WATER QUALITY AND DENSITY OF WATER SOURCES AS RISK INDICATORS OF DIARRHEAL DISEASE IN AN URBAN AREA IN SOUTH INDIA

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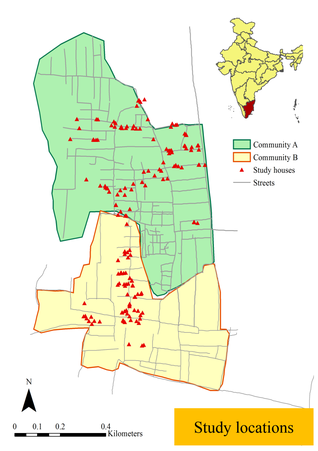
Source: Privately collected GPS coordinates

INTRODUCTION

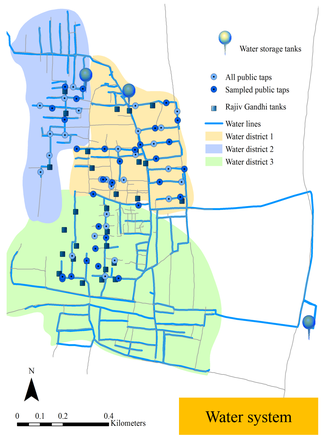
In this project, I explore water quality and quantity as indicators of diarrheal disease in two adjacent communities located in Tamil Nadu province in South India. The communities have two types of water sources. In the *public water taps* (central water distribution system), water is supplied 4-10 times per month. *Rajiv Gandhi tanks* (on-site wells) produce brackish water all the time. Although the water is unsuitable for drinking, RGTs increase water quantity available for sanitation, especially during the dry seasons.

OBJECTIVES:

- Observe the trend in bacterial contamination and disease cases over time
- Observe the trend in overall risk score and disease cases over time
- Perform regression analysis to determine if water quality, tap density and RGT density are associated with disease risk on a monthly basis



Study locations

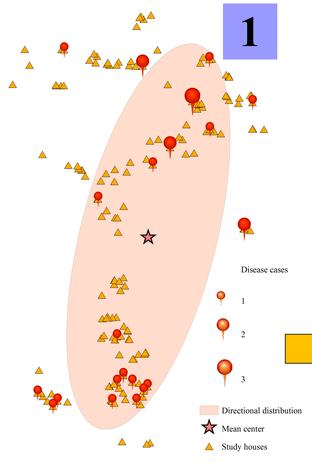


Water system

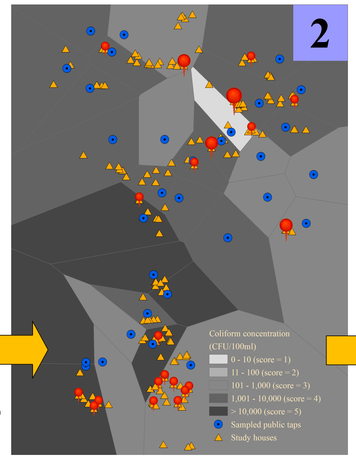
Photos A through C show examples of public water taps. Photo D shows a Rajiv Gandhi tank.

METHODOLOGY

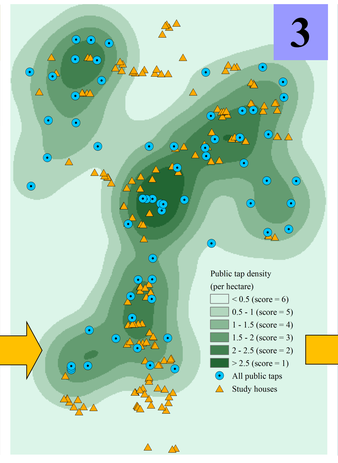
1. Map monthly disease incidence in each household
2. Map directional distribution and mean center of disease cases
3. Create public tap polygons & map the coliform concentrations
4. Create density surfaces for public taps & RG tanks
5. Combine 3 scores and map the overall score vs. disease and WQ polygons



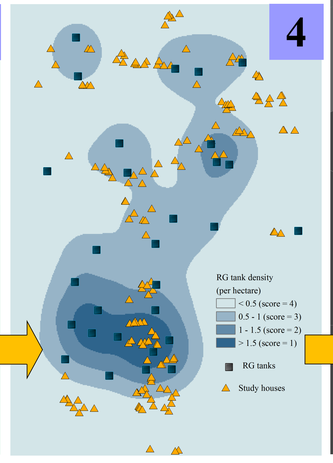
Disease cases were aggregated monthly for each household. For each month, directional distribution and mean center of disease cases were determined using spatial statistics tools.

