Michigan Climate Impacts and Costs

Climate change poses many costly risks to Michigan residents, including an increase in severe storms, extreme winter weather, fluctuations in lake levels, and hotter temperatures.[1] Even if fossil fuel emissions and atmospheric concentrations of greenhouse gasses eventually stabilize through aggressive climate action, the severity of these events will continue to rise as we adjust to the new reality of the climate crisis. Below we outline the impacts of climate change Michigan faces and some of the potential costs associated with these impacts. This list is not all-encompassing and other costs may be incurred as a result of additional climate change impacts.

Severe Storms

Since a warmer atmosphere can hold more water vapor, climate change increases precipitation in many areas, including Michigan (Table 1).[2] Average annual precipitation in the Midwest has increased by 5-10% and precipitation for the four wettest days of the year has increased by 35%,[3] resulting in more frequent flooding in Michigan.[4] By 2100, average annual precipitation in Michigan is expected to increase by another 5%.[5] As storm events continue to intensify due to climate change — especially hourly rainfall accumulation[6] — stormwater infrastructure will be overwhelmed causing even more extreme flooding.[7] The Sanford Lake dam failed in central Michigan in 2020 because it was overwhelmed with water after 5 inches of rain fell in the area in the preceding two days.[8] According to NOAA, flooding costs an average of $4.6 billion per event and severe storms cost an average of $2.4 billion per event.[9] A recent analysis by Swiss Re, a reinsurance company, found that severe storms in the U.S. incurred $34 billion in insured losses during the first half of 2023.[10]

[1] Cameron et al., "Michigan Climate and Health Profile Report 2015: Building Resilience Against Climate Effects on Michigan's Health"; "What Climate Change Means for Michigan." https://www.michigan.gov/mdhhs/-/media/Project/Websites/mdhhs/Folder3/Folder11/Folder2/Folder111/Folder1/Folder211/MI_Climate_and_Health_Profile.pdf?rev=ab2c0a4563ff4310b7811cfcfc077a42&hash=66C31F4B31C24F0245E51034E91FE51E
[2] Sillmann et al., "Climate Extremes Indices in the CMIP5 Multimodel Ensemble." https://onlinelibrary.wiley.com/doi/abs/10.1002/jgrd.50188
[3] "What Climate Change Means for Michigan." https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-mi.pdf
[4] Mallakpour and Villarini, "The Changing Nature of Flooding across the Central United States." https://www.nature.com/articles/nclimate2516
[5] Kim, Ivanov, and Fatichi, "Climate Change and Uncertainty Assessment over a Hydroclimatic Transect of Michigan." https://doi.org/10.1007/s00477-015-1097-2
[6] Ham et al., "Anthropogenic Fingerprints in Daily Precipitation Revealed by Deep Learning." https://www.nature.com/articles/s41586-023-06474-x
[7] "What Climate Change Means for Michigan."
[8] Fountain, "'Expect More.'" https://www.nytimes.com/2020/05/21/climate/dam-failure-michigan-climate-change.html
[9] National Atmospheric and Oceanic Administration (NOAA), "NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters," 2023. https://doi.org/10.25921/stkw-7w73.
[10] The Associated Press, "Surge in U.S. Thunderstorms Has Caused 'unprecedented' $34B US in Insured Losses This Year." https://www.cbc.ca/news/business/swiss-re-insurance-damage-1.6932920

Table 1: Changes in average precipitation (inches) from 1952-2022 in Michigan.[11]

GLISA Division	Annual	Winter	Spring	Summer	Fall
Southwest Lower Michigan	5.9	0.9	1.2	1.6	2
South Central Lower Michigan	7.1	1	1.6	1.6	2.6
Southwest Lower Michigan	5.9	0.5	1.5	1.6	2.2
West Central Lower Michigan	6	0.7	2	1.3	2
Central Lower Michigan	5.9	1.3	2.2	1.1	1.2
East Central Lower Michigan	5	0.5	1.6	1.4	1.3
Northwest Lower Michigan	4.6	0.8	1.6	0.4	1.8
Northeast Lower Michigan	3.1	0.7	1	0.5	0.9
Western Upper Michigan	0.4	0.7	-0.4	-1.5	1.6
Eastern Upper Michigan	2.7	0.8	-0.4	-0.1	2.4

