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Spatial distribution of chikungunya in Rasipuram town, using spatial information technology

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Abstract
Namakkal is well located in the vector borne disease zone and the Mosquito takes shelter in these regions. The presence to Chikungunya disease is high in this zone when compared to the other Chikungunya control units in Tamilnadu and it is because of the fact that they infect mainly rain water low lying areas that surrounding area people affected for click. With this background the present problem has mainly focused to study the spatial and environmental aspects of those who are affected due to the Chikungunya disease and keep them in the Geographical Information System (GIS) for further Analysis.

Keywords: Chikungunya, *Aedes aegypti* mosquito, insomnia

Introduction

Chikungunya Makonde for "that which bends up" is an infection caused by the chikungunya virus. It features sudden onset fever usually lasting two to seven days, and joint pains typically lasting weeks or months but sometimes years. The mortality rate is a little less than 1 in 1000, with the elderly most likely to die. The virus is passed to humans by two species of mosquito of the genus Aedes: A. albopictus and Aegypti Animal reservoirs of the virus include monkeys, birds, cattle, and rodents. This is in contrast to dengue, for which only primates are hosts. The best means of prevention is overall mosquito control and the avoidance of bites by any infected mosquitoes. No specific treatment is known, but medications can be used to reduce symptoms. Rest and fluids may also be useful.

Chikungunya basic concepts and definition

Chikungunya is a relatively rare form of viral fever caused by an alphavirus that is spread by mosquito bites from the *Aedes aegypti* mosquito, though recent research by the Pasteur Institute in Paris claims the virus has suffered a mutation that enables it to be transmitted by Aedes albopictus (Tiger mosquito). This was the cause of the plague in the Indian Ocean and a threat to the Mediterranean coast at present, requiring urgent meetings of health officials in France, Italy, and Spain.

The name is derived from the Makonde word meaning "that which bends up" in reference to the stooped posture developed as a result of the arthritic symptoms of the disease. The disease was first described by Marion Robinson and W.H.R. Lumsden in 1955, following an outbreak on the Makonde Plateau, along the border between Tanganyika and Mozambique, in 1952. Chikungunya is closely related to O'nyong'nyong virus.

Chikungunya is generally not fatal. However, in 2005-2014, 200 deaths have been associated with chikungunya on Réunion island and a widespread outbreak in India, primarily in Tamil Nadu, Karnataka, Kerala, and Andhra Pradesh. As of September 2006, after the flood and heavy rains in Rajasthan in August 2006, India, thousands of cases were detected in Rajsamand, Bhilwara, Udaipur, and Chittorgarh districts and also in adjoining regions of Gujarat and Madhya Pradesh, and in the neighbouring country of Sri Lanka. As of October 12, 2006 in the southern Indian state of Kerala, 125 deaths were attributed to Chikungunya with the majority of the casualties reported in the district of Alapuzha [mainly in Cherthala Talk]. In December 2006 an outbreak of 3,500 confirmed cases occurred in Maldives, and over 60,000 cases in Sri Lanka, with over 80 deaths

The symptoms of Chikungunya include fever which can reach 39°C, (102.2°F) a petechial or maculopapular rash usually involving the limbs and trunk, and arthralgia or arthritis affecting multiple joints which can be debilitating. The symptoms could also include headache, conjunctival infection, and slight photophobia. In the present epidemic in the states of Andhra Pradesh and Tamil Nadu, India, high fever and crippling joint pain are the prevalent complaint. The fever typically lasts for two days and abruptly comes down. However, other symptoms, namely joint pain, intense headache, insomnia and an extreme degree of prostration last for a variable period, usually for about 5 to 7 days.

Dermatological manifestations observed in a recent outbreak of Chikungunya fever in Southern India (Arun Inamadar, Aparna Palit, V.V. Sampagavi, Raghunath S, N.S.

