APRIL 2025

# RESEARCH BRIEF

Clean Wisconsin Environmental Health Initiative

## Using Cumulative Impacts to Assess Environmental Burden in Wisconsin

By Kayla Rinderknecht, MPH & Paul Mathewson, Ph.D.

**SUMMARY –** Environmental quality is an important determinant of community health via the air we breathe, the water we drink, and the land we play on. To identify areas that experience high environmental burdens in terms of exposure to pollution and other environmental health risks, Environmental Health Indices have been developed.

Environmental Health indices look at multiple pollutants using a variety of sources and combine them into a single score to give a broad picture of the overall environmental health in an area. Higher scores on these indices, indicating worse environmental conditions, have been linked to various health problems such as increased asthma, cancer, adverse pregnancy outcomes, and cardiovascular disease.

Because these indices describe the cumulative impact of multiple environmental risks, they represent a good starting place to understand where environmental health burden is the highest in Wisconsin and who is most affected. Here, we explore what picture of environmental health burden that two existing Environmental Health Indices show for Wisconsin.

Key takeaways from this exploration include:

- The vast majority (70-95%) of census tracts with the highest environmental burden were in the southeast region, mostly concentrated in the Milwaukee urban area.
- As the minority population in an area increases, overall environmental burden also increases.
- There is a 52-percentile-point difference in total environmental burden between the least white and most white neighborhoods, the second largest gap among surrounding states
- Air pollution is the leading cause of racial/ethnic exposure disparities in environmental health risks, and Wisconsin has a 60-percentile-point difference in cumulative air pollution exposure between the least white and most white neighborhoods disparity for air pollution among surrounding states, the largest gap among surrounding states.

This analysis is intended to be the starting point for understanding environmental determinants of health in Wisconsin. It highlights where the greatest environmental burden occurs, who is impacted, and the environmental health disparities that currently exist to inform efforts to address these burdens and disparities. Next steps include investigation of individual exposures within these indices to better understand what is driving environmental burden and related health disparities for communities in Wisconsin.

One important limitation of these existing indices is that they do not account for drinking water quality. For example, they do not consider the widespread nitrate contamination in private wells in rural areas of the state. This will be an important gap to fill to gain a more complete picture of environmental health burden throughout the state.

## Definitions

- **Environmental Health Indices:** tools that look at multiple pollutants using a variety of sources and combine them into a single score to give a broad picture of the overall environmental health in an area. [1]
- **Cumulative Impacts:** Combined chemical and non-chemical stressors on a community's health, well-being and quality of life.[2]
- **Environmental Burden**: Overall impact to human health that occurs from the combination of pollution, poor environmental conditions, pre-existing health conditions, and social factors.[3]
- **Environmental Determinants of Health**: Environmental factors that impact human health, including physical, chemical, and biological factors external to a person, and all related behaviors.[4]
- **Environmental Health Disparities**: Differences in health outcomes that are closely linked to environmental factors and social inequities.[5]

## Contents



cleanwisconsin
your environmental voice since 1970

## Introduction

One way of understanding how environmental pollution is impacting public health in Wisconsin is looking at environmental burden indices. These indices go beyond looking at a single pollutant and its impact on public health by combining multiple indicators into a composite score to provide a broader picture of cumulative environmental burden.[1]

Worse environmental index scores have been associated with adverse health outcomes, including asthma prevalence [6], cancer prevalence [7], cardiovascular diseases and risk factors [8], adverse pregnancy outcomes [9], mortality [10], and self-reported health measures [11]. These associations indicate that an increase in index scores (worsening environmental quality and injustice) can increase the chance of poor health outcomes.

Air pollution domains have the strongest associations with health outcomes for environmental exposures. Sociodemographic domains then have the next strongest associations with health outcomes throughout review. This indicates a need to focus on environmental exposures related to air pollution and direct resources toward policies and programs that address socioeconomic stability of communities.

## Environmental Health Indices

Based on the health outcomes associated with the environmental quality indices, we analyzed what these indices identify as the areas of greatest environmental burden and who is being most impacted in Wisconsin. We explored three existing environmental health indices: the EPA's Environmental Quality Index (EQI), the CDC's Environmental Justice Index (EJI), and Texas A&M's U.S. Climate Vulnerability Indicator (CVI). Due to coarse resolution (only county-level) and dated information in the EQI (many dating back prior to 2010), we have focused on the EJI and CVI, which provide a more accurate representation of the current environmental burden in Wisconsin.

