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Director's Message

India, due to its specific geographical and geological conditions, is vulnerable to various natural disasters. In India, the incidents of flood, drought and other natural disasters are on the rise and pose a major challenge to the society in general and administration in particular. Each disaster heightens the sense of urgency to equip ourselves better in coping and managing them. In this context, the training of Civil servants in Disaster Management assumes critical significance.

The recurring incidence of such disasters necessitates learning from our own experience as well as the best practices adopted all over the world in the field of Disaster Management. Well documented best practices that can be circulated widely for creation of awareness at all levels of administration play an important role in such a context.

No Administrator can afford the luxury of waiting for any disaster to happen in his/her jurisdiction to learn from it. It is, therefore, imperative to be able to convey the experience of practitioners to each other, in an effort to educate about the variety and intensity of challenges faced in this dynamic field. The response might not have been the best in all cases but they would certainly be elucidating some aspects of disaster resilience to the discerning eye.

By virtue of the DM Act 2005, the District Magistrate/ Divisional Commissioner play a pivotal role as head of the District Disaster Management Authority (DDMA) and hence, it is essential that he /she should be well versed in the various aspects of Disaster Management.

It gives me immense pleasure to note that Centre for Disaster Management, LBSNAA is bringing out an edited case studies series "Disaster Governance in India" Series-9, Issue 2 for the year 2023-24 under the project "Capacity Building on Disaster Management for IAS/ Central Civil Services Officers." This compilation of case studies, learnings and experiences of the civil servants in the field, is an effort of the Academy that is sponsored by National Disaster Management Authority (NDMA), Government of India, New Delhi.

I hope this compilation will be useful for both the Officer Trainees and the Administrators in handling disasters and emergency situations across the country. I want to congratulate the CDM team for this publication and also place on record my appreciation for the contribution made by the faculty & staff of CDM who contributed in various capacities for bringing out this.

(Sriram Taranikanti)

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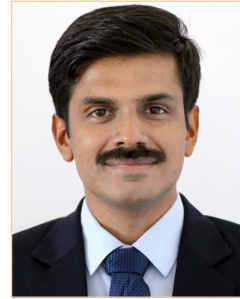
Preface

Disasters have never ceased to adversely affect human civilization. Natural disasters and manmade disasters have increased both in frequency and fury over the years. India has suffered enormously, in terms of loss in lives and livelihoods and damage to both public and private property due to recurrence of disasters. In response, various strategies have been formulated and implemented with regard to mitigation, prevention, response, rehabilitation and reconstruction. These activities span pre-disaster and post disaster time periods. All these efforts have the same underlying goal – to reduce the impact of disasters on our society!

No administrator can afford the luxury of waiting for a disaster to happen in his or her jurisdiction to learn from it. It is therefore imperative to be able to convey the experiences of practitioners to each other, in an effort to educate about the variety and intensity of challenges faced in this dynamic field. The responses might not have been the best in all cases–but they would certainly be elucidating some aspect of disaster resilience to the discerning eye.

In continuation to the successful publication of the fourth series of the publication "Disaster Governance in India" by the Centre for Disaster Management, it is our privilege to publish the Series-9, Issue 2 for the year 2023-2024. The book will be useful to administrators, at various levels, who are handling Disaster Management. It can also serve as a good reference material for ATIs and CTIs for their in-house courses.

I would like to thank the Centre for Disaster Management, Lal Bahadur Shastri National Academy of Administration who have been able to compile the best practices adopted by District Administrations, PSUs and other Institutions in the form of a Disaster Governance of in India, Series-9, Issue 2.

(Abhiram G. Sankar)

Contents

Ensuring Food Availability amidst Floods for Disaster Affected People in Bihar

Sanjay Kumar Agarwal, IAS and Amrita Dhiman*

Abstract

Bihar is a multi-disaster-prone state, wherein floods are the most devastating in terms of damage caused to human lives and property. Amidst floods, shelter camps come into functioning. However, the reluctance of people to move to the shelter camps makes the situation more challenging for the government to handle. It forced the disaster management department to think out of the box. The result is the strategic initiative of community kitchens, wherein people are involved in a participatory manner to ensure food supply during floods. It ensures the availability, accessibility, and acceptability of food for disaster-affected people. This document details the innovative disaster response mechanism contributing to SDG 2 of zero hunger during floods.

Key words: Community Kitchen, zero hunger, disaster preparedness and response, transparency and accountability, feeding amid floods.

1. Introduction: The severity of floods in Bihar

The state of Bihar is prone to multiple types of disasters like floods, drought, lightning, earthquake etc. Amongst these, floods are the most devastating ones, causing severe loss of lives and property. The topography of the state is marked by a number of rivers like Gandak, Burhi Gandak, Baghmati, Kosi, Mahananda, Falgu, Son, Punpun etc. The rivers crossing the northern part of the Bihar are mostly responsible for flooding in the state. Amongst all, Kosi is known as the sorrow of Bihar causing recurring floods.

Flood Hazard Atlas of Bihar (version 2) highlights the fact that Bihar is one of the most flood affected States in the country, accounting for more than 17% of the flood prone area of the country (National Remote Sensing Centre, 2020).

As per the information from the Bihar State Disaster Management Authority (BSDMA) more than 70 per cent area of North Bihar is considered prone to floods. 28 districts out of the total of 38 are considered flood prone in the state, wherein 15 districts are severely flood affected. In the year 2002, Kosi had

flooded a large part of the northern land of Bihar causing loss of around 350 thousand acres of rice crop, 18 thousand acres of maize and 240 thousand acres of other crops. It had negatively impacted 500 thousand farmers in the state.
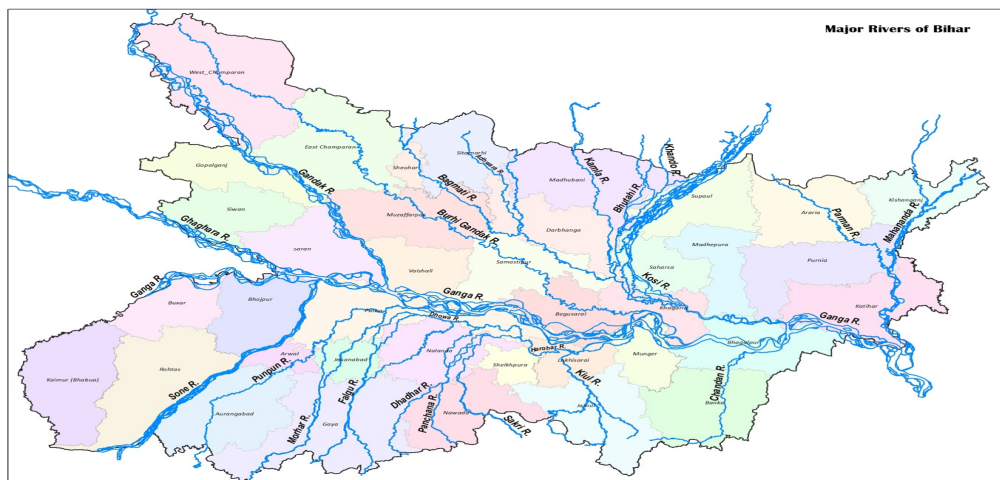
Figure 1: Map showing rivers in Bihar
(**Source:** Water Resources Department, Govt. of Bihar)

The year 2019 was another flood year in the state, wherein it happened in the month of September as a result of sudden and severe rains in Nepal, the neighbouring country. As per the reports from the Disaster Management Department, Bihar the estimated crop damage was of Rs.7278 million. The number of panchayats affected were more than 1.4 thousand and the number of lives affected due to floods were more than 10 million. The number of people affected due to floods were around 15 million in 2021 and the affected total area was more than one million hectares. It indicates the increasing severity of floods in Bihar being exacerbated by climate change conditions.

The honourable Chief Minister of the State has mandated that **"disaster-affected people have the first right on the state treasury"**, hence all the departments in the state along with the Disaster Management Department have been focussing on prompt disaster response during disasters like floods and overall to reduce disaster risk for the communities in the state.

The Sustainable Development Goals (SDG) two (2) of Zero Hunger reinforces the global emphasis of ensuring food for all in all conditions. While chronic poverty is the root cause of all food insecurity, this is exacerbated to an acute level by natural disasters such as floods (Barret, 2010). Food security is characterised by three necessary conditions: availability, access, and utilisation. Floods adversely affect all three of these conditions.

Figure 2: Flooding in a village in Bihar

2. Disruption of food supply chain in disasters

Disasters negatively impact the accessibility and availability of food for the community. The disaster not only impact the current availability of food but also the production in the upcoming cropping seasons. For example stagnant water, affect the crop production post floods.

2.1 Disruption in food supply during floods: During floods, people are forced to evacuate their homes and congregate on raised areas such as railway lines and embankments. They are displaced and take shelter in relief camps set up by the government for them. The availability of food gets affected as the supply chain is disrupted. Roads and other transport networks become non-functional, impacting the availability of food. The crops suffer losses and people's purchasing capacity come down as their livelihoods gets hampered during floods.

At these times, they are cut off from both their household storage of food as well as stores selling commodities. In most cases, the food stored in homes is irrevocably damaged. The availability of and access to food therefore is severely constrained. The rural households preferably use wood or bush to cook food for the family. Families relocated in floods are left with very limited options for food. They also face unavailability of fuel to cook food due to the water submergence situation. Women get forced to cook in wet and open conditions with fewer utensils.

The Diaster Management Department had been distributing dry ration packets containing gram, *chura*[1], jaggery, *sattu*[2], salt, matches, candles etc. The *utilisation*

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[1] Presed rice eaten raw in Bihar
[2] Flour of roasted gram, can be eaten with minimal inputs like small quantity of water, salt etc.

of food is therefore also constrained. People tend to eat handfuls of puffed rice and sometimes roasted gram. While this does provide calories, carbohydrates, and some protein; it is neither nutritionally complete nor emotionally satisfying. Thus we see that in times of flood, the rural flood affected peoples of Bihar experience scarcity from the point of nearly every criterion used to define food security.

During floods, the disaster management department designates shelters where people have access to shelter and food. However, some families do not make use of the shelters; this is often because of the need to care for livestock, concern for property, family members with restricted mobility, or some other personal reasons.

2.2 Issue of food availability during the pandemic for the migrants: COVID-19 is an infectious virus-borne disease that primarily causes respiratory distress, though it also affects the cardiac and neurological systems (Diabetes, 2022; Lancet, 2021). January 2020, India reported its first case of the coronavirus; just 3 months later, in March, Bihar reported its first case.

Consequently, a nation-wide lockdown was imposed by the end of March in 2020. Millions of workers began to walk home in the largest exodus since the partition (The Guardian, 2020). The humanitarian crisis continued when the workers reached home, placing a burden on family members who were themselves unemployed and food-insecure. By first May 2020, about 50 percent of the workers surveyed by the Stranded Workers Action Network (SWAN) had rations left for less than 1 day (Stranded Workers Action Network. 2020a). Access to cooked food was a rarity during the exodus with over 68 percent not having access to a cooked meal.

The pandemic continued to impact employment and food security through 2021. The second wave of COVID 19 struck India in the first quarter of 2021. A combination of loosening of activity restrictions and new variants with increased transmissibility led to the second wave being devastating across the country (Shekhar Chandra, June 2021). During the second wave, Bihar experienced a lockdown of 35 days in May 2021. However, even when a complete lockdown was not being implemented, partial lockdowns and restrictions in movement were imposed throughout the second wave. All educational institutions, religious places, parks, malls, gyms, restaurants and cinema halls were closed. This meant that not only the people employed by these institutions but also the several hundreds of informal workers were unemployed for the duration.

At the same time, workers from Bihar that had migrated to other states returned to their home state (Manoj, 2021). Several states that employ workers from Bihar- including Maharashtra, Punjab, Haryana, Uttar Pradesh, Delhi, Rajasthan and Madhya Pradesh- had begun imposing partial lockdowns around April 2021 (Indian Express, 2021). Fearing a return of the previous year's nationwide lockdown that saw several thousand workers being stranded without employment or food, people returned as the cases in the country began to rise. This inevitably increased the number of people experiencing extreme food scarcity.

Thus, any kind of extreme event like disasters impact the food accessibility and availability for the community. This also warrants timely and appropriate action to help the community and to ensure that no one is left behind in this effort to ensure food supply.

3. Initiation of community kitchens for the community with the community

In 2016, the idea of community kitchens was born to alleviate hunger among vulnerable communities. Community Kitchens is an initiative of the Government of Bihar, wherein nutritious food availability and accessibility is ensured at the nearest possible local point for the disaster affected people.

