“Mathematics of Vector-borne Diseases”

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Abstract

Vector-borne diseases (VBDs), such as malaria, dengue, Lyme disease, leishmaniasis, and West Nile virus, constitute over 17% of all infectious diseases of humans, causing in excess of 1 million deaths annually (with malaria alone accounting for about 600,000 of these deaths, mostly in children under the age of five in malaria-endemic areas). These vectors are typically controlled using insecticide-based control methods, and their lifecycle (and those of the pathogens they vector) are greatly affected by changes in local climatic conditions, such as temperature, precipitation, and humidity. Although much progress has been recorded in the battle against several VBDs, particularly malaria, over the last few decades (prompting a renewed quest for malaria eradication, for instance), these efforts are unfortunately threatened by several factors, such as widespread resistance to the currently-available insecticides used in vector control, evolution of drug resistance, changes in local climatic conditions (which affect all aspects of the lifecycle stages of the vectors), land-use changes, emergence of invasive species, human mobility (rural-urban migration), and quality of public health infrastructure and care. I will discuss some of these advances and challenges associated with the mathematical modeling and analysis of the transmission dynamics of VBDs, using malaria and possibly Lyme disease as case studies. One of the key questions to address is whether or not anthropogenic climate change will lead to a range expansion or a shift of the vectors to new areas. Furthermore, the potential effectiveness of alternative biocontrol/genetic approaches (such as sterile insect technique) on controlling the population abundance of the disease vectors will be discussed.