The EJI was developed to measure cumulative impacts at the census tract level using multiple domains simultaneously. This allows public health officials to locate areas of concern that experience health outcomes related to environmental burden.[12] The EJI produces one score based on three main modules: Social Vulnerability, Environmental Burden, and Health Vulnerability. The Environmental Burden Module produces an overall Environmental Burden score based the following subdomains: Air Pollution, Potentially Hazardous and Toxic Sites, Built Environment, Transportation Structure, and Water Pollution.[13] A higher score indicates a higher environmental burden (worse environmental quality).

The CVI was also developed to measure cumulative impacts at the census tract level or neighborhood scale. This tool visualizes the intersections between growing climate risks, health, social, environmental, and economic conditions.[14] The CVI includes two overarching indicators – Community Baseline and Climate Impacts. One of the Community Baseline Domains includes the Environmental Domain, which looks at Transportation Sources, Exposures and Risks, Pollution Sources, Criteria Air Pollutants and Land Use.[15] A higher overall Environmental Domain score indicates higher environmental pollution exposure risk.

## Analysis

The distribution of environmental burden based on these indices is shown in Figures 1 and 2. Census tracts with the highest environmental burden (defined as the top 10% most burdened census tracts), are concentrated in the southeastern region.

Using the EJI, the vast majority of the highest burdened tracts (71%) were in the southeast region urban areas, despite these tracts only accounting for 43% of all tracts in the state. The remainder were scattered throughout the state, including Appleton, Beloit, Green Bay, Janesville, and Madison, urban areas.

Using the CVI, similar results were found that the vast majority (96%) of the highest environmental burden

was found in the southeast region urban areas (Milwaukee). The remainder for the CVI were found in Madison and Green Bay Urban Areas.

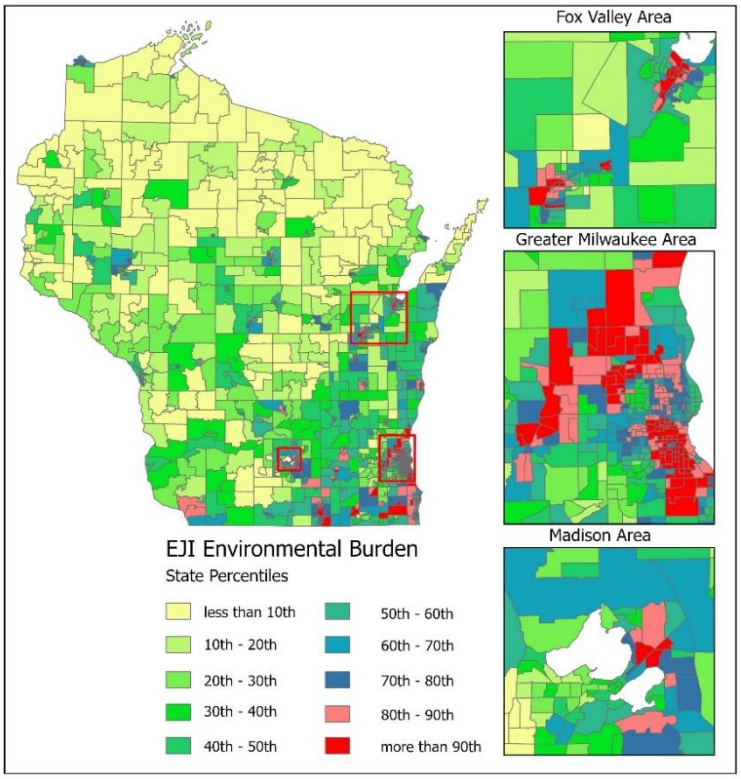


**Figure 1.** Relative ranking of environmental health burden, using the EJI's Environmental Burden Module. A higher percentile indicates a higher environmental burden (i.e., more pollution, poorer environmental quality)

