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A spatiotemporal dengue fever early warning model accounting for nonlinear associations with meteorological factors: a Bayesian maximum entropy approach

Chieh-Han Lee (1), Hwa-Lung Yu (1), and Lung-Chang Chien (2)

(1) Department of Bio-environmental system engineering, National Taiwan University, Taipei, Taiwan (hlyu@ntu.edu.tw), (2) Division of Biostatistics, University of Texas School of Public Health at San Antonio Regional Campus; Research to Advance Community Health Center, University of Texas Health Science Center at San Antonio Regional Campus, U.S.A. (chienorz@gmail.com)

Dengue fever has been identified as one of the most widespread vector-borne diseases in tropical and sub-tropical. In the last decade, dengue is an emerging infectious disease epidemic in Taiwan especially in the southern area where have annually high incidences. For the purpose of disease prevention and control, an early warning system is urgently needed. Previous studies have showed significant relationships between climate variables, in particular, rainfall and temperature, and the temporal epidemic patterns of dengue cases. However, the transmission of the dengue fever is a complex interactive process that mostly understated the composite space-time effects of dengue fever. This study proposes developing a one-week ahead warning system of dengue fever epidemics in the southern Taiwan that considered nonlinear associations between weekly dengue cases and meteorological factors across space and time. The early warning system based on an integration of distributed lag nonlinear model (DLNM) and stochastic Bayesian Maximum Entropy (BME) analysis. The study identified the most significant meteorological measures including weekly minimum temperature and maximum 24-hour rainfall with continuous 15-week lagged time to dengue cases variation under condition of uncertainty. Subsequently, the combination of nonlinear lagged effects of climate variables and space-time dependence function is implemented via a Bayesian framework to predict dengue fever occurrences in the southern Taiwan during 2012. The result shows the early warning system is useful for providing potential outbreak spatio-temporal prediction of dengue fever distribution. In conclusion, the proposed approach can provide a practical disease control tool for environmental regulators seeking more effective strategies for dengue fever prevention.