Article

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Strategies on the control and prevention of vector borne, zoonotic and water borne diseases during floods in Cuddalore District of Tamil Nadu, India

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Abstract

In the province Tamil Nadu, India has both south west and North East monsoons fall in months of June to August and October to December every year respectively. In 2015, the North East monsoon had poured 1476 mm rains and flooded everywhere in Cuddalore ***(Lat $11^0 75^{'}$ Long79^0 $50^{'}$)*** *district. It was identified that water stagnation in low lying area where human dwellings situated were stratified so as able to provide temporary shelter, food and medical care. Since the stagnation of water and its anticipation of water borne and vector borne diseases to be prevailed in the community, surveillance was intensified by the organized teams to overcome Acute Diarrheal Disease (ADD), malaria, leptospirosis, dengue, chikungunya, scrub typhus and other viral fever after raining till the normal situation brought in Cuddalore district. In its outcome, none of malaria positive cases detected from 111 blood smears collected in active and 233 blood smears in passive surveillance. However, there were one chikungunya, six dengue, five leptospirosis and five scrub typhus cases had been reported sporadically from one fifty blood serum samples collected. It was learnt that specific containment measures implemented were appropriate as their impact lead to halt their transmission within time frame of fifteen days. Besides, the roles of supportive data to stop these diseases transmission are discussed in detail in this paper.*

Key words: airborne**,** strategies, vector borne, water borne, and zoonotic diseases.

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1. Introduction

Natural disasters are catastrophic events with atmospheric, geologic and hydrologic origins. They include earthquakes, volcanic eruptions, landslides, tsunami, floods and drought. Natural disasters can have rapid or slow onset, and serious health, social and economic consequences. During the past two decades, natural disasters have killed millions of people adversely affecting the lives of at least one billion more people and resulting in substantial economic damage [1].

Developing countries are disproportionately affected because of their lack of resources, infrastructure and disaster preparedness systems. The sudden presence of large numbers of dead bodies in disaster-affected areas can heighten expectations of disease outbreaks, despite the fact that dead bodies do not pose a risk of outbreaks following natural disasters rather; the risk of outbreaks is associated with the size, health status and living conditions of the population displaced by the natural disaster. Crowding, inadequate water and sanitation, and poor access to health services, often characteristic of sudden population displacement, increase the risk of communicable disease transmission. Although the overall risk of communicable disease outbreaks is lower than often perceived, the risk of transmission of certain endemic and epidemic-prone diseases can increase following natural disasters [2-5].

In the province Tamil Nadu, India has both South west and North East monsoons in different months of June to August and October to December every year respectively. Since the North East monsoon had been brought exorbitant rains in entire state including the Cuddalore district in November 2015 to January 2016, floods was a resultant and became a disaster.

Since disasters can be measured based on claiming of lives by physical, chemical and biological in different phases like immediate, in short span and specific periods based on their magnitude of disease causing organisms those may take days to months to multiply exponentially in a susceptible group of population to express their clinical features in the form of disease, the present study was undertaken to explain the containment measures implemented to combat the possible vector borne and zoonotic diseases those would have become probable after flood in Cuddalore District **(Lat $11^0 75^{'}$ Long79^0 $50^{'}$)** and its management with available resources of man power along with the existing surveillance mechanism based on the guide lines of, National vector Borne Disease Control programme (NVBDCP), Government of India, state administration and the Directorate of Public Health and Preventive Medicine, Government of Tamil Nadu [6-11].

2. Methods

The study area Cuddalore District is in the province of Tamil Nadu, India (**Lat $11^0 75^{'}$ Long79^0 $50^{'}$**). The district has been divided into 13 Blocks in which only 11 Blocks had been affected by flood which comprised 561647 population and 135730 houses **(Table-1)** and **(Fig-1).** Among the blocks, the Cuddalore block is one of the worst floods affected blocks as 152873 populations living in 30575 houses surrounded by the rivers **Kedilam** on the South and **South Pennai** on the North and the **Bay of Bengal** is on the East which is stretched up to the entire boundary of the district. Thus, Cuddalore is the vulnerable for floods, cyclone and Tsunami by experienced in the past. The present study is focused on strategies implemented for the prevention and control of probable cases of vectorborne, water borne and Zoonotic diseases supposed to be emerged usually in the post floods.

2.1. Fever surveillance

Fevers presented in villages during flood were noticed from door to door enquiry made by Health Inspectors (HI) and Village Health Nurses (VHN) by active and by the institutional surveillance called passive surveillance. Information on fever cases obtained from out patients in Primary Health Centers (PHC), Mobile Medical Units (MMU), Sentinel surveillance hospitals and

private Nursing Homes. Blood smears collected were screened for malaria by both the malaria microscopy and Rapid Diagnostic kits. All these fever information had been converged every day to reveal the magnitude of the fever cases in the district **(Fig-2).**

For ruling out dengue, Chikungunya, Leptospirosis and scrub Typhus from suspected cases in the flood affected villages were noticed by signs and symptoms from out Patients in PHC, temporary medical camps in shelters and sentinel hospitals and they were confirmed by the Ig-M ELISA diagnostic tools followed by the standard procedures of each disease with the help of laboratory facilities available both in Zonal Entomological Team (ZET) and Public Health Laboratory, Cuddalore. In addition to that, cases of the said diseases reported in private nursing homes, Government Hospitals and the tertiary care hospital, Jawaharlal Institute of Post graduate Medical Education and Research (JIPMER), Pondicherry were also taken to incorporate in the implementation for the early prevention and control activities in the affected villages.

2.2. Special fever Survey

Since 10 imported malaria cases were reported from January to November 2015 in the village Pachayankuppam of the PHC Karaikadu in Cuddalore District, intensive larval survey was conducted with the assistance of Vector Control Research Center, (VCRC) Pondicherry and collected larvae in rain water stagnations in and around human residents and 12 used wells in the village. The collected larvae were allowed to emerge in the laboratory of the Zonal Entomological Team (ZET), Cuddalore and identified. Biological control was employed by the agent *Gambusia affinis* species fishes introduced in feasible breeding habitats of *Anopheline*. For this activity, Fishes were taken from the repository maintained by the ZET, Cuddalore.

2.3. Water borne Disease Control

To prevent water borne diseases, Acute Diarrheal disease (ADD), typhoid and leptospirosis, chlorination was made in all public drinking water storage in 655 Over Head Tanks (OHT) in different storing capacity of 30000, 60000 and 100000 liters every day with 33% chlorine content bleaching powder to bring out 1.2 ppm (parts per million) residual chlorine in OHT before releasing water for consumption. To sustain 1.2ppm chlorine in OHTs, 4gm of bleaching powder was made as paste with small amount of water and it is made to dissolve completely with some more water. Then it was kept for some time till deposit all lime in a pail and decanted into 1000 liters of drinking water. Thus, sufficient quantity of bleaching powder was used to all OHTs situated in floods affected residential areas based on their storing capacities mentioned above. Water was released after an hour of chlorination from tanks for consumption so as able to sustain 0.5 ppm in tail end of tanks for ever. External sources of water supplied by transports were also checked for chlorination by Health Inspectors (HI) regularly by a separate squad and qualitative check in drinking water to be tested by adding two drops Ortho Toludine solution (OTS) and color developed was compared by the comparator affixed either in the Chloroscope or card comparator which was simplified by the Directorate of Public Health and Preventive Medicine, Chennai. All non chlorinated sources of water were chlorinated on the spot itself by HI team **(Table-6).**

