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ADAPTING TO ADVERSITY: PUBLIC HEALTH FLOOD RESPONSE STRATEGIES FOLLOWING TWIN DISASTERS

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Abstract

INTRODUCTION : Floods represent the most prevalent natural calamities globally, with their impact expected to amplify due to the influences of climate change and population displacement. In December 2023, Tamil Nadu faced substantial rainfall, notably in Chennai and its suburbs and in the southern districts of Tamil Nadu namely Thoothukudi, Tirunelveli, Tenkasi and Kanniyakumari, triggering extensive flooding. This paper endeavours to document the lessons learned from Tamil Nadu's flood response in 2023 and the subsequent measures being undertaken by the public health system to enhance preparedness. The various Public Health interventions implemented to address potential outbreaks following a disaster, included establishment of incident command system at the State and District level; establishment of a helpline number for immediate assistance; continuous Disease Surveillance; risk stratification of areas; formation of task-specific teams to address different aspects of the emergency and continuous monitoring of activities. The flood response activity in Tamil Nadu has demonstrated remarkable effectiveness, as evidenced by the absence of any outbreaks in both Chennai and the southern districts, which were affected by flood.

KEYWORDS : Flood response activities

INTRODUCTION

Floods represent the most prevalent natural calamities globally, with their impact expected to amplify due to the influences of climate change and population displacement. In recent years, Tamil Nadu has confronted numerous flooding incidents, posing immediate peril to human well-being along with enduring repercussions such as displacement and deteriorating living conditions. Consequently, it's imperative that the initial response to flood emergencies encompasses provisions for shelter, clean water, nutrition, sanitation, and hygiene to mitigate health risks. Adequate Public Health preparedness plays a pivotal role in averting morbidity and mortality associated with flood disasters.[1]

In the beginning of December 2023, Tamil Nadu faced substantial rainfall, notably in Chennai and its environs with a downfall of 46 centimeters of rainfall over two days (December 3 and 4, 2023) , triggering extensive flooding due to Cyclone Michaung. The Indian Meteorological Department (MET) predicted further heavy precipitation over southern Tamil Nadu (Tenkasi, Tirunelveli, Thoothukudi, Kanyakumari) on December 17, 2023.[2] The southern districts faced a downpour of maximum 93 cm in Kayalpattinam of Thoothukudi districts over two days (December 17 and 18, 2023). The aftermath of this unprecedented deluge was immediate and catastrophic, resulting in localized road inundation, hampering transportation and mobility, and inundating low-lying areas, causing severe damage to both public and private property. Buildings were breached by water, leaving inhabitants stranded without essential provisions such as food, water, and electricity, while causing complete destruction to household assets and vehicles, rendering homes uninhabitable for an extended period. Displaced individuals were relocated to temporary shelters established by the State Government. According to disaster management data, the floods on December 17 and 18 damaged over 7,417 dwellings, claimed the lives of 1.07 lakh livestock, and ravaged 2.24 lakh acres of crops. The Tamil Nadu State Government spearheaded relief and rescue operations in response.

These floods have significant implications for Public Health. Immediate and medium-term health impacts are primarily associated with communicable diseases, with disruptions in basic preventive and curative health services exacerbating the challenge of accessing appropriate healthcare. The

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displaced population faced an imminent risk of waterborne and foodborne disease outbreaks, such as Acute Diarrheal Diseases, Dysentery, etc., due to interruptions in safe water supply and sanitation.

Additionally, overcrowding resulting from population displacement increases the transmission of airborne diseases like measles and pneumonia. Moreover, increased vector breeding heightens the risk of vector-borne diseases.

Thus, the role of the Public Health system during and after floods is monumental, aiming to prevent and manage any ensuing illnesses.

This paper endeavours to document the lessons learned from Tamil Nadu's flood response in 2023 and the subsequent measures being undertaken by the Public Health system to enhance preparedness.

Public Health Interventions :

Several Public Health Interventions were implemented to address potential outbreaks following a disaster, including:

1. Establishment of incident command system at the state and district level.
2. Establishment of a Helpline number for immediate assistance
3. Disease Surveillance
4. Risk stratification of areas
5. Formation of task-specific teams to address different aspects of the emergency.
6. Monitoring of activities.

