Determining a Region's Susceptibility to Diarrheal Diseases

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INTRODUCTION

Diarrhea kills 2,195 children a day and over 800 thousand children every year (CDC). Deaths by diarrhea are caused by the extreme depletion of fluids and dehydration through the infection of the intestinal track by various bacterial, viral and parasitic organisms. Diarrhea is spread through the fecal oral route, with 88% of fatal cases attributable to unsafe water, hygiene and sanitation practices (CDC).

The goal of this project is to use sociodemographic factors in combination with health indicators in order to predict a region's susceptibility to high prevalence of diarrheal diseases. The model is based on Cameroon, a country in west Africa selected for it's high mortality attributed to diarrhea which accounted for 11% of deaths for children under 5 and for 14.4% of deaths overall in 2013 (WHO).

METHODOLOGY

The factors included in this model are: 1) the percentage of women aged 15-49 who reported problems with the distance to health care facilities, 2) the percentage of females over 6 years of age with no schooling, 3) the percentage of the under-5 population practicing open defecation, 4) the percentage of the under-5 population who are wasted (2 standard deviations below weight for height, 5) the percentage of the population living in the lowest economic quintile and 6) population density. Since population density was added as a factor and the data was not confined to the 13 regions described, each region was given a range of susceptibility scores instead of just one.

The first step of this analysis required developing an ArcGIS compatible table in order to extract the numerical data from the Cameroon 2012 Demographic Health Surveys (See **Table 1**.). These data points were then joined spatially to an administrative map of Cameroon.

Using the feature to raster tool, each map was converted into a raster and reclassified into scores ranging from 1-6 based on the percentages of each indicator. Next, using the map algebra tool, the maps were added together to produce the "predicted susceptibility map" based on the 6 factors. The equation below shows the weight of each factor used to calculate the susceptibility scores (see maps below for rational of each respective weight).

(2* "Population Scores") + (.5* "SES Scores") + (1.75* "Wasting Scores") + (1.25* "Open Defecation Scores") + (.5* "Education Scores") + (.75* "Distance Scores")

RESULTS AND DISCUSSION

This project was designed to be implemented in locations where data on the prevalence of diarrheal diseases is unavailable. From this analysis, regions with the most need for interventions can be targeted. The map that was developed from the combinations of the six factors and the associated scores does have a high correlation to the 2012 reported prevalence of diarrhea in Cameroon's under-5 population. The region with the highest reported prevalence is Nord, with a 35.8% prevalence of diarrhea in the under-5 population. This region has areas that scored between 25 and 23. The region with the next highest prevalence was Extrême Nord, with a prevalence of 31.2% and scores ranging from 28.25 to 24.25 (See **Table 2.** for more detailed data).

The observed pattern is that as the prevalence of diarrhea decreases, so does the susceptibility score ranges. The regions Sud and Ouest have a 14.7% and a 14.2% prevalence of diarrhea in the under-5 population and susceptibility scores of 12.5 and 13 respectively. Both the differences in the prevalence and the differences in the scores were viewed as negligible. There was a lot of observed variation in the scores for Douala, with calculated scores ranging from 15 to 7.2. The overall prevalence of diarrhea in the under-5 population in Douala was 11.2%, which was the second lowest of all the regions.

