

The Great Lakes and Climate-Induced Human Migration

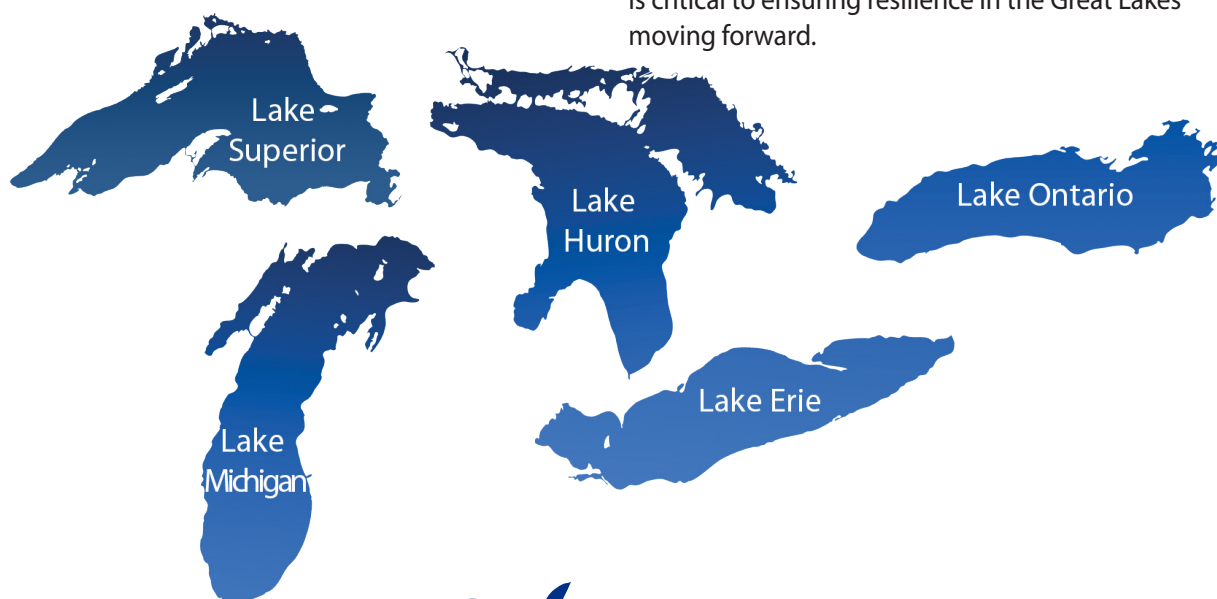
By Andrea Harder *an M.U.P.* candidate at the University at Buffalo*

Overview

Lake Superior, Michigan, Huron, Erie, and Ontario come together to form the Great Lakes, an invaluable freshwater resource that contains 95% of the United States' surface water supply.¹ More than 34 million people in the United States and Canada and 3,500 species of plants and animals live within the Great Lakes basin.¹ We depend on the Great Lakes and the social, environmental, cultural, and economic benefits that they provide. These services have created the preconditions for a thriving regional economy that directly supports more than 1.3 million jobs in coastal counties in the following sectors: "manufacturing; tourism and recreation; transportation and warehousing; and agriculture, fishing, and food production".² However, unsustainable growth and development are exacerbating environmental degradation at the local level while contributing to rising temperatures across the globe.

In 2020 approximately 30 million people were displaced by extreme weather events internationally.³ Without action to mitigate the impacts of climate change, it is projected that nearly 216 million people across six regions, including Sub-Saharan Africa, East Asia and the Pacific, South Asia, North Africa, Latin America, and Eastern and Central Asia, could be displaced within their countries by 2050.³

After decades of population decline in manufacturing centers across the Great Lakes region in the latter half of the twentieth century, there is an opportunity to welcome those who have been displaced from other regions while supporting equitable growth and revitalization efforts. Climate migrants may find themselves attracted to the Great Lakes basin due to its northeastern and midwestern location, an abundance of freshwater resources, and room to accommodate growth. Even though the region is anticipated as a future climate destination, climate change will still impact the Great Lakes at the local level. Understanding the specific challenges that climate change will pose and how those challenges will likely induce human migration is critical to ensuring resilience in the Great Lakes moving forward.



