The Surveillance Cycle

- Collection of pertinent data in a regular, frequent and timely manner
- Orderly consolidation, evaluation and descriptive interpretation of data
- Prompt dissemination of findings

Objectives of the National Malaria Control Program

- To reduce the incidence of malaria
- To minimize the proportion of *P.falciparum* nfections
- To eliminate mortality due to malaria
- To prevent malaria epidemics
- To prevent malaria in pregnancy

Strategies Adopted

- Early diagnosis and prompt treatment
- Selective use of integrated vector control methods
- Chemoprophylaxis
- Building and sustaining partnerships
- Community participation

How will surveillance help?

- Early diagnosis and prompt treatment
  - Distribution of cases
  - Establishment of malaria diagnosis and treatment centers
  - Detect epidemics
  - Proportion of *P. falciparum* infections
  - Drug resistant malaria

How will surveillance help?

- Selective use of integrated vector control
  - Identify high risk areas
  - Distribution of vectors
  - Identify areas for vector control
  - Monitor and evaluate the vector control programme

How will surveillance help?

- Chemoprophylaxis
  - Identify high risk groups
  - Monitor Chemoprophylaxis programme
- Building partnerships and Community Participation
  - Monitoring and evaluation

Current Surveillance System for Malaria in Sri Lanka

- Legacy of the eradication era
- “Reactive” rather than “Pro-active”
- Does not address current problems
- Reporting by place of diagnosis rather than place of residence/transmission
- Delays
- No feedback
- Not optimally used for planning purposes

Proposed changes

- Computerized system
- Weekly reporting system
- Reporting by place of residence (GN level)
- Additional data to be obtained
  - Treatment failures
  - Chemoprophylaxis
  - Investigation of cases/deaths

Anticipated Benefits

- Detect changes in incidence early
- Useful tool in planning malaria control activities
- Tool in the decision making process
- Establish a dialogue between Regional Malaria Officers
- Reduction in the morbidity and mortality i.e., burden of disease in the community

Use of GIS and Remote Sensing Tools for Malaria Research and Control

Lal Mutuwatta, GIS & RS Specialist
and
Eveline Klinkenberg, Malaria Consultant, IWMI

Computerized information management systems incorporating Geographic Information Systems (GIS) provide a powerful means of capturing, storing and displaying spatial information. It would be a useful tool for evidence-based decision making in malaria control. This technology could be used in identifying risk areas and risk factors, stratification for malaria interventions, allocation of limited resources in a cost-effective manner and forecasting epidemics or identifying sudden outbreaks. A microepidemiological study of malaria conducted in southern Sri Lanka used GIS technology to display house type distribution and incidence rates in relation to different house types. In this study, GIS was used to generate nearest distance between houses and bodies of water and forest edges, and to create a buffer zone around water bodies. Finally, the findings were used to estimate the impact of malaria risk reducing interventions (Gunawardena et al. 1998). In a study in India (Mutuwatta et al. 1997) GIS techniques were used to correlate malaria, irrigation density, rainfall and rice intensity making use of Thiessen Polygons.

Remote sensing is the science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation. This tool can be used in studies of disease transmission and vector ecology. There are many earth-observing satellites and the features of some commonly used satellites in health studies are given below:

SATELLITE	Temporal Resolution (d)	Spatial Resolution (m)	Remarks
NOAA AVHRR	Daily	1,000-4,000	Free, low resolution
SPOT	2-7 days	2.5-20	US$ 2500
LANDSAT	16	15, 30, 60	US$ 600/image-(180kmX180km)
Ikonos	8-14 days	1-5	US$ 3000 - Suitable for detailed information
Terra ASTER	16 days	15-90	US$ 100 on request (60kmx60km)

In many malaria studies remotely sensed data have been used to derive vegetation cover, landscape structures and water bodies. Remotely sensed factors have potential links with malaria, especially vector habitat and vector survival.