Flooding also increases the amount of polluted runoff and sewage overflow to streams, rivers, and lakes. Increased nutrient load to the lakes can cause harmful algal blooms (HABs) and pollute beaches, increasing public health risks. Warmer waters and changes to both regional precipitation patterns and timing can increase the risk of HABs. In Michigan, harmful algae is growing in more places, more often, and earlier than ever before.[12] For example, over 80 HABs affecting 38 counties in Michigan were reported in 2022.[13] In June 2023, a harmful algal bloom formed in Lake Erie much earlier than usual.[14] HABs cause many health impacts to humans and their pets, such as: asthma-like symptoms, stomach pain, vomiting, rashes, and more.[15] Further, HABs deplete oxygen in the water, killing fish and creating economic impacts to fishing and other recreational industries.[16] Taxpayers are paying the price for HABs, which cost anywhere from $10-$18 more per year per person for drinking water treatment.[17]

In addition to flooding, severe storms often bring intense winds and sometimes tornados. Though more work is needed to understand the full impacts of climate change on tornadoes, recent research suggests an increased risk and occurrence of tornadoes throughout this

[11] GLISA, "Great Lakes Climatology: Interactive Climatology Map." https://glisa.umich.edu/climate-data/great-lakes-climatologies/
[12] Johncox, "Watch Out." https://www.clickondetroit.com/news/michigan/2023/08/04/watch-out-algal-blooms-common-on-michigan-waters-in-summer-can-cause-illness/
[13] ibid
[14] Graham, "Harmful Algal Blooms Appearing on Lake Erie Earlier than Usual." https://www.michiganradio.org/environment-climate-change/2023-07-06/harmful-algal-blooms-appearing-on-lake-erie-earlier-than-usual
[15] "Algal Blooms." https://www.niehs.nih.gov/health/topics/agents/algal-blooms/index.cfm
[16] ibid
[17] Graham, "Harmful Algal Blooms Cause Problems in Lake Erie; Drinking Water Customers Pay the Price." https://www.michiganradio.org/environment-climate-change/2022-05-23/harmful-algal-blooms-cause-problems-in-lake-erie-drinking-water-customers-pay-the-price

century. This is due to the climate impacting hazardous convective weather, or the conditions that form tornadoes.[18] In August 2023, at least five people died in Michigan after a severe storm brought seven tornadoes.[19] The storm downed power lines, led to road and bridge closures, damaged buildings and other structures, overwhelmed stormwater infrastructure, deposited debris, and prompted the Governor to declare a state of emergency to deal with the resulting damages.[20] According to the National Weather Service and National Centers for Environmental Information, tornadoes cost $2.5 million per event.[21]

Michigan is situated on four great lakes. The lower Peninsula has Lake Michigan to the west and north, Lake Huron to the east and north, and Lake Erie to the southeast. The upper Peninsula has Lake Superior to the north, Lake Michigan to the south, and Lake Huron to the southwest. The Great Lakes play a large role in regional precipitation patterns, especially lake effect snow.[22] Temperatures are rising the fastest in the winter months, which means winter precipitation is more likely to fall as rain or freezing rain, increasing winter flooding.[23] Even though winters are becoming increasingly warm, winter storms and freezes are simultaneously intensifying when they do occur, which some scientists attribute to a warming Arctic weakening the jet stream, though competing ideas still exist in the scientific community.[24] Warming temperatures also mean that the lakes have more open water in winter, potentially adding fuel in the form of water vapor to winter "lake effect" snow storms. In February 2023, a severe winter storm left 797,000 Michigan residents without power, led to road closures, and killed a local

[18] Tippett et al., "Climate and Hazardous Convective Weather"; Strader et al., "Projected 21st Century Changes in Tornado Exposure, Risk, and Disaster Potential." https://doi.org/10.1007/s40641-015-0006-6; https://doi.org/10.1007/s10584-017-1905-4
[19] Gross, "At Least 5 Dead in Michigan After Severe Storms." https://www.nytimes.com/2023/08/25/us/michigan-tornado-storm-deaths.html
[20] Sylvester, "Gov. Whitmer Expands State of Emergency in Michigan Following Storms and Tornadoes." https://wwmt.com/news/local/gov-whitmer-expands-state-of-emergency-michigan-following-storms-tornadoes-eaton-ingham-county-community-heavy-rain-strong-winds-flooding
[21] Hurst, "Tornadoes Caused $2.5 Million in Damage Per Storm Across U.S. in Past Decade." https://www.valuepenguin.com/damage-caused-by-tornadoes
[22] Scott and Huff, "Impacts of the Great Lakes on Regional Climate Conditions." https://www.sciencedirect.com/science/article/pii/S0380133096710067
[23] Fair, "Issues of the Environment." https://www.wemu.org/show/issues-of-the-environment/2023-01-18/issues-of-the-environment-michigan-winters-are-changing-and-climate-adaptation-is-key-to-the-future
[24] Fountain, "A 'Once in a Generation' Storm. What's the Role of Climate Change?" https://www.nytimes.com/2022/12/28/climate/storm-buffalo-climate-change.html

firefighter.[25] About a week later, another severe winter storm left 350,000 Michigan residents without power.[26] Severe winter storms often cost more than $1 million dollars per event and storm size and intensity have increased since the 1950's.[27]