PEOPLE
ON THE
MOVE IN A
CHANGING
CLIMATE

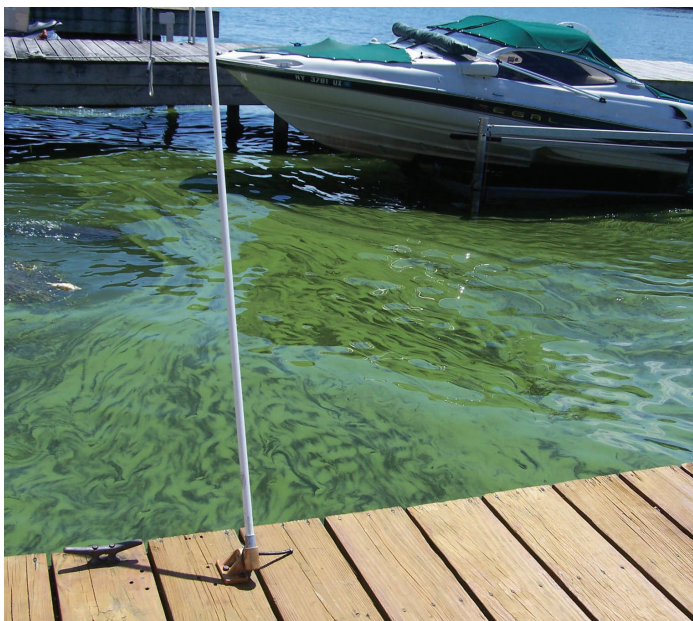
Sea Grant
New York

PEMOCC is supported by the National Science Foundation under Grant No. (1940082). Any opinions, findings, and conclusions or recommendations expressed on this fact sheet are those of the authors and do not necessarily reflect the views of the National Science Foundation.

The Impacts of Climate Change on the Great Lakes

Record-Breaking Temperatures

Human activity and the consumption of coal, oil, and natural gas have significantly increased the concentration of greenhouse gases in our atmosphere while contributing to rising temperatures across the globe. In 2019, carbon dioxide concentrations in the atmosphere “were higher than at any time in at least 2 million years.”⁴ Consequently, 2020 was documented as the second-warmest year on record.⁵ At current rates, average air temperature trends are on track to exceed 1.7°C to 3.3°C by mid-century and 3.3°C to 6.1°C by the end of the 21st century.⁶ However, studies have shown that temperatures are already on the rise across the Great Lakes and that average annual air temperatures have increased in the region by 1.3°C since 1951.⁶ Since the 1960s, heat waves have become more common and by the end of the century, the region will likely experience 30 to 60 additional days each year of extremely warm weather.¹ In general, nights and winters will become warmer, and the Great Lakes region will experience 15-16 fewer days in which the temperature drops below freezing by the 2030s.¹ Rising average annual temperatures could thus have serious implications for human health and environmental processes that have historically relied on relatively stable and predictable atmospheric conditions.



Algal blooms on Lake Ontario.
Image credit: Save Our Sodus

Water Quantity and Water Quality

Rising temperatures have allowed the atmosphere to retain more moisture resulting in a 14% increase in precipitation over the Great Lakes since 1951.⁶ By the end of the century, warmer winters mean that more snow will fall as rain in the Great Lakes Basin. Projections forecast a 30-50% decrease in annual total snowfall under different emissions scenarios.¹ Meanwhile, warmer air and water temperatures have already led to a reduction in ice coverage on the Great Lakes in the past several decades.¹ Despite general increases in precipitation in the Great Lakes region as a whole, some areas and land surfaces within the region are expected to become drier.⁶ As the soil becomes more arid during the summer months when annual temperatures are at their peak, there is an increasing need for irrigation. As a result, groundwater resources have increasingly been tapped and depleted to irrigate crops in the Midwest.¹

Increasingly erratic precipitation patterns can have serious implications on hydrological and watershed processes. Stormwater that cannot be absorbed fast enough via natural processes can lead to flooding, and can overwhelm sewer systems in urban areas. Rain that is more frequent and intense can also amplify the risk of erosion and runoff. In general, runoff will increase in the winter and spring and decrease during the summer months.¹ However, stormwater runoff to date has impacted each of the Great Lakes in unique ways. For example, runoff into Lake Superior has decreased by 8.6% while simultaneously increasing by 7.3% for Lake Erie and 9.8% for Lake Ontario.¹

