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An outbreak investigation of dengue fever in the coastal areas of Nagapattinam, Thiruvarur and Thanjavur districts in Tamil Nadu, India during 2012

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Abstract

An outbreak of dengue fever occurred in the coastal Nagapattinam and adjoining Thiruvarur and Thanjavur districts of Tamil Nadu during late October-early November, 2012. An-depth investigation was made into the reasons attributable to the spread of dengue in these districts, both urban and rural settings, between 23rd and 27th November, 2012. Till 22nd November a total of 299 cases and 2 deaths in Nagapattinam district and 612 cases with 3 deaths in Thanjavur district were reported due to dengue. An increased trend in dengue cases was observed from September to November, with all the age groups affected. High entomological indices along with eco-bio-socioeconomic factors such as unprecedented rainfall, construction sites, abandoned houses and boats, tyres and coconut shells were the major reasons for sudden abundance of *Aedes* mosquitoes. Robust monitoring and surveillance activities, along with control measures, by the district authorities kept the disease spread under check by effectively strengthening both case management and laboratory support, on one hand, and regularly organizing interactive co-ordination meetings at all levels to sensitize people through IEC and awareness programmes as well as source reduction of *Aedes* mosquito breeding.

Keywords: Dengue, outbreak, coastal districts, Nagapattinam, Thiruvarur, Thanjavur, Tamil Nadu

Introduction

During last two decades dengue, which has lately become a serious public health problem both geographically and in its intensity, emerged as the fastest spreading mosquito-borne viral infection in the world [1, 3]. It is an acute systemic viral disease that has established itself globally in both endemic and epidemic transmission cycles. Dengue virus infection in humans is often unapparent [4] but can lead to a wide range of clinical manifestations, from mild fever to potentially fatal dengue haemorrhagic fever (DHS) and dengue shock syndrome (DSS) [2]. The lifelong immunity developed after infection with one of the four virus types is type-specific [1, 2] and progression to more serious disease is frequently, but not exclusively, associated with secondary infection by heterologous types [2, 5]. Clinical features of dengue virus infection include fever, rash and joint pain [2, 3], which are however common in other certain febrile illnesses and may lead to misdiagnosis and interpretation. The diagnostic methods available also have limitations and a full complement of tests is not feasible in many healthcare points. Owing to the inherent problems related to definition of these diseases, on one hand, and, since dengue transmission comes in a wide variety of forms, with varying levels of spatial coverage and reliability, on the other, there has been differences in opinion of its global distribution which, considering varied estimates, seems to range from 30% [1] to 54.7% [2] of the world's population (2.05–3.74 billion) from about 136 countries [1, 6].

Ironically, though more than a century has elapsed when dengue virus was first discovered, there is no effective antiviral agent yet existing to treat dengue infection, nor any licensed vaccine is available against dengue infection [2]. Because the dengue treatment remains to be supportive, the only way to curb dengue transmission is to focus on the vector control, using combinations of insecticides and biological control agents targeting *Aedes* mosquitoes and management of breeding sites [7].

India is among the worst dengue-affected countries in the world, along with Brazil, albeit significant under-reporting [1, 6]. During 2012, dengue resurged almost throughout the country but maximum cases and deaths were reported in Tamil Nadu where some of the coastal districts

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were worst-affected [8]. Since this outbreak of dengue cases occurred severely in those districts which were earlier hit by the devastating tsunami during December 2004 and government had initiated post-tsunami several re-habilitation and vocational schemes, it became all the more important to comprehend the factors behind this upsurge of dengue cases in coastal districts [9]!

Material & Methodology

The worst-affected coastal districts, namely, Nagapattinam, Thiruvarur and Thanjavur, were surveyed from 23rd to 27th November, 2012, along with several senior state and district administrative and health officials, primarily to investigate reasons attributing to the spread of dengue fever in coastal Tamil Nadu districts (Fig. 1).

