**Title:** Water System Service Areas and Environmental Justice Analysis of Drinking Water

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**Abstract:** A public water system (PWS) service area is the geographic extent of a drinking water system’s customer base. Service areas have a wide variety of applications for non-profits, in academia, and in government. However, there is no nationally consistent and complete spatial dataset of all PWS service areas. Moreover, there has been minimal systematic testing of the implications of employing different service area boundary types. This paper aims to fill this gap by summarizing a set of environmental justice indicators in drinking water across four distinct methods for assigning service areas. These methods include assignment of county polygons, zipcodes served, EPIC/SimpleLab tiered data, and boundaries produced by EPA’s Office of Research and Development (Buchwald et al., 2022; Hydroshare, 2023). While it is generally understood that different service area assignment methods have varying accuracy, it is not yet known how significant this accuracy may be for the conclusions of environmental justice analysis. As such, this paper fills a critical gap in our understanding of the importance of collecting service areas and producing a high-quality nationally consistent geodatabase.

In this paper, we explore two research questions that assess policy implications related to the selection of water system boundary products for environmental justice analyses. First, we investigate the extent to which the choice of boundary product may produce different results in environmental justice analyses. Second, we illustrate national differences in drinking water quality across demographic groups over a range of novel drinking water indicators.

To answer our two research questions, we assemble all existing service area boundary products and apportion them to census block groups to determine population characteristics of each water system according to each boundary product. We next construct a set of novel and national drinking water quality metrics for each service area boundary product and compare across the boundary products. We construct diverse metrics related to bacterial detection, disinfectant byproduct formation, lead concentrations, PFAS detection, and health-based violations of the Safe Drinking Water Act. We draw on at least 30 million drinking water samples across multiple underlying datasets to build the drinking water metrics in this analysis (EPA, 2016). Using these drinking water indicators, we construct a set of relative risk ratios between environmental justice groups of concern and a mutually exclusive comparison group. These relative risk ratios allow us to compare the conclusions that would be informed by employing different service area products.

We find that the type of service area employed can significantly affect the conclusions of an environmental justice analysis. In six out of ten relative risk comparisons, an environmental justice disparity may be characterized in opposite ways or under-stated by at least a 25% margin across service area products employed. The direction of bias is not always clear for different service area types and indicators. Further, our analysis of drinking water disparities across all demographic groups suggests that Black populations experience lower drinking water quality across all drinking water indicators. We also observe strikingly high disparities in incidence of health-based violations for American Indian populations.

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