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Towards a climate-driven dengue decision support system for Thailand

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Dengue is a peri-urban mosquito-transmitted disease, ubiquitous in the tropics and the subtropics. The geographic distribution of dengue and its more severe form, dengue haemorrhagic fever (DHF), have expanded dramatically in the last decades and dengue is now considered to be the world's most important arboviral disease. Recent demographic changes have greatly contributed to the acceleration and spread of the disease along with uncontrolled urbanization, population growth and increased air travel, which acts as a mechanism for transporting and exchanging dengue viruses between endemic and epidemic populations. The dengue vector and virus are extremely sensitive to environmental conditions such as temperature, humidity and precipitation that influence mosquito biology, abundance and habitat and the virus replication speed. In order to control the spread of dengue and impede epidemics, decision support systems are required that take into account the multi-faceted array of factors that contribute to increased dengue risk. Due to availability of seasonal climate forecasts, that predict the average climate conditions for forthcoming months/seasons in both time and space, there is an opportunity to incorporate precursory climate information in a dengue decision support system to aid epidemic planning months in advance. Furthermore, oceanic indicators from teleconnected areas in the Pacific and Indian Ocean, that can provide some indication of the likely prevailing climate conditions in certain regions, could potentially extend predictive lead time in a dengue early warning system.

In this paper we adopt a spatio-temporal Bayesian modelling framework for dengue in Thailand to support public health decision making. Monthly cases of dengue in the 76 provinces of Thailand for the period 1982-2012 are modelled using a multi-layered approach. Environmental explanatory variables at various spatial and temporal resolutions are incorporated into a hierarchical model in order to make spatio-temporal probabilistic predictions of dengue. In order to quantify unknown or unmeasured dengue risk factors, we use spatio-temporal random effects in the model framework. This helps identify those available indicators which could significantly contribute to a dengue early warning system and allows us to quantify the extent to which climate indicators can explain variations in dengue risk. Once accounting for spatial-temporal confounding factors, lagged variables of temperature and precipitation were found to have a statistically significant positive contribution to the relative risk of dengue. Therefore, forecast climate information has potential utility in a dengue decision support system for Thailand. Taking advantage of lead times of several months provided by climate forecasts, public health officials may be able to more efficiently allocate intervention measures, such as targeted vector control activities and provision of medication to deal with more deadly forms of the disease, well ahead of an imminent dengue epidemic.