GIS in Decision support of control of Vector Borne Disease in India

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GIS based Malaria Surveillance System
Functionalities

Information attached to each point can be retrieved at the click of the mouse.

Housewise malaria info can be attached.

Dindigul

Blow up of any ward can be seen, and from ward level one can reach to streets and also to house.

<table>
<thead>
<tr>
<th>House No.</th>
<th>Owner’s Name</th>
<th>Monthly Income</th>
<th>Family Members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Family Details:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Relation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Age</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ward_no</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>street_no</td>
<td>3206</td>
</tr>
<tr>
<td>name</td>
<td>Sidco Ind. Estate</td>
</tr>
<tr>
<td>ward_area</td>
<td>60000</td>
</tr>
<tr>
<td>population</td>
<td>4254</td>
</tr>
<tr>
<td>houses</td>
<td>786</td>
</tr>
<tr>
<td>slums</td>
<td>3</td>
</tr>
<tr>
<td>slum_popul</td>
<td>1812</td>
</tr>
<tr>
<td>pond</td>
<td>0</td>
</tr>
<tr>
<td>case_63</td>
<td>0</td>
</tr>
<tr>
<td>case_64</td>
<td>3</td>
</tr>
</tbody>
</table>
Spatio_temporal distribution of malaria

API

0 - 2

2 - 5

> 5

Time 'n'

Time 'n+1'
Overlaying of breeding sites

OHT

UGT

API

Wells

OST
Evaluation of Control activities

Insecticide:
- Target_99
- Supplied_99
- Sprayed_99
Buffer Zone
Implementation

- GIS based malaria surveillance system was implemented in Dindigul municipality on November 19th 1999, ‘The World GIS Day’
- Health officers from the district and state head quarters Tamil Nadu were trained for its proper utilisation
- A Website URL [www.malaria-tn.org](http://www.malaria-tn.org) was constructed for fast dissemination of information
- Info was entered at district level and revised maps were instantly available at State and Centre
GIS database for Vaccine Site Selection at Sundergargh

- Total 13 Villages with about 4000 population
- Eight forest villages with about 2000 population
- Five villages in plain area with about 2000 population
- A three tier database, village, house and personal level database
GIS based information system gives an overview of the scenario, click at the house pops up the information of that particular house, can also give overview of malaria scenario. Inset 1: House Info, Inset 2: Houses with malaria cases
The system helped in selection of vaccine testing site.

House wise info shows that there are 11 members, 4 had malaria click at one dot says that Laxmi had 4 episodes of Pf on different dates.
Advantages

- Instant retrieval of information
- Dynamic maps, pinpointing areas requiring immediate attention
- Web hosting eliminates the need for traditional flow of info
- Universal accessibility of info
- Once the infrastructure is ready can be used to build DSS for any other disease
India
High Risk States

Priority API Pf% No. of Villages
1 > 5 > 50 80
2 > 5 > 30 & <= 50 7
3 >3 & <= 5 > 50 13
4 >3 & <= 5 > 30 & <= 50 4
104 Total Villages

No. of Malarious Villages in Nagaon = 242 (Total Villages - 1383)

Mapping of high Risk Area for Focused Malaria Control

Naogaon
Interstate Border Collaboration
Dear Dr. Bhaskar,

Malaria is a major public health problem in Assam. I would like to apprise you that there has been an increase in total number of Malaria Cases in the state which is a serious situation and needs immediate attention for taking remedial measures.

For the analysis of the epidemiological situation, Geographical Information System (GIS) mapping was carried out with the help of National Institute of Malaria Research, (ICMR), Delhi which indicates the intensity of transmission of malaria in a population and proportion of plasmodium falciparum. It shows that except Goalpara, Lakhimpur, Nagaon and Bongaigaon, the API in all other districts was more than 5 in 2005. In some districts, namely Karbi-Anglong (16.14), N.C. Hills (12.62) and Kokrajhar (7.18), it was very high. District-wise distribution of API-2005 is shown at Map 'A' & 'B' (enclosed).