Deshmukh), Western India (Surat) (Western India reported by Buddhadev) and Eastern India (Puri) (Milon Mitra *et al.*) includes the following:

a. Maculopapular rash
b. Nasal blotchy erythema
c. Freckle-like pigmentation over centro-facial area
d. Flagellate pigmentation on face and extremities
e. Lichenoid eruption and hyperpigmentation in photodistributed areas
f. Multiple aphthous-like ulcers over scrotum, crural areas and axilla.
g. Lympoedema in acral distribution (bilateral/unilateral)
h. Multiple ecchymotic spots (Children)
i. Vesiculobullous lesions (infants)
j. Subungual h emorrhage
k. Photo Urticaria
l. Acral Urticaria

Histopathologically, pigmentary changes, maculopapular rash, lichenoid rash, aphthous-like ulcers show lymphocytic infiltration around dermal blood vessels (Inamadar *et al.*). Pedal oedema (swelling of legs) is observed in many patients, the cause of which remains obscure as it is not related to any cardiovascular, renal or hepatic abnormalities.

History of Chikungunya

The name of this disease 'Chikungunya' is derived from the Makonde word that means -"that which bends up" and is in reference to the stooped posture that develops due to the arthritic symptoms of the disease. The first outbreak of the disease was seen in the year 1952, in the Makonde plateau, along the border between Tanzania and Mozambique. Marion Robinson and W.H.R. Lumsden first described about the Chikungunya disease in 1955. The first outbreak in India's was in the year 1963, in Calcutta. Since the first reported case in India in 1963 there have been sporadic outbreaks in varies parts of India. However, recently reports have been shown the re-emergence of the disease in India in 2005, especially in the southern states. In December 2005 there have been a major outbreak and it is reported that more than 180,000 cases of Chikungunya in India. Beginning of 2006 between Februarys to March there have been more than 2000 cases reported in Maharashtra. Besides India, outbreaks have also been reported in Central and South Africa, Africa.

Symptoms of Chikungunya

The symptoms of Chikungunya include the following characteristics to the human being, Fever (greater than 40^{o} C, 104^{o} F), Headache, Joint pain, Arthritis affecting multiple joints that can be debilitating, Swelling of joints, Rash (May occur rarely), Sometimes there may be infection of the conjunctiva of the eye and some photophobia, Chills, Nausea, Vomiting, Bleeding or hemorrhage (May occur rarely).

The incubation period of chikungunya disease ranges from two to twelve days, typically three to seven. Between 72 and 97per cent of those infected will develop symptoms. Symptoms include sudden onset, sometimes biphasic fever typically lasting from a few days to a week, sometimes up to ten days, usually above 39 °C (102 °F) and sometimes reaching 41 °C (104 °F), and strong joint pain or stiffness usually lasting weeks or months but sometimes lasting years. Rash (usually maculopapular), muscle pain, headache, fatigue, nausea or vomiting may also be present. Inflammation of the eyes may present as iridocyclitis, or uveitis, and retina lesions may occur. Typically, the fever lasts for two days and then ends abruptly. However, headache, insomnia and an extreme degree of prostration last for a variable period, usually about five to seven days.

Causes of Chikungunya

Chikungunya Virus, also known as Buggy Creek Virus, is transmitted by Aedes aegypti mosquito bites. The virus belongs to the Family-Togoviridae, and the Genus is Alpha virus. Till date there has been no reported direct person-to-person spread. The mosquitoes that cause infection due to the Chikungunya virus in Africa and Asia are the same mosquitoes that cause yellow fever and dengue fever in many parts of the world. Hence the Chikungunya virus could affect many parts of the world. Genetic analysis of the Chiungunya viruses reveals that there are two distinct types of the virus. a. One contains all isolates from western Africa and, b. The second comprising all southern and East African strains, as well as isolates from Asia.

Mode of transmission

There is no direct transmission from the infected person to healthy person. It is transmitted by the bite of the infected mosquito.