2.4 Physical parameters

To predict the acidic, alkaline nature and the ambient temperature in aquatic habitats those have been preferred by *Aedes* mosquito's, was measured by hydro thermometer and pH meter. Data arrived from these metric was analyzed **(Table-2).**

2.5 Vector Control Activities

Since, imported cases of malaria and sporadic cases of dengue, Chikungunya and scrub Typhus reported in this district in the past, vectors monitoring was initiated to control immature stages of mosquitoes in breeding sources identified in and around floods affected areas and adult

control by fogging operation. Mosquito collection was also made in human dwellings during dusk (6PM to 8PM) and dawn (6AM to 8AM) to study the impact of both larval and anti adult measures respectively. The density of *Anopheline* larvae and *Culex* larvae was expressed as positive dips out of total dips made in their habitats and adult density was expressed as Per Man Hour Density (PMHD) **(Table-3).** Simultaneously, dengue vectors habitats in containers like plastic cups, unused grinders, coconut shells, water stored barrels, cement cistern, automobile wet tyres, and sumps. It was probed door to door by Field workers in the prescribed formats (Table-3) under the supervision of Health Inspectors (HI), Junior Entomologist (JE) and Senior Entomologist (SE). The presence of *Aedes* larvae were identified in these containers with the characteristic features like wriggling movements in aquatic environment and larval taxonomic cheotaxis. The findings were expressed as House Index (HI), Container Index (CI) and Breteau Index (BI) by the formulae as follows.

HI = Number of houses presented with *Aedes* larvae / Total number of Houses searched X100

CI = Number of containers found with *Aedes* larvae / Total number of containers searched X100

BI = Number of containers found positive in 100 houses.

Aedes indices were taken as an outcome of AL work in a place or village was utilized to find out the degree of vulnerability of dengue and Chikungunya **(Table-6).** It has been known that < 1% HI and <5 BI are permissible level of indices according to the guide lines of WHO [12].

The source reduction, application of the larvicide Abate or Temephos50% Emulsifiable Concentration (EC) and *Bacillus thuringeansis Var israeliansis* (*Bti*) WP (wettable Powder) is available commercially as Bacticide marketed by Biotech International Ltd, Chennai, India was employed by Field workers.1 ppm (Parts per million) of Abate or Temephos was applied as one ml to one liter of stored water to kill larvae in 24 hours observation. Similarly, 250 grams of *Bacillus thuringeansis Var israeliansis* (*Bti*) WP was dissolved in 10 liters of water to spray over both in clean and polluted water stagnation in and around human dwelling with knapsack sprayers by the trained field workers of National Filaria Control Programme (NFCP), Chidambaram unit of Cuddalore District and found that 10 liters of formulation is sufficient to cover 500 square meters **(Table7).**

2.6. Adult mosquito control

Whenever vector mosquitoes found in flood affected areas and information on the nuisance mosquitoes, immediately, Ultra Low Volume (ULV) thermal indoors and out door fogging was performed by the Pulse Fog machines and mini Fog machines with 2% Pyrethrum extract and Diesel was used as solvent in the ratio of 1: 19. For the fogging operation, 8AM to 11 AM and late evening (3 PM to 5PM) was preferred as *Aedes* are diurnal **(Table-6).**

2.7. Entomological Surveillance

To forecasting the vector borne zoonotic disease, Japanese Encephalitis (JE), host preference studies were done in wild caught full fed JE vectors *Culex tritaeniorhynchus, culex gelidus, Anopheles barbirostris.* These mosquitoes were collected and their blood meals were blotted on 1cm radius on the Number 1 circle What man filter paper and sent them to the Directorate of National Vector Borne Diseases Control Programme (NVBDCP), Delhi for precipitin tests to find out the host preferred by the vectors. Based on that, it could be able to identify possible high risk of Acute Encephalitis Syndrome (AES) cases in a place with reference to the blood fed by mosquitoes owned

any of amplifying host of JE. If it is, all containment measures would be implemented in advance. The dried vector mosquito's pools of JE, primarily *Culex tritaeniorhynchus* (each pool contains 50 mosquitoes dried in room temperature) in a small polystyrene sachets and they were sent to the Institute of Vector Control and Zoonosis (IVCZ), Hosur, Government of Tamil Nadu by the speed post for JE antigen analysis. For this study Vector mosquitoes were collected from selected flood affected pockets where Acute Encephalitis Syndrome (AES) reported in the past was preferred **(Table- 8).**

2.8. Polymerase Chain Reaction analysis (PCR)

JE vector *Culex tritaeniorhynchus* collected from the erstwhile endemic village Suthukulam of Cuddalore block by the back Pack aspirators and subjected them for PCR analysis to find out JE virus with the help of the VCRC, Pondicherry **(Table-7).**

2.9. Fly Control

It was achieved by the removal of garbage every day as source reduction and chemical control with Dichlorvas (5%) based on its density. The density was measured by both the Scudder method and manual counting of flies on eatables, things and decayed materials accumulation in and around floods affected places. Its density was expressed as either mean number of flies in a square feet or mean number of flies per thing respectively. These methods were done in 10 spots randomly in the flood affected place and ascertained fly density [13].

2.10. Rodent control

It was achieved by the community participation through IEC as Leptospirosis and scrub typhus are spread by rodents. The serovars of Leptospirosis are found in excreta of rodents and more possibility of these wastes dissolve in flood water. Human might be got into body through aberration of skins and bare footing practices. Transmission of scrub typhus agent *Orientia tsutsugamushi* is usually through ecto parasite *Trombiculid* mites' on rodents. The immature stage of these mites called chiggers which hang on vegetation, humans supposed to be happened to get infection by its bites. Rodents are living in the close proximity of residential and temporary shelters, its control was undertaken.

2.11. Carcass removal

The dead animals were removed soon after its notification and buried safely based on public health guidelines.

2.12. Execution of control activities

Under the supervision of Deputy Director of Health services (DDHS), one senior entomologist (SE), 3 Junior Entomologists (JE), 7 Health Inspectors (HI) and 21 trained Field workers (FW) of NFCP were deployed and formed seven teams. Each team consists of 1 HI and 3 Field Workers (FW) as the following assignment; 1 FW was for the source reduction of immature stages of mosquitoes in water holding containers, application of Temephos in households and assisting the HI for Blood smear collection and serum samples; Second FW was for spraying *Bti* formulation (250 grams in 10 liters of water) in water stagnation and the third FW was for Thermal Fogging operation with Pulse Fog and mini fog machines. Thus the entire affected population covered within a week. It is summarized in the Cladogram at a glance **(Fig-3).**

2.13. Mobile Medical Team

There were fourteen Mobile Medical teams formed to conduct medical camps in all temporary shelters and flood affected villages by medical officers of Primary Health Center (PHCs) in Cuddalore District, Medical Officers deployed from non floods affected Districts, volunteer's medical professionals and Internship medical students from nearby medical colleges. Besides,

medical camps organized by Non Governmental Organizations (NGO) were also utilized to treat for flood related minor ailments and stress.

2.14. Vaccination campaign

Among vaccine preventable diseases, Diphtheria, Pertusis and Tetanus (DPT) vaccines were administered to all eligible children. Measles vaccine was administered to all nine months old eligible children through special campaign organized in all floods affected area. Likewise JE vaccination also performed by live attenuated SA 14-14-2 vaccine to 9 - 23months old children.