The first pilot of community kitchen was done in Bakhtiyarpur district in Bihar for the flood affected people. Based on thee encouraging feedback received from the community, the improvisations were done and the strategic initiative was rolled out across the state to ensure food accessibility and availability for people amidst floods.

The floods of 2020 and 2021 were extremely challenging since they overlapped with the pandemic. Bihar government officials were aware of the potential consequences of the overlapping of floods which required the evacuation of millions with the pandemic. The annual floods mean that the state disaster management department has protocols in place and is well equipped to plan for challenges such as these.

The state disaster management policy mandates the provision of food to flood affected communities. Initially relief packets of dry ready to eat food are air dropped to stranded communities. These relief packets include healthy and calorie dense foods that are familiar to rural communities such as beaten rice, roasted gram flour (sattu), jaggery, and salt as well as essentials such as matches and candles, oral rehydration salts and halogen tablets for disinfection of water for drinking. Many areas are completely inaccessible due to the floods; these are

supplied with the emergency relief packets on priority, often by boats. Shortly thereafter, community kitchens are set up and stocked by the disaster management department. Once established, these community kitchens were managed with the participation of the communities. Rapid setting up and operationalisation of the community kitchens are a key relief measure that contributed to the well-being of flood affected people.

Figure 3: Community kitchen in functioning at a village in Bihar

4. The Community Kitchen model in Bihar

From 2016, flood affected families are served hot meals by way of community kitchens, set up at an elevated place close to their settlements. The steps involved in planning for community kitchens:

1. *Site selection:* The sites for the community kitchens are selected keeping in mind both elevation above flood levels, and safe access to the communities. Locations that offer the advantage of the presence of cooking infrastructure such as stoves and utensils such as schools and Anganwadi centres are preferred.

    Rather than seek the convenience of central kitchens, it was decided to take the community kitchens to where the people were. During the floods, Kitchens were set up along highways and on railway platforms, or in remote villages where community kitchens would be set up for just a few households. In 2020, the magnitude of the floods provided a new challenge as many of the Anganwadi centres and schools that were normally used to set up community kitchens were themselves inundated. For several square kilometres, the highways were all that were visible. The dhabas[3], or roadside eateries acted as first responders. These were

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3   Local restaurants on the highways are called as dhabas

situated on highways where people were congregated; they also already had functioning kitchens design for high volume cooking and the trained staff to manage these kitchens.

2. *Staffing:* Cooking food, serving it, and cleaning up are all done with the help of volunteers from the disaster affected villages. They are provided with remuneration of Rs.400 on per day basis for their assistance. Attention is paid to the quality of the food, as well as cleanliness of the kitchen. Gram panchayat members, and Anganwadi workers, JEEViKA didi'[4] and ASHA workers often take the lead due to their rapport with and knowledge of the affected households. The setting up and staffing of community kitchens is done in a highly participatory manner with the community.

3. ***Provisioning the kitchens:*** Provisions for the kitchens were supplied though the existing Public Distribution Scheme network that is used to supply subsidised staples to the poor. When needed, local vendors were also drawn upon for necessary supplies.

    The determination to set up decentralised kitchens and so ensure that no household is excluded meant that the distribution systems needed to be equally adaptable. Provisions were sent to the kitchens almost on a daily means by any and all means possible including trains, boats and motorcycles. Special attention is paid to the food being hygienic and both nutritionally and culturally appropriate. To maintain sanitary conditions and prevent the accumulation of trash, stainless steel utensils are preferred over disposables.

4. ***Menu provided:*** To ensure good nutrition, there is an emphasis on "home-style" food such as cooked rice, lentils and vegetables and a ban on fried food like pooris. The community kitchens began by serving khichri - the simple and nutritious one-pot comfort meal of rice, lentils and vegetables that is beloved of most Indians. Later, at the behest of the chief minister this was changed to the more elaborate and complete thali meal of rice, dal and a cooked vegetable. Special provision was made for milk for children and lactating mothers. During 2020 and 2021, the pandemic years, community kitchens were directed to make a decoction with herbal ingredients and serve to the people eating at the kitchens and residing in the relief camps thrice a day in a bid to build up their immunity.

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4   The Government of Bihar (GoB), through the Bihar Rural Livelihoods Promotion Society (BRLPS), an autonomous body under the Department of Rural Development, is spearheading the World Bank aided Bihar Rural Livelihoods Project (BRLP), locally known as JEEViKA with the objective of social & economic empowerment of the rural poor.

5. *Registration and documentation:* Arrangements have been done to facilitate the registration of all those eating food. All need of any identity proof to access the meal was waived aside. A meal is provided to anyone who is in need of food. Photo and video documentation of the facilities is done. Arrangements are made for the regular supplying of the community kitchens. Random checks are carried out by district officials to make sure there is no lapse in quality of hygiene. Every effort was made to implement COVID-19 safety protocols such as adequate social distancing during meals. After an order to that effect on 19 May 2021, the community kitchens also provided food to the caretakers of COVID patients at various health facilities.

Figure 4: Village level health workers supporting in a community kitchen at a village in Bihar

5. Monitoring of community kitchens for effective implementation

The strategic policy formulated of community kitchens in Bihar are implemented at the grassroots level to ensure the food security for disaster affected people. The proper implementation is ensured by way of monitoring mechanisms. The regular physical monitoring of the regular functioning of the community kitchens is ensured by the block, subdivision and district level officials time to time. Surprise visits are also conducted by the officials and they eat at the community kitchen to check the quality of the food.

The Honourable Chief Minister of the state has also been personally visiting the community kitchens during his field visits to ensure the access and availability of nutritious food for people through community kitchens in difficult situations.

CM Nitish Kumar enquired from the beneficiaries since when s/he is taking meal from the centre, how many time they take meal in a day, and do they face any difficulty in getting meal from the Govt. run kitchens? Mrs. Hazra Khatoon, one of the beneficiaries of the community kitchen, being run at the Jehanabad bus stand, told the CM, "I am a street hawker. Our business is closed due to the lockdown. Here, there are very good arrangements for meals".

Figure 5: Honourable Chief Minister of Bihar interacting with the family at the community kitchen

Ruchi Bhardwaj, one of the beneficiaries at Sasaram community kitchen centre, informed the CM, "The centre delivers our food at the home after we inform them through mobile phone. Most of the members in my family are COVID-19 infected and we all are in home isolation. As we get both meals from the community kitchen, we feel very relieved."

Community Kitchen is more than just a means to access a meal. They provided interaction, vital communication, and an assurance to the stricken communities that the government was aware of their plight and working to improve the situation.

Based on the feedback received from the community, community kitchen initiative has been strengthened and ensured to reach up to the village level. The Disaster Management Department has done used technology to ensure the GIS (Geographic Information System) mapping of all the community kitchens in the state.

The GIS mapping of the community kitchens has been integrated through the mobile numbers of the in-charge of the community kitchens, who is preferably
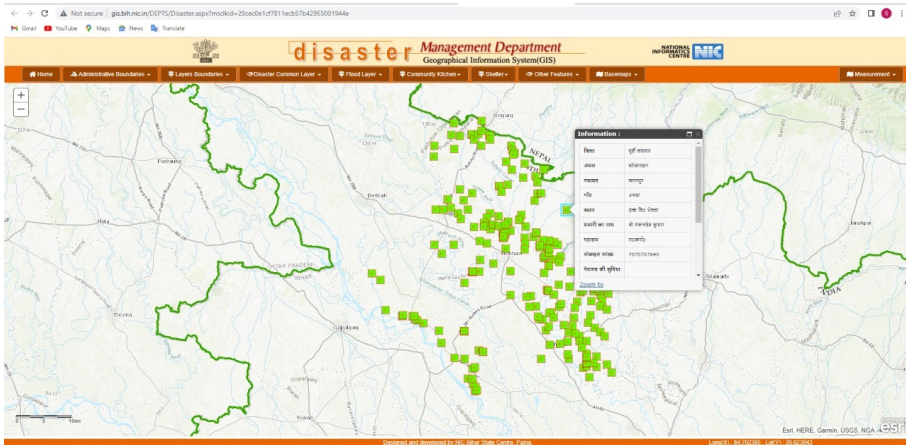
Figure 6: Snapshot of the GIS tagging of Community Kitchen in
Samanpur panchayat of East Champaran District
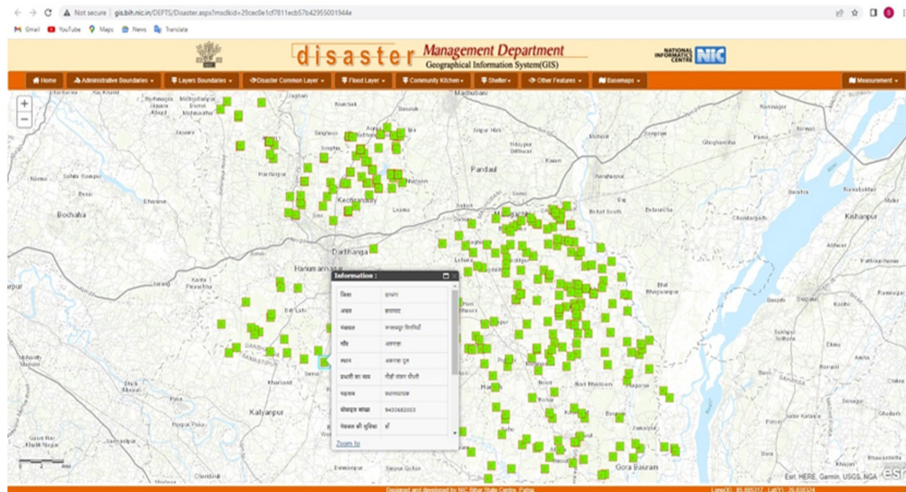
Figure 7: Snapshot of the GIS tagging of Community Kitchen in
Akaraha village of Darbhanga District

from the local institutions at the village or the gram panchayat level like schools etc.

The GIS based virtual monitoring clubbed with the physical monitoring has been helpful in effective implementation of community kitchens in Bihar. It has emerged as a best practice wherein upgration and improvements have been incorporated in a bottom-up approach based on the feedback from the community.

6. The contribution of community kitchens in ensuring accessibility, availability and acceptability of food during floods

In 2016, the idea of community kitchens was born to alleviate hunger among vulnerable communities. During the COVID-19 lockdowns as during other natural disasters, vulnerable people including daily labourers, the homeless, ill and frail people faced extreme hunger. Considering their needs, a community kitchen was set up in designated spots in each district (Siasat, May 7, 2021).

The floods of 2020 and 2021 were extremely challenging since they overlapped with the pandemic. Bihar government officials were aware of the potential consequences of the overlapping of floods which required the evacuation of millions with the pandemic. The annual floods mean that the state disaster management department has protocols in place and is well equipped to plan for challenges such as these.

The state agencies included measures to reduce the potential spread of COVID-19 in the flood evacuation plans by building additional evacuation centres, informing communities about how to prevent COVID-19 transmission, and providing essential items like hand soap, water, and hygiene kits in evacuation sites. The disaster management department coordinated with the Water Resources Department (WRD) and the Health Department to control the spread of COVID-19 while managing floods. Relief camps were set up twinned with quarantine centres, so that people exhibiting COVID-19 symptoms could be shifted there. However, the distances that needed to be covered when transport was at a standstill meant that a large proportion of the flood affected people could not make it to the relief centres; it was the community kitchens that upheld the goal of not neglecting any person facing hunger.

By 27 July 2020, nearly 6, 40, 000 people were affected by floods. A total of 29 community kitchens were being operated in flood affected areas by that day. By 20 August 2020, these had increased to more than 818 community kitchens at which more than 0.663 million people ate every day (Sphere India, 2021).

Floods in 2021 started by mid of June, and by 21 July 2021, more than 0.8 million people had been displaced by floods. More than 200 community kitchens had been set up by 21 July 2021(Save the Children, July 2021). On 17 August 2021, the floods had affected 2.7 million people in 15 districts. Over 85,000 people were evacuated to safer areas with many thousands more getting assistance at community kitchens. The table below gives an idea about the setting up of the community kitchens to serve the flood affected communities in the state.

Table 1: Number of community kitchens set up to serve the flood affected communities

Sl. No.	Year	Number of kitchens functional	People eating food per day (in thousand)
1	Floods 2017	2569	49
2	Floods 2019	2718	923
3	COVID 2020	204	302.5
4	Floods 2020	2478	2318
5	COVID 2021	739	574.5
6	Floods 2021	2002	2111

Year on year, the community kitchens have been found to be very helpful in ensuring zero hunger. The community kitchens are strategic initiative to ensure nutritious meals for people who were experiencing food scarcity either due to a disaster like floods, or due to unemployment brought on by COVID-19 management measures. A large part of the community affected by the crisis was served with nutritious food. Due to the process of working together to cook and clean up, as well as eating together, the people who participated in the community kitchen had a greater sense of belonging to the community.

