Surveillance and Control of Malaria Transmission in Thailand using Remotely Sensed Meteorological And Environmental Parameters

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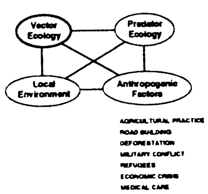
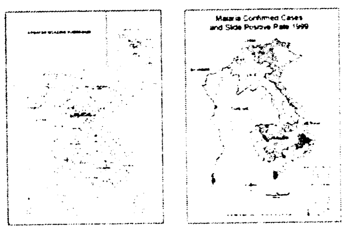
- Dr. Jetsumon Sattabongkot

OBJECTVES		BENEFITS
Detection of larval habitats *Textural-contextual classification*	→	Applying larval control as a preventive measure
Prediction of current and future endemicity *Neural network methods*	→	Strengthening and mobilizing public health support
Identification of key factors that sustain or promote transmissions *Agent-based discrete event simulation*	→	Cost-effectively curtailing malaria transmission

Meteorological & Climatological Parameters



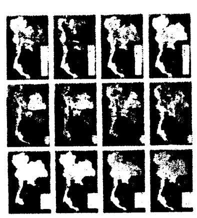
The Greater Mekong Subregion is the world's epicenter of multi-drug resistant falciparum malaria.



Detection of Ditches using Pan-sharpened Ikonos Data

(Larval Habitats of *Anopheles sinensis* in Korea)

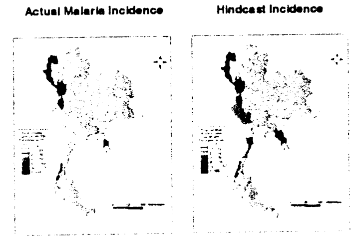
Satellite-Observed Meteorological & Environmental Parameters For Four Thailand Seasons

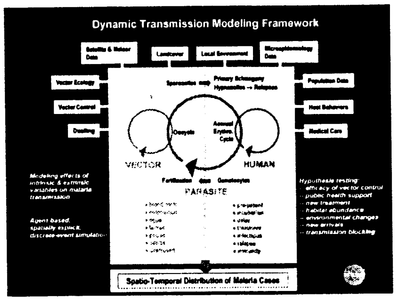


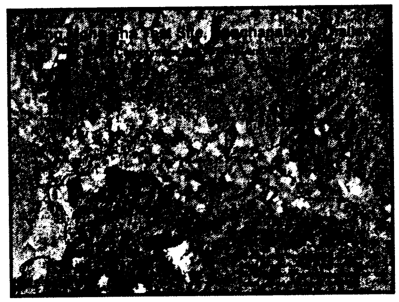
Surface Temperature
MODIS Measurements

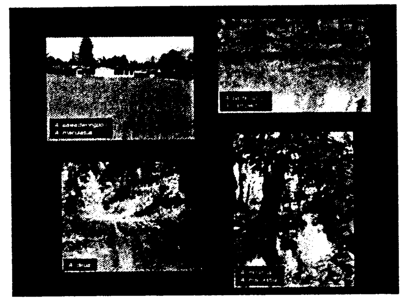
Vegetation Index
AVHRR & MODIS Measurements

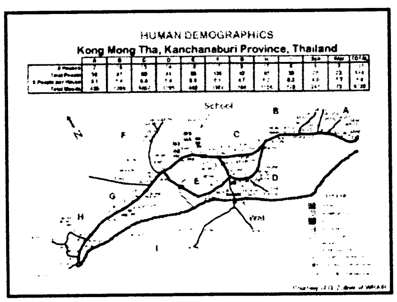
Rainfall
TRMM Measurements

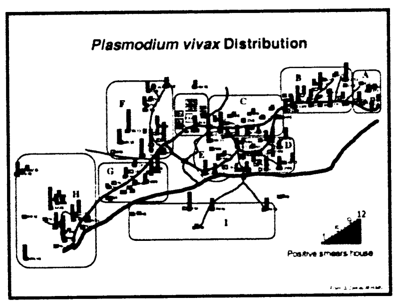


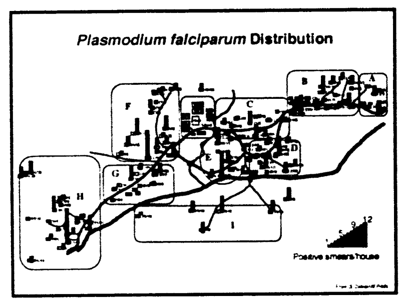

Dynamic Transmission Modeling Framework
VECTOR
HUMAN
PARASITE
Spatio-Temporal Distribution of Malaria Cases