2.15. Information Education and Communication (IEC)

IEC on awareness created for the consumption of safe drinking water among the public by the public addressing system, phalmlets, scrolling in local cable TVs and broadcasting in FM All India Radios. For the dengue control and prevention, following three cardinal messages had been extended to the public are

1. No specific anti-pyretic available for dengue.
2. Attributes of trans-ovarian transmission in *Aedes* species mosquitoes.
3. Significances of *Aedes e*ggs those withstand desiccation in extreme temperature without water even after one year.
4. Also the significance on the preference of chlorinated drinking water, boiled water, use of bleaching powder as a disinfectant and avoiding bare foot walking were also extended.

3. Content analysis

3.1.Fever surveillance

After a week from the rain stopped, fever cases elevated was noticed from passive surveillance in PHCs, Government Hospitals, sentinel Hospitals and private nursing Homes. This information had been converged every day and screened for malaria by malaria microscopy in PHCs, Zonal Entomological Team (ZET), Cuddalore and none of indigenous positive cases reported from 344 Blood smears collected from both active and passive surveillance. Its sustainability, blood smears collected in PHCs up to March 2016 were analyzed and found negative (Table- 10).When differential diagnosis made among fever cases, 150 Blood serum were collected and tested for dengue, leptospirosis and scrub typhus by Ig-M ELISA and found that one chikungunya, six dengue, five leptospirosis and five scrub typhus cases in the floods affected population sporadically. Based on this information, all appropriate control measures implemented and stopped further transmission within 15 days by the action plan delineated. It is given in the cladogram **(Table- 5).**

Since the village Pachayankuppam of Karaikadu PHC had been reported imported cases of malaria, vector surveillance was made and found that the emergence from some of larvae were *Anopheles stephensi*, a potential malaria vector. Based on the information, anti larval work was made with the formulation of Bti and Temephos in all clean water stagnation except wells. In wells, there were 48 pairs of *Gambusia affinis* fishes, the biological control agent were introduced. As its outcome, no malaria vector mosquitoes caught from both dusk and dawn collection in subsequent months.

3.2.Water borne disease control

There was no outbreak of water borne diseases, typhoid, and jaundice in all floods affected area whereas 25 ADD cased reported sporadically. Then the chlorination was tightened up in 761 drinking water sources. Out of them 564 places alone found residual chlorine qualitatively on the first day of intervention. It was achieved only 74%, remaining 26% lacuna was substituted by the supply of protected drinking water by local bodies and non Governmental Organization (NGOs). Along with, awareness was created on the consumption of safe drinking water by the public addressing system, intra personal communication, broadcasting in All India Radio (AIR) and pamphlets in which the

most important public health message were promulgated particularly, waterborne and zoonotic diseases. Sanitation and chlorination was initiated by the supply of 250 grams of 33% chlorine content bleaching powder to every household to chlorinate themselves and to disinfect the environment in and around their residents. To predict the prevalence of leptospirosis, 150 blood serum samples were tested by Ig-M- ELISA and found 5 positive cases sporadically.

3.3.Vector borne and Zoonotic diseases control

From the intensive fever surveillance of both active and passive in which probable cases of Leptospirosis, scrub typhus and dengue were identified in 150 random serum samples lifted from individuals with signs and symptoms of respective diseases. Out of them, 5 Leptospirosis, 5 scrub typhus and six dengue cases reported since 11.12.2015 to 09.01.2016 in the flood affected Cuddalore Block and it is evident that the big threat had been averted as these diseases were noticed earlier and interventional measures for their control implemented in advance. It's evident that these diseases had been stopped within their one incubation. After 15 days, there were 90 blood serum samples collected and tested for these diseases found negative.

Leptospirosis was controlled by *Bti* application in all stagnation by Knapsack sprayers and improved the environmental sanitation with the help of local bodies (municipalities) in villages and town panchayats. Bti was sprayed over 244.3 square kilo meters during the surveillance. All positive cases of leptospirosis were treated with Doxycycline 400 mg tablets Bi day for 7 days and follow-up had also been taken to avoid it further.

Scrub typhus was controlled by abating rodent's population by Rat traps installed in human dwellings and health education. All positive cases of scrub typhus were treated with Doxycycline and there was no further spread from these cases found.

Since dengue cases have been reported from 2015 in the months of the North West monsoon August to December every year, intensive surveillance in which source reduction of *Aedes* breeding, application of Temephos 50% EC or Abate in wet containers and by fogging operation for adult control was implemented on war foot basis. The outcome of these measures was monitored by indices HI, CI and BI generated and the existence of *Aedes aegypti* was monitored by the mosquito collection during dawn and dusk randomly in all floods affected places to know its fauna **(Table- 6).**

Probing the *Aedes* indices, both House Index and Breteau Index was 8.7% and 8.7 respectively. These indices had been brought to 0.8 within 15 days and its sustainability; it was being monitored till 45 day from the day of intervention. The indices were arrived from the survey made from the day 1 to 47 days in which the range of HI and BI were analyzed and found that the range of HI was 10.08 to 0.8; CI was 3.4 to 0.01 and the BI was 14 to 0.8.

Further, the preference of habitats of *Aedes* mosquitoes had been known that plastic containers, earthenware, automobile tyres, country grinder, refrigerators, coconut shell, sumps, broken bottles, ground level reservoir, OHT, tea cups and egg shell. Among them, plastic containers are predominant as it had contributed 52% and remaining habitats were contributed as 14.4%, 12.1%, 7.8%, 3.5%, 2.7%, 1.5%, 1.5%, 1.2%, 0.4% and 0.1% respectively **(Fig- 4)**

From the fauna of mosquitoes in different flood affected areas of both Fixed and random catching stations, it was known that the existence of both the dengue vectors *Aedes albopictus* and *Aedes aegypti.* The density of *Aedes albopictus* and *Aedes aegypti* had become to 4 MHD on the 15th day of intervention from 40 10 MHD and 20 10 MHD respectively (**Table- 3**).

3.4.Physical parameters

To understand the physical and chemical nature of aquatic habitats preferred by *Aedes* mosquitoes, it was known that ambient mean temperature is 27^0 C and medium which Aedes species mosquito's preferred was alkaline **(Table-2).**

3.5.Entomological Surveillance

Other than dengue, Chikungunya, leptospirosis and scrub typhus, Japanese encephalitis surveillance was made in the erstwhile JE endemic village Suthukulam by precipitin tests through blood meal papers and antigen analysis in dried mosquitoes of JE vectors *Culex tritaeniorhynchus* and *Culex gelidus*. It was found that none of them were positive from 80 numbers of blood meal papers and 6 number of dried pools analyzed. Further, the efforts made to determine JE virus in *Culex tritaeniorhynchus* by PCR found negative. Hence JE transmission was known as free in the village during the flood**.**

3.6.Mobile Medical Team

There were 14 Mobile Medical Teams Unit (MMU) formed in Cuddalore Block and they had been functioning for one month and rendered their service to the public on need basis. Scrutinizing the morbidity among 10102 out patients, 2292 were fever and it was 1.5% of the affected population. Next to fever cases, there were 125 minor injuries and25 Acute Diarrheal Disease (ADD) found by the MMU.

