

Use of GIS to analyze the priority to far edge residents for presumptive treatment to control the spread of malaria

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Introduction

Mosquito-borne malaria is one of world's major infectious diseases killing around two to three million people each year and threatening around forty per cent of the world's population, mainly in developing countries where resistance is low and resources scarce.

This paper culminates from a study conducted in the New Station Lines at the Ranichera Tea Estate, Malbazar Block, Jalpaiguri District, West Bengal one of the most malaria-prone region in West Bengal. In the paper we use some graph theoretic techniques to analyze the nature of spread of the disease and suggest a pattern of presumptive treatment using the concept of far edges [1]. The results obtained by using the suggested presumptive treatment pattern is compared with the actual results using the GISView Software. We show that priority to far edge residents for presumptive treatment could reduce the infection and death rate faster than the case of random presumptive treatment.

Graph Theoretic Concepts

A graph consists of a set of Vertices and a set of edges. Each edge connects a pair of vertices. A sequence of edges form a path if every consecutive edges in the sequence share a common vertex and no edge is selected twice in the sequence. In a graph with n vertices and E edges, if there exists an edge e joining vertices a and b where there are distinct paths of lengths $1, 2, 3, \dots, k$ between a & b , but no path of length $k + 1$, then e is said to be a far edge of order k .

The Model

In our model, the vertices of a graph represent houses in New Station. Using the concept of buffer zone we define every house within a buffer zone of 50 metres of a certain house share an edge in the neighbourhood graph. After the neighbourhood graph is drawn, the far edges of various orders can be identified. Identification of the far edges can help to control the spread of the disease by giving priority to the vertices lying on far edges for presumptive treatment during a mass survey.

The model is tested on a malaria-prone residential area (New Station) in a tea garden (Ranichera Tea Garden) of the Malbazar Block, Jalpaiguri district, West Bengal. The houses are mapped using ArcView.

In the View1 window, the different themes available are:

- a) Houses in the village
- b) Roads in the village
- c) Houses containing People affected by Plasmodium Vivax from 4th April, 2003 to November 15th, 2003 (one theme for every week)
- d) Houses containing People affected by Plasmodium Falciparum from 4th April, 2003 to November 15th, 2003 (one theme for every week)
- e) Houses containing People died after being affected by Plasmodium Falciparum from 1st December, 2002 to November 15th, 2003 (one theme for every month)
- f) Houses containing People unaffected during the period 4th April, 2003 to November 15th, 2003
- g) Edges of neighbourhood graph

For View 2 it's assumed that the death cases every month are random external inputs and they infect all the neighbours who have 20% chance of death if not given presumptive treatment and so on. It's also assumed that presumptive treatment are given to 5 household a day with priority to people in far edges of highest order. The themes are:

- a) Houses with People affected by Plasmodium Falciparum (one theme every week)
- b) Houses with People given presumptive treatment with priority to far edge residents (one theme every week)
- c) Houses with People died after being affected by Plasmodium Falciparum (one theme every month)

For View 3 the assumption is same as view 2 excepting that people for presumptive treatment are chosen randomly. The themes are:

- a) Houses with People affected by Plasmodium Falciparum (one theme every week)
- b) Houses with People selected randomly for presumptive treatment (one theme every week)
- c) Houses with People died after being affected by Plasmodium Falciparum (one theme every month)

At the end of this paper, a View containing Plasmodium Vivax figure for the week 4th-11th April, 2003 has been attached.

Conclusion

By comparing the themes “People affected by Plasmodium Falciparum” for every week between the results in View2 and View3 it’s noted that the number of people affected will be much lesser if priority is given to the far edge residents for presumptive treatment.

At the same time it’s also noted that the rate of decrease is slower in View 3 which suggest that in case of availability of more resources for presumptive treatment and quarantine facility for population of this village, malaria would die out faster in case of random presumptive treatment than in case of far edge presumptive treatment, though the cumulative number of patients will be lesser in the later case.

[1] S. A. Pandit and R. E. Amritkar. *Characterization and control of smallworld networks*. Phys. Rev. E, 60:R1119{R1122, 1999.

[2] Longley P.A., Goodchild M.F., Maguire D.J. and Rhind D.W., *Geographic Information Systems and Science* , John Wiley & Sons, Ltd., Chichester, United Kingdom, 2001.

View1