Infection Agents

CHIKV is a single-stranded RNA alphavirus, from the family Togaviridae. CHIKV is most closely related to O'nyong-nyong, but remains genetically distinct. It is transmitted by the bite of the infected mosquito.

Incubation Period

The incubation period is usually 1-12 days. This means the disease manifests 1 to 12 days after the bite of the mosquito.

Treatment for Chikungunya

Supportive care and rest there has been no effective vaccine developed to prevent Chikungunya. Vaccine trials were carried out in 2000, but funding for the project was discontinued. To relieve symptoms of fever and joint pain the drug commonly used is Paracetamol. Rest is indicated during acute joint symptoms. Movement and mild exercise may improve stiffness and morning joint pains. In unresolved arthritis that does not respond to aspirin and non-steroidal anti-inflammatory drugs, Chloroquine Phosphate (250 mg/day) has given some promising results. Some studies have also shown that Chloroquine has some antiviral activity.

Chikungunya incidences in India and Tamilnadu

In December 2005, 80000 people were affected in Karnataka and 2000 in Andhra Pradesh in 2006. The disease was first identified in Calcutta in 1963, 1964 in Madras and 1973 in Maharashtra where the cases numbered several lakhs. In Tamil Nadu, all districts barring the Nilgiris and Tiruvannamalai have been affected by the disease, he said. The Nilgiris does not have any incidence of chikungunya

because of the cold weather conditions there. The disease has not affected Tiruvannamalai, where even malaria and filarial are prevalent, because of the awareness generated through students, Prof. Appavoo said.

In Tamil Nadu, 1063 villages out of 58,105, 26 out of 104 Municipalities and the Salem and Chennai Corporations have recorded incidence of chikungunya, he said. The first report of the disease this time was given on March 20 at Vellore by the Christian Medical College. While the transmission of the disease could have been from Andhra Pradesh and Karnataka, the highest number of cases was reported from Vellore (6,916), Namakkal (11,498) and Krishnagiri (5,747), he said, quoting from Department of Public Health figures.

Test results of blood serum samples of 10 patients have confirmed cases of Chikungunya in Coimbatore district. Out of the 41 samples sent to the National Institute of Virology in Pune, health officials here have received the results of 15, of which 10 are confirmed cases of Chikungunya. A health official said on Monday that none of the confirmed cases were from the city. Six of them were from Tamaraikulam village at Nallatipalayam near Kinathukadavu in Pollachi taluk.

Though not described an outbreak, this confirmation by health authorities in the district announced Chikungunya's invasion in Coimbatore also after leaving thousands of persons debilitated across western Tamilnadu, right from Krishnagiri to Erode. Health authorities in Coimbatore and the Nilgiris districts maintained till recently that there were no cases of Chikungunya.

Study area description

Figure-1 shows the study area details of Rasipuram Town along with the ward boundary and other infrastructural facilities. Rasipuram is located between 11.47° N Latitude and 78.17° E Longitude. It has an average elevation of 246 metres (807 feet). Rasipuram is a panchayat town. It is a town 27 km (16.5 miles) from Salem, in Namakkal district, has a population of around 50 thousand. The town is approximately 380 km southwest of Chennai, 235 km south of Bangalore and 110 km northwest of Tiruchirapalli.