The Plasmodium falciparum (PF) situation in most of the districts was also found to be more than 70%, namely Cachar (99.62), Hallakandi (99.69), Dhubri (90.53), Bongaigaon (91.84), Karimganj (90.06), K-Anglong (94.81), Goalpara (84.54), Kokrajhar (82.68), Nalbari (80.73), Sibsagar (80.77), Kamrup (78.87), Dibrugarh (76.32) and N.C.Hills (76.03) which reflects grim situation. Delay in detection and treatment of PF malaria cases may lead to various complications resulting in multi-organ failure and death. In fact, this may be one of the reasons for high number of deaths due to malaria in the State. The district-wise situation of PF (%) is enclosed for your kind perusal. (Map 'C' & 'D').

Therapeutic efficacy studies were carried out in the State which showed emerging resistance of PF to conventional antimalaria drug Chloroquine in many districts. In such areas, the State Govt. has been requested to introduce the second line drugs. The districts and number of Primary Health Centres (PHCs) with resistance to Chloroquine are indicated below:

<table>
<thead>
<tr>
<th>Districts</th>
<th>No. of PHCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karbi-Anglong</td>
<td>11 (whole)</td>
</tr>
<tr>
<td>Nagaon</td>
<td>11 (whole)</td>
</tr>
<tr>
<td>Darrang</td>
<td>1</td>
</tr>
<tr>
<td>Kamrup</td>
<td>1</td>
</tr>
<tr>
<td>Nalbari</td>
<td>1</td>
</tr>
<tr>
<td>Sonitpur</td>
<td>1</td>
</tr>
<tr>
<td>Tinsukhia</td>
<td>1</td>
</tr>
<tr>
<td>Lakhimpur</td>
<td>1</td>
</tr>
</tbody>
</table>
Director  
National Institute of Malaria Research  
Sector 8, Dwarka 110077  

Dear Sir

It is my pleasure to inform you that the GIS study on Identification of malaria hotspots for focused intervention in tribal state of India, namely, Madhya Pradesh (International Journal of Health Geographic (2009), 8:30) carried out by Dr Aruna Srivastava and Dr B.N. Nagpal of your institution in collaboration with State Health Department has proved very useful in decision making at block level for control of disease. Looking at the potential of GIS and expertise available at your Center I suggest continuation of the collaboration at the village level. I am sure with the joint efforts it will possible to control malaria in the state.

With best regards

Yours Truly

[Signature]

(D.C. Paliwal)  

[Signature]  

[Signature]  

Dr. Nagpal

[Signature]  

13/7/2009
Predictive habitat modeling of Indian Anophelines

**Major Malaria Vectors**

- *An. sundaicus* - a coastal species
- *An. dirus* - a forest species
- *An. minimus* - species of forest fringe areas
- *An. fluviatilis* - species of foothill areas
- *An. culicifacies* - a rural vector
- *An. stephensi* - an urban vector
GIS to Predict Vector Habitats

Altitude

Thematic maps

Soil

Temperature

Rain

Forest

1:6,000,000 MRC
Validation

- Validation from reported distribution
- Field validation (4 states)
  - From reported areas
  - New areas
  - Uttarakhand (7 surveys), Jalpaiguri, Assam, Meghalaya
- Validation by independent team
Validation through Field Surveys
Highlights

- **Challenging areas**
  - **A) Uttarakhand**
    - Banbasa: 7 surveys, larval/pupal skin identification, re-appearance
  - **B) Assam**
    - Dubri: in spite of earlier surveys, first time report
    - Karbi Anglong: no minimus found in non-favourable predicted area
New Khoonia Basti

Jalpaiguri - breeding sites for An.minimus

Mangal Bari

Raja bhat khao
An. minimus breeding places

Dubri
Banbasa _ An. minimus breeding sites
## GIS predicted Most Favourable range for An. minimus