Potential links between RS factors and malaria

Factor	Opportunity
Vegetation/crop type	Breeding/resting/feeding habitats
Vegetation development	Timing of habitat creation
Permanent water	Mosquito habitat
Flooding/flooded forests	Mosquito habitat
Soil moisture	Mosquito habitat
Wetlands	Mosquito habitat
Rivers/streams/canals	Dry season mosquito-breeding habitat

Remotely sensed data have been used in malaria research. In a study carried out in Mexico, LANDSAT-TM satellite derived information was used to characterize and detect larval habitats (Beck et al. 1994) and in a study conducted in Belize, SPOT data were used to predict vector densities based on distances to larval habitat (Rejmankova et al. 1995). In a Kenya study, satellite images were used to predict key malaria transmission factors such as biting rates and Entomological Inoculation Rates (EIRs), using NDVI and modeled Soil Moisture (Patz et al. 1998).

Development of an Epidemic Forecasting System for Malaria in Sri Lanka by Monitoring Remotely Sensed Soil Moisture Data

Dr. D.M. Gunawardena
Research Associate, IWMI

Malaria continues to be a major public health problem and the leading cause for hospital admissions in many disease endemic countries. The disease hinders the general development of poor rural communities who are mainly dependent on an agricultural livelihood. One of the difficulties in reducing malaria transmission risk is the lack of prior information on transmission potential in space and time. Therefore, there is a clear need for developing an effective and simple forecasting system of malaria transmission that could be incorporated into decision-support systems for malaria control. Such a system could be feasible and give adequate time for preparing for the prevention and control of transmission. It would also provide timely information for a rapid response and will alert and assist planners, program managers and policy makers in their planning process and implementation of a successful prevention and control program. Prediction of malaria outbreaks/ epidemics in advance would facilitate the allocation of resources in a cost-effective manner with savings to both the government and the individuals, alert populations on transmission risks and introduce preventive measures through health education campaigns.

There have been some efforts to develop systems for predicting malaria transmission through indoor resting densities of vectors (Lindblade et al. 2000), biting and entomological inoculation rates and modeled soil moisture (Patz et al. 1998). Malaria control services, however, have still neither developed nor used a successful mechanism to predict malaria transmissions in advance (WHO 1998). The Water, Health and Environment Theme of IWMI initiated a study on mapping malaria risk and development of an epidemic forecasting system by monitoring remotely sensed routine soil moisture in the Moneragala district of Sri Lanka. The soil moisture (cm^3/cm^3) data derived from NOAA (National Oceanic Atmospheric Administration) images gives clues on availability of surface water that could be favorable for breeding of malaria vectors. In this study, Grama Niladhari (GN) level malaria incidence of Moneragala district on a 10-day basis from June 1999 to July 2000 were correlated with 40 days lagged soil moisture. The preliminary data analysis did not reveal a significant relationship between soil moisture and malaria incidence. The outcome could have been constrained by the following: 1) though there are many factors involved in malaria transmission we considered only one factor (soil moisture index) for the data analysis; 2) the low-resolution images used could not be adjusted to fit exactly with some small GN areas; 3) soil moisture data were only available for a one-year period and were present for the latter part of the epidemic and 4) in some areas, case data were unavailable or not represented due to lack of diagnostic facilities or patients seeking treatment from private facilities. Therefore at the next stage of data analysis we need to consider more specifically other geographical and environmental factors that influence malaria transmission such as NDVI (normalized difference vegetation index), surface temperature, land use pattern etc. The factors derived from high-resolution images in conjunction with long-term epidemiological and entomological data series of known high-risk areas will be useful for the development of an epidemic forecasting system for malaria.

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Use of GIS and remotely sensed data for malaria control

Lal Mutuwatta,Eveline Klinkenberge
and D.M Gunawardena

National Workshop on Mapping Malaria Risk - 2001.05.25

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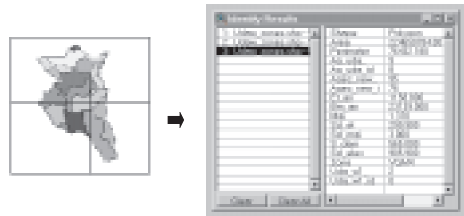
What is GIS?

A computer assisted information management system of geographically referenced data



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Use of GIS

- GIS would be a useful tool for evidence based decision making.
  - In identifying risk areas and risk factors.
  - In stratification for interventions
  - Use of limited resources in a cost-effective manner.
  - In forecasting epidemics or identifying sudden outbreaks.

