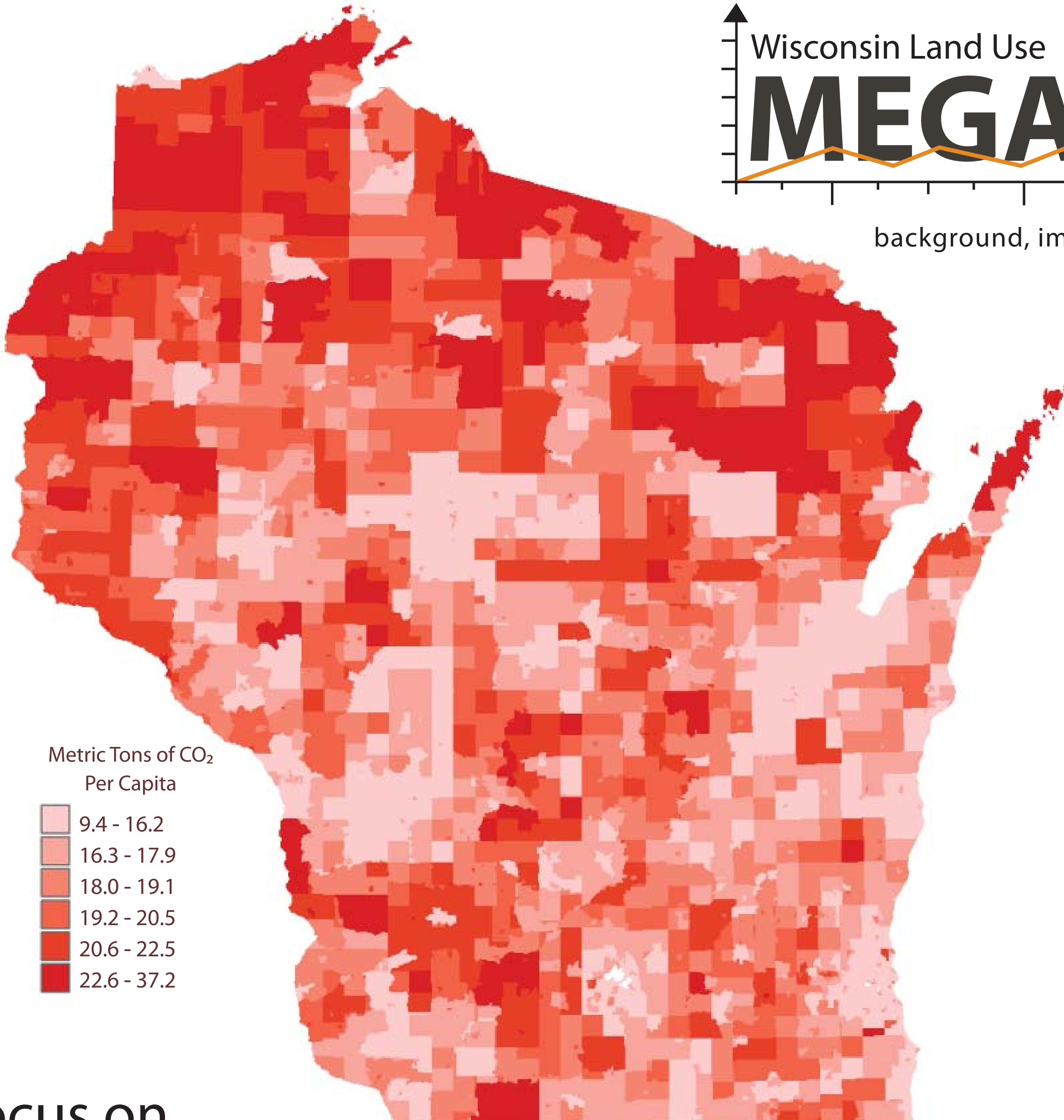
Summer 2009

Wisconsin Land Use MEGATRENDS

background, impacts, policy ... information you need to know



Find Your Community

How many tons of CO_2 are you and your neighbors emitting to the atmosphere?

Focus on

CLIMATE CHANGE

Introduction

Already the impacts of climate change to the landscapes, economy and people of Wisconsin are felt with routine flooding occurring in southwest Wisconsin, severe drought in the Northwoods, and less ice leading to increased evaporation on lakes, to name a few effects. Most scientists and policy makers have moved beyond a discussion of whether or not climate change is happening to what to do about it. The discussions about solutions to climate change often focus on mitigation strategies for households, businesses, and government, though thinking about adaptation strategies has begun. Rarely do these discussions engage in understanding the land use and spatial implications of climate change impacts. Many communities, local organizations, and businesses find it challenging to think about the range of spatial considerations associated with climate change. This challenge will grow along with Wisconsin's fossil fuel dilemmas and our state's efforts to develop renewable energy alternatives.

This publication is intended for local government officials and others interested in investigating the connections between climate change and land use. Throughout these pages, we explore land use trends related to climate change. We present an introduction to climate change at the global and state level, examine infrastructure and economic implications, and show how natural resources may change through this current century. We wrap up by looking at state level policies and potential tradeoffs and community level mitigation and adaptation strategies.

Figure 1 (cover)

Per Capita CO_2 Emissions

This map displays average annual per capita carbon dioxide emissions associated with transportation and residential fossil fuel use.[1, 2, 3] Transportation sector emissions are allocated at the census tract level based on commuting distances to work.[4] Residential sector emissions are allocated at the municipal level based on home heating fuel type, age of structure, and household income.[5, 6] This map does not consider emissions attributable to the commercial or industrial sectors since the consumption of goods and services does not necessarily coincide with their source. Emitting 1 metric ton of CO_2 is the equivalent of burning 114 gallons of gasoline or traveling 2,545 miles by car.

Global Greenhouse Gas Trends

Global Greenhouse Gas Emissions

Worldwide emissions of greenhouse gases (GHG) have risen steeply since the start of the industrial revolution with the largest increases occurring since 1945. Mid-range projections suggest that, in the absence of policy actions, GHG emissions will increase by another 50 percent by 2025 compared to present levels.[7,8] Avoiding serious climate changes, such as the temperature swings depicted in Figure 2, will require slowing this global trend in the short term, and reversing it over the coming decades.

