# Seasonality of Schistosomiasis

## Background

Schistosomiasis is the second most destructive parasitic disease, following malaria. Often considered a Neglected Tropical Disease, Schistosomiasis infects more than 200 million people worldwide according to the Center for Disease Control. Schistosomiasis refers to the trematode *Schistosoma*, often considered the agent in the epidemiological triangle. The difficulty with schistosomiasis is that it has two hosts, the human as well as the snail. As a result, transmission of the disease requires an interaction between snail habitat and human activity.

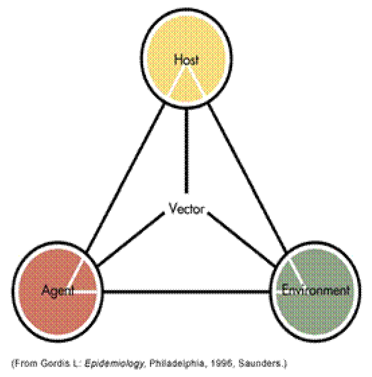


Figure 1: Epidemiological Triangle, Host=Snail and Human, Agent=*Schistosoma*, Vector=Water Body; Environment= Snail Living Conditions

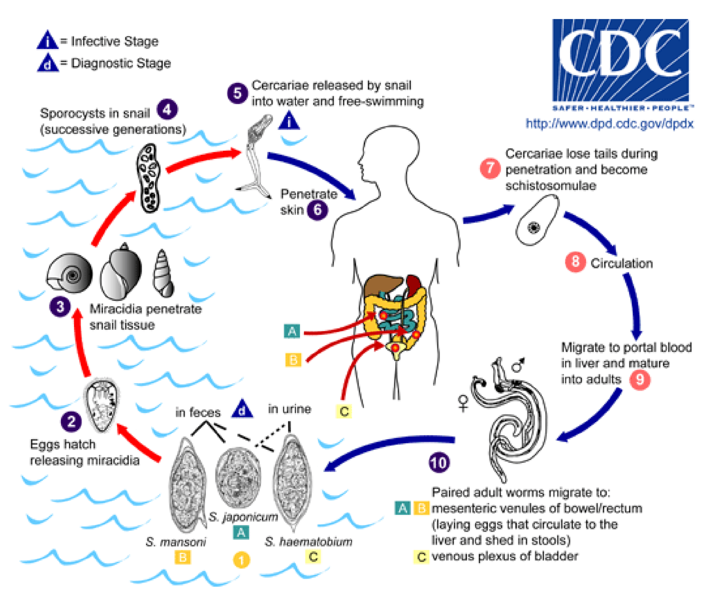


Figure 3: Life cycle and the transmission of schistosomiasis

Conditionality of snail population density is largely influenced by rain, vegetation and temperature. These environmental constraints make schistosomiasis ideal for using spatial software in predicting prevalence.

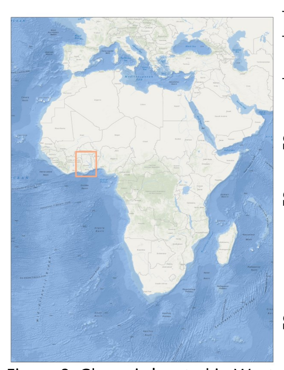


Figure 2: Ghana is located in Western Africa and has temporal nature of Saharan as well as sub-Saharan Africa

In Ghana, there are three main types of schistosomiasis present, two intestinal and one urogenital.

## Methodology

The main factor in determining snail prevalence examined by this project was rainfall. Using images from the Tropical Rainfall Measuring Mission (TRMM) provided by the National Aeronautics and Space Agency (NASA), monthly accumulated rainfall was calculated. Zonal statistics were then used on the images to relate them to the geopolitical boundaries of the 170 districts in Ghana. A similar process was taken to gather schistosomiasis counts. The data provided by Ghana Health Services was not up to date with the 2013 redistricting. As a result, areal interpolation was used to account for the remaining three districts.

In determining Ghana's rain seasons, this project focused on the averaged rainfall for the entire country as opposed to dividing into Saharan versus sub-Saharan. From there, months were divided depending on level of rainfall. It was determined that there were two main peaks with three troughs. However, because months are continuous, if more years were used, January, February, November and December could have been grouped into one trough.

An aggregate by seasons was done for accumulated rainfall as well as schistosomiasis counts. Both were normalized according to the respective 2013 range.