7. The Learning from community kitchen to Conclude

The community kitchens were a strategic decision to ensure nutritious meals for people who were experiencing food scarcity either due to a disaster like floods, or due to unemployment brought on by COVID-19 management measures. They were found to be an effective measure increase food security by addressing the availability, accessibility and utilisation. Internationally also community kitchens have proved to improve the food security and livelihoods of participants, while facilitating better social cohesion and integration of the disaster displaced people with the host communities in emergency situations (Ibrahim N, 2019).

It was a great relief to people who were staying at their homes during the flood times when the food supply and distribution chains are interrupted due to multiple reasons. A large part of the community affected by the crisis was served with nutritious food. Due to the process of working together to cook and clean up, as well as eating together, the people who participated in the community kitchen had a greater sense of belonging to the community.

The community kitchens proved their value and usefulness during the COVID-19 pandemic. The floods of 2021 were especially challenging since they overlapped

with the pandemic and the vaccination drive. While setting up relief camps may not always have been possible, community kitchens provided food, a safe space, and access to some basic services. On 7th June, the Hon'ble Chief minister, Bihar had instructed officials to vaccinate flood affected people on priority. The community kitchens provided a safe space to carry out vaccinations and reach people.

Thus, community kitchens have emerged as an effective participatory strategic initiative in aligning the efforts to achieve the milestones under SDG two of Zero Hunger while enabling and empowering the communities towards resilience by ensuring food security amidst disasters.

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Fire Safety Management for Tent City during Major Religious Programme

Paras Nath Rai, IPS (retd.)

1. Introduction

Commemoration of the 350 year of birth of Shree Guru Gobind Singh Ji and the beginning of 350th Prakash Parv celebrations were organised on a grand scale in Patna by the Dept of Tourism, Bihar during 3-5 January, 2017. On this occasion lakhs of pilgrims arrived from all over the world. On the request of Shiromani Gurudwara Prabandhak Committee (SGPC) and Takht Sri Harimandir Ji Patna Sahib, the Darbar was created in Gandhi Maidan, Patna, where Guru Granth Sahib was placed for reverence by the pilgrims. The Hon'ble Prime Minister of India inaugurated the function and special commemorative postal stamps were released. The major challenges that were faced during this event are as under.

a) To attract pilgrims and devotees from every corner of India and around the world in large numbers to Bihar to participate in this grand event.

b) Ensuring Proper *Infrastructure*

c) *Coordination* of the State Government with the Government of India and other State Governments including all Stakeholders to ensure participation of devotees in large numbers

d) *Accommodation:* The arrangements were made by Dept. Of Tourism of Tourist Govt. of Bihar for the stay of pilgrims in and around various places of reverence, in schools, Dharmashalas, Gurudwaras besides small and large hotels but major arrangement was made in the vicinity of Takht Sri Harimandir Ji Patna Sahib. For this purpose 3 tent cities were made at Gandhi Maidan with 10000+ beds, Kangan Ghat with 5000+ beds and Patna bypass NH 30 with 35000 + beds (in approx.100acre campus).

e) *Safety and Security CCTV network* was installed with round the clock monitoring by the police officers at the control room. Temporary police stations were created at all the places where large number of pilgrims were accommodated with a view to provide not only fool proof security cover but also to create a sense of security amongst the visitors.

f) *Fire fighting:* Fire brigade deployment was done very systematically with fire tenders, water tankers, mist technology fire fighters and a sufficiently large number of fire fighting personnel posted. These were distributed

in and around the residential areas. Water replenishment points were also identified in the event of any emergency requirement. In addition adequate number of fire extinguishers were installed in the entire tent city residential blocks distributed all over with trained staff posted along with. Sand buckets were installed in various suitable locations

g) *Disaster management:* NDRF & SDRF team was strategically deployed with necessary number of personnel and essential equipment to take care of any exigency that may arise out of crowding or any other unforeseen situation. Continuous back up of Generators was provided in all the concerned areas to prevent any possibility of black out or any problem arising out of such a situation.

The 350th PrakashParv (also Prakash Utsav) or birth anniversary of Guru Gobind Singh ji was celebrated in January 2017 in Patna, Bihar. 2017 is the year of the 350th anniversary of the 10th Sikh Guru, a spiritual master, warrior, poet and philosopher. At the date of this anniversary, a number of events was organized on the occasion in Patna marking a grand celebration in their history.

In the view of huge importance of the Sikh faith and close association of Shree Guru Govind Singh Ji with Bihar the concept and program to celebrate the 350thPrakashParv was conceived almost 2 years back and was exhaustively publicized on various forum through advertisement in electronics and print media.

a.   Development of 3 tent cities were made at Gandhi Maidan with 10000 + beds, Kangan Ghat with 5000+ beds and Patna bypass NH 30 with 35000+beds (in approx.100 acre campus)

b.   In these tent cities facilities like Swiss cottage, Camp beds, blankets, heaters, helpdesks, luggage room etc. were provided.

c.   Devotees from various parts of the country and also abroad from places like Australia, United Kingdom, Kenya, Africa and America arrived in this religious event.

d.   The Prime Minister, Shri Narendra Modi, also attended the 350th birth anniversary celebrations of Shri Guru Gobind Singh Ji Maharaj in Patna.

e.   Several tourist information centres were opened in Patna

f.   Over 200 CCTV cameras was installed to monitor the situation

g.   The Gurudwara Prabandhak Committee (Gurudwara management committee) is also undertaking huge constructions and renovations on its campus.

h.   Multiple tent cities have been planned across Patna under the aegis of Department of Tourism, Government of Bihar, with the main celebrations being conducted at Gandhi Maidan.

i.   Bihar observed three-day public holiday in Patna from 3 to 5 January 2017

2.   Challenges for Fire Safety

Fire safety was more critical than any other arrangement during the three day programme. Devotees were fairly disciplined and therefore no expectation of law and order. Likewise very pious event where entire Patna was celebrating and supporting the outside devotees, there was least possibility of criminal activities. It was no wonder that no such events happened.

All temporary arrangements highly inflammable – Tent, Carpeting material, camp beds, swiss cottage etc. Usage of highly inflammable ply boards for tent cities and main worship sites. Huge crowd of devotee from different parts of countries and aboard. The estimated people staying in three tent city were above 50,000.

a)   *Availability of water for fire fighting*

- The water supply arrangement for the temporary cities was designed to meet requirement of drinking and sanitation. Hence the size of the pumping station outlet was much narrow than required for feeding water to fire tender. When the department responsible for this was told to increase the water outlet system, they refused on the ground of non-approved work. Here too intervention by higher authorities and water supply system was modified to take care of fire tender requirement.

- Everyone needed to appreciate that in this scenario, where almost everything in tent cities was vulnerable to fire, quick availability of water was absolute must, and same goes with other fire safety arrangements. Rushing fire safety support from outside would have been highly dangerous and therefore, we decided to have fire extinguisher installed at every 100 feet so that the fire could be extinguishes in very initial stage.

b)   *Safety from Community Kitchens*

- Massive community kitchens within tent city premises, catering to thousands of devotees were again a safety nightmare created in tent and dining area. Kitchens in all tent city were created where the

gas cylinders, as usual, were alongside the burners. This was highly dangerous. It was a downting task to make organisers appreciate safety arrangements. They were asked to dig deep to keep gas cylinder at certain distance from the cooking area to prevent possible blast in gas cylinders. Possibility of gas cylinder causing loss of life in kitchen and the dining area. We had terrible time to get it done.

c) **Sensitisation of organisers-** department of tourism and others for making fire safety arrangement part of tender arrangement.

- It was again a herculean task to sensitise the people to make the tent material, plywood etc. fire resistant. The fire services had great difficulty in getting this work done as it did not form part of work order/tender.

- **Design of city allowing movement of fire tenders:** Even then fire safety requirements were not made part of the tender document and therefore, the vendors were not willing to install or make arrangement according to requirement of fire safety as suggested by us.

- **Sensitisation within fire services:** Unfortunately most of firemen did not have had exposure to such arrangement and therefore it was an extremely challenging task to orient them to think on safety features. They seemed content with deployment of tenders around the city premises. Probably they were not at fault as the entire orientation is toward fire fighting as against preventive fire arrangement. They were basically trained and tuned to respond to fire. The aspect of DRR and preventive activity were not a part of work culture.

- We did not have had any design of fire safety system for such an event as the fire services had not experienced or engaged in such fire safety arrangement.

d) **Safety from electrical system**

- Event was organised in December therefore threat from electrical system including heating was extremely critical. Therefore, the safety of electrical system/fitting was absolutely necessary. We insisted on having covered wiring. This again was resisted. Heaters were installed in all tents. They themselves were fire hazards. The fire services had to request electricity department to vet the quality of wire and electrical fittings. Safety procedures required there, the wire and other electrical system were of the prescribed standards. Secondly the capacity of the transformers and generators was as per load of the tent city. Such

sensitivity with regard to fire safety was also not part of work culture.

- The heater were of low quality and there was fear of their being cause of fire in case of overheating. In fact one such incident did happen in a tent housing in police-man, where-in fire in a heater damaged entire tent and belongings. Fortunately, the police men had gone on duty and no human loss was there.

e) *Multiple places of worship*

- Examples–3 tent cities and 5 Gurudwaras where people were staying. Gurudwaras Harmandirsahib were main gathering place where main functions were conducted.

f) *Shortage of trained firemen*

- The requirement of firemen was huge for tent cities, Gurudwaras and the places were devotees from outside state were residing. The deployment of fire personals was for 24 hrs in 8 hrs shift. A copy of deployments attached as annexures. Hence, home guard personnals were also deployed with training to handle extinguishers and support fire safety personnals. The entire area of each cities and Gurudwaras was divided in sectors and giving charge of officers at rank of DY.S.P. The personnals needed to stay as close to site as possible. Hence the organisers accepted our request and provided accommodation for stay within the campus. Additionally, tent was provided for the fire personnals to stay closers to their deployment place in each sector/sub-sectors, so that they are ready to respond immediately. It did help as a couple of fires that did occur were doused before they could spread.

- Safety protocol for such kind of event was unknown. In this case, the concern for fire safety was within tent cities. Fire extinguishers were installed at every 100 feet under the charge of fireman.

A Case Study on the Role of 5th Battalion of National Disaster Response Force-Irshalwadi Landslide in Maharashtra

Ravi Prakash

Abstract

India's National Disaster Response Force (NDRF) is a specialized force that is essential to disaster response and management. During natural and man-made disasters, its main responsibility is to conduct relief and rescue efforts. On 19th of July 2023 a catastrophic incident took place in Irshalwaadi which is in the Raigad district of Maharashtra, within the Sahyadri mountain range. The village is situated amidst steep hills, with structures built on the slopes was completely vanished in this catastrophic incident. In this research researcher using in-depth interview conducted interview with 8-9 NDRF personnel to unveil the role of NDRF in Irshalwadi landslide incident. The general aim of this study was to find the overall role of NDRF in landslide incident. As a result, it has been found that upon receiving information at the 5 battalion NDRF headquarter four teams promptly rushed to the incident site and commenced the operation. The rescue operation commenced on 20th July 2023 and concluded on 23rd July 2023, in these four days the team successfully recovered 23 dead bodies from the incident site and subsequently handed over to the local authorities.

Key words: *National Disaster Relief Force, Catastrophic, Relief and Rescue.*

1. Disaster Management Framework in India

A disaster is an unexpected, frequently disastrous event that significantly disrupts daily life and harms people, their property, and the environment. These occurrences, whether natural or man-made, have the potential to cause fatalities, injuries, the breakdown of critical infrastructure, and financial losses. The scope and impact of disasters can vary, from small-scale localized catastrophes to large-scale, broad events affecting entire regions or even entire countries. In mountainous terrain, landslides are a frequent natural disaster that often result in significant loss of human life and natural resources. It is primarily blamed on natural phenomena, such earthquakes and rainfall that occurred in these locations (Shah et al, 2019).

