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Is Climate Connected with Communicable Diseases?: Assessing and Projecting Climate-Related Infectious Diseases in a Urban Setting in the Philippines

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INTRODUCTION

Based on the Global Climate Risk Index (2019), the Philippines is one of the countries with the highest long-term vulnerability to climate change impacts. Ideally, health surveillance should be available to predict the disease burden expected from the climate-related catastrophes.

This study aimed to:

1. describe the 2010-17 spatio-temporal distribution of climate exposures, dengue, and leptospirosis
2. analyze the association between climate and the above infectious diseases
3. forecast the 2018 temporal trends of climate-related health outcomes

METHODS

This was a two-part ecological study utilizing the United States' Center for Disease Control and Prevention's Building Resilience Against Climate Effects (BRACE) Framework.

Annual health outcomes (dengue and leptospirosis) and climate-related exposure (mean and maximum temperature, relative humidity, and precipitation) data from 2010-17 were collected from a large city in the Philippines. The study used modeling, spatial analysis, and forecasting to answer the study objectives (See Table 1.)

RESULTS

The dengue model suggested that there will be a 2% increase in annual cumulative incidence of dengue per 1.7% increase in annual relative humidity. For the leptospirosis model, we also expected an increase in cumulative incidence for every unit increase in mean or maximum temperature and relative humidity. Meanwhile, accumulated rainfall was expected to have an inverse relationship with the outcome. (Table 2)

The peak months of the disease forecasts were consistent with those of 2010-17. Dengue cases were projected to be significantly less than the previous year while leptospirosis cases showed a slight decrease. (Figures 2A,2B)

For the spatial analysis, the LISA maps showed: (1) a single dengue hotspot with low leptospirosis incidence, and; (2) a leptospirosis hotspot which had low dengue incidence. This means no community has a high burden for both diseases. There is no double-burden in terms of dengue and leptospirosis clustering in Quezon City. (Figure 3)

DISCUSSION

Significant relationships between specific climate indicators and dengue and leptospirosis incidence were established in Quezon City, with leptospirosis significantly clustered across barangays. This study is a proof-of-concept for disease forecasting.

This study emphasizes the need for better climate and health monitoring at high resolutions and more complete longitudinal historical data. It is also imperative that future studies be done to explore the sensitivity of this methodology and the availability of data for public health surveillance.

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	Statistical Modeling	Spatial Analysis	Disease Forecasting
Purpose	To estimate relationships and effect of climate exposure to health outcomes Takes into account data interdependencies	To assess whether there are clusters and outliers in the communities (i.e., possible double burden)	To project the health outcomes for at least 1 year
Techniques Used	Generalized Linear Mixed Model	Spatial Autocorrelation (Global Moran's I), Anselin Local Moran's I (LISA), and Getis-Ord Gi* Hot-spot analysis tests based on fixed distance bands	Seasonal Auto-Regressive Integrated Moving Average (SARIMA) and Support Vector Regression (SVR)