Stormwater runoff can also carry fertilizer from agricultural areas as well as other contaminants that can reduce water quality and cause Harmful Algal Blooms (HABs) when introduced to elevated water temperatures.¹ Toxic algal blooms have already impacted water security across the Great Lakes watershed. In 2014, 500,000 people in the Toledo area went without safe drinking water for 72 hours because of toxic algal blooms on Lake Erie.¹ More recently, unprecedented blue-green algal blooms have been spotted on Lake Superior. Despite being the “deepest and most northern of the Great Lakes”, Lake Superior is now regarded as one of the “fastest-warming lakes in the world” according to Robert Sterner, director of the Large Lakes Observatory at the University of Minnesota Duluth.⁷

More than 30 million residents currently rely on the Great Lakes to supply drinking water to their communities, including “10 percent of the U.S. population and 30 percent of the Canadian population.”⁸ As the prevalence of water-borne pathogens increases as a result of climate change, the costs of maintaining safe and reliable drinking water will rise.

Agriculture and Wildlife

Agriculture and associated industries play a significant role in the region's economy, "contributing \$1 billion in revenue and about 19,000 permanent jobs"⁹ Over a third of the land in the Great Lakes basin is dedicated to agricultural practices and "main agricultural outputs include dairy, produce, and commodity crops"^{1,9} Changing temperatures, precipitation patterns, atmospheric conditions, and ecological processes will impact food production and biodiversity in the Great Lakes moving forward. Conventional agricultural practices have plowed, tilled, and over-cultivated the land, resulting in soil degradation, poor plant health, and crops that are more susceptible to infestation and disease. To date, inferior crop yields have been compensated with herbicides, pesticides, fungicides and fertilizers that can pollute freshwater resources when not properly managed. Some studies have found that crop yields in the Midwest could potentially decline by 10-30% by the middle to latter parts of the century as a result of a changing climate.¹ However, other studies have predicted that rising average annual temperatures could extend the duration of the growing season and increase the proportion of arable farmland which could ultimately improve the yield of certain commodity crops.²

Climate change is also affecting the composition, distribution, and migration of both plants and animals. Numerous studies have shown that different plant and animal species are shifting northwest in an attempt to adapt to rising temperatures. For example, some tree species are moving northwest at a pace of 10-15 km per decade and different species of sportfish across the Great Lakes have shifted "northward at a rate of 8 to 11 miles (12.9 to 17.5 km) per decade over the past 30 years"¹ As the distribution and composition of plants and animals continue to shift, native species could effectively be replaced by invasive species and impacted by the introduction of previously unacquainted pests and diseases.¹

Ultimately, targeted habitat restoration and conservation efforts can prevent or reduce the loss of agricultural yields and protect ecosystem biodiversity by making plant and animal species more resilient to the impacts of climate change.²

Infrastructure

Infrastructure plays a critical role in providing everyday services that are required to ensure human health and wellbeing. However, across the Great Lakes and throughout the country as a whole, much of our infrastructure is in a state of decline. The American Society of Civil Engineers graded the current state of infrastructure in the United States as a D+ on their infrastructure report card in 2017.¹⁰ In general, aging and inadequate power, transportation, water, and sewer infrastructure are more sensitive to adverse weather conditions.

Power plants across the Great Lakes region require large amounts of water for cooling. Because of this, thermo-electric power plants tend to be built along waterways and can thus be impacted by "lower lake levels and higher water temperatures"¹ Changing lake levels, increased precipitation, and extreme heat can also erode and damage transportation infrastructure throughout the region.¹ The shipping industry currently transports more than 150 million tons of cargo throughout the Great Lakes each year and has relied on relatively stable lake levels to navigate throughout the region.¹ Lower lake levels can thus force cargo ships to lighten their loads, making shipping more expensive, and can also "affect the ability of ships to safely navigate shallow portions of the Great Lakes' channels and harbors".¹

One report states that "2019 was the fifth consecutive year (2015–2019) in which 10 or more billion-dollar weather and climate disaster events have impacted the USA"¹¹ Therefore, proactive investments should be made to improve the quality of the country's infrastructure. More specifically, money invested in green infrastructure and renewable energy technologies can improve environmental and atmospheric conditions, spur economic development, and ensure the resilience of our communities.



