Water Insecurity and Plumbing Access in U.S. Counties (2022–2023)

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Introduction to Topic & Motivation

Topic Introduction:

- Plumbing access is a critical component of public health, sanitation, and overall quality of life. While often taken for granted in developed countries, there are still communities across the United States where complete indoor plumbing is not available in every household. This lack of access can contribute to broader health disparities, environmental risks, and social inequalities—especially in rural, Indigenous, and low-income communities.

Motivation:

- We were motivated to investigate plumbing insecurity because it serves as a visible marker of deeper structural challenges in American infrastructure and public investment. By examining changes over time and spatial patterns in plumbing access at the county level, we aimed to uncover where disparities are most pronounced and whether progress is being made.

Water Insecurity Questions

Question 1

How has access to complete indoor plumbing changed from 2022 to 2023?
Is this change associated with population size?

Question 2

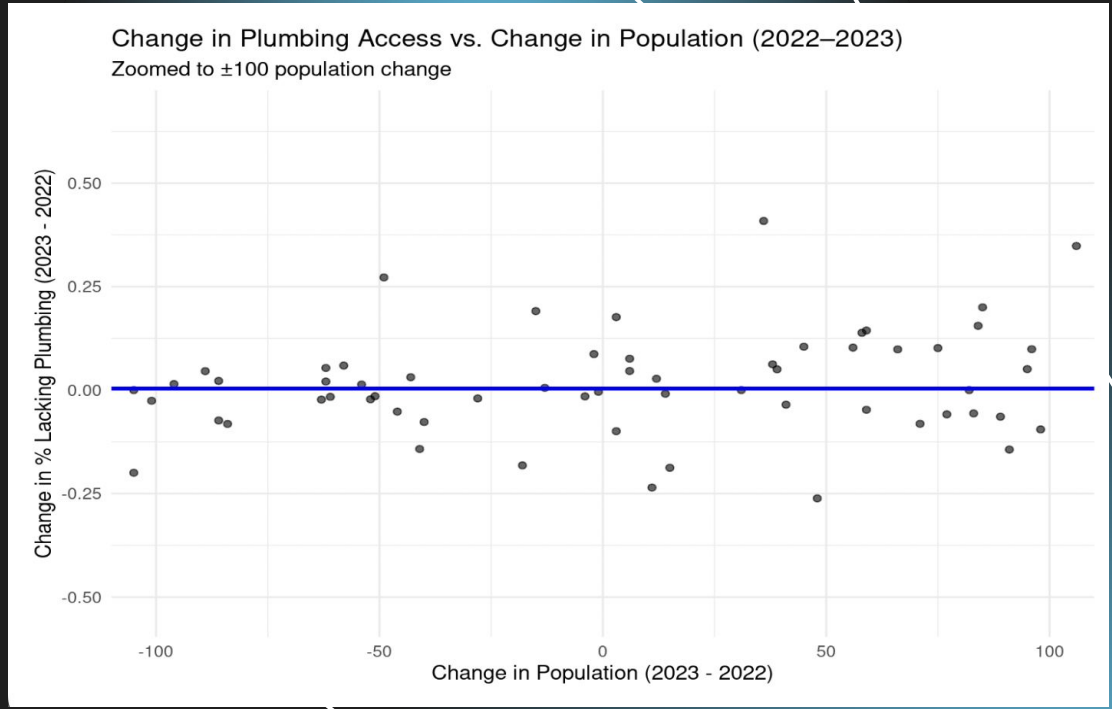
Are there observable disparities among Indigenous-majority counties in Arizona in 2023, and to what extent can these disparities be attributed to differences in income levels?

Question 1: Visualization

Scatterplot: Change in % lacking plumbing (2023 – 2022) vs. change in population size (2023 - 2022)

No strong correlation observed — both small and large-pop counties saw a mix of improvements and setbacks.

Trendline near flat: suggests population size alone does not explain change in plumbing access.