<table>
<thead>
<tr>
<th>Category</th>
<th>Altitude (m)</th>
<th>Rainfall (mm)</th>
<th>Temp (°C)</th>
<th>Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Favourable</td>
<td>0-600</td>
<td>2000-2800</td>
<td>22.5-25</td>
<td>Evergreen forest</td>
</tr>
<tr>
<td>Med. Favourable</td>
<td>600-900</td>
<td>2800-3200</td>
<td>20-22.5</td>
<td>Moist Deciduous</td>
</tr>
<tr>
<td>Less Favourable</td>
<td>900-1800</td>
<td>3200-4000</td>
<td>&lt;20</td>
<td>Moist Deciduous</td>
</tr>
</tbody>
</table>
GIS Estimated Statewise Favourable Areas of *An. minimus*

<table>
<thead>
<tr>
<th>State</th>
<th>% Favourable area</th>
<th>State</th>
<th>% Favourable area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assam</td>
<td>25.25</td>
<td>Uttarakhand (earlier part of Uttar Pradesh)</td>
<td>9.42</td>
</tr>
<tr>
<td>Mizoram</td>
<td>90.61</td>
<td>Maharashtra</td>
<td>1.42</td>
</tr>
<tr>
<td>Manipur</td>
<td>69.50</td>
<td>Meghayala</td>
<td>18.85</td>
</tr>
<tr>
<td>Karnataka</td>
<td>7.13</td>
<td>Tripura</td>
<td>33.36</td>
</tr>
<tr>
<td>Chhatisgarh (earlier part of Madya Pradesh)</td>
<td>8.94</td>
<td>Jharkhand (earlier part of Bihar)</td>
<td>2.15</td>
</tr>
<tr>
<td>Nagaland</td>
<td>35.12</td>
<td>West Bengal</td>
<td>1.39</td>
</tr>
<tr>
<td>Kerala</td>
<td>18.05</td>
<td>Orissa</td>
<td>0.50</td>
</tr>
<tr>
<td>Madya Pradesh</td>
<td>1.98</td>
<td>Uttar Pradesh</td>
<td>0.25</td>
</tr>
<tr>
<td>Arunachal pradesh</td>
<td>7.07</td>
<td>Himachal pradesh</td>
<td>0.03</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>4.27</td>
<td>Sikkim</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Mapping of malaria safe areas and to facilitate distribution of bed nets in Sonitpur, Naogaon and Kamrup

IRS 1D LISS III Images, 1:250,000 maps
Distribution of *An. minimus* and *An. dirus* in northeastern India

**Distribution of An. minimus in North-Eastern States**

- **Temperature (°C):**
  - 25.0 - 27.5
  - 27.5 - 30.0

- **Altitude (m):**
  - 1000 - 10000

- **Rainfall (mm):**
  - 100
  - 150
  - 200
  - 600
  - 900
  - 1500

- **Forest (+):**
  - Tropical Evergreen
  - Tropical Moist Deciduous

**Distribution of An. dirus in North-Eastern States**

- **Temperature (°C):**
  - 27.5 - 30.0

- **Altitude (m):**
  - 4000 - 10000

- **Rainfall (mm):**
  - 100
  - 150
  - 300
  - 600
  - 900
  - 1500

- **Forest (+):**
  - Tropical Evergreen
  - Tropical Moist Deciduous
An *minimus* favourable and non favourable areas in District Kamrup, Assam

Amchang Tea Estate

Favourable area

Sonapur Village

Non favourable area
Integration of *An. minimus* and *An. dirus* distribution in northeastern India helped in identification of malaria free areas and areas suitable for bednet distribution to control malaria.
Album: GIS based distribution of Indian Anophelines

Each leaf Consists of

– GIS predicted distribution in India,
– blow up map of GIS predicted district wise favourable areas
– validation of GIS predicted distribution through reported surveys.
GIS Based Distribution of *An. sergentii* in India

**GIS predicted districtwise favourable areas**

- **Temperature**:<br>
  - <20 deg C<br>
  - 20 - 22.5 deg C<br>
  - > 27.5 deg C

- **Soil**:<br>
  - Clay<br>
  - Clay Loam<br>
  - Loam<br>
  - Loamy Sand<br>
  - Silt<br>
  - Sandy Clay<br>
  - Sandy Clay Loam<br>
  - Sandy loam<br>
  - Very Fine Sandy