Coastal Infrastructure impacted by erosion in Monroe County. Image credit: Mary Austerman, New York Sea Grant. 2017 Coastal Flooding Survey Project

Public Health and Wellbeing

In 2012, a Midwestern heatwave and drought caused more than \$30 billion in economic damage, 123 deaths, and harmful long-term impacts across most of the midwestern United States.¹ Today extreme heat takes on average 1,300 lives on an annual basis and remains one of the “leading causes of weather-related deaths in the United States.”¹² Moving forward, heatwaves, flooding, unfavorable atmospheric conditions, and extreme weather events will continue to jeopardize the physical and mental health of the public through increased risk of heat-related illness, respiratory disease, and death.¹²

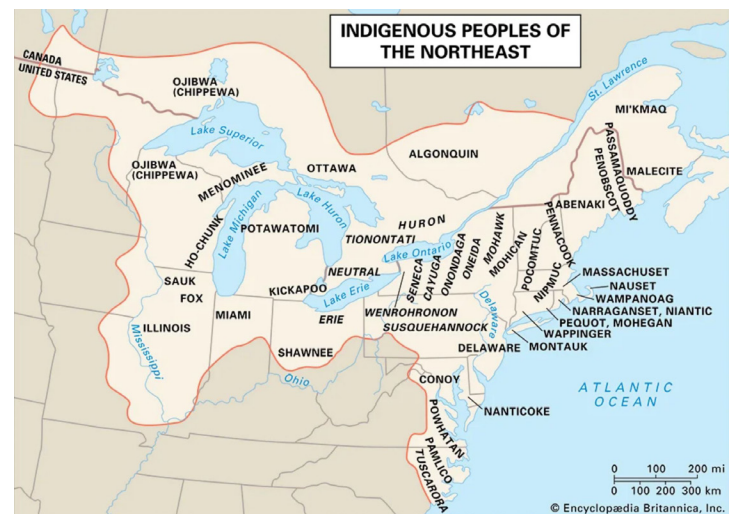
As we continue to burn fossil fuels, the concentration of greenhouse gases and other pollutants in the atmosphere will continue to increase, having a negative impact on human health while contributing to rising average annual temperatures across the globe. Nationally, the impacts of fossil-fuel generated air pollution and climate change exceed \$820 billion in healthcare costs each year.¹² Without meaningful action to reverse current emissions trends from the burning of fossil fuels, the World Health Organization estimates that 250,000 additional climate-related deaths will occur per year between 2030 and 2050.¹²

Despite contributing the least to global greenhouse gas emissions, low-income, communities of color, and coastal communities will be most impacted by the effects of climate change. Underserved and underrepresented communities are more likely to reside in areas of high exposure to localized environmental burdens such as air pollution or in zones that are prone to flooding. This is in part due to inequitable housing policies that resulted in racially-segregated residential areas. The residents in underserved and underrepresented communities, including women and children, as well as those with pre-existing conditions, the elderly, and people with disabilities often find themselves at the frontlines of the climate crisis yet without the resources and the assets to effectively prepare for and recover from its impacts.¹¹

Tribal Nations and Indigenous Communities

The Great Lakes region has been home to approximately 120 bands of Native peoples throughout history.¹³ Today, Indigenous populations that reside in the Great Lakes region are leading the fight against the climate crisis. For example, the Anishinaabe people of the Bay Mills Indian Community (BMIC) have protested Enbridge’s Line 5 petroleum pipeline and the expansion of fossil fuel infrastructure in the state of Michigan for nearly a decade.¹⁴

Tribal nations rely on and protect the ecosystem and the benefits it provides. However, environmental degradation and pressures from encroaching development pose a threat to tribal sovereignty and wellbeing. Moving forward, the Traditional Ecological Knowledge that has been acquired by indigenous and local peoples over hundreds or thousands of years and emphasizes a balance between mankind and the environment will be valuable in restoring and preserving the natural world.¹⁵



Indigenous populations in the Great Lakes Region.
Image credit: Encyclopædia Britannica, Inc.

