CASE STUDY 4F

PREDICTING THE IMPACTS OF CLIMATE ON DENGUE IN BRAZIL: INTEGRATED RISK MODELLING AND MAPPING

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Research

Product and service development

CONTEXT

Dengue fever represented 83% of the cases of diseases with mandatory notification in Brazil from 2007-10. This caused estimated losses of about US$ 880 million in 2010 *(17)*, with approximately one-quarter comprising direct costs, and the remainder as indirect/productivity losses. Dengue is transmitted by female *Aedes aegypti* mosquitoes and the cycle, reproduction and survival of mosquitoes are highly dependent on weather conditions. This study tests the role of climate on the risk of dengue in Brazil. Its climate variability makes Brazil an interesting setting for this study.

NEW APPROACHES

We propose a dengue risk model based on determinants of the disease, in order to control for other variables. The determinants of dengue (d) can be sub-divided into four groups *(18)*: environment (climate, C; vegetation, V; and spatial contagious, d_j), socio-demography (mainly income, P; education, E; and sanitary conditions, S), medical factors (local investments in eradication, M) and local history of the disease (previous notifications of dengue, d^(t-1)). The relevant climatic conditions for dengue vector survival and reproduction are: mild average temperature; sufficient humidity to regulate the temperature of mosquitoes; and a reasonable amount of precipitation for the deposit of eggs (although large amounts of rain may have the reverse effect). The risk model for dengue is:

$$d_i = g(d_i^{t-1}, d_j, M_i, E_i, f(C_i), F_i, S_i, P_i, V_i), \forall i,j = 1,\ldots,N \text{ and } i \neq j,$$

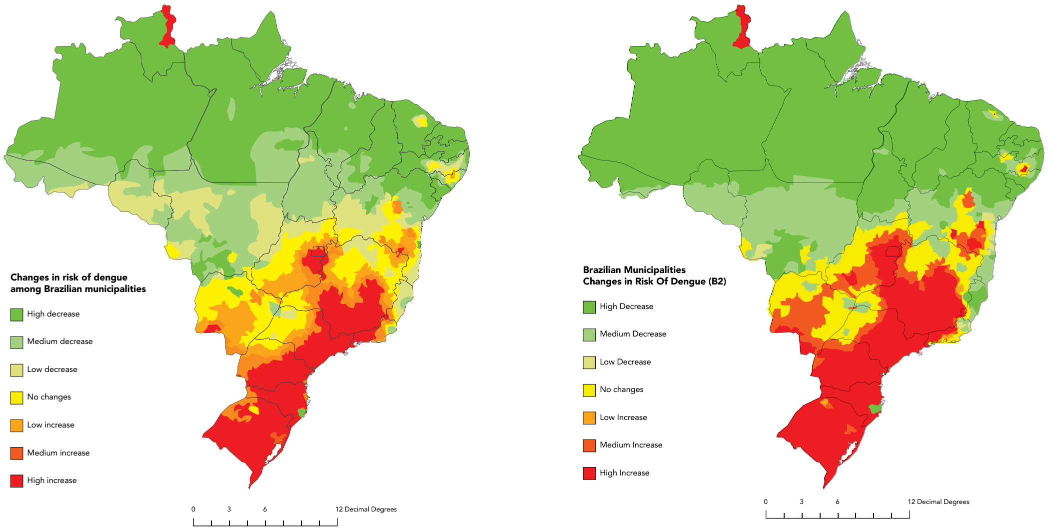
where i,j identifies Brazilian municipalities. The function can be estimated using count data models *(19)*.

The period analysed was 2010 and data sources were: SINAN (dengue notifications); National Demographic Census (socio-demographic variables); National Treasury (local investments in health); Brazilian Ministry of Health (health information); US National Aeronautics and Space Administration (NASA) and IRI Data Library (Normalized Differenced Vegetation Index); National Meteorology Institute (monthly historical climate measures: temperature, relative humidity and rainfall); and Centro de Previsão de Tempo e Estudos Climáticos (CPTEC), Instituto Nacional de Pesquisas Espaciais (INPE) (climate predictions). For all the climatic variables, average data over the seasons were created and sub-divided into two groups: 30-year average climatic conditions, $E(C_{1980\text{-}2009})$; and deviation from climatic conditions, $C_{2010} - E(C_{1980\text{-}2009})$.

BENEFITS AND LESSONS

The climate variables showed statistical relevance to explain the risk of dengue in Brazil. Moreover, if climate change occurs as expected, the results suggest a potential added risk for central–southern areas in Brazil and a risk reduction for northern areas of the country, which can be seen in the maps below (Figure 4.10):

Figure 4.11 Projected changes in dengue risk due to climate change, 2040–69 (left) and 2070–99 (right), Brazil, Scenario B2. High reduction: < -80%; Medium reduction: from -80% to -40%; Low reduction: -40% to -2%; No change: -2% to 2%; Low increase: 2% to 40%; Medium increase: 40% to 80%; High increase: > 80%.



The 3-month predictions from the Instituto Nacional de Meteorologia (INMET) and Instituto Nacional de Pesquisas Espaciais (INPE) could also be used to forecast dengue cases for the next season. The use of precise climate data must be emphasized in order to obtain accurate forecasts. Figure 4.11 shows the model as used to identify the spatial vulnerability index for dengue, based on socioeconomic conditions and average climate in Brazil.

ACKNOWLEDGEMENTS

Figure 4.12 Dengue vulnerability ratio among Brazilian municipalities. predicted by the Poisson model, 2010.