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Getting ahead of dengue

by Luis Wilfrido Atienza

Prevalent and dangerous, dengue plagues some 800,000 Filipinos and causes a thousand deaths every year. Researchers from the University of Sto. Tomas (and one from the Vietnam National Space Center) have created a mathematical model that will help predict where an outbreak of dengue is likely to come next. This allows government bodies, and other healthcare units more time to prepare for possible outbreaks, which could prevent a significant number of infections and deaths.

The mathematical model was designed to trace how dengue spreads, figure out when outbreaks are more likely to occur, pinpoint which regions would be most affected by these outbreaks, and show how the prevalence of dengue in these regions can change over time and under different conditions. To do this, the model takes into account different climate factors, which have been known to be important factors in the prevalence of dengue. The model also aims to take into account the effects of climate change, and how these climate factors and change over time because of it by “learning” from old data and using it to refine further predictions.

The prevalence of dengue has been related in a few studies in other countries to temperature and climate change, but each country’s unique conditions make no single model globally applicable. Here the researchers wanted to figure out how the amount of rainfall and the temperature affected the number of dengue cases in Ilocos, Central Luzon, Calabarzon, and Metro Manila, the regions with the highest number of dengue cases in the country.

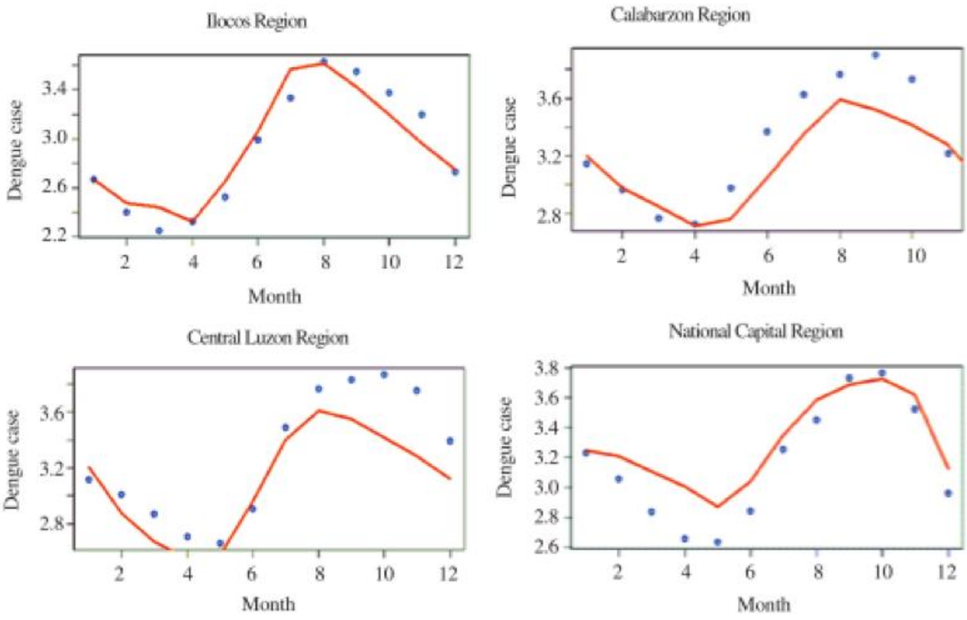
To relate different variables to dengue and to predict dengue prevalence, the researchers used an autoregressive moving average model, or ARIMA. ARIMA was particularly well-suited for this work, because of how it can deal with how different factors interact with one another and how using older events and data points can refine future predictions.

The researchers used climate data from 2008 to 2014 to create their model. They obtained the amount of rainfall in each region over this period from the Global Satellite Mapping of Precipitation (GSMaP) database, a Japan Science and Technology Agency project using satellite data to create a worldwide map of surface rainfall levels.

Land surface temperature data for these regions over the same period came from the Moderate Resolution Image Spectroradiometer (MODIS), a satellite tool used by the National Aeronautics and Space Administration (NASA) to obtain different types of geographical data, such as ocean color, atmospheric temperature, and the properties of clouds and the ozone layer. This data is made publicly available by NASA in a database similar to GSMaP.

With data on the dengue prevalence in these regions from 2008 to 2014, the model found correlations among rainfall, temperature, and dengue prevalence in certain regions at certain times. Using these correlations, the model was able to make predictions about dengue prevalence in these regions.

To put this model to the test, the scientists had it predict the prevalence of dengue for each month of 2015 and compared the results to the actual prevalence of dengue that year.



The model's predicted dengue prevalence (in red) closely predicted the actual dengue prevalence rates (in blue).

The model's predictions for the hypothetical year of 2015 were very close to the actual number of reported dengue cases that year.

By using a model that was heavily based on climate factors and previous climate data to predict the prevalence of dengue in different regions, the researchers showed that climate is indeed a key factor that affects the prevalence of dengue.

Further, showing that data from remote sensing sources such as GSMaP and MODIS can result in accurate predictions, the researchers have illustrated that using archived, publicly available data from sources like these can be a viable option for similar studies. This means that other researchers working on similar projects have more options for their data, without having to rely on time-consuming or expensive data gathering methods. The researchers also created a model tailored to the Philippines, making predictions that much more reliable.

This work opens many further possibilities for advancements in the field. These include refining the model and making it even more accurate, expanding it to include the rest of the country, and having it take into account even more climate factors, and even possibly biological factors relating to mosquito behavior or social factors such as human reactions to dengue.

This model shows how even disciplines like mathematics and statistics can make a difference in helping to prevent the spread of dengue. Efforts like these, all contribute to making dengue infections more manageable, and helping the Philippines get ahead of the disease, making it much more resilient.

REFERENCES

Pineda-Cortel MB, Clemente BM, Nga PT. Modeling and predicting dengue fever cases in key regions of the Philippine using remote sensing data. Asian Pac J Trop Med 2019; 12(2):60–66.

Undurraga EA, Edillo FE, Erasmo JV. Disease burden of dengue in the Philippines: adjusting for underreporting by comparing active and passive dengue surveillance in Punta Princesa, Cebu City. Am J Trop Med Hyg 2017; 96(4):887–98.

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