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Modeling and Dynamics of Mosquito Population and Transmission of Mosquito-borne Diseases

Vector mosquitoes and mosquito-borne diseases (MBDs) have become a severe burden of the public health. For prevention and control, it is essential to understand the triggers and mechanisms of an outbreak and repeated infestations. In this short course, I will first introduce some models for the population dynamics of vector mosquitoes. Compartmental models are used to study the transmission dynamics of MBDs. Dynamical system and bifurcation theory, and geometrical singular perturbation approach will be used to study the dynamics of the models to answer the two questions mathematically. I will present the local stability and lower codimension bifurcations to explain the triggering conditions for an outbreak and mechanisms for repeated outbreaks. I will also explain the global stability, existence, and non-existence of periodic solutions, multi-scale dynamics of the models, and the challenge of the study by connecting to Hilbert's 16th problem. In the end, I will show our predictive modeling studies based on the surveillance data for weekly real-time forecasting of mosquito abundance and risk of West Nile virus in five regions of the Greater Toronto Area.