International debate and discussion on disaster response and preparedness peaked in the middle of the 1990s and continued for the next ten years. The UN's adoption of the Yokohama Strategy Plan (1994) and the Hyogo Framework for Action (2005) were two of the more noteworthy and significant ones. India saw some of its worst natural disasters during this time, including the Orissa Super Cyclone (1999), Gujarat Earthquake (2001), and Indian Ocean Tsunami (2004). The need for an extensive disaster management plan was highlighted by this series of events and the global context. This resulted in the Disaster Management Act being passed on December 26th, 2005. To establish the policies, plans, and procedures for disaster management, the National Disaster Management Authority (NDMA) was established. For the purpose of providing specialized response to natural and man-made disasters, the Disaster Management Act contains statutory provisions for the creation of the National Disaster Response Force (NDRF).

2.   Emergence of NDRF

Consequent to High Power Committee Report and considering the Risk profile of India a dedicated response Force was created at National Level called National Disaster Response Force. NDRF was raised in 2006 with 8 Battalions, Two Bn.'s each were divided geographically in four zones. Currently, the NDRF has 16 Battalions, each of which has 1149 members. Initially, members of the NDRF were also sent out on ordinary law enforcement missions. The need for the NDRF to become a dedicated force was brought up and acknowledged in a meeting between the NDMA and the Prime Minister on October 25, 2007. Due to this, NDRF Rules were notified on February 14th, 2008, establishing NDRF as a force specifically designated for tasks connected to disaster response, under the unified leadership of DG NDRF. The BSF, CISF, CRPF, ITBP, SSB, and Assam Rifles are represented by 16 battalions in the National Disaster Response Force now. Each battalion has 18 self-contained specialized search and rescue teams with a total of 47 members which includes engineers, technicians, electricians, dog squads, and medical/paramedic professionals. All 16 NDRF battalions have state of the art equipment and training to respond to both natural and man-made calamities. Additionally, battalions are prepared and trained to respond to CBRN (chemical, biological, radiological, and nuclear) emergency.

3.   Role of NDRF in Disaster Management

India's National Disaster Response Force (NDRF) is a specialized force that is essential to disaster response and management. During natural and man-

made disasters, its main responsibility is to conduct relief and rescue efforts. The following are some of the main duties and roles of the NDRF:

a) **Search & Rescue:** NDRF teams are prepared and trained to execute search and rescue operations in a variety of catastrophe scenarios, including earthquakes, floods, cyclones, landslides, and building collapses. They locate and rescue trapped survivors in disaster-affected areas using specialized tools and methods.

b) **Medical Care:** The injured are given rapid medical attention by NDRF personnel, who also arrange for their transportation to hospitals. They have trained paramedics and doctors on their crews, along with medical supplies.

c) **Evacuation and Relief:** NDRF teams assist in the evacuation of individuals from disaster zones to safer places during emergencies like floods or cyclones. Additionally, they provide those in need with relief supplies including food, drink, and shelter.

d) **Mitigation and Preparedness:** The NDRF works to educate communities about disaster preparedness and mitigation strategies. They conduct mock exercise, community awareness program and training sessions to improve disaster preparedness at the local level.

e) **Chemical, Biological, Radiological and Nuclear Response (CBRN Response):** The NDRF has specialized teams and equipment to deal with emergencies involving hazardous materials, chemical spills and CBRN threats.

f) **Water Rescue:** NDRF teams are trained in flood water rescue operations and frequently deployed to save trapped victims in floodwaters.

g) **Collapse Structure Search and Rescue:** Teams from the NDRF are skilled at coping with complicated situations like building collapses.

h) **Liaison and Coordination:** To guarantee an effective and coordinated response to disasters, NDRF works closely with other disaster management organizations, state governments, and municipal authorities.

i) **International Assistance:** In exceptional circumstances, NDRF teams may be sent out for global disaster relief operations in collaboration with governments and international organizations.

j) **Training and Capacity Building:** To increase the capacity of state and municipal authorities in disaster management, NDRF runs training programs and workshops.

The NDRF is essential in reducing the loss of life and property during catastrophes and increases India's overall capacity to withstand such events. To ensure a quick reaction to crisis events, it is divided into many battalions stationed in various locations across the nation (egyankosh).

4. Literature Review- Landslide

The landslides are among the most destructive big disasters on the earth, and they are made worse by the wet season. principal causes of the slope instability are geological and geomorphologic in character. The Himalaya, the newest mountain range, is an extremely landslides and tectonically active zone have increased many occurrences here (Kumara, et al, 2022).

Landslides are caused by sudden downhill movement of the consolidated, unconsolidated soils, and rock matter from a geomorphic structure as a result of both natural and artificial processes (Patil & Gopale, 2018). Such motion may take many different forms, including a fall, topple, slide, spread, or flow (Ering & Babu, 2016). The theory behind landslides was that in steep terrain, rainwater penetration reduces the suction (i.e., negative pore water pressure) in the soil, which lowers shear strength and causes landslides to occur (Fredlund & Rahardjo, 1993).

Malin, a small village located on the slopes of the mighty' ''Sahyadri'', the North-South running Western Ghat section in Maharashtra; was struck by a disaster of colossal nature in the form of a landslide. On 30/07/14 at 0820 hrs, it was raining heavily when a landslide affecting an area of about 100x 150 meters buried 46 houses of village Malin. 24 remaining houses of the village were saved from devastations by playing crucial role by the NDRF (Sarvade, et al, 2014).

5. Objective of the Study

- To find out the overall role of 5 Bn. NDRF in Irshalwadi Landslide.
- To find out the problem and challenges faced by NDRF in the entire operation of Irshalwadi Landslide.
- To find out the mitigation and preparedness role of 5Bn NDRF in Irshalwadi Landslide.

6. Methodology

Qualitative research design has been incorporated in this research. Primary data has been collected by using In-depth interview. This research demands qualitative research approach hence in-depth interview has been

incorporated keeping in view the nature of the research. An interview is an important qualitative research method in which the researcher collects data directly from the participants. Interviews are significant in unfolding opinions, experiences, values, and various other aspects of the population under study. Interviews are always goal oriented (Kothari, C. R. 2004).

Purposive sampling is employed in this research in which purposively the NDRF officers and other personnel (The one who were involved in the Irshalwadi landslide operation) were chosen to interview with for extracting the data for this research. In this research the researcher prepared 15-18 open ended questions for the interview. Questionnaire was based on the specific role of NDRF in landslide operation. Researcher did the interview face to face with each chosen sample for this research. Probing technique was also used by the researcher to clarify the vague and unclear statement made by the interviewee to avoid any ambiguity in the data.

7. Irshalwadi- Geology

Irshalwadi village (Latitude 18° 55′ 58.23″ and Longitude 73° 14′ 4.17″) is located on a hill at around 1200 m elevation above sea level near the Irshalgad Fort in Raigad district of Maharashtra. Its geographical and environmental characteristics that make it susceptible to landslides. The village is situated amidst steep hills, with structures built on the slopes. The elevation varies significantly, making the region prone to slope instability during heavy rainfall. While the lush paddy vegetation enhances the scenic beauty, it can also contribute to landslides by increasing soil saturation during monsoon rains. The undulating terrain and narrow pathways create challenges for access, both during regular conditions and during disaster response. Continuous heavy rainfall, which is common in the Western Ghats region during the monsoon season, can saturate the soil, leading to landslides.

In the interview it was mentioned by to the NDRF Personnel that landslides are not uncommon in regions with similar geographical features to Irshalwadi, especially during the monsoon season. The typical triggers for landslides in this region are continuous heavy rainfall, which saturates the soil, and the steep slopes that become unstable due to soil erosion. While the frequency of landslides can vary, they are more likely to occur during periods of intense rainfall and increased soil saturation.

8. NDRF Response at Irshalwadi

On July 19, 2023, the entire Irshalwadi village in the Raigad district of Maharashtra, India, was obliterated due to a catastrophic landslide. District

Administration, Raigad through Maharashtra State Disaster Management Authority requisitioned support of NDRF for responding to this catastrophic incident. Upon receiving the requisition, NDRF teams were mobilized and deployed to the incident site. Before leaving for the operation, the NDRF battalion conducted preparations that included mobilizing trained personnel and equipping them with specialized disaster management equipment. They also ensured that teams were briefed about the response plan, potential hazards, and precautions to be taken during operations.

8.1 Irshalwadi Operation- Sequence of Actions: The following were the sequential activities performed by NDRF:

a) *Mobilization and Deployment:* Upon receiving a requisition from the State Disaster Management Authority (SDMA), 4 x NDRF teams of 5th Bn of NDRF were mobilized and deployed to the incident site.

b) *Preparatory Activities undertaken by NDRF:* Before moving out from the permanent location Teams undertook following preparedness measures;

- Downloaded satellite imagery of the incident location (prior to incident) to access the affected area

- Detection and Search Equipment to undertake operation for detecting and locating the survivors under debris

- Each rescue member carried Medical First Responder Kit to administer immediate first aid to survivors

- Considering the physical infrastructure in the area, Teams carried extrication and Access Equipment

- Rescuer life being precious considering terrain, weather and ground situation, each member of team was provided with suitable Personnel Protective Equipment

c) *Tactical Planning at the Site:* While moving to the landslide area process of information acquisition related to incident site continued and on reaching the site of Landslide, situational assessment was done and based on resource s (men, material and equipment) availability operational objectives were decided considering priority tasks to be undertaken. The teams earmarked and assigned tactical activities to be undertaken.

d) *Search and Rescue:* NDRF teams conducted search and rescue operations meticulously, focusing on retrieving individuals trapped under debris under most challenging situation. The location was inaccessible to vehicular traffic and rains prevented air effort. All equipment's were brought to the location manually by the team members.

e) *Safety Precautions:* It is inherent in NDRF operations to ensure total safety in execution of their task as well as dealing with victims whether debris removal or rescuing from rubble. Considering that entire operation was manual, due safety measures were taken during SAR operations.

f) *Coordination:* Considering the accessibility to the location, the local volunteered participation was restricted, notwithstanding, the local teams were integrated in overall operations, which was very useful.

g) *Continuous Monitoring:* Weather updates were being continuously monitored to warn rescue teams on potential hazards.

h) *Community Engagement:* NDRF teams engage with the local community, leveraging their knowledge of the terrain and familiarity with affected areas.

i) The following mitigation measures were taken at the site:

- Spraying of disinfectant was arranged to stop the spread of disease
- Mourning villagers were counselled and given psychological support
- Arranging fodder for the livestock
- Disposal of dead animals

j) Equipment and resources play an important role in any landslide operation. NDRF teams deploy specialized disaster management equipment, including:

The rescue operation commenced on 20th July 2023 and concluded on 23rd July 2023, in these four days the team successfully recovered 23 dead bodies from the incident site and subsequently handed over to the local authorities.

9. Challenges Faced during Conduct of SAR Operation

The NDRF teams encountered several challenges during the operation, including:

a)   *Inaccessibility of Heavy Machinery:* Lack of proper road connectivity prevented immediate deployment of heavy machinery, necessitating manual digging.

b)   *Manual Digging:* The absence of heavy machinery required manual digging, which slowed rescue efforts and posed safety risks.

c)   *Weather Conditions:* Heavy rainfall and high wind velocity affected the efficiency of rescue operations and safety of teams.

d)   *Secondary Landslide Threat:* Fear of secondary landslides added complexity and safety concerns. Due to incessant rain and poor visibility operation was conducted in day light only.

e)   *Limited Resources:* Availability of equipment and resources, due to inaccessibility of motorable road, was a limiting factor.

f)   *K-9 Search Ineffectiveness:* K-9 search was ineffective in the difficult terrain.

g)   *Hygiene and Sanitation:* Hygiene and sanitation concerns added complexity to the disaster zone.

10. Risk Reduction

As far as reducing the risk in Irshalwaadi in future is concern it was mentioned that it is required to improved land use planning and infrastructure development in hilly terrains. There should be enhanced community awareness programs on disaster preparedness. Continuous monitoring and mitigation of environmental factors contributing to landslides shall be done. Places/Villages already earmarked as vulnerable to landslide shall be vacated and population shall be shifted to a safer place. Something like inter-agency coordination for implementation of order is required for better disaster management.

11. Conclusion

Maharashtra's sensitivity to the effects of climate change is anticipated to increase, especially in its mountainous parts. The possibility of experiencing future devastating disasters is becoming more and more concerning due to the region's continued rapid growth activities. 5th Bn. NDRF is deployed in this region for rescue operation in any disaster happening in this region. 5th Bn. NDRF is playing significant role in rescue operation. In this research it has unveiled that 5bn NDRF is rapid in their response in any landslide disaster.

The NDRF has played a very important part in these activities. Regardless of the severity of the calamity, research has shown that they react to landslide disasters with surprising speed. They have proven their readiness in every way imaginable and continue to fulfil their duties even in the face of. Regardless of the magnitude of the catastrophe, they are fully prepared in every conceivable manner. They continue to fulfil their roles diligently, undeterred by the hardship they encounter during the operation.

