**Malaria Modeling and Surveillance in Thailand and Indonesia**

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**Meteorological & Climatological Parameters**

- Vector Ecology
- Predator Ecology
- Anthropogenic Factors
- Local Environment

**NASA’s Earth Observing System**

**THE PROBLEM**

- 40% of the world’s populations at risk
- 300-500 million cases per year
- 1-3 million deaths per year
- Highest risks for children, pregnant women, and people with depressed immunoresponse
- One death every 30 seconds
- Counterfeit and substandard antimalarial drugs abound
- ACT is becoming less sensitive
- Previously unaffected regions may have outbreaks due to climate change

**OBJECTIVES**

- Risk detection
  - Detection of larval habitats
  - Textural-contextual classification
- Risk prediction
  - Prediction of current and future endemicity
    - Neural network methods
- Risk reduction
  - Identification of key factors that sustain or promote transmissions
    - Agent-based discrete event simulation

**BENEFITS**

- Applying larval control as a preventive measure
- Strengthening and mobilizing public health support
- Cost-effectively curtailing malaria transmission

**In Collaboration With**

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[Image links]  
https://ntrs.nasa.gov/search.jsp?R=20090006631 2019-06-15T05:03:58+00:00Z
The Greater Mekong Subregion is the world’s epicenter of multi-drug resistant falciparum malaria.

Most Thai provinces endemic with malaria are border provinces.

40% of the 245M Indonesians Live in Malarious Regions

Malaria incidence in Aceh increased significantly after the Tsunami Disaster in December 2004

Detection of ditches using Pan-sharpened Ikonos Data
Classification Accuracy using Pan-Sharpened Ikonos Data (1 meter resolution)

Satellite-Observed Meteorological & Environmental Parameters For Four Thailand Seasons

Surface Temperature MODIS Measurements
Vegetation Index AVHRR & MODIS Measurements
Rainfall TRMM Measurements

Actual Malaria Incidence
Hindcast Incidence

Dynamic Transmission Modeling Framework

Kong Mong Tia Test Site, Kanchanaburi, Thailand
In Collaboration with AFRIMS and WRAIR

Malaria Surveillance Study (Jun 99 – Jan 04)
Blood films from ~450 persons/month
Microscopy and Polymerase Chain Reaction
Larval and adult mosquito collection

In Collaboration with AFRIMS and WRAIR

A. dirus
A. minimus
A. maculatus
A. barbirostris
A. campestris
A. sawadwongpori
A. maculatus
Example: A Small Hamlet

- 23 houses
- 2 cattle sheds
- 24 clusters of larval habitats
- 69 adults
- 23 children
- 8 cows

600m
100m

Modeled and Observed Prevalence

Modeled and Observed Sporozoite Rates

Modeled and Observed Entomological Inoculation Rates

Well Placed Farm Animal Sheds and Zoonotic Prophylaxis May 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 (such as migrant workers, refugees, foreign military forces)
With over 18,000 islands and a decentralized government, it is challenging to implement malaria control policy.

Rainfall Pattern, Which Drives Malaria Transmission, Varies Significantly from Island to Island

Average Monthly Precipitation for the Major Cities on the 8 Islands 2000-2005

Precipitation Based on TRMM Measurements

Hindcasting Malaria Cases in Jawa Tengah, Indonesia
Actual (red), Modeled (blue), and Hindcast (green) Malaria Cases

Districts Involved in Menoreh Hills Project
— A MOH-WHO-NAMRU2-USAID Collaboration

Comparison of Kulong Progo and Purworejo ACD Cases (blue) with Jawa Tengah PCD Cases (red)
Thank you!