Ongoing Research

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Outreach and Communication

Photo: Darren Bush

CHAPTER NINE

MOVING FORWARD

This report is the first of what will be a recurrent assessment of climate change impacts and adaptation strategies in Wisconsin. Even as we synthesized the findings of the working groups, those working groups continued to move forward with their vulnerability assessments and identification of possible adaptation strategies. In this chapter we highlight ongoing climate and adaptation research efforts, describe areas in need of future attention and present an outreach strategy for communicating the results of the current WICCI effort.

Ongoing Research

This first assessment report reflects the current state of the science on climate change in Wisconsin at the time of publication. We recognize that science progresses and new discoveries are continually being made. In this section we outline significant ongoing work associated with the WICCI working groups. Future WICCI efforts, including future impact and assessment reports, will benefit from these Wisconsin-based studies. We acknowledge, however, that as our understanding of climate change evolves and new information is obtained – some of which may appear to conflict with previous data – we will need to build close relationships between policy-makers, managers and scientists as a way of integrating new knowledge into future impact and vulnerability assessments and adaptation strategies.

Downscaled Climate Data for the Upper Midwest and Great Lakes

With support from the U.S. Fish and Wildlife Service and Environmental Protection Agency, researchers at the University of Wisconsin-Madison Nelson Institute Center for Climatic Research are extending downscaled temperature and precipitation (including snow cover) projections for Wisconsin to the Great Lakes region. These Great Lakes climate projections will be coordinated with similar projections that are being developed for the plains and prairie potholes region. Since the models employed in the projections will be downscaled from a suite of national models, these projects could establish a standard for a national system of downscaling.

Photo: Elizabeth Katt-Reinders

Downscaled Wind and Other Climatological Parameters

Researchers at the UW-Madison Nelson Institute Center for Climatic Research are downscaling additional climatological parameters of relevance to energy production in the state. With support from Wisconsin's Focus on Energy program, the team has identified additional variables that will help us better understand future impacts, including wind (alternative energy production, lake mixing, coastal processes), humidity (human health, evapotranspiration, hydrology), evapotranspiration (lake levels, ecosystems, hydrology) and solar radiation (human health, lake stratification).

Hydrologic Impact Modeling

With support from Wisconsin's Focus on Energy program, researchers at the Wisconsin Department of Natural Resources are assessing the long-term hydrologic impacts of climate change across Wisconsin. Ten-year average annual runoff and nonpoint source pollutant loadings will be modeled for approximately 1,700 sub-watersheds and 50,000 stream catchments. Models will be built and run for the period between 1950 and 2006 using daily precipitation data developed by WICCI partners. Runoff and pollutant loadings will be calculated under multiple future climate and land use scenarios using downscaled global climate model precipitation data created by WICCI partners for the period between 2046 and 2055.