Fig. 1: Geographical Location of Irshalwadi

Fig. 2: Irshalwadi after the Landslide
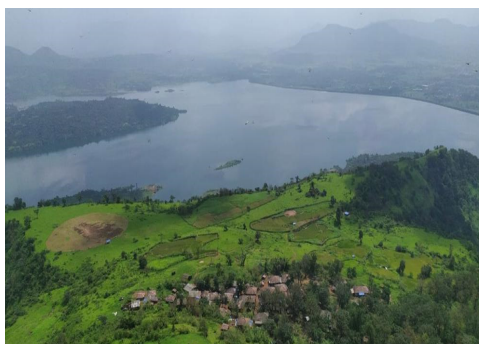

Fig. 3: Irshalwadi before the Landslide

Fig. 4: NDRF personnel performing their duty

Fig. 5: NDRF personnel performing their duty

12. Limitation of the Study

During the research the researcher encountered a paucity of relevant literature available for reference. Researcher successfully completed the research using the limited available literature and the response provided by the respondents. More available research could have provided better understanding of the research topic. Due to time constraints researcher was unable to conduct interviews with the victims of the Irshalwaadi landslide in order to gain better understanding of the role played by the 5th Battalion NDRF.

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Best Practices for Enhanced Ecological Resilience of Chennai Using Eco-system based Adaptation (EbA)

S. Rajendiran

Abstract

Increased urbanization compounded with the effects of climate change are the major driving factors rendering communities vulnerable to climate-related disasters. Eco-system- based approaches like strengthening blue-green infrastructure offer myriad benefits that are socially, economically, and environmentally beneficial making a strong case for its promotion as best practices for building climate resilience in cities. Chennai city is naturally vulnerable to floods being a coastal city and droughts due to the absence of a perennial source of fresh water supply facing the critical challenges of climate extremes. Being the fifth most populous urban agglomeration with about 11.78 million inhabitants, the residents' exposure to climate risks is even higher. This paper aims to present the adaptation measures practiced by the Greater Corporation of Chennai in combating the effects of climate change using blue-green infrastructure. It also discusses the various enabling factors such as policy, financial support, and coordinated efforts of relevant stakeholders in the implementation of eco-system-based adaptation approaches in confronting the climate change impacts.

Key words: *Flood/ drought mitigation, Eco-system based adaptation, water conservation, Greater Chennai Corporation.*

1.   Introduction

Ecosystem-based Adaptation (EbA) is a nature-based solution that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience to climate change. EbA help adapt a new culture of prevention, preparedness and quick response for managing disasters and reduce the community's vulnerability. Therefore, it becomes imperative that nature-based solutions are prioritized in Local, State, National, and Global level adaptation strategies for realizing the Sustainable Development Goals, reaching global biodiversity targets, and to effectively addressing climate change impacts (IUCN, 2017). Ecosystem-based Adaptation (EbA), involving restoration of ecosystems, conservation-enhancement and sustainable management are cost-effective solutions that can help people adapt to minimize the impacts of climate change. Examples of eco-system based adaptation approaches to adapt to climate change impacts include watershed management, water infrastructure projects

with a focus on vegetative measures, protection and restoration of coastal ecosystems such as mangroves, salt marshes, and barrier beaches to provide natural protection from storms and flooding due to sea level rise.

Chennai, a coastal city of Tamil Nadu, India has a flat terrain just 2 to 6 m above msl that renders it difficult for the monsoon floods to drain causing inundation and flooding in the city. The city comprises of four major rivers namely Araniyar, Kosasthalaiyar, Cooum and Adyar through which flood water naturally discharges into the sea. The man-made Buckingham Canal stretching north-south across the city serves as an interception of all rivers and drains into the sea. Despite the expanding network of stormwater drains that eventually link to these drainage systems, the city faces critical issues during flooding exacerbated due to high population density and dense built-up area, sprawling across the Chennai Metropolitan Area of 1185 sq. km. The 2015 floods in Chennai are reported to have affected about 4 million On the other hand, the city is prone to drought as it is monsoon-dependent and lacks a perennial source of water supply. The June 2019 drought proved to be one of the worst testing times for the city when it faced a prolonged dry period over six months leading to drying up of water resources in the city. The city authorities sourced water from the desalination plants in Chennai and the remaining water requirement was met from neighboring towns from where water was brought through trains to cater to the needs of the city.

However, Chennai city is not new to this exposure and has faced similar hazards in the past due to its geographical vulnerability aggravated by the effects of urbanization leading to increased built-up area. The built-up area in the city has increased by 174 % from 1988 to 2017 as reported by researchers from Anna University based on their study on Land Use Land Cover Change in the city (Mathan and Krishnaveni, 2019).

In addressing the hazards of floods and droughts induced by natural and anthropogenic causes, the city authorities have taken up a slew of measures to build a safe city and take up eco- system based approaches for climate adaptation and sustainable living. One of the approaches that are widely being adopted across the city is wetland restoration that forms an eco-system based approach for mitigating the risks of floods and drought across the city. In addition to offering drought and flood mitigation benefits, wetland restoration offer additional benefits such as heat island mitigation, offering bio-diversity habitats, and natural spaces for community recreation and pleasant aesthetics. The other measures implemented by GCC include setting up extensive rainwater harvesting structures across the city and creation of sponge parks.

The importance of enabling factors such as policies, finance, coordination between stakeholders and evidence-based solutions cannot be overstated in the success of any programme and the importance of such factors in supporting the efforts on eco-system-based adaptation is discussed in this case study.

2. Enabling Factors for Eco-system based Adaptation

2.1 Policies as an enabling environment: Recognizing the need for holistic growth, international, national and local policies have converged on Sustainable Development Goals (SDGs) that present a global framework for developments to be economically, socially and environmentally sustainable. The SDGs provide 17 interconnected goals that serve as a blueprint to achieve inclusive development covering people, planet, peace, prosperity, and partnerships. The Paris Agreement, 2015 on Climate Change stresses upon countries to commit to sustainable development thereby preventing further global warming and environmental degradation towards mitigating climate change impacts. At the State level, the Disaster Management Policy 2023 aims to build a safe and disaster resilient through inclusive development and mainstreaming disaster risk reduction into the sustainable development ethos of the State especially through adopting SENDAI framework of action to guide the climate resilient responses such as EbA. The Sendai Framework for Disaster Risk Reduction 2015-2030 was the first major agreement of the post-2015 development agenda and provides Member States with concrete actions to protect development gains from the risk of disaster.

Some of the national policies that protect environment and contribute to EbA include, The Indian Fisheries Act - 1897; The Indian Forest Act - 1927; Wildlife (Protection) Act - 1972; Water (Prevention and Control of Pollution) Act - 1974; Water (Prevention and Control of Pollution) Cess Act - 1977; Forest (Conservation) Act - 1980; The Environment (Protection) Act - 1986; Wildlife (Protection) Amendment Act - 1991; National Conservation Strategy and Policy Statement on Environment and Development - 1992; The Biological Diversity Act - 2002; National Water Policy - 2002; National Environment Policy - 2006; Environment Impact Assessment Notification - 2006; Wetlands (Conservation and Management) Rules - 2010, Government of India; National Water Policy - 2012; Wetlands (Conservation and Management) Rules - 2017, Government of India.

In addressing the concerns of climate change and to promote sustainable development in the country, India formulated the National Action Plan on

Climate Change in 2008 encompassing eight national missions that focus on renewable energy, energy efficiency, Himalayan ecosystems, green India, water security, sustainable habitat, sustainable agriculture and building strategic knowledge on climate change. Of the missions, the Mission on Sustainable Habitat focuses on creating healthy cities with better urban planning, resource efficiency and management and modal shift to public transportation. The smart cities mission, AMRUT, HRIDAY, Jal Jeevan and Jal Sakthi Abhiyan schemes under the sustainable habitat mission have played an important role in bringing transformational changes in cities imbibing the concepts of sustainable development. The examples from New Delhi Municipal Corporation (NDMC) on smart road with energy efficient lights, CCTV and smart detectors and the city of Indore showcasing environmental sound waste management practices are notable efforts in this regard.

Institutional and Legal Arrangements as envisaged under Tamil Nadu Disaster Management Policy of 2023 serve as an enabling environment to undertake EbA measures as risk reduction options. In resonance with the global and national priorities, the State Government of Tamilnadu has adopted significant policy measures boosting sustainable development in the State.

The State has formulated a State Action Plan on Climate Change to work across various industrial, urban and rural sectors on efforts related to energy efficiency, improving public transportation and promoting sustainable agriculture. Further, in order to streamline the climate efforts more efficiently, the State Government has set up the Tamil Nadu Green Climate Company (TNGCC) to implement the three key Missions of the Government of Tamil Nadu, viz., The Tamil Nadu Climate Change Mission (TNCCM), The Green Tamil Nadu Mission (GTNM) and the Tamil Nadu Wetlands Mission (TNWM). The objective of the Tamil Nadu Green Climate Company is to create a strong policy support for climate change, cutting across all sectors of governance and also devise strategies to reduce greenhouse gas emission (GHGs) and to identify, secure and channelize resources in terms of technological support, funding etc., from national/international donor agencies, institutions of repute and corporate social responsibility (CSR) partnerships. In addition to the above, the State Government of Tamilnadu had introduced several policy measures in adapting eco- centric approaches for building climate resilience in the City. Some key policy measures in support of EbA are as follows:

2.1.1 Rain water Harvesting: Given the impact of climate change on dwindling water resources, conservation of water is the right thing to do and therefore

rainwater harvesting (RWH) as a EbA strategy is effective. The approach has become successful because of the policy support by GoTN to take rainwater harvesting measure to reach a critical mass to impact groundwater recharge to a large extent.

With a view to harvesting rain water that helps in reducing rain water run-off and improve groundwater recharge, the Government of Tamilnadu has enacted an ordinance titled Tamil Nadu Municipal Laws Ordinance, 2003, dated July 19, 2003 through which the Government of Tamil Nadu has made rainwater harvesting mandatory for all the buildings, both public and private, in the State. The ordinance mandated RWH in three storied buildings irrespective of the size of rooftop area.

The very potential risks in the reliable supply of available water sources demand large-scale implementation of RWH across the city including from the building roof tops, RWH integrated in strom water drains and in open areas such as sponge parks. Roof top conditions allow for more replication efforts and also for the fact that most rooftops provide the necessary platform for collecting water in a relatively pure form which makes adaptability attractive. Rain water harvesting structures help reduce disaster or climate risk and further help reducing soil erosion and flood disaster by collecting rainwater and reducing the flow of storm water to prevent urban flooding. Most buildings that utilize rainwater harvesting systems have a built-in catchment area on top of the roof, which has a capacity of collecting large volumes of water in case of rainstorms and thereby contribute to the run-offs.

Further, the incorporation of rain water harvesting structures along the storm water drain as part of the Integrated Storm Water Management is showing a systematic and steady progress.

2.1.2 Tamilnadu Water Security Mission for Sustainable Management (TNSWASM): Through the initiatives of Tamilnadu Water Security Mission for Sustainable Management (TNSWASM) 2015 under funding from Chennai Mega City Development Mission (CMCDM) various types of works such as construction of Campus Rain Water Harvesting (RWH), grey water re-cycling, storm water harvesting, restoration of temple tanks, lakes and ponds are taken up.

2.1.3 The State Disaster Management Plan: The State Disaster Management Plan 2018-2030 aspires "to build a safe and disaster resistant Tamil Nadu through systems approach and inclusive development. The plan involves mainstreaming disaster risk concerns into the development ethos of the State

with the following goals based on eco-system based adaptation.

- Restore and protect ecologically fragile wetlands and Marsh Lands with special focus on Pallikaranai and Ennore Creek Areas and Gulf of Mannar

- Restore and strengthen waterbodies and enhance the capacity of the water bodies through desiltation to mitigate floods and drought

2.1.4 Chennai City Disaster Management Plan: The Greater Chennai Corporation has released a City Disaster Management Plan 2023 that provides a broad framework covering the implementation. The plan underpins a coordinated approach among all stakeholders, active participation of the civil society, community based organizations and private sectors. The disaster management plan lists out measures to prepare, mitigate and respond to disasters including floods, cyclones, earthquakes and tsunamis.

The plan has taken into account the city's vulnerabilities to disasters based on its geography, demography and social and environmental aspects. It has also been prepared based on the principles of the National Disaster Management Plan and State Disaster Management Plan. The plan takes into consideration the land use pattern in Chennai, which shows that 56.7% of the area is taken up by buildings, 17.1% by trees and 8.9% by tanks.