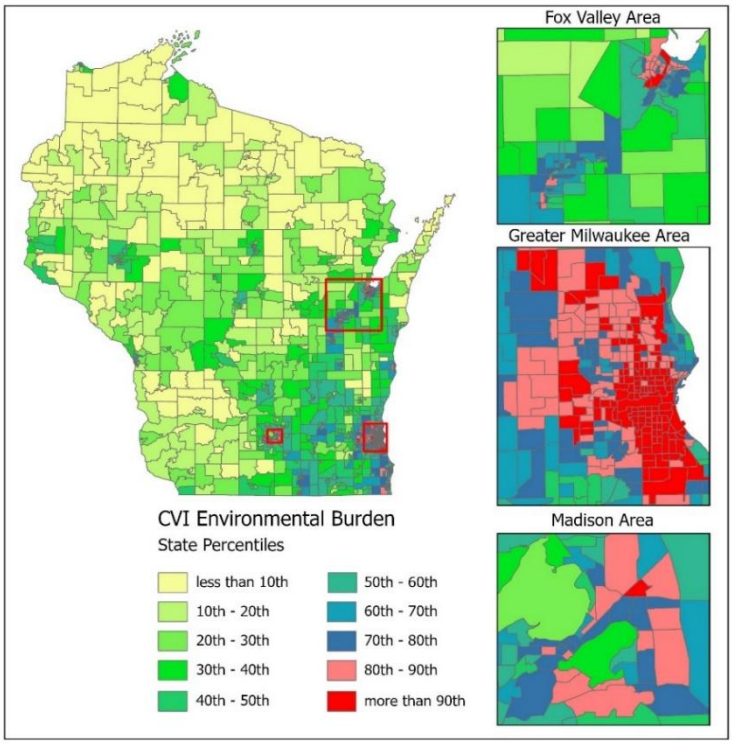


**Figure 2.** Relative ranking of environmental health burden, using the CVI's Baseline Environment Domain. A higher percentile indicates a higher environmental burden.

Focusing specifically on the air pollution domain since this has the strongest connection to adverse health outcomes, we can see from figure 4 below that the southeastern region is also the biggest area of concern. Census tracts in this region average from the 80th percentile to the 100th percentile, with the most burdened census tracts in the Milwaukee area.

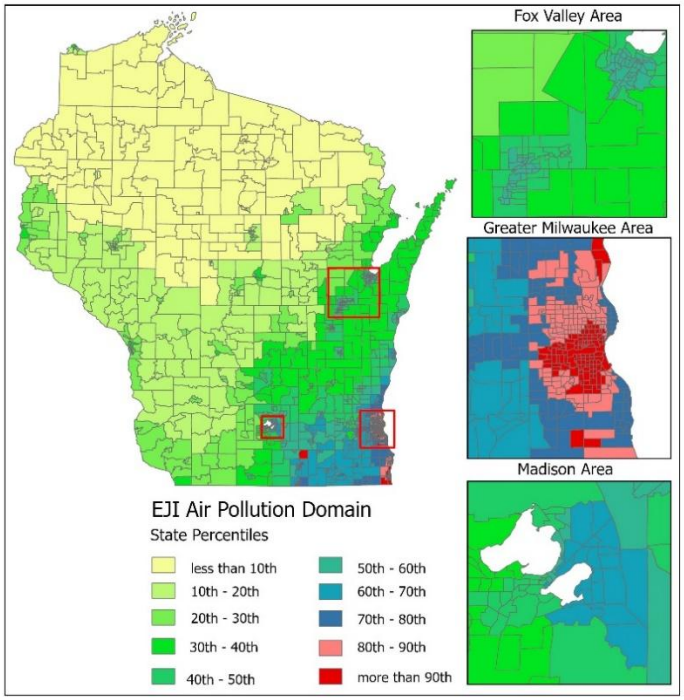


**Figure 3.** Relative ranking of air pollution burden in Wisconsin, using the EJI's Air Pollution Domain. Air Pollution Domain is measured with the following indicators: Ozone, $PM_{2.5}$, Diesel Particulate Matter, and Air Toxics Cancer Risk. Higher percentiles indicate more air pollution and poorer air quality.

## Environmental Health Disparities

Census tracts with the highest environmental injustice scores tend to be predominantly minority neighborhoods, lower socioeconomic status, and have higher exposure to hazardous chemicals and pollutants due to proximity of roads and railways.[16]

In Wisconsin there are prominent racial/ethnic disparities related to environmental burden. When looking at the overall environmental burden by minority status, there is a steady increase in environmental burden with increasing minority population (Figure 5). This indicates that predominantly minority neighborhoods experience worse environmental burden in Wisconsin. Using the EJI data, census tracts with the highest percentage of minority residents averaged in the 78th percentile of environmental burden compared to the census tracts with the lowest percentage of minority residents, which averaged in 26th percentile of environmental burden, a 52-percentile-point gap (Figure 5). The CVI index shows a similar trend and even larger 65-percentile-point disparity, with census tracts with the highest percentage of minority residents averaging in the 88th percentile of environmental burden compared to the census tracts with the lowest percentage of minority residents, which averaged in the 23rd percentile of environmental burden (Figure 5).

