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Preparing for Climate Change in the Midwest and Great Lakes Region: A Primer for Citizens and Community Leaders

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OVERVIEW

For a number of reasons, climate change has been slow to enter the public dialogue in the Midwest, but this is changing as local residents are experiencing more volatile weather, extreme temperatures, floods, changing growing seasons, and fewer snow days.

The past several decades have witnessed increasingly intense weather extremes, resulting in costly damage throughout the region. In 2019, following a winter arctic air outbreak ("polar vortex") that delivered near-record low temperatures in many areas (for example, South Bend reached -20°F without wind chill), the Midwest region suffered a spring season of extremely heavy rainfall and flooding which delayed agricultural planting, only to be followed by wide-spread drought in late summer. Echoing climate trends being experienced over the Midwest as a whole, South Bend has faced a string of extreme weather events in recent years. In 2013-2014, the region experienced one of the coldest winters since the late-1970s. In August 2016, a 1000-year rainfall event (~8" in 24 hours) caused wide-spread groundwater flooding. In February 2018, due to extreme snowmelt and intense precipitation, the St. Joseph River experienced a 2,500-year flood that caused major damage to infrastructure and homes. Many rivers in nearby communities witnessed flooding at the 500-year level or higher in the same event. Heavy rainfall has increased in intensity in many areas of the Midwest, and extreme storms have caused major storm water impacts in a growing number of cities in the U.S. and Canada. Yet, wet periods have alternated with periods of extreme drought, as occurred in the 2010-2013 drought that affected the entire country and again the 2019 extreme cold-rain-drought cycle that hit the Midwest.

STAGGERING STATISTICS

THE ST. JOSEPH RIVER EXPERIENCED A **2,500-YEAR FLOOD** THAT CAUSED MAJOR DAMAGE TO INFRASTRUCTURE AND HOMES.

FUTURE IMPACT

Future projections show that the worst threats to the region are yet to come. The Indiana Climate Change Impacts Assessment (INCCIA), led by the Purdue University Climate Change Research Center, projects the following impacts for the region:

- Extreme heat and humidity
- Increasing winter and spring precipitation
- Loss of snow cover and increasing precipitation as rain
- River flooding
- Increases in extreme precipitation and storm water flooding
- Spread of disease and pests
- Agricultural impacts

According to these projections, Indiana's annual average temperature will rise 5 to 6°F by mid-century and as high as 6 to 10°F by late-century, depending on global efforts to reduce greenhouse emissions. The number of extreme heat days is expected to increase in frequency from seven extremely hot days per year to 50-89 extreme heat days exceeding 95°F per year by late-century (Hamlet et al., 2019). As a result of higher temperatures, water deficits are expected to double by mid-century, placing further stress on the natural system and in turn agriculture (Bowling et al., 2018).

Annual precipitation is also projected to increase 6 to 8 percent by mid-century and as much as 10 percent by late-century (Hamlet et al., 2019). Snowfall is expected to decline throughout the state, and become uncommon in southern Indiana by late century. The combined effects of projected changes in temperature, precipitation and snowfall are anticipated to result in increased surface runoff during winter and spring, which increases the risk of flooding in Indiana rivers such as the Wabash and St. Joseph (Byun et al. 2018; Hamlet et al., 2019). Further, there is a growing body of evidence from observations alone that the Great Lakes will likely experience greater variability in a future climate. In recent years, for example, the Great Lakes have moved between historical extreme low-water conditions (in 2013), and extreme high-water conditions (in 2019). These historical impacts suggest that communities in the nearshore environment will need to be able to respond to both high- and low-water conditions in a resilient manner.

These climatic changes are expected to severely adversely affect the Midwest's agricultural sector. Agriculture remains central to the region's economy and culture. Elevated temperatures, particularly overnight temperatures, increase plant respiration, reduce sugar availability for grain production, and change pollination patterns, reducing crop yield. Indiana corn yields reduce about 2 percent for every 1°F increase in overnight temperatures during July. The combination of temperatures and water stress are projected to reduce corn yields by as much as 20 percent and soybean yields by as much as 11 percent by mid-century. Increasing precipitation and soil moisture in spring are also expected to reduce the number of days suitable for spring field work, which may delay planting (Bowling et al., 2018). Later planting schedules may result in greater crop water demand in the late summer and increase need for irrigation.

STAGGERING STATISTICS

ANNUAL PRECIPITATION IS PROJECTED TO INCREASE 6 TO 8% BY MID-CENTURY AND AS MUCH AS 10 PERCENT BY LATE-CENTURY.