The GCC has mapped areas on their degree of vulnerability to floods from 2015. While there were 18 'high vulnerability' locations in 2021, it had come down to one in 2022 due to various interventions. To address the recurrent urban floods in Chennai and its peri-urban areas, the Government of Tamil Nadu has proposed a study for implementation of "Real Time Flood Forecasting and Spatial Decision Support System for Greater Chennai Corporation and the river basin areas of Adyar, Cooum, and Kosasthalaiyar.

The State Government has constituted an advisory committee for the Management and Mitigation of Flood Risk in Chennai metro in December 2021 under the Chairmanship of Dr. V. Thiruppugazh, I.A.S. (Retd.) for recommendations and suggestions on flood mitigation measures. The committee after a detailed assessment of the flood mitigation systems in Chennai has stressed upon increasing the blue green infrastructure for flood mitigation and to create additional storage structures in the upper catchment areas.

2.2 Financial support as enabling environment: The 15th Finance Commission has provided Rs. 2,500 crore for reducing the Risk of Urban Flooding in seven most populous cities. An allocation of Rs. 500 crore is to be provided to Chennai at the rate of Rs.100 crores per year in five years. These include measures

integrating eco-system based adaptations such as restoration of ponds and integrating rain water harvesting structures for storm water management.

Table.1. Multiple financial aids for eco-system based adaptation projects in Chennai

Projects on Eco-system based approach	Supporting Schemes			
	State Level	Central Level	Externally Aided Projects	Corporate Social Responsibility/ NGOs
Restoration of 173 water bodies have been completed under various funds	GCC Capital fund, and Chennai Mega City Development (CMCDM) fund	Smart City fund	-	CSR fund
Restoration of 11 water bodies are completed	CMCDM fund			
Restoration of 2 water bodies are in progress under Namakku Namme Thittam.	Namakku Namme Thittam			
Restoration of 12 water bodies in progress	Singara Chennai 2.0 fund			
Restoration of 5 water bodies in progress		AMRUT 2.0 Scheme		
Eco restoration of Kadapakkam Lake (Proposed)			Global Environ-mentalFacility (GEF) grant of ADB	
Proposed restoration of 6 water bodies	Singara Chennai 2.0 fund			

At the state level, in the Tamilnadu revised budget 2021-2022, the total fund allocation for Tamilnadu Climate Change Mission is Rs. 500 Crore for carrying out activities on climate change adaptation and mitigation. The fund allocation for Tamilnadu Wetlands Mission is about Rs. 150 Crore for activities on identifying and mapping 100 wetlands in 5 years and to restore the ecological balance with focus on livelihood options[1].

At the city level, a cost allocation of around Rs. 200 crores were made available under various schemes for supporting restoration of water bodies in Chennai. Details of the schemes and the number of water bodies restored/ proposed for restoration by Greater Chennai Corporation is presented below.

As mentioned above, rejuvenation of ponds and lakes were taken up under Chennai Smart City fund, CMCDM Scheme, Singara Chennai 2.0 Scheme, Namakku Naame Thittam Scheme. Incorporation of silt catch pit with rainwater harvesting structures has been taken up under Kosasthalaiyar Integrated Storm Water Drain Project (ISWD) and Kovalam ISWD Project, Singara Chennai 2.0 scheme, I& A Fund SWD works.

3. Implementation of Eco-system based adaptation solutions

With a vision to building a climate resilient city, the Greater Chennai Corporation has progressed appreciably in implementing eco-system based adaptation (EbA) solutions. However, what guides us to qualify the above interventions to be the best practices are indicated in the following table 2. Some of the best practices as adopted in alignment with EbA solutions and which are in conformity with the policy /enabling environment are:

3.1 Rainwater Harvesting structures: The GCC is setting up about 43500 numbers of rainwater harvesting structures at a cost of about Rs. 341.77 Crores under the various schemes previously mentioned in section.

The newly constructed storm water drains are provided with silt catch pits integrated with percolation pits for recharging the underground aquifers. The silt catch pit with rain water harvesting structures are provided at every 30 m intervals to collect the rain water and to increase the ground water level. Storm water drains are connected to nearby recharge pits and to nearby parks.

Table.2. Key indicators for EbA as best practices

| Key indicators	EbA solutions as the best practices		
	Rainwater Harvesting structures	Rejuvenation of Water Bodies	Creation of Sponge parks
1. Effective and successful	Yes	Yes	Yes
2. Environmentally, economically and socially sustainable	Yes	Yes	Yes
3. Gender sensitive	Yes	Yes	Yes
4. Technically feasible	Yes	Yes	Yes
5. Replicable and adaptable	Yes	Yes	Yes
6. Reducing disaster/crisis	Yes	Yes	Yes
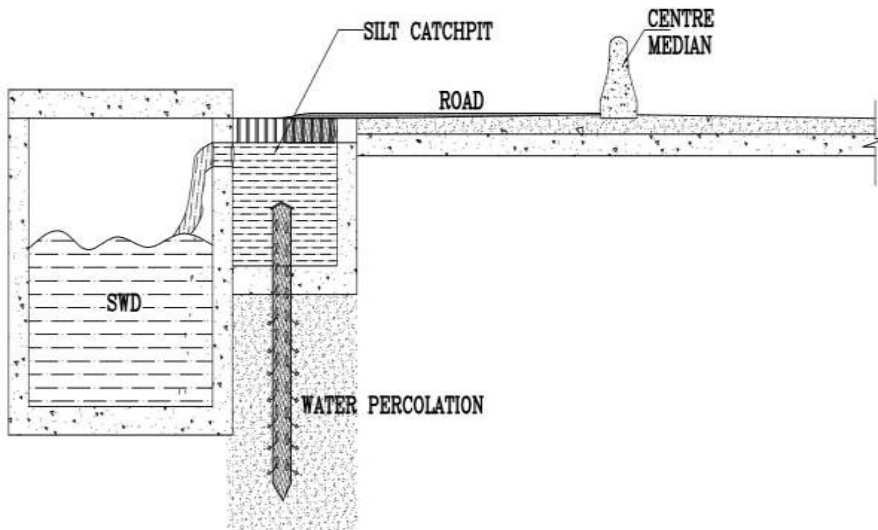
Fig. 1. Schematic Representation of Rainwater Harvesting Structure installed along Stormwater

Rain water harvesting structures such as sunken wells schematically represented below, of about 200 Nos, are being provided in the parks, OSR Lands, play grounds etc. Community wells are set up in areas where individual rainwater harvesting structures are unable to be built as part of the Integrated Storm Water Drain Projects. For example: Chennai Metro water has identified around 45 water stagnating areas in Besant Nagar in the stretch of Alcot Kuppam to Odai kuppam, 14 locations on Kamarajar Salai and 4 locations in Chintadripet for implementing RWH structures. As the stagnant rainwater can be recharged into the ground, suitable RWH structures were installed to these locations as

a measure of flood mitigation. In coastal areas, these structures contribute to creating a water wall that blocks sea water intrusion and decreases salinity in groundwater.
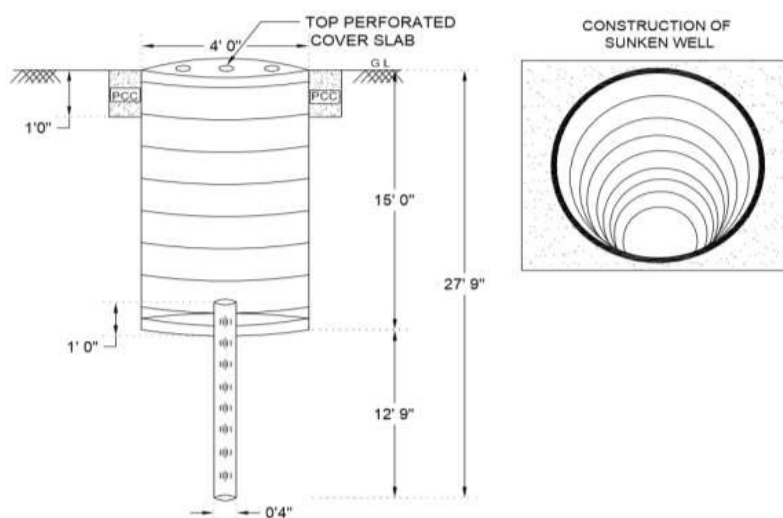

Fig. 2. Schematic Representation of sunken well structure installed along Storm water Drains

Observations by Greater Chennai Corporation in the year 2019 showed that groundwater levels have risen by 2.5 meters between September 2019 and October 2019 in areas where rainwater harvesting (RWH) structures have been implemented in most houses. Of the 3.05 lakh houses inspected, around two lakh houses were found to have installed rainwater harvesting structures. The highest increase in groundwater of 2.76 meters was in zone 7 in Ambattur, where 12,013 of 20,238 houses inspected by the corporation had rain water harvesting structures. Alandur zone, where 12,244 of 13,126 homes had RWH structure saw ground water levels increase by 2.48 m. In zones like Thiruvottiyur and Manali, less than half of the houses inspected had RWH structures and this was reflected in ground water levels. After the October rain, the ground water level went up only by 0.65 m and 1.02 m respectively. The observation showed encouraging results on rainwater harvesting with the increase of ground water levels corresponding to higher number of rain water harvesting structures offering evidences on eco-system based adaptation approaches.

The GCC notes that proper care needs to be taken while installing rainwater harvesting structures depending on the soil strata, level of groundwater table, and pollution factors. They recommend that since clayey soil strata have poor percolation rates, suitably designed percolation pipes should be embedded with

the rainwater structures to allow penetration into the soil substrata enabling rainwater absorption.

In other cases, as in most densely populated areas, there are likely chances that sewer lines may overflow into storm water drains causing pollution. In such areas, strict monitoring and plugging of gaps in sewer lines need to be ensured to prevent contamination of stormwater. Further, it was seen the rainwater harvesting systems yield remarkable results in areas where there is a proper and closed network of sewer and stormwater drains that are not affected by contamination.

3.1.1 Justification for RWH as a best practice

a) *Effective and successful:* Given the impact of climate change on dwindling water resources, conservation of water is the right thing to do and therefore Rainwater harvesting as a EbA strategy is effective and it has become successful because of the policy support by GoTN to take rainwater harvesting structure to make an critical impact on groundwater recharge to a large extent.

b) *Environmentally, economically and socially sustainable:* By appropriate social- environmental and economic safeguards in place these harvesting structures have the potentials to become socially-economically and environmentally sustainable interventions

c) *Gender sensitive:* Rain water harvesting structure being neutral to social stratification like the gender differentials, it is by design gender sensitive to be gender neutral.

d) *Technically feasible:* It can be assumed without loss of generality that RWHs technical feasibility is based on the water balance concept and analysis of the rainwater tank capacity compatibility. And therefore RWHS implementation is technically feasible in the majority of the buildings and along stormwater drains designed suitably for various soil conditions.

e) *Replicable and adaptable:* The very potential risks in the reliable supply of available water sources demand large-scale implementation of RWH and it can be assumed that integration of rainwater structures along the existing and proposed storm water drains allows for more replication efforts and also for the fact that most rooftops provide the necessary platform for collecting water which makes adaptability easier.

f) ***Reduce Disaster /Risk:*** Rainwater harvesting structures by design help reduce disaster or climate risk and further help reduce soil erosion and flood disaster by collecting rainwater and reducing the flow of stormwater to prevent urban flooding.

3.2 Rejuvenation of Water Bodies: Nearly all regions of the world are expected to experience a net negative impact of climate change on water resources and freshwater ecosystems as per the Intergovernmental Panel on Climate Change (IPCC), 2007. This calls for an immediate rejuvenation of water bodies.

Fig. 3. Photos taken before (left) and after restoration (right) of Pidari Ponniamman Kulam, Ambattur, Chennai, Year 2019

Fig. 4. Photos taken before (left) and after restoration (right) of Thandukarai Pond, Year 2020

Urban waterbodies/lakes form an intrinsic part of the urban ecosystem. They have rationally served the function of meeting water requirements of the people for recharging of groundwater, preventing waterlogging and flooding in neighborhood. For centuries, these waterbodies played a vital role in ensuring water security in Chennai and its surrounding areas. Rejuvenation of water bodies enhances the ecological value of the natural resource base through adoption of vegetative measures around the periphery of the wetland system thus ensuring environmental sustainability.

Recognizing the vital role played by the waterbodies, the city authorities of Chennai took a systematic approach to restoring 210 water bodies that are interspersed across the city. Relevant stakeholders such as the State Government of Tamilnadu, Greater Chennai Corporation, Chennai Smart Cities Ltd, and Water Resource Department joined together in this massive effort with participation from NGOs and Corporate organizations with CSR support.

