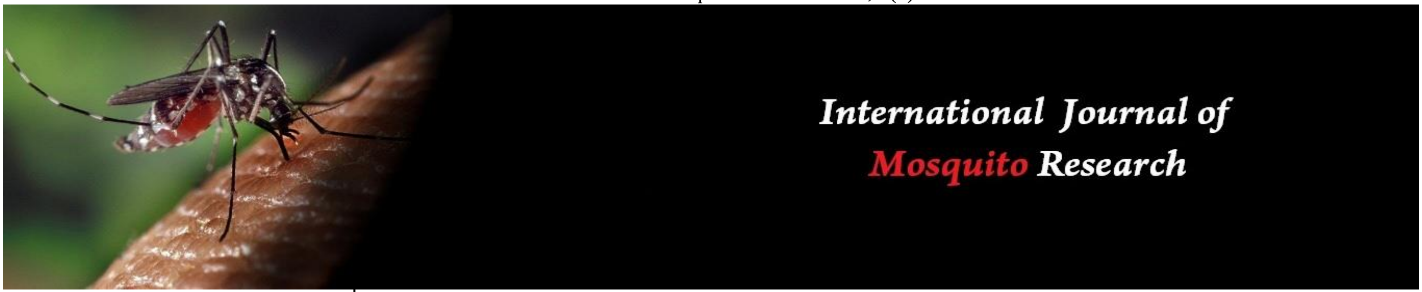

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Post flood vector borne disease surveillance: An experience from Malappuram district of Kerala, India in 2018

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Abstract
Vector-borne diseases are illnesses which are caused by pathogens and parasites in human populations. More than one billion people every year are infected and more than one million people die from vector-borne diseases, including malaria, dengue, yellow fever, lymphatic filariasis and onchocerciasis. One sixth of the ill health suffered worldwide is due to vector-borne diseases, with more than half of the world's population currently estimated to be at risk of these diseases. An entomological survey was carried out extensively during 15 days from 17th September, 2018 – 1st October, 2018 following the post-flood (2018) in Malappuram district of Kerala to assess the post-disaster, epidemic risk factors, exposure to flood water and disease vectors. A total of 723 houses was surveyed from 15 villages and 21 houses had positive breeding sources for *Aedes* mosquitoes and *Culex* mosquitoes as well. Out of 1464 containers screened 23 containers were found to support the *Aedes* mosquito breeding. In our study the HI, CI, BI, and PI varied from 1.8– 11.5, 0.8 – 5.4, 1.8 – 11.5 and 00 – 6 respectively. The highest breeding habitat for *Aedes* was tyres followed by plastic storage and earthen pot. Our study implies that the two villages have high larval indices and so many potential containers were found in all villages. Thus, it is evident that plenty of empty containers is responsible for endemicity of dengue and it can give rise to outbreak at any point of time if control measures are not taken.

Keywords: Dengue, chikungunya, *Aedes aegypti*, larval indices, breteau index, Malappuram