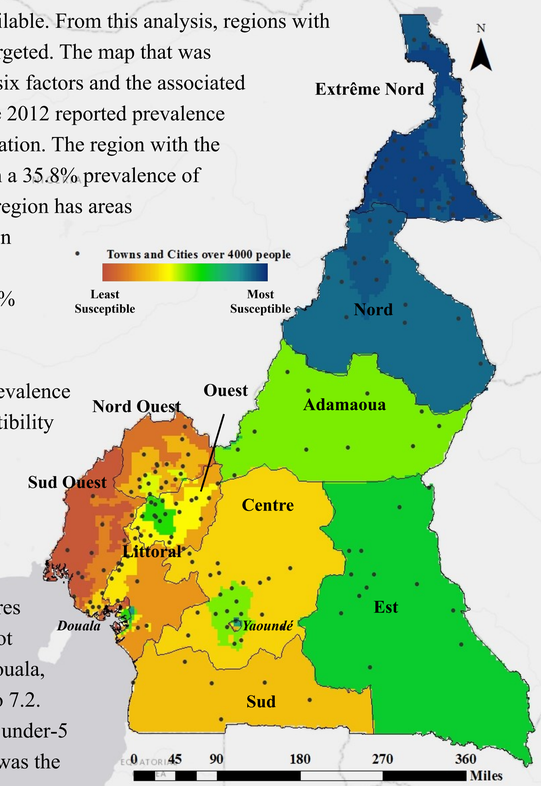

Table 1. Data on Regional Percentages of Each Sociodemographic Factor

Region Name	Lowest Economic Quintile	Women over 6 with no Education	Problems with distance to health care (Women aged 15-49)	Children 2 SD below Weight/ Height	Open Defecation Children Under-5
Adamaoua	17.7	38.3	13.2	6.3	1.2
Centre	2.0	9.6	24.8	4.2	7.2
Douala	0.0	5.1	9.4	2.5	0.9
Est	20.1	19.1	20.0	6.0	4.6
Extrême-Nord	54.8	61.0	23.3	11.8	18.1
Littoral	2.5	14.2	21.3	1.2	3.3
Nord	51.7	50.4	26.7	10.1	7.7
Nord-Ouest	9.2	16.6	8.6	2.5	1.2
Ouest	2.3	13.0	16.7	0.7	8.0
Sud	1.4	6.4	23.1	4.3	2.7
Sud-Ouest	1.9	9.2	22.8	3.0	0.2
Yaoundé	0.0	4.5	13.3	2.2	0.2

Table 2. Determined Susceptibility Scores for each region sorted by highest prevalence of diarrhea

Region Name	Range of Scores	Prevalence of Under-5 Diarrhea	Percentage of Children with Diarrhea Whose Parent Sought Help	Percentage of Children under 5 who received ORS (Rehydration Salts)
Nord	25 to 23	35.8	15.3	12.7
Extrême-Nord	28.25 to 24.25	31.2	15.7	8.1
Yaoundé	18 to14	20.8	33.1	30.6
Est	16.75	18.2	32.5	24.4
Littoral	15.25 to11	16.2	37.9	31.1
Centre	14.5 to13	15.9	21.7	14.4
Sud	12.5	14.7	37.1	24.5
Ouest	13	14.2	36.0	24.9
Adamaoua	15	13.4	31.4	19.5
Sud-Ouest	14 to11.5	11.9	31.3	30.8
Douala	15 to 7.5	11.2	25.6	25.6
Nord-Ouest	14 to 10	8.5	39.9	42.0

LIMITATIONS

One important thing to keep in mind for this analysis is the relationship between the factors and the demographics of each region. What is meant by this is determining if an area is more prone to diarrheal diseases just because it has a high percentage of children under 5 or if having a high percentage of children under 5 actually increases susceptibility to diarrheal disease for underlying social and behavioral regions. Since diarrheal diseases have such a high mortality rate for children under 5, the data could be stratified to make two separate susceptibility predictions, one for children under 5 and another for the rest of the population.

Another observed limitation of this analysis is the way in which the original DHS data was collected. In order to make generalizations about an entire region, a small sample of people are selected and data is collected on them. This is done due to limitation in resources however, sampling large regions can frequently misrepresent the true population prevalence of each factor chosen and the compared values that represent the prevalence of diarrheal diseases.

CONCLUSION

In order to more accurately verify the precision of the 6-factor model presented, similar projects would have to be conducted. By using multiple areas, the weights used for each factor could be refined and factors could be changed if the observed correlation was only apparent in the Cameroon model. In the future, more data that are not confined to the regions defined by the demographic health surveys should also used. By using other data related to tropical diseases and diarrhea such as climate, topography and rainfall, more specific "hotspots" could be identified.

In a more depth analysis, these regions would be compared to available city level data. If the region identified by the literature and the spatial analyses are not the same, further research on the steps that area has taken to reduce the incidence of diarrheal disease should be conducted. Still, if the indicators chosen do not accurately represent the distribution of diarrheal diseases, the weighted scale and factors chosen should be reexamined again.