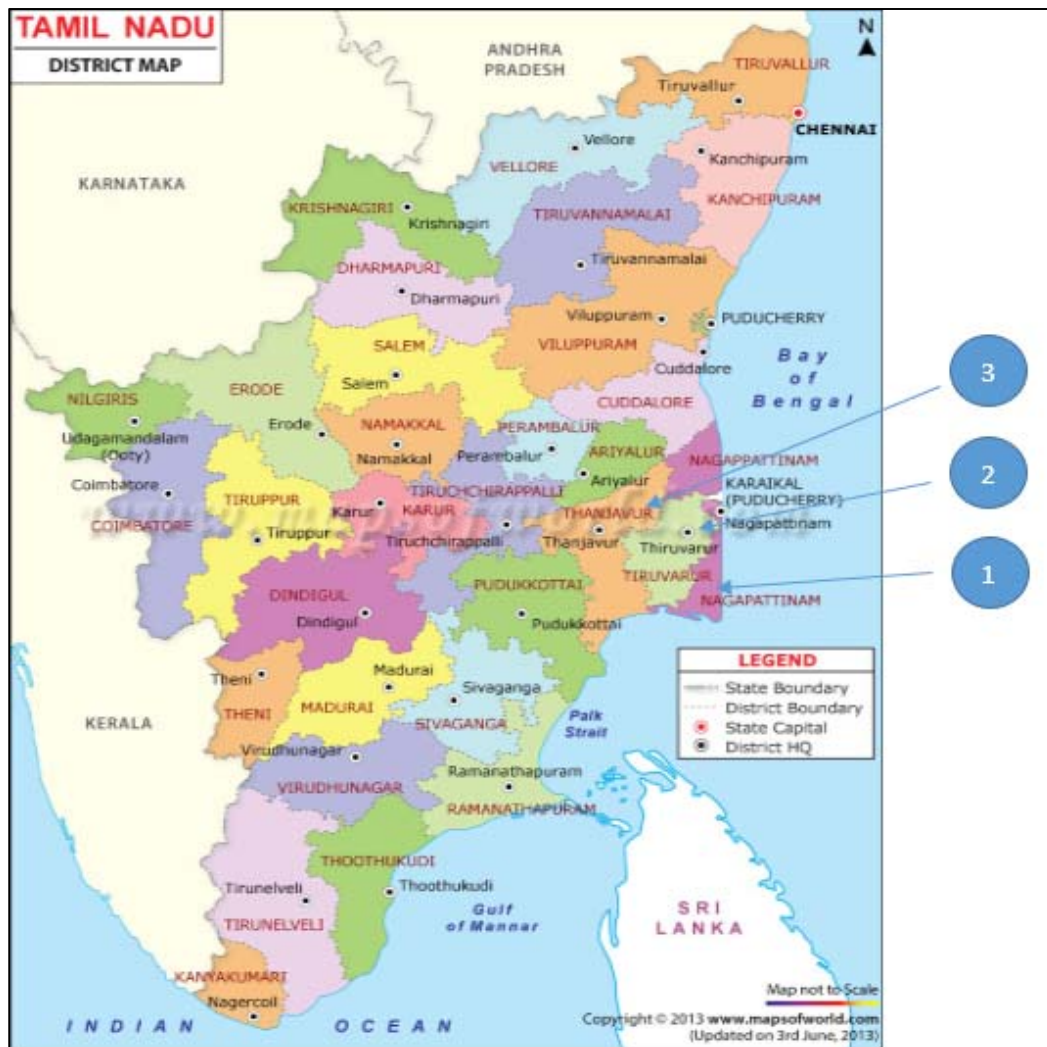


Fig 1: Map of peninsular India showing Tamil Nadu with districts ([Note the marked districts of Nagapattinam (#1), Thiruvarur (#2), and Thanjavur (#3)] which were surveyed both virologically and entomologically during a dengue outbreak in November, 2012.

The following methodology was pursued:

- Discussion with District Collector and District Health officials of Nagapattinam, Thiruvarur and Thanjavur districts.
- Secondary data mining and analysis of the three districts.
- Visit to hospitals, laboratories and affected villages in the three districts.
- Larval and adult collections were done using standard procedures. The identification was made following the keys of Barraud (1936) and Puri (1962).
- The vector incrimination was carried out following the standard method.

Observations & Results

Nagapattinam district

(i) Demography, topography and climate

Nagapattinam district of Tamil Nadu is located on the shores of the Bay of Bengal covering an area of 2715.83 sq. km. This coastal district of Tamil Nadu lies between 10.10° and 11.20° North latitudes and 79.15° and 79.50° East longitudes. Nagapattinam district was carved out by bifurcating the composite Thanjavur district. District Nagapattinam has a population of 16,14,069 (as per the 2011 census) and is divided in eight taluks, ten blocks and four municipality areas. The average maximum temperature during the summers remains around 35 °C. The relative humidity of district hovers around 60 to 65%. The average annual rainfall is around 1000mm, notwithstanding majority of precipitation hails during Northeast Monsoon, October-December (Fig. 2).