Introduction

Vectors are living beings which can transmit infectious diseases between humans or from animals to humans. Among these vectors, many are blood sucking insects that consume disease-producing micro-organisms during a blood meal from an infected host (human or animal) and later inject them into a new host during their next blood meal. Mosquitoes are the best known disease vector. Others include certain species of flies, sand flies, fleas, ticks, mites, bugs and freshwater snails. Vector-borne diseases are illnesses which are caused by pathogens and parasites in human populations. More than one billion people every year are infected and more than one million people die from vector-borne diseases, including malaria, dengue, chikungunya, Zika, yellow fever, lymphatic filariasis and onchocerciasis. One sixth of the ill health suffered worldwide is due to vector-borne diseases, with more than half of the world's population currently estimated to be at risk of these diseases. The poorest segments of society and the least-developed countries are most affected. [1] Nowadays dengue fever, one of the mosquito borne diseases, has created havoc to all over the world. It is an acute febrile illness and is a crucial public health problem. Every year newer area of the world is invaded by this frightful dengue infection. The disease may cause haemorrhages and plasma leakage giving birth to fatal diseases; the dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS) respectively (WHO, 1997) which are the main causes of infant mortality. In India, DF and DHF has knocked the doors of many different parts of the country including southern India. Globally, it has been reported that 2.5 billion people are at risk and this disease is found all over the world [2]. Natural calamities, particularly meteorological events such as tornado, hurricanes, cyclones, earthquake and flooding can affect vector breeding sites and vector-borne disease transmission. While preceding flood may wash away existing mosquito breeding sites, following natural calamities: Risk assessment and priority interventions by the overflow of rivers or heavy rainfall can create new breeding sites which can result in an increase of the vector population and potential for transmission of diseases, depending on the local mosquito vector species and its preferred habitat. Malaria outbreaks in the awake of flooding are a well-known phenomena. El Nino-Southern Oscillation linked by a periodic flooding has been associated with malaria epidemics in the dry coastal region of northern Peru. Meteorological conditions including rainfall and humidity influenced the dengue transmission and often exhibits strong seasonality. However, transmission indirectly associated with flooding. Such events may concur with periods of high transmission risk and be worsened by increased availability of vector breeding sites – mainly artificial containers – caused by disturbance of basic water supply and solid waste disposal services. Specific preventive interventions for malaria, which can be caused by natural disasters must be based on an informed assessment of the local situation. Early detection of an impending malaria outbreak can be strengthen by monitoring weekly case numbers which must be part of the early warning/surveillance system. Periodic laboratory confirmation of rapid test-positive fever cases are recommended to trace the test positivity rate. For dengue, the main preventive efforts should be directed towards vector control [3]. It is also advisable to have plans for hospitalization, emergency vector control, advocacy, community mobilization, logistics and monitoring and evaluation in the case of the increased risk or presence of vector-borne diseases. Both early recognition of the disease and thorough knowledge of the anticipated clinical manifestation in successive phases of disease are the basis for effective case management. Also prompt notification of infections and their locations must be communicated to the emergency response unit to facilitate detection and management of outbreaks [4]. On the day of 16th August 2018, severe floods affected Kerala, due to unusually severe rainfall during the monsoon season. It was the worst flood in Kerala in nearly 100 years. Over 483 people were dying and 140 went missing. About millions of people were evacuated, mainly from Aranmula, Pandanad, Chengannur Edanad, Ranni, Kozhencherry, Ayiror, Malappuram, Pandalam, Kuttanad, Aluva, Vallamkulam, Thiruvalla, Chellanam, North Paravur, Vypin Island and Palakkad. All 14 districts of Kerala were placed on red alert. One-sixth of the total population of Kerala had been directly affected by the floods and related incidents according to the Kerala government. The Indian government also had declared it "calamity of a severe nature" or a Level 3 Calamity [4]. The aim of the study is for the analysis of the situation for surveillance of Dengue and other vector borne diseases in Malappuram district of Kerala in post flood period.

Fig 1: Photos showing flood affected areas of Kerala

Materials and methods

Study area

A team of Emergency Medical Relief (EMR) was formed by the Ministry of Health and Family Welfare, Government of India comprising of Epidemiologist, Entomologist and Microbiologist for post-disaster outbreak risk assessment after the flood event. An entomologist visited the flood affected areas in Malappuram districts of Kerala to assess the post-disaster, epidemic risk factors, including sanitation, living conditions of flood affected populations, exposure to flood water and exposure to disease vectors. Malappuram is a revenue district in the Indian state of Kerala and is located in the southern part of the former Malabar district. The name of the district is given by the city of Malappuram, the district headquarters itself. It is the most populous district in Kerala, which is home to about 12.3% of the total population of the state. The temperature of Malappuram is almost steady throughout the year. It has a tropical climate. It also has significant rainfall in most of the months, with a short dry season. The district is located at 75°E - 77°E longitude and 10°N - 12°N latitude in the geographical map and is the most populous district of Kerala. As of the 2011 census, 12.31% of the total population of Kerala reside in Malappuram.

