

Investigating spatial patterns of Urogenital Schistosomiasis in schoolchildren in one rural community in Ghana

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CEE 187: Introduction to GIS
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Map Projection: WGS 1984 UTM Zone 30N



Background:

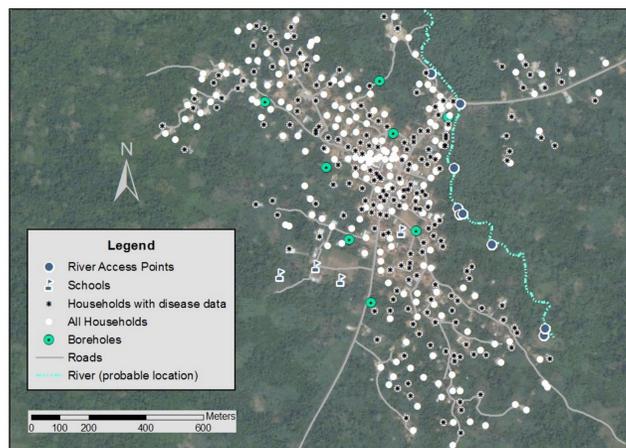
Urogenital Schistosomiasis (UGS) is a neglected tropical disease caused by the *S. haematobium* roundworm parasite; it affects over 112 million people in the world (WHO 2002). Infection occurs through contact with certain rivers where the juvenile parasite lives in an intermediate snail host. Children are often disproportionately burdened with the disease because they are more likely than adults to contact the river during play or water fetching.

UGS research is shifting from drug discovery and parasite biology to sociological and water resources research to better understand community structures and issues that affect prevalence of the disease. UGS is endemic in western Africa, where Tufts researchers have been studying the disease for several years in the Eastern Region of Ghana (see map, above). This research focuses on data from June 2012 from one high-prevalence community, Asamama.



One of the goals of the research this summer was to identify spatial patterns of UGS in order to better understand the disease and the unique factors that may contribute to prevalence in a particular community. Children in Asamama are infected from the Abresu River (left), which runs along the eastern edge of the town (see map, below). The community also has several boreholes that provide a UGS parasite-free source of water.

Based on the infection mode of the disease, a child's household proximity to the river, or, conversely, distance from a working borehole, could be risk factors for Urogenital Schistosomiasis in Asamama.



Methods:

GPS data was collected for water sources and individual households in Asamama (see map, above). Children in the community who were tested and treated for UGS in school were manually matched with their house location and their disease status was entered into attribute tables for the houses. 364 children with disease and spatial data were mapped in ArcGIS version 10.1.

All point data and subsequent layers made in CS: WGS 1984 UTM Zone 30N

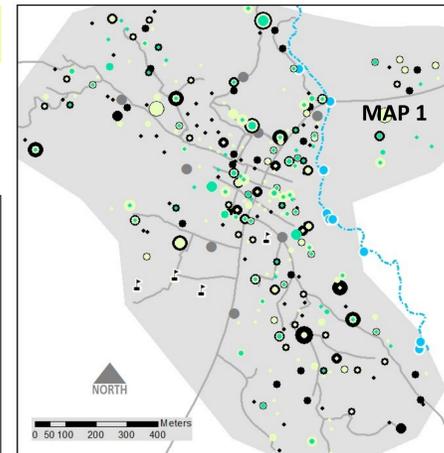
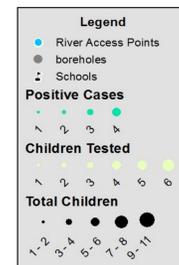
In ArcGIS, several analyses were performed:

- Spatial joining of households and river access points
- Spatial joining of households and boreholes
- Kernel density plots of households, households with disease data, and households with at least one infected child
- Nearest neighbor (NN) analysis of households, households with disease data, and households with at least one infected child

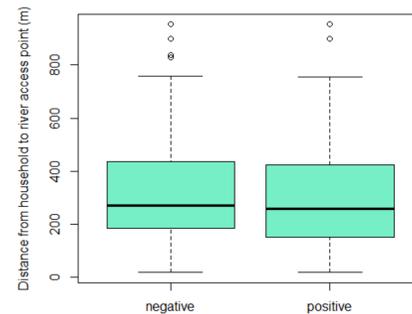
Results:

Analysis 1:

