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EE 538
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Analyzing Tribal Analyzing SDWA violations data and for Tribal Community Water Systems to pinpoint common issues

Introduction

Under the Safe Drinking Water Act (SDWA) of 1974 States are required to report specific information about water quality of public water systems (PWS) to the EPA. This information stored in these reports includes basic qualities of each system like its location, population served, and source water characteristics, as well as more specific data on violations that source has which includes, the type of violation and which SDWA rule is violated. These reports are filled in the Safe Drinking Water Information System (SDWIS) database and accessible for download by any entity.

Violations of the SDWA are split into several categories: Monitoring and Reporting Violations which have to do with a failure to properly monitor for a specific rule such as Synthetic Organic Chemicals, or to properly report the results of that monitoring. While they can be listed as two separate categories they are often grouped together. Public Notice violations occur when a system fails to properly notify customers of an issue whether it be water quality or otherwise. Health Based violations are the last category and these include when PWSs fail to use proper treatment techniques to clean the drinking water, when errors in the disinfection process cause the water to become contaminated with disinfectants and byproducts, or when levels of contaminants are above EPA maximum contaminant levels.

There is a considerable gap in literature when it comes to tribal drinking water challenges, but also when it comes to overall SDWA compliance as well. There is not yet much scientific consensus on how different characteristics impact a utility's ability to comply with a regulation, but there is some understanding that below a certain size, Community Water Systems (CWS) are likely to face higher numbers of violations both health-based and monitoring. (Allarié et al., 2018). Health based and monitoring violations continue to be a challenge nationwide, but research suggests that tribal CWS are particularly vulnerable to monitoring and reporting violations, twice as much as their non-tribal counterparts (Conroy-Ben, et al., 2018).

By examining violation data of all tribal CWS in the US, this study attempts to obtain an aggregate profile of these systems and better understand what specific challenges they face. Comparing these results to other scientific literature, and EPA research will then provide a picture of any disparities and allow for further research to be conducted. The study attempts to fill the gap of aggregate tribal water quality data because the current research is focused mostly by state. Instead this study groups by both size, and region to observe trends and establish some characteristics that might impact water quality.

Methods

Data was all pulled from EPA SDWIS Federal Reports Search at https://sdwis.epa.gov/ords/sfdw_pub/r/sfdw/sdwis_fed_reports_public/200.[1] Violation reports were queried and filtered to be only Native American and Community Water systems then downloaded for all EPA Regions Quarters 1-3 of 2024, and Quarter 4 for 2023 to get a year's worth of data. This data had to be downloaded in chunks due to the size as the final dataset was over 500,000 rows. Regions 1-8 were downloaded together and then Region 9 and 10 were downloaded individually due to their size as a majority of the tribal CWS are located in Regions 9 and 10.

After the data was downloaded it was cleaned in excel and converted into CSVs making sure to code the appropriate columns into numerical values as the SDWIS does not preserve the data numerical qualities in the download. After converting into CSVS the data was uploaded into R and combined.

Within R, the data was filtered into unique violation reports eliminating many rows of data, although it is important to note that Region 9 records their violation reports differently and so this process was unable to be standardized across all regions. Region 9 has a unique violation report for each contaminant while Regions 1-8 and 10 all have multiple contaminants under one violation if it is the same rule. This poses a challenge for apples to apples comparison but it is important for understanding how to process and compare the data. After obtaining the unique violations they were sorted into two separate categories (stored in separate data frames), Health-based (HB) and Monitoring and Reporting (MR). Public notice violations were included in MR Violations due to their similar nature, and because some violations recorded a Public Notice Rule violations as a MR violation. Therefore to get the most accurate results they were combined.

The data was further analyzed by binning by both size and EPA Region. Size bins were exponential, with extra small CWSs having a Population of under or equal to 100, small CWSs having a population of range of 101, to 1000, medium utilities with population range inclusive and between 1001 to 10000, and large utilities with populations over 10001.

Within these categories the most common rule violations were pulled from the data along with the number of CWSs in each bin, the number of tribes, and and the number of violations. For size and region per capita violations were also observed using CWS numbers for the capita data.

After performing a data analysis on the downloaded data, results were then compared to data from EPA's EPA/State Drinking Water Dashboard to gain understanding of how the Tribal community's results fit into the general picture.

Beyond the data analysis, informational interviews with staff members of the GAO and EPA Tribal Drinking Water group were conducted to gain a better understanding of the circumstances.