Increasing frequency of extreme warm temperatures will also pose a risk to humans and livestock. Currently, heat-related deaths are the number one weather-related source of mortality. Under projected future conditions, outdoor work may become difficult or even life threatening, and vulnerable urban communities (e.g. those with existing health problems, very old and very young people, and disadvantaged communities without A/C or other heat refugees) may experience serious human health impacts or even death. By mid-century, high temperature days above 86°F are expected to double from 40 days per year to 80-100 days per year. The average duration of heat stress events will also double (Bowling et al., 2018).

FIGURE 1: GLOBAL- & REGIONAL-SCALE PROJECTIONS OF TEMPERATURE CHANGE

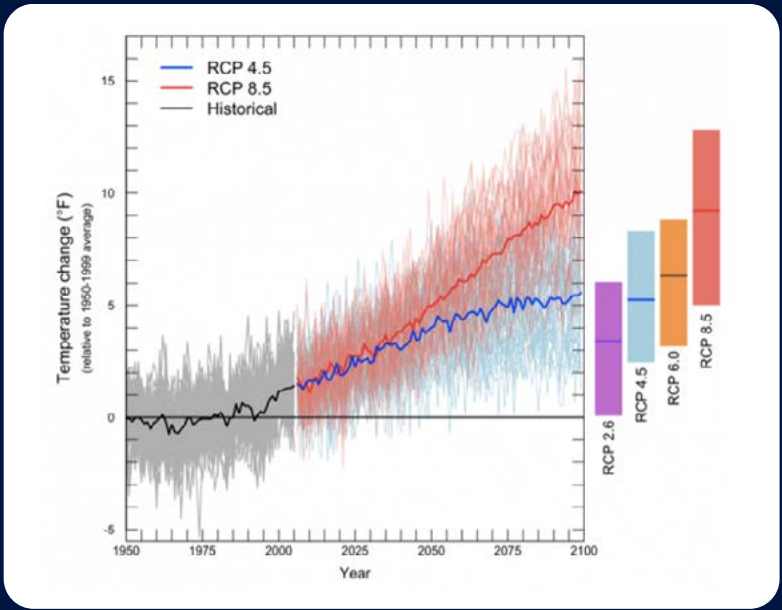

FIGURE 1A

GLOBAL PROJECTIONS

(Sources: Snover, A.K, G.S. Mauger, L.C. Whitely Binder, M. Krosby, and I. Tohver. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle. https://cig.uw.edu/resources/special-reports/wa-sok/).

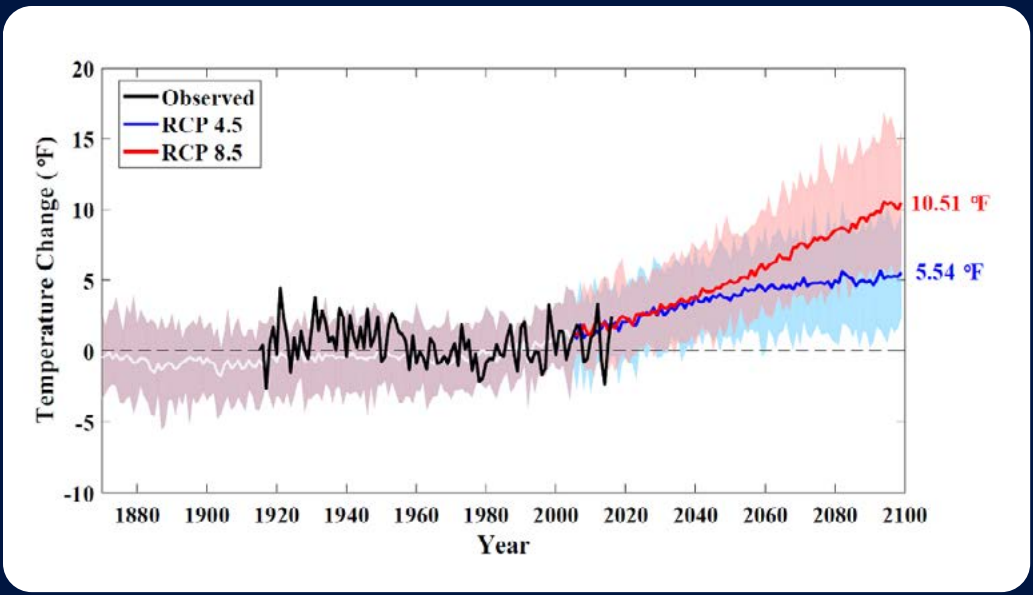

FIGURE 1B

PROJECTIONS FOR INDIANA

(Source: INCCIA).