1. Establishment of incident command system at State and District level

The Directorate of Public Health and Preventive Medicine quickly implemented epidemic prevention and disease control strategies.

The State Emergency Operation Centre and Public Health Control Room were immediately established by the Directorate, along with 104 medical helpline services.

On December 18, 2023, District Control Rooms were established at the offices of the District Health Officers in Thoothukudi, Tirunelveli, Tenkasi and Kanyakumari.

These served as hubs for outbreak detection and epidemic prevention, functioning as daily reporting and monitoring centers for cases of fever, diarrhea, etc., in flood affected areas.

They also coordinated field epidemic control activities, including the collection of reports from mobile medical units, static camps, and the Integrated Health Information Platform (IHIP).

2. Establishment of a Helpline number for immediate assistance

In the State Public Health Control Room, the flood helpline number 9444340496/8754445477 was established as a crucial component of the public health emergency response and epidemic surveillance system for flood-affected communities.

The helpline was widely publicized through television, newspapers, and other media platforms.

Health Inspectors stationed in the State Public Health Control Room managed the helpline, serving as the primary point of contact for the general public.

They provided information and advice on epidemic control measures during floods, including safe drinking water practices and mosquito management, to ensure the well-being of the affected population.

3. Disease surveillance and prevention :

Numerous measures were implemented to monitor disease occurrence and mitigate epidemics. Disease Surveillance involved utilizing data from medical camps and the Integrated Health Information Platform (IHIP).

The geographical localization and reporting of Acute Febrile Illness (AFI) and Acute Diarrheal Disease (ADD) were achieved through Choropleth Mapping. Trend analysis of each reported disease served as a valuable tool for monitoring disease trends.

These analyses aided in prioritizing vulnerable populations, carrying out risk stratification of areas and consequently planning activities for the following day, including providing healthcare services to high-risk focus areas.

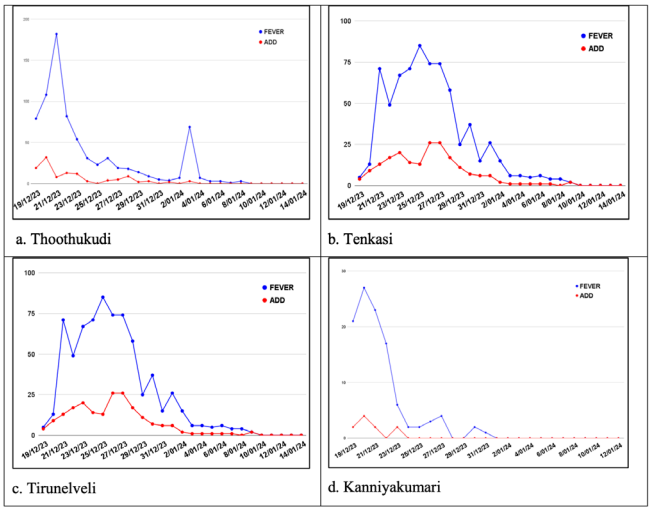

Figure 1 : Trend analysis of fever and diarrhoeal diseases in the Southern Districts of Tamil Nadu.

