Spatiotemporal Analysis of Environmental Cholera Risks in a Haitian Informal Settlement

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Abstract

In the wake of the devastating earthquake that struck Port-au-Prince, Haiti in 2010 is an on-going cholera epidemic. Informal settlements are hit particularly hard by the disease due to increased environmental exposures from crowded housing and lack of sanitation. The lack of infrastructure and dynamic nature of informal settlements necessitates a multi-layered approach to data gathering and problem solving. An in-depth approach to the spatial epidemiology of this outbreak is essential and can be partially achieved by implementing a technique known as Spatial Video. Using GPS-enabled, high-definition cameras, local health workers can film the environment, documenting cholera risks overtime, at a level of detail otherwise unattainable by conventional mapping methods. The resulting information will be digitized in Google Earth and then coded and analyzed in GIS.

Introduction

Fine-scale and longitudinal geospatial analysis of health risks in developing countries is often limited by the lack of spatial data. Conventional mapping methods fall short due to inability to capture enough detail or because they are too resource-intensive to feasibly implement in a dynamic setting. Spatial Video (SV) is one approach to fill this gap. By filming the environment with GPS-enabled video cameras, the SV technique can map all observations to their real-world locations. In this study, SV is used for the assessment of environmental risks for cholera at the street and building level.

Methods and Materials

<u>Study site.</u> Cite Michel is an informal settlement in coastal Port-au-Prince, Haiti and a stronghold for the cholera epidemic. There are 14 water access points that served as the focal point for video collection; nine are clean water and five are dirty drainage water. <u>Study design:</u> Serial cross-sectional audit of the built and social environment. <u>Data collection:</u> SV was used to collect street-level information, including standing water, mud, trash, and presence of animals and people (**Figure 1**). The videos were collected monthly from May – August in 2020. Each water point and the path walked is rated on a scale of one through five for each of the risk factors listed above. A score of one is considered mild or nonexistent and five is severe. <u>Analysis:</u> Data were digitized into Google Earth and then coded and analyzed in ArcGIS (**Figure 2**).

Figure 1. Images of environmental risks changing over time.

Figure 1. Images of three different water points over time. Images A and B show an increase in water and mud at a water pipe; B and C show an increase in trash in a drainage channel; E and F, an increase in trash at the ocean

Figure 2. Digitizing video into risk maps

Figure 2. Video and GPS are synchronized and uploaded into Spatial Video software (developed in house) and environmental risks are identified and pinned on map.

Table 1. Proportions of severe risk scores in each category over time

	Water	Mud	Trash	Activity
May	83	0	100	0
June	10	0	40	0
July	60	20	40	30
August	0	0	0	33

Table 1. Severity scores of 4 and 5 were combined into one category and the proportion of that category against total risk scores calculated.

Results

Video from four different time points, spanning May - August, was analyzed **(Figure 1).** Severity scores of four and five are grouped into a "severe" category and the grouped proportions calculated for each risk category, at each time point. Severe risks are found in variable proportions in each risk category over time; the proportions ranging from 0 – 100 % with the May and July months having the highest proportions of severe risk scores. At each time point, except for August, the risk categories that most frequently exhibited severe scores were water and trash; during the August time point, activity had the greatest proportion of severe scores **(Table 1).**

Figure 3. GPS path and identified risks

Figure 3. Synchronized video and GPS are digitized into Google Earth Pro, then imported into ArcGIS to generate a map of risk locations. All three time points combined to show relative proximity of risks.

Conclusions

The cumulative body of evidence uncovered in this study supports the findings reported in the literature that informal settlements are dynamic and challenging environments that require nuanced mapping techniques. Video captured from the same sites over time shows varying degrees of risk severity. Using SV, risks can be identified, synchronized with GPS, and mapped so as to provide in-depth information about street-level cholera risks **(Figure 3).**

Discussion

The apparent need for on-going surveillance is reinforced by the highly variable severity scores between and within water points over time. While the current analysis is limited to only the summer months of 2020, it clearly reveals the complexity of street-level environmental risks and the need for nuanced mapping to better inform intervention strategies.

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