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[1] Source data available by request. Email tesscs@bu.edu.

More extensive code with descriptions are attached to this report in a separate file.

Results

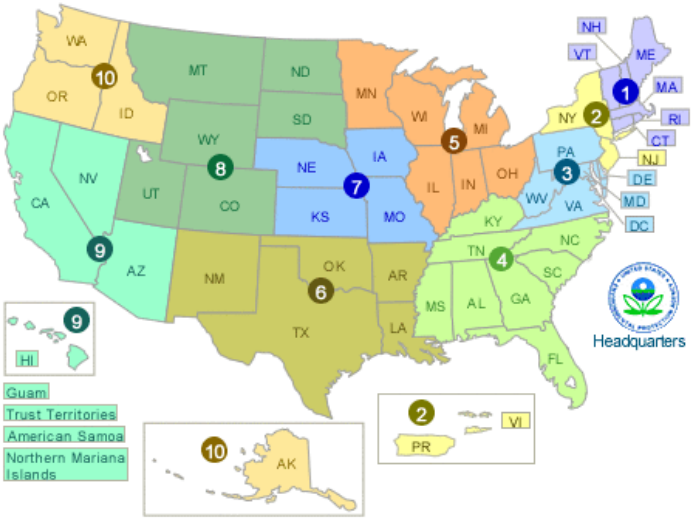

Figure 1. EPA Regions, Source: EPA.

Region	# of tribal CWS	# HB Violations	Top HB Rule Violations	# MR Violations	Top MR Violations
10	150	174	TCR	5012	TCR
9	285	2068**	TCR	23589**	SOC
8	101	490*	TCR	4682*	SOC
7	15	181*	S1 Disinfectants+ Disinfection Byproducts Rule	302	SWTR
6	57	498*	TCR	1108	TCR
5	74	92	TCR	2849*	SOC
4	14	27	S1 Disinfectants+ Disinfection Byproducts Rule	150	SOC
2	8	14	TCR	376	RTCR

1	4	66*	TCR	246	SOC

Table 1: Violation data and counts sorted by HB and MR violations by EPA region excluding Region 3 which does not have any tribal CWS. *violations per capita was higher than total avg
**Region 9 reports their violations differently so their count is artificially higher

Size	# of tribal CWS	# Health Based Violations	HBV/Per Capita	Top Non_MRRule Violation	# MR Violations	Top MR Violations	MRV/Per Capita
xs (pop <100)	139	1034	7.43	TCR	22821	SOC	164.17
s (pop <1000)	360	3684	10.23	SWTR	61179	SOC	169.94
m (pop <10000)	187	1651	8.8	TCR	14860	SOC	79.46
l (pop <10000)	21	196	9.33	TCR	994	SOC	47.33

Table 2: Violation data and counts sorted by HB and MR violations by CWS size. Includes Per Capita (CWS) violation counts.

