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The **drinking water advisories indicator** can help identify both priorities for drinking water infrastructure investment and potential environmental injustices.

Drinking water advisories (DWAs) are public health announcements issued by health or regulatory authorities. DWAs flag problems with drinking water quality and water system integrity, and inform consumers of the measures they should take to protect themselves from real or potential health risks related to their drinking water.

DWAs in Canada and the United States are categorized into three types: Boil Water Advisories, Do Not Drink Advisories, and Do Not Use Advisories. According to Environment and Climate Change Canada (ECCC), the vast majority of advisories are boil water advisories (ECCC, 2018).

DWAs are usually issued for equipment malfunction, inadequate disinfection, or unacceptable microbiological quality, and most are precautionary (Black et al., 2018).

WHY IS THIS INDICATOR IMPORTANT?

Between 2012 and 2014, 20,978 drinking water alerts were issued in the U.S. Approximately 53% were issued out of precaution, commonly due to a water main leak or break. Low-pressure events caused the second largest number of alerts, roughly 14% of the

total. Microbial contamination resulted in 2,909 alerts (13.9% of the total). Inorganic contamination resulted in 69 alerts (0.3% of the total). The highest portion of boil water advisories (BWAs) were issued in the summer, possibly due to enhanced bacterial growth enabled by warmer temperatures (Reynolds, 2016).

Between 2012 and 2014, water main break rates increased 27% in the U.S. and Canada. Most of the increase can be attributed to cast iron pipes over 50 years old (Folkman, 2018). This increase, observable in the number of BWAs issued, may indicate problems both with drinking water quality and with infrastructure integrity.

In the mid-2000s, drinking water advisories gained national attention in Canada, mainly due to long-term water advisories affecting First Nation peoples. Since 2016, the Canadian government has reduced the number of long-term advisories by 45%, and has also started tracking DWAs on a national level as an environmental indicator (Indigenous Services Canada, 2019).

Short-term advisories in Canada fall into three main categories—detection of *E. coli* (4%), other microbial issues (13%), and equipment or process-related issues (83%). ECCC also reported that the majority of advisories are issued in communities of ≤ 500 people (ECCC, 2018).

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?

In the United States, the Public Notification Rule of the Safe Drinking Water Act (1974) requires public notification in the event of unsafe, or potentially unsafe, drinking water. When a DWA is issued by a community water system, the water system is required to inform the state enforcer of the Safe Drinking Water Act. The number of DWAs can be requested from state government agencies, or mined from public media sources.

Most DWAs in Canada are reported using a national, web-based data management system, which allows the government to track advisories. Canada has designated DWAs as an environmental indicator and data are reported by ECCC. The ministry notes that it integrates DWAs into a surveillance system that has been operational since 2008. The system is used as a central resource to support policies that improve water systems, nationally and regionally (ECCC, 2018).

DATA AVAILABILITY AND LIMITATIONS

In order to build a sustainable model to obtain drinking water advisories, we constructed a web scraping application that extracts DWAs from the online Newsbank database. The application pulls dates, location, and reason for the advisory from articles announcing DWAs in the U.S.

This method allows for data collection and updates without the involvement of state and local governments or water agencies. Further, the data can be scraped for specific time periods, allowing for temporal analyses. However, the method has limitations—most significantly, inaccuracy due to the subjective nature of news reporting. DWAs that are small or are not featured in local news will not be in the dataset. Similarly, the web scraping tool will capture DWAs reported in multiple news outlets, resulting in duplicate entries. Finally, the application cannot read articles published as PDFs, limiting the understanding of some DWAs issuances.

Only Wisconsin reports the number of main breaks publicly by water system. Their historical data can be used to test the accuracy of the web scraping application results for other states.

While web scraping is an option for obtaining data in Ontario, the Adverse Water Quality Incident dataset (AWQI) from the Ministry of the Environment, Conservation and Parks reports the number of boil water advisories and water main breaks. The AWQI is available from 2015 to present and shows boil water advisories by drinking water system and date of occurrence. Long-term boil water advisories in Ontario are made available by ECCC.

