Cholera in Haiti: A Map to the Cure

PICMath

Oluwakemi Adeagbo, Sophia Morrell, Coral Nimz, Niabelle Thelemaque, Owen Thomas

Faculty Mentor: Dr. Zhisheng Shuai

Department of Mathematics

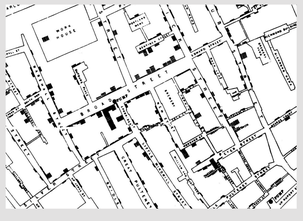
UCF

Introduction

Vibrio cholerae is an infectious disease of the small intestine that, if left untreated, can be deadly within a few hours [1]. Cholera was first seen in the Ganges Delta in 1817, and has been present on every populated continent since. In third world countries, cholera is a prevalent concern due to poor sanitation and insufficient resources [2]. This is especially evident in Haiti, a small country located on the Caribbean island of Hispaniola, bordering the Dominican Republic.

In January 2010, Haiti experienced a devastating magnitude 7 earthquake. In mid-October of that year, the first outbreak of cholera was reported, and the disease has persisted since then. In October 2016, Hurricane Matthew hit the southwestern part of Haiti near Les Anglais, refueling the epidemic. Due to lack of funds and resources, cholera has proven to be an ongoing concern in Haiti, and extant plans have had little long term efficacy [4].

In 1854, during a cholera epidemic in London, English physician John Snow revolutionized epidemiology by hand-mapping the locations of cholera cases (pictured below). From his map, the source of the disease was found and eventually eradicated [2]. Inspired by Snow's work, our group will create an interactive map that will include several variables we predict are related to the spread of cholera, and thus could lead to potential solutions.



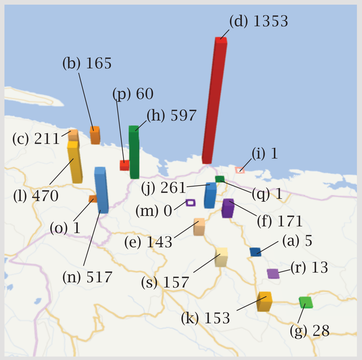
We decided to focus specifically on Department Nord due to its climate and its distribution of rural and urban areas. Since Nord is home to one of Haiti's largest cities, Cap-Haitien, there are more sources from which to obtain medical data. In addition, Nord has a substantial rural population, suggesting significant need for aid.

Methodology

We are using Excel 3D Maps in order to visually represent the relationship between cholera incidences and the following factors: climate, medical availability, waste disposal, and clean water supply. Our data comes from various sources, including the Haitian Ministry of Public Health, weather archives, and the World Health Organization.

Visualizations of Data

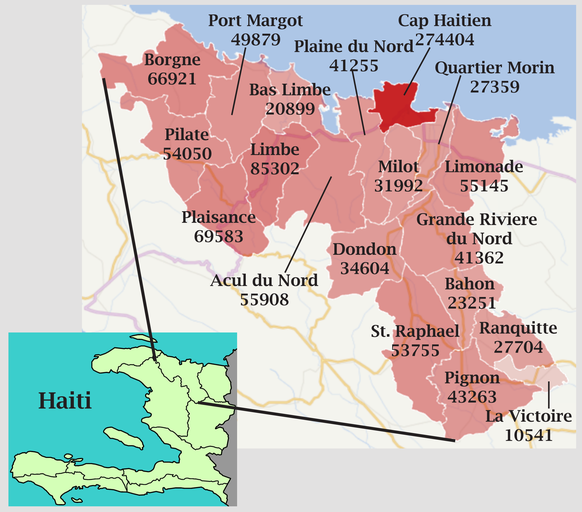
Number of Cholera Cases by Hospital



(a) Dispensaire de Bahon
(b) CAL de Borgne
(c) Petit Bourg Borgne
(d) Hôpital Justinien
(e) CSL de Dondon
(f) CAL de Grande Rivière du Nord
(g) CSL La Victoire
(h) CAL Saint Jean de Limbé
(i) Disp de Bord de Mer
(j) Hôpital Sacré Coeur de Milot
(k) Hôpital Bienfaisance de Pignon
(l) CAL de Pilate
(m) Dispensaire de Robillard
(n) CM Populorum Progression
(o) Dispensaire de Gobert
(p) Centre Wesleyen de Port Margot
(q) Hôpital de la Convention B
(r) CSL de Ranquitte
(s) CSL de Saint Raphael