Neighborhoods with lower socioeconomic status also experience greater environmental burden in WI, although the disparities are not as large as racial disparities (Figure 6). Using the EJI index, census tracts with the highest percentage of low SES experienced substantially higher environmental burden (average of 81st percentile of environmental burden) compared to the census tracts with the lowest percentage of low SES (average of 42nd percentile of environmental burden). A slightly smaller but similar difference was shown using the CVI Index, with a 38-percentile-point disparity between census tracts with the highest percentage of low SES (average of 87th percentile of environmental burden) and the census tracts with the lowest percentage of low SES (average of 49th percentile of environmental burden).

Photo credit: 'https://homegets.com/

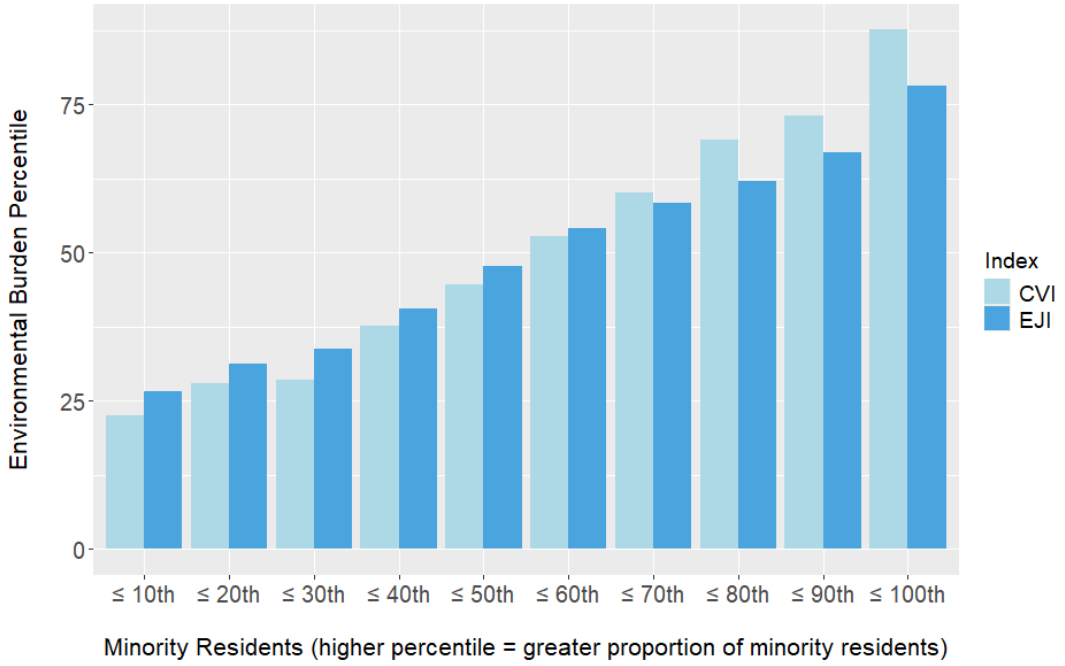


**Figure 4.** Average overall environmental burden index percentile for census tracts with increasing proportions of minority residents, illustrating how predominantly minority neighborhoods experience worse environmental quality in Wisconsin.

