Malaria Modeling and Surveillance In Thailand and Indonesia

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Meteorological & Climatological Parameters

Vector Ecology
Predator Ecology

Local Environment
Anthropogenic Factors

AGRICULTURAL PRACTICE
ROAD BUILDING
DEFORESTATION
MILITARY CONFLICT
REFUGEE
ECONOMIC CRISIS
MEDICAL CARE

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.

NASA’s Earth Observing System

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

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

40% of the 245M Indonesians Live in Malarious Regions

Malaria Incidence in Aceh Increased Significantly After the Tsunami Disaster in December 2004

Most Thai provinces endemic with malaria are border provinces.

Collecting larvae, mosquitoes, and blood samples.

Detection of Ditches using Pan-sharpened Ikonos Data (Larval Habitats of Anopheles sinensis in Korea)
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

Satellite & Remote
- Land Use
- Local Environment
- Weather
- Population Data
- Vector Biology
- Weather
- Land Use
- Local Environment
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- Land Use

Kong Mong Tha Test Site, Kanchanaburi, Thailand

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. minitus
A. maculatus
A. barbirostris
A. campestis
A. sawadwongpori
A. maculatus
Example: A Small Hamlet

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

Modeled and Observed Prevalence

\[ Pf + PV \]

Modeled and Observed Sporozoite Rates

\[ A. minimus \]

Modeled and Observed Entomological Inoculation Rates

(wet season)

\[ A. minimus \]

(wet season)

\[ A. minimus \]

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!

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