Table 1. Summary of Methods

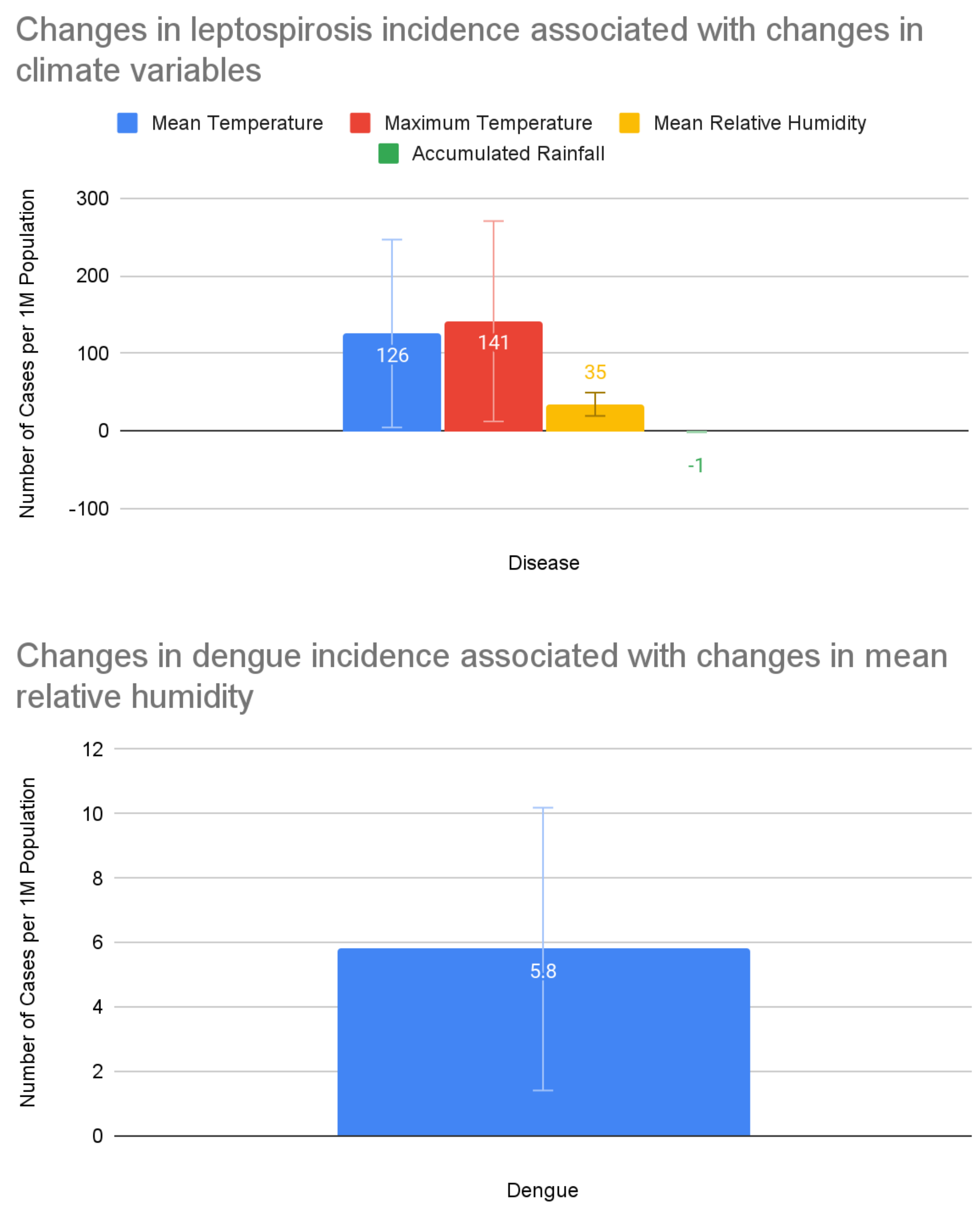

Figure 1. Dengue was only associated with mean relative humidity while leptospirosis was associated with all climate variables.