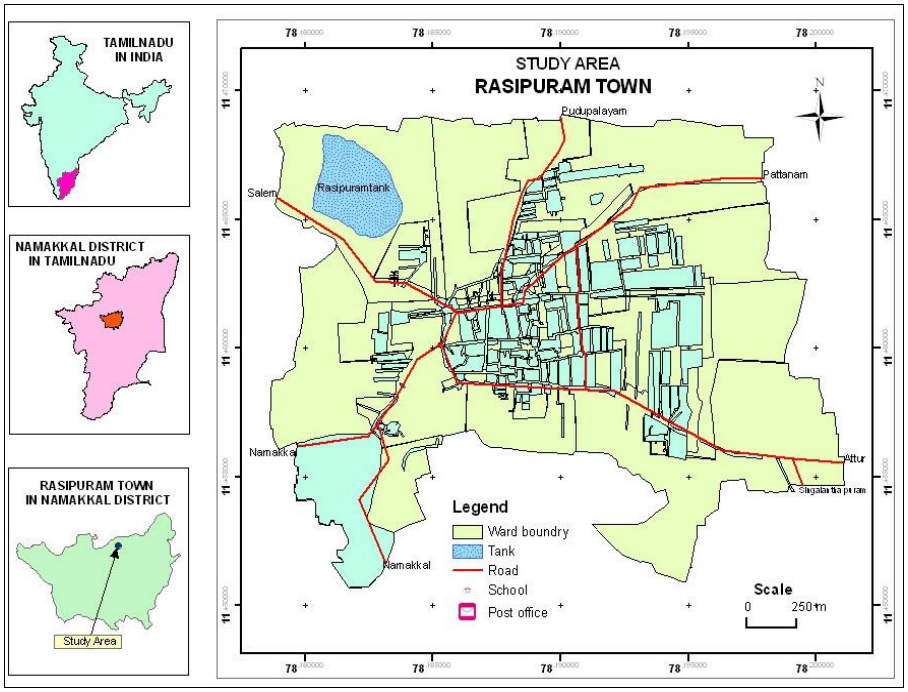

Fig 1

Problem Statement

According to the Ministry of Health and Family Welfare, Government of Tamil Nadu, Namakkal recorded a high incidence of 11,459 cases, followed by Krishnagiri (5,747), Tirupattur (5339), Tirunelveli (4466) and Chennai (2700). No deaths were reported due to the disease, he said. The present problem is the high incidence rate of Chikungunya in Rasipuram Town of Namakkal district when compared to other towns in the state, which has a long history of its presence. Namakkal has a conductive atmosphere and its adverse environmental and ecological conditions favor for the growth of Chikungunya worm inside town as well as its peripheral wards. Namakkal is one of the oldest cultural heritage town located in the central parts of Tamilnadu. Waterfalls of kolli hills surround the Namakkal District. The fresh water tanks carry stagnant water, which also caters the feed for vectors in this region.

Objectives

It is clear from the above, that Rasipuram Town is facing several environmental problems. The Chikungunya virus, particularly in a wide variety of fresh water containers, from water tanks, cisterns, and houses to rubbish, discarded plastic containers and abandoned vehicle tiers that trap little puddles of water pollution zones Mosquito breeding sites. The Mosquitoes can grow continuously and infect the people to the dreaded disease like Chikungunya. To study the spatial and behavioral aspect of the affected persons in this region the

following objectives are formulated:

a. To study the Spatial-environmental problems of affected persons in Rasipuram and locate the incidence cases of Chikungunya using Global Positioning system to ward wise to analyze the problem
b. To find the most dominating factors that are responsible for the High incidence of Chikungunya in this town

1.17 Methods of Analysis

To study the spatial and environmental aspects of Chikungunya in Rasipuram Town data relating to the reported were gathered from the Namakkal Chikungunya control unit particularly for the month of June and July, 2014, as these two months records high incidence rates. The details include name of the affected person, age of the person, their contact address, monthly affected persons, total population, climatic data, ward and streetwise affected people and so on. A base map of Rasipuram has been obtained from the Rasipuram Municipal Town planning Department and map has been digitized and Geo referenced using Arc map and converted into shape file. Digitized spatial feature layers like the hospital location, schools, post office, tank, lake, street, ward, affected people have been stored in the shape files and are maintained in Arc catalog that contains details about the Chikungunya incidences in every ward. The area has been surveyed primarily using GPS instrument – GS 20. Sample points for Garbage's, well, tank, lakes has been taken under from GPS survey. The incidence map overlaid on the man made environmental implication zones the origin of this problem in the town can be studies and further analyzed how to overcome this problem with people's participatory approach.