Climate Migration: Global Trends

By the end of the 21st century, climate change is expected to make well-established communities across the globe increasingly uninhabitable. Rapid and slow onset events will drive short-term and long-term human mobility which broadly includes displacement, migration, and planned relocation. Slow onset effects can include but are not limited to “desertification, glacial retreat, increasing temperatures, land degradation, loss of biodiversity, ocean acidification, salinization and sea-level rise”.¹⁶ Meanwhile, rapid and extreme weather-related events, such as hurricanes, floods and wildfires, have already become more frequent over the past couple of decades, driving hundreds of thousands of people out of their homes and causing billions of dollars in damages. For example, in 2005, Hurricane Katrina, an unprecedented tropical storm that struck New Orleans, displaced 800,000 residents and damaged more than 100,000 housing units.¹⁷ However, communities of color were disproportionately displaced and often lacked access to the resources required to return following the reconstruction and subsequent gentrification of their communities.¹¹

Approximately 40% of the population in the United States lives in coastal areas.¹¹ Sea level rise alone could displace 13.1 million Americans from the Atlantic and the Pacific coast, the Gulf of Mexico, and the Great Lakes by 2100.² International studies, on the other hand, have found that 30 million people were displaced by extreme weather events across the globe in 2020.³ Without action to mitigate the impacts of climate change, it is projected that nearly 216 million people across six regions, including Sub-Saharan Africa, East Asia and the Pacific, South Asia, North Africa, Latin America, and Eastern and Central Asia, could be displaced within their countries by 2050.



Seiche waves blast a shoreline structure in Buffalo, NY in April 2018. Image credit: New York State Department of Environmental Conservation

that could exceed 216 million across six regions, including Sub-Saharan Africa, East Asia and the Pacific, South Asia, North Africa, Latin America, and Eastern and Central Asia, by 2050.³ However, meaningful mitigation and adaptation efforts could “reduce the scale of internal climate migration by as much as 60–80%” across the globe.³

Different push and pull factors influence the decisions people will make when faced with no other option than to move. Numerous studies have found that a vast majority of climate migrants across the globe have relocated within their own countries, not across international borders and that “migration tends to be short distance and driven largely by social networks and kin ties”.^{3,18} However, in situations where climate migrants do seek to cross national borders as a result of uninhabitable living conditions, there are “no domestic laws or multilateral treaties” to ensure that they will not be turned away.¹⁹ In 1951 when the United Nations refugee convention decided that refugee status would be determined based on an individual’s “fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion” the term climate migration wasn’t widely recognized.²⁰

Today, when climate migrants can take refuge in a host community, they “often face worse social and economic conditions following resettlement”.² However, it is important to recognize that not everyone will have the same opportunity or capacity to evacuate, relocate, and or return when climatic conditions become hostile. Socio-demographic factors involving race, gender, class, age, and ability can create additional inequalities and obstacles for those who would like to move but can’t, making them “demographically stuck”.²¹

Cities generally will be more capable of receiving the people who can and will want to relocate after a disaster due to existing services, programs, and infrastructure to accommodate growth. Most cities will fall under one of the three following categories when it comes to climate migration: vulnerable cities, recipient cities, and climate destinations.¹¹ Vulnerable cities will suffer population losses as a result of climate change. Recipient cities may be unsuspecting, unwilling, and unprepared to receive migrants following a rapid onset event. Meanwhile, climate destinations will include cities that are open to accepting new migrants, embracing sustainable development, and rebranding their communities as “climate havens”.¹¹

Preparing for Climate Migration in the Great Lakes

Across the Great Lakes region, “climate amenities, like mild seasonal weather, high elevation, inland location, abundant surface water, and minimal wildfire risk could be a potential draw for climate migrants.”² Post-industrial “cities like Duluth, Minnesota; Buffalo, New York; and Cincinnati, Ohio” have the potential to frame themselves as climate destinations.¹¹ Ultimately, there will be a myriad of opportunities and challenges associated with climate-driven population growth in cities across the Great Lakes.