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Applications

Microepidemiological study of malaria in Southern Sri Lanka

Gunawardena et.al, 1996

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Malaria Incidence Rates

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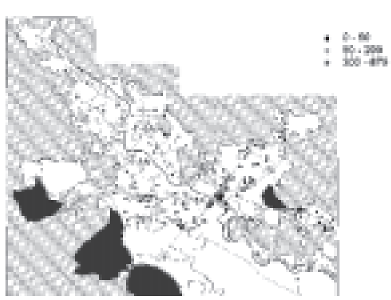

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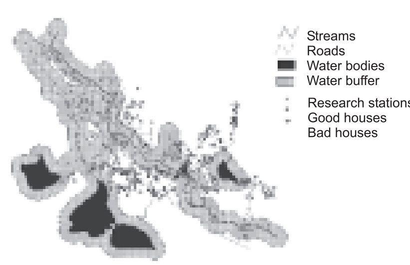
Buffer Zone of 200 meters around Water Bodies



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Malaria risk in the two house types in relation to their distance from a source of water

Distance from Water (M)	Malaria incidence rates (no of houses) in houses of construction type Good*	Poor*
0 - 100	41.5(47)	189.1(52)
101 - 200	36.1(42)	125.6(37)
201 - 400	68.5(38)	92.0(52)
>400	62.0(34)	91.3(47)

*Spearman correlation coefficient r=0.14; p=0.0676 for good houses and r=-0.13; p=0.0001 for poor houses.

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Water related environmental factors and Malaria transmission
In Mahi Kadana, Gujarat, India

Muthuwatta et.al 1997

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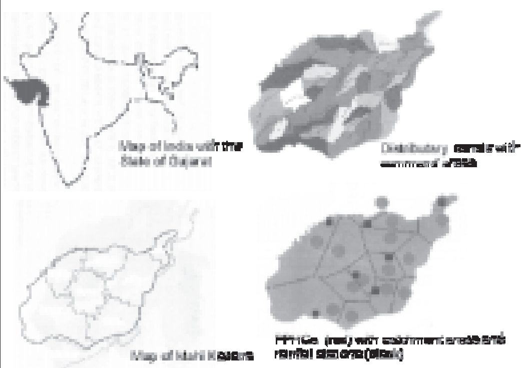

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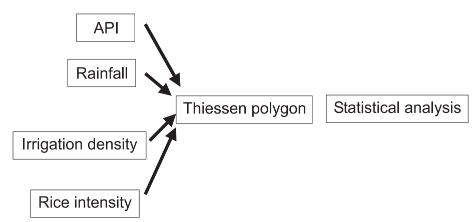

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Correlation coefficients between variables aggregated at PPHC catchment for 1981

	Rainfall	Irrigation density	Rice intensity
Ln(API)	0.77 (P = 0.001)	0.412 (P = 0.127)	0.56 (P = 0.028)

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What is Remote sensing ?

Remote sensing is the science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation

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NOAA
AVHRR
(Advanced Very High Resolution Radiometer)
Image Receiving System at the Department of Meteorology, Colombo.

Antenna diameter - 2 m
PC based
networked system

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Annual actual evapotranspiration (mm)
June 1999 to May 2000

Soil moisture (cm^3/cm^3)
May - 2000

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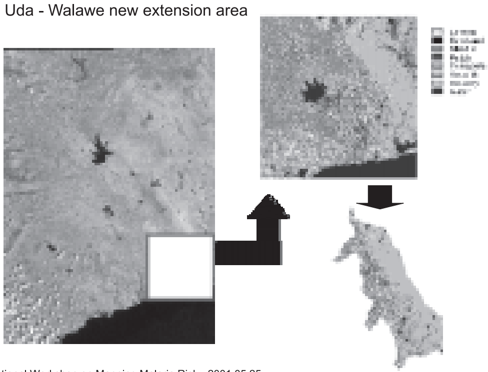
Land cover classification of
Uda - Walawe new extension area



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Some features of current sensor systems

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Use of RS in malaria

- Research
  - vector ecology
  - disease transmission
- Control
  - monitoring patterns of malaria transmission
  - early warning or predicting epidemics
  - planning control strategies (Mapping risk/stratification, resource allocation)

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Variables that could be obtain from RS

- Landscape structures
- Vegetation cover
- Water bodies

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