Potential Costs Related to Severe Storms

Structure and Infrastructure Projects

- Remove, relocate, acquire, or demolish structures to minimize future flood losses.
- Install, reroute, increase capacity, or implement a routine cleaning plan of the storm drainage system.
- Add extra culverts, increase dimensions of existing culverts, or implement routine cleaning and repairing.
- Install detention or retention basins, relief drains, spillways, drain widening/dredging or rerouting, etc.
- Inspect and maintain drainage systems and flood control structures (dams, levees, etc.).
- Inspect bridges in order to identify and/or implement repairs or retrofits or clean under low bridges.
- Resurface roads with more permeable pavement and concrete.
- Elevate roads and bridges above the base flood elevation (BFE)[28] to maintain dry access.
- Elevate structures above the BFE, or relocate utilities, water heaters, etc. above BFE.
- Floodproof inside of municipal buildings, for example by installing check valves, sump pumps, or backflow prevention devices.
- Floodproof wastewater treatment facilities located in flood hazard areas.
- Floodproof water treatment facilities located in flood hazard areas.
- Protect emergency operations by requiring or moving all emergency operations centers, police stations, and fire department facilities outside of flood-prone areas.
- Protect critical and emergency facilities by requiring all critical facilities be built one foot above the 500-year flood elevation (to meet requirements of FEMA Executive Order 11988).[29]
- Protect critical and emergency facilities from floods using any other technique, for example, raising components above BFE, installing pumping systems or back-up generators for pumping, building dikes or stabilizing banks.
- Construct floodwalls, small berms, revetments, bioengineered bank stabilization, or other small structural mitigants.
- Implement severe storm strategies for the future like burying utility lines underground.

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[25] Nguyen, "Winter Storm Pounds US; Firefighter Killed in Michigan; NWS San Diego Issues First-Ever Blizzard Warning." https://www.usatoday.com/story/news/weather/2023/02/23/winter-weather-forecast-snow-storm-0223/11326523002/

[26] National Weather Service, "Winter Storm Impacts Michigan March 3-4, 2023." https://www.weather.gov/grr/2023March3-4WinterStorm

[27] Changnon, "Catastrophic Winter Storms." https://doi.org/10.1007/s10584-007-9289-5

[28] Base flood elevation (BFE), as defined by FEMA, is "the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year."

[29] Federal Emergency Management Agency, "Executive Order 11988: Floodplain Management," www.fema.gov/executive-order-11988-floodplain-management.

Natural Flood Mitigation

- Protect and enhance natural floodplain mitigation features (such as wetlands, dunes, and vegetative buffers) to help prevent flooding in other areas and increase water quality.

Public Health

- Protect public water supplies from harmful algal blooms.
- Increased hospitalizations related to water-borne illness.

Local Planning and Regulation

- Update flood risk maps and flood zones.
- Develop a floodplain management plan.
- Adopt a stormwater management or drainage plan.
- Adopt, apply, and enforce building codes to ensure buildings can withstand flooding.
- Obtain easements to use privately-owned land for temporary water retention and drainage.
- Join or improve compliance with the National Flood Insurance Program (NFIP) if needed.[30]
- Preserve floodplains as open space using any of several land use planning tools: develop a plan that targets hazard areas for acquisition, reuse, and preservation, a land banking program, use of transfer of development rights to keep floodplains vacant, easements to prevent development, or acquiring properties in the floodplain and turning them into open space.

Education and awareness programs

- Increase public outreach to encourage flood insurance purchase; educate residents in flood safety, flood mitigation, technical assistance availability, funding sources, and best practices.
- Increase public outreach to provide awareness of harmful algal blooms and their health impacts.
- Locate new utilities and critical facilities outside of susceptible areas.

