National Institute of Environmental Health Sciences

El Niño Southern Oscillation and vegetation dynamics as predictors of dengue fever cases in Costa Rica

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Abstract:

Dengue fever (DF) and dengue hemorrhagic fever (DHF) are growing health concerns throughout Latin America and the Caribbean. This study focuses on Costa Rica, which experienced over 100 000 cases of DF/DHF from 2003 to 2007. We utilized data on sea-surface temperature anomalies related to the El Niño Southern Oscillation (ENSO) and two vegetation indices derived from the Moderate Resolution Imaging Spectrometer (MODIS) from the Terra satellite to model the influence of climate and vegetation dynamics on DF/DHF cases in Costa Rica. Cross-correlations were calculated to evaluate both positive and negative lag effects on the relationships between independent variables and DF/DHF cases. The model, which utilizes a sinusoid and non-linear least squares to fit case data, was able to explain 83% of the variance in weekly DF/DHF cases when independent variables were shifted backwards in time. When the independent variables were shifted forward in time, consistently with a forecasting approach, the model explained 64% of the variance. Importantly, when five ENSO and two vegetation indices were included, the model reproduced a major DF/DHF epidemic of 2005. The unexplained variance in the model may be due to herd immunity and vector control measures, although information regarding these aspects of the disease system are generally lacking. Our analysis suggests that the model may be used to predict DF/DHF outbreaks as early as 40 weeks in advance and may also provide valuable information on the magnitude of future epidemics. In its current form it may be used to inform national vector control programs and policies regarding control measures; it is the first climate-based dengue model developed for this country and is potentially scalable to the broader region of Latin America and the Caribbean where dramatic increases in DF/DHF incidence and spread have been observed.

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Resource Description

Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other elements of climate change to prevent harm to health

A focus of content

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Precipitation, Temperature

Temperature: Fluctuations

Geographic Feature: ☒

resource focuses on specific type of geography

Tropical

Geographic Location: ☒

resource focuses on specific location

Non-United States

Non-United States: Non-U.S. North America

Health Impact: ☒

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: Dengue

Mitigation/Adaptation: ☒

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ☒

type of model used or methodology development is a focus of resource

Outcome Change Prediction

Resource Type: ☒

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content