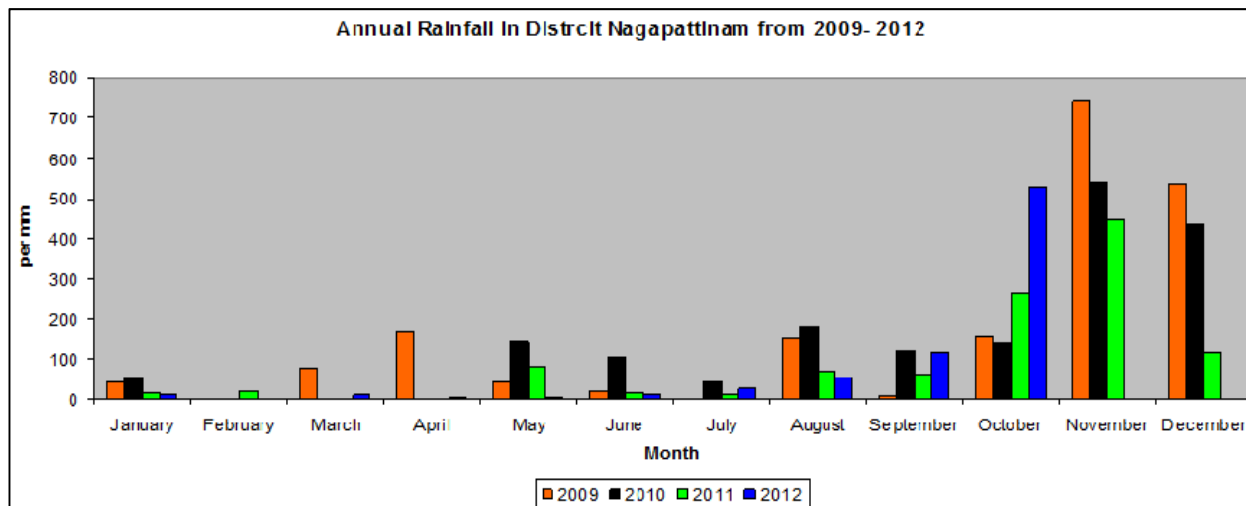


Fig 2: Mean annual rainfall (2009-2012) for Nagapattinam district.

(ii) First-hand interaction with state and district health and administrative authorities

To review dengue situation in the state of Tamil Nadu, particularly the badly affected Nagapattinam, Thiruvarur and Thanjavur districts, foremost an interactive meeting on November 23, 2012, was held with the Health Secretary of Tamil Nadu, Dr. J. Radhakrishnan, IAS, joined by the Director of Public Health, Dr. Porkai Pandiyan, and other senior officials including Dr. Paranjothy, Director of Medical & Rural Services; Dr. P Kannan, Additional Director (Malaria & Filariasis); Dr. Kolandai swamy, Additional Director (Primary Health Centre); Dr. Saravanan, Joint Director (VBCP); Dr. Rukmanandhan Additional Director (Planning); Dr. Raju, Additional Director (Medical); Dr. Kathiresan, Chief Entomologist and various other entomologists at DMS complex, Chennai During the meeting the following observation were made:

- A total of 10,096 cases and 62 deaths due to dengue were reported in Tamil Nadu till 22nd November 2012, (Table 1).
- All the 32 districts were affected by dengue outbreak, however, Nagapattinam and Thanjavur districts seemed to have been impacted worst.
- While Nagapattinam reported 299 cases and 2 deaths, Thanjavur had reported 612 cases and 3 deaths.
- Spurt in dengue cases was reported during September-November.
- Monitoring and surveillance activities, along with containment measures, were carried in both the districts.
- Coordination meetings at all levels, sensitization and awareness programmes and IEC were emphasized in both the districts.

Table 1: Year-wise distribution of dengue cases and deaths in Nagapattinam and Thanjavur districts of Tamil Nadu (2010-2012 (till 22nd Nov.))

Year	Tamil Nadu		District Nagapattinam		District Thanjavur	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
2010	2060	8	17	0	14	0
2011	2501	9	5	0	45	0
2012	10096	62	299	2	612	3

* Source: NVBDCP, Tamil Nadu

Again on 24th November, to seek appraisal on the dengue scenario in the district with various containment measures undertaken by the District Health Authorities, an in-depth discussion was held at the district headquarters of Nagapattinam with Mr. Munusamy, District Collector and Mrs. Asia Mariam, District Revenue officer, Dr P Kannan, Additional Director (Malaria & Filariasis), Dr. V.A. Ralphselvin, Deputy Director, Nagapattinam, Dr. S. Rajesekar, Deputy Director, Health (On Dengue Special Duty), Dr. Gurunathan, Joint Director Medical and Rural Health Services, Dr. Kathiresan, Chief Entomologist and Dr. Kumar, Senior Entomologist at District Collectorate, Nagapattinam. Following observations emerged in the meeting:

- Even though signs of outbreak began in September, sporadic cases occurred since January (Table 2).
- Two deaths in children below 5 years of age were reported from Nagapattinam block.
- An increased trend in dengue cases was observed from September to mid October 2012 (Fig 2)
- Block Nagapattinam, an urban setting, was mostly affected (140 cases) having a population of 82,559 and 16,515 households.
- Dengue cases were also reported from blocks Sembanarkoil, Keezhaiyur, Kollidam, Sirkazhi away from the centre of the city.
- All age groups were affected (Table 3)
- Entomological indices were found high enough to trigger spread of dengue infection.
- Environmental Man-made environmental factors were supporting for *Aedes* mosquito breeding (Fig 45).
- Diagnostic treatment facilities were available at district hospital where sources of mosquito breeding were regularly monitored and reduced, the health department carried out dissemination of educational and information material.

Table 2: Health care delivery infrastructure in district Nagapattinam

Sl. No.	Health Facility	No.
1	District hospital	1
2	No. taluk hospital	8
3	Blocks	10
4	PHC	51
5	SC	258
6	Villages	434

(iii) On-spot surveys in affected areas of the District Hospital Nagapattinam

- A total of 4859 fever cases were admitted between 27th August to and 22nd November.
- 285 cases were laboratory-confirmed for dengue by IgM ELISA.
- A separate adult and paediatric ward was identified in the hospital for admission of dengue patients where all beds were provided with the bed-nets.
- All on-duty physicians and pediatricians were found working at the hospital.
- Blood platelets, plasma cell volume and dengue serology diagnostics (IgM ELISA) were available in the hospital round the clock.
- Blood bank had adequate stock of blood for blood transfusion, whenever needed.

