**Malaria Modeling and Surveillance In Thailand and Indonesia**

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**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 antimalarials abound.
- ACT is becoming less sensitive.
- Previously unaffected regions may have outbreaks due to climate change.

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**Meteorological & Climatological Parameters**

- Vector Ecology
- Predator Ecology
- Anthropogenic Factors
- AGRICULTURAL PRACTICE
- ROAD BUILDING
- DEFORESTATION
- MILITARY CONFLICT
- REFUGEES
- ECONOMIC CRISIS
- MEDICAL CARE

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**NASA’s Earth Observing System**

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**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 transmission
Agent-based discrete event simulation

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**Benefits**

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

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**THE PROBLEM**

**OBJECTIVES**

**BENEFITS**

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https://ntrs.nasa.gov/search.jsp?R=20090006631 2020-03-20T01:34:47+00:00Z
Value & Benefits
• Reduced morbidity & mortality for US Forces
• Improved public health for local populations
• Reduced damage to the environment
• Reduced likelihood of larvicide, insecticide & antimalarial resistance

Research
• Climate Prediction
• Earth Sci. Model
• Earth Observation
  - ASTER
  - MODIS
  - TRMM
  - AVHRR
  - SIESIP
  - Ikonos
  • QuickBird

Partners
• Epi.
• Entomo., parasit., & immun.
• Socioeconomic data

Malaria Models
• Local Habitat Detection
• Endemicity Estimation
  – Present
  – Future
• Dynamic Transmission
• Regional Spatial Targeting
• Cross-Regional Estimation

Decision Set
• Preventive measures
• Countermeasures

Detection
• Ditches
• Larval habitats

Users
• DSS

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

Most Thai provinces endemic with malaria are border provinces.

Mae La Camp

Kong Mong Tha Test Site

40% of the 245M Indonesians Live in Malarious Regions

Source: WHO SEARO

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

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

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

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
- 8 cows
- 2 cattle sheds
- 23 children

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

- 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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