3.7.Vaccination campaign

To anticipate the disease Measles soon after floods, Measles vaccine campaign was conducted by teams formed for the entire Cuddalore district and measles vaccine administered to 94185 children of 9 months to 5 years old and 241962 children of 5 years to 15 years old. Thus 336147 children benefitted during the special vaccine campaign. Similarly 3221 doses of Anti Rabies Vaccine (ARV) were used during the post flood phase **(Table-9)**.

3.8. Fly Control

It was achieved by insecticide Dichlorvas 5% which sprayed over the accumulation of garbage and in and around temporary shelters. At the beginning, House fly density was 8 per square feet by Scudder method and 12 per thing. After that it had become 1.5 per square feet and 0.2 per thing within a week due to the sanitation improved.

4. Discussion

Human population density and behavior, housing type and location, water supply, sewage and waste management systems, land use and irrigation systems, availability and use of vector control programmes are a few social and demographic factors for the disease distribution in a place with the influence of meteorological factors, temperature, humidity and rain fall patterns [1].The inter governmental panel on Climate Change noted in its 2007 report that climate change may contribute to expanding risk areas for infectious diseases such as dengue and may increase the burden of diarrheal diseases, putting more people at risk [15].

From the present study it has been known that there were no such waterborne, vector borne and zoonotic diseases outbreaks in Cuddalore district after floods by the strategies employed. Further, the strategies delineated were based on integration and co-ordination over components of diseases to be emerged after flooding with reference to measures undertaken in developed countries. Chlorination tightened in all resources of drinking water supply and health education promulgated by all modes of media so as able to reach to the community is reasons to stop ADD and not to spread further. As a collateral benefit of chlorination in all drinking water sources and application of *Bti* formulation in stagnant waters and supply of 250 grams of bleaching powder to each household to involve them for their peri domestic sanitation yielded none of typhoid and leptospirosis outbreak in affected areas except 5 sporadically cases of leptospirosis at the beginning. To prevent typhoid cases, intensive fly control activities with the help of garbage removal then and there in and around flood affected areas and temporary shelters and application of Dichlorvas, the insecticide was also taken part to prevent these diseases.

In developed countries, flood control efforts, sanitation infrastructure, and surveillance activities helped to detect, control outbreaks and minimize disease risks caused from flooding [16]**.** In developing countries, increase in diarrheal disease, cholera, dysentery, and typhoid is of specific concern [17]. For example, after flooding in West Bengal in 1988, cholera was thought to be the cause of an outbreak of diarrhea that resulted in 276 deaths [18]. Numerous studies have linked previous floods in Bangladesh and parts of India with outbreaks of diarrhea as well as respiratory infections [19-22]**.**

Flooding can also be contributed to increase vector-and rodent-borne and other infectious diseases. For example, collections of stagnant water provide breeding grounds for mosquitoes, potentially aiding in the spread of malaria [23]**.** Other studies have linked flooding in Bangladesh and parts of India with outbreaks of rotavirus and leptospirosis [24-28].

On the Vector borne disease malaria, no indigenous cases reported since a long time in Cuddalore district. Further, the existing surveillance for vector borne diseases namely active, sentinel and passive by the guidelines of NVBDCP, the stratification based on month wise imported cases of malaria, blood smear collection from fever cases in the affected places, the teams formed exclusively for the anti larval and anti-adult measures, the role of mobile medical teams and the establishment of medical camps in shelters and in affected places by the deployment of medical officers and para-medical staffs had been taken part a great role to halt vector borne Zoonotic diseases Leptospirosis and scrub typhus.

Probing the spectrum of diseases other than malaria and leptospirosis, there were 5 scrub typhus and 5 Ig-M dengue cases had been reported scatterdly and these diseases had been averted to become outbreaks from early warning signals. On the scrub typhus, health education on rodent borne diseases, sanitation improved in and around human dwelling and temporary shelters and quick removal of rat falls yielded not to emerge it in the form of epidemic. In addition to that, administration of common antibiotic Doxycycline 400mg drug would be acted as the prophylaxis for both the scrub typhus and leptospirosis.

Pertaining to dengue control and prevention, door to door source reduction of dengue vectors of both immature and adults, efforts taken to decline the indices HI, and BI to the permissible level < 1% and <5 respectively have been yielded desirable outcome. Particularly the properties of rapid *Aedes* survey in the community, the reduction of dengue fever cases due to the permissible level of HI and BI, the effective supervision and appraised over field work, implementation of surveillance in neighborhood areas adjacent to dengue positive cases reported in the radius of 400 meters and monitoring permissible *Aedes* indices HI and BI for the evaluation of dengue control and prevention had been taken for the present study [29-32],

It could be also known that plastic containers took part as major source of *Aedes* breeding in the flood affected areas and the preference of medium was alkaline in nature at the ambient temperature 27^{o} C. Further, the density of dengue vectors *Aedes albopictus* and *Aedes aegypti* were 40 10 MHD and 20 10MHD respectively was observed and it became to 4 10 MHD and nil in selected random and fixed mosquito collection stations respectively.It might be the reason for declining trend of fever cases observed. It was also observed that the co-existence of *Aedes albopictus* and *Aedes aegypti* found to be less transmission of dengue rather than the existence of *Aedes aegypti* alone.

Since the district was erstwhile endemic for Japanese Encephalitis (JE) and the village Suthukulam is one among flood affected village, precipitin tests for the host preference among vector mosquitoes caught in the village and known that mosquitoes did not prefer the blood of amplifying

host likes pigs and ardeid birds. It was supported by antigen PCR tests carried out in dried mosquitoes.

Among vaccine preventable diseases, measles vaccine was administered to children in a special campaign and the availability of Rabies vaccine stock against dog bites were evident for avoiding consequences related to floods. While the entomological surveillance made to combat vector borne and zoonotic diseases, non frequent occurrence of *culex* mosquito species *Topomyia* and sand fly *Phelebotomus papatasi* are indicators that makes changes in the environment with reference to the objective of the entomological surveillance delineated by the WHO [33].

5. Conclusion

The containment measures implemented in the present strategic plans are exigence to overcome flood situation in Cuddalore district. Further, it is the compact contingent plan for the flood related diseases management and it has also merits to include in the National disaster management contingent plan after experts opinion in this field.

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Table-1 Showing the Block wise population in which affected Blocks is earmarked

S.No	Name of the Blocks	No. of villages& Hamlets affected	Total population of each Block	Total Houses
1	Kurinjipadi	208	130503	26101
2	Cuddalore **	188	152870	30575
3	Parangipettai	166	108546	21709
4	Kammapuram	90	61559	12312
5	Keerapalayam	77	83672	10734
6	Kumaratchi	71	62738	12548
7	Panruti	27	62785	12587
8	Annagiramam	41	25798	5160
9	Mel Bhuvanagiri	11	8349	1670
10	Virudhachalam	11	9552	1910
11	Kattumannarkoil	4	2272	454
TOTAL		934	561647	1357

** Study Area

Table-2. Temperature and pH in different aquatic habitats where the immature stages of *Aedes* spp found in flood affected areas.