These mid- to late-century projections at the low end of the given ranges are not merely possible, they are now virtually certain to occur due to the amount of carbon emissions we are producing, and even achieving these levels of impact will require intense mitigation efforts. Worse, given current trends in population, consumption patterns, and resulting emissions from human and natural sources, we could very well exceed even the upper end of these ranges. Even if we were to completely decarbonize the global economy by mid-century as urged by climate scientists and the UNFCCC, to date, we have emitted enough carbon to ensure that we experience 4-5°F global average warming during this century. These results hold for the Midwest. Figure 1A above, depicting historical and projected global-average temperatures, illustrates that present day emissions levels correspond to projected increases in temperature of 4-5°F even if the global climate is successfully stabilized by 2075 or so.

Temperature projections for Indiana from the INCCIA (Figure 1B) show somewhat warmer temperatures than the global average by 2100 of about 1°C for RCP4.5, and about 0.5°C for RCP8.5 (Hamlet et al. 2019). Projected warming for the Midwest region as a whole are even greater, about 1.8°C warmer than the global-average land temperatures for the same time period and greenhouse gas concentration scenario (Byun and Hamlet, 2018).

Given the very high likelihood of warming in the coming decades, we must now do three things simultaneously to limit the damage to society. First, we must reduce greenhouse gas emissions. Second, we must adapt our infrastructure and human systems to emerging risks posed by a rapidly evolving climate. Adaptation involves making physical systems more resilient by building smarter and stronger, but also making institutions more resilient to climate-related challenges. Examples include improving forecasting capability, incorporating long-term forecasts into planning, facilitating more flexible and far-sighted decision making, and developing financial reserves to respond to climate contingencies and maintain the capacity of human systems. Third, we must scale up disaster management capabilities in order to respond to increasing risk of weather extremes.

WE MUST LIMIT THE DAMAGE TO SOCIETY BY:

1. Reducing greenhouse gas emissions
2. Adapting our infrastructure and human systems to emerging risks posed by a rapidly evolving climate
3. Scaling up disaster management capabilities in order to respond to increasing risk of weather extremes

Despite obvious connections to changing weather extremes, disaster management has featured comparatively little in the climate dialogue, relative to mitigation and adaptation. Disaster management is certainly best avoided, as allowing failures to occur in an uncontrolled manner is costly to human life and societal resources. By one recent estimate, investment in prevention saves 6 times that amount in future disaster costs (Multihazard Mitigation Council, 2017). However, because we are now very likely to face natural disasters in quantity and severity beyond our current experience, we must now plan for them. As we fail to make progress against climate change, the issue will become how much can we afford

STAGGERING STATISTICS

TO DATE, WE HAVE EMITTED ENOUGH CARBON TO ENSURE THAT WE EXPERIENCE 4-5°F GLOBAL AVERAGE WARMING DURING THIS CENTURY.

to invest between mitigation, adaptation, and disaster management, or less euphemistically, disaster relief. In short, disaster management must join mitigation and adaptation, forming a triad of approaches in both dialogue and budgets.

Some tools to help us both adapt and manage disasters, such as the Federal Emergency Management Agency (FEMA) flood insurance are available, however there is a growing body of evidence that these programs are currently being managed in an unsustainable manner. FEMA's flood insurance program, which is intended to cover its costs through the collection of premiums, is perennially in debt to the Federal government, attesting to the fact that actual risks in recent decades exceed premiums collected by the Agency. Private sector insurance is not a replacement for federal programs, because private insurers increasingly withdraw from markets where risk and/or uncertainty are unusually high, such as near coastal areas vulnerable to sea level rise.

For the Midwest, we can expect increases in extreme weather events causing damage to crops and livestock, increasing the demand for insurance and other safety nets to assist farmers who are liable to face the full brunt of climate change. Additionally, we will experience increases in events triggering risks to assets of those living in low-lying areas or flood plains (current and future). In particular, houses, vehicles, appliances, and other household assets are expected to experience significant damage. While the poor are likely to experience the greatest impact of climatic shocks given their dearth of safety nets, weather extremes may significantly affect the assets of middle-class and wealthy households as well.