Emissions by Country

A relatively small number of countries produce the majority of global GHG emissions. Most of these countries also rank among the most populous and have the largest economies. As of 2000, the United States was the largest emitter, with 21 percent of global emissions, followed by China (15%), the European Union (14%), Russia (6%), and India (6%).[10] Emissions growth rates are highest in developing countries such as China where emissions grew about 50 percent from 1990-2002.[10]

Emissions by Sector

GHG emissions come from almost every human activity. The GHG Flow Diagram depicted in Figure 3, illustrates the contributions that different sectors and activities make to worldwide GHG emissions. The left side of the diagram shows that energy consumption, primarily in the form of coal, oil and natural gas, accounts for about 60 percent of total emissions. Electricity and heat generation (25%), transportation (14%), and industry (10%) account for the highest levels of emissions within this category.

The industrial sector, taken as a whole, comprises about 21 percent of total GHG emissions—this includes both direct emissions (due to fossil fuel combustion) and indirect emissions (due to electricity consumption and industrial processes). Land use change/deforestation (18%) and agriculture (14%) are other major contributors to global GHG emissions even though they consume relatively small amounts of energy.

Future growth is likely to be especially high in the electricity and transportation sectors, suggesting that these are particularly important sectors for promoting policy change, investment, and technology innovation.[10]

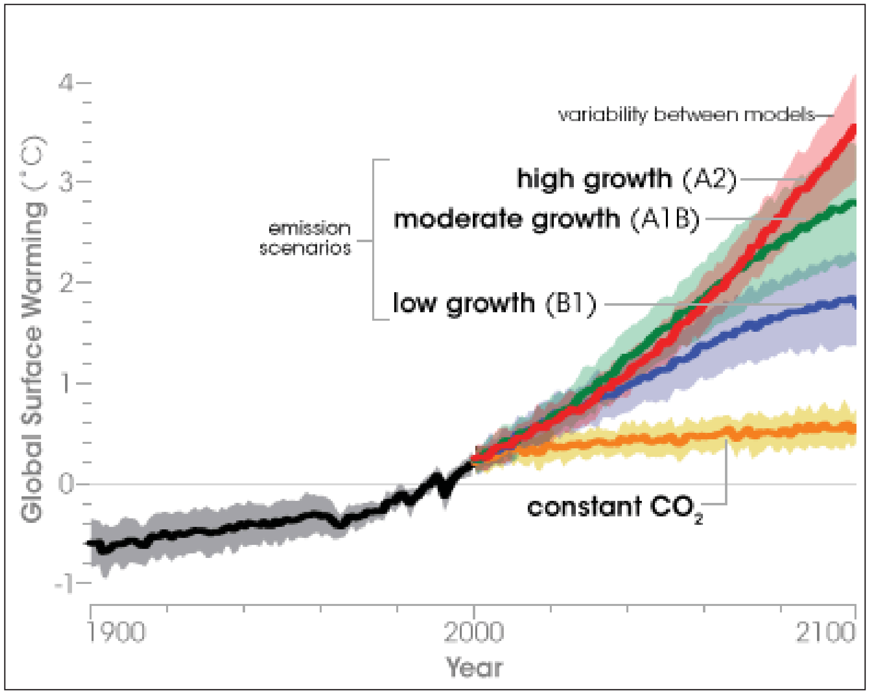
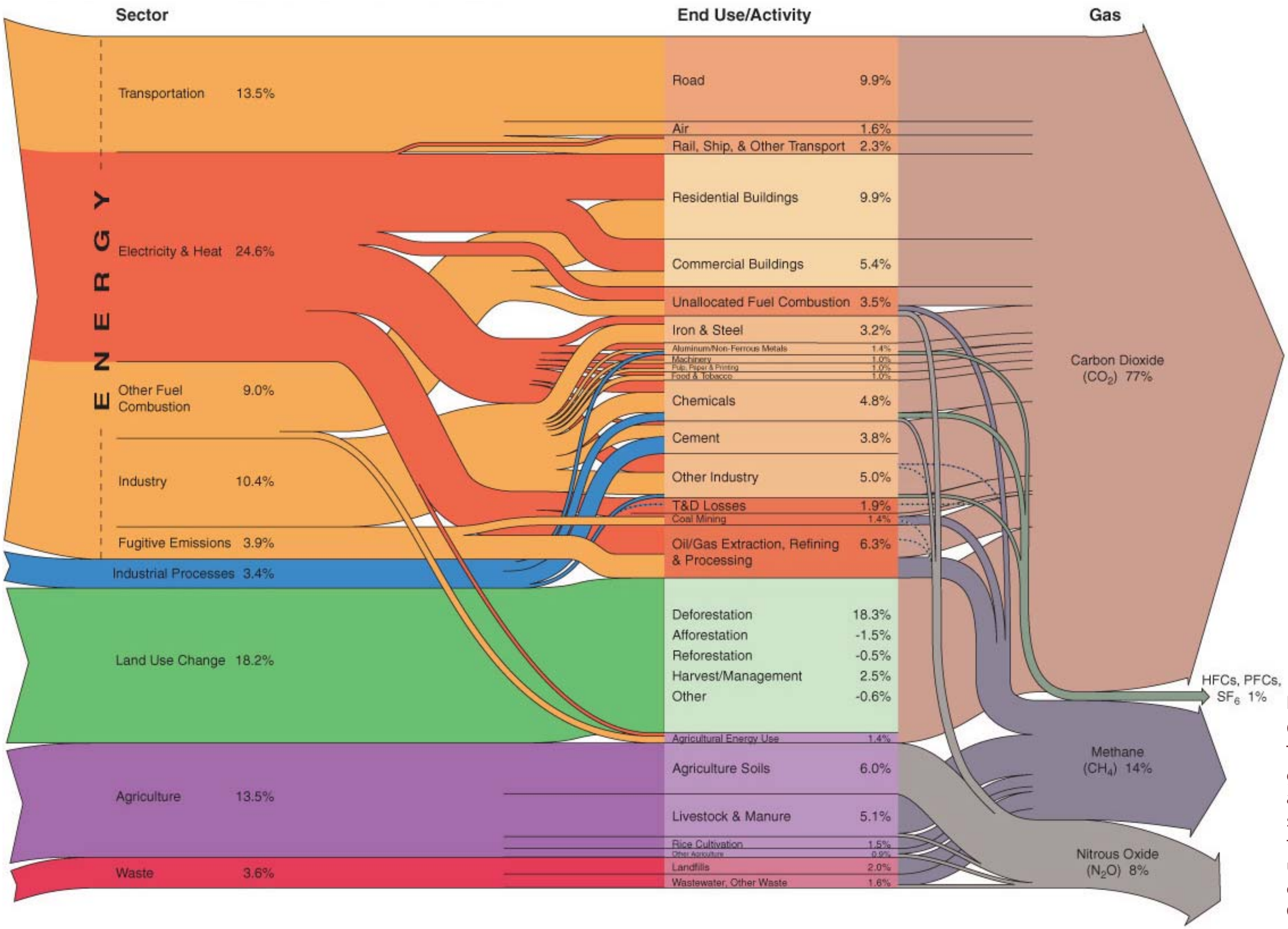


Figure 2:
Global Climate Change Projections[9]
Temperature projections to the year 2100, based on a range of emission scenarios and global climate models. Scenarios that assume the highest growth in greenhouse gas emissions provide the estimates in the top end of the temperature range. The orange line ("constant CO2") projects global temperatures with greenhouse gas concentrations stabilized at year 2000 levels. A change of 1 degree Celsius is the equivalent of 1.8 degrees Fahrenheit.