Summary of Costs from Increased Precipitation and Severe Storms

Floodproof buildings, relocate infrastructure in especially flood prone areas, improve drainage systems and flood control structures, elevate infrastructure (buildings, roads, and bridges) where needed, restore natural flood protection, develop and implement comprehensive flood management plans, preserve floodplains, increase public awareness of flooding and HABs.

[30] U.S. Federal Emergency Management Agency (FEMA), The National Flood Insurance Program (NFIP), at www.fema.gov/national-flood-insurance-program Policy Information by State (https://nfipservices.floodsmart.gov//reports-flood-insurance-data), accessed September 1, 2023; Michigan has over $4 million in total coverage and over 19,000 policies, but local governments should make sure they comply.

Hotter Temperatures – Air and Water

By 2100, average annual temperature is predicted to increase by almost 9°F in Michigan.[31] Already, the average annual temperature has increased by more than 2.5°F in most areas of the state, with the largest increases observed in average winter temperatures (Table 2).[32] This corresponds to a decrease in the number of frost days and an increase in the length of the growing season. Warming — especially in the winters — will decrease revenue from recreational activities like ice fishing, snowmobiling, and skiing.

The number of days with temperatures above 90°F is expected to quadruple by mid-century,[33] which will increase the need for air conditioning in schools and public buildings.[34] For example, this past June both Detroit and Grand Rapids closed schools due to inadequate air conditioning, which impacted thousands of students.[35] The Center for Climate Integrity estimates Michigan will need to spend $2.3 billion by 2025 to install air conditioning in schools and hotter temperatures will impact over 500,000 students.[36]

Warmer temperatures will change the composition of forests and decrease agricultural yields of corn, soybeans, and other crops. For example, without winter freezes,[37] crops and other plants are more vulnerable to pests, less productive, and bloom too early.[38]

Warmer temperatures will also increase ground level ozone, increase heat-related illness, and increase vector-borne illness.[39] The District Health Department #10 found that Lyme disease has already been increasing in Michigan.[40]

Table 2: Changes in average temperature (°F) from 1952-2022 in Michigan.[41]

GLISA Division	Annual	Winter	Spring	Summer	Fall
Southwest Lower Michigan	2.3	3	2.4	1.7	1.8
South Central Lower Michigan	2.4	3.2	2.7	1.7	1.9

[31] Kim, Ivanov, and Fatichi, "Climate Change and Uncertainty Assessment over a Hydroclimatic Transect of Michigan." https://doi.org/10.1007/s00477-015-1097-2
[32] GLISA, "Great Lakes Climatology: Interactive Climatology Map." https://glisa.umich.edu/climate-data/great-lakes-climatologies/
[33] Malewitz, "Climate Change Could Bring Woe to Michigan's Lakes, Farms, Forests | Bridge Michigan"; Dahl et al., "Killer Heat in the United State: Climate Choices and the Future of Dangerously Hot Days." https://www.bridgemi.com/michigan-environment-watch/climate-change-could-bring-woe-michigans-lakes-farms-forests; https://www.ucsusa.org/sites/default/files/attach/2019/07/killer-heat-analysis-full-report.pdf
[34] LeRoy, Matthews, and Wiles, "Hotter Days, Higher Costs: The Cooling Crisis in America's Classrooms."
[35] Bosman, "High Heat Closes Schools in Grand Rapids, Mich., and Other U.S. Cities." https://www.nytimes.com/2023/06/01/us/michgan-schools-heat.html
[36] LeRoy, "Michigan - Hotter Days, Higher Costs: The Cooling Crisis in America's Classrooms." https://coolingcrisis.org/uploads/media/CCI-StateReport-Michigan.pdf
[37] Ocko, "5 Reasons Why Your Warmer Winter Is so Alarming." https://www.edf.org/blog/2020/02/12/5-reasons-why-your-warmer-winter-so-alarming
[38] "Leaves Emerging Earlier." https://www.climatecentral.org/climate-matters/leaves-emerging-earlier
[39] "Climate and Health Overview." https://www.michigan.gov/mdhhs/safety-injury-prev/environmental-health/topics/climate/overview
[40] District Health Department #10, "Lyme Disease Increasing in Michigan." http://www.dhd10.org/wp-content/uploads/2017/07/DHD10_LymeDisease_July2017.pdf
[41] GLISA, "Great Lakes Climatology: Interactive Climatology Map."

