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Design and Implementation of Integrated Surveillance and Modelling Systems for Climate-Sensitive Diseases

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Abstract: Climatic variations can have a multitude of impacts on human health, ranging from the direct impacts of extreme heat events to indirect effects on the vectors and hosts that transmit a multitude of infectious diseases. Infectious disease surveillance has traditionally focused on monitoring human cases, and in some instances tracking population sizes and infection rates of arthropod vectors and zoonotic hosts. For climate-sensitive diseases, there is potential to strengthen surveillance and obtain early indicators of future outbreaks by monitoring environmental risk factors using broad-scale sensor networks that include earth-observing satellites as well as ground stations. We highlight the opportunities and challenges of this integration by presenting lessons learned from two projects focused on surveillance and forecasting of mosquito-borne diseases. The goal of the EPIDEMIA project is to integrate malaria case surveillance with remotely-sensed environmental data for early detection of malaria epidemics in the Ethiopian highlands. The SDMIS project similarly combines entomological surveillance with environmental monitoring to generate up-to-date risk maps for West Nile virus in the north-central United States. Despite important differences in disease ecology and geographic setting, the results from these projects highlight several important lessons learned that can inform future efforts. These include the critical role of automated workflows to facilitate timely integration data from multiple sensor networks encompassing a range of spatial and temporal scales, the need for effective models to simplify complex epidemiological systems and translate observations into disease risk indicators, and the importance of focused visualizations that synthesize these results for public health end users.

***Keywords**:* Disease surveillance; environmental monitoring; epidemic forecasting; malaria; West Nile virus.