World Greenhouse Gas Emissions Flow



World Resources Institute

Figure 3

Greenhouse Gas Flow[10]

This diagram traces global greenhouse gas emissions from specific sectors and end-use activities through to emissions. Electricity and heat generation, transportation, buildings, industry, land use change, and agriculture are major contributors to global GHG emissions. Carbon dioxide is the most prevalent form of GHG, but methane, nitrous oxide and other gases have greater potential to contribute to global warming.

Wisconsin Climate Change Trends

Increasing Temperatures

In the coming decades, Wisconsin's climate is expected to become warmer and drier, especially in the summer (See figures 4 & 5). Before the century ends, average summer temperatures are projected to increase by 8 degrees or more and average winter temperatures by 6 degrees or more. In both cases, larger rises in temperature will likely occur in northern parts of the state. In southern parts of Wisconsin, an 8-degree increase in temperature would push average daytime highs from the low 80s to 90 degrees or higher for 31 days each summer and nudge it above the freezing mark all winter long.[11]

Rate of Long-Term Trend Temperature Change (°F Per Decade)
January-March - Based on 1941-2005; Trend begins 1976

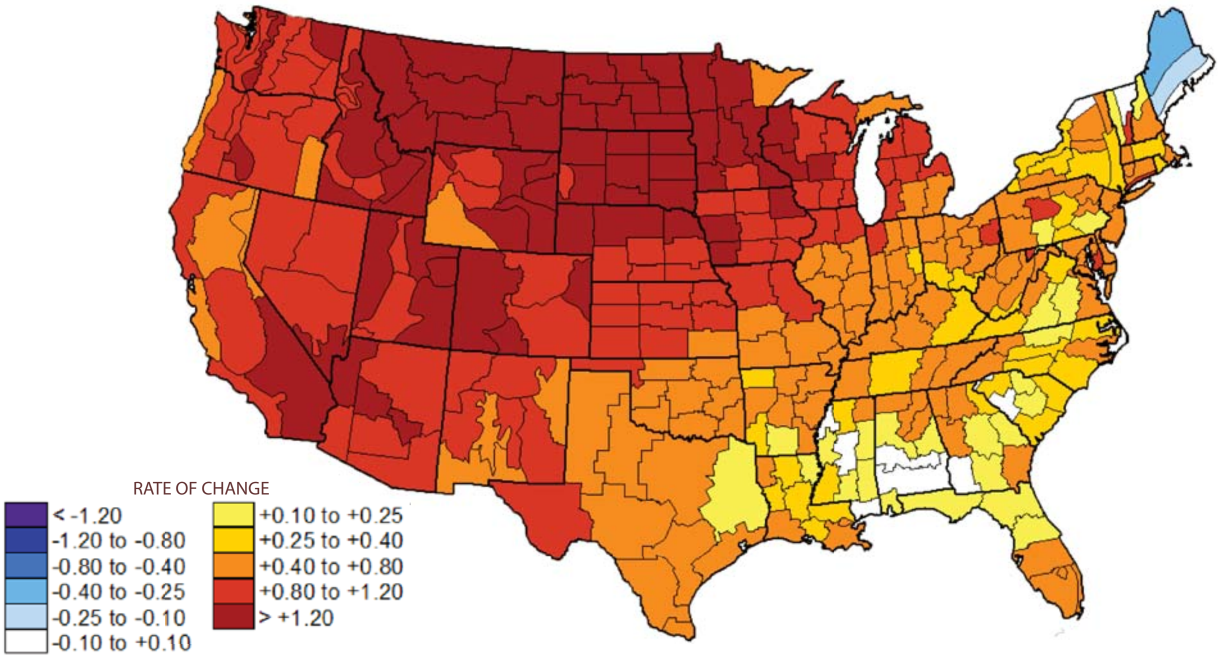


Figure 4

Winter Temperature Trend[6]

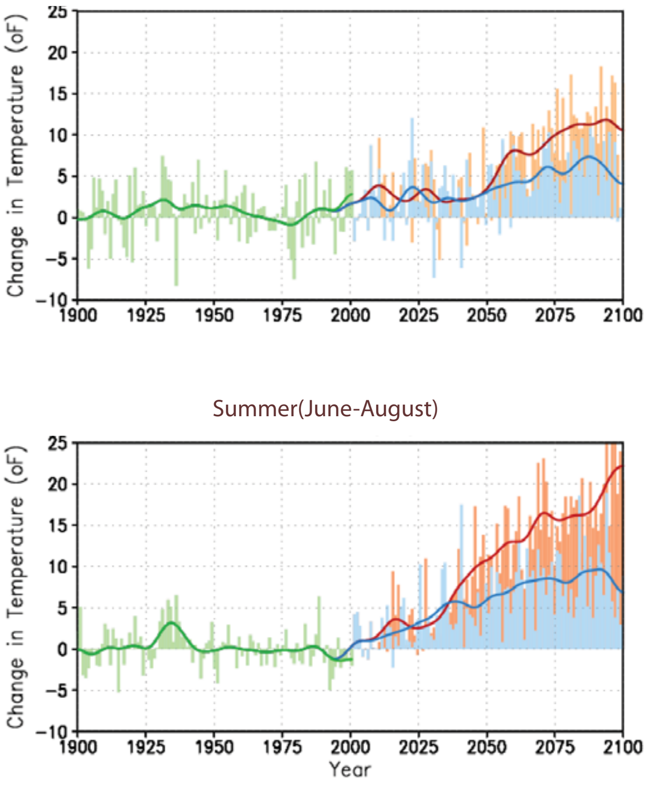
Since 1976 Wisconsin has experienced increasing winter temperatures of approximately 1°F or more per decade.

