI) of Towson University.
20. U.S. Geological Survey, North Dakota Water Science Center *Missouri River Ohio Basin* (Bismarck, N.D.: USGS, 1999); [nd.water.usgs.gov/pubs/wdr/wdrnd991/htdocs/d.06439980wq99.html](http://nd.water.usgs.gov/pubs/wdr/wdrnd991/htdocs/d.06439980wq99.html).
21. North Dakota Department of Environmental Services, *Situation Report No. 2 Incident No. 2006-032*.
22. Ibid.
23. North Dakota Office of the Governor, *Hoeven Requests Preliminary Flood Damage Assessment* (Bismarck, N.D.: Office of the Governor, 2002); [governor.state.nd.us/media/news-releases/2002/07/020719b.html](http://governor.state.nd.us/media/news-releases/2002/07/020719b.html).
24. M. Bell, Dr. A. Giannini, E. Grover, Dr. B. Lyon, C. Ropelewski, and Dr. A. Seth, *IRI Climate Digest, April 2004 Climate Impacts - March* (Palisades, N.Y.: International Research Institute for Climate and Society, 2004); [iri.columbia.edu/climate/cid/Apr2004/impacts.html](http://iri.columbia.edu/climate/cid/Apr2004/impacts.html).
25. U.S. Fish and Wildlife Service, *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: State Overview*, (Washington, D.C.: USFWS, 2007); [library.fws.gov/nat\\_survey2006\\_state.pdf](http://library.fws.gov/nat_survey2006_state.pdf).
26. North Dakota Department of Environmental Services, *Situation Report No. 2 Incident No. 2006-032*.
27. North Dakota Office of the Governor, *Proclamation: North Dakota Drought Disaster March 10, 2005, Until Further Notice* (Bismarck, N.D.: Office of the Governor, 2005); [www.governor.state.nd.us/procl/docs/2005/03/20050310.pdf](http://www.governor.state.nd.us/procl/docs/2005/03/20050310.pdf).
28. Angela Magstadt, "North Dakota Waterfowl Fish and Wildlife Service Plays Role from Production to Migration," *North Dakota Outdoors* (Bismarck, N.D.: N.D. GFD, 2006); [gf.nd.gov/multimedia/ndoutdoors/issues/2006/may/docs/nd-waterfowl.pdf](http://gf.nd.gov/multimedia/ndoutdoors/issues/2006/may/docs/nd-waterfowl.pdf).
29. U.S. Fish and Wildlife Service, *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (Washington, D.C.: USFWS, 2001); [www.census.gov/prod/2002pubs/FHW01.pdf](http://www.census.gov/prod/2002pubs/FHW01.pdf).
30. National Wildlife Federation, *Global Warming and North Dakota* (Reston, Va.: NWF, 2008).
31. Business Management of Operations: Division of Economics, *Economic Analysis of the Migratory Bird Hunting Regulations for the 2007-2008 Season: A partial update of the 2004 Economic Analysis* (Washington, D.C.: U.S. FWS, 2007); [www.fws.gov/migratorybirds/reports/SpecialTopics/EconomicAnalysis-2007Update.pdf](http://www.fws.gov/migratorybirds/reports/SpecialTopics/EconomicAnalysis-2007Update.pdf).
32. U.S. Fish and Wildlife Service, *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: State Overview*.
33. Jeff Price, *Global Warming and Songbirds in North Dakota* (Washington, D.C.: American Bird Conservancy, 2002); [www.abcbirds.org/newsandreports/globalwarming/NorthDakota.pdf](http://www.abcbirds.org/newsandreports/globalwarming/NorthDakota.pdf).
34. Office of Energy Efficiency and Renewable Energy, *Electric Power and Renewable Energy in North Dakota* (Washington, D.C.: U.S. DOE, 2008); [www.eere.energy.gov/states/electricity.cfm?state=ND#fuel](http://www.eere.energy.gov/states/electricity.cfm?state=ND#fuel).
35. Energy Information Administration, *North Dakota: State Energy Profile* (Washington, D.C.: EIA, 2008); [tonto.eia.doe.gov/state/state\\_energy\\_profiles.cfm?sid=ND](http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=ND).
36. U.S. Geological Survey, *Dams and Reservoirs of the Upper Missouri River* (Reston, Va.: USGS, North Dakota Water Science Center, 2001); [nd.water.usgs.gov/lewisandclark/dams.html](http://nd.water.usgs.gov/lewisandclark/dams.html).
37. South Dakota Drought Task Force, *Missouri River: Drought and the Impacts to Authorized Uses* (Pierre, S.D.: South Dakota Drought Task Force, May 14, 2008); [www.state.sd.us/applications/MV31DroughtTaskForce/Documents/SDEngineerSociety.pdf](http://www.state.sd.us/applications/MV31DroughtTaskForce/Documents/SDEngineerSociety.pdf).

These reports are the result of collaboration between the National Conference of State Legislatures and the University of Maryland's Center for Integrative Environmental Research. Funding for these publications was provided by the Environmental Defense Fund.