Cover photo by 13727445 on Pixabay

The **water affordability indicator** captures variation in households' ability to pay for their water service. Our measure is the ratio of annual water and sewer expenses to household income. The measure is calculated from survey data.

National and international organizations use this ratio to measure water affordability. For example, the threshold for water unaffordability defined by the U.S. Environmental Protection Agency (EPA) is crossed by a community when the average bill for a family of four exceeds 4.5% of the median income. Globally, the United Nations Department of Economic and Social Affairs declared water unaffordable when that ratio hits 5% (UN, 2010).

Calculating this measure across the Great Lakes Basin, and across demographic variables, gives policymakers, advocates, and the general public insight into affordability concerns, their magnitude, and—when trend data are available—how they have changed over time. It is a measure of equity, as well as a component of water system sustainability.

WHY IS THIS INDICATOR IMPORTANT?

Safe drinking water is an essential good. Therefore, it is important to monitor trends in equitable access.

This is especially true because support for the operation of public drinking water systems varies. In some cases, systems rely entirely upon ratepayers for their operation and maintenance. In other cases, systems receive additional support from federal, state, or local governments.

Levels of support vary across jurisdictions and time. For example, the U.S. federal government offers support for capital expenditures on drinking water infrastructure to water utilities and local governments through the Drinking Water State Revolving Fund. This fund provides low-interest loans, with some principal forgiveness, to local and state governments who secure the requirement of a non-federal match of 20%. As of 2017, over $32 billion in low-interest loans to support drinking water infrastructure had been made across the U.S.

However, the Drinking Water State Revolving Fund alone cannot meet all investment needs. Long-term efforts to avoid water rate hikes have led to outdated infrastructure and caused a backlog of infrastructure renewal projects, magnifying the current need for investment. As a result, many local water and sewer providers are forced to continue raising rates, increasing the number of people who find their water and sewer bills unaffordable (ASCE, 2017).

This research is part of the Great Lakes Indicators project funded by the Erb Family Foundation. The project is rooted in the understanding that the environmental health of the Great Lakes directly affects the region's economic health, individual and societal health and well-being, as well as values and perceptions of the Great Lakes.

*The Great Lakes offer valuable ecosystem services, including providing **drinking water** to many of the region's inhabitants. The **drinking water indicators** are intended to help regional leaders and advocates understand their water quality, reliability, affordability, and constituents' trust in their drinking water, better positioning them to influence management and policy decisions.*

HOW IS IT MEASURED?

Measures of ability to pay for water service have evolved over time. In 1995, the EPA developed a measure of community water affordability wherein an average water/wastewater bill above 4.5% of the median household income indicates unaffordability in that community (EPA, 1995). The measure was intended to be used with other community metrics to determine a community's financial capacity to comply with the Safe Water Drinking Act. Since then, the EPA measure has received criticism for masking affordability issues because it uses averages, failing to illuminate fully the challenges for those at the lowest end of the income distribution (Teodoro, 2018; Mumm & Ciaccia, 2017).

Two different approaches can mitigate this shortcoming. The first approach is to adjust both the numerator (bills) and the denominator (income) of the EPA or UN metric to better capture the ability to pay (Teodoro, 2018). Deviating from the EPA or UN metric, however, risks a measure misalignment with these mainstream policy agencies.

The second approach is to examine the distribution of household water burdens in a given community, focusing on the percentage of households that fail to meet an established affordability threshold (such as the UN 5% of household income threshold). This approach retains the EPA or UN standard, and also illuminates the magnitude of difficulty to pay for water within a specific community.

DATA AVAILABILITY AND LIMITATIONS

U.S. Integrated Public Use Microdata Series

The IPUMS dataset from the American Community Survey (ACS) consists of dis-identified individual and household observations. Each observation includes respondent estimates for the numerator and denominator of the EPA or UN metric: water costs and household income. The IPUMS also includes a reasonably comprehensive list of demographic factors that can be used to examine topics such as equitable access.

There are, however, several limitations of the IPUMS. Foremost is that water costs are based on respondent recall, and are not cross-validated with data from utilities. To collect water service costs, the ACS asks the following question:

> *"IN THE PAST 12 MONTHS, what was the cost of water and sewer for this house, apartment, or mobile home? If you have lived here less than 12 months, estimate the cost."*

The question provides options for water "included in rent or condominium fee" and for "no charge." This method has the potential to introduce bias to the dataset, especially for those respondents who do not receive regular water service bills. The data from 2018 shows that 16.58% of households reported, "Included in rent or condominium fee." This percentage varies widely between urban, suburban, and rural areas.