Figure 5

Seasonal Temperature Projections[13]

Temperature projections for Wisconsin show winter temperature increases as great as 11°F by 2100 and summer temperature increases as great as 18°F.

Changes in Daily Average Temperature for Wisconsin
Relative to 1961-1990
Winter (December-February)



Changes in Daily Average Precipitation for Wisconsin
Percentage Change Relative to 1961-1990 average
Winter (December-February)

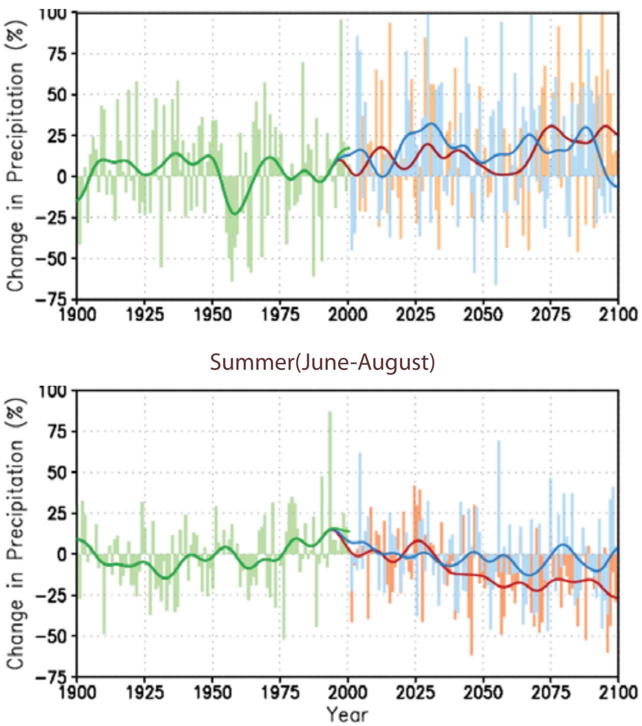


Figure 6
Seasonal Precipitation Projections[13]
Precipitation projections for Wisconsin show increasing winter precipitation and declining summer precipitation.

Historical observed data
- 10-year running average
- Year to year variation

High emissions scenario (A1F1)
- 10-year running average
- Year to year variation

Low emissions scenario (B1)
- 10-year running average
- Year to year variation

Figure 5 & 6 Legend
Historical observed data is green. Model Projections are red (A1FI 'high' emissions scenario) and blue (B1 'low' emissions scenario). Vertical bars indicate the year-to-year anomalies while horizontal lines show the 10-year running average.

Sporadic Precipitation

Wisconsin's average annual amount of precipitation is not expected to change much, but our summers are expected to become drier as warmer temperatures increase evaporation and seasonal precipitation patterns shift (See figures 6 & 7). Winter precipitation is projected to increase by as much as 30 percent, while summer precipitation may decline by as much as 20 percent. As the amount of water vapor in the atmosphere increases with global temperatures and warmer ocean waters, the air will become more humid. When it does rain or snow, it's likely to be in larger amounts.[11]

Extreme Weather Events

All of these changes mean we can expect an increase in extreme heat waves and more frequent droughts in summer. At the same time, severe thunderstorms may double in frequency, increasing the amounts of damage caused by heavy rainfall, hail and strong tornadoes. The winter season is likely to be punctuated with increasingly frequent mid-winter thaws, freezing rains, ice storms, and flooding. We may expect heavier snowfalls, especially over the next few decades, yet the average length of time the ground stays snow covered and our lakes remain ice covered will shrink with each passing decade[11]

Rate of Long-Term Trend Precipitation Change (Annual Total (") per Decade)
July-September - Based on 1931-2005; Trend begins 1976

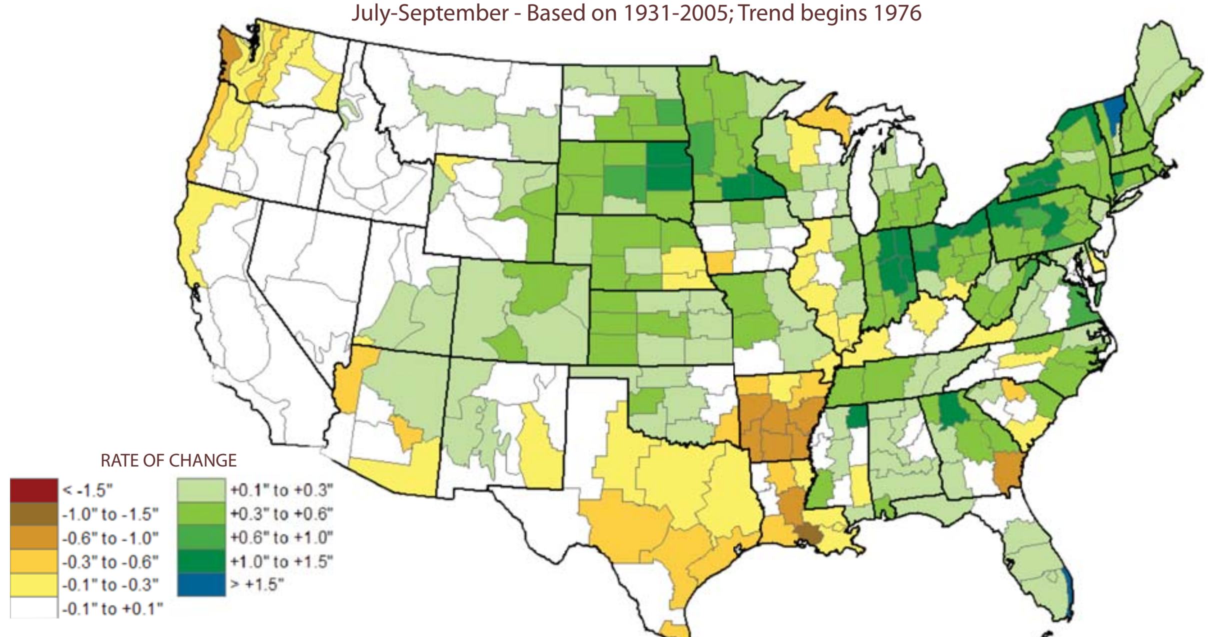


Figure 7
Summer Precipitation Projections[12]
Since 1976 Wisconsin has experienced relatively constant or slightly increased levels of summer precipitation.