(iv) Prevention and control activities undertaken by district health authorities

The district authorities played a key role in containing density of the dengue vector, *Aedes aegypti*, by organizing periodic antilarval spray and fogging activities. These teams adopted a novel *modus operandi* by classifying the affected regions into high risk and low risk blocks for administering antilarval and fogging activities. Entomological surveys were carried out during both before and after the outbreak months in the affected blocks so as to deplete any increase in the *Stegomyia* indices. Some key measures adopted by the health administration included the following:

- District hospitals of Nagapattinam and Thiruvavar Medical College were well equipped with diagnostic kits such as ELISA, and other necessary infrastructure.
- Anti-larval and fogging operations were conducted in all the 10 blocks.
- A total of 12 teams in urban and 10 teams in rural areas

were formed to carry out the antilarval and fogging operations.

- A 6-day working block was organized at the Subcenter level under strict vigilance by both the junior as well as the Senior Entomologist.
- District coordination meetings were regularly held at all levels in the district.
- Dengue awareness, sensitization meetings, IEC materials' exhibition were carried out at the community level.

(v) Dengue profile during and before outbreak

As evident from Table 3, dengue cases surged typically with the onset of South-West Monsoon and the first cases occurred in June, which gradually culminated in October. Since October onward the incidence declined steadily. The first, and the last, instance of mortality, however, was recorded in September. It is obvious from the Fig. 3 that maximum cases occurred in the second and third weeks of October, particularly the former.

Table 3: Month wise distribution of dengue cases and deaths in district Nagapattinam (till 22nd Nov., 2012)

Month	Cases	Death
January	3	0
February	0	0
March	0	0
April	2	0
May	0	0
June	7	0
July	2	0
August	6	0
September	61	2
October	159	0
November	59	0
Total	299	2

* Source: NVBDCP, Tamil Nadu.

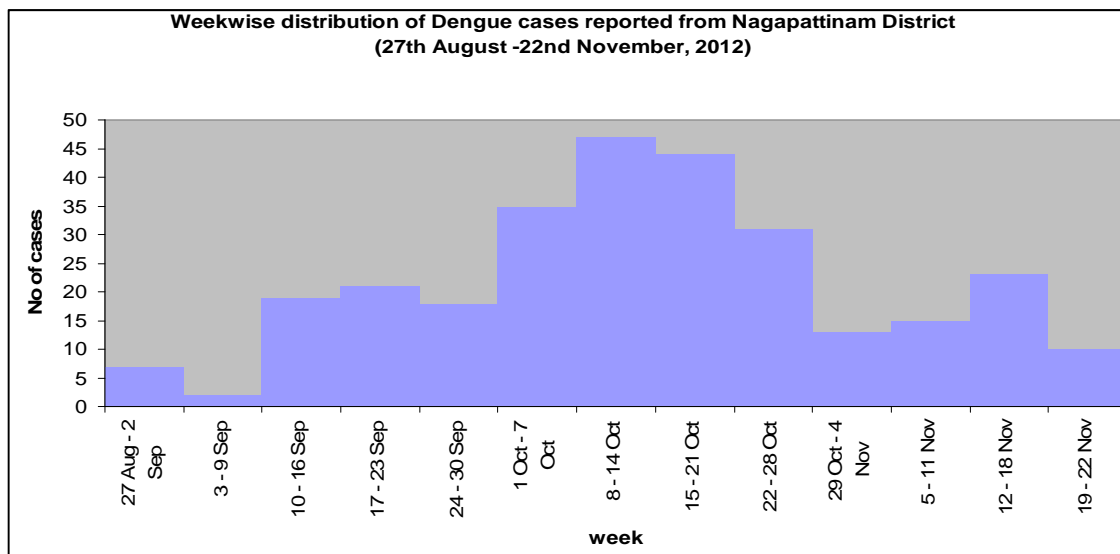


Fig 3: Week wise distribution of dengue cases reported from Nagapattinam

District from Aug. 27 to Nov. 22, 2012.

On block-wise analysis of distribution of dengue cases it became apparent that the maximum cases were reported from the Vadugachery block in the central Nagapattinam town (total cases 14 between September and November), where the outbreak has exacted two deaths as well, followed by

Sembanarkoil (57 cases) and Sirkazhi (17 cases) for the same period. Although all age groups were found affected, nevertheless more cases occurred in early age groups (< 40 yrs) with maximum cases hailing from 5-14 yrs. age group, followed by 0-4, 15-29, 30-44 yrs. age groups, respectively, in that order Table 5

Table 4: Block wise distribution of dengue cases, district Nagapattinam

S No.	Block	September	October	November
1	Vadugachery (Nagapattinam)	45 (2 deaths)	70	25
2	Keezhaiyur	3	12	5
3	Keelvelur	2	3	2
4	Thalanayar	0	5	4
5	Vedaranyam	0	2	2
6	Thirumarugal	3	5	2
7	Mayiladuthurai	0	1	0
8	Kollidam	0	11	3
9	Sembanarkoil	3	39	15
10	Sirkazhi	5	11	1

Table 5: Age-wise distribution of dengue cases in Nagapattinam district

Age group	Male	Female
0 – 4yrs	28	40
05 -14 yrs	63	66
15 – 29 yrs	21	22
30 – 44 yrs	10	21
45 – 59 yrs	1	5
60 above	2	0