DESCRIPTIVE SUMMARY OF DATA

The web scraping program pulled 18,462 boil water advisory-related articles from the Great Lakes states between 2007 and 2019. This number is much lower than found by Reynolds (2016), most likely due to the fact that Reynolds requested data directly from state regulatory agencies, and only used web scraping for a select few states that did not respond. The Public Service Commission of Wisconsin publishes extensive utility reports that include main breaks. These data point to 3,000-4,000 main breaks every year between 2010 and 2014. During those years, the web scraping application pulled 35-50 articles a year, suggesting a roughly ten-fold undercount by the web scraping application. The difference is most likely because not all main breaks are reported in news outlets.

For the web-scraped data, the single highest year is 2014. This corresponds to the Toledo, Ohio, water crisis, in which 500,000 people were issued a “do not use advisory” due to a harmful algae bloom in Lake Erie. The number of articles pulled seems to level off after 2013, except for the 2014 spike. We expect that data before 2013 is less comprehensive than post-2013 data, due to the large variation in yearly articles before 2013.

Figure 1: Number of Drinking Water Advisories by Year in Great Lakes States

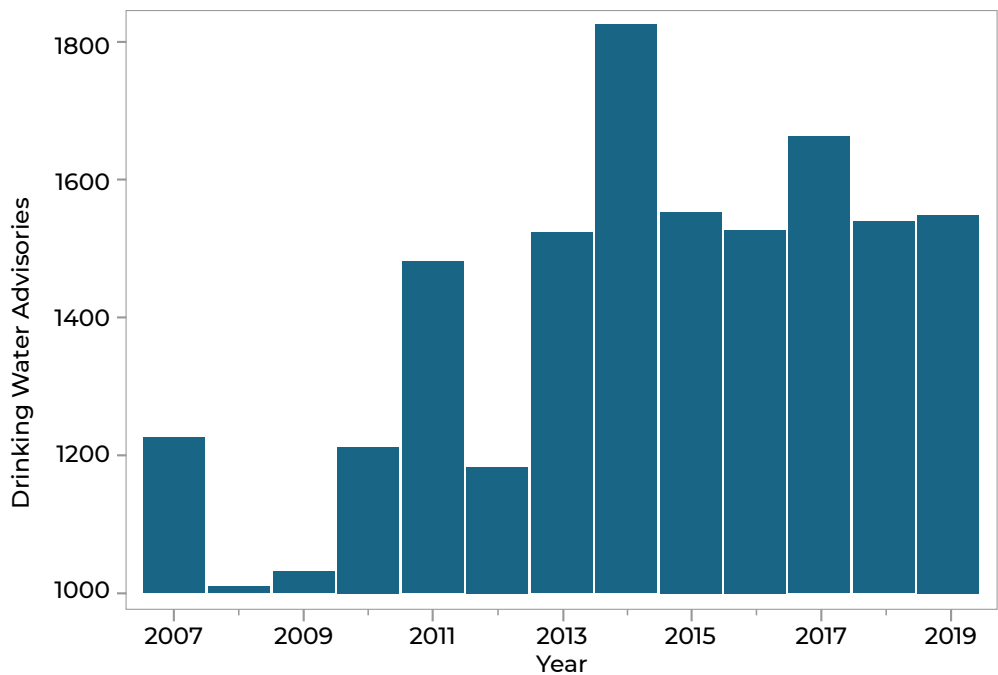


Figure 2: Number of Drinking Water Advisories per 100,000 People Between 2007 and 2019 by State