- **Rainfall**:<br>
  - 100 mm<br>
  - 200 mm<br>
  - 300 mm<br>
  - 400 mm<br>
  - 500 mm<br>
  - 600 mm<br>
  - 700 mm<br>
  - 800 mm<br>
  - 900 mm<br>

- **Forest**:<br>
  - Alpine<br>
  - Himalayan Temperate<br>
  - Tropical Broad Leaved<br>
  - Tropical Dry Evergreen<br>
  - Tropical Evergreen

**Validation through reported surveys**

- **Favourable Range**
- **Non-favourable Range**

**Source:** NATMOS ATLAS

**Latitude:** 6 deg - 37 deg N
**Longitude:** 68 deg E - 97 deg E
Advantages

• Map malaria safe areas & vector control activities can be limited to problem areas
• Fast for covering vast areas, easy updation
• Good for precision mapping, economizes on survey cost
• Can derive information on
  - Bio diversity
  - Fauna
  - Map stable corridors for species
GIS Mapping of Dengue Cases Delhi

Delhi
Total Population
1, 38, 50, 507

Yamuna River

MCD
Zones - 12
Wards - 133

NDMC
Zone - 1
Wards - 9

Cantt Area
Zone - 1
Ward - 1
Zone and Ward wise Dengue Cases in Delhi
Ward and Locality wise Dengue cases in Delhi
Ward wise density of dengue cases in Delhi (2006)
Zone wise Dengue Cases, Aedes Breeding, GPS Track & Way Points
Zonewise Dengue Cases and Container wise breeding positivity (NIMR)
Localitywise Dengue Cases in Badarpur Zone, Delhi

Ward No. 65
Badarpur

Dengue cases in ward 65
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 50

Locality:
- Jasola Vihar
- Sarita Vihar
- Madanpur Khadar Extn.
- Raju Camp
- Ali Extension
- Regional Power Institute
- Badarpur Extn.
- Molarband Village
- Molarband Extn.
- Mohan Coop Indus. Estate
- Abul Fazal Enclave
Village wise Mapping of Kala Azar Cases in Bihar
Kala Azar Cases and Musahar Population in Bihar
Villages requiring setting up Medical Facilities
Health Impact Assessment of Narmada Basin – GIS based approach

**Jabalpur Unit**
1) Rani Avantibai sagar Project
2) Upper Narmada
3) Upper Burhner
4) Halon
5) Ataria
6) Chinki
7) Sher
8) Machrewa
9) Shakkar
10) Lower Goi
11) Rosra
12) Raghavpur
13) Basania

**Bhopal Unit**
1) Kolar
2) Tawa
3) Barna
4) Morand
5) Handia
6) Ganjal
7) Dudhi
8) Sitarewa

**Narmada Nagar Unit**
1) Indira Sagar Project
2) Omkareshwar Project
3) Jobat Project
4) Man Project
5) Upper Beda
6) Sardar Sarovar Project
7) Maheshwar Project
8) Chota Tawa
9) Rosra
10) Upper Narmada
11) Raghavpur
12) Basania
Selection of Villages

- Using GIS a buffer zone of 3 kms depending upon the flight range of vector mosquitoes was created along with the dam, river, down stream and minors and villages falling within the buffer zone was selected.
Advantages

- Dynamic maps & Easy updation
- Better info management
- Pin points areas requiring attention
- Can map receptive areas for early warning
- Can map suitable sites for Resettlement & Rehabilitation colonies
- Helps in decision support in disease control
In appreciation for generating healthy environment in the Narmada Valley area NVDA, Bhopal put up a "Jhanki" on the 63rd Republic Day Parade on 26th Jan 2012 on the activities of NIMR at Bhopal
Challenges:

• After even so many years GIS has not been geared up in Health

• Disease based and time based, the projects are not continuous – spatial data has to be generated for each application and resource sharing is limited

• No continuous input of data and analysis

• Projects are initiated based on interest of Head of Organization

• Limitation in distribution of maps, models, and tools poor data security and integrity.
Credits to all GIS Team and Field Staff

M.C. Sharma
Rekha Saxena
V.P. Singh
Pawan Kumar
Sanjeev Gupta
Mr. Jitendra Kumar
Mr. Arvind Tomar
And all
Thank you