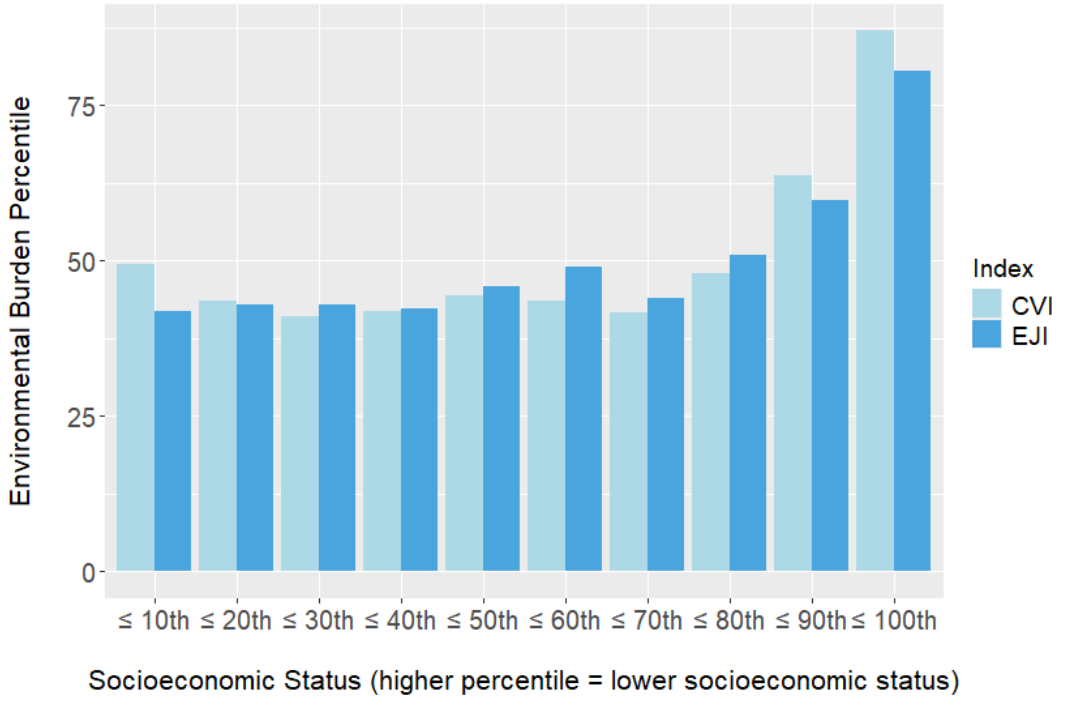


**Figure 5.** Average overall environmental burden index percentile for census tracts with increasing proportions of lower socioeconomic status residents, illustrating how the lowest 20% of SES census tracts experience higher environmental burden in Wisconsin.

## State Comparisons

When using the EJI to compare environmental burden in surrounding states, Wisconsin experiences the second largest racial/ethnic disparity (behind Illinois) with a 52-percentile-point difference between the least white and most white neighborhoods (Figure 7).

Looking at EJI environmental burden domains individually, Wisconsin has the highest racial/ethnic disparity for the air pollution domain, with an air pollution percentile difference of more than 60% between the least white and most white census tracts (Figure 8). This indicates that air pollution is a leading contributor to racial/ethnic health outcome disparities, with increased air pollution exposure for predominantly minority neighborhoods. While there is also a large disparity for water pollution, this metric only looks at surface water impairments in the census tract watershed, not drinking water quality so it does not impact health as directly as air pollution.

