Dynamic Transmission Modeling Framework

Plasmodium vivax Distribution - Modeled and Observed Prevalence

Plasmodium falciparum Distribution - Modeled and Observed Sporozoite Rates

Example: A Small Hamlet - Modeled and Observed Prevalence
Modeled and Observed Entomological Inoculation Rates

Sensitivity Studies and Simulations Performed
Using Agent-Based Disease Event Simulation Models
- Abundance of animal habitats
- Access to healthcare and appropriate treatment
- Asymptomatic cases
- Age-related immunity
- Active and passive case detection
- vector or personal protections
- Improved dwelling conditions
- Parameter sensitivity or interactions
- Zoonotic prophylaxis
- Annual or non-continuous populations (e.g., migrant workers, refugees, foreign military ventures)

Well Paved Farm Animal Sheds and Zoonotic Prophylaxis May Significantly Reduce Malaria Transmission

Bednets, Personal Protection and Improved Dwelling Significantly Reduce Malaria Transmission

Thank you!
Surveillance and Control of Malaria Transmission in Thailand Using Remotely Sensed Meteorological and Environmental Parameters

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At 4,200 km, the Mekong River is the tenth longest river in the world. It directly and indirectly influences the lives of hundreds of millions of inhabitants in its basin. The riparian countries form the Greater Mekong Subregion. This geographical region has been the world’s epicenter of falciparum malaria. Depending on the country, approximately 50 to 90% of all malaria cases are due to this species.

In the Malaria Modeling and Surveillance Project, which is part of the NASA Applied Sciences Public Health Applications Program, we have been developing techniques to enhance public health’s decision capability for malaria risk assessments and controls. The main objectives are: 1) identification of the potential breeding sites for major vector species; 2) implementation of a risk algorithm to predict the occurrence of malaria and its transmission intensity; 3) implementation of a dynamic transmission model to identify the key factors that sustain or intensify malaria transmission. The potential benefits are: 1) increased warning time for public health organizations to respond to malaria outbreaks; 2) optimized utilization of pesticide and chemoprophylaxis; 3) reduced likelihood of pesticide and drug resistance; and 4) reduced damage to environment.

Environmental parameters important to malaria transmission include temperature, relative humidity, precipitation, and vegetation conditions. The NASA Earth science data sets that have been used for malaria surveillance and risk assessment include AVHRR Pathfinder, TRMM, MODIS, NSIPP, and SIESIP.

Textural-contextual classifications are used to identify small larval habitats. Neural network methods are used to model malaria cases as a function of the remotely sensed parameters. Hindcastings based on these environmental parameters have shown good agreement to epidemiological records. Discrete event simulations are used for modeling the detailed interactions among the vector life cycle, sporogonic cycle and human infection cycle, under the explicit influences of selected extrinsic and intrinsic factors. The output of the model includes the individual infection status and the quantities normally observed in field studies, such as mosquito biting rates, sporozoite infection rates, gametocyte prevalence and incidence. Results are in good agreement with mosquito vector and human malaria data acquired by Coleman et al. over 4.5 years in Kong Mong Tha, a remote village in western Thailand.

Application of our models is not restricted to the Greater Mekong Subregion. Our models have been applied to malaria in Indonesia, Korea, and other regions in the world with similar success.