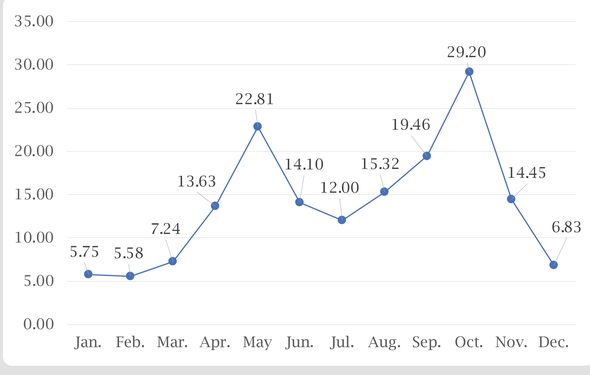
The cholera case data was obtained from a 2016 report from the Haitian Ministry of Public Health and Population. Low numbers could indicate that there were few cholera cases in that region, but could also be attributed to inappropriate reporting, misdiagnosis, or travel to better equipped medical facilities.

Population of Nord by Commune



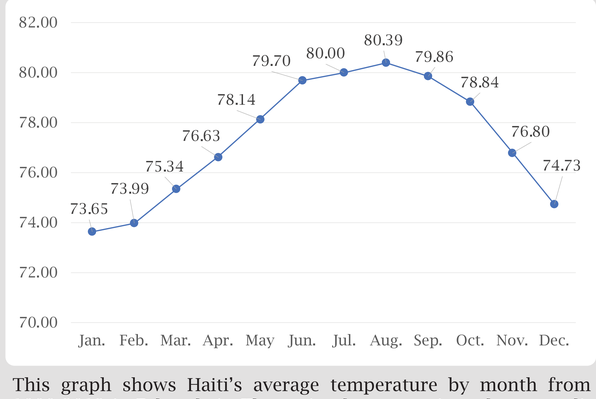
This data was obtained from the 2015 report on population from the Haitian Institute of Statistics and Information. Population data is integral to our map as it allows us to determine the rural or urban status of a commune, as well as the relative severity of the reported cholera incidences.

Haiti Average Rainfall (cm)



This graph depicts Haiti's average rainfall by month from 1990-2012 in centimeters. On average, the months with the most rainfall were May and October. These peaks indicate a dual rainy season, with torrential rain and flooding occurring in May and multiple hurricanes and tropical storms in October [3].

Haiti Average Temperature (˚F)



This graph shows Haiti's average temperature by month from 1990-2012 in Fahrenheit. The nation has a consistently warm climate, with peak temperatures occurring between June and September [3].

Solutions

Our map will allow aid organizations to compare cholera incidences to population and climate at a regional level. Ultimately, it will also show where aid and sanitation equipment have already been implemented. This will optimize the transmission of aid by facilitating decisions to either follow up with maintenance or begin programs in new locations.

The biggest factors in reducing cholera incidences are clean water, effective sanitation, and public awareness. Disease free water can be achieved cheaply through simple at-home straining and boiling, electrically-powered filter systems, or reservoir chlorinators. Effective waste disposal can be executed using appropriately-lined pit latrines and urban waste removal systems.

Thanks to ongoing aid efforts, some of these solutions have already been implemented in Haiti. Electric water filter systems using long-lasting batteries have been deployed in some villages throughout the country [4]. Haitian schools and villages have been provided with similarly inexpensive water chlorinators, inspired by the success of these devices in Honduras [5]. We predict that manual waste removal systems, like those in the city of Dubai, would also be successful [6]. Coupled with education and normalized hygiene practices, these solutions will greatly reduce the risk and prevalence of cholera in Haiti.

Next Steps

We will populate our map with information about previous and current humanitarian outreach - particularly water purification systems - and pinpoint areas of highest need for future aid efforts. We will also perform time series analyses to search for significant trends and unexpected correlations.

References

Acknowledgments

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Citations

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