For households on private wells or septic systems, as is common in rural areas, one might assume that the response is "no charge." However, some households may list maintenance and operation costs. The data from 2018 shows 2.86% of the respondents did not provide a water cost, and 21.1% of households reported "no charge." USGS estimated in 2010 that 16%-18% of households in the Great Lakes states use private wells (Johnson et al., 2019). If the majority of private well and septic systems users are reporting "no charge," then the IPUMS data does not account for affordability of those systems.

There are also geographic limitations of the Public Use Microdata Area. To maintain respondent anonymity, all IPUMS geographic units include at least 100,000 people. Thus, the geographic units in IPUMS are larger in sparsely populated, rural areas. The large units may not be aligned with political boundaries or water utility service areas, making it difficult to link affordability issues to specific water providers or municipalities.

DESCRIPTIVE SUMMARY OF DATA

Table 1: Great Lakes Basin Summary Statistics: Water Affordability (USD)

USA (2018 DATA) CANADA (2017 DATA)	CANADA TOTAL	ONTARIO TOTAL	USA TOTAL	GLB STATES TOTAL	USA CITY	GLB STATES CITY	USA SUBURB	GLB STATES SUBURB	USA RURAL	GLB STATES RURAL
Average annual water bill	$735	$729	$601	$573	$645	$645	$607	$568	$540	$536
Average water bill / household income	1.54%	1.65%	1.69%	1.77%	2.01%	2.57%	1.54%	1.57%	1.92%	1.88%
Percent of consumers above UN threshold*	3.10%	2.85%	6.31%	6.39%	8.92%	12.66%	5.34%	5.04%	6.42%	7.61%

**The UN defines unaffordable water as water costs that exceed 5% of household income.*

Statistics Canada Survey of Household Spending—Ontario

The public use microdata from the Survey of Household Spending conducted by Statistics Canada is collected biannually and made publicly available at the provincial level. The survey asks the following question:

> *"How much was [your/your household's] last payment for the following? Water and sewage charges? Include pumping services and water tankers that deliver water and fill water tanks at private homes."*

The survey does not include options for renters or for those who pay condominium fees. A total of 56% of weighted households in the 2017 survey did not report water costs or reported $0. This dataset has similar limitations to the ACS data, and it has much less refined demographic data.

Table 1 shows that in 2018, average annual water and sewer expenses in the U.S. were $601 per household, and expenses were $573 per household in the Great Lakes region. The average across Canada in 2017 was $735, and the Ontario average was $729. Thus, on average, households in the U.S. portion of the Great Lakes Basin pay $28 less per year than the national average for water and sewer. Ontarians pay approximately $6 less on average than Canadians nationally.

While these statistics suggest that proximity to the Great Lakes lowers water expenses, there are other possible explanations for this difference. For example, given the relatively high regional rainfall, the average household in the Great Lakes Basin may consume less water than households elsewhere.

These data also allow for a comparison across areas with varying levels of population density, from urban to suburban to rural. The statistics suggest that any Great Lakes Basin advantage in household water expenses only benefit suburban residents. According to the statistics, over 12% of urban residents on the U.S. side of the Great Lakes Basin cross the UN threshold for water unaffordability—a substantially higher proportion than among urban residents nationwide (8.9%).

Again, it is important to note that the primary driver of both the EPA and the UN affordability indicators is household income. The statistics cited here reflect the location of the poor as much as they do the cost of water. Comparatively, Ontario has a much lower percentage of households with unaffordable water.