Fig 2: Map showing different study locations of Malappuram district, Kerala

Entomological surveillance

The study was conducted during 15 days from17th September, 2018 – 1st October, 2018. The survey was done by one entomologist accompanied by a staff (Health Inspector / medico-social worker). Severe floods affected Kerala in the month of August, 2018. The entomological survey was carried out extensively (covering large areas) following the post- flood (2018) in Malappuram district of Kerala. The study was performed in randomly selected houses in different areas of Malappuram district, Kerala, India (namely, Manjeri, Perinthalmanna, Ponnani, Neduva, Oorakam, Othukkungal, Kottakkal, Pookkottur, Chungathara, Kuzhimanna, Makkaraparamba, Ponmala, Mankada, Valenchery and Moorkkanad). Various breeding sources of *Aedes, Culex and Anopheles* mosquitoes were operating in our study.

Larval Collection

All indoor and outdoor breeding habitats were examined to collect the *Aedes* as well as *Culex* immature. A container which contains any amount of water was considered as the wet container and the wet container containing any number of immature (larvae, pupae or both) was considered as positive container. Service M W (1993) which describes the habitat evaluation method was adopted in collecting the larvae from different habitats using appropriate sampling method (e.g. dipping, pipetting, etc.) [5]. The immatures were collected using different immature collecting materials like pipettes, dipper, strainer depending upon the type and size of breeding sources. The collected immatures were kept in plastic containers labeled with house identification code, name of a locality, breeding source, and date of collection. The samples were carried to the laboratory and immature (larvae and pupae) were counted and reared in enamel trays for their emergence into adults. The larval identification was done by using standard keys [6]. The data were analyzed and different indices like house index (HI, percentage of houses), container index (CI, percentage of containers positive for larvae), Breteau index (BI, number of positive containers per 100 houses) were calculated and pupal index (PI, percentage of houses positive for pupae per 100 houses).

Adult collection

Adult female mosquitoes were collected from the same premises as those which were studied during the larval survey. To collect the female adult mosquitoes both indoor and outdoor resting places were searched using oral aspirators/mechanical and flash torch was used to locate the resting places of mosquitoes from dark areas. The collected adult mosquitoes were stored in test tubes which were labelled with locality name, house identification code and date of collection. The mosquito density was calculated by means of per man hour density (PMHD), the number of mosquitoes collected by a man in an hour using a mechanical aspirator.

Results and Discussion

A total of 723 houses was surveyed from 15 villages (Table 1) and 21 houses were had positive breeding sources for *Aedes* mosquitoes and *Culex* mosquitoes as well. Artificial and natural breeding sources were examined in which out of 1464 containers searched 23 containers were found to support the *Aedes* mosquito breeding (Table 1). The various larval indices were calculated on the basis of positive houses and positive containers which were observed to determine the distribution dynamics of *Aedes* species and to detect the dengue prone areas. In our study the HI, CI, BI, and PI varied from 1.8–11.5, 0.8 – 5.4, 1.8 – 11.5 and 00 – 6 respectively (Table 1). *Aedes* breeding sources were observed in Plastic storage, Unused plastic, Aluminium container, Coconut shell, Sewage pipe, Rubber latex, Syntax tank, Planted pot, Earthen pot, Grinding stone, Tires and Unused commode (Table 2). The highest breeding habitat for *Aedes* was tyres followed by plastic storage and the earthen pot. Potential breeding habitats of *Aedes* were uncovered wells, empty coconut shells, unused toys, unused steel containers, planted pots, Tarpaulin, Aluminum sheets, containers made of leaves, cement pits, leaflets, discarded commode, water filled coconut shells, grinding stone, rubber bowl, empty ice cream box. Adult mosquitoes were also collected from the surveyed areas and no *Aede*s mosquitoes were collected. Adult mosquitoes collected were mostly *Culex quinquefasciatus* and *Armigeres* species. Per man hour density were calculated and per dip density were also calculated for Culex mosquitoes. Details of adult mosquitoes with their per man hour density and per dip density is shown in Table 3.