Climate Change and Infrastructure

The prospects of climate change and variable weather present numerous challenges for land use decision makers. For private individuals, there is uncertainty about the future of their land and buildings. Companies will face new questions when designing and constructing facilities, from parking lots to factory roofs. Local governments, responsible for an array of infrastructure, will need to reconsider many of the current review procedures and approval standards. The leading edge of these challenges already appears to be entering private and municipal affairs with increasing frequency.

Photo 1

June 2008 flooding, like this shown in southern Wisconsin, left behind an estimated $765 million in damages.

Wisconsin Department of Natural Resources. Flood Water Photo Gallery. Accessed June 24, 2009. www.dnr.state.wi.us/emergency/flood/photos.html

Weather Events and Changing Climate

Recent years have featured weather and flooding events consistent with numerous expectations of climate change and global warming. This is not to say that global climate was the direct cause of recent weather. However, it is helpful to discuss these events to better understand likely future consequences of the changes in Wisconsin's climate described in the previous section.

Severe storm events, delivering large amounts of rain in very short time periods, place significant strains on landscapes, crops, stormwater systems, and individual structures. The floods of fall 2007 caused over $110 million in damage in southwest Wisconsin. More widespread flooding in 2008 caused $765 million in damage, the most expensive natural disaster in Wisconsin's history.

A large portion of the state's losses arose from damaged crops. In the hilly terrain of the driftless region, massive amounts of topsoil were washed away with the heavy rains and runoff. It will take hundreds to thousands of years to replace the fertility and soil structure lost to such floods. Should the climate shift in such a way that similar deluges are more common, the soil may not have much of an opportunity to return. For land use decision makers, the loss of structures, roads, culverts, and even dams creates an opportunity to review the considerations that go into designing and installing new replacements.

The Stormwater Challenge

Wisconsin has a long tradition of anticipating and planning for harsh weather. The state has developed design standards that require major development projects to estimate and accommodate stormwater and snowmelt runoff as part of any review and approval process. Many of the standards included in the requirements are tied into records and events in our recent climate history. You may be familiar with the term "100 year storm"; this refers to a precipitation event likely to occur about once every 100 years. Another way to interpret the "100 year storm" designation is that there is a one percent chance of such a storm in any given year and particular location.

Using these planning terms, what Wisconsin experienced in fall 2007 and summer 2008 were a series of 100+ storm events, or storms that have a less than one percent chance of occurring within one year. The record of storm events used to calculate these odds is a moving target, as each year's history is added to the set of past events for estimating the probability of a repeat.

A consequence of this is that earlier design standards for runoff management may be insufficient for handling future storm events should high volume storms become more common. If a portion of today's stormwater sewer is engineered to accommodate a one-in-one-hundred odds rain event based on the last century of data, it may not be able to handle such an event several decades in the future as new records are established. More likely than not, today's infrastructure will prove to be undersized to handle the volume and frequency of storms arising from a more energized climate.

Photo 2
Road damage, like that shown in Calumet County, is among the many infrastructure challenges that will face local governments.
Calumet County Official Website. Photo Gallery. Accessed June 24, 2009. www.co.calumet.wi.us/photo_gallery.iml?dept_id=183

The continuing expansion of built up areas and creation of more impervious surfaces complicates stormwater management even further. Upstream and upland land use changes have consequences for downstream land owners and municipalities. A water management system built to handle today's runoff volume could be overwhelmed by the changing land uses in a watershed.

The value of the total stormwater system already in place in Wisconsin includes the cost of storm sewers, roadways, parking lots, retention and infiltration basins, delivery systems, and filtration systems. If added together, this infrastructure is valued in the tens of billions of dollars. This "sunk cost" in the present system is not readily adjusted for new events; it is fairly complicated to enlarge even the most basic components such as culverts. Therefore today's decision makers should consider future expectations when designing and approving these components of our built landscape.

Such information is likely to be couched in rather large error terms due to the uncertainty associated with climate change and weather variability. No one knows just how far the weather in the 21st Century will vary from what we recorded in the 20th. In the meantime, governments and private parties need to make investment decisions on an ongoing basis using today's scarce financial resources. While the prudent decision maker may want to sufficiently prepare for a more volatile future with larger storm events, significant upfront costs are required to build a system capable of handling that future today. Should the system prove to be overdesigned, the money spent on larger or more fortified infrastructure may be misallocated.

The Heat Challenge

Stormwater is but one dimension of our landscape that merits deeper consideration in light of climate change. Other aspects include the condition and longevity of paved surfaces and the effects of urban built-up areas on local "microclimates", also known as the urban heat island effect.

One researcher in the Atlanta area has investigated both of these dimensions to better understand how climate change will impact cities. Looking at recent historic records, Dr. Brian Stone found that cities in the United States were already warming faster than rural areas.[14] This change is largely due to the urban heat island effect, the combined consequence of large expanses of sunlight absorbing surfaces (roads and parking lots) and the loss of cooling vegetation (trees, natural areas). Stone projects that this heat island effect will likely amplify global climate warming in cities by 150%.

The National Research Board published a detailed analysis of climate change effects on transportation infrastructure in 2008. Changes in temperature alone pose threats to roads, bridges, airports, and railroad tracks. This is largely due to an increase in the number and intensity of severe heat waves during summer months. These events cause concrete and pavement to expand beyond their engineered specifications, leading to road buckling, pavement softening, bridge cracking, and rail-track deformities.[15]

In summary, a warming and more active climate will add uncertainty and cost to Wisconsin's public and private infrastructure. We will likely need to replace roads, bridges, and stormwater systems more frequently and the new systems should be designed and built to higher specifications to meet the potential conditions that will emerge in coming decades.

Ecological Consequences of Climate Change

Forest Response to Climate Change

Wisconsin's forests and trees have adapted to particular climate conditions; so as climate change occurs, our forests will too. These changes may include variations in tree species, distribution, productivity and health. Researchers say that our forests will probably not die suddenly. Instead, expect changes to be more subtle. These changes are likely to occur during the lifetime of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.[16]

If conditions become warmer and drier as projected, the current range, density, and type of forest species could be reduced and eventually replaced by plant communities more suitable for that climate. The acreage of Wisconsin's northern forests of hemlock, spruce and fir, as well as birch and jack pine, are likely to shrink and perhaps disappear from the landscape altogether. These species will likely lose their ability to reproduce and compete with more suitable trees. Southern oaks and hickories are expected to migrate north, but their dispersal may depend on traits of individual tree species, such as seed dispersal methods. The ability of each species to adapt to changing climates also depends on human influences, including development, roads, and fragmentation.[17] Because Wisconsin's landscape has already been dramatically altered, it is unlikely that many plant species will have the capability to migrate. These changes would affect the nature of Wisconsin forests and the activities that depend on them.