Spatial distribution of Chikungunya

To create different GIS database files and also to study the spatial distribution of Chikungunya in Rasipuram Town, the data has been gathered from Rasipuram Town Administrative office for June and July 2014. According to the data 612 cases were reported in Rasipuram Town for two months. Rasipuram Town map has been obtained from town Administrative office to prepare base map. The map was then converted into digital data by scanning with a Scanner. The scanned maps are then Geo referenced with Latitude and Longitude points collected by using GPS (Global Positioning System). The spatial features needed for the study are digitized in the Geo referenced Rasipuram Town map using Arc map, the software tool Arc GIS 9.0 by converting it into shape files.

Digitized spatial features layers such as major roads, tanks, schools, post office, ward boundary, etc… are stored in shape files and the files are maintained in Arc catalog. The collected information has been plotted on the base map of Rasipuram Town. Each and every point has been traced from the addresses of the affected persons for two months. The details includes the patient ID, name of the Patient, Address with door number, Street name, Sex category, Age, Disease particulars.

The Chikungunya reported cases in Rasipuram Town with the number of affected cases and the individual patient's name. From this map it is clear that very high reported cases are seen in eastern part (V. Nagar) of the town. The low reported cases located in western part (Kattukottai) of the town. The statistics indicate that the total numbers of Chikungunya affected cases are 612 in Rasipuram Town.

Table 1: Rasipuram Town: Chikungunya Affected Cases June 2014

Below 5 years Adult Total										
S.No	**Date**	**Fama**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
1	09.6.2014	-	-	-	47	40	87	47	40	87
2	10.6.2014	-	-	-	6	2	8	6	2	8
3	11.6.2014	-	1	1	2	2	4	2	3	5
4	12.6.2014	-	-	-	6	2	8	6	2	8
5	13.6.2014	-	-	-	4	2	6	4	2	6
6	14.6.2014	-	-	-	5	3	8	5	3	8
7	15.6.2014	-	1	1	7	8	15	7	9	16
10	18.6.2014	-	1	1	2	1	3	2	2	4
11	19.6.2014	-	1	1	8	6	14	8	7	15
12	20.6.2014	-	-	-	3	5	8	3	5	8
13	21.6.2014	-	-	-	6	6	12	6	6	12
14	22.6.2014	-	-	-	7	6	13	7	6	13
15	23.6.2014	-	-	-	10	9	19	10	9	19
16	24.6.2014	-	-	-	13	6	19	13	6	19
17	25.6.2014	-	-	-	-	3	3	-	3	3
18	26.6.2014	-	-	-	13	7	20	13	7	20
19	27.6.2014	-	-	-	12	8	20	12	8	20
20	28.6.2014	-	-	-	5	4	9	5	4	9
21	29.6.2014	6	6	12	21	39	60	45	27	72
22	30.6.2014	2	-	2	5	-	5	7	-	7
	Total	9	11	20	189	168	357	198	179	377

***Source*:** Administrative Office in Rasipuram

The mosquito breeding sites in Rasipuram Town. This map has been prepared using GPS (Global positioning System) individual mosquito breeding cites in the town such as: major Rainwater harvesting tank, drinking water storage tank, major garbage location, wells and stagnant water areas have been located. The major garbage was occurred in Thattankuttai area and it is located in southeastern part of the town. The Thattankuttai garbage is the major mosquito breeding sites in Rasipuram Town and majority of reported cases of Chikungunya are distributed in this area. (Number of cases in Thattankuttai 67).