Examining a child's distance from the river as a risk factor



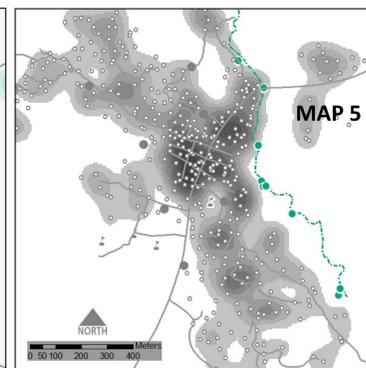
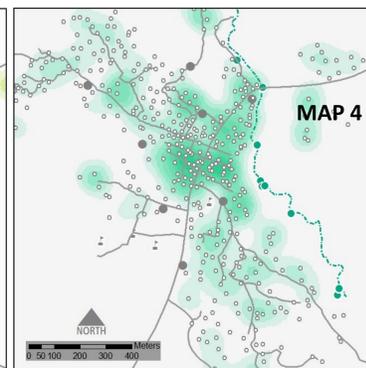
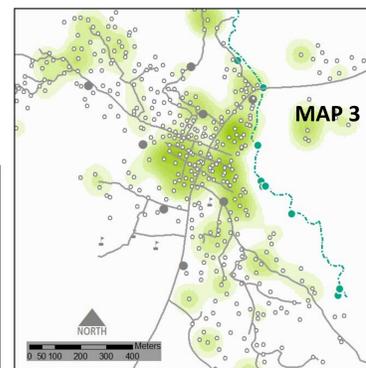
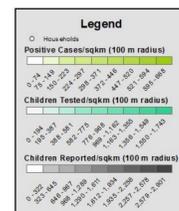
Distance from River and Disease Status in Children



Hypothesis testing (Z-test, $\alpha=0.05$) revealed that there is not enough evidence to suggest a difference between infected children and uninfected children in how far they live from a river access area (picture above) in Asamama.

Analysis 3:

Examining density distributions of the data

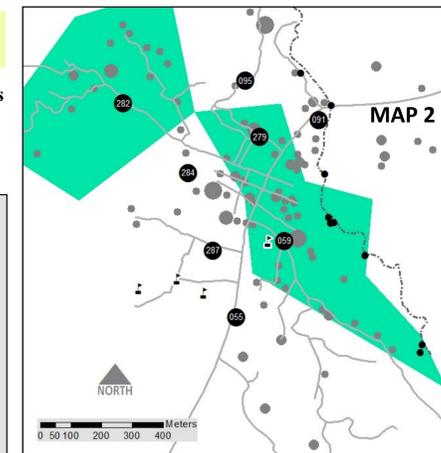
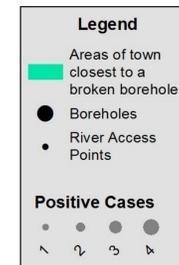


z value
p value
NN observed (m)
NN expected (m)

houses	children tested	positive cases
-3.017	-3.422	-1.967
0.00255	0.000621	0.0490
29.11	39.11	59.88
31.63	44.84	67.3

Analysis 2:

Examining a child's access to borehole water as a factor



Proximity to Borehole and Disease Status

	broken	working	total
positive	61	57	118
total tested	182	182	364

closest borehole*	positive	total tested	% positive
055	11	55	20 %
059	30	82	37 %
091	23	58	40 %
095	7	18	39 %
279	14	48	29 %
282	17	52	33 %
284	12	35	34 %
287	4	16	25 %
Overall	118	364	32 %



There is no clear pattern in disease rates for populations close to particular boreholes (example above) in town.

* broken boreholes highlighted

Conclusions:

- NO RELATIONSHIP:** disease status and river proximity
 - there are not significant differences in the distance from a child's household to the river for infected and uninfected populations (Analysis 1)
 - there are no clear spatial patterns in disease evident from in Map 1
- NO RELATIONSHIP:** disease status and closest borehole
 - there are no obvious spatial patterns evident in Map 2
 - there are no clear patterns in disease rates for populations based on their proximity to certain boreholes in town (Analysis 2)
- NO OBVIOUS CLUSTERING OF DISEASE DATA**
 - from Maps 3,4,5 there are no strong spatial patterns in the disease data compared to the household data
 - households and households sampled appeared to be strongly clustered based on the nearest neighbor analysis (Analysis 3)
 - disease data also appears to be clustered (not random), but perhaps less clustered than the household data (randomly distributed among houses)

While these conclusions do not agree with the original hypothesis, they make sense for a small community such as Asamama, where all water resources are within 1 km of households (this distance is often considered a "convenient" distance for a water source). At this scale, distance is perhaps less of a factor in water choices for households than other factors, such as traditional beliefs and taste preferences.

Further research will involve analyzing patterns in data from household surveys in the town, in order to determine other factors that affect water choices and disease prevalence.

Work Cited:

World Health Organization, Geneva, Switzerland (2002). Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis: Report of a WHO Expert Committee. Tech. Rep. Series, vol. 912.

Acknowledgements:

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