Background

According to the World Health Organization, one in three people in the world are affected by water scarcity and the problem is intensifying with population growth, urbanization, and rise in industrial water use. Poor storage practices and lack of sanitation further increase contamination at the household level. This collaborative, inter-disciplinary study therefore analyzes the correlation between the distribution of water in households and the incidence of water-borne diseases in rural and urban populations in Vellore, India. Estimates on drinking water consumption are necessary in risk assessments on microbial hazards. The data was collected from a survey of 72 homes, 36 of which were selected using a simple random sampling technique to be directly observed. The preliminary findings, shown through GIS, have discovered various flaws in the distribution of water given that urban slums, which had access to water only once a week, had a higher risk of enteric diseases compared to rural villages that had daily water supply. The study shows that homes with compromised water access and lack of water use for hygienic purposes are more susceptible to enteric diseases. Providing access to adequate quantities of safe water, establishing proper disposal facilities of excreta, and educating the public on hygienic practices are of utmost importance in reducing the burden of enteric diseases in India.

Purpose

Since Vellore, India has a high incidence of diarrheal diseases, water use and availability could be crucial indicators on the susceptibility of enteric diseases in the region. Results on identifying distribution flaws and measuring water allocations within the households will nonetheless assist in preventing the spread of diarrheal diseases. Therefore, GIS was used to model data on:

Water use:
- For drinking, cooking, bathing, washing clothes, washing dishes, cleaning, etc.
- Water quality parameters: Coliform, fecal coliform, pH, total dissolved solids (TDS), nitrites

Water sources:
- Public tap, public borewell (handpump or tap), private borewell, tanker, private well, water cans, private tap, open well, bottled water

Distance to water source:
- How far water source is to the household
- How often water is distributed to the area

Water storage practices:
- Type of containers, storage time, placement and coverage of containers

Methodology

- GIS was used to map four study sites in Vellore, India (two urban slums and two rural villages as seen in Figure 1)
- For base map layers, files were downloaded from Bing Maps Aerial Imagery
- Prior data was observed on the number and duration of diarrheal episodes in a year-long cohort of 1274 individuals (27% under 5) in Vellore, India by the Christian Medical College (CMC)
- Selected environmental factors that could have potential effects on enteric disease transmission were analyzed
- Data on location of water taps and households in the study were obtained from CMC
- Data on water allocations in the households as well as water source and distance to water source were joined with location of households
- Water quality parameters on total dissolved solids, coliform, and fecal coliform levels were joined with water tap location
- Spatial joins were done to observe the distance from the study house to the water source
- Contamination points, which are areas where sewage pipelines intersect with water pipelines were identified

Analysis

- Rural areas have significantly higher water use per capita than urban slums (88.38L vs. 66.4L, p=0.031, ANOVA)
- Water samples from urban households have significantly higher fecal coliform counts, as well as total dissolved solids (TDS), compared to samples from rural areas (p<0.001, p=0.012, respectively)
- Intermittent water supplies identified mostly in urban slums where water was only available once a week, whereas rural areas had daily supply
- Urban households mainly rely on private taps and borewells, as compared to public taps for rural areas
- Widespread contamination of drinking water was observed in both rural and urban areas at the source and point of use
- Households further away from water source had more enteric disease cases than those closest to water taps

Acknowledgments

Cartographer: Negin Ashoori
Civil & Environmental Engineering
Projected Coordinate System: GCS_WGS_1984
Data Sources: Christian Medical College, Negin Ashoori, Bing Maps Aerial Imagery