Figure 8 [18]

Map A: Pre-settlement forests

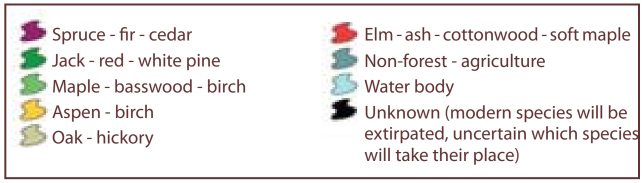
In this period, forests covered most of Wisconsin with pockets of spruce, fir and cedar extending to the central part of the state.

Map B: Modern forests

Currently, many parts of the state have been converted to agriculture and development. Most deforested lands from the cutover era have slowly been replaced by aspen and birch.

Map C: Future forests

This map forecasts future forest types in Wisconsin due to climate change. Many species such as fir, birch, and red pine may no longer grow in Wisconsin's forests. It is uncertain that other species will take their place because of adaptation and dispersal limitations like development and fragmentation.



Map A Map B Map C

Species Diversity

The rich diversity of plants and animals in Wisconsin is closely related to the state's historical climate. Much of the state was covered in thick glaciers 10,000 years ago, a short time considering the planet's multi-billion year history. Since the glaciers receded, the state has experienced an influx of species from the south, initially made up of "pioneer" plants and animals that could thrive in the primitive soils left behind by the glaciers. As time passed, organisms that migrate more slowly came into the state. The most recent glaciers did not advance in the southwest corner of the state, resulting in the unique landscape and ecology of the driftless region.

The present era of warming may seem at first to merely be a continuation of the thousands of years of warming that ended the glacial period in Wisconsin, but scientists are certain that the pace of warming is faster and the effects more dramatic than what has happened historically. The consequences for natural communities are already evident and the concern is that many natural cycles will be so severely impacted that complex ecological relationships will begin to break down.

Evidence of Change from the Leopolds

Famed conservationist Aldo Leopold was well known for his keen observational skills. Since he was a teenager, Aldo would record the dates of significant events in the natural world. His observations ranged from the arrival of particular birds each spring to the flowering of different plants over the course of a season. This type of record keeping, referred to as phenology, allows for comparisons to be made over broad stretches of years. More recently, one of Aldo's daughters, Nina Leopold Bradley, has begun recording the same sets of events that her father so diligently tracked. Her comparisons with records made only forty to fifty years ago reveal a quickly changing schedule for many Wisconsin ecological events.

Working with a fellow researcher, Nina found 108 natural events for which there were at least three observations from her father in the period 1935-45 as well as three modern records from the same places. They found that many, though not all, natural events had shifted forward in time, with spring events moving forward at a faster rate than fall events. Plants appear to be reacting to the warmer spring temperatures, allowing them to grow and bloom at times that previously were impossible due to freezing temperatures. Birds that only migrate short distances responded to warmer weather and open water. Nina found that geese were arriving five weeks earlier on average during 1994-2004 compared to her father's records from the 1930s and 1940s. Neotropical birds did not change their timing as they rely more heavily on day length to schedule their arrival in Wisconsin.

What's the Relationship to Land Use?

While early arrival of geese may seem like a trivial matter, there are untold numbers of complex ecological relationships that may be stressed or broken by changing phenology. Insects that rely on a particular flower at a specific time may decline as the flower is no longer available; birds that feed on those insects may then be stressed as their food source becomes less available. Other plants that rely on those birds for seed dispersal may be unable to disseminate across the land. All told, we could see nature's tapestry unravel before our eyes.

Photo 3

Potential changes to Wisconsin's natural landscapes will also affect tourism and recreational opportunities.

U.S. Fish & Wildlife Service. National Digital Library. Accessed June 24, 2009. http://digitalrepository.fws.gov/index.php

Economic Impact of Climate Change

Forestry

Aspen currently is the most commonly harvested species in the state and is used to produce paper and engineered wood products such as wafer board. Wisconsin is at the southern-most extent of the range for this species. The warming climate will create less than ideal growing conditions for aspen trees and result in increased tree stress and greater susceptibility to insects. Aspen is also ozone sensitive.[19]

Paper, pulp and various composite board industries buy their timber on the global market based on least cost for the purpose needed. These industries have developed the flexibility to use different tree species based on overall cost for production. Many have mills located throughout the world and as a result, may not be directly affected by climate change in Wisconsin. At greatest risk are current state timberland owners and smaller businesses that depend on a single or limited number of tree species.[20]

Of the policies associated with climate change and greenhouse gas emissions, a carbon cap and trade program could significantly raise the cost of wood products production. Pulp and paper mills will need to purchase offset credits since many no longer have major land holdings that could be used to create credits. Electric and gas utilities would also need to buy credits which could result in increased rates to the forest products industry.[19]

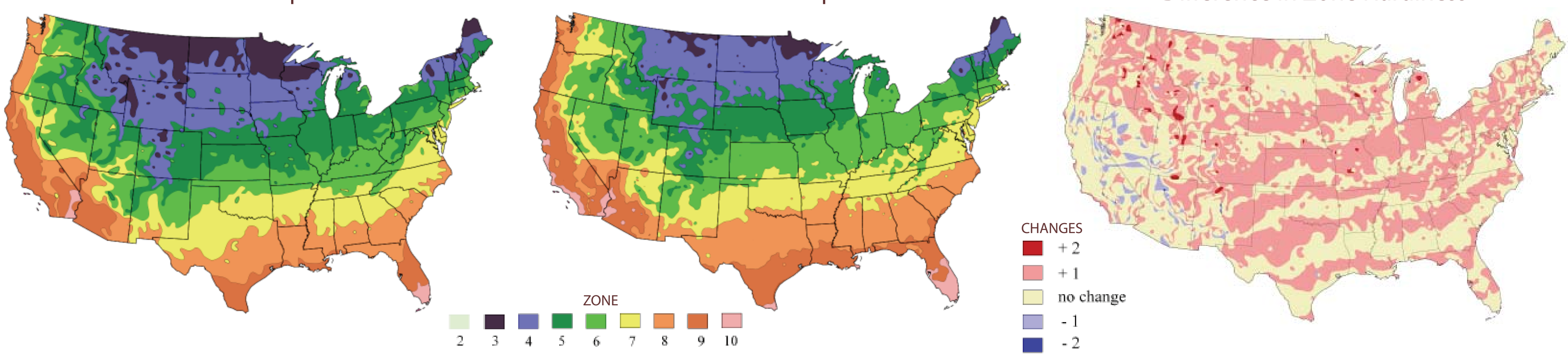
Agriculture

Wisconsin's principal crops are corn, silage, hay and soybeans. About 3% of the state's farmed acres are currently irrigated. Wisconsin agriculture may benefit from warmer temperatures and a longer growing season. (See Figure 9 for changes.) However, if temperatures rise too high in the summer, crop productivity could be adversely affected. Increased temperatures could also result in higher zone concentrations that can damage some crops.[21]