S.No	Name of the area	Name of the habitats	Temperature in Celcius	pH
1.	SaiBaba Nagar, Pathirikuppam, Uchimedu and Gnanamedu	Cistern	27.01 (N=11)	7.05 N=11)
2	Gnambal Nagar, Vadugapalayam	Coconut Shells	26.8 (N= 10)	7.55 (N=10)
3.	Papammal Nagar, Unnamalai Chettichavadi, S.Kumarapuram, Maruthadu, periya kattupalayam , Sivanandapuram	Tyres	27.65 (N=12)	7.16 (N=12)
4	Sri Ram Nagra, panangattu colony, Kavery Nagar, Vanniyar Street, Varakalpattu,	Earthernwares	26.5 (N= 17)	7.51 (N= 17)

	Vellapakkam, KN Pettai and Koothapakkam			
5	Annaveli village, Sri Ram Nagar, Maruthadu, Madalapattu, KN Pettai	Metal Boxes and Plastic containers	27.3 (N=18)	7.42 (N=18)

Table-3 Status of Dawn and Dusk adult mosquito collection made from random and fixed stations in Cuddalore Block

S.No	Name of the area	Adult Aedes Indices (From Random Collection)	
		Name of the species	10 Man Hour Density(MHD)
1	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Aedes albopictus* *Armigerus spp*	40 93.3
2	Kurinji Nagar, Arunachala nagar, JV Garden and Gnaambal Nagar	*Aedes albopictus* *Aedes aegypti* *Armigerus* *Culex quinquefasciatus*	32 20 20 16
3	Friends nagar, Jothy Nagar, Pennai Nagar, Muthiah Nagar	*Armigerus* *Culex quinquefasciatus*	32 24
4	Papammal Nagar and Extension, Tamil Muthu Nagar,	*Aedes albopictus* *Aedes aegypti* *Armigerus* *Culex quinquefasciatus*	4 4 56 20
5	Kamaraj Nagar, Kurinji Nagar, pappammal Nagar	*Aedes albopictus* *Armigerus* *Culex quinquefasciatus*	8 20 40

Fixed Collection

Days	Name of the area	Adult Aedes Indices (From Fixed Collection)	
		Name of the species	10 Man Hour Density(MHD)
1	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Aedes albopictus* *Armigerus spp*	40 93.3
2	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Aede albopictus* *Aedes aegeypti* *Anopheles subpictus* *Anopheles vagus* *Sand fly Phelebotomus papatasi*	28 08 11 12 12
3	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Aedes albopictus* *Anopheles subpictus* *Culex quinquefasciatus*	14 04 10
4.	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Anopheles subpictus* *Culex quinquefasciatus*	04 04

5	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Culex quinquefasciatus* *Armigerus*	02 03
6	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Culex quinquefasciatus*	03
7	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Culex quinquefasciatus*	03
8	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Culex quinquefasciatus*	03
9	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar	*Anopheles vagus*	02
10	Ram Nagar, Kamatchi nagar, subbu Lakshmi nagar		
11	Thottapattu	*An.barbirostris 1* *An.hyrcanus2* *An.vagus2* *Culex Topomyia species1* *Culex Ficalbia species1* *Culex gelidus 50* *Culex tritaeniorhynchus50*	

Table-4 Details of Blood smear and serum samples collection from the flood affected area of Cuddalore District for screening malaria and other vector borne diseases.

S.No	Source of surveillance		No. of blood smears collected for malaria/No. of serum samples collected	Examined	Name of the Diagnostic tool	Remarks
	Active	Passive				
1	111	233	344	All were examined	Malaria microscopy	Negative
2	40 blood serum	110	150 blood serum	18 positives	Ig-M ELISA	1 chikungunya;6 dengue;5 leptospirosis and 6 scrub typhus

Table 5- Details of the status of Chikungunya, dengue,Leptospirosis and Scrub typhus in Cuddalore Block in flood affected areas of Cuddalore District

Month	Dengue NS1		Dengue Ig-M		Chikungunya		Leptospirosis		Scrub typhus	
	Tested	Positives	Tested	Positives	Tested	Positives	Tested	Positives	Tested	Positives
December	16	0	16	2	7	1	7	0	7	0

2015										
January 2016	24	0	40	2	7	0	40	5	40	5

Table-6- The outcome of Anti Larval, anti adult and chlorination activities in the flood affected Areas of Cuddalore

S.No	Date	Mname of the PHC	Name of the Village	HI%	CI%	BI	Fogging covered in Population	Chlorination checked in OHTS	Chlorination found in OHTs
1	11.12.2015	Thiruvandhipuram	Kondur	10.8	4.1	14.7	12500	20	10
2	12.12.2015	Thiruvandhipuram	Kondur	15.3	4.9	21.3	2400	34	25
3	13.12.2015	Thiruvandhipuram	Kondur	7.4	2.2	2.2	1800	10	7
4	14.12.2015	Thiruvandhipuram	Kondur	14	4	18	3100	16	12
5	15.12.2015	Thiruvandhipuram	Kondur	12	4	19	3400	32	25
6	19.12.2015	Thiruvandhipuram	Kondur	8.3	2.5	13.5	1500	35	24
7	09.01.2016	Thiruvandhipuram	Kondur	0.8	0.3	0.8		4	2
8	16.12.2015	Thiruvandhipuram	Pathirikuppam	10	2.9	13.4	3000	48	40
9	17.120.2015	Thiruvandhipuram	Pathirikuppam	9	2.6	12.5	3100	60	51
10	18.12.2015	Thiruvandhipuram	U.Chavadi	7.1	2.6	11.7	3500	44	35
11	20.12.2015	Thiruvandhipuram	K.Pakkam	7	2.7	10	1500	7	5
12	21.12.2015	Thiruvandhipuram	S.K.Puram	7.4	1.8	NA	350	10	6
13	21.12.2015	Thiruvandhipuram	Varakalpattu	8.1	4.2	NA	150	5	5
14	21.12.2015	Thiruvandhipuram	Maruthadu	8.7	3.4	13.5	2800	39	30
15	21.12.2016	Cuddalore Mty	Ward 35	6.5	2.1	6.5	3000	16	10
16	22.12.2015	Thiruvandhipuram	Varakalpattu	8.9	2.5	11	2000	27	20
17	22.12.2015	Thiruvandhipuram	Karamanikuppam	5.7	1.4	NA	1500	14	9
18	22.12.2015	Thiruvandhipuram	Pillali	23.4	7.7	27.4	2000	7	5
19	23.12.2015	Thiruvandhipuram	Vellapakkam	8.5	3.4	11.8	3000	44	38
20	23.12.2015	Thiruvandhipuram	Thiruvandhipuram	8.4	2.5	9.5	3500	34	30
21	24.12.2015	Madalapattu	PK Palayam	12	5.4	20.6	4000	38	30
22	24.12.2015	Madalapattu	Karikan Nagar	9.9	3.2	11.8	1800	16	10
23	24.12.2015	Madalapattu	CK Palayam	18.5	3.8	NA	1100	5	3
24	25.12.2015	Madalapattu	Sivanarpuram	3.3	2.5	NA		4	3