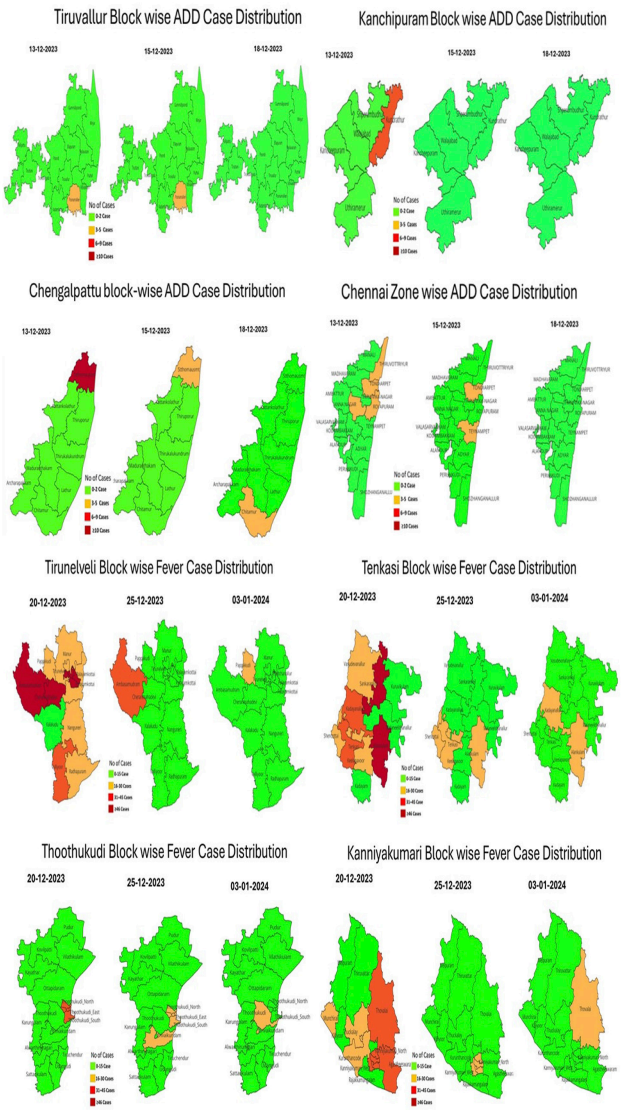

Figure 2 : Choropleth mapping of the Fever case distribution in the flood affected districts of Tamil Nadu.

4. Risk stratification of areas :

Based on the number of illness reported, the areas were stratified as high-risk areas and control measures were undertaken. An area is classified as high risk, if there were >15 acute febrile illness (AFI) reported per day or five or more cases of acute diarrhoeal diseases(ADD).

Once the high-risk area is identified and epidemiological linkage for ADD/AFI cases are confirmed, medical teams were sent to these areas. They were engaged in active surveillance to detect additional cases, treat both cases and contacts, ensure chlorination at household and community levels, and conduct disinfection in and around the households of affected individuals. Source reduction for vector control, along with fogging and anti-larval measures were implemented in necessary areas. Comprehensive details were reported to the control room for follow-up.

5. Formation of task-specific teams to address different aspects of the emergency

The Directorate of Public Health and Preventive Medicine appointed personnel from the cadre of Joint Directors of Public Health and Preventive Medicine to oversee the incident command system in the districts and supervise the monitoring of medical camps, vector control, and chlorination activities. They took command roles, providing directives for essential actions, such as scheduling mobile medical camps, addressing inadequate chlorination sites, prioritizing high-risk areas for vector control, and ensuring disinfection of drinking water supplies and mobile medical camps to curb epidemics.

Additionally, officials in the cadre of District Health Officers were tasked with monitoring field activities. Their responsibilities encompassed overseeing all medical camps, vector control efforts, and chlorination activities. This team contributed insights for planning activities in the subsequent days and prioritizing high-risk areas based on reports. Furthermore, the field monitoring team ensured the administration of chemoprophylaxis to vulnerable populations in flood-affected regions and distribution of Non-Communicable Disease (NCD) drugs to beneficiaries through medical teams.

To address specific needs, task-specific teams were formed, including flood response teams, vector control teams, and water analytics teams. These teams were allocated specific functions, and based on their reported data, the district and state command systems promptly initiated epidemic prevention and disease control measures.

Table 1 : Deployment of various teams to flood affected districts

DISTRICT	Vector control - Regional Entomologist Teams	Vector control- Senior /Junior Entomologist Teams	Water Analyst Teams	External Mobile Medical Teams
Chennai	3	6	6	159
Chengalpattu	1	1	1	60
Tiruvallur	1	1	1	51
Kancheepuram	1	1	1	30
Thoothukudi	1	2	2	30
Tirunelveli	1	2	2	30
Tenkasi	1	1	1	5
Kanyakumari	1	1	1	5