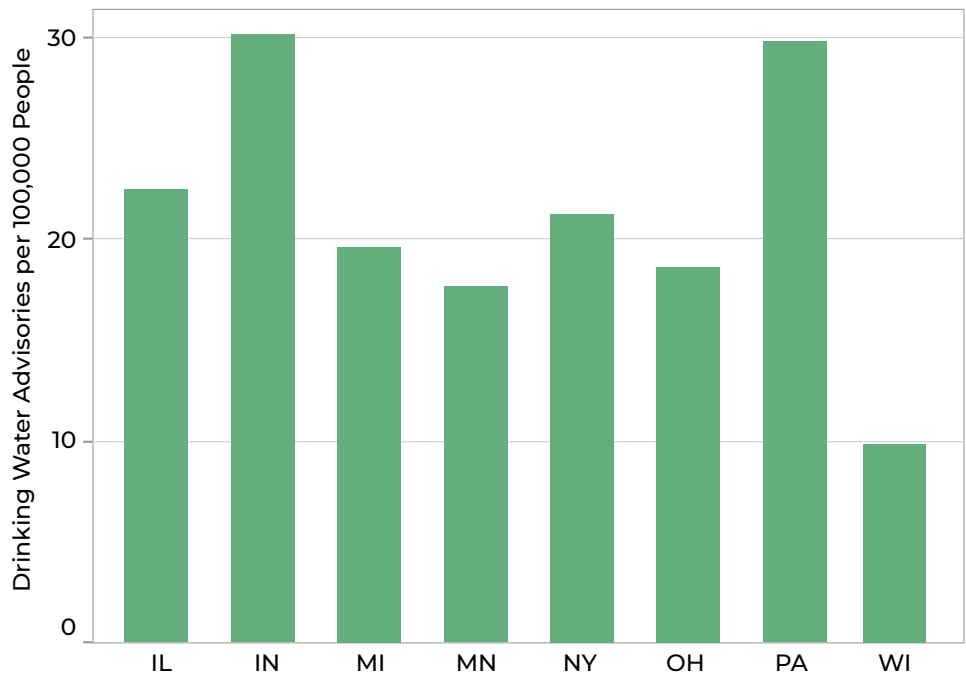
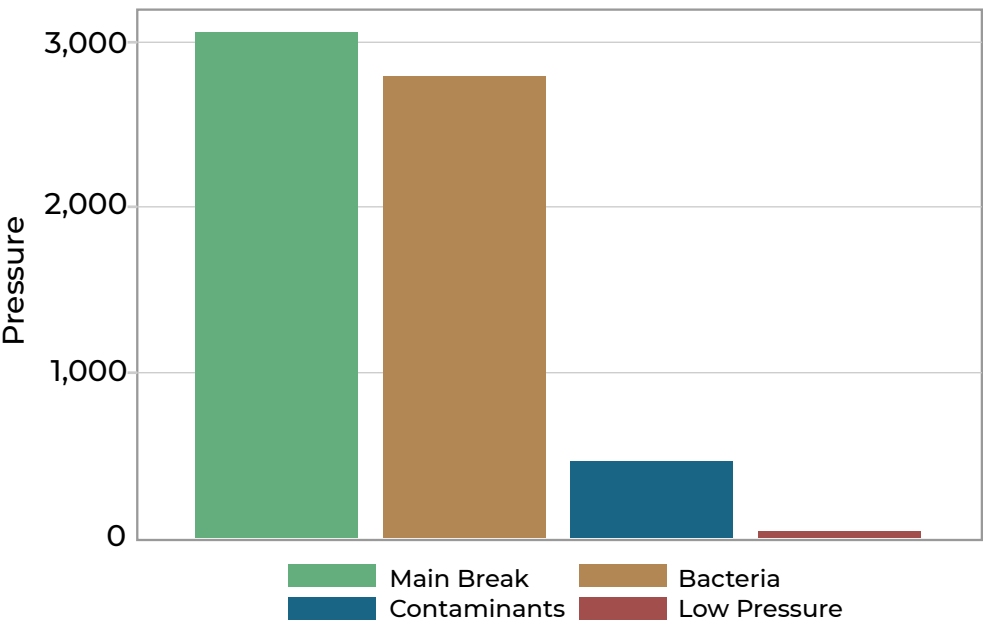


Figure 2 shows that per capita advisories are led by Indiana and Pennsylvania, each with around 30 advisories per 100,000 people between 2007 and 2019. States with higher populations tend to have more advisories; New York has the greatest number of advisories between 2007 and 2019.

Through the web scraping process, we can also pull keywords from the articles to learn more about the type and cause of the advisory. The majority of advisories concern main breaks and bacteria; fewer concern other contaminants and loss of pressure events.

Figure 3: Number of Drinking Water Advisories by Alert Type Between 2007 and 2019



Finally, the AWQI reports 97 boil water advisories in Ontario in 2018. The boil water advisories correspond with 97 main breaks across 61 different water supplies. The AWQI does not include data on indigenous communities, which are regulated by the federal government. There are currently 81 long-term drinking water advisories in First Nation communities in Ontario. Since 2015, 189 long-term drinking water advisories have been lifted from First Nation communities (ISC, 2021).

OPTIONS FOR FURTHER ANALYSIS

The web scraping application allows users to pull data from news articles. With this we have captured sub-state geography on drinking water advisories. The location information can allow for better geographic analysis of drinking water advisories and poor infrastructure. The data can also be run for Ontario to ground-truth the numbers reported in the AWQI database.

REFERENCES

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