25	25.12.2015	Madalapattu	Villupalayam	3.1	3.5	NA	372	2	2
26	26.12.2016	Madalapattu	PKKuppam	10	2.9	12.9	3500	41	34
27	26.12.2015	Madalapattu	Ckkuppam	4.4	1.9	5.1	900	5	3
28	27.12.2015	Madalapattu	Sivanarpuram	29	10	NA	650	6	4
29	28.12.2015	Thiruvandhipuram	Knpettai	5.4	2	6.2	3500	31	26
30	29.12.2015	Thiruvandhipuram	K.Pakkam	6.4	1.6	7.6	3000	38	32
31	29.12.2015	Thiruvandhipuram	KNpettai	4.4	1.4	4.4	438	12	10
32	30.12.2015	Thiruvandhipuram	K.Pakkam	6.1	1.8	7.6	3500	25	20
33	31.12.2015	Cuddalore Mty	Ananadan Nagar	12.2	3.6	16.9	850	0	0
34	31.12.2015	Thiruvandhipuram	Annaveli	10.2	1.9	12.5	1100	17	0
35	31.12.2015	Thiruvandhipuram	Gnanambal Nagar	9.8	3.3	NA	750	4	0
36	04.01.2016	Thiruvandhipuram	Kannarapettai	5	6	6.6	1800	1	0
37	04.01.2016	Thiruvandhipuram	Karamanikuppam	6.3	2.1	8.5	3000	1	0
38	05.01.2016	Naduverapattu	Naduveerapattu	13.8	4.4	13.8	1800	0	0
39	05.01.2016	Thiruvandhipuram	KNpettai	2.6	1.8	3.2	3500	2	0
40	06.01.2016	Thiruvandhipuram	Vadugapalayam	4.9	1.5	4.9	1917	2	1
41	06.01.2016	Thiruvandhipuram	Gunamangalam	6.6	1.7	6.6	1598	1	1
42	07.01.2016	Thiruvandhipuram	Thiruvandhipuram	3	0.9	3		2	1
43	06.01.2016	Thiruvandhipuram	Thotty Pillali	1.3	0.4	1.3		2	1
44	08.01.2016	Thiruvandhipuram	kumarapettai	7.2	2.6	8.5		1	1
45	08.01.2016	Thiruvandhipuram	Sangolikuppam	8	1.5	10.5		1	0
46	09.01.2016	Cuddalore Mty	Ward 18,20 &21	8	1.5	10.5		1	0
47	09.01.2016	Thiruvandhipuram	Kondur	0.8	0.3	0.8		4	2

Table- 7 details of the formulation of *Baccillus thuringeansis* application on the rain water stagnation in and around Human dwellings in the worst flood affected area of Cuddalore Block of the District

S.No	Date of the activity	Name of the PHC	Name of the area	Bti sprayed in square meter
1	12.12.2015	THIRUVANDHIPURAM	Kurinji nagar, Arunachala Nagar,Thiruvandhipuram and Jothy Nagar	6000
2	13.12.2015	THIRUVANDHIPURAM	Jothy Nagar, Pennai Nagar and Muthiya Nagar	2000
3	14.12.2015	THIRUVANDHIPURAM	Kondur, VIP Nagar,Thiru Nagar,Visvanathan Nagar, Vinayaga Nagar, Kondur, Sai Baba nagar and Radhakrishnan Nagar	13500
4	15.12.2015	THIRUVANDHIPURAM	Kondur, TNCSC Nagar, kurinji nagar, Indra Nagar and RadhaKrishna Nagar	14500
5	16.12.2015	THIRUVANDHIPURAM	Kanniyammal nagar, Sundaram	10000

			Nagar and Sapthagiri Garden, and Nathaveli Cross and main road	
6	17.12.2015	THIRUVANDHIPURAM	Mariamman koil Street, Pathirikuppam,Balwadi street, Raman Nagar, kondur Colony, Raja rajan Nagar, Unnamalai chavadi, Panangattu colony	16300
7	18.12.2015	THIRUVANDHIPURAM	Unnamalaichavadi, Nathapattu,Iyya Nagar, Brindavan Nagar, Vishali Nagar,KAP Nagar, MA Koil Strret, Water Tank street, Dhoby Street	12500
8	19.12.2015	THIRUVANDHIPURAM	BVR Garden,Thottapattu colony, Muthukumar Nagar, Om sakthi Nagar, Kondur, Agri Nagar, Venkatachalaopathy Nagar, Krishna Garden, Varakal Pattu	23500
9	20.12.2015	THIRUVANDHIPURAM	Iyyanar Koil street, S.Kumarapuram,Maruthadu, Periyar Nagar,	11500
10	21.12.2015	THIRUVANDHIPURAM	Cuddalore Municipality Ward-35, Chellankuppam, Pudu Nagar, Veeraragavan Nagar,	6000
11	22.12.2015	THIRUVANDHIPURAM	Varakalpattu,Vanniyar Street, Karamanikuppam,Pudu Nagar colony, Pillali,	18000
12	23.12.2015	THIRUVANDHIPURAM	Thiruvandipuram East, North, M.A.Koil street, Vellapakkam Lakshmi Nagar, Gnanamedu,Othawadi street, Vaikkal street of Thiruvandhipuram	17000
13	24.12.2015	MADALAPATTU	Karikan Nagar, Mahalir valaga street, School street, Sivanarpuram,	12000
14	25.12.2015	THIRUVANDHIPURAM	Periyakattupalayam, Chinnakattupalayam	5000
15	26.12.2015	MADALAPATTU	Chinnakanganakuppam, Babu Reddy nagar,Baba Nagar, Muthiya Nagar, MAKoil street, Periya colony, Pannai street,	9000
16	27.12.2015	MADALAPATTU	Periyakanganakuppam, Indira nagar, Saraswathy Nagar	6000
17	28.12.2015	THIRUVANDHIPURAM	Periyar Nagar, Sathya Sai Nagar, Anaimedu, Gnanasundaram Nagar and KN Pettai	11000
18	29.12.2015	THIRUVANDHIPURAM	KNPettai, Postal Colony, Shankar	25000

			nagar, Palani Pillai Nagar, Nathan Nagar, Bharathy Nagar, Vijayalakshmi Nagar, Perumal Nagar,	
19	30.12.2015	THIRUVANDHIPURAM	Narayansamy Nagar, Gopal Nagar, sarathy Nagar, Pankajam Nagar,Koothapakkam,Velu Nagar, Maduraiveeran Nagar, sudahar nagar, Valliammai Nagar, Krishna nagar, SP Nagar	25500
			Total sprayed area in square meters	244300/ 244.3 square kilometers

Table-8 Details of Blood meal and Dried pools of (JE) vector mosquitoes for the Precipitin Tests and JE Antigen analysis

S.No	Name of the village	Name of the JE vector whose blood meals/ dried pools collected	Nature of the sample	No of samples taken	Name and place of the test employed	Results
1	Suthukulam	*Culex tritaeniorhynchus*	Blood meal	60	For the Precipitin test. Tests performed at NVBDCP, Delhi-54, India	None of Blood meals belong to JE amplifying hosts either Pig or Ardeid Birds
2	Suthukulam	*Culex gelidus*	Blood meal	20	For the Precipitin test. Tests performed at NVBDCP, Delhi-54, India	None of Blood meals belong to JE amplifying hosts either Pig or Ardeid Birds
3.	Suthukulam	*Culex tritaeniorhynchus*	Dried mosquitoes	6 pools . Each pool contains 50 female JE vectors	For the JE antigen analysis Tests. Tests performed at the Institute of Vector Control and zoonosis, Hosur, tamil Nadu, india	Negative
4	Suthukulam	*Culex tritaeniorhynchus*	Whole full fed mosquitoes	5 pools each contains 50 female JE	PCR analysis performed to determine the JE virus at the	Negative

				vectors	Vector Control Research Center (VCRC), Government of India Puducherry	

Figure-1 District Map of Cuddalore District with Blocks in which the worst affected Block Cuddalore is shown