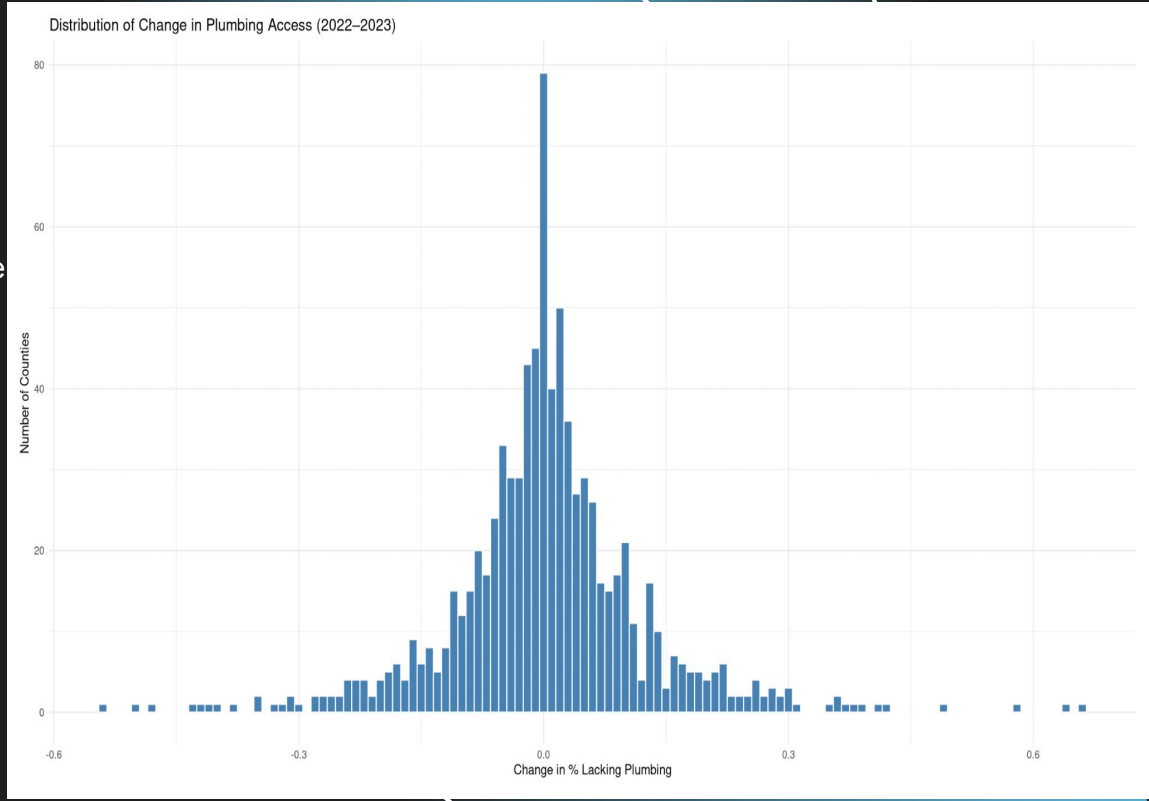


Question 1: Visualization

Most counties experienced little to no change in plumbing insecurity, as shown by the sharp peak centered around 0%. This suggests stability in access for the majority of the U.S.

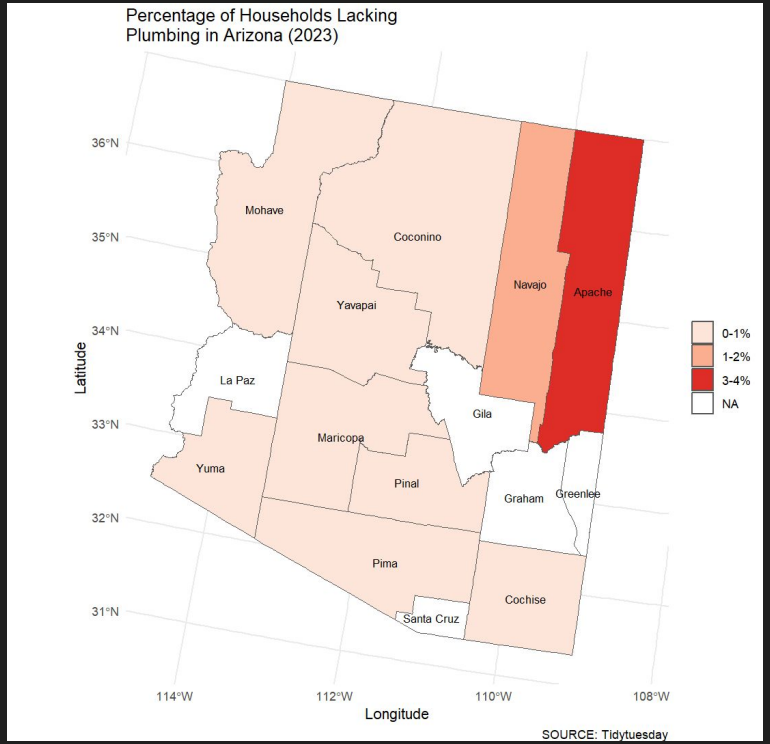
The distribution is roughly symmetric, with a relatively even spread of counties seeing slight improvements (negative values) and slight worsening (positive values) in plumbing access.