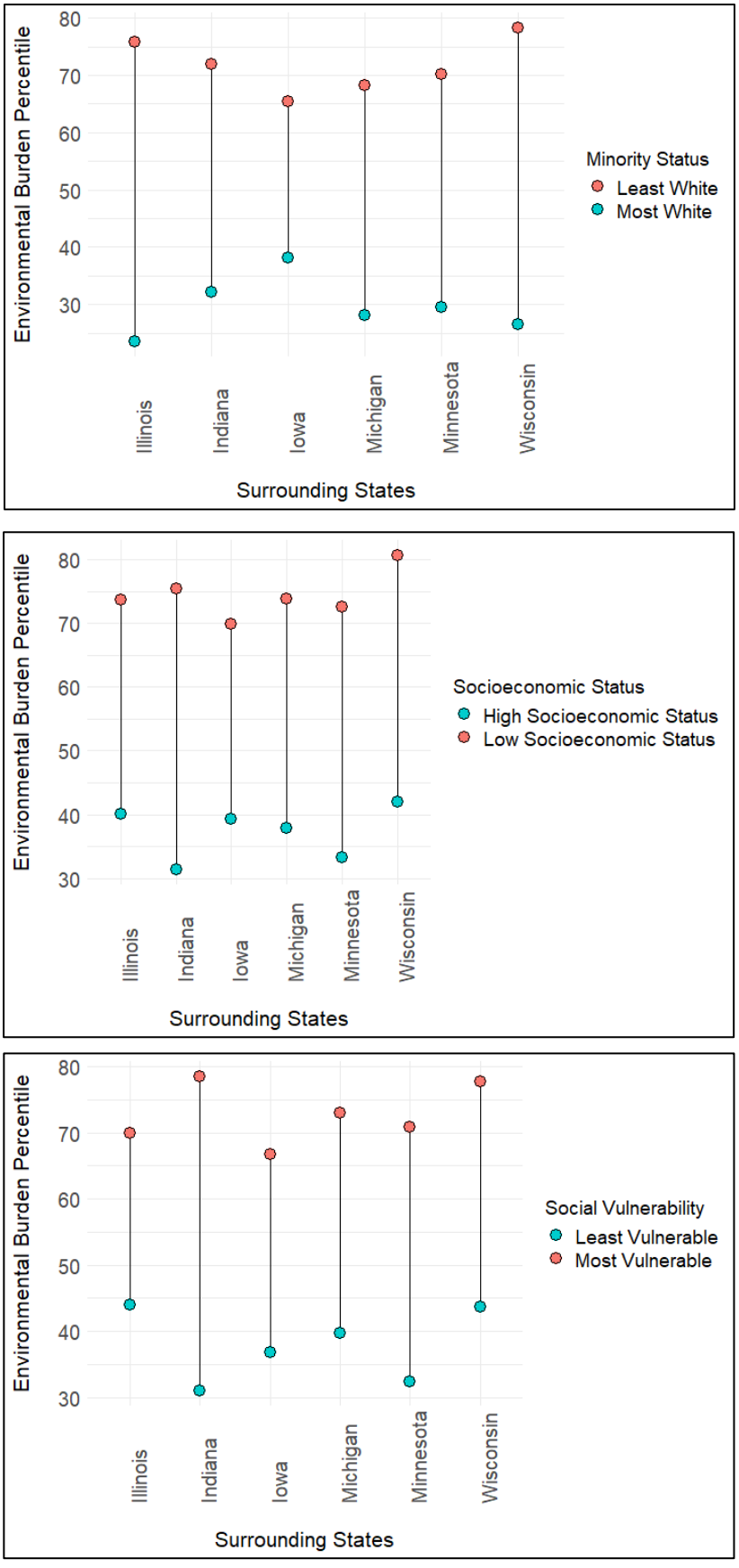


**Figure 6.** Overall environmental burden in the Environmental Justice Index for each surrounding state by minority status (top panel), socioeconomic status (SES; middle panel), and overall social vulnerability (bottom panel). Wisconsin has the second largest racial/ethnic disparity (behind Illinois). Most white indicates census tracts in the <10$^{th}$ percentile ranking of non-white residents. Least white indicates census tracts in the >90$^{th}$ percentile ranking of non-white residents.