Entomological findings

During entomological surveys made in all the affected areas, larval breeding of the vector, *Aedes aegypti*, was found quite high considering vector breeding control measures conducted on war-footing, with house index (HI) ranging between 5.6 and 9.6 and container index (CI) between 5.6 and 10.5 (Fig. 4). The worst dengue-affected Nagapattinam block lies bordering the coastal region where the dwellings have been abandoned and locked following the 2004 tsunami. Many of these ravaged clusters of houses had subsequently given way to the ceiling and become more or less roofless. Such situations, coupled with old and irreparable abandoned boats and construction sites, were often found to be breeding heavily with the vector, *Ae. aegypti*, even long after the rains had ceased to occur. Others breeding habitats for the vector in the block included unused, stacked tyres, fishing barrels, flexible banners, water collecting tray under the refrigerator, plastic containers, coconut shells etc. (Fig. 4). Due to scarcity of electricity in the district, the community has adopted water storing practices such as cement cisterns and ground level sumps.

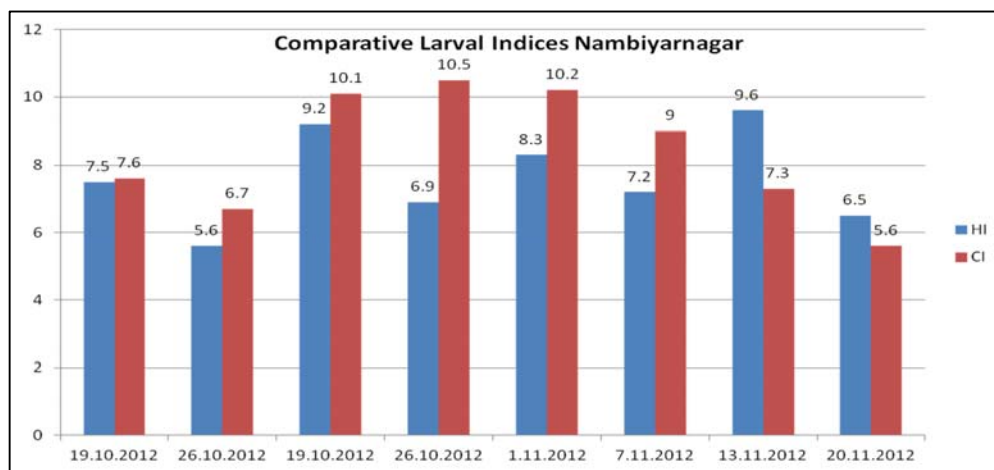


Fig 4: Larval indices in Nagapattinam block (Nambiyarnagar)



Fig 5: Environmental factors include roofless houses, abandoned boats.

(a) Nambiyarnagar (an urban area under Nagapattinam municipality)

Nambiyarnagar ward consisted of 716 households which were all periodically monitored by municipality and local bodies for antilarval and fogging activities. Daily fever surveillance, entomological survey and source reduction activities were carried out in Nambiyarnagar.

(b) Keechankupam Village (PHC: Vadavur; SC: Akkarepetai)

PHC Vadavur has eight Subcenters and 24 villages. Village Keechankupam has 302 households and is located near Nambiyarnagar. A team consisting of Health Nurse, Health Inspector supervised the antilarval and fogging activities in the village. Daily fever surveillance, entomological survey and source reduction activities were conducted with the help of

community and monitored by the Centre's team. Houses were surveyed for breeding sites of mosquitoes such as plastic cans, vases, urns, underground cement tanks etc. Due to scarcity of regular electricity supply, the community adopted the practice of storing water. Major occupation of the community was fishing. Most of the inhabitants were rehabilitated following the tsunami 2004 and had two-house pattern; one of these, generally the newly built house was commissioned by the Government and the other having been ravished by the typhoon of tsunami. The ravaged dwellings were however left

unattended during rains which became major breeding sites for mosquitos. Added to this were the abandoned old boats which too contributed significantly to the breeding of vectors. Fogging and antilarval activities were carried out but on surveying the team found some houses in the community were still found positive for vector breeding (Table 6). Entomological survey revealed decreasing trend but the percentages of the indices are still feasible for dengue transmission (Fig 4 & Fig 6).

