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Dengue epidemic early warning system for Brazil

The problem

Brazil has reported more cases of dengue fever than anywhere else in the world this century[1]. Many cities have tropical and sub-tropical climate conditions that allow the dengue mosquito to thrive during warmer, wetter and more humid months, particularly in densely populated urban areas. Dengue epidemics depend on mosquito abundance, virus circulation and human susceptibility. In order to prepare for dengue epidemics, early warning systems, which take into account multiple dengue risk factors, are required to implement timely control measures. Seasonal climate forecasts provide an opportunity to anticipate dengue epidemics several months in advance.

The science

A new predictive model framework for climate-sensitive diseases was developed[2-4] as part of the Leverhulme network project EUROBRISA[5] (led by the University of Exeter and the Brazilian Centre for Weather Forecast and Climate Studies, CPTEC), which explored how European seasonal climate forecasts could be better exploited to improve climate resilience in South America[6]. In collaboration with European and Brazilian climate services, Universities and the Brazilian Climate and Health Observatory, data from different sources and spatial/temporal scales (e.g. dengue, climate, cartographic, demographic, socio-economic) was collated to formulate the model, which produces probabilistic dengue predictions for the 553 microregions of Brazil. By assessing the past performance of the model, optimum trigger alert thresholds are identified to maximise "successful prediction" and minimise "false alarms" for scenarios of medium-risk and high-risk of dengue, according to incidence alert levels defined by the Ministry of Health.

The application to policy and practice

The model was applied to predict the risk of dengue during the 2014 World Cup in Brazil, a mass gathering of more than 3 million Brazilian and international spectators[7]. The timely production of the forecast relied on close collaboration between public health specialists, climate scientists, and mathematical modellers to incorporate real-time seasonal climate forecast and epidemiological data into the model framework several months ahead of the event (Fig. 1) and effectively present model results into an understandable format for stakeholders (Fig. 2).

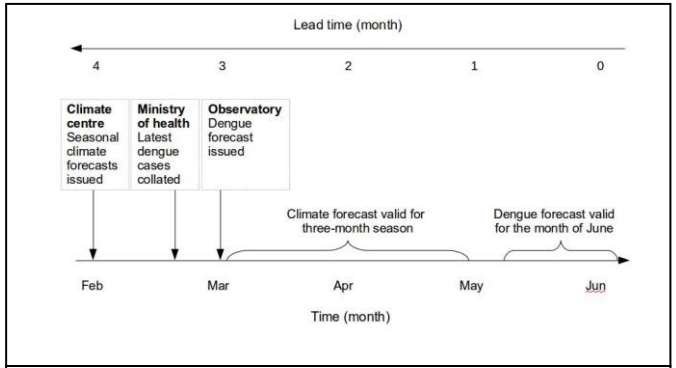

Figure 1: Dengue forecast lead-time schematic. *Source:* Lowe *et al.*[8]

According to the model, the most likely scenario for all twelve cities was for low risk. However, there was a greater probability of outbreaks in the north-eastern cities of Natal, Fortaleza and Recife[8]. Along with the forecast, decision makers were provided with an assessment of past performance of the model. Over the last 14 years (2000-2013) the early warning system performed better than the long-term average distribution in all twelve World Cup host venues, particularly in the northeast region.

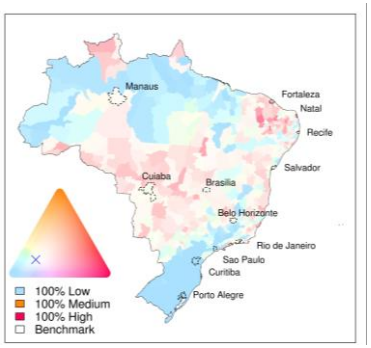

Figure 2: Probabilistic dengue forecast for Brazil, June, 2014. *Source:* Lowe *et al.*[8]

Did it make a difference?

This timely dengue early warning assisted the Ministry of Health and local authorities in implementing appropriate, city-specific mitigation and control actions up to three months ahead of the World Cup. The early warnings were also disseminated to the general public and visitors travelling to Brazil. For example, the predictions were incorporated into the European Centre for Disease Control (ECDC) health risk assessment[9], reported by the UK National Health Service (NHS)[10] and published by more than 18 international press outlets, including the BBC[11]. Therefore, this study further contributed by raising general awareness about dengue fever and the risk of contracting the disease when travelling to endemic regions.

As the games took place during the southern-hemisphere winter, the risk was expected to be relatively low compared to summer[12]. Overall reported dengue cases for 2014 were lower than the previous year[13], although some outbreaks were observed in the southeast and northeast regions. At the time of writing, the case data at the microregion level is still being compiled in order to fully evaluate the June 2014 forecast.

To our knowledge, this is the first example of a climate service for public health, ahead of a major global event. This framework may be useful, not only ahead of mass gatherings, but also before the peak dengue season each year, to control or contain potentially explosive dengue epidemics. The operational use of seasonal climate forecasts in routine dengue early warnings is now a priority for the Brazilian Climate and Health Observatory[14], in collaboration with the Brazilian Space Agency (INPE).

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