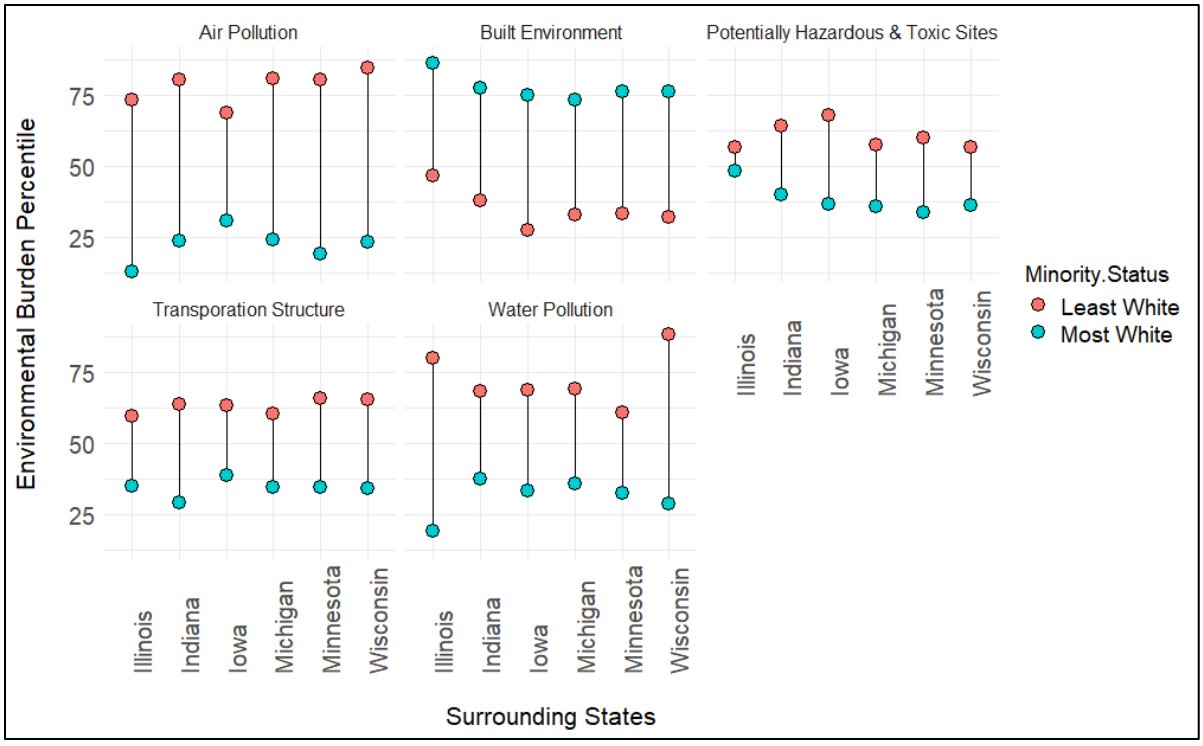


**Figure 7.** Racial/ethnic disparities for each environmental burden domain in the Environmental Justice Index across surrounding Midwest states, highlighting Wisconsin with the largest disparity for air pollution. Most white indicates census tracts in the <10$^{th}$ percentile ranking of non-white residents. Least white indicates census tracts in the >90$^{th}$ percentile ranking of non-white residents.

## Policy Recommendations

These environmental burden indices can inform targeted interventions[1] and identify communities most at risk for environmental burden and quality, which can inform state and local policymakers on environmental health disparities of their local community.[12] Policy recommendations include:

- Uphold and sustain the implementation of the Inflation Reduction Act, the Justice40 initiative, and other federal policies that address environmental injustice.[8]
- Increase funding for research regarding the environmental burden and its disproportionate impact on health outcomes in the state of Wisconsin and its local communities.
- Encourage cross-sector collaboration between non-governmental environmental health organizations, healthcare organizations, and local or state health departments to address environmental health disparities through grants and policy.
- County and state health departments should consider utilizing prominent environmental health indicators throughout community health assessments to allow more meaningful, measurable, and consistent data that can inform policymakers.
- Develop state equity mandates that enable the state to pursue a disproportionate impact analysis, which aims to address issues of legal and scientific defensibility.

## Conclusions

This is a starting point to understand the environmental determinants of health in Wisconsin. Environmental quality indices provide an informative high-level screening of where cumulative environmental burdens are the greatest to focus efforts throughout the state. The greatest environmental burden occurs in southeastern Wisconsin, but areas of particularly poor environmental quality also occur in Janesville, Beloit, Madison, and Green Bay.

It is important to highlight the racial and socioeconomic disparities occurring throughout the state, particularly with respect to air pollution. The least white neighborhoods in Wisconsin have significantly poorer environmental quality and are thus at risk of experiencing environmental health disparities. Areas of concern with predominantly minority neighborhoods must be at the forefront of environmental policy discussion that addresses racial and ethnic health disparities.

An important limitation to these indices is that they do not include any metrics of drinking water quality and thus, for example, do not account for the known widespread nitrate contamination of private wells in rural agricultural regions of the state.

This is a high-level analysis aimed to start developing a comprehensive understanding of how pollution and climate change are impacting public health in Wisconsin. Further investigation of individual components of these indices will help to better understand what is driving environmental burden and related disparities in Wisconsin.