Under this initiative, the restoration of 188 water bodies has been completed under funding from Smart City fund, Chennai Mega City Development Fund (CMCDM), Corporate Social Responsibility (CSR) fund and Capital fund. Restoration of 12 water bodies are in progress under funding from Singara Chennai 2.0. Restoration of 5 water bodies are in progress under funding from AMRUT 2.0. Restoration of 5 water bodies are to be taken up under Singara Chennai 2.0/2023-24.

The completion of restoration of the identified 210 ponds is estimated to yield an additional 1 TMC of water storage in these waterbodies. The benefits of increased storage include an increase in recharge of the groundwater table and relieving water stagnation in neighborhoods while also ensuring sustainable water security.

Fig.5. Tree plantations carried out along River Adyar, Year 2020

Fig. 6. Tree plantations carried out along River Cooum, Year 2020

Table. 3. Tree plantations for strengthening embankments along river stretches

River	Total No. of Plantation	Estimate Amount (Rs. In Cr.)
Adyar River	63266	13.78
Cooum River	49800	7.12
Total	113266	20.90

Some of the important points to be noted for the restoration of water bodies include that the soil strata be studied thoroughly to decide on a dredging depth, as there could be chances of increased water seepage if the lake bed is formed of fractured rocks. Similarly, a clayey soil stratum may require recharge shafts to allow optimal water percolation into the groundwater table. Caution should be taken to provide adequate inlet and outlet points so the flow of water takes place in an undisturbed manner and the risk of water stagnation and flooding is minimized. In case of newly formed embankments, the invert levels of inlets and outlets need to be designed properly to allow undisturbed hydraulic flow. Construction and maintenance of connecting channels between the water bodies need to be ensured so that the rainwater is stored in a cascading effect before the surplus is discharged to the sea. Preventive measures such as plugging pollution sources, if any to be carried out to protect the water quality and aquatic life of the waterbodies.

Besides restoration of ponds, non-structural measures such as having plantations along the riverine embankments are being undertaken for controlling soil erosion and silt accumulation in riverine systems. Tree plantations were made along the stretches of Adyar river and Cooum River offering soil stability to embankments while increasing the green cover and providing biodiversity benefits.

3.2.1 Justification for Rejuvenation of Water bodies as the best practice

a) *Effective and successful:* As water resources become further stressed due to increasing levels of societal demand, understanding the effect of climate change on various components of the water cycle is of strategic importance in management of this essential resource. In this context, rejuvenation of water bodies will serve as the most effective green infrastructure solution for mitigating effects of urbanisation and climate change by offering increased water storage, ground water recharge and thereby reducing run-

off contributing to flood and drought mitigation benefits. These are cost effective and are well proven to be successful in contributing to enhanced biodiversity habitats, heat island mitigation effects, pleasant aesthetics and offering a healthy recreational space for communities.

b) *Environmentally, economically and socially sustainable:* It is important to acknowledge the fact that water bodies hold cultural, ecological, and economic significance which holds future for sustainable livelihoods as water is a critical centrality to lives and livelihoods and also for economic and social wellbeing. Rejuvenation of water bodies enhance the ecological value of the natural resource base though adoption of vegetative measures around the periphery of the wetland system thus ensuring the productive ecosystems and environmental sustainability. The interventions calls for social mobilisation process and community participation to guarantee social sustainability as it is a fact that water is treated as an economic, social, and environmental good.

c) *Gender sensitive:* The global environmental crisis, growing poverty in urban and rural areas, and continued gender inequalities all point to the need for a different governance approach for better water governance to address the compelling needs of both men and women. Both women and men should be recognized as central to the provision, management and safeguarding of water as conserved through rejuvenation of water bodies. Rejuvenation of water bodies as an encompassing element of integrated water resources management strategies is gender sensitive as it offers an opportunity to create a paradigm shift in our approach to water conservation & enhancement to meet the global demand.

d) *Technically feasible:* Rejuvenation of water bodies involve structural measures such as silt removal and strengthening the embankments and ecological measures such as treatment of pollution and planting vegetation for green cover and biodiversity benefits. When carried out using a science based approach restoration of water bodies prove to be highly cost effective and viable offering eco-system services.

e) *Replicable and adaptable:* Replicable and adaptable characteristics of rejuvenation of water bodies interventions is in the fact of multiplier effect the very intervention creates. For example, rejuvenated water bodies provide easy access to water for domestic needs, animal

husbandry, drinking water and agriculture particularly in rural areas. This can help improve water security and reduce the burden of water collection for households, Interventions are relatively low-cost to construct and maintain. This makes them an attractive option for small-scale water storage and management, also help recharge groundwater resources, particularly in areas where groundwater depletion is a concern and support a diverse range of plant and animal species, including many rare and endangered species. They provide important habitat and breeding grounds for aquatic and semi- aquatic organisms, such as fish, amphibians, reptiles, and birds.

f)   *Reduce Disaster /Risk:* Rejuvenation of water bodies can help reducing the risk of flooding by capturing and storing excess water during heavy rain events, and slowly releasing it over time. The intervention like rejuvenation of water bodies does recognize the close linkages between development and poverty reduction and sound water resource management, as well as access to safe drinking water and adequate sanitation, to enhance the resilience to climate extremes.

3.3 Creation of Sponge parks:

The Greater Chennai corporation is working on developing 42 sponge parks across the city as part of restoring 57 parks, commissioned at a cost of Rs.7.67 crore. The project has a potential to be scaled upto 734 parks spread across the city. The location of a sponge park is chosen based on an existing park with roads surrounding it so that water flow was guaranteed and based on the soil condition.

Sponge parks have the ability to collect and store water during heavy rain, preventing floods in the surrounding areas. These parks serve as ways to recharge the groundwater level and make urban spaces more permeable. The capacity of a sponge park depends on the infiltration rate of the soil and the intensity of rain. Excess water is directed to the nearest storm-water drain. However, it is crucial to note that though sponge parks act as a flood absorbing structure in growing cities, lack of adequate outlet structures may itself lead to flooding in the surrounding areas. Hence, it is imperative that well designed connecting channels are provided in the sponge parks so that the surplus flow finds its way to the nearby storm water drains during heavy rains. The advantages of Sponge Park include that as it acts as a rainwater recharging

structure it hosts appreciable biodiversity during both rainy and non-rainy seasons. In addition, with the inhabitant birds, other fauna and flora they offer a pleasant aesthetics for people and a healthy living environment.

3.3.1 Justification for Creation of Sponge parks as a best practice

a) *Effective and successful:* The fact that, sponge parks effectively absorb rainwater through eco-system based adaptation approach including the use of permeable surfaces such as green roofs, permeable pavements and rain gardens allow rainwater to infiltrate and not run off the ground. Upscaling initiatives of GCC towards implementation of sponge park technology only shows its success.

b) *Environmentally, economically and socially sustainable:* Sponge park as an urban water retention solution help solve water shortage problems, especially in regions where droughts are common. Secondly, they promote environmental protection by reducing water pollution, improving air quality and increasing green space. Thirdly, they are more friendly to residents, as they provide more green space, which improves their health and well-being. In addition, such cities can also help reduce the risk of urban flooding by absorbing excess rainwater more quickly.

c) *Gender sensitive:* As the design criteria of sponge parks are technical parameter centric, social dimension remains a ubiquitous variable but notwithstanding this the social equity in access to and control over benefits accruing from the technical intervention like sponge parks ensure that interventions are gender sensitive.

d) *Technically feasible:* The functions of a sponge parks are mainly embodied in the six aspects of seepage, retention, storage, purification, use, and drainage (X. Chou, 2015 and K. Yu et al., 2015). The core of the construction is to build aquatic ecological infrastructure across different scales, combining multiple specific technologies, and promote coordinated development of urban and ecological environment.

e) *Replicable and adaptable:* Without losing the essence of the technical design parameters, repeating the same intervention like sponge park execution in an another cultural context can be termed as replication. Given this understanding of replicability, it can be said without loss of generality that Sponge park intervention as a best

Fig.7. Formation of Sponge Park inside the existing Murasoli Maran Park, Chennai

practice is replicable and further, given the existence of social and environmental safeguards in place, the intervention is adaptable.

f) ***Reduce Disaster /Risk:*** Sponge parks has the ability to mitigate flood risks, improve water resource management, and enhance overall urban resilience to cope with the impact of disaster and its associated risks and these sponge parks can hold more water in rivers, greenery, and soil, making them more resilient to droughts. Through this intervention, the water is filtered into aquifers, allowing maximum rainfall to be locally utilized. This mitigates the devastating risks posed by floods and also addresses water shortage in the summer by harvesting the rain.

4. Conclusion

The eco-system-based adaptation approach helps in building urban resilience in a holistic manner and are proven to offer remarkable benefits in terms of mitigating climate change impacts such as of floods, droughts and loss of biodiversity.

A major factor that helped in catapulting the implementation of the EbA approach has been the enabling environment like pro-NbS policies, legal provisions, and financial allocation and support proving the significance of

top-down mechanisms in environmental governance, as can be witnessed by the large-scale implementation of nature-based solutions in Chennai. The combined measures from policy and financial support enable the creation evidence-based solutions for eco-system based adaptive approaches that can be promising to fuel more such integrated approach for building climate resilience for communities. Restoration of 210 water bodies benefitted in storage increase of 1 TMC offering evidence-based solutions for wider replication.

Coordinated efforts at the local and grassroots levels with participation from ULBs, NGOs and Corporates on projects supporting climate adaptation offer a reflection of the commendable buy-in from local communities for the implementation of EbA measures. By implementing Rain Water Harvesting systems as NbS, communities can enhance their water security, reduce strain on existing infrastructure, mitigate floods, and improve overall resilience. Rainwater harvesting as a stormwater management practice reduces the volume of stormwater runoff, thereby preventing flooding and soil erosion. Rainwater harvesting is a cost-effective solution since it can lead to significant cost savings in terms of water bills and infrastructure creation costs. Communities that rely on rainwater can mitigate the impacts of rising water prices and reduce the need for costly water treatment processes.

Climate change has an impact on various components of the water cycle and therefore, balancing the demand and supply constraints of water resources places a high demand on in- situ conservation and rejuvenation of water bodies in addition to exploring the pathway to ensure social sustainability of water bodies through social mobilization process & community participation.

Enabling policy environment and financial support has helped the State to implement a significant number of stormwater harvesting structures and flood control projects in all the river basins of Tamilnadu which have proved to be cost-effective solutions and act as an EbA towards runoff reduction, local flood control, non-point source pollution reduction, and stormwater utilization. The sponge park as an EbA fundamentally follows natural and ecological laws, which allows stormwater to be managed with natural infiltration, natural retention, and detention.

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Case Study on Development and Implementation of State Heat Action Plan for Better Preparedness and Planning against Extreme Heat in the State of Uttar Pradesh, India

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Abstract

Climate change is responsible for a worldwide escalation in mean temperatures, as well as a rise in the occurrence, length, and severity of extreme heat events, leading to unparalleled levels of heat exposure. The phenomenon of being subjected to high temperatures, particularly during periods of prolonged heatwaves, is increasingly becoming a widespread occurrence on a global scale. Furthermore, it is anticipated that such occurrences will intensify in severity and frequency within the near future, even if efforts to mitigate the effects of climate change align with the objectives outlined in the Paris Agreement by the year 2030. The state of Uttar Pradesh is significantly affected by extreme heat events and other disasters. The Uttar Pradesh State Disaster Management Authority has developed and implemented state heat action plan for better preparedness and planning against extreme heat events.

Key words: Heatwave action plan; Climate change; Temperature extreme; Uttar Pradesh; Disaster Management.

1. Introduction

Emissions of greenhouse gases from the burning of fossil fuels are a major cause of the extensive and quickly deteriorating effects of climate change. Anthropogenic greenhouse gas emissions are causing the Earth to warm rapidly, which has significant long-term effects on the human health. Since 1900, the average global temperature has already risen by 1.1°C, with the last 50 years seeing the bulk of this increase. The polar and highland regions have experienced the greatest degree of change, while tropical temperatures are gradually approaching the thermal thresholds of many species. By the end of this century, a warming of 2.5°C to 2.9°C or higher is predicted given the existing policies and actions (Thomson and Stanberry, 2022). Anthropogenic activities have significantly contributed to the escalation of carbon emissions during the past century, thereby expediting climate change and elevating the average world temperature to a concerning extent.

Flood Hazard Atlas of Bihar (version 2) highlights the fact that Bihar is one of the most flood affected States in the country, accounting for more than 17% of

the flood prone area of the country (National Remote Sensing Centre, 2020).