5.1 Flood Response teams :

The flood response team comprised a Medical Mobile Unit consisting of one Medical Officer, one Staff Nurse/ Pharmacist, one Health Inspector, and a dedicated driver, each equipped with their own Medical Mobile Unit vehicle. These teams were instructed to carry essential medications

for disease control and prevention. In addition to the existing Medical Mobile Teams, more teams were mobilized from districts all over Tamil Nadu and deployed in the flood-affected districts as follows :

Table 2 : Deployment of Mobile Medical Teams in flood affected districts of Tamil Nadu

District	Number of additional external medical teams	Total medical camps Conducted	Total beneficiaries
Chennai	159	7834	4,85,109
Chengalpattu	60	2953	1,68,526
Tiruvallur	51	2308	1,22,806
Kancheepuram	30	1270	69,328
Thoothukudi	30	3885	2,75,346
Tirunelveli	30	2945	1,02,458
Tenkasi	05	2055	59,280
Kanyakumari	05	1569	50,358
TOTAL	**370**	**10,454**	**13,33,211**

At the medical camp, several measures were implemented :

• Socio-demographic details of patients were documented.

• Patients presenting with fever had their blood samples collected for serologic tests to detect diseases such as Leptospirosis, Dengue, and Malaria.

• Cases of Acute Diarrheal Diseases (ADD) requiring stool sample collection for Cholera investigation was done.

• Food handlers were provided with chemoprophylaxis, including Doxycycline 200 mg, Metronidazole 400 mg, and Albendazole 400 mg. Additionally, individuals in high-risk areas received Doxycycline 100 mg / Azithromycin 500mg tablets as Chemoprophylaxis

• A Measles-Rubella vaccination campaign was successfully carried out administering 52,516 doses.

Furthermore, initiatives were undertaken to reach out to Antenatal mothers, facilitate safe deliveries for expectant mothers, monitor the health status of those in need of palliative care, and ensure compliance with medication refills for patients with non-communicable diseases including Injection Insulin. They were given even for persons taking treatment in private sector.

Follow-up calls were conducted for patients seen at the medical camps, with specific attention given to monitoring and mapping cases of fever, acute diarrheal disease (ADD), acute respiratory infections, skin diseases, and injuries to identify any clustering trends. Overall, a total of 14,365 medical camps provided medical assistance to 845,769 individuals from December 6th to December 20th, 2023 in flood affected Northern Districts and 10,454 medical camps provided medical assistance to 4,87,442 individuals in flood affected Southern Districts.

5.2 Vector control teams were deputed with Regional Entomological teams along with Senior and Junior Entomologists to oversee vector control activities in the flood affected areas. Vector control activities included:

- Source reduction involving the elimination or disposal of open containers and elimination of artificial water stagnation found both indoors and outdoors.
- Anti-larval measures consisted of applying Temephos to water containers containing larvae that could not be drained.
- Additionally, indoor fogging with Pyrethrum and outdoor fogging with Technical Malathion was employed as an anti-adult vector control measure.

5.3 Water Analysis team :

Water Analyst teams were dispatched to the districts affected by the flood. Each team consisted of 1 Assistant Water Analyst, 1 Junior Water Analyst, and a health inspector. Water teams analysed water distribution system along with local body officials and TWAD board team in order to identify the waterline leakages and ensured cleaning of OHTs before regular drinking water supply started. Temporary water supply through tanker lorries and tractor water tankers were done to ensure chlorination at source itself and also before distribution to the public in order to ensure provision of safe drinking water. The activities of the Water Analytical teams included:

- Reporting drinking water pipe leakages and unsanitary drinking water supply to the district command system, followed by subsequent follow-ups the following day.
- Monitoring the chlorination level of drinking water sources and devising action plan for chlorination activities in these areas.
- Testing the quality of drinking water in water-supplying tanks and private drinking water sources for any contamination and ensuring adequate chlorination.
- Collecting water samples from taps, hand pumps, overhead tanks, and portable water sources at houses for testing residual chlorine levels.
- Prioritizing flood-affected areas with reported cases of acute diarrheal diseases or fever for water sampling the following day.
- Sending collected samples for bacteriological analysis to detect any contamination, while residual chlorine levels are measured in the nearest Chief Water Analysis Laboratory.
- Chlorinating water sources found unfit for drinking in the

presence of a team member from the Water Analytical team. - Inspecting water-supplying lorries for rust, debris, or dirt, and ensuring adequate chlorination of the drinking water.