While private-sector insurance is expected to play an important role, we are already seeing limits to this approach for households, businesses and municipalities as insurers increase prices for high risk areas or withdraw coverage altogether, as has occurred for low-lying and coastal areas with heavy exposure to hurricanes or coastal erosion. Crop insurance during the 2019 wet season only provided incomplete coverage for the risks faced by Midwest farmers (Briscoe, 2019). Advanced financial products like parametric insurance, financial derivatives, and catastrophe bonds expand the options available, however these instruments often share the same limitations as traditional insurance.

Communities that are late starters in preparing for climate change may also be denied coverage. Insurance companies are increasingly considering risks for municipalities based on whether they start to take action on climate change through a sustainability plan. Thus, adaptive measures to climate change cannot be deferred in the hope that insurance will address climate risks—instead adaptive measures will likely be a precondition to obtaining insurance.

As noted earlier, the impacts of climate change will not be felt equally. Climate change will most severely affect the poor, exacerbating existing inequities. As a result, investment in adaptation and disaster management must be made strategically, both to optimize the impact of limited resources, and to ensure that traditionally at-risk populations receive equitable protection. The tension between prioritizing investments in climate mitigation, adaptation and disaster management, and ensuring equitable treatment of all will present difficult

STAGGERING STATISTICS

BY ONE RECENT ESTIMATE, INVESTMENT IN PREVENTION SAVES 6 TIMES THAT AMOUNT IN FUTURE DISASTER COSTS.

challenges both politically and practically. It could become one of the most challenging ethical issues presented by climate change. Pope Francis, in his Laudato Si' (2015), alluded to these issues of social justice, and identified responding to climate change and its impacts on the poor as one of the most important moral issues of our time.

Responding on his call to action will require communities to consider these issues in an open and inclusive discourse, to plan and invest amongst mitigation, adaptation and disaster management measures, and on both a community and individual basis, to take action.

RECOMMENDATIONS—ACTIONS THAT COMMUNITIES CAN CONSIDER, INCLUDE:

MITIGATION

- Reduce emissions through investment in distributed renewable energy, which are increasingly emerging as the least cost option over traditional energy sources.
- Purchase electric vehicles, which combined with distributed renewable energy as a source, are emissions free and eliminate air pollution.
- Purchase and adopt energy efficiency measures in households, businesses and public buildings. Many of these measures have positive net returns.
- For agriculture, adopt low-till crop techniques and water saving technologies.

ADAPTATION

- Incorporate long-term climate projections into infrastructure design of buildings and infrastructure. Opportunities include upgrading waste water and drinking water treatment plants with advanced control systems and at elevations impervious to projected flooding. These measures can prevent damage and reduce recovery time following a major flooding event.
- Invest in distributed residential solar power networks. These have the potential to be both more robust and more resilient than current centralized power networks during extreme events.
- Improve weather forecasting systems, which pays dividends for the agricultural industry even under normal conditions, and can reduce serious loss in the event of extreme weather.

DISASTER MANAGEMENT

- Enhance relief and rescue capabilities, inclusive of life-saving measures such as salvaging people from immediate harm and ensuring access to basic needs such as water, food and shelter.
- Plan for helping people recover and reconstruct their lives, while simultaneously adapting to changing conditions, including provisions to maintain the price of inelastic food crops to a level where they will remain affordable to consumers in aftermath of crisis.
- Enhance capabilities of first responder communities, calling for more people and infrastructure (i.e. helicopters, boats, emergency shelters, health centers) to support flood rescues, and deteriorating health

conditions for highly vulnerable populations such as the elderly, children, pregnant mothers, immuno-compromised patients and others with similar chronic conditions. Local and state governments are likely to be most affected by this, in the amount of resources they will need to put forward to afford these emergency services.

- Train police for addressing emergencies triggered by climatic events as many communities also tend to witness an increase in theft, domestic abuse, and violence towards children, resulting in a greater need for protection measures and social services.
- Plan for loss of work days to allow employees to care for themselves and family members given the impact of weather shocks on assets and dependents. These economic losses alone could be substantial and warrant careful calculation. Local institutions (i.e. schools) and small businesses are also likely to experience significant harm.
- Create backup stocks of supplies of food, water and medical supplies. In the event of contamination or depletion of water sources, plans to ration water consumption during high deficit periods, which are expected to increase, should be developed in advance.

Visit pulte.nd.edu/hart-sources for a full list of sources used to write this policy brief.

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