In our study the highest larval indices were founded in Moorkkanad (Ward nos. 10 and 11) of indices H.I-11.5, C.I-5.04 and B. I- 11.5 followed by Valancheri (Ward nos. 17 and 18). Other villages are below the critical level and there is no risk of transmission in the areas. In the 15 villages surveyed most of the houses have wells which contain larvivorous fish. Most of the villages were maintaining hygiene and kept their surroundings clean. Most of the houses have empty coconut shells in their surroundings and were made them to keep inverted on the spot during surveys which can be the breeding potential of mosquitoes. Control of mosquito by environmental management was done simultaneously during survey in which people were made to remove water holding containers in and around their surroundings. People were also made them aware that different types of water holding containers could be the potential breeding places of *Aedes* mosquitoes which causes Dengue, Chikungunya and yellow fever. *Culex* breeding places were also observed in polluted containers, wells and cemented drain pits. In some villages it was observed that people live in a remote area near paddy fields, rice fields and running water nearby their house which could be the potential breeding places of *Anopheles* mosquitoes. Even though after flood there is a great possibility of a Vector borne disease outbreak, but it happens unlikely in Kerala that most of the containers were dried and larval indices were low in most of the villages surveyed. This could be due to shortage of rain after the flood. The weather was dry and humid which in turn could be the reason for less breeding of mosquitoes. A study, which was conducted in urban areas of Ernakulam district, Kerala, India, revealed that *Aedes* indices were high during the month of June and lowest in the month of February which were almost corresponds with our study in which our survey was done in the month of September and our indices were not high [7]. A study to calculate larval indices in the municipal area of Perinthalmanna, Kerala in 2014 showed that all the entomological indices were found to be above the critical level. The indices HI= 25.15%; CI= 10.36% and BI=73.05% showed high chances for outbreaks of mosquito borne diseases. Also, 97.6% (163 houses) were found to have potential sources of mosquito breeding, which is higher than our findings in our study [8]. A similar study was also conducted post-flood entomological surveillance in Ernakulam district of Kerala in 2018 in which their indices (House Index ranged from 2 – 18 percent, Container Index, which ranged from 0.6 – 6.3 percent and Breateau Index ranged from 1.8 – 24.8 percent) were higher than our study. Also the main potential containers with chances for mosquito breeding were plastic containers (35.7%), metal containers (21.9%), Plastic drums (9.9%) and discarded containers (8%) [9]. Another study which was conducted in rural Kerala before and after floods in 2018 two days initially in June and in September. All the larval indices were found to be above the critical level in the survey which was done in June. The larval indices (HI=36%; CI=44%; BI =143%) showed high chances for outbreaks of mosquito borne diseases while in September the indices were very low house index 1.25% container index 2.77% and Breteau index which is similar to our study [10]. Another study which was conducted in rubber plantation areas of a village in Palakkad district, Kerala, highest larval indices BI -120 was recorded in July and lowest BI- 16 in April and highest larval indices CI – 62.5 in May and lowest CI-16 in April. Similarly highest Breateau index was recorded during the monsoon season in July (120) and lowest during pre-monsoon season in April (16). Of all the containers, latex collection cup has the major breeding habitat, which constitutes about 84.12%, followed by plastic containers (4.5%), discarded coconut shell (3.03%) which can be similar to our study in which rubber latex cup were also found as a breeding habitat [11]. Another study which was conducted in Thiruvananthapuram district, Kerala, the house index, container index and the breteau index were 13.08, 13.28 and 16.57%, respectively, which is higher than our study. In outdoor the most common water holding containers found were of plastic, which is followed by coconut shells. Tyres had the highest ratio of breeding preference. Remarkably lesser positivity was found for containers during monsoon period as compared to the pre-monsoon period [12]. In general, immature surveillance and indices reflect the abundance of *Aedes* in a particular locality. Further, it is an initial step in vector surveillance and the present study showed the presence of *Aedes* vectors, their abundance, distribution, breeding habitats, breeding preference ratio and level of mixed breeding. Thus, routine *Aedes* surveillance would enable to identify high risk areas and thereby to initiate source reduction and other suitable vector control measures.