GLISA Division	Annual	Winter	Spring	Summer	Fall
Southeast Lower Michigan	2.8	3.3	3.1	2.3	2.2
West Central Lower Michigan	2.5	3.6	2.6	1.9	1.9
Central Lower Michigan	2.8	3.9	2.7	2.2	2.3
East Central Lower Michigan	2.9	3.8	2.8	2.3	2.4
Northwest Lower Michigan	3.1	4.1	2.9	2.7	2.5
Northeast Lower Michigan	2.9	3.8	2.5	2.6	2.3
Western Upper Michigan	2.7	3.9	2.2	2.5	2.3
Eastern Upper Michigan	2.3	2.8	1.8	2.5	2

Temperatures are increasing the most in the winter (Table 2), posing many challenges for Michigan. According to the Environmental Protection Agency, winter ice coverage on the Great Lakes has decreased by 63% due to warmer air and water temperatures.[42] Declining ice coverage and warmer waters pose both ecological and recreational threats. In 2020, winter tourism brought $3.6 million to Michigan according to TravelUSA.[43] But Michigan winters, as many know them, are "coming to an end."[44] Muskegon Luge, for example, hasn't opened for business during the holiday break in the last 5 years due to lack of snow,[45] a trend observed across Michigan.

The water level in the Great Lakes has been increasing and lake level fluctuations up to 2 meters have occurred.[46] Until about 2016, the Great Lakes experienced decreased water levels due to increased evaporation of the warmer waters.[47] More recently, lake levels have been rising. Lake Michigan water level is the highest it has been since the 1980's.[48] By 2040, lake levels in the Great Lakes are projected to rise up to another 0.4 meters, as over-lake precipitation and basin run-off increase due to climate change.[49] Increased wind and wave action in the Great Lakes also causes coastal flooding.[50] Fluctuating lake levels impact shipping, ecosystem assemblages, coastal infrastructure, hydropower, and recreation.

Harmful algal blooms (HABs) are also caused by warmer temperatures, so the impacts related to HABs in the "Severe Storms" section above apply here too. It is important to note

[42] "What Climate Change Means for Michigan."
[43] Miller, "As Snow and Ice Disappear with Climate Change, Some Michigan Businesses Struggle." https://michiganadvance.com/2021/12/27/as-snow-and-ice-disappear-with-climate-change-some-michigan-businesses-struggle/
[44] Matheny, "Michigan Winters, as Generations Have Known Them, May Be Coming to an End." https://phys.org/news/2021-01-michigan-winters.html
[45] Miller, "As Snow and Ice Disappear with Climate Change, Some Michigan Businesses Struggle."
[46] "Future Rise of the Great Lakes Water Levels Under Climate Change | Great Lakes Research Center | Michigan Tech." https://www.mtu.edu/greatlakes/research-highlights/climate-change-great-lakes/
[47] US EPA, "Climate Change Indicators." https://www.epa.gov/climate-indicators/great-lakes
[48] "State Climate Summaries: Michigan."
[49] Kayastha et al., "Future Rise of the Great Lakes Water Levels under Climate Change." https://linkinghub.elsevier.com/retrieve/pii/S0022169422007788
[50] Changnon, "Changes in Climate and Levels of Lake Michigan"; Hartmann, "Climate Change Impacts on Laurentian Great Lakes Levels." https://doi.org/10.1007/BF01091616

that warmer temperatures or increased runoff can cause HABs (in other words, both conditions do not need to be present for a HAB to occur), but if both conditions are present HABs may become more likely.

Potential Costs Related to Hotter Temperatures

Structure and Infrastructure Projects

- Energy efficiency retrofits in public and private buildings and housing, including costs for the design and development of standards.
- Increased cooling costs for all public buildings, including green roofs or cool roofing systems on public buildings and new AC installation or upgrade costs for schools.
- Increased road damage due to more frequent extreme heat events.
- Plan for and increase capacity for increased energy demands due to both increased daytime and nighttime temperature.
- Increase high-albedo surfaces on buildings, roads, and other locations where feasible.
- Increased costs of dredging during times of lower lake levels.
- Update piers and other coastal infrastructure to accommodate fluctuating water levels.

Public Health Projects

- Build and manage more cooling centers, including staffing and tracking of high-risk individuals.
- Increased demand for publicly financed air conditioning targeted to low-income families and public housing.
- Control the increase of vector borne illness using education and physical and chemical controls for ticks and mosquitos.
- Treat victims of vector borne illness.
- Treat an increase in asthma attacks requiring hospitalization (resulting from increased heat and ground level ozone, and the increase in airborne allergens).
- Reduce the urban heat island effect by planting trees.
- Protect drinking water supplies from hazardous algae blooms.