Table 2 displays summary statistics on water/sewer expenses, water affordability, and the UN threshold

Table 2: Great Lakes Basin Summary Statistics for Water Affordability (USD), continued

2018 DATA	USA WHITE	GLB WHITE	USA BLACK	GLB BLACK	USA HISPANIC	GLB HISPANIC	USA OTHER RACE	GLB OTHER RACE
Average annual water bill	$592.62	$556.61	$552.76	$618.60	$650.36	$660.78	$657.11	$571.70
Average water bill / household income	1.49%	1.51%	2.28%	2.89%	2.09%	2.24%	1.63%	1.60%
Percent of consumers above UN threshold*	5.09%	4.85%	10.09%	14.16%	8.29%	8.15%	6.62%	6.23%

**The UN defines unaffordable water as water costs that exceed 5% of household income.*

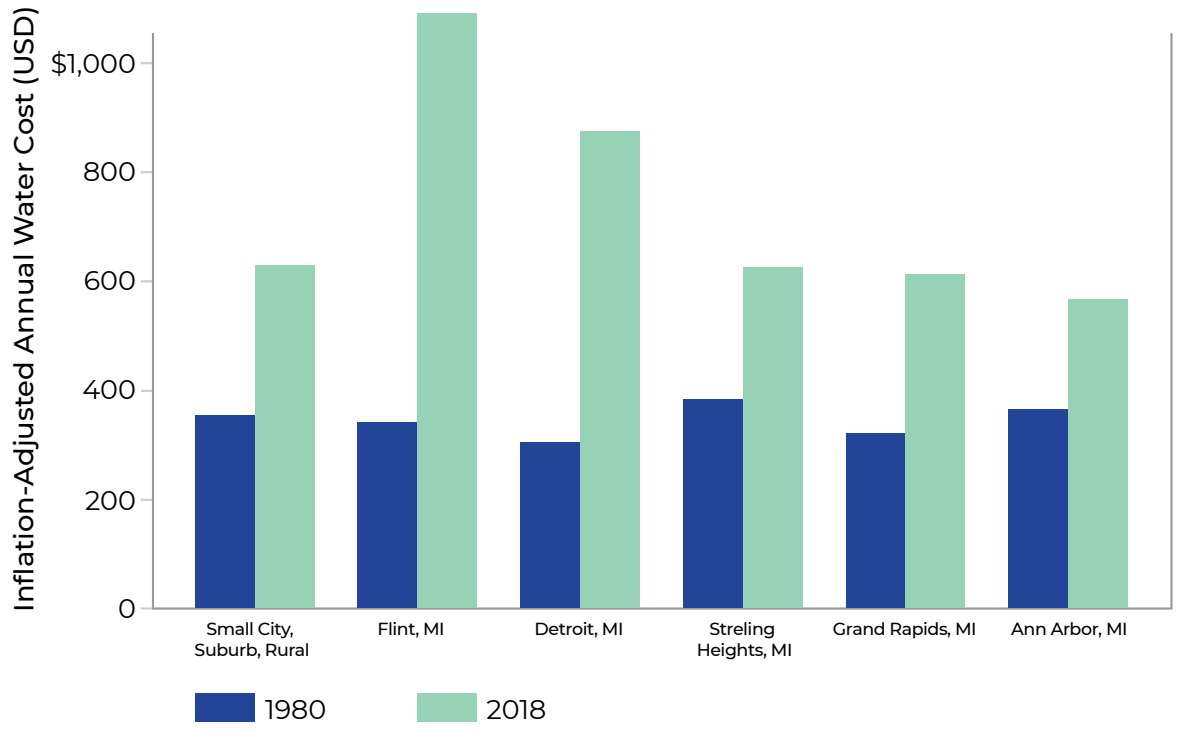
across different racial groups. Again, U.S. averages are compared to Great Lakes Basin averages. StatsCan does not share comparable race data.

These water affordability statistics suggest racial disparity in water costs in the U.S. The average annual water bill is higher for Black and Hispanic households than for white households. This preliminary presentation indicates that living in the Great Lakes Basin may not provide water expense relief to minority populations. It is also important to keep in mind that race/ethnicity and urban residence correlate on the U.S. side of the Great Lakes Basin.

OPTIONS FOR FURTHER ANALYSIS

The figures in this section show the affordability ratio distribution across political jurisdictions and geographic areas. These figures demonstrate the relative level of water affordability hardship for populations in given political jurisdictions and regions.