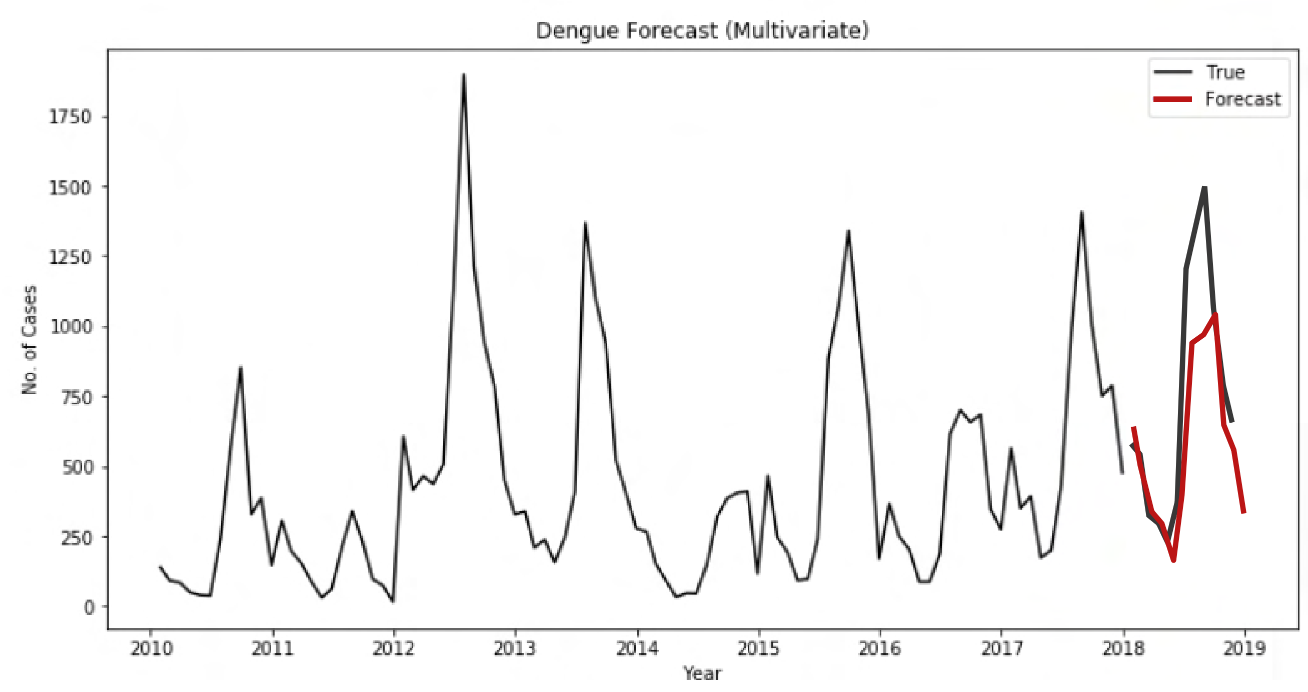

Figure 2. Although the 2018 dengue forecast underestimated the observed values, the seasonal pattern was correctly predicted.

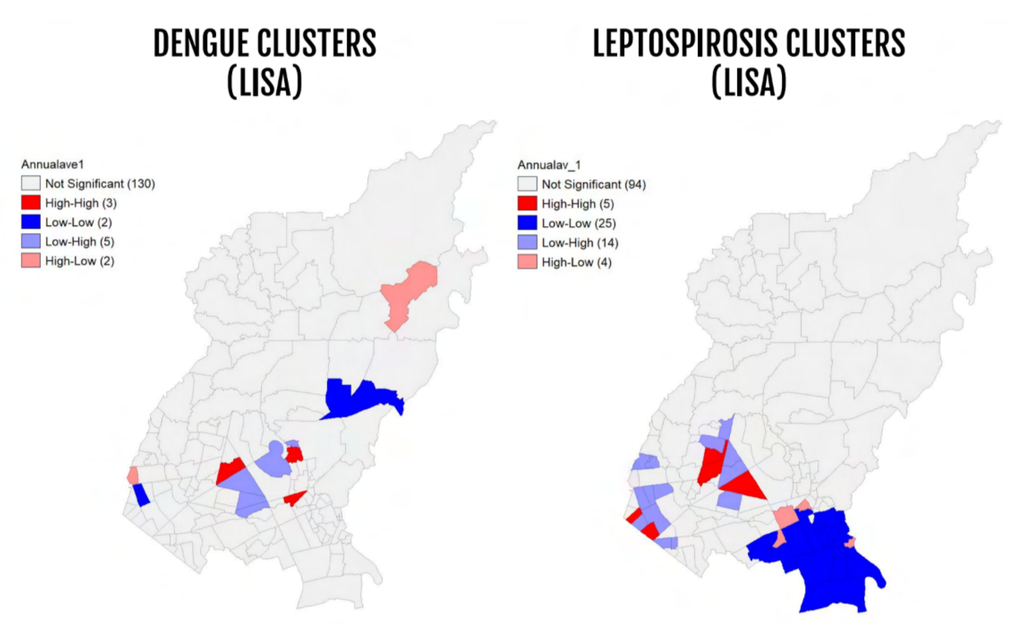

Figure 3. Dengue and leptospirosis LISA maps do not show any communities that have a high incidence of both diseases