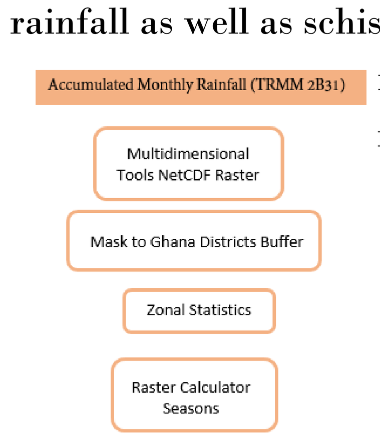


Figure 4: Workflow diagram for tools used in processing of TRMM data

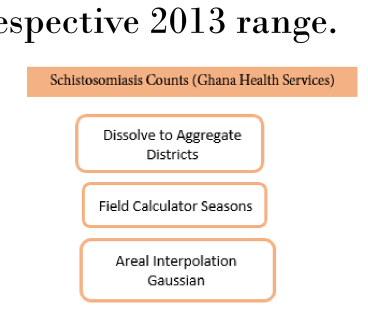
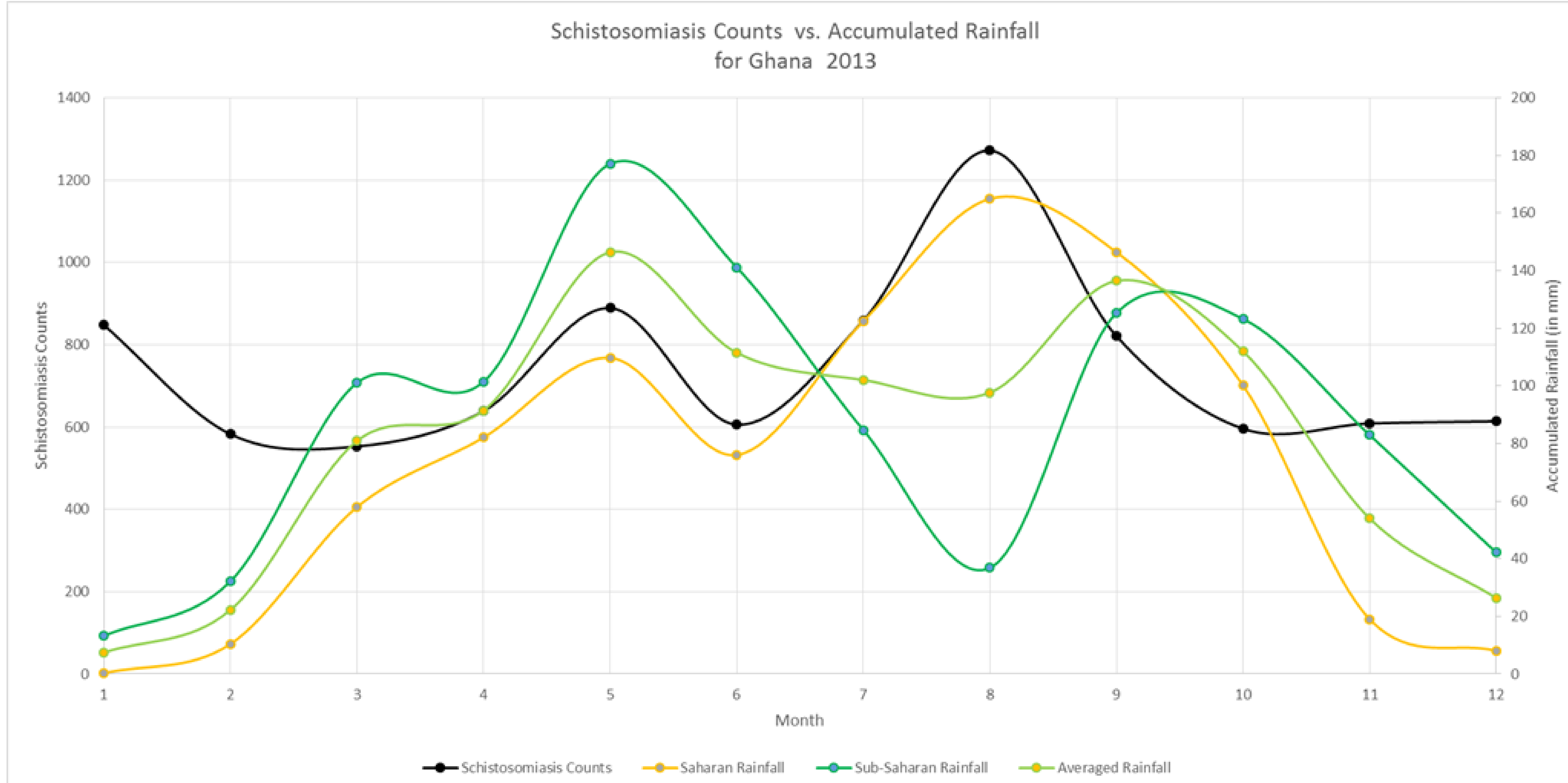