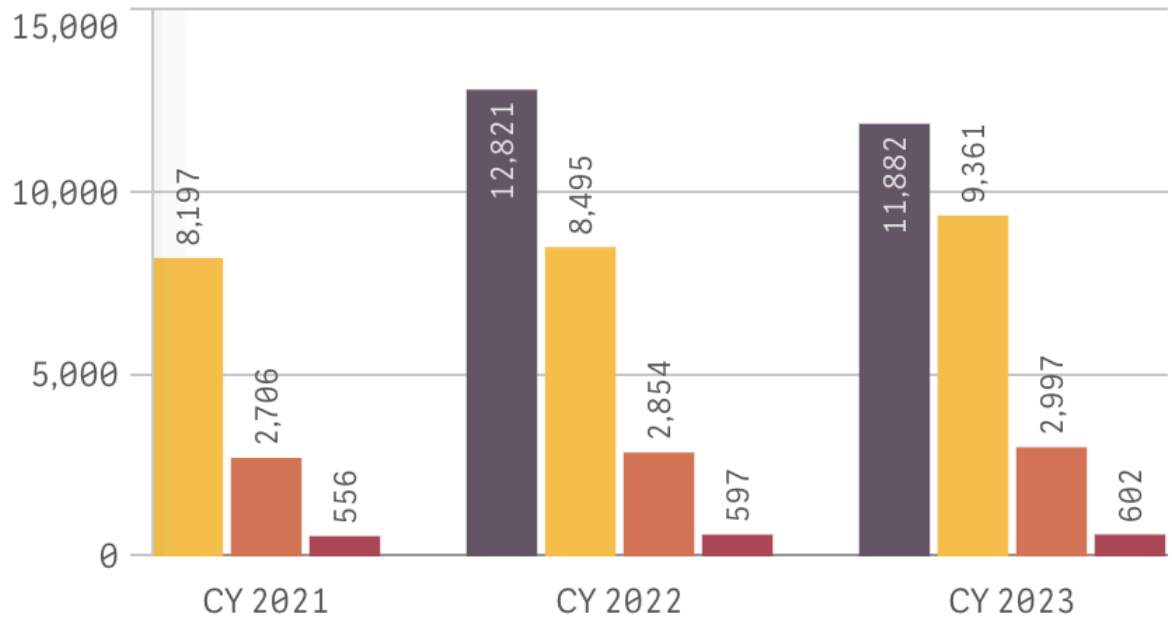

Figure 3. Violation types by calendar year for all public water systems. Source: EPA). Monitoring and Reporting , Public Notification, Health-Based, Acute Health-Based.

Region 9 had the most CWS followed by Region 10. Region 3 did not have any tribal CWS and Regions 1,2,4, and 7 all had below 20 unique CWS(Table 1). By size, there were 139 extra small, 360 small, 187 medium and 21 large CWS (Table 2).

In the past year there were over 108,829 unique violations. With a total of 1827 HB violations. Excluding Region 9, the other top HB violation accumulators per-capita were regions 1, 7, 6 and 8 with Region 7s count at almost 8 over the mean and region 1 at over 10 more violations per capita than the group average (excluding Region 9) (Table 1). There were 76,628 MR violations in the regionally sorted dataset. The total does not account for all unique violations because some CWS report to a state not an EPA Region. For MR violations, Regions 8 and 5 had the highest per capita counts, with Region 8 sitting at 12 points over the group average and Region 5 at 4 points over (Table 1).

In terms of rule violations the most common HB rule violation for seven out of nine Regions was the Total Coliform Rule (TCR) (Table 1). Regions 7 and 2 had the S1 Disinfectants Disinfection Byproducts Rule as their most common HB violations (Table 1). MR violations were more dispersed with Regions 6 and 10 having the TCR as their most common violation, Regions 1, 4, 5, 8, and 9 violated the Synthetic Organic Chemicals (SOC) rule the most, Regions 2 violated the Revised TCR (RTCR) the most and Region 7 the Surface Water Treatment Rule (Table 1).

By size, the small and large groups had the most HB violations per capita at 10.23 and 9.33 respectively, but the whole group was relatively in the same range of 7-10.5 violations per CWS (Table 2). For MR violations small utilities had 169.94 violations per capita and extra small utilities had 164.17 violations per capita, while medium utilities had 79.46 violations per capita and large utilities had 47.33 violations per capita (Table 2).

Of the HB violations a majority were TCR across all groups except small whose most common was the SWTR (Table 2). For the MR violations, the top violations were all the SOC rule (Table 2).

Using data from the EPA drinking water Dashboard the ratio of MR and PN violations to HB Violations for a year for all CWS is 5.90:1, while the overall ratio of Tribal MR and PN violations to HB violations is 10.89:1 (Figure 2). This is not a perfect comparison because the overall data includes some tribal utilities and the years are not the same due to the 2024 data not being released yet. There were about 2.35 MR violations per CWS based on the EPA dashboard data and far lower than any sized-or-region-based violation per-capita (Figure 3).

Discussion

Performing an analysis on the SWDIS tribal CWS data, highlights several similarities and differences between tribal drinking water quality and overall PWS drinking water quality. This data concludes that smaller and extra small utilities are more likely to face violations than larger utilities.

In analyzing solely this data it is clear that the TCR is a huge problem for tribal communities both in reporting and especially when it comes to HB violations. This is consistent with the findings of Allarié et al., 2018 which took violation data from 87% of all PWS in the

country to better understand challenges of the current water system. The TCR is a clear leader in health based violations nationwide (Figure 2). This suggests that tribal water systems are likely facing many of the same challenges as non-tribal water systems. Health based TCR violations are often due to a problem in the treatment process specifically with keeping the system closed or an equipment failure (EPA). Contaminants such as Goose Dung and other undesired contaminants entering the water source. TCR rule violations are based on a zero threshold standard due to the severity of E.Coli and its linkage to the presence of Coliform (EPA). The rule requires all PWSs to monitor for the presence of total coliforms in the distribution system at a frequency proportional to the number of people served which would suggest leniency on smaller utilities that could reflect in the evenness of tribal HB violations. However, the rule also requires monthly reports for many utilities also possibly connecting to the high levels of violations (EPA).