Example 1: Average Inflation-Adjusted Cost of Water in Michigan, 1980 and 2018



Temporal and Specific City Analysis

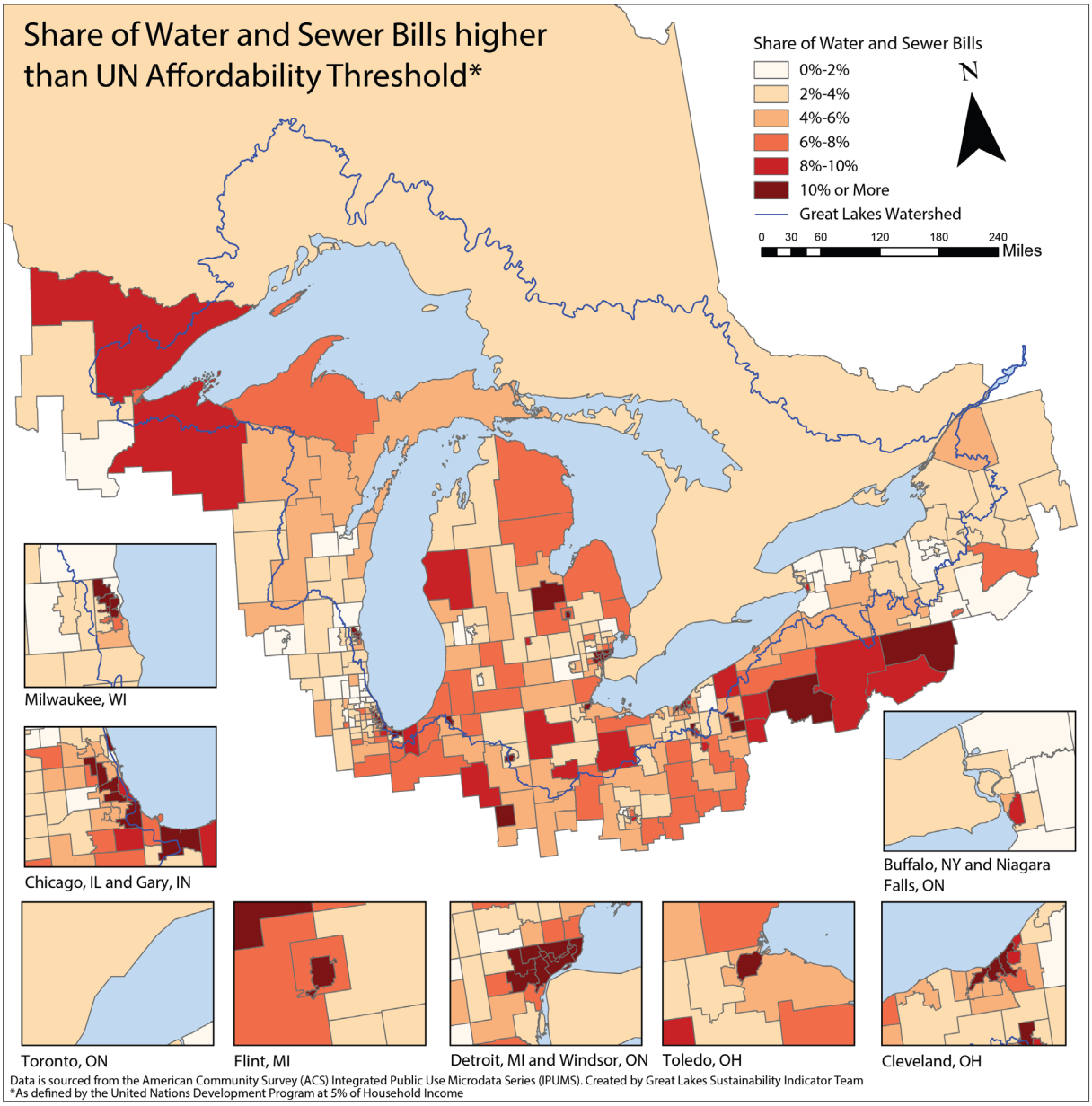
The IPUMS data is released annually and the "cost of water" question was introduced in 1960. This allows for an analysis of water cost trends over time. The IPUMS data also includes city markers for most cities with populations greater than 100,000 people. These markers can be used to compare large cities over time.

Geographic Analysis

All IPUMS data are mapped to Public Use Micro Areas (PUMAS). This geography is specifically designed by the Census Bureau to match the IPUMS data so that it can be mapped.

Example 2: Percent of Households Whose Water Bill Is Above UN Affordability Threshold, 2018

With geospatial data, the water share indicator (percentage of income spent on water costs) can be mapped across the Great Lakes region.



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