A few outlier counties experienced large shifts, both improvements and declines (as seen on the far left and right), but these are rare and likely due to localized factors or anomalies worth exploring further.



Question 2: Visualization

- Northeast AZ = Indigenous Land
- Navajo and Apache counties had significant amount of areas lacking plumbing
    - 3.9% of Apache county households don't have plumbing
- There are 5 counties not included in the dataset

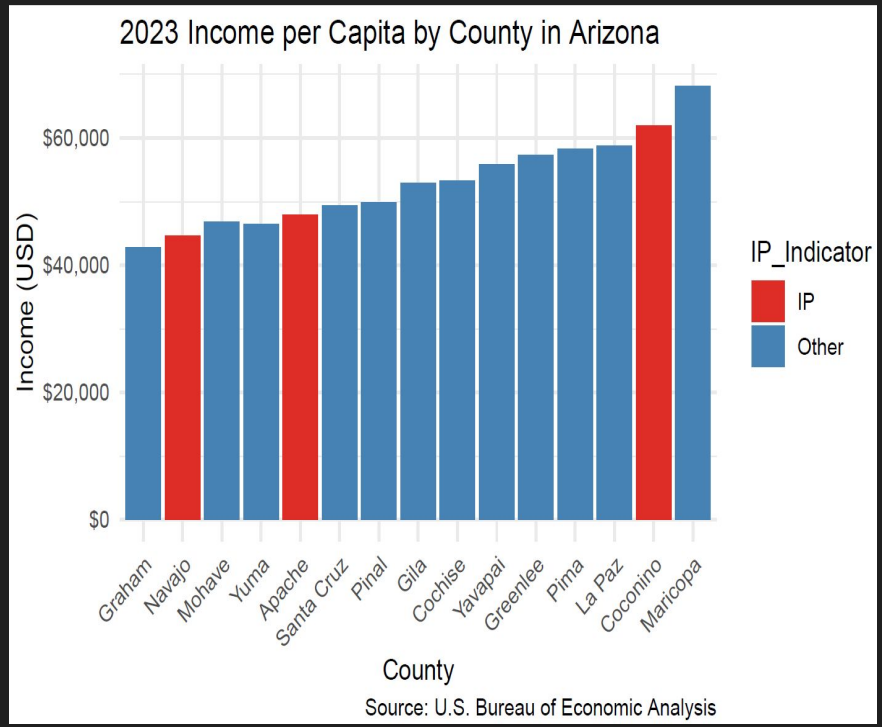


Theory

1. Local residents/ businesses pay taxes
2. The local government takes those taxes and improves the quality of Life within the local areas
3. The higher the income per capita in a county = the more taxes generated
4. The more taxes generated = the better quality of life for residents
5. Indigenous counties have a higher chance of being in an area with a lack of plumbing
6. Do the indigenous counties also have low sources of income per capita to which the theory would hold?

Question 2: Visualization

- The theory does hold to some level
- Apache and Navajo counties are both in the bottom third in income per capita
- Coconino is the second highest income per capita
  - Flagstaff, Grand Canyon are there
- More research needs to be conducted in order to prove the theory
  - Hypothesis testing with models
  - Regression analysis
  - Etc.



Conclusions + Future Work

Conclusions

- Plumbing insecurity persists in specific U.S. regions, with consistent clustering over time.
- No strong association found between population size and plumbing access change.
- Spatial patterns highlight systemic infrastructure inequalities.

Future Work

- Explore correlations with race, income, and rurality.
- Incorporate Tribal land boundaries and environmental factors.
- Extend analysis over more years for trend detection.

Thank you!