Links Between Marine Debris and the Prevalence of Zika Virus Disease in the Caribbean: A Case Study in Puerto Rico

Los Vínculos entre los Desechos Marinos y la Prevalencia del Virus de la Enfermedad de Zika En El Caribe : Un Estudio de Caso en Puerto Rico

Les Liens entre les Débris Marins et la Prévalence de Zika Virus de la Maladie dans les Caraïbes: Une Étude de Cas à Puerto Rico

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EXTENDED ABSTRACT

The Gulf and Caribbean Fisheries Institute (GCFI) and UNEP's Regional Coordinating Unit for the Caribbean (CAR/RCU) which establishes the Caribbean node of the GPML, outlined a project proposal framework for high priority small projects to be implemented under a small-scale funding agreement. This current project related to marine litter and the incidence of mosquito-borne public health concerns in the Caribbean region was funded under this proposal framework.

Aedes aegypti a primary vector for several human viral pathogens and viruses, including yellow fever virus, dengue virus, chikungunya virus, and Zika virus is known to inhabit urban environments and breed in artificial water-holding containers (Brown et al. 2014). While links have been well established between human modified terrestrial environments and *Aedes aegypti* habitat (Basso et al. 2016, Chadee and Martinez 2016), few studies have examined the role of the near shore environment and marine debris as potential habitat for *Aedes aegypti* and subsequent role in Zika virus transmission. We mapped the incidence of Zika virus incidence, performed *Aedes aegypti* habitat suitability modeling (Kraemer et al. 2015), and compared these data spatially with marine debris. First these analyses were performed at a Caribbean regional level using public health data from regional health departments, regional habitat suitability models, and marine debris data from the Ocean Conservancy's International Coastal Cleanup Program then at a finer spatial resolution with a more detailed focus on the island of Puerto Rico (Figure 1). Multiple regression models were built around various potential factors of marine debris as well as demographic and environmental factors. To test the hypothesis that marine debris may serve as potential habitat for *Aedes aegypti* and play a role in subsequent in Zika virus transmission we performed a variety of statistical techniques to explore the relationship between large marine debris (debris capable of holding water and providing potential breeding habitat for *Aedes aegypti*) and subsequent Zika incidence. Analysis were performed at the municipality level, with a total of 78 municipalities with available public health data in Puerto Rico. A linear correlation between total amount of large marine debris per mile and Zika Incidence shows a statistically significant positive relationship, Pearson correlation coefficient of .359, *p* value of .001. Additionally, we constructed an OLS (ordinary least squares) linear regression model with geographic weighting. The dependent variable of Zika Incidence, is compared to the potential explanatory variables of; large marine debris, percent of the municipality that is urban, the percent of the municipality that was in poverty, and a digital elevation model (Figure 2). These explanatory variables all show statistical significance and result in an adjusted R squared of .899 or approximately 70% of the deviation from the mean. Residuals were seen to be randomly distributed, however the model run currently includes influencing outliers, these outliers were deemed important to the project as they correspond to the regions of both San Juan (the most populous area on the island), as well as Ponce (the area with the highest incidence as well as high amount of marine debris) we suggest more in depth statistical analysis controlling for outlier effects, as well as finer resolution spatial analysis to corroborate these preliminary findings.

Results suggest a relationship between relative density of large marine debris and Zika incidence in Puerto Rico. While preliminary these analyses advocate that attention should be paid to near shore environments capable of harboring *Aedes aegypti*, especially during summer months when Zika transmission is highest and in areas with endemic disease transmission to reduce potential breeding habitat. While the incidence of mosquito-borne public health concerns such as Zika is complex and multifaceted these results suggest that regions hard hit by Zika may want to prioritize beach cleanup efforts and target large marine debris to reduce potential mosquito habitat. Further work using higher spatially and temporally resolute data is necessary in evaluating the potential link between marine debris and *Aedes aegypti* habitat and subsequent Zika virus transmission.

