ESTIMATES OF SEASONAL PROBABILITY OF DISEASE OUTBREAKS IN STOCHASTIC MOSQUITO- AND WATER-BORNE EPIDEMIC MODELS

Simon A. Levin Mathematical, Computational and Modeling Sciences Center
Distinguished Lecture
School of Mathematical and Statistical Sciences Math Biology Seminar

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SCOB 101

Seasonal changes in temperature, humidity, and rainfall impact pathogen and vector survival which are reflected in the seasonal patterns of vector-borne and water-borne disease outbreaks. Dengue, a mosquito-borne disease, and cholera, a water-borne disease, are subject to strong seasonal patterns of disease outbreaks in various regions of the world. Studies of deterministic and stochastic epidemic models have investigated long-term seasonal patterns. We extend these studies to investigate the probability of a disease outbreak at a given time during the season using dengue and cholera stochastic models with demographic and seasonal variability. In the stochastic model for dengue, adult vectors emerging from the larval stage vary seasonally and in cholera, direct transmission and indirect environmental transmission rates vary seasonally. A multitype branching process approximation of the stochastic models near the disease-free periodic solution is used to calculate the probability of a disease outbreak. This approximation provides a periodic probability of a disease outbreak that depends on the strength of seasonality and the number of initially infected individuals. Numerical examples illustrate that seasonality in epidemic models can drive the patterns of disease outbreaks and that the combined effects of demographic and seasonal variability provide a better understanding of the risk of dengue and cholera outbreaks. This is joint work with Kaniz Fatema Nipa, Sophia Jang, and Xueying Wang.

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