Table 2: Rasipuram town Chikungunya affected cases July 2014

Below 5 years Adult Total										
S. No	**Date**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
1	1.07.06	2	4	6	11	17	28	13	21	34
2	2.07.06	-	-	-	10	9	19	9	10	19
3	3.07.06	1	1	2	15	9	24	16	10	26
4	4.07.06	-	-	-	6	8	14	6	8	14
5	5.07.06	-		-	5	7	12	5	7	12
6	6.07.06	-	-	-	7	5	12	7	5	12
7	7.07.06	-	-	-	3	2	5	3	2	5

8	8.07.06	-	-	-	9	2	11	9	2	11
9	9.07.06	-	-	-	3	3	6	3	3	6
10	10.07.06	1	1	2	5	4	9	6	5	11
11	11.07.06	-	-	-	2	3	5	3	3	6
12	12.07.06	2	-	2	5	10	15	7	10	17
13	13.07.06	-	1	1	4	2	6	4	3	7
14	14.07.06	-	-	-	5	3	8	5	3	8
15	15.07.06	-	-	-	2	2	4	2	2	4
16	16.07.06	-	-	-	-	1	1	nil	1	1
17	17.07.06	-	-	-	2	2	4	2	2	4
18	18.07.06	-	-	-	1	3	4	1	3	4
19	19.07.06	-	-	-	2	1	3	2	1	3
	Total	6	8	14	97	93	190	103	101	204

***Source*:** Administrative Office in Rasipuram

Figure-2 Shows the Chikungunya affected cases for ward wise in Rasipuram Town. According to the map the affected cases are plotted in ward wise and one dot represent for one case. The spatial distribution shows that the disease has widespread. Maximum number of cases located in ward number 9, 10, 20, 21, 22, 23, 24. The reason for high reported cases in ward number 9 and 10 was maximum number of water tanks and garbage's located in this ward.

Table 3: Rasipuram Town wards wise Chikungunya Affected cases

Ward no.	Female	Male	Total
1	2	8	10
2	1	2	3
3	2	6	8
4	7	8	15
5	2	5	7
6	4	4	8
7	10	6	16
8	5	4	9
9	40	50	90
10	60	49	109
11	3	3	6
12	4	4	8
13	2	2	4
14	3	2	5
15	6	2	8
16	4	1	5
17	2	1	3
18	2	2	4
19	4	4	8
20	50	20	70
21	40	23	63
22	50	17	67
23	30	30	60
24	4	3	7
25	2	3	5
26	2	7	9
27	2	3	5
Total			612

***Source*:** Administrative Office in Rasipuram

Chart-1 shows the Chikungunya affected cases for street wise in Rasipuram Town. The green colours indicated for affected cases. Highest Chikungunya affected cases are located in V.Nagar Road, Koneripatti Nadu Street, Sigalandhapuram road, Madha Koil Street, Vinayagam Street of Rasipuram Town.

Chart – 1

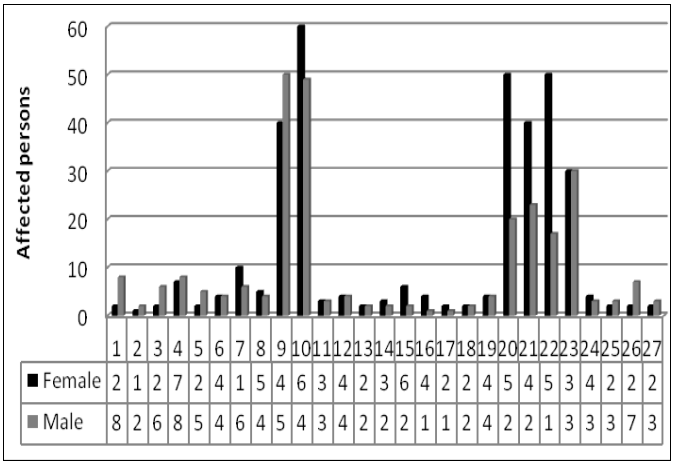

Fig 2: Rasipuram town wards wise chiununya affected cases

The very low reported cases are living in Theradi Street, Arasamaram Street, and Town bank Street of Rasipuram Town. Moderate reported cases are located in Tiruvalluvar Street, Mangalamramalingam Street, Anna nagar, Kattur road of Rasipuram Town. The spatial pattern of diseases indicated that it has widespread prevalence in the eastern part of Rasipuram Town. The western part of Rasipuram has very low reported cases compared to eastern part.