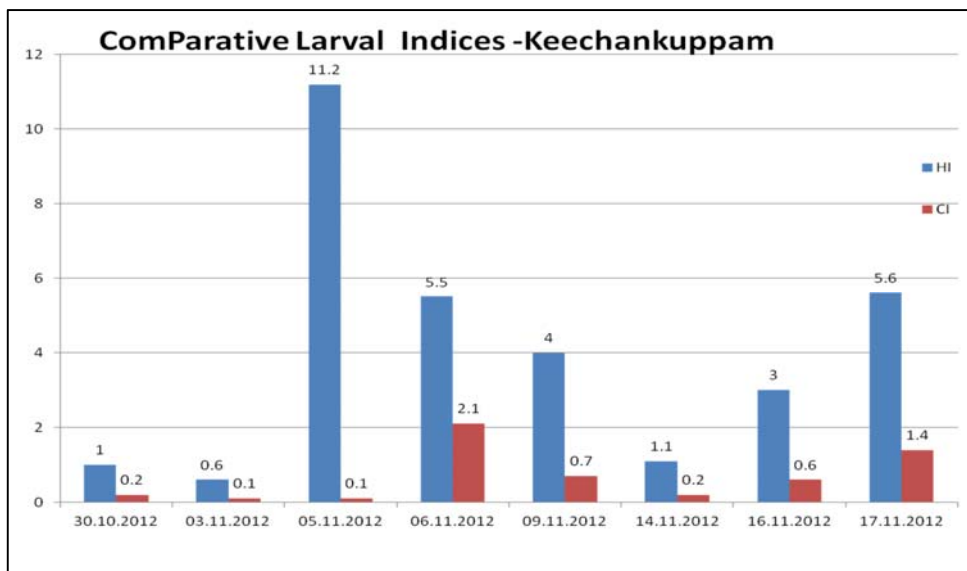


Fig 6: Larval indices in Village Keechankuppam from 30th Oct to 17th Nov 2012

(c) Thalainayar Village (Block Thalainayar; PHC Thalainayar)

IDSP reporting on forms P and L were found properly executed weekly. The OPD registered 100 cases daily in the PHC. A total of nine cases of dengue were referred to District

Hospital Nagapattinam during October and November. Fogging and antilarval activities were carried out but vector breeding persisted several houses (Table 6). Entomological survey revealed decreasing trend in view of the repeated fogging and antilarval activities (Fig: 7).

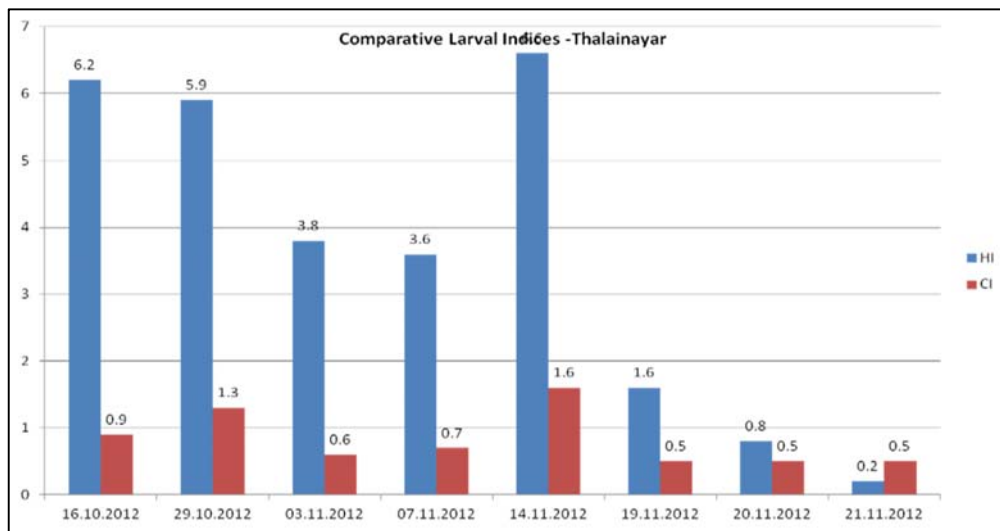


Fig 7: Larval indices in village Thalainayar from 16th Oct to 21st Nov, 2012

Entomological Survey

Larval and adult vector surveys confirmed presence of *Aedes aegypti*, *Ae. albopictus* and *Ae. vittatus* in Nagapattinam district, with entomological indices HI, CI and BI as 54.5, 35

and 63.6, respectively. One pool of *Ae. aegypti* (1 No. male) and two pools of *Ae. vittatus* (male 12 and female 12 no.) were found positive for dengue virus using ELISA (Table 7).

Table 6: Dengue immature survey in the villages of Nagapattinam

Sl No	House		Containers		Stegomyia indices		
	No Examined	No of +ve	No Examined	No of +ve	HI	CI	BI
1	11	6	20	7	54.3	35	63.6

Table 7: Virological surveillance of dengue vectors

Sl No	District	Total No of pools	Pools +ve	Pools -ve	%
1	Nagapattinam	30	3	27	10

Thiruvarur district

Thiruvarur, earlier a constituent tehsil under Thanjavur district till 1991 and, subsequently under Nagapattinam district up to 1997, finally became annexed to the Thiruvarur district and designated as its headquarters geographically situated strategically between 10 °20' N and 11 °07' S latitudes, and 79 °15' E and 79 °45' W longitudes, covering an area of 2097.09 sq. km. and a population of 12,61,677 organized in seven taluks, 10 blocks and four municipalities. The average maximum temperature during the summer remains around 39 °C and the relative humidity about 60-65%. The average annual rainfall is app. 967 mm.

On 25th November, a discussion was made with the Thiruvarur Medical College authorities including Dr. Mahadevan, Dean, Dr. Chinnappan, Medical Superintendent, Dr. Sundar, RMO, Dr. Kannapiran, Deputy Superintendent, Dr. Ramamani, Paediatric Chief, Dr. Ashika, HOD Microbiology. Following observations emerged:

- Thiruvarur Medical College was identified as a Sentinel Surveillance Hospital for dengue under NVBDCP for tackling the current outbreak.