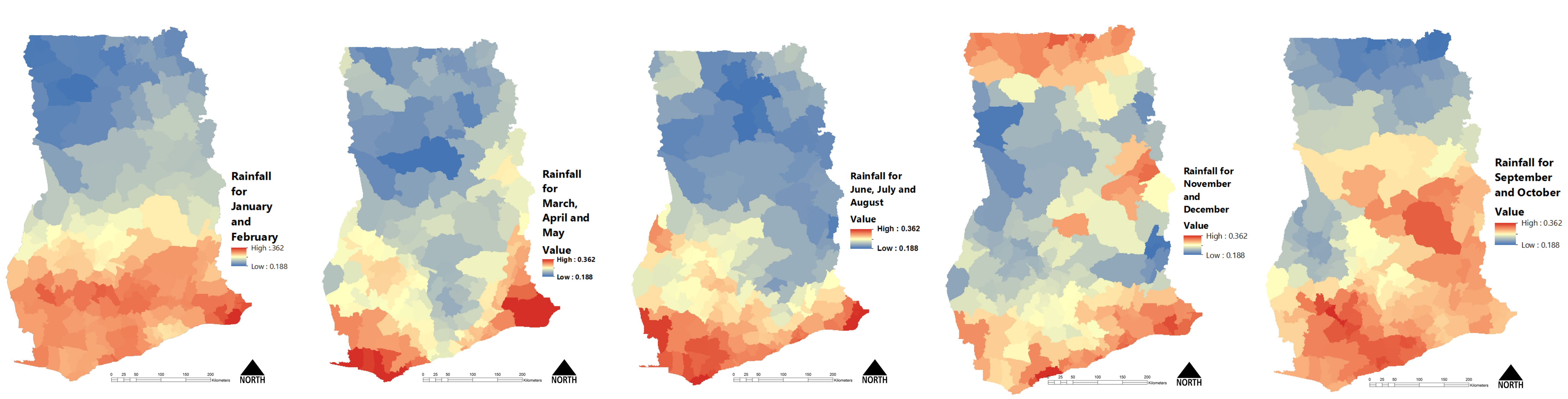
Figure 5: Workflow diagram for tools used in processing of schistosomiasis counts

## Schistosomiasis Counts vs. Accumulated Rainfall (Ghana, 2013)



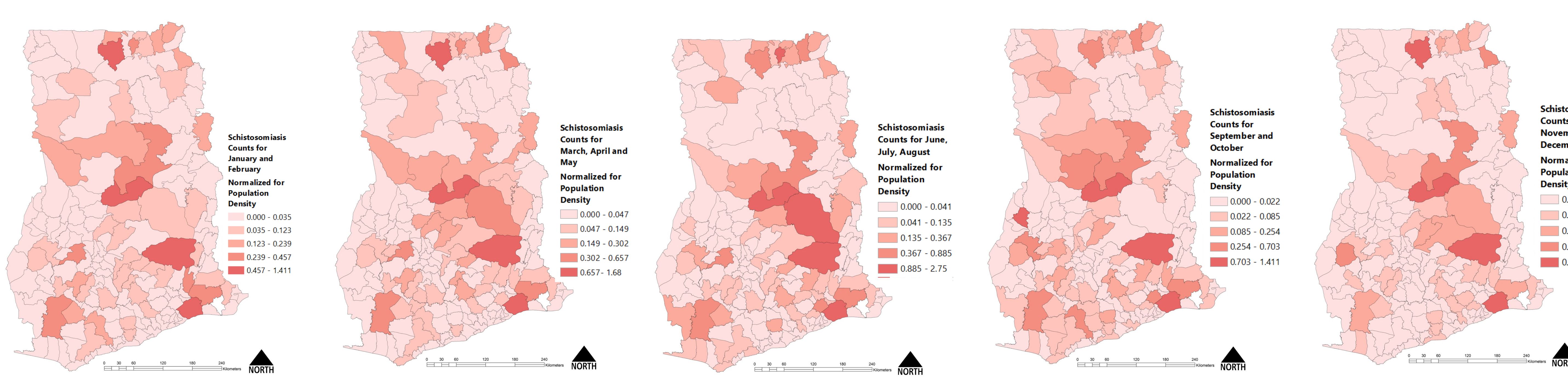

## Accumulated Rainfall Ghana, 2013 (TRMM 2B31)

January and February | March, April, and May | June, July and August | September and October | November and December




## Schistosomiasis Counts Ghana, 2013 (Ghana Health Services)- Normalized for Population Density

January and February | March, April, May | June, July and August | September and October | November and December




## Results

Looking at the accumulated rainfall as compared to schistosomiasis counts for 2013 allows us to visualize two of the major challenges in the spatial extent of this project: first, the necessary division between sub-Saharan versus Saharan climatology and second, the "schistosomiasis time lag."

By examining the curves for Saharan versus sub-Saharan is clear that the two have differing peaks and troughs. While the two follow a similar trend up until June, in July and August the two switch. There is a trough in sub-Saharan rainfall but a peak in Saharan rainfall. This makes it difficult to aggregate months into seasons as the two diverge in the months following.