Figure-3 displays the Chikungunya affected male population and female population in Rasipuram Town. Based on the gender wise classification male and female are equally affected for Chikungunya.

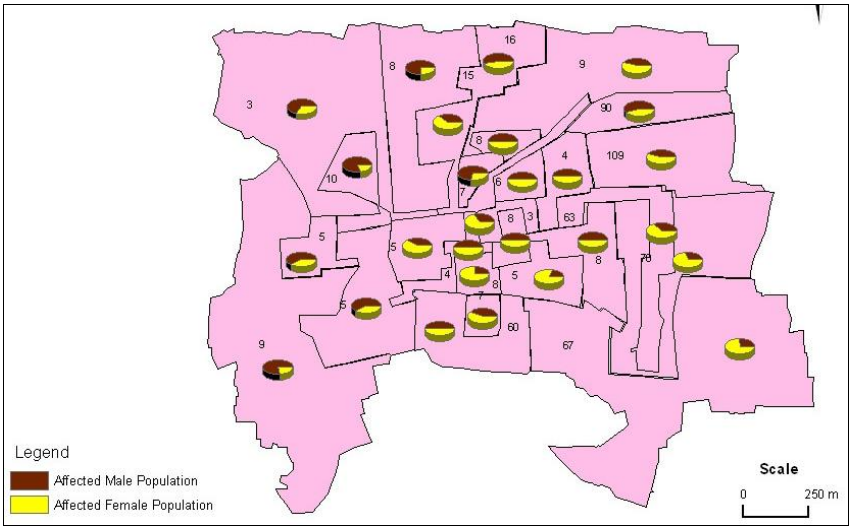

Fig 3: Rasipuram town chikunya: affected male female cases

Figure-4 shows the incidence of Chikungunya in Rasipuram Town. The incidence rate calculated forward wise, based on the ward wise population identified the ratio of affected cases. The incidence rate classified in to four categories, high incidence rate are 9 to 44, the moderate incidence rate are 5 to 9, low incidence are 3 to 5. High incidence rate are found distributed in eastern part of the Town, moderate incidence are wide spread of the area. In eastern side of the Town so many environmental problems are found, especially garbage's and stagnant water is the major problem in the Town area resulting high incidence of Chikungunya.