- A total of 3136 fever cases were examined during November out of which 148 were lab confirmed Dengue (IgM ELISA).
- A separate ward each for adults and paediatric were identified in the hospital for admission of dengue patients.
- All beds in the ward had bed nets.
- Physician and Pediatricians were positioned at the hospital.
- Plasma cell volume and dengue serology kits (IgM ELISA) were available round the clock in the hospital.
- Blood bank had adequate stock of blood for blood transfusion.
- National guidelines were followed for case management practices.

Entomological survey

Larval surveys conducted in Thiruvarur district showed the *Stegomyia* indices HI, CI and BI as 66.6, 50 and 100, respectively. A pool of female *Ae. albopictus* was found positive for dengue virus using ELISA (Table 8,9).

Table 8: Dengue immature survey in the villages of Tiruvarur

Sl. No	House		Containers		Stegomyia indices		
	No Examined	No of +ve	No Examined	No of +ve	HI	CI	BI
1	3	2	6	3	66.6	50	100

Table 9: Virological surveillance of dengue vector, *Ae. Albopictus*

Sl No	Total No of pools	Pools +ve	Pools -ve	%
1	7	1	6	14.2

Thanjavur district

Thanjavur is situated in the eastern coast of the state of Tamil Nadu. Geographically, Thanjavur is placed in between 9 50' and 11 25' North latitude and 78 45' and 70 25' East longitude. District Thanjavur has a population of 23, 64, 714 (as per 2011 census) and is divided in eight taluks, 14 blocks and three municipalities (Table 10). The average maximum temperature during the summers remains around 40 °C. The average annual rainfall is around 1113 mm.

Table 10: Health care delivery infrastructure in District Thanjavur

S. No.	Health Facility	Quantity
1	Medical college	1
2	District Hospital	1
3	No. Taluk hospital	8
4	Blocks	14
5	PHC	63
6	Subcenter	309
7	Villages	589

On 26th November 2012, a detailed interactive discussion was made with the District Collector, Mr. K. Baskaran and Dr. P. Kannan, Additional Director (Malaria & Filariasis), Dr. A.

Mohan, Deputy Director, Thanjavur, Dr. H. Mol Jaw, Joint Director Health Services (Hospital), Dr. P. Srinivasan, MHO, Thanjavur Municipality, Mr. N. Ravichandran, Municipal Commissioner, Thanjavur, Dr. Ananthkrishnan, Fever Management Coordinator, and Dr. Kumar, Senior Entomologist, ZET, Thanjavur. During the discussion the following observations emerged:

- A total of 612 cases and three deaths of dengue reported from January to November, 2012 (Table 11).
- Three dengue deaths were reported from blocks Pattukottai, Peravurani and Thanjavur during June to October 2012.
- An increased trend in dengue cases was observed from mid-October to first week of November 2012 (Fig 8).
- Block Thanjavur was majorly affected (307 cases and one death) having a population of 5, 10, 411.
- The dengue cases were also reported from blocks namely Pattukottai, Orathanadu, Thiruvaiyaru.
- All age group were affected (Table 12, 13).
- Entomological indices were found conducive for dengue spread.
- Man-made environmental factors were supporting for *Aedes* mosquito breeding (Fig 9).
- Diagnostic treatment facilities were available at district hospital; mosquito breeding source reduction and Information educational communication were carried out by health department.

Table 11: Month wise distribution of dengue cases and deaths, district Thanjavur

Month	Cases	Deaths
January	1	0
February	4	0
March	2	0
April	2	0
May	3	0
June	8	1
July	16	0
August	15	0
September	40	1
October	309	1
November	212	0
Total	612	3

* Source: NVBDCP, Tamil Nadu.

Table 12: Block wise distribution of dengue cases in Thanjavur

Sl No	Blocks	September	October	November
		Cases	Cases	Cases
1	Thiruvaiyaru	0	31	14
2	Papanasam	0	7	13
3	Kumbakonam	1	14	4
4	Thirupanandal	0	1	0
5	Thiruvudaimaruthur	1	3	3
6	Ammappettai	2	4	10
7	Orathanadu	4	17	17
8	Madukkur	0	1	2
9	Pattukottai	1	17	17
10	Sethubavachatiram	1	1	2
11	Peravurani	6 (1 death)	14	6
12	Thiruvonam	3	12	9
13	Budalur	0	7	9
14	Thanjavur	21(1death)	180	106