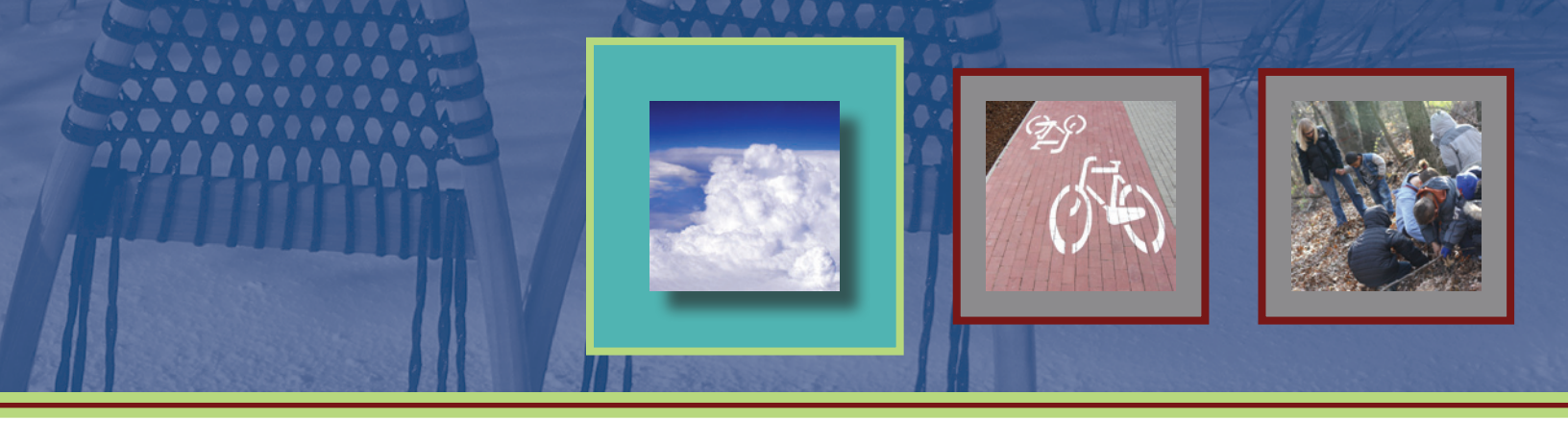

Photo: Bob Korth

Lake Superior Carbon Balance

The Ocean Biogeochemistry Research Group affiliated with the UW-Madison Nelson Institute Center for Climatic Research is leading a project to understand the carbon balance of Lake Superior. This team is working to understand the lakewide carbon budget and the processes controlling its variability using numerical models and data. This work includes evaluating the impact of lake-to-air carbon dioxide fluxes on atmospheric carbon dioxide, work on analytical techniques, adding biogeochemical inputs from major rivers to the existing model, and evaluating inversion algorithms for biogeochemical properties.

Fluxes of Carbon and Water in Lakes and Wetlands

Researchers at the Wisconsin DNR are working to better understand fluxes of water and carbon in northern Wisconsin lakes and wetlands. With support from Wisconsin's Focus on Energy program, this team has developed new technologies that allow us to remotely monitor the short- and long-term effects of rainfall and drought on water fluxes. They will now link these technologies with methods developed by UW-Madison limnologists to remotely monitor internal carbon fluxes in lakes over similar time scales. The team will also explore technologies to monitor carbon fluxes between lakes and their adjoining wetlands. Data from this study can be used to enhance models of the regional carbon cycle.

Climate Analogs and Potential Shifts in Forest Composition and Extent

Researchers at the UW-Madison Nelson Institute Center for Climatic Research are using funding from Wisconsin's Focus on Energy program to identify the closest analogs between 21st century projected climates for Wisconsin and existing climates in the U.S. and Canada. The results will provide policy-makers with examples of current landscapes that may be the closest parallels for what Wisconsin will become over this century. The team will also model the likelihood of prairie encroachment into southern Wisconsin forests and the likelihood of invasion of non-native tree species. This work relies on the previously downscaled climate data generated by WICCI partners.

Carbon Fluxes and Climate Change Impacts from Forest Land Management

Photo: Avery Dorland

Researchers at the UW-Madison's Department of Atmospheric and Oceanic Sciences are working to quantify the flux of carbon in Wisconsin forests undergoing land management. The primary objective of their study is to understand how land management alters the carbon cycle for forest ecosystems and investigate how well we can predict carbon

cycle impacts of differing land management scenarios. The study will measure pre-, during and post-harvest carbon fluxes in a hardwood forest, analyze the impact of this management on carbon fluxes and compare the findings to a state-of-the-art landscape ecosystem model.

Climate-Vulnerable Terrestrial Species and Natural Communities

Researchers have developed a climate change sensitivity database for terrestrial species in our region. This database includes life history characteristics for 463 species and provides an initial screening tool for assessing impacts on these species. With support from the U.S. Fish and Wildlife Service, researchers will integrate outputs from the database with those of selected national/regional climate change vulnerability assessments. The findings, including indices of scientific knowledge and management expenditures for each species, will be presented to government entities across the Upper Midwest. State and regional working groups will identify common management objectives, evaluate the results of the screening process, and identify 30-50 terrestrial species for further detailed evaluation.