Water – the amount and timing – may become the limiting factor rather than the length of the growing season. Increased precipitation in the form of snow cover in winter would protect some plants through

Figure 9
Hardiness Zone Differences Between 1990-2006 [26]

1990 Map | 2006 Map | Difference in Zone Hardiness



USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 175, Issued January 1990

National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Differences between 1990 USDA hardiness zones and 2006 arborday.org hardiness zones reflect warmer climate.

increased insulation and reduced frost depth. If summer droughts increase, farmers in certain areas may need to invest in more water infrastructure to maintain yields. An increase of severe storms and floods during planting and harvest seasons could decrease crop productivity as well as increase farmers' costs to maintain soil fertility.[22]

Livestock production may not be affected unless there is a significant rise in summer temperatures for a long period of time and reduction in summer rainfall. Under these conditions, livestock tend to gain less weight and pasture yields and quality decline, limiting forage. Local crops may change requiring farmers to import feed from greater distances at an increased cost.[22]

Warmer winters, shifts in rainfall, and extended growing seasons may create more favorable conditions for weeds and pests. Besides loss of income from damaged crops and sick livestock, increased pests may drive farmers to use more pesticides or related chemicals, placing an additional burden on water quality.[23]

Energy costs will have a significant impact on growing and transporting crop inputs and commodities. Higher energy prices could create a greater demand for more locally grown food. Energy costs coupled with changes in technology, price supports, interest rates, available credit and land use conflicts (urban/rural) could have as much influence if not more on farmers than changes in the climate.[22]

Recreation and Tourism

Some warm weather activities may benefit from climate change; however winter activities will see the greatest loss. This loss may be somewhat reduced if snowfall increases during the months that remain cold and communities are able to expand their warm weather tourism and recreation. All tourism seasons may be impacted by the increased unpredictability of the weather which makes it difficult to continue weather-dependent events like the Birkebeiner cross-country ski race. Outdoor activities that are part of a community's cultural heritage may not survive. If temperatures warm further, extreme heat, extreme storms, elevated ozone levels, and possible increases in risk from insect and waterborne diseases will affect activities and may result in some activity restrictions.[24]

Sport fishing will change as the range of warm-water fish expands northward, while cold-water species such as trout, and even some cool-water fish like walleye and perch, disappear from southern parts of the state. Ice fishing may become extremely limited. Many small streams may dry up, and wetland size and function could be diminished. All fish could face other threats including increased potential for oxygen depletion in waterways and possible increased pollution-related impacts from shallower water and storm-induced heavy erosion. Additional losses of wetland and forest habitat and food resources for migratory songbirds, shorebirds, and waterfowl will affect Wisconsin's multimillion-dollar bird watching and hunting industries.[23]

Community Impacts

Reduced water levels and warmer water would impact sectors of the economy that use large quantities of water for production, cooling or hydroelectric production. Reduced surface and ground water could also increase costs to municipalities to acquire drinking water due to the need to drill new or deeper wells or extend pipes. Higher summer temperatures and humidity would increase the need for air conditioning resulting in increased costs for consumers and additional infrastructure and electricity to meet these demands. Warmer winters may reduce heating needs but increased snowfall would impact road plowing costs.[25]

Table 1
Economics of Major Sectors Impacted by Climate Change

Sector	$ Generated	Jobs
Forestry (2004) [19]	$18 billion	70,000
Agriculture (2007) [21]	$8.97 billion (Products sold)	420,000
Crops	$2.67 billion	
Livestock	$6.30 billion	
Tourism (2005) [23]	$12 billion	300,000
Winter	$2.2 billion	
Fishing	$2.3 billion	

Photo 4
Winter recreational opportunities are likely to be most affected by climate change.
U.S. Fish & Wildlife Service. National Digital Library. Accessed June 24, 2009. http://digitalrepository.fws.gov/index.php

Adaptation and Mitigation

Tradeoffs between Action and Inaction

Faced with a set of problems as large and encompassing as global warming and climate change, it is understandable that some people prefer to "stay the course". They may do so in hope that the negative consequences never materialize, or they may have a significant stake in the status quo. The problem of climate change poses risks in all directions, but such risks are not new to public officials who often need to approve or deny projects based on forecasts and probabilities; the future is always somewhat uncertain.

In such situations, it can be helpful to compare the risks of action and inaction and decide which path is more acceptable. Decision-makers can use a risk table like the one at right to move from questions surrounding the accuracy of the predictions (given that all predictions involve probabilities) to questions regarding the wisdom of taking action or not.

From this simplistic risk chart, a decision maker can develop a ranked list of preferred outcomes. Results in box "C" are likely to be the most preferred, followed by the results in box "B". The more challenging question may be how to rank the outcomes in boxes "A" and "D". It may be helpful to consider the role that the planet and its climate play in supporting a healthy economy: without clean air, water, and a stable climate for growing food, it would be difficult if not impossible to have a functional economy. On the other hand, the planet existed long before there were humans and human economic activities. In short, our society depends on the existence of an accommodating planet; outcome "D" is the least desirable.

Given an order of preferred outcomes (C, B, A, D in the chart), one can return to the questions surrounding the accuracy of climate predictions. There is a high and ever growing level of support in the scientific community for the proposition that human activities result in climate change and that such changes will create massive disruptions for socioeconomic and ecological systems. There remains and will likely always be a group of skeptics who believe that climate predictions are inaccurate. If one wishes to prevent outcome "D" (the worst outcome), we would be taking action with the backing of climate scientists and a growing number of commercial institutions. If instead we focus on preventing "A", we need to do so in the face of a broad scientific consensus that we are heading for a disaster. A decision maker must consider which outcome he or she can live with if their own appraisal of climate risk is inaccurate: economic disruption or planetary disaster.