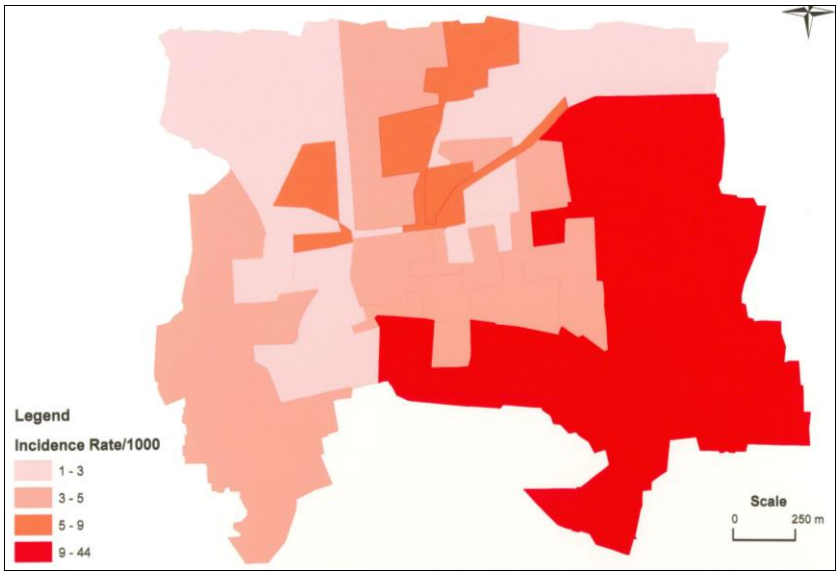

Fig 4: Rasipuram town incidence of chikungunya

Remedial measure and conclusion

To avoid mosquito bites

- Wear full sleeve clothes and long dresses to cover the limbs;
- Use mosquito coils, repellents and electric vapour mats during the daytime;
- Use mosquito nets – to protect babies, old people and others, who may rest during the day. The effectiveness of such nets can be improved by treating them with permethrin (pyrethroid insecticide). Curtains (cloth or bamboo) can also be treated with insecticide and hung at windows or doorways, to repel or kill mosquitoes.
- Mosquitoes become infected when they bite people who are sick with chikungunya. Mosquito nets and mosquito nets and mosquito coils will effectively prevent mosquitoes from biting sick people.

To prevent mosquito breeding: The Aedes mosquitoes that transmit chikungunya breed in a wide variety of manmade containers which are common around human dwellings. These containers collect rainwater, and include discarded tires, flowerpots, old oil drums, animal water troughs, water storage vessels, and plastic food containers. These breeding sites can be eliminated by

- Draining water from coolers, tanks, barrels, drums and buckets, etc.;
- Emptying coolers when not in use;
- Removing from the house all objects, e.g. plant saucers, etc. which have water collected in them
- Cooperating with the public health authorities in anti-mosquito measures.

Role of public health authorities

- National programme for prevention and control of vector borne diseases should be strengthened and efficiently implemented with multisectoral coordination
- Legislations for elimination of domestic/peridomestic mosquitogenic sites should be effectively enforced
- Communities must be made aware of the disease and their active cooperation in prevention and control measures elicited
- Minimizing Transmission of Infection: This can be done in the following ways:

Risk communication to the household members: Educate the patient and other members in the household about the risk of transmission to others and the ways to minimize the risk by minimizing vector population and minimizing the contact with vector.

Minimizing vector population

- Intensify effort to reduce larval habitats in and around the houses: remove stagnant water from all junk items lying around and in the household and in the peri-domestic areas
- Stagnating water in flower pots or similar containers should be changed daily or at least twice weekly
- Introduce larvivorous fish in aquaria, garden pools, etc
- Weeds and tall grasses should be cut short to minimize shady spaces where the adult insects hide and rest during hot daylight hours
- Drain all water stagnating after rains
- Fogging and street sanitation with proper waste management(fogging does not appear to be effective, yet it is routinely implemented in epidemic situation

Minimize the vector-patient contact at household level

- Have the patient and infants in the house rest under bed-nets, preferably permethrin-impregnated nets
- Insecticide sprays: bed rooms, closets and crevices, bathrooms, kitchens, nooks and corners; alternatively, coils, mats, vapourizers, etc
- Have the patient as well as other members of the household wear full sleeves to cover extremities, preferably bright coloured clothes
- Wire-mesh/nets on doors and windows

Reporting to the nearest public health authority: Occurrence of the case in the community needs to be communicated immediately to the nearest public health official for identification of clusters by person, place and time and for expansion of the control measures in the community and district levels.

Conclusions

In the present study, the reported higher incidence of Chikungunya in Rasipuram town has been selected to analyse the cause and effect of the disease in this region. The reported cases data were plotted on the base map, which shows the spatial spread of the disease. The man-made environmental problem zones were identified and plotted using GPS survey. Data relating to the reported cases and the environmental problem parameters were overlaid to identify the locations of adverse effects due to the Chikungunuya in Rasipuram town. The town administration is required to concentrate on the above-identified areas of risk, to enable them to prevent the disease for further aggravation.

There is no specific treatment (therapies) or vaccines are available for chikungunya. But the Homoeopathic system of medicine claims to have medicines as well as preventives against this disease. The effects of these medicines are not scientifically proved. They claim to have used these effectively in recent outbreaks in Kerala State of India. Themost effective means of prevention are those that protect against any contact with the disease carrying mosquitoes.

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