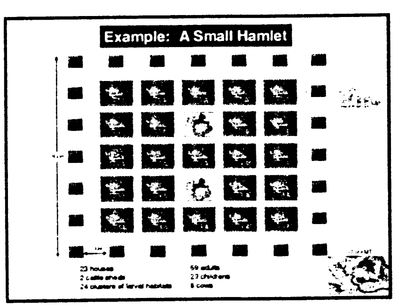


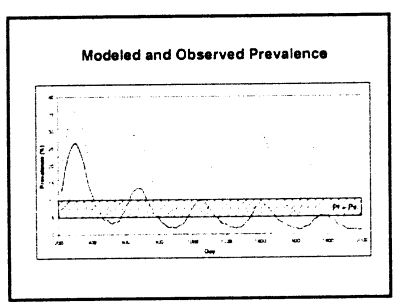


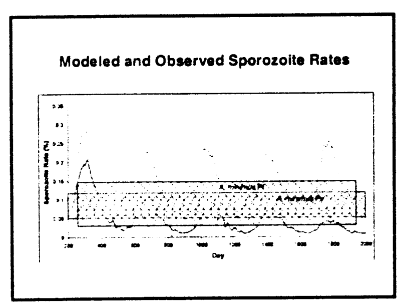

HUMAN DEMOGRAPHICS
Kong Mong Tha, Kanchanaburi Province, Thailand
School
Wat


Plasmodium vivax Distribution
Positive smears/house


Plasmodium falciparum Distribution
Positive smears/house

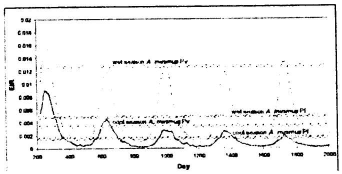

Example: A Small Hamlet


Modeled and Observed Prevalence
Day

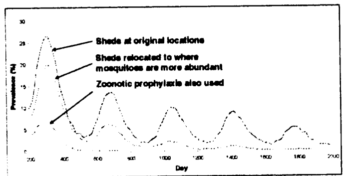

Modeled and Observed Sporozoite Rates
Day

Modeled and Observed Entomological Inoculation Rates

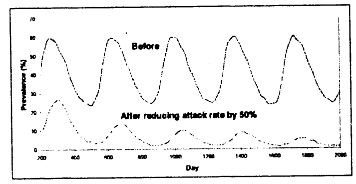
(number of infective bites / person / day)



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



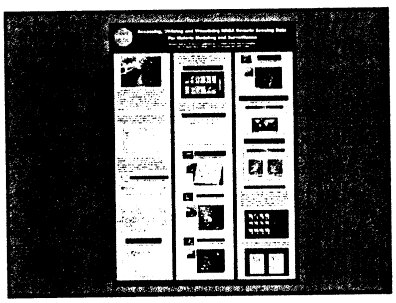
Bednets, Personal Protections and Improved Dwelling Significantly Reduce Malaria Transmission



Sensitivity Studies and Simulations Performed

Using Agent-Based Discrete Event Simulation Model

- Abundance of larval habitats
- Access to health care and appropriate treatment
- Asymptomatic cases
- Acquired immunity
- Active and passive case detections
- Bednets or personal protections
- Improved dwelling construction
- Parasite infectivity in mosquitoes
- Zoonotic prophylaxis
- Arrival of non-immune populations (e.g., migrant workers, refugees, foreign military forces)



Thank you!

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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.