Summary of Costs from Hotter Temperatures:

Public health costs (e.g., medicare/medicaid), AC installation and upgrades where needed, establishing new cooling centers, planting trees to reduce urban heat islands, protecting drinking water supplies, and updates to coastal infrastructure.

Intensified Drought

Despite increases in average precipitation, summer droughts — a natural part of Michigan's climate — are predicted to intensify.[51] Increased summer droughts threaten crop yields in

[51] "State Climate Summaries: Michigan."

Michigan, like asparagus, which brings in $73 million annually.[52] Summer droughts will also likely increase wildfire occurrences in Michigan's forests.[53]

Potential Costs Related to Intensified Drought

Water Management

- Protect drinking water supplies from low lake levels.
- Individual purchase of water during water scarce times.[54]
- Treatment for victims of water-borne illnesses.[55]
- Replace old pipelines that have water leak issues.[56]
- Hire a climate scientist to recommend updates to water treatment, wastewater treatment, and other energy infrastructure using the best available science.[57]

Wildfires

- Increase fire suppression, including staffing and aviation.
- Rebuild or relocate damaged properties and public infrastructure, such as homes and utility lines.
- Relocate public infrastructure where necessary.
- Update power lines to withstand wildfires.
- Implement fire mitigation strategies for the future like burying utility lines underground.
- Plan for and disburse community aid after wildfires.
- Implement fire detection strategies, like solar-powered sensors.[58]
- Rehabilitate the landscape post-fire to reduce the risk of erosion and invasive species and mitigate future fire risk.
- Increased hospitalization costs for asthma attacks and other chronic health conditions (resulting from decreased air quality due to wildfire smoke).

Education and awareness programs

- Increase public outreach to encourage wildfire risk management; educate residents in wildfire safety, technical assistance availability, funding sources, and best practices.

Summary of Costs from Extreme Drought:

Fire prevention and recovery, water security and water treatment, infrastructure damages, public health, and education and awareness.

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[52] Brainard et al., "Managing Drought Risk in a Changing Climate." https://www.sciencedirect.com/science/article/pii/S0378377418304517
[53] Neuman, "Climate Change and Wildfire in the Great Lakes Region." https://www.canr.msu.edu/uploads/resources/pdfs/e-3277_wcag_2_aa.pdf
[54] Zoë Roller et al., "Closing the Water Access Gap in the United States: A National Action Plan," Dig Deep and US Water Alliance, 2022. https://static1.squarespace.com/static/5e80f1a64ed7dc3408525fb9/t/6092ddcc499e1b6a6a07ba3a/1620237782228/Dig-Deep_Closing-the-Water-Access-Gap-in-the-United-States_DIGITAL_compressed.pdf.
[55] ibid
[56] CISA, "Drought and Infrastructure - A Planning Guide" https://www.cisa.gov/sites/default/files/publications/Drought_and_Infrastructure_A_Planning_Guide_508c.pdf
[57] ibid
[58] Jennifer L, "Wildfires Cost Over $148B" https://carboncredits.com/wildfires-cost-emissions/

Losses to Local Revenue

Climate change — especially warmer Winters — impacts revenue from agriculture, recreation, and tourism. Around 2000, snowmobile sales produced $187 million in income and created thousands of jobs in Michigan. Since then, snowmobile sales have dropped by 70%, due in part to warmer winters and decreased snow accumulation.[59] According to the U.S. Fish and Wildlife Service, over 2 million anglers flock to the Great Lakes to ice fish in the winter, but as the number of days of ice cover on the Great Lakes decreases, ice fishing revenue will decline as well.[60]

Other Potential Costs

Other plausible impacts from climate change that would incur public health costs are increased allergen levels, food- and water-borne infections, and zoonotic diseases.[61] Since Michigan's climate is historically moderate, Michigan is also likely to see an influx of climate refugees, which will incur costs as they plan for and accommodate more residents.[62]

[59] Matheny, "Michigan Winters, as Generations Have Known Them, May Be Coming to an End."
[60] Gitelman and Cheng, "Great Lakes Fish and Fisheries Suffer Stress of Warming Climate." https://www.freep.com/in-depth/news/local/michigan/2022/06/14/great-lakes-fish-fisheries-warming-climate/9925762002/
[61] Carmen Milanes et al., "Indicators of Climate Change"
[62] Freedman, "The Great Lakes Region Could Be a Haven for Climate Migrants. Some Are Already Here. https://www.crainsdetroit.com/crains-forum/climate-change-extreme-weather-spur-migration-great-lakes