Another major issue is the "schistosomiasis time lag." Unlike other water-borne disease such as cryptosporidiosis where the seasonality can be clearly graphed due to immediate need for medical attention, schistosomiasis count is harder to gather as individuals 1) do not show symptoms for weeks up to months and 2) do not need to seek immediate medical attention. In the graph above, the January and the August peak is the best indicators of this trend. While accumulated rainfall is low at the beginning of the year, schistosomiasis rates my be high following from the previous year. The high rates in August follow the high rates of rainfall in May. Other possible lags include the time it takes for rainfall to affect vegetation, which snail population density is highly dependent upon.

While the schistosomiasis counts were normalized for population density, the hotspots for disease burden still occur mainly in the same districts independent of the seasons. The central right bears the brunt event though it has minimal rain between March to August. Figure 6 shows a vulnerability analysis created; the areas of highest likelihood of schistosomiasis seem to be in the central right as well. One of the factors, use of unprotected water sources defined as use of river, stream, lake, rain water and unprotected wells, is shown in Figure 7 and is highly correlated. High usages of unprotected water sources increases contact points between schistosomiasis and humans. The best seasonal analysis seems to be in November and December. In the central districts as well as the western districts, with higher rainfall follow higher schistosomiasis cases.

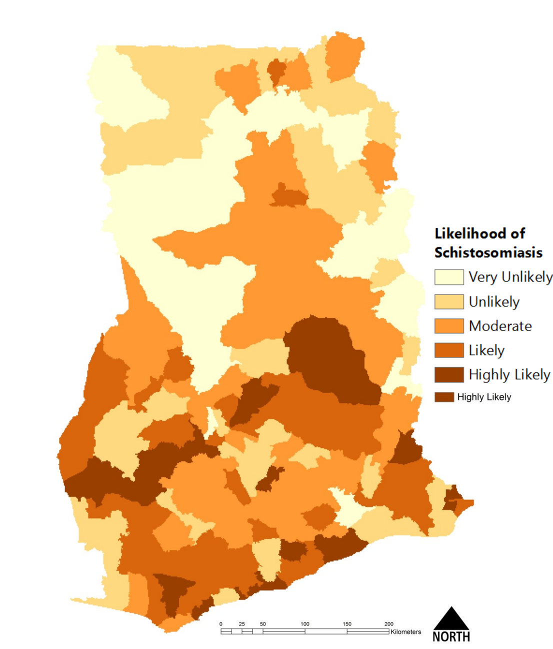


Figure 6: Vulnerability analysis based on river order, population density, use of protected and unprotected water sources and 2013 rainfall

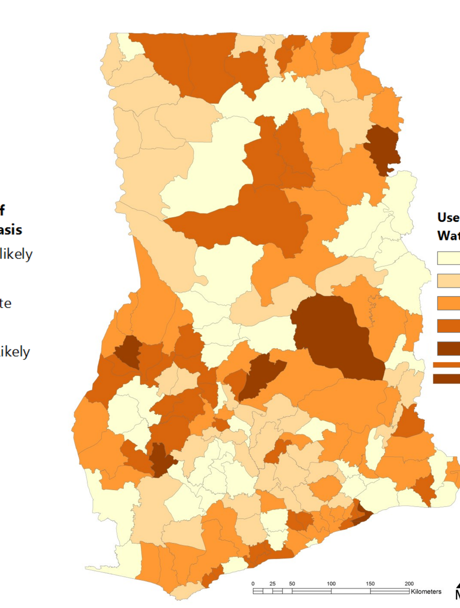


Figure 7: Likelihood of Schistosomiasis based on use of unprotected water sources

## Conclusion

Considering the challenges faced in determining the seasons, further research should include a Fourier analysis of schistosmiasis counts at a lower districts level to create the most accurate base curve for disease prevalence. For such analysis, seasons should be separated by Saharan and sub-Saharan weather conditions.

Additional weight should also be given to environmental factors such as the normalized difference vegetation index, temperature, and land use classifications. Socioeconomic conditions could include the availability and use of protected water sources versus unprotected, the contamination of nearby water ways, and the proximity to health facilities.

The time fame of this project was limited to a one year period, however, additional years may provide more contextualized models for the seasonality of schistosomiasis in Ghana. A more in-depth analysis is necessary and worthwhile as seasonality has been shown in diverse locations such as China, Brazil, Nigeria and Ethiopia.


Map Created By: Jessie Wang
Projection: Ghana TM
Data Source: Ghana Health Services, 2000 Ghana Census and TRMM NASA
Scale: 1:2,885,868
Introduction to GIS Spring 2014
Professor Carl Zimmerman assisted by Carolyn Talmadge