Research Brief

Environmental Justice Implications of a Groundwater Dependent Domestic Water Supply in California's Central Valley:

Exploring the socioeconomic distribution of dry and contaminated domestic wells

Groundwater represents an important component of California's domestic water supply portfolio, supplying about 1.5 million Californians with domestic water (1). However, unsustainable groundwater use, particularly in California's Central Valley, is resulting in chronic lowering of groundwater levels and exacerbating contamination (2).

There is a lack of understanding regarding the distribution of dry and contaminated domestic wells in relation to areas that have been identified as disadvantaged due to the cumulative presence of environmental, socioeconomic and health stressors in California. This research aims to understand the environmental justice implications of groundwater dependent domestic water supplies, considering both quality and quantity issues. The hypotheses being investigated are:

1. Disadvantaged communities in the Central Valley are experiencing a disproportionate burden of dry wells

2. Disadvantaged communities in the Central Valley are experiencing a disproportionate burden of contaminated wells

In 2014, the California Department of Water Resources (CA DWR), along with a cross-agency working group, developed a voluntary reporting system for domestic water supply issues, including dry domestic wells (3). To date the system has recorded 2,239 dry wells, however, due to the incompleteness of data collected by voluntary reporting, the number of households experiencing dry wells is likely higher than what available data suggests.

The California Environmental Protection Agency (Cal EPA), along with the California Office of Environmental Health Hazard Assessment (OEHHA), have developed CalEnviroScreen as a tool for identifying populations throughout the state that are most affected by the cumulative impacts of environmental, socioeconomic and health hazards. This tool identifies disadvantaged communities and directs funding towards those areas as a portion of Cal EPA's environmental justice efforts. The CalEnviroScreen scores census tracts based on the degree of cumulative impacts experienced. The overall CalEnviroScreen score ranges from 0-100, with zero representing the least disadvantaged areas, and 100 representing the most disadvantaged areas (4).

Photo: San Mateo County Office of Sustainability

1. Johnson, T. D., & Belitz, K. (2015). *Journal of Hydrology: Regional Studies*, *3*, 31–86. https://doi.org/10.1016/j.ejrh.2014.09.002
2. Smith, R., Knight, R., & Fendorf, S. (2018). *Nature Communications*, *9*(1), 2089. https://doi.org/10.1038/s41467-018-04475-3
3. DWR Dry Well Reporting System. https://mydrywatersupply.water.ca.gov/report/publicpage
4. CalEnviroScreen. https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

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Dry Wells. The findings of this study suggest that not only are highly disadvantaged areas in the Central Valley more likely to have some incidence of dry wells (at least one reported), but also that these communities are more likely to experience a greater percentage of the dry wells.

In total, 2,239 domestic well supply issues have been reported through the DWR voluntary reporting system; 2,088 of those reported shortages (93.3%) fall within the Central Valley. Two hundred census tracts in California's Central Valley have reported at least one dry domestic well to the CA DWR. Of those 200 census tracts, 170 (85%) fall above the fiftieth percentile for CalEnviroScreen score, meaning they are among the most disadvantaged half of the population. Additionally, the average ratio of total domestic wells reported dry is higher in areas that score above the fiftieth percentile on CalEnviroScreen (8.9%), than in areas scoring at or below the fiftieth percentile (2.1%). The census tract with highest proportion of dry wells to total domestic wells (83.3%) falls in the ninetieth percentile (Figure 1).

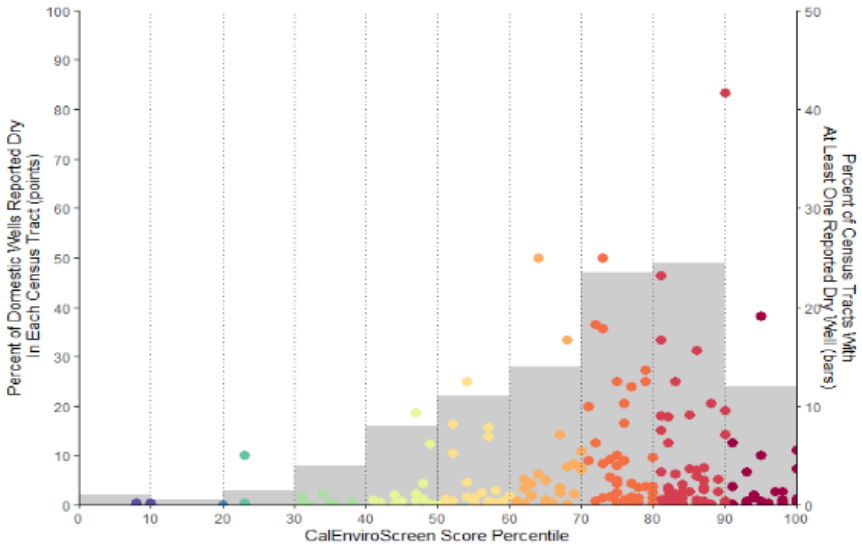

Figure 1. Distribution of the percent of total domestic wells in the Central Valley reported dry by CalEnviroScreen score percentile. The points on the graph show the percent of domestic wells in a census tracts within the Central Valley that have been reported dry by the CalEnviroScreen score percentile for that census tract. Each point represents a census tract that has at least one dry well recorded by the CA DWR voluntary reporting system. Each color represents a 10% range of CalEnviroScreen score from 0-100 (zero being least disadvantaged, 100 being most disadvantaged). The grey bars represent the percent of census tracts, out of 200 total, within each of the 10 unit percentile score groups that have reported dry wells.