Photo: A.B. Sheldon

Identifying Key Vulnerabilities for Birds and Mammals

Photo: Callen Harty

Researchers at the UW-Madison departments of Botany and Forest and Wildlife Ecology are conducting a thorough review of northern Wisconsin paleorecords (pollen assemblages), research on contemporary ecological processes and regional and local climate/biotic response models. From this review, they will identify terrestrial habitat and species vulnerabilities and make management recommendations. This work includes 1) collection and analysis of new sedimentary pollen records in habitats of concern and in landscapes with poor representation, 2) analysis of existing sedimentary records – finding locations with different rates of vegetation change and reinterpreting existing sedimentary records and 3) explaining stability and variability of natural communities.

Climate Adaptation Recommendations for Site Managers

With support from the U.S. Fish and Wildlife Service, WDNR researchers are assessing tradeoffs between mitigation and adaptation strategies within sub-regions of the Great Lakes region. They will conduct a literature review for climate mitigation and adaptation options for natural resource managers. Agencies will be interviewed for additional detail on management options and the management tools they use. Tradeoffs between multiple scenarios of mitigation and/or adaptation strategies will be analyzed. Mitigation and adaptation options will be classified by their compatibility with each other and existing management priorities. A follow-up project will identify the most climate-resilient lands in the Great Lakes basin, such as places where adaptation planning for resilience is most likely to succeed.

Climate Change, Shifting Land Use and Urbanization

Researchers at the UW-Madison are using integrated scenarios and model experiments to assess effects of changing drivers on 1) human benefits derived from

ecosystems, 2) evaluations of governance, 3) public engagement and 4) information management. The focus is the Yahara River watershed, where they will address three questions: 1) How do different patterns of land cover, land management and water resource engineering practices affect the resilience of freshwater ecosystems under a changing climate? 2) How can governance systems for water and land use be made more responsive to drivers of change to meet diverse human needs? 3) In what ways are human-environment systems able to cope with change, and in what ways are they vulnerable to potential changes in climate and freshwaters?

Climate Change Impacts on Warmwater Fishes

Researchers at the WDNR are expanding efforts to assess the impacts of climate change on fish communities. As a follow-up to the WICCI Coldwater Fish and Fisheries Working Group's initial efforts, scientists are now modeling potential impacts on additional coldwater fish species as well as changes in warmwater systems and predicting impacts on species typical of these habitats.

Future Areas of Focus

Although broad and comprehensive in our approach, we were not able to predict impacts, assess vulnerabilities or suggest adaptation strategies for all of Wisconsin's natural resources and sectors in this first report. Below, we highlight several areas that merit additional attention. We hope to address these areas in future phases of the WICCI effort and include vulnerability assessments and adaptation strategies in follow-up reports.

Great Lakes

Scientists already have observed record warmth in both lakes Superior and Michigan. The effects of warmer water on the lakes' fisheries remain in question. Scientists are also working to understand potential changes in water chemistry and lake levels.

Mississippi River

Changes in precipitation will result in changes in surface water runoff and groundwater recharge throughout the Mississippi's watershed. The effects of these changes have not yet been studied because downscaled climate models do not yet cover the entire basin, most of which lies outside of Wisconsin. A downscaled climate model for the Upper Mississippi River watershed (above the confluence with the Missouri River) is needed to make predictions regarding physical effects of climate change on the main stem of the river.

Groundwater

Changes in precipitation patterns and soil moisture will affect groundwater recharge. How these changes might impact drinking water quality, irrigation, discharges to lakes and wetlands or other characteristics of groundwater resources has yet to be investigated.

Air Quality

Climate governs several of the natural processes that influence air quality. Scientists and regulators will need to consider how climate change might impact Wisconsin's overall ability to meet air quality standards.

Agriculture

While we discussed climate change impacts on Wisconsin's corn and soybean crops, we have yet to assess the vulnerabilities of the rest of our agricultural commodities, for example, heat stress impacts on dairy cattle production or air quality impacts on crop yields.

Water Use and Availability

Future demands for water – including residential, agricultural and industrial water uses – due to increased temperatures, potential modifications of cropping practices and extended periods of drought may stress already limited aquifer resources in some areas and put more pressure on surface waters and the Great Lakes as a water source. We need to better understand the implications of future water supply and demand issues in the context of climate change.