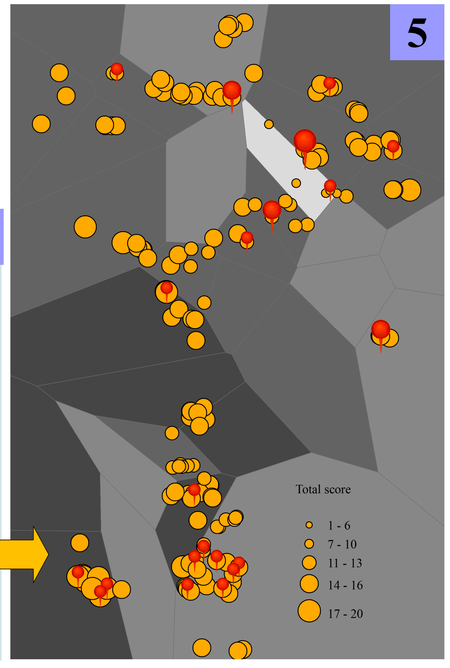


Thiessen polygons were created around each sampled public tap and monthly coliform concentrations in each polygon were mapped. A score was assigned to each polygon based on the log scale.



Density surface rasters were created to show the density of all public taps and RG tanks. A search radius of 150m was used for both. Scores were assigned in reverse order because a higher density of either water feature is assumed to represent a lower risk of disease in this simplistic model.





The overall score was calculated as follows:
[coliform sc]*2 + [tap sc] + [RG sc] assuming that water quality and density of water sources are weighted the same in this simplistic model. Polygons with no coliform data are shown with no fill and houses within those polygons as black dots.

RESULTS

OBSERVATIONS:

- The Southern most part of the area experiences high risk conditions throughout the year
- In the majority of the areas, disease pattern persists throughout the year
- Water quality is worse in November, December and January in the majority of the areas

REGRESSION MODEL RESULTS:

- When used individually, all three risk scores showed a very small effect on the disease outcome
- When used together, only the RGT score was statistically significant
- Regression coefficients from generalized linear model (Poisson distribution) are presented in **Table 1**
  - Pink represent positive association (intuitive effect) with disease
  - Blue represent negative association (opposite effect) with disease
  - Very few of the coefficients were statistically significant

Table 1: Regression Coefficients

	Feb-11	11-Mar	11-Apr	11-May	11-Jun	11-Jul	11-Aug	11-Sep	11-Oct	11-Nov	11-Dec	12-Jan
Coliform sc	+	-	-	-	-	-	+	-	+	-	+	-
Tap density sc	-	+	-	-	+	+	+	+	-	+	-	+
RGT density sc	+	+	+	-	-	+	+	+	-	-	+	+
Overall sc	+	+	-	-	+	+	+	+	-	+	-	+

CONCLUSIONS

Although the *intuitive relationships* between the assigned risk scores and disease were observed during most months, the associations were not statistically significant

- Higher coliform concentrations (higher score) = greater risk of disease
- Lower tap or tank density (higher score) = greater risk of disease

It is possible that extremely high levels of contamination throughout the year diminish the association between water quality and disease. Some possible improvements to consider:

- Use distance to closest tap vs. water source density as a measure of access
- Different weighting of quality and quantity in the overall score calculation
- Different break points in the coliform concentration categories
- Incorporate water supply frequency into the model
- Exclude houses that had no disease during the study period from analysis

Monthly progression of water quality, overall risk and disease cases