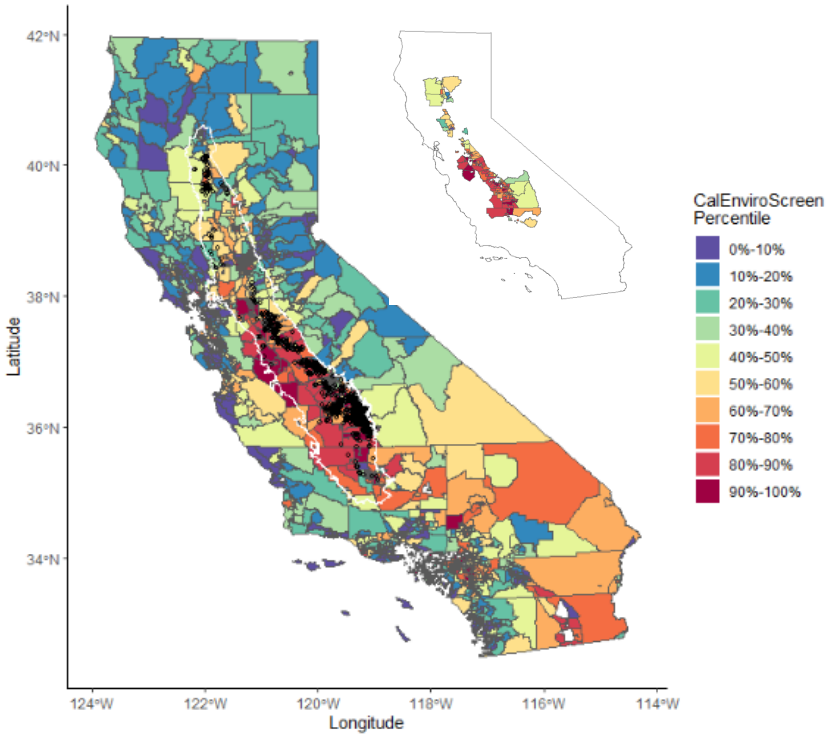

Figure 2. Location of dry domestic wells in California's Central Valley. Each black point represents one of the 2088 dry domestic wells reported in the Central Valley. The white outline in the center of the state delineates the boundary of the Central Valley. The map is colored based on CalEnviroScreen score percentile for each census tract. Cool colors and low percentiles represent the least disadvantaged areas of the state, while warm colors and high percentiles represent the most disadvantaged ares. The inset map displays the CalEnviroScreen percentile for each of the 200 census tracts in the Central Valley that have reported dry domestic wells.

The Central Valley tends to have census tracts that are more highly disadvantaged than some other regions of the state, with 63% of all census tracts in the Central Valley scoring above the fiftieth percentile (Figure 2). Despite this, there is a statistically significant difference ($p<0.001$)* between the CalEnviroScreen score of census tracts with dry wells when compared to CalEnviroScreen scores of all census tracts in the Central Valley.

Contaminated Wells. Findings regarding the contamination of domestic wells in the state are less telling. This study lacked sufficient data to test for a significant relationship between the CalEnviroScreen Score and the number or severity of contaminated domestic wells located in a given census tract. It should be noted that the data available through the Groundwater Ambient Monitoring and Assessment Program (GAMA) for domestic well contamination are sparse, with testing data confined to only three counties in the Central Valley (5). Resources should be directed towards a more comprehensive statewide domestic well water quality monitoring program to ensure that areas that are highly disadvantaged are not also facing a disproportionate burden of groundwater contamination affecting their domestic water supply.

5. GAMA. https://www.waterboards.ca.gov/water_issues/programs/gama/domestic_well.html

*Determined using a non-parametric Wilcoxon Signed Rank statistical hypothesis test

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Photo: Chad Ress

Limitations. The voluntary reporting system for dry domestic wells established by the CA DWR is inherently under-representative. For a number of reasons, some among them being: linguistic barriers, lack of awareness or education, and perceived risk of reporting, it is likely that there are dry wells throughout the state that have not been captured by the current dataset. Similarly, statewide domestic groundwater quality conditions are not adequately represented by the available data and more comprehensive monitoring is needed.

Additionally, this research used well completion records to determine the total number of domestic wells in the state. The stated planned use of the well at the time of drilling was used to extract domestic wells from a dataset that also included agricultural, industrial and municipal supply wells. Because of this, the dataset may not be completely representative as some wells may have lacked a planned use record or changed use since the time of drilling, implying that the data analyzed may be incomplete.

Finally, the CalEnviroScreen resolution at the census tract level results in a large range of spatial areas, with a single score given to each. Heterogeneous populations within census tracts may not be accurately represented by a single CalEnviroScreen score, meaning that some areas within a census tract may be more or less disadvantaged than the available data suggests.

Conclusion. Despite these limitations, the environmental justice implications of this research are clear: 93.3% of dry wells reported across the state are located in the Central Valley; 85% of census tracts in the Central Valley with at least one reported dry domestic well score above the fiftieth percentile on CalEnviroScreen, and the average percent of total domestic wells reported dry in a census tract is higher in areas that score above the fiftieth percentile on CalEnviroScreen. Available data show that not only are disadvantaged communities more likely to experience dry domestic wells, those same communities are also more likely to have a higher percentage of all domestic wells go dry than in less disadvantaged areas.

Access to clean water is a crucial component of human health and safety. The disproportionate risk of losing access to a domestic water supply experienced by already disadvantaged communities represents an environmental justice concern. More accurate data and further research are needed to reduce the burdens caused by domestic water supply issues in disadvantaged communities, which may compound the cumulative effects of socioeconomic, health and environmental stressors.

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