A total of 4,549 sources were inspected by the team for adequate chlorination during the control measure activities, and 4,465 sources were found to be adequately chlorinated in Thoothukudi district. Spot tests for residual chlorine were conducted on 1,251 water samples in the flood-affected areas of Tirunelveli, with 1,099 samples testing positive for residual chlorine. Additionally, approximately 56 water samples were collected from the flood-affected areas of Tirunelveli district, of which 47 samples underwent bacteriological testing and 9 underwent chemical testing.

Supply of Chlorine tablets

Due to extensive damage to drinking water supplies caused by flood inundation in Thoothukudi and Tirunelveli, there was an urgent and dire need for super chlorination in these areas. Approximately 40 lakh chlorine tablets were swiftly procured and supplied within 24 hours. The procurement of chlorine tablets was facilitated through the Tamil Nadu Medical Service Corporation. These tablets were airlifted from Bhopal to Chennai and subsequently to Tuticorin Port after undergoing thorough quality checks. The delivery of chlorine tablets to local residents was accomplished within 48 hours, despite the urgency, without compromising on quality.

Quality control

Quality checks for the chlorine tablets were conducted in both drinking Reverse Osmosis (RO) water and tap water for residual chlorine levels at the Directorate of Public Health and Preventive Medicine. The residual chlorine effect was found to be there both in RO water as well as Tap Water. In RO water it lasted for 8 hours and 30 minutes, while it lasted for 7 hours in tap water. This disparity may be attributed to the higher total dissolved solids (TDS) content in normal water. The quality check process was approved by the Chief Water Analyst.

A total of 40 lakh chlorine tablets were distributed in these areas through mobile medical units, static medical camps, and door-to-door visits. Each household received 10 tablets, with each tablet being sufficient to chlorinate 20 litres of water.

6. Monitoring of activities

A daily review meeting was held at the end of each day, chaired by the Health Secretary and the Director of Public Health and Preventive Medicine. This meeting was attended by City Health Officers, Additional City Health Officers, Zonal Health Officers, and Zonal Medical Officers of Greater Chennai Corporation and District Health Officers of concerned districts as well as monitoring District Health Officers and Joint Directors via video conferencing calls.

The purpose of these meetings was to review the current situation, coordinate with assigned officials, and plan forthcoming activities. This meeting served as a nodal point where specialized teams for each task presented their reports, leading to comprehensive action. Each report was interconnected, resulting in appropriate actions being taken. The teams were intricately intertwined, operating in a cause-and-effect manner. State monitoring provided an overarching view of the entire action.

Impact of flood response activities

Based on the data reported through P form in Integrated Health Information Platform(IHIP) ,which is part of a monitoring mechanism, we try to compare the reporting of acute febrile illness and acute diarrhoeal disease for the year 2022-23 with year 2023-24 for Weeks 48-52 &Week 1-4.

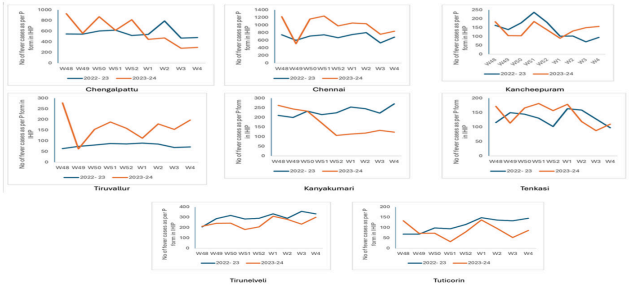

Figure 3 : Distribution of fever cases reported in IHIP in the flood affected districts comparing data for the year 2022-23 with year 2023-24 for Weeks 48-52 &Week 1-4.