Table 2
Risk Assessment Matrix[27]

	SOCIETAL ACTION TO HEAD-OFF CLIMATE CHANGE IS…	
ACCURACY OF PREDICTIONS BY CLIMATE SCIENTISTS IS…	BASED ON RECOMMENDATIONS OF CLIMATE SCIENTISTS	MINIMAL OR NON-EXISTENT
LOW	A Poor! Money was spent addressing a non-existent problem, and the economy suffers as a result.	C Good! Economy not impacted, and climate still functions as usual.
HIGH	B OK. We made significant societal and economic changes but avoided disaster.	D Poor! The climate deteriorates, resulting in significant health, economic, and ecological diasters.

Local Level Strategies and Plans

Given the previous discussion about climate change, it is important for local governments, businesses, households, and individuals to plan for climate change through adaptation and mitigation. This section focuses on local government.

Strategies

Prior to working on particular adaptation and mitigation strategies, it's important for local governments to identify an approach with which they are comfortable. Below are three general approaches to dealing with climate change.[28]

- Ride it Out – take no proactive steps to prepare for climate change; absorb damages that occur
- Build Your Way Out – replace failed systems; protect sensitive systems with structural measures
- Green it Out – revise standards, plans and projects; as existing infrastructure deteriorates, design and build based on the revised standards

Many communities by default take the first approach because they are not proactive when it comes to climate change. The Ride it Out approach has the potential to be costly – financially and environmentally. This approach may also pose a threat to human life. We only need to look to New Orleans and the impact of Hurricane Katrina to see the devastating effects of not being proactive. The second approach is proactive, but is also likely to be very expensive. It takes a technical and engineering perspective to the climate change issue. The third approach may be the most pragmatic and still proactive. It works within current organizational systems – for example, capital improvement plans and code revisions.

Planning

One of the key tasks to deal with climate change is preparing a plan. Both adaptation and mitigation measures should be addressed in a climate change action plan (CCAP). Many communities run the risk of creating a myriad number of plans and not following any of them. A CCAP needs to be relevant and appropriate and not run counter to other plans a community may have in place (comprehensive, master, land use, open space, farmland preservation, etc.). If possible, we recommend that Wisconsin communities infuse adaptation and mitigation measures into the appropriate elements of a comprehensive plan.

Box 1 [29]

ICLEI's Five Milestone Methodology:

1. Conduct a baseline emissions inventory and forecast
2. Adopt an emissions reduction target for the forecast year
3. Develop a Local Climate Action Plan
4. Implement policies and measures
5. Monitor and verify results

Box 2

Definitions:

- Mitigation - Slowing and reversing the trend of warming by decreasing human-produced greenhouse-gas emissions.
- Adaptation - Minimizing negative impacts of climate change and maximizing positive impacts.

ICLEI outlines a five-step methodology for identifying climate action steps, whether that occurs within the context of a new or existing plan. The five steps resemble a typical planning process: collecting and analyzing data, establishing goals, identifying policies and actions, implementing, and monitoring (see Box 1).

Adaptation and Mitigation Policies

Part of CCAP is identifying adaptation and mitigation policies. This section discusses a number of potential sectors to focus on and related actions and policies. Box 2 defines these two terms.

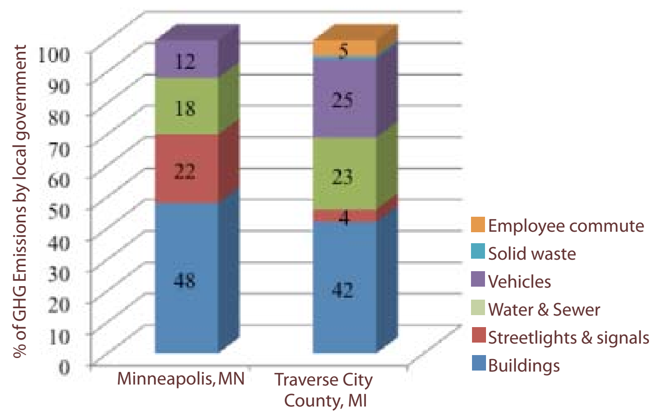
To effectively mitigate greenhouse gas emissions from local governments, it is helpful to understand their sources and sinks. Figure 10 illustrates the sources of GHG emissions from two local governments in the Midwest: Minneapolis, Minnesota and Traverse City County, Michigan. The sectors that contribute the greatest amount of GHG emissions for both governments are buildings, water and sewer, and vehicles. Streetlights and traffic signals are a large component for the city, but not the county.

Below are four risk management approaches to adapt to climate change.[30] The approaches range from the most proactive to the most reactive. Each one is necessary because not all events or hazards can be prevented, but always taking a reactive approach can result in loss of life and high costs.

- Prevent - action taken to reduce probability of an impact or change occurring, for example stricter floodplain ordinances.
- Prepare - action taken to better understand the climate risk or opportunity, to reduce vulnerability and improve resilience, for example raising public awareness.
- Respond - action taken in response to an event to limit the consequences of the event, for example restricting non-essential water uses during a drought.
- Recover - action taken after an event to enable a rapid and cost-effective return to a normal, or more sustainable state, for example enhancing the flood resilience of a property when undertaking flood damage repairs.

Climate change and its impacts vary from one region to another; therefore, adaptation and mitigation actions will differ from place to place. Examining plans from other places can offer many ideas to start thinking about possible actions. The Megatrends website provides a menu of adaptation and mitigation options for local governments.

Figure 10
GHG Emissions in % by Sector for Two Local Governments in the Midwest [31, 32]



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Additional Resources

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The Wisconsin Initiative on Climate Change Impacts (WICCI) is a research and outreach program of the University of Wisconsin, the Wisconsin Department of Natural Resources, and other state agencies and institutions. Its website can be accessed at: http://wicci.wisc.edu/about.htm

The Wisconsin State Climatology Office is the information gateway to Wisconsin climate variability and change. Its website contains additional data, graphs and links: www.aos.wisc.edu/~sco/

On The Web

The Wisconsin Land Use Megatrends series examines statewide land use trends related to specific topics. Previous publications have focused on forestry, housing, recreation, and energy. These reports are available on our website at: http://www.uwsp.edu/cnr/landcenter/megatrends/. The online version of the Climate Change report includes additional features.

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