A NEW HOSPITAL FOR HAITI:

MAPPING LOCATION SUITABILITY AFTER THE 2010 EARTHQUAKE

INTRODUCTION

After the 2010 Earthquake, many of the major health facilities across Haiti were destroyed. With such a high morbidity rate, it became crucial to not only identify the location and status of remaining hospitals across the country, but also to identify locations for new health facilities. There are many essential criteria that play a role in identifying these locations; consequently overlaying representative maps acts as an effective way to combine these criteria. Using data from directly after the earthquake, this model seeks to identify the best location for a new hospital.

Three primary criteria were identified for this research question. Primarily, what portion of the population would have access to the hospital in a given location? Secondly, how close is the location to existing hospitals? Finally, what was the level of damage from the Earthquake in that particular area? While there are certainly more criteria that would impact the suitability of a location, these variables were isolated for simplicity purposes.

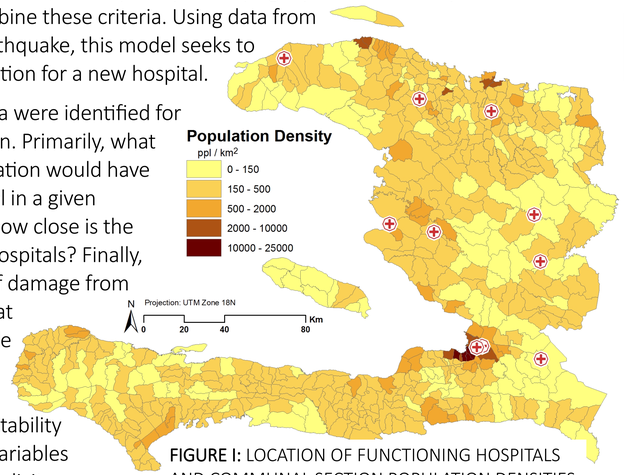

FIGURE I: LOCATION OF FUNCTIONING HOSPITALS AND COMMUNAL SECTION POPULATION DENSITIES

METHODOLOGY

Three major data sources were used to represent these three criteria. Communal section population densities are expressed using population data from the Haiti Demobase project compiled by the US Census Bureau. To represent functioning hospitals post-earthquake, points were pulled from a larger dataset representing all Haiti's health facilities compiled by the Haitian Ministre de la Santé Publique. Data from the UN Stabilization Mission was used to portray earthquake severity.

Using weighted map overlay analysis, it is possible to create a suitability map for hospital location. In this model, three layers are created that assign values to different cells based on the three identified criteria. The values at any point are normalized and combined to create a single value of suitability at any given cell (cell size = 1000).

1. **Proximity to existing hospital:** this value is calculated using a *Euclidean Distance Function,* which creates a continuous surface that represents the distance from each cell to the nearest Hospital. These values are classified using a six-class normalized value system.
2. **Population Density:** The population within one kilometer of each cell is identified using *focal statistics* on rasterized population density. Varying population densities are then reclassified.
3. **Damage from Earthquake:** By rasterizing data on earthquake severity, this layer assigns values to cells that are located in areas where damage ranged from light to violent, using a six-class value system.

Given the three different scores determined from each layer, the model uses a raster calculator to determine an overall score for hospital suitability in a given location. The following function was used:

LOCATION VALUE = [HOSPITAL PROXIMITY **+** POPULATION DENSITY **+** DAMAGE**] / 3**

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RESULTS

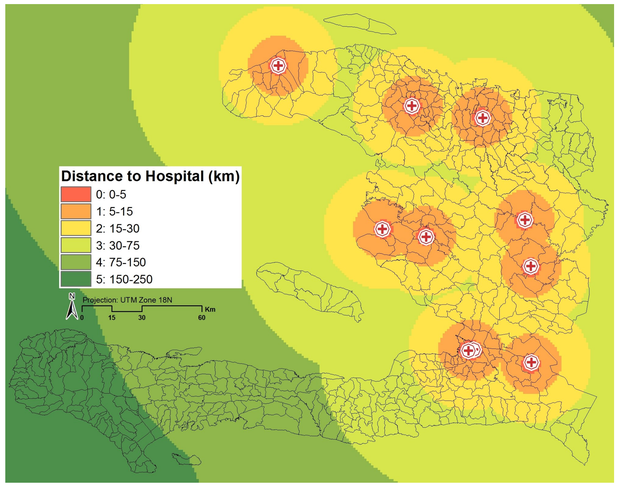
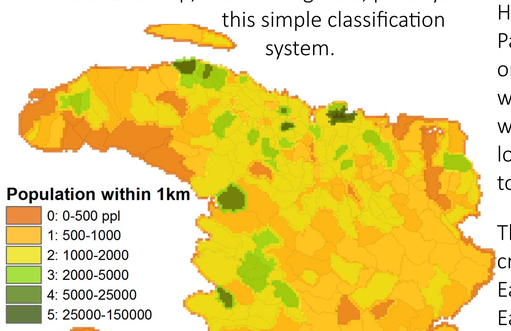


FIGURE 2: LOCATION PROXIMITY TO EXISTING HOSPITAL

By aggregating the three map layers created to represent these criteria, this model shows the varying suitability of locations across Haiti. The final rasterized map, shown in figure 5, portrays this simple classification system.