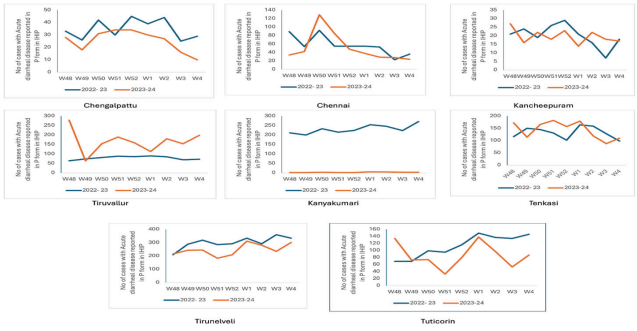

Figure 4 : Distribution of acute diarrheal diseases reported in IHIP in the flood affected districts comparing data for the year 2022-23 with year 2023-24 for Weeks 48-52 &Week 1-4.

Figure 3 &4 shows the distribution of the acute fever cases and acute diarrheal diseases reported in the IHIP over

the year 2022-23 and 2023-24. The data shows that there is no significant increase in the cases reported especially in the southern districts compared to Chennai and its neighbouring districts.

Chennai experienced floods in early December, causing significant disruption and damage. The establishment of the state incident command system was delayed due to the headquarters being directly affected by the floods. However, once operational, the system swiftly implemented Standard Operating Procedures (SOPs) for team formation and functions. Despite the initial challenges, necessary logistics and SOPs were efficiently organized.

Subsequently, when floods hit the southern districts a few weeks later, the state incident command system was already equipped with established SOPs and guidelines for flood response activities. This proactive preparedness likely contributed to the relatively low number of reported cases in these districts, as evidenced by Figures 3 and 4. This underscores the critical importance of having comprehensive guidelines and SOPs in place and the Disaster Response Teams ready particularly in disaster situations, to effectively mitigate impacts and prevent outbreaks.

DISCUSSION

The flood response activity in Tamil Nadu has demonstrated remarkable effectiveness, as evidenced by the absence of major outbreaks in both Chennai and the Southern Districts, which were affected by flood.

This success can be attributed to a series of well-coordinated efforts, including proper delegation of tasks, specific assignment of responsibilities, pooling of resources from neighbouring districts, establishment of a command system at both state and district levels, and the utilization of technology for informed decision-making.

These measures facilitated the development and execution of appropriate plans to mitigate the impact of the floods on health. The response efforts extended beyond mere prevention and management of outbreaks and encompassed the provision of regular health services to those most in need. Tamil Nadu has faced similar floods in the past.

Chennai floods, which happened during November – December 2015 was feared to result in major epidemic outbreaks considering the amount of damage it caused. However, the floods ended with no major outbreaks due to the various outbreak control measures undertaken which includes, formation of 24*7 control room, organizing screening camps, vector control, monitoring of water supply, sanitation and surveillance mechanism, etc. 3The previous experience of handling such disasters paved way for a swift action during a disaster.

A comprehensive review conducted by Mohajervatan et al highlighted the importance of flood emergency response plans in safeguarding public health.

The review delineated two main phases of response plans: initial and specific. Each phase plays a crucial role in mitigating the adverse effects of flooding.

The initial phase involves early warning dissemination, establishment of a command system, information management, coordination, development of incident action plans, establishment of safety/security/relief camps, and management of logistics.[4]

All these actions were diligently undertaken by Tamil Nadu, as part of its flood response activities. Since most of the activities were carried out by mobilizing the available Human Resources and Mobile Medical Unit vehicles from unaffected districts, the entire Public Health measures were done in a cost-effective manner costing only around Rs. 5.35 Cr except for repair of building damages.

Majority of funds (more than Rs. 4 Crore) was spent on Drugs, Disinfectants and Insecticides, with only a meagre amount utilized for Contingency measures to accommodate the medical teams and for food and fuel. This was possible because of the structured Public Health System available in the State.

CONCLUSION

Documenting the flood response activities is vital for informing future guidelines aimed at incorporating the health effects of floods into comprehensive response plans. By understanding and analysing past successes and challenges, authorities can enhance preparedness and response strategies, thereby minimizing the impact of future flood events on public health and safety.

As climate change is expected to cause more such floods in the future, the health problems caused by floods will increase. Hence, it's crucial to quickly evaluate how well different public health actions work to reduce the health impact of floods.

The public health actions that have been documented in this paper can be helpful for other states and countries dealing with similar disasters.

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