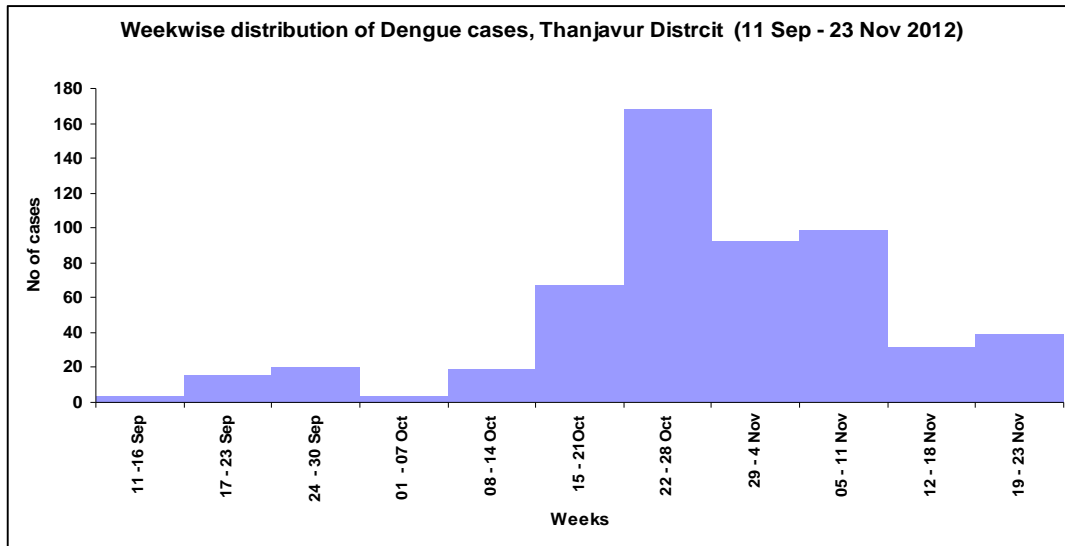


Fig 8: Week-wise distribution of dengue cases reported from Thanjavur district (11 Sep - 23 Nov, 2012)

Table 13: Age-wise distribution of dengue cases in Thanjavur district

Age group (in yrs)	Male	Female
0 - 4	23	11
05 -14	58	41
15 - 29	125	85
30 - 44	59	69
45 - 59	26	40
> 60	15	9



Fig 9: Anthropogenic environmental factors such as tyres, grinding stones, coconut nutshells

The above pictures from Thanjavur district suggested that coconut shells, grinding stones, tyres, water tanks, underground tanks etc. were the major breeding sites for

dengue transmission. Due to scarcity of electricity in the district, the community has adopted water storing practices such as cement cisterns and ground level sumps.

The district authorities and municipal authorities played a key role in controlling dengue vector by organizing teams for antilarval and fogging activities. Entomological survey carried out as pre and post survey in the affected blocks revealed decreasing trend but the percentages of the indices are still feasible for dengue transmission.

On 27th November 2012, the central team did a field visit in the affected block. The following affected areas were visited

Thanjavur municipality (Ward No. 21, 20, 36, 38) Urban area

The municipality is divided into 51 wards with a population of 2-32-361. Survey for *Stegomyia* indices on vector larval prevalence was carried out in four wards, viz., No. 21-20-36 and 38. House-to-house survey was done to detect breeding, despite antilarval and fogging activities. Fever cases were reported in Ward No.20 (3 fever cases), N0. 21 (3 cases), No. 36 (2 fever cases), and in No. 38 (3 fever cases) on 23rd November 2012 who were referred to the district hospital. No fever cases were reported on 27th November 2012.

Orathanadu Village (PHC: Thelungankudikadu)

The PHC Thelungankudikadu had in place both presumptive and laboratory forms of IDSP, and the data in P form was entered in the village Orathanadu and transmitted to the district on weekly basis. A total of seven cases of dengue were reported between September to and November, 2012.

House-to-house survey for detecting vector breeding was carried out in the village Orathanadu and many households were found positive despite antilarval and fogging operations (Table 14). The record of daily fever surveillance and antilarval activity of Village Health Nurse and Health Inspectors were analyzed. No fever cases were reported during last week.

Village Papanadu (PHC: Pappanadu)

House-to-house survey for fever cases and vector breeding was made (Table 14). Larval surveys showed the *Stegomyia* indices HI, CI and BI as 38.8, 17.4 and 44.4, respectively. One pool (five males) of *Ae. aegypti* was found positive to dengue virus using ELISA (Table 15).

Table 14: Dengue vector immature survey in the villages of Thanjavur

SI No	House		Containers		Stegomyia indices		
	No Examined	No of +ve	No Examined	No of +ve	HI	CI	BI
1	14	8	26	10	38.8	17.4	44.4

Table 15: Virological surveillance of dengue vectors

SI No	Total No of pools	Pools +ve	Pools -ve	%
1	29	1	28	3.4

Discussion

Tamil Nadu is endemic to dengue for decades, but occurrence of an outbreak following a tsunami (December 24, 2004) in any district was witnessed for the first time. Tsunami water had filled low lying offshore areas which became breeding sites for various kinds of mosquitoes. Amongst all the districts, Nagapattinam was worst affected, whereby it attracted the maximum rehabilitation activities subsequently. A hoard of assistances was provided including housing, boats etc. Tamil Nadu in 2012 experienced an unprecedented rain preceded by early monsoon showers [9]. The monsoon hailstorms were so intense that most of the coastal districts, particularly Nagapattinam, Thanjavur and Thiruvarur were abundantly inundated in parts [10]. Abandoned boats and households, besides, other associated reasons, attracted heavy *Aedes* breeding that resulted in intensive and extensive biting by the vector mosquitoes, particularly *Ae. aegypti*, though *Ae. albopictus* was also infrequently encountered.

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