Opportunities

After a half-century of population declines and suburbanization that resulted in housing vacancies and neighborhood disinvestment, post-industrial Rust Belt cities across the Great Lakes have an opportunity to focus revitalization efforts on climate-driven population growth while advancing sustainable and equitable development across the region. Immigration from Asia, Africa, and Central and South America has already helped to fuel revitalization efforts across the Great Lakes.² Cities such as Buffalo, New York, have enjoyed “economic benefits to hosting newcomers including \$622 million in taxes paid, and \$1.5 billion in spending power in 2017.”¹¹ Money that is spent to mitigate the impacts of climate change, improve the condition of the region's infrastructure, and expand

affordable housing options, social services, and employment opportunities would benefit both existing and future populations. The result could revitalize the region's economy through increased economic activity and productivity if incoming climate migrants complement existing local labor forces and our communities are prepared to receive them.²

Challenges

Despite numerous cities across the Great Lakes region being characterized as climate destinations, each community will face “their own share of social, economic, and environmental stressors.”¹¹ Extreme weather events and the long term effects of climate change can and likely will impact housing, land values, programs, and services.² Aging and inadequate infrastructure across the region will likely struggle to cope with the effects of climate change and an influx of climate migrants. As the population continues to grow and investment returns to these previously disinvested post-industrial urban centers across the Great Lakes, land values will likely increase. Climate-based gentrification could be the result if low-income populations are displaced by more affluent populations looking to relocate to cities that are portrayed as climate havens. Additionally, in communities that have a long history of being segregated across socio-demographic lines, climate migrants could be met with hostility. Therefore, a community's openness to accept new residents and climate migrants will play a critical role in building social cohesion, unity, and harmony.



The shoreline of Lake Superior at Duluth, Minnesota with Canal Park in the foreground, a Baymouth sandbar that separates Lake Superior from the Port of Duluth-Superior. August 2019.
Image credit: University of Minnesota Duluth

Moving Forward

What we do now to prepare for the primary and secondary effects of climate change will be critical to ensuring social, environmental, and economic resilience across the Great Lakes moving forward. To date, support for climate migration efforts has been provided on an ad hoc basis.² With a lack of dedicated funding, guidance, and policies, the U.S. federal government may be “ill-prepared to deal with the immense and undeniable human security challenge.”² Ultimately, preparing for climate-induced migration in the Great Lakes region will require a concerted effort and partnerships among a variety of stakeholders including community members, the public sector, the private sector, and non-profit organizations. However, local, state, and federal governments can undertake specific actions to catalyze equitable and sustainable growth.

Climate change is a known “injustice accelerator” that will have a disproportionate impact on low-income, communities of color, and coastal communities while amplifying existing inequalities. For this reason, equity must be a central component of all mitigation and adaptation

strategies moving forward.⁹ Incentives, policies, and plans that equitably distribute resources and benefits could be put into place to minimize injustices across socio-economic lines. The most effective plans will include migrants and other vulnerable or at-risk populations in discussions and decision-making processes while recognizing them as the resident experts on their communities. Additionally, resources could be allocated to established community-based organizations and resettlement agencies that are already advocating for change and supporting in-migration at the grassroots level.

Additional and continued science-based research by Sea Grant and others will help further our understanding of the primary and secondary impacts of climate change. Public outreach and education will extend that understanding to help communities learn about the opportunities and challenges associated with climate-induced human migration in the Great Lakes region.

Further investments may need to be made to improve the physical condition of the region's infrastructure and to expand services that will meet the needs of existing and future populations. Existing and future populations could specifically benefit from investments in affordable housing, public transportation, renewable energy, healthcare, and other services.²

Building Community Resilience: Possible Areas for Engagement

Level of Government	Action Items
Local	<ul style="list-style-type: none"> • Support infill development and revitalization efforts in urban neighborhoods through community engagement and participation • Engage the community in climate migration-related discussions and decisions • Identify environmental justice communities and other vulnerable populations that may be adversely impacted by the effects of climate change • Protect and expand affordable housing options for existing and future populations • Support and empower the efforts of community-based organizations
State	<ul style="list-style-type: none"> • Encourage investment in mitigation and adaptation efforts through the creation of tax incentives • Provide technical expertise and assistance to local governments • Invest in critical infrastructure • Plan and prepare for a variety of climate-related and migration-related scenarios
Federal	<ul style="list-style-type: none"> • Create and implement policies that extend rights to those displaced by climate change • Establish both public and private partnerships • Provide federal funding for mitigation and adaptation efforts • Invest in continued research in relation to climate migration

New York Sea Grant is part of a multi-Sea Grant project that is providing a science-based framework for studying climate-driven population shifts. Learn more at <https://www.pemocc.org>.