## References


1) U.S. Environmental Protection Agency (EPA). (2024). *Environmental quality index*. United States Environmental Protection Agency. https://www.epa.gov/healthresearch/environmental-quality-index-eqi

2) Union of Concerned Scientists & Coming Clean. (2024). *The community guide to cumulative impacts.* Union of Concerned Scientists. https://www.ucsusa.org/sites/default/files/2024-10/Cumulative%20Impacts%20Guide_Eng.pdf

3) Agency for Toxic Substances and Disease Registry (ATSDR). (2024). *EJI fact sheet*. Centers for Disease Control and Prevention. https://www.atsdr.cdc.gov/placeandhealth/eji/fact_sheet.html

4) Pan American Health Organization (PAHO).(n.d.) *Environmental determinants of health.* Pan American Health Organization. https://www.paho.org/en/topics/environmental-determinants-health

5) National Institute of Environmental Health Sciences. (2024). *Area 5: Environmental health disparities, environmental justice, and health equity.* National Institute of Environmental Health Sciences: Strategic Plan. https://www.niehs.nih.gov/about/strategicplan/research/health-disparities

6) Gray, C.L., Lobdell, D.T., Rappazzo, K.M., Jian, Y., Jagai, J.S., Messer, L.C., Patel, A.P., DeFlorio-Barker, S.A., Lyttle, C., Solway, J., Rzhetsky, A. (2018). Associations between environmental quality and adult asthma prevalence in medical claims data. *Environmental Research*, 166, 529-536. https://doi.org/10.1016/j.envres.2018.06.020.

7) Jagai, J. S., Messer, L. C., Rappazzo, K. M., Gray, C. L., Grabich, S. C., & Lobdell, D. T. (2017). County-level cumulative environmental quality associated with cancer incidence. *Cancer*, *123*(15), 2901–2908. https://doi.org/10.1002/cncr.30709

8) Khadke, S., Kumar, A., Al-Kindi, S., Rajagopalan, S., Kong, Y., Nasir, K., Ahmad, J., Adamkiewicz, G., Delaney, S., Nohria, A., Dani, S. S., & Ganatra, S. (2024). Association of environmental injustice and cardiovascular diseases and risk factors in the United States. *Journal of the American Heart Association*, *13*(7). https://doi.org/10.1161/jaha.123.033428

9) Del Pozzo, J., Kouba, I., Alvarez, A., O'Sullivan-Bakshi, T., Krishnamoorthy, K., & Blitz, M. J. (2024). Environmental Justice Index and adverse pregnancy outcomes. *AJOG global reports*, *4*(1), 100330. https://doi.org/10.1016/j.xagr.2024.100330

10) Jian, Y., Messer, L. C., Jagai, J. S., Rappazzo, K. M., Gray, C. L., Grabich, S. C., & Lobdell, D. T. (2017). Associations between environmental quality and mortality in the contiguous United States, 2000–2005. *Environmental Health Perspectives*, *125*(3), 355–362. https://doi.org/10.1289/ehp119

11) Patel V.R., Jella T., Gupta A., Nassel A., Ibrahim A., & Hussaini S.Q. (2023). Association of Neighborhood-Level Environmental Injustice with Health Status in the US. *JAMA Intern Med.* 183(10):1162–1163. https://doi.org/10.1001/jamainternmed.2023.2835

12) U.S. Environmental Protection Agency. (2020). *Environmental Quality Index - Technical Report (2006-2010)*. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-20/367.

13) P. Grace Tee Lewis, Weihsueh A. Chiu, Ellu Nasser, Jeremy Proville, Aurora Barone, Cloelle Danforth, Bumsik Kim, Jolanda Prozzi, Elena Craft. Characterizing vulnerabilities to climate change across the United States, Environment International, Volume 172, 2023, 107772, ISSN 0160-4120. https://doi.org/10.1016/j.envint.2023.107772

14) Grunwell, J. R., Mutic, A. D., Ezhuthachan, I. D., Mason, C., Tidwell, M., Caldwell, C., Norwood, J., Zack, S., Jordan, N., & Fitzpatrick, A. M. (2024). Environmental injustice is associated with poorer asthma outcomes in school-age children with asthma in metropolitan Atlanta, Georgia. *The Journal of Allergy and Clinical Immunology: In Practice*, *12*(5). https://doi.org/10.1016/j.jaip.2024.02.015


## Additional Resources

**Clean Wisconsin:** Clean Water, Clean Air, Clean Energy - Clean Wisconsin

**Environmental Justice Index:** EJI Data Download | Place and Health | ATSDR

**Environmental Quality Index**: Environmental Quality Index (EQI) | US EPA

**Climate Vulnerability Index:** Home - The U.S. Climate Vulnerability Index

**Community Guide to Cumulative Impacts:** The Community Guide to Cumulative Impacts

**WI Department of Health Services Environmental Public Health Tracking:** Environmental Health Data Dashboards | Wisconsin DHS