Amylee Anyoha
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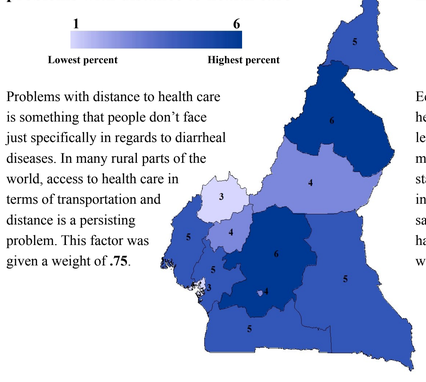
CEE 187 Geographical Information Systems
Map Projection: Custom

Sources: Cameroon 2012 Demographic Health Surveys, Spatial Data Repository, World Resources Institute, ESRI, Nelson, Andy, 2004. African Population Database, UNEP GRID Sioux Falls
Thanks: Laurie Baise, Lurong Yang

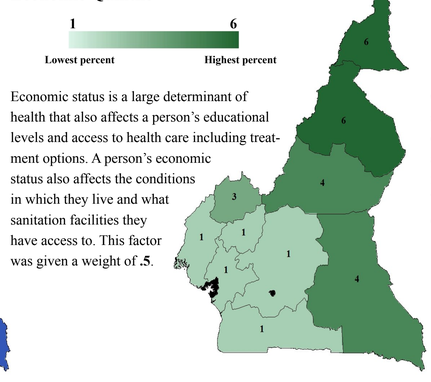
Sociodemographic Factors Used for Susceptibility Prediction

Percent of Women aged 15-49 who reported problems with distance to health care



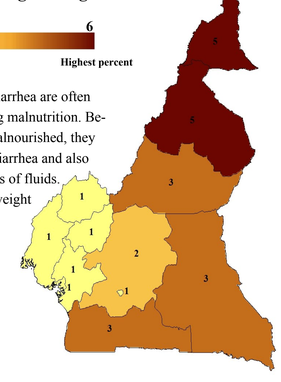
Problems with distance to health care is something that people don't face just specifically in regards to diarrheal diseases. In many rural parts of the world, access to health care in terms of transportation and distance is a persisting problem. This factor was given a weight of **.75**.

Percent of the Population in the Lowest Economic Quintile



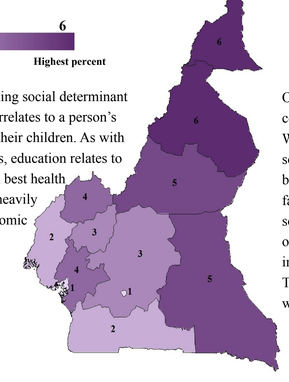
Economic status is a large determinant of health that also affects a person's educational levels and access to health care including treatment options. A person's economic status also affects the conditions in which they live and what sanitation facilities they have access to. This factor was given a weight of **.5**.

Percent of Children who are 2 Standard Deviations below Weight/ Height



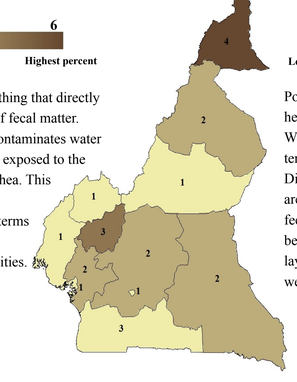
Children who die from diarrhea are often suffering from underlying malnutrition. Because they are already malnourished, they are more susceptible to diarrhea and also from dying due to the loss of fluids. This factor was given a weight of **1.75**.

Percent of Women over 6 with no Education



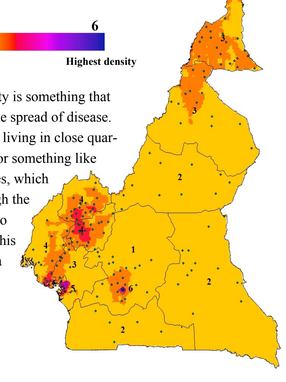
Education is an overarching social determinant of health that directly correlates to a person's health and the health of their children. As with other public health issues, education relates to a person's knowledge on best health practices. This factor is heavily connected to social economic status so it was given a weight of **.5**.

Percent of Children Under 5 who Practice Open Defecation



Open defecation is something that directly correlates to the spread of fecal matter. When this fecal matter contaminates water sources, more people are exposed to the bacteria that causes diarrhea. This factor is also related to socioeconomic status in terms of who is able to afford improved sanitation facilities. This factor was given a weight of **1.25**.

Population Density



Population density is something that heavily affects the spread of disease. When people are living in close quarters, it is easier for something like Diarrheal diseases, which are spread through the fecal oral route, to be transmitted. This layer was given a weight of **2**.