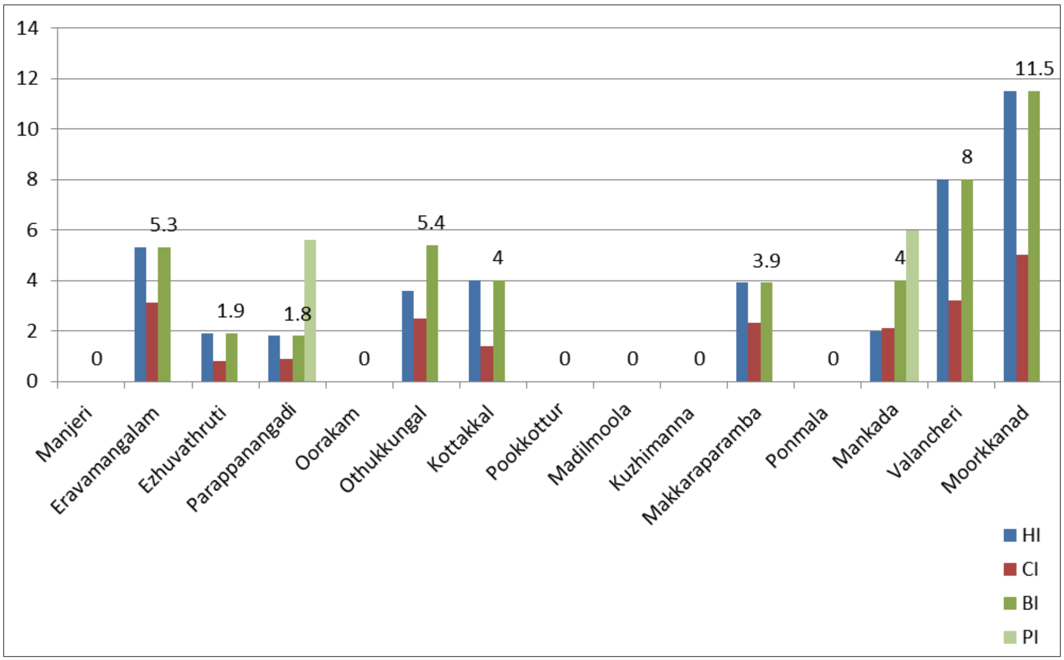

Fig 3: Graph showing larval indices of different study areas of Malappuram district of Kerala.