Conroy-Ben, et al., 2018, a more state level analysis of tribal facilities in comparison to non-tribal facilities, found that Monitoring and Reporting violations were much higher for tribal facilities than non-tribal ones. Comparing the tribal CWS results to the overall CWS results it was clear that tribal utilities had a much higher ratio of MR violations to HB violations. Additionally, per capita MR violation rates were much higher in the Tribal only dataset suggesting that tribal utilities do experience more MR violations than non-tribal utilities. This conclusion should be taken with a grain of salt however because of the limitations in EPA region 9. However the rates of MR violations between tribal and non-tribal communities offer a great area for further study to better draw conclusions between the two datasets. The high rates of MR violations within tribal CWS might point to a greater problem in staffing, or operations which is consistent with what I observed in my discussions with both EPA and GAO staff.

There are multiple sources of uncertainty and error within this paper that could be corrected. In the future a further literature and data review might reveal how previous studies compared apples to apples between all regions given that Region 9 data was stored and reported differently. Additionally, more statistical analysis could be performed on the dataset to attempt to find significance between specific characteristics a CWS might have.

Through literature review it has become apparent that there is still a large gap of understanding how water systems comply with SDWA rules and what characteristics impact their compliance abilities. In the future more research should be done so policymakers and staff members are better able to help allocate funding and resources to challenged systems and also so they can more quickly understand potential challenges.

Conclusion

One single download of a year's worth of EPA data can offer a lot of useful information and insights, but at the end of the day it is merely one part of the complex web of tribal drinking water. Tribal utilities are not so different from other utilities in most ways, but they do appear to face a strong challenge with monitoring and reporting to SDWA standards. This likely connects to a larger problem within tribal drinking water communities suggesting that even though there is significant grant funding available for these communities that they still face compliance challenges.

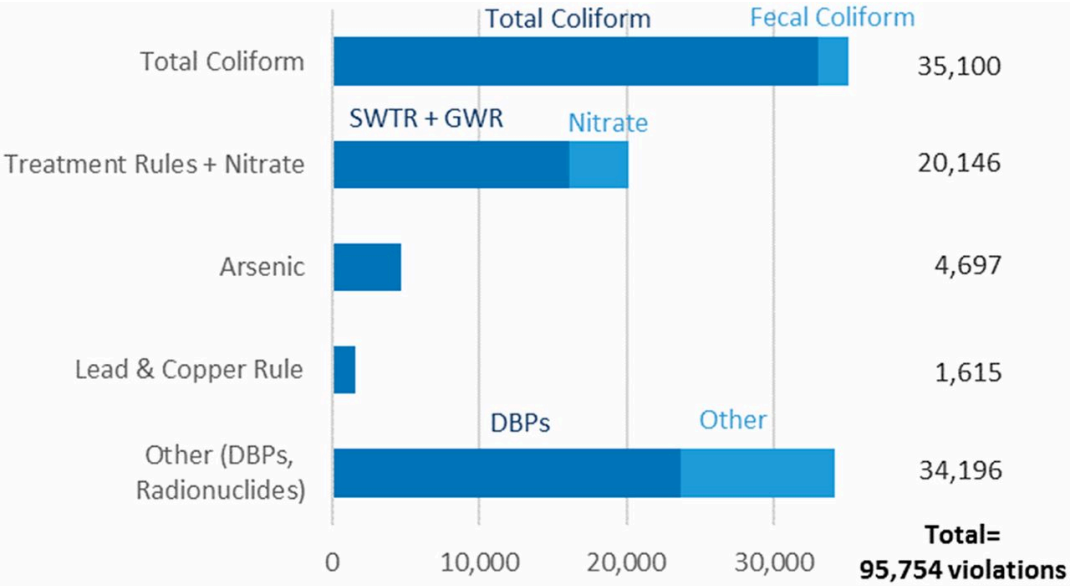

Figure 3.HB Violation data sorted by rule violation for all PWS (Allarié et al., 2018).

Literature Cited

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