Conclusion

Overall, climate-induced human mobility is a growing concern within the U.S. and throughout the Great Lakes region and there are many questions that have yet to be answered. Climate-induced displacement and migration “is the result of a complex process with many drivers” and there are many uncertainties regarding exactly who will be displaced, when they will be displaced, where they will go, and why.¹⁶ Understanding the specific opportunities and challenges related to climate change and climate-induced migration will be critical to ensuring social, economic, and environmental resilience in the Great Lakes moving forward.

References

1. Wuebbles, D., Cardinale, B., Cherkauer, K., Davidson-Arnott, R., Hellmann, J., Infante, D., ... & Ballinger, A. (2019). *An assessment of the impacts of climate change on the Great Lakes*. Environmental Law & Policy Center.
2. American Society of Adaptation Professionals. “Climate and Demographic Change in the Great Lakes Region: a Narrative Literature Review of Opportunities and Opportunity Barriers.” March 2021.
3. Clement, V., Rigaud, K. K., de Sherbinin, A., Jones, B., Adamo, S., Schewe, J., ... & Shabahat, E. (2021). *Groundswell Part 2: Acting on Internal Climate Migration*. World Bank.
4. Allan, R. P., Hawkins, E., Bellouin, N., & Collins, B. (2021). *IPCC, 2021: Summary for Policymakers*.
5. Bateman, J. (2021, January 14). *2020 was Earth's 2nd-Hottest Year, just behind 2016*. National Oceanic and Atmospheric Administration.
6. *Climate Change in Great Lakes Region References*. GLISA. (2019, February 14).
7. Oosthoek, S. (2022, March 16). *Lake superior summer: Blue-green algal blooms come to a lake once believed immune*. Great Lakes Now.
8. *National Oceanic and Atmospheric Administration*. (2022, May 27). *Fast Facts: Great Lakes*. NOAA Office for Coastal Management.
9. *Introduction to Climate Issues in the Genesee-Finger Lakes Region*. Climate Solutions Accelerator. (2021, April).
10. ASCE. (2017). *2017 infrastructure report card*. In American Society of Civil Engineers.
11. Marandi, A., & Main, K. L. (2021). *Vulnerable City, recipient city, or climate destination? Towards a typology of domestic climate migration impacts in US cities*. *Journal of Environmental Studies and Sciences*, 11(3), 465-480.
12. *Impact of climate change on health*. NIHCM. (2021, October 14).
13. *Native Peoples of the Great Lakes Region*. Environmental Education for Kids. (n.d.).
14. *Native American Rights Fund*. (2022, April 26). *Enbridge's Line 5 pipeline*. NARF.
15. Rinkevich, S., Greenwood, K., & Leonetti, C. (2011, February). *Traditional Ecological Knowledge Fact Sheet*.
16. IDMC, “Global Report on Internal Displacement 2021”.
17. Johnson, A. E., & Wilkinson, K. K. (Eds.). (2021). *All we can save: Truth, courage, and solutions for the climate crisis*. One World/Ballantine.
18. Findlay, A. M. (2011). *Migrant destinations in an era of environmental change*. *Global Environmental Change-Human and Policy Dimensions*, 21, S50-S58.
19. *On the Frontlines of the Climate Emergency: Where immigrants meet climate change*. Unbound Philanthropy. (2021, December).
20. *United Nations High Commissioner for Refugees*. (1978). *Convention and protocol relating to the status of refugees*. UN.
21. American Society of Adaptation Professionals. (2021, December 7). *Climate migration workshop: In-Migration Methodologies and Understanding Climate Receiving Regions*.

We would also like to acknowledge the efforts of the Great Lakes PEMOCC Workshop Planning team, Natalie Chin, Nate Drag, Nicholas B. Rajkovich and other experts for their assistance in reviewing this factsheet.

Andrea Harder

*Master of Urban Planning candidate, Class of 2023
University at Buffalo
amharder@buffalo.edu

New York Sea Grant

112 Rice Hall
Cornell University
Ithaca, NY 14853-5905
(607) 255-2832
nyseagrant.org

Katherine Bunting-Howarth Ph.D., J.D.

Associate Director, New York Sea Grant Institute
Assistant Director, Cornell Cooperative Extension
keb264@cornell.edu



**PEOPLE
ON THE
MOVE IN A
CHANGING
CLIMATE**

August 2022