KEYWORDS: Zika, marine debris, *Aedes aegypti*, public health

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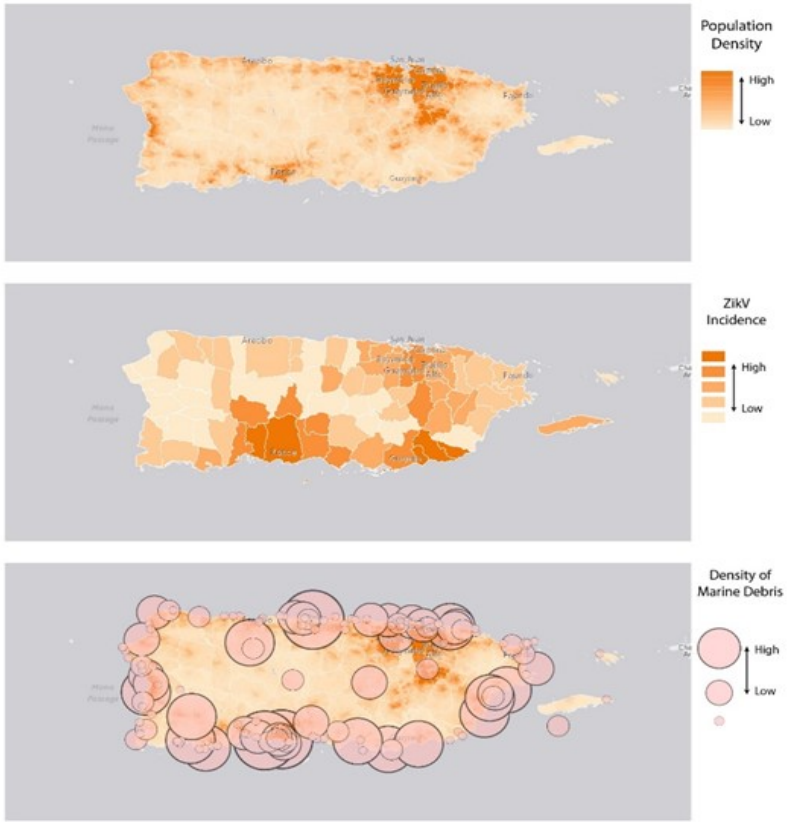

Figure 1. Maps of Puerto Rico and explanatory variables (Population, Zika virus incidence, and Density of Marine Debris).

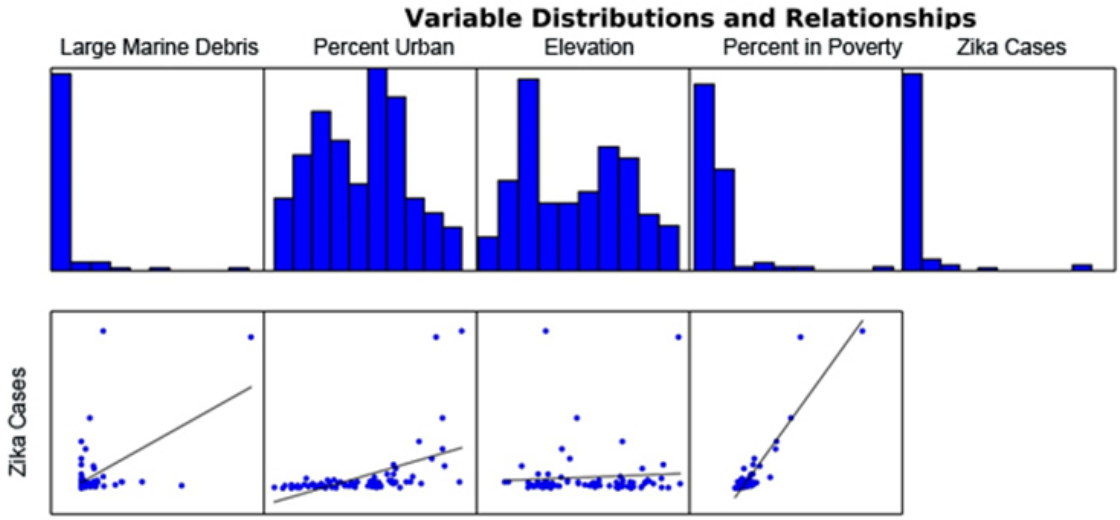

Figure 2. Variable distributions and relationships of (Zika virus incidence and explanatory variables).