Energy Utilities

Discussions about the energy sector and climate change often focus on utilities as a source of carbon dioxide emissions. It also is important to consider how a changing climate affects the ability of utilities to power Wisconsin homes and businesses.

Biomass

Biomass represents a significant renewable energy resource. Agricultural biomass may be impacted by changes in food-crop residue and growth rates and yields of crops produced specifically for energy production.

Transportation

The National Research Council recently concluded that every mode of transportation will be affected as the climate changes. We will need to identify critical infrastructure that is particularly vulnerable and make more strategic, risk-based decisions in our transportation planning.

Tourism

Climate contributes to the suitability of locations for many tourist activities. It also is a principal driver of seasonality in tourism demand. Changes in climate will require adaptation by tourism stakeholders to ensure tourism's continued vitality.

Loss of Winter as We Know It

Winter contributes to our "sense of place." Our culture, music and activities (ice skating, downhill and cross-country skiing, sledding, snowboarding, ice fishing, snowmobiling) recognize this portion of our four seasons. Economies in parts of our state depend on the ability to provide winter amenities. We are slowly losing winter as we know it, and this trend is very likely to continue – meaning that winter features will be degraded or lost, resulting in both aesthetic and economic consequences.

Community Planning

It is largely at the local government level where many adaptation actions will be needed, discussed, agreed to, prioritized and implemented. Wisconsin's communities will need to consider how climate adaptation measures can be integrated into plans, ordinances and related policies.

Economics, Policy Implementation and Social Systems Considerations

We must begin identifying our capacity to plan and sustain long-term efforts to adapt to our changing climate. Stakeholders will want to analyze both the positive and negative economic impacts of a changing climate as well as the tradeoffs associated with specific adaptation measures.

Outreach and Communication

If Wisconsin is to successfully adapt to current and future climate change, information about climate science, predicted impacts, types of adaptation strategies and means of implementing those strategies must reach local and state decision-makers. The Wisconsin Initiative on Climate Change Impacts has been well-designed to perform climate modeling scaled to our state (Chapter 1), identify likely impacts from future conditions (Chapters 3-7), suggest adaptation strategies and highlight gaps in knowledge and capacity for climate adaptation. WICCI itself, however, lacks the capacity to make a comprehensive statewide effort to bring this information to the people who need it. Furthermore, the time scale of climate adaptation (years to decades) is beyond the likely organizational lifespan of WICCI. Consequently, WICCI envisions a climate adaptation outreach model that:

- Supports natural- and human-system managers and other decision-makers in assessing vulnerabilities and evaluating risks from climate impacts.
- Continues to engage Wisconsin academic institutions, state agencies, professional associations and other organizations in a process of identifying adaptation strategies.
- Provides general information on climate risk and adaptation to communities to support implementation of climate adaptation.
- Builds a foundation for long-term integration of climate risk education into Wisconsin's professional and community development efforts.

Photo: Darren Bush

To meet these objectives, WICCI will collaborate with existing education providers and support integration of WICCI information into existing and new outreach programs. These providers include:

- Professional organizations that have participated in WICCI working groups.
- Member organizations of the WICCI Advisory Committee (for example, Wisconsin Towns Association, League of Wisconsin Municipalities, etc.).
- Professional organizations that have participated in WICCI working groups.
- State outreach programs in the departments of Natural Resources, Health Services, etc.
- Outreach education programs through UW-Extension.
- Non-governmental education providers.

Delivery of WICCI outreach education will encompass many modes of learning:

- WICCI will provide speakers and prepared presentations on climate adaptation for delivery to organizations and communities.
- WICCI will sponsor ongoing workshops for other outreach education providers to update them on climate information and outreach methods.
- The WICCI Web site will be maintained as an accessible source of current, reliable information on climate adaptation strategies and outreach tools.
- The WICCI series of assessment reports will continually update knowledge about climate prediction, vulnerabilities and adaptation strategies.

Photo: William Walker