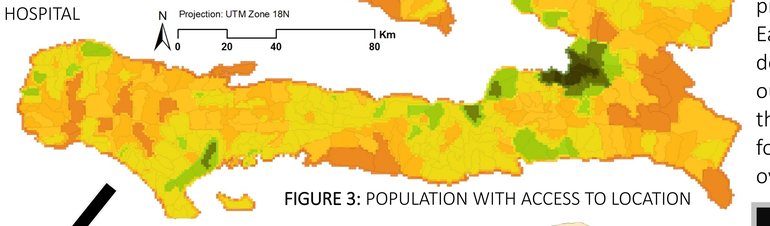


FIGURE 3: POPULATION WITH ACCESS TO LOCATION

[1]

[2]

[3]

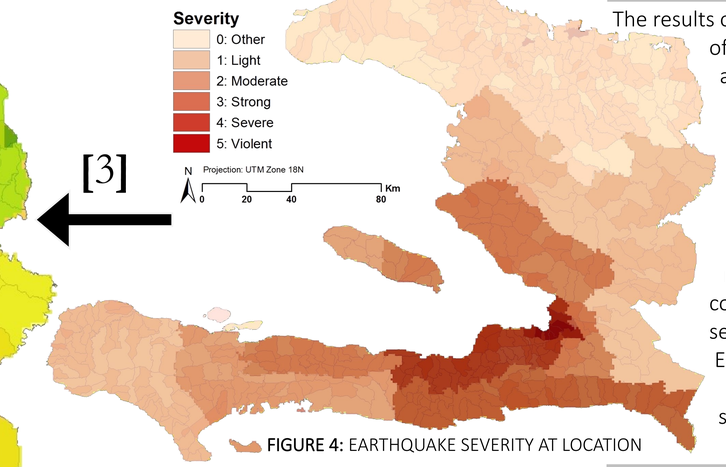


FIGURE 4: EARTHQUAKE SEVERITY AT LOCATION

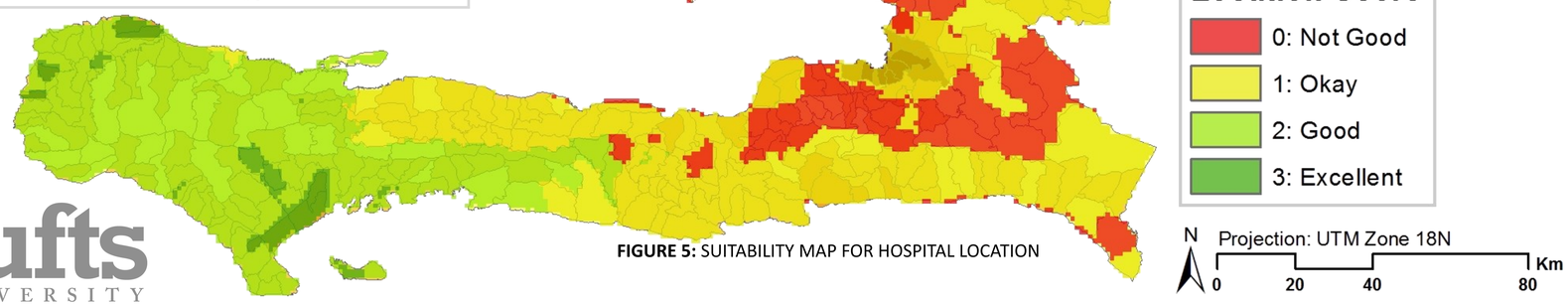


FIGURE 5: SUITABILITY MAP FOR HOSPITAL LOCATION

DISCUSSION

This model represents a method through which emergency relief programs after the 2010 Earthquake in Haiti could provide the most effective and sustainable medical aid. Since the disaster, many hospitals have been constructed, such as Hopital Universitaire de Mirebalais, which was built by Partners in Health in 2013. It is likely that PIH and other relief organizations and non-profits took these criteria into account when deciding where to locate their programs. If newer data was available on hospital status, it could also be beneficial to look at the current status of hospitals in order for this model to be applicable to newer interventions.

The study is limited primarily by the number of included criteria. For instance, while this model includes the original Earthquake Severity, it does not take into account the Earthquake aftershocks, which could cause higher levels of damage in affected regions. Similarly, cholera is a huge health problem for the country of Haiti, and though unrelated to the Earthquake, would realistically be taken into account in these decisions. These omitted variables could vastly change the output. Furthermore, the census data is taken from before the earthquake and thus does not reflect mortalities *or* forced migrations, so population densities would likely be overestimated here.

CONCLUSION

The results of this suitability model highlight the importance of many different criteria in determining hospital access and need across a country with limited health care resources. Although this study concentrates on the impact of the 2010 Earthquake, it has further implications. A suitability map to identify the best place for healthcare resources could be extremely beneficial to many other locations following natural disasters. The methodology used here could realistically be replicated in any number of settings. For instance, in light of the recent Earthquake in Nepal, if medical relief organizations or even the government were use a model similar to this one, it could serve to provide greatly needed aid.

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