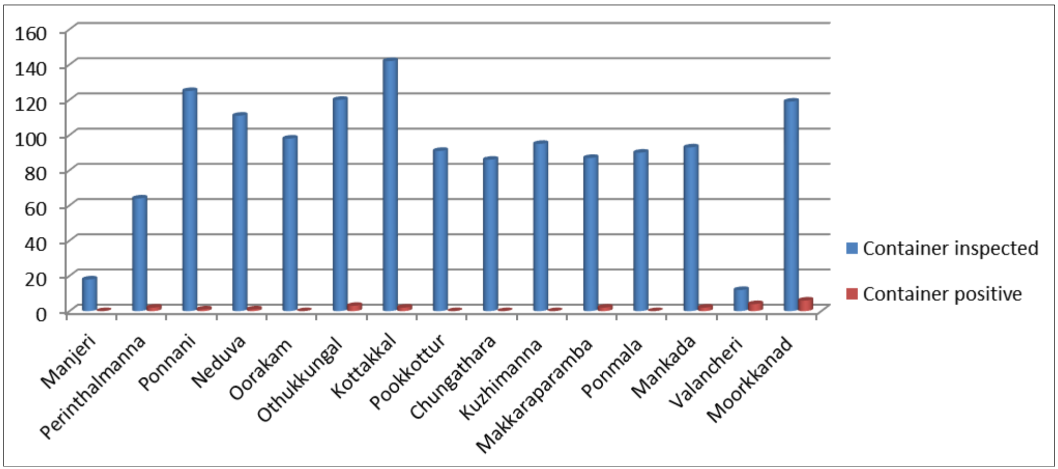

Fig 4: Graph showing comparison of container inspected and container positive in different study areas of Malappuram district of Kerala.

Fig 5: Graph showing the type of positive containers surveyed for Aedes mosquitoes

Table 1: Larval indices in different villages of Malappuram district, Kerala

Village name	Houses			Containers		Larval indices			
	Inspected	Positive for Aedes	Positive for Culex	Inspected	Positive	HI	CI	BI	PI
Manjeri	15	0	0	18	0	0	0	0	0
Perinthalmanna	38	2	0	64	2	5.3	3.1	5.3	0
Ponnani	52	1	1	125	1	1.9	0.8	1.9	0
Neduva	53	1	1	111	1	1.8	0.9	1.8	5.6
Oorakam	54	0	0	98	0	0	0	0	0
Othukkungal	55	2	0	120	3	3.6	2.5	5.4	0
Kottakkal	50	2	0	142	2	4.0	1.4	4.0	0
Pookkottur	50	0	0	91	0	0	0	0	0
Chungathara	50	0	0	86	0	0	0	0	0
Kuzhimanna	50	0	0	95	0	0	0	0	0
Makkaraparamba	51	2	0	87	2	3.9	2.3	3.9	0
Ponmala	55	0	1	90	0	0	0	0	0
Mankada	50	1	0	93	2	2	2.15	4	6
Valancheri	50	4	0	125	4	8	3.2	8	0
Moorkkanad	50	6	1	119	6	11.5	5.04	11.5	0
Total	723	21	4	1464	23				

Table 2: Infestation and breeding preference of *Aedes* species in the study areas.

S. No	Breeding preference of *Aedes* mosquito	Number of container positive for *Aedes* mosquitoes
1	Plastic storage	3
2	Unused plastic	2
3	Aluminium container	1
4	Coconut shell	1
5	Sewage pipe	1
6	Rubber latex	1
7	Syntax tank	1
8	Planted pot	2
9	Earthen pot	3
10	Grinding stone	2
11	Tyres	5
12	Unused commode	1

Table 3: Adult collected in different villages of Malappuram district, Kerala

Village name	Adult collected	Per man hour density	Culex larvae per dip density
Manjeri	0	0	0
Perinthalmanna	0	0	0
Ponnani	0	0	2
Neduva	*Culexquinquefasciatus*	0.33	0
Oorakam	0	0	0
Othukkungal	*Armigerus* spp	0.33	0
Kottakkal	0	0	0
Pookkottur	0	0	0
Chungathara	0	0	0
Kuzhimanna	*Culexquinquefasciatus*	0.33	0
Makkaraparamba	0	0	0
Ponmala	*Armigeres* spp	0.33	1.33
Mankada	0	0	0
Valancheri	0	0	0
Moorkkanad	*Armigeres spp*	6	1.2

Conclusions

The study shows that the two villages have high larval indices. As noticed so many potential containers were found in all villages. Thus it is evident that plenty of empty containers is responsible for endemicity of dengue and it can give rise to outbreak at any point of time if control measures are not taken properly and unless serious action is taken with community participation, we may have to take the brunt of explosive outbreaks of disease like dengue fever and repeated attacks of which attains severe forms like hemorrhagic dengue and shock syndrome.

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