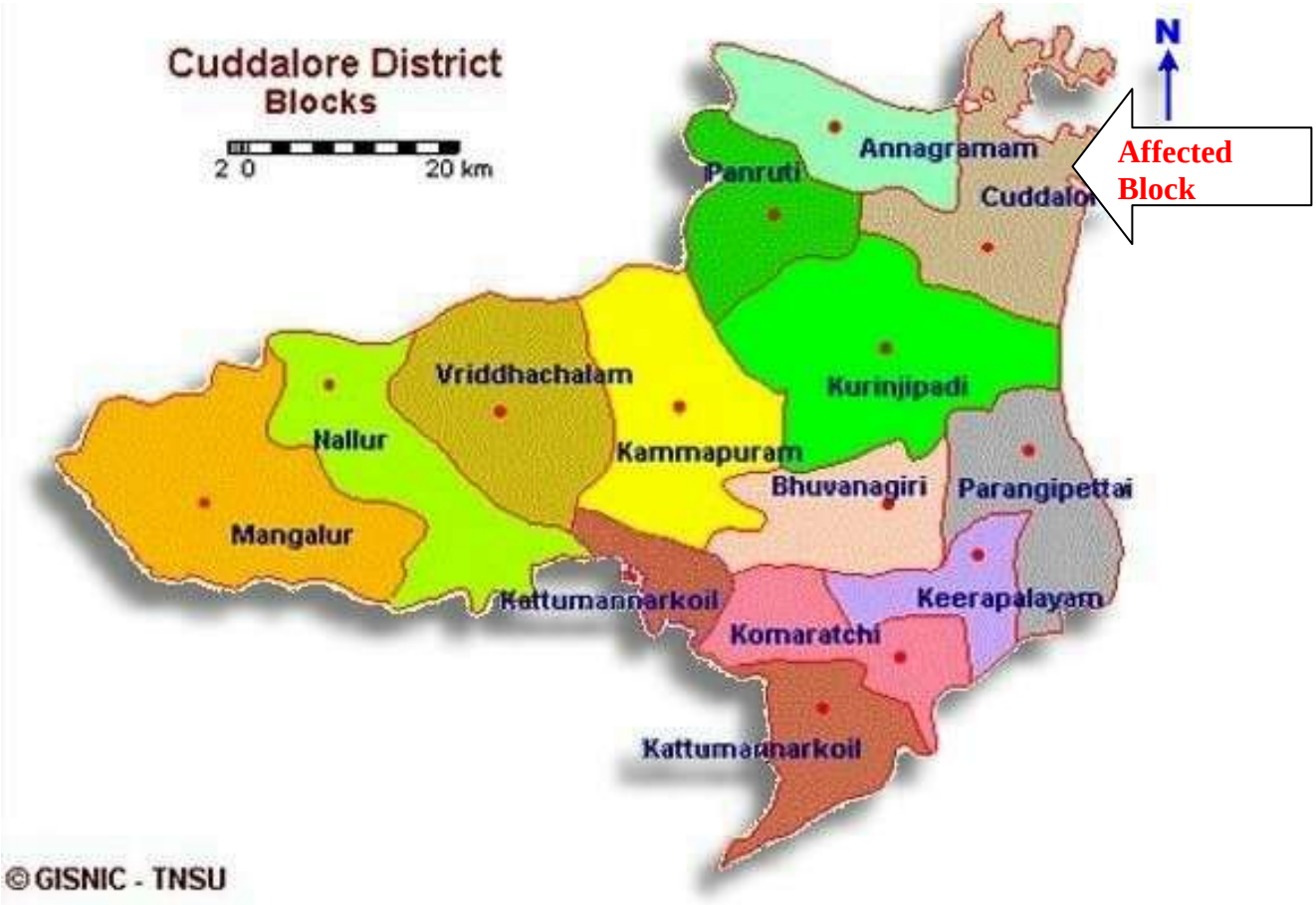


Figure- 2.The progression of fever convergence mechanism

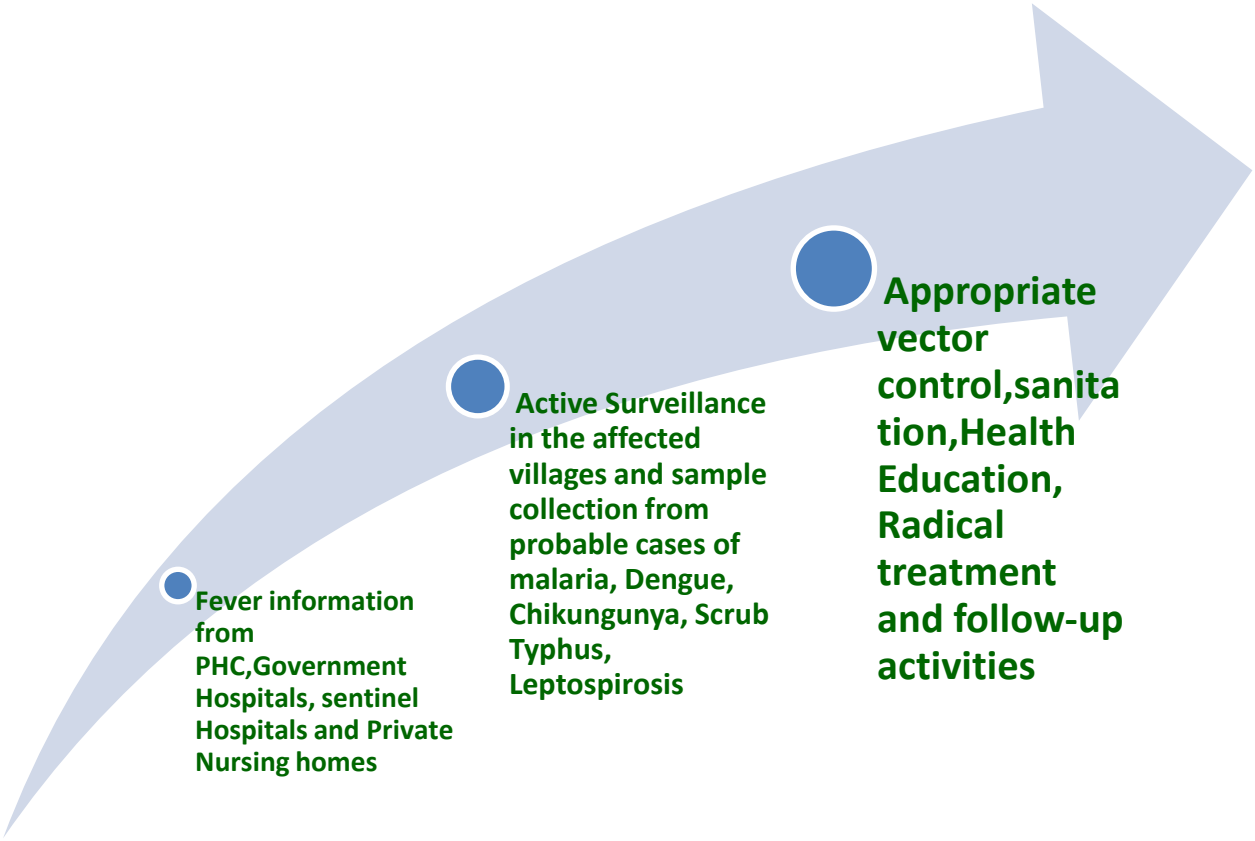
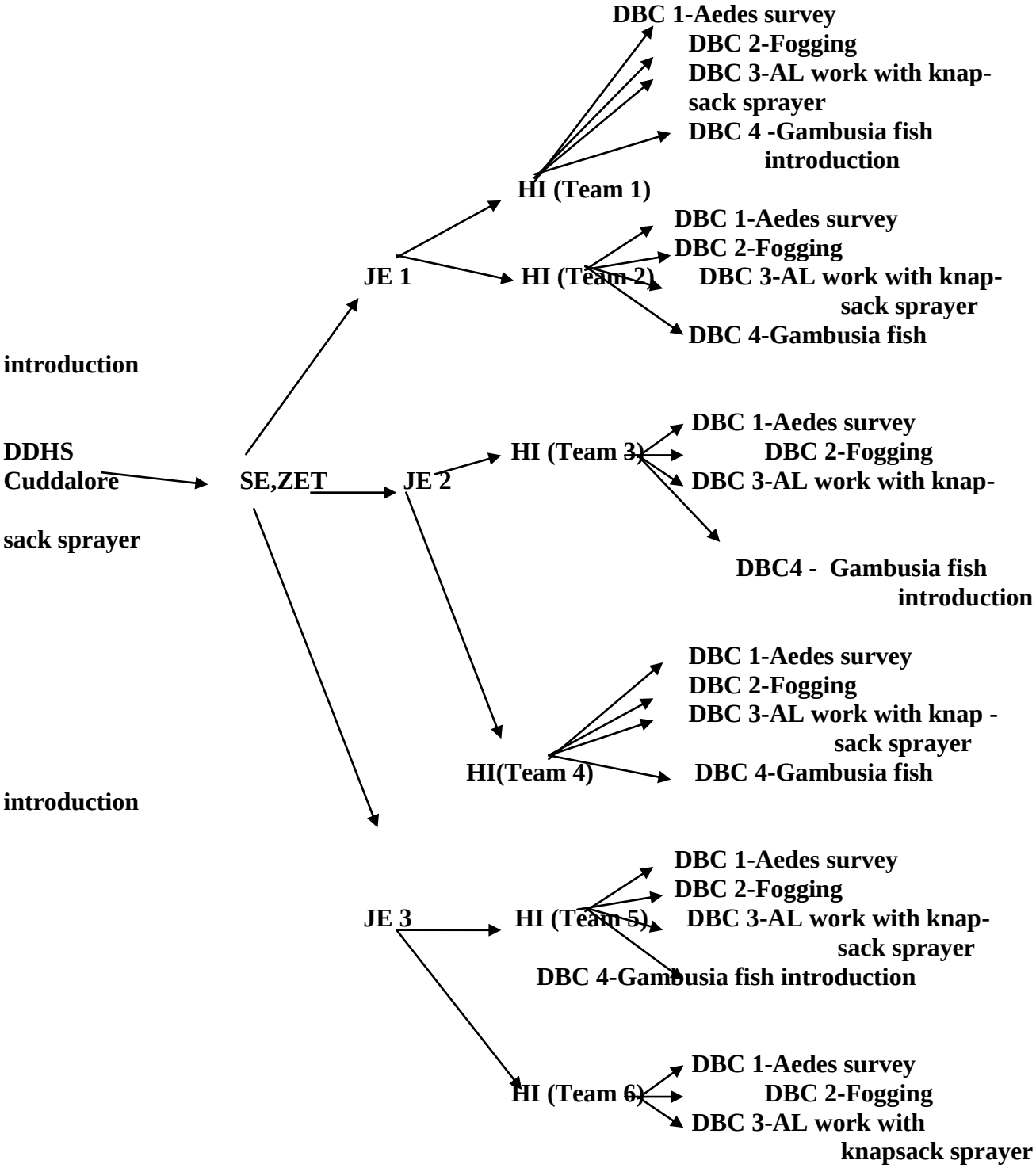
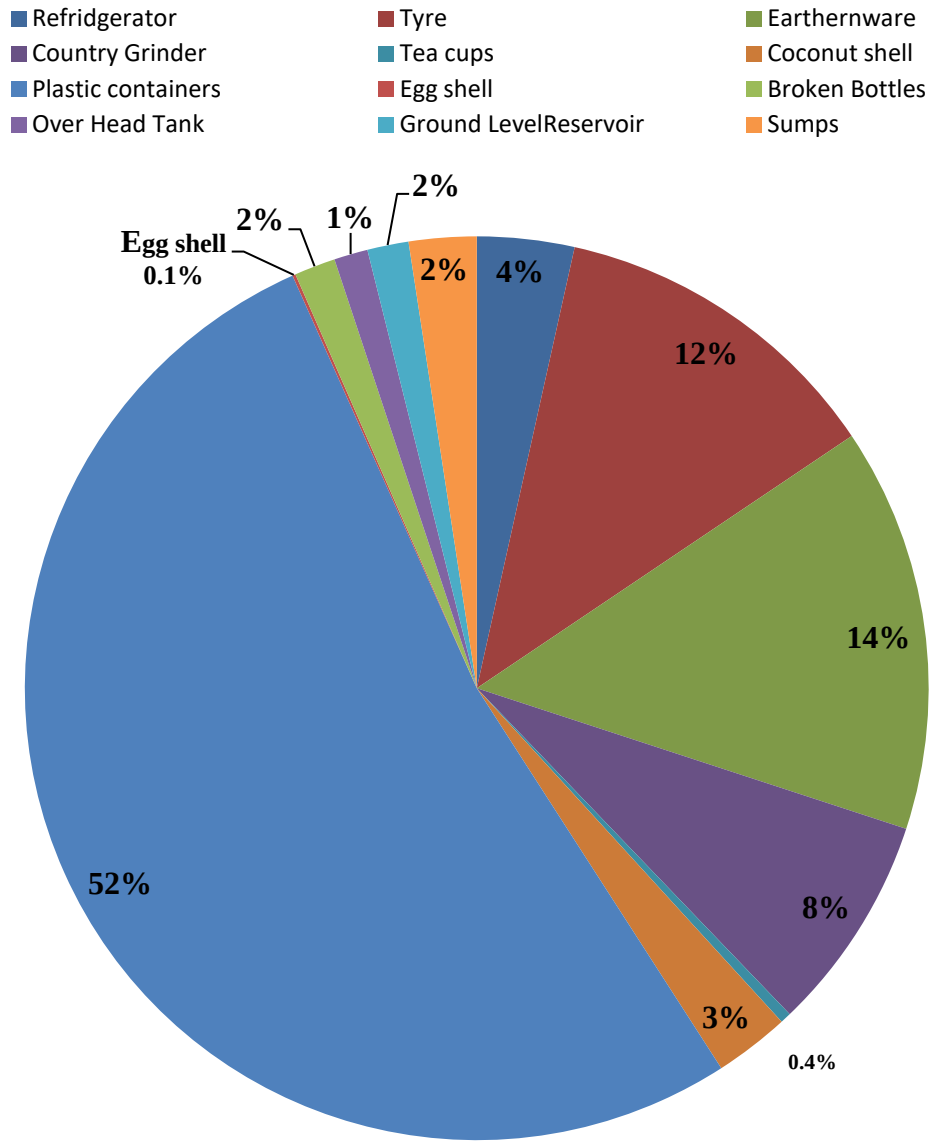


Fig-3.CLADOGRAM FOR ACTIVITIES GENERATED BASED ON INTEGRATED VECTOR CONTROL APPROACH



DBC 4-Gambusia fish introduction

Figure-4. The distribution of *Aedes* species mosquito larvae in different types of habitats in flood affected areas in Cuddalore



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