Climate change is largely regarded as the greatest worldwide threat of the twenty-first century. The Intergovernmental Panel on Climate Change (IPCC) predicts that as global average temperatures rise, severe temperature occurrences will become more frequent and intense (IPCC, 2022). These dangers are of particular concern in low-middle-income economies with inadequate public health resources and a population that lives in urban sprawl (Geirinhas et al., 2020). Climate change causes temperature and humidity fluctuations, which have an impact on living and working conditions. Climate change has a number of direct negative consequences for both working and non-working populations, including heat fatigue and heat stroke. Human-caused greenhouse gas (GHG) emissions have caused an approximate 1 degree Celsius rise in the Earth's global temperature since the pre-industrial era. There is regional variation in temperatures, with certain areas experiencing increases in excess of 2 degrees Celsius (Vicedo-Cabrera et al., 2021).. Heat and excessive heat exposure have severe adverse health effects on humans.

A heat wave is characterized by extreme temperatures that last for an extended length of time, sometimes accompanied by high levels of humidity. Numerous epidemiological studies have established the negative effects of heatwaves on human health, particularly death (Guo et al., 2017) and morbidity (Burnett et al., 2014). Extended periods of high heat, often classified as heat waves, have been connected with a considerable increase in mortality, and specific instances have been discovered as public health disasters. The natural environment is also severely impacted by heatwaves. An example of this phenomenon is the rise in frequency and severity of forest fires, which has devastating effects on people, ecosystems, and wildlife (Guleria and Gupta, 2018).

Taking on climate change may present the biggest opportunity for world health in the twenty-first century (Watts et al., 2015). They prepare for dangerously hot periods because previous heat waves have taken hundreds of lives. The coronavirus pandemic's negative effects on mortality and economic ramifications need that society prioritizes public health more than ever at the same time.

A study by Vicedo-Cabrera (2021) reveals that escalating temperatures linked to anthropogenic climate change were responsible for over one-third of heat-related fatalities that occurred between 1991 and 2018. An increase in the global surface temperature has an impact on the climate of the Earth. Human-caused climate change is responsible for 37% of all heat-related fatalities, according to the researchers' estimation. Although these results differ significantly among regions and nations, the investigators documented annual increases in mortality ranging from dozens to hundreds of individuals across all continents. The

regions of southern and western Asia, Southeast Asia, and portions of Central and South America exhibited the most substantial impact of climate change on heat-related mortality, exceeding 50% among the countries examined (Vicedo-Cabrera et al., 2021).

1.1 Heat wave in India: As per IMD, in India, heat waves are described as the periods, when the actual maximum temperature of a station reaches a certain threshold and is above the normal value of temperature by a certain magnitude. Heat wave is regarded to prevail if a station's peak temperature for Plains is at least 40° C, 37° C in coastal areas and 30° C for Hilly regions and departure from normal is 4.5°C to 6.4°C. Heat wave is considered to be severe if the departure is more than 6.4°C. Once these thresholds are reached, it is called Heat Wave (HW) when actual maximum temperature ≥ 45° C; and Severe Heat Wave (SHW) when actual maximum temperature ≥47° C, irrespective of deviation from normal (NDMA, 2019).
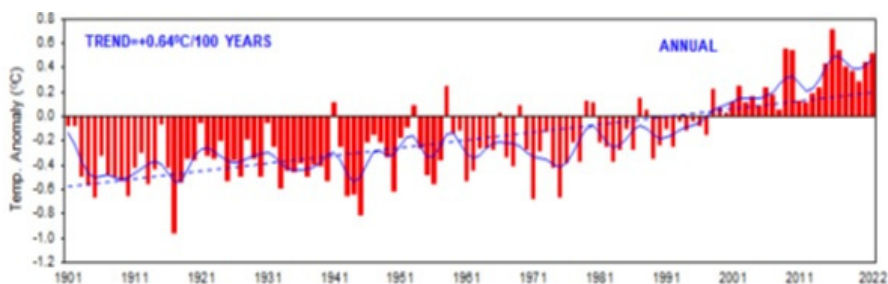
Figure 1: Temperature Trend in India between 1901-2022

The annual mean land surface air temperature anomalies across India from 1901 to 2022 were calculated using the 1981-2010 base period. The dotted line in the visualisation depicts the linear trend in the time series, while the solid blue curve depicts the sub-decadal time scale variation smoothed with a binomial filter.

Notably, the most recent decadal averaged annual mean temperature anomaly (Actual-LPA) of 0.37°C/0.41°C has been identified as the warmest on record (2012-2021/2013-2022). The country's average annual mean temperature increased by 0.64°C/100 years from 1901 to 2022, as shown in the accompanying figure-1. Within this trend, maximum temperatures increased at a significant rate of 1.0°C/100 years, while minimum temperatures increased at a relatively slower rate of 0.28°C/100 years (IMD, 2022).

Thus, in order to respond to and adapt to such climate dangers, governments and communities must act decisively and methodically. Combating heat waves

and climate change is a significant social issue that will require the swift reduction of carbon emissions in addition to the extensive adoption of urban climate adaption strategies.

1.2 Heat Induced Hazards in the state of Uttar Pradesh: The state of Uttar Pradesh is located in the centre of the Indo-Gangetic plain. Uttar Pradesh's climate ranges from temperate in the east to extremely dry in the west to semi-arid in the Bundelkhand and Agra zone. As a result, it is quite challenging to classify it within a certain climatic context. Nevertheless, the winters are frigid and the summers are extremely scorching. Typically, heat waves start in the northwest of India or across northern Pakistan and spread to the neighbouring states, including Uttar Pradesh. In the event of development, a heat wave could also form locally across the area. State experience heat wave condition from March to June. In April the land area becomes hot with daytime maximum temperatures often reaching above 40°C. The temperatures start to rise over Uttar Pradesh in March. At many locations, the difference between the highest and lowest temperatures throughout this season is found to be greater than 15°C. By the end of May and the beginning of June, maximum temperatures quickly increase and surpass 46°C, resulting in extremely hot summers, especially over the SW UP (Bundelkhand). When high pressure (3000-7600 metres) in the atmosphere strengthens and stays over a region for several days to several weeks, heat waves result.

The air sinks toward the surface when there is a lot of pressure. This falling air covers the atmosphere like a dome. Instead of allowing heat to rise, its cap aids in its retention. As per IMD report, Banda was the hottest place in Uttar Pradesh with maximum temperature of 47.7 degrees Celsius, Prayagraj with 46.8, Agra 45.6, Kanpur 46.3, Jhansi 46.2, Orai 44.5, Sultanpur 44.4, Varanasi 45.2, Aligarh and Hamirpur 44.2 degree Celsius in April 2022. Maximum temperatures went up to 6.2 degrees Celsius above the normal (Table 1). Further, number of heat wave days have also increased significantly (Figure 3, 4 and Table 2). State capital Lucknow recorded maximum and minimum temperatures of 45.1 Celsius. The day and night temperatures were 4.7 and 3.9 degrees Celsius above normal. In our endeavour to comprehend and visualize the climatic patterns over the past three decades, we have meticulously crafted a map illustrating the mean maximum temperatures for the months of April, May, June, and July spanning from 1991 to 2020. This comprehensive mapping initiative serves as a powerful tool to discern the temperature trends during the crucial pre-monsoon and early monsoon months, providing valuable insights into the climatic variations over the specified period (Figure-2).
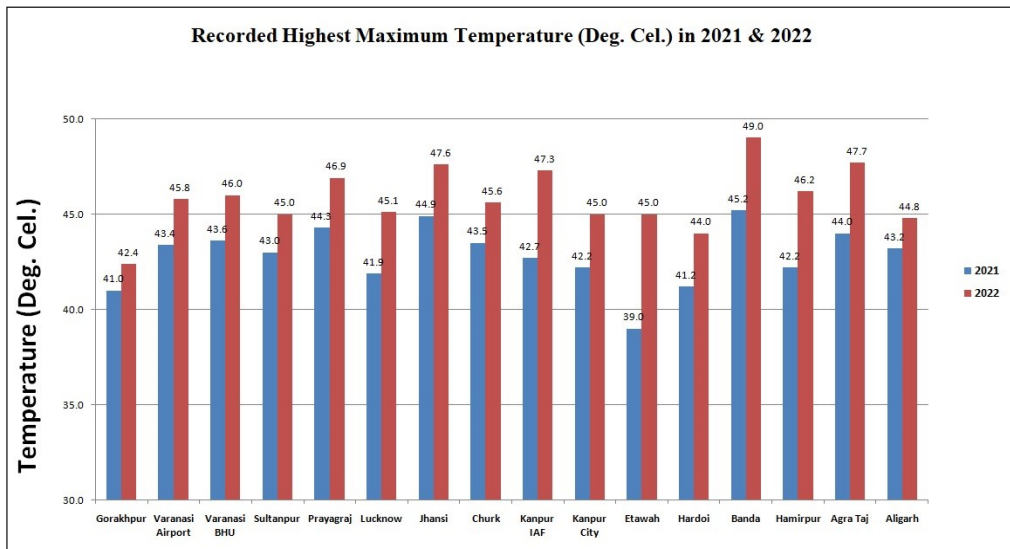
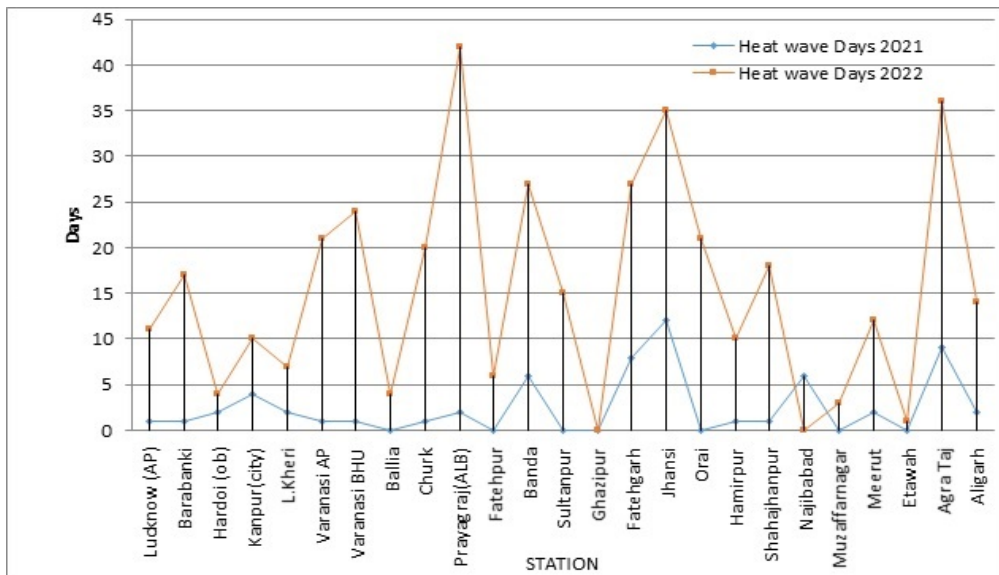**Figure 2:** Recorded Highest Maximum Temperature in 2021 and 2022

Figure 3: Number of days with Heat wave in 2021 and 2022

Table 1: Maximum Temperature at Major Station of Uttar Pradesh during 2021 and 2022

Station	2022 Maximum	2021 Maximum
Lucknow (AP)	45.1	41.9
Barabanki	41.8	40.0
Hardoi (ob)	43.0	40.2
Kanpur (IAF)	46.3	42.7
Kanpur(city)	44.0	42.2
L.Kheri	42.0	42.2
Gorakhpur	42.4	41.0
Varanasi AP	45.2	43.4
Varanasi BHU	45.0	43.6
Ballia	41.5	41.4
Churk	45.0	43.5
Bahraich	41.4	41.0
Prayagraj(ALB)	46.8	44.3
Banda	47.7	45.2
Sultanpur	44.4	43.0
Ayodhya(FZB)	42.5	41.0
Fursat ganj	45.4	42.8
Fatehgarh	43.8	42.4
Basti	43.0	43.0
Jhansi	46.2	44.9
Hamirpur	44.2	42.2
Bareilly Ob.	41.2	41.5
Shahajhanpur	42.4	41.5
Najibabad	39.8	40.8
Muzaffarnagar	41.4	40.1
Meerut	42.7	41.2
Etawah	42.2	39.0
Agra Taj	45.6	44.0
Aligarh	44.2	43.0

Table 2: Number of days with Heat wave in 2021 and 2022

Sl. no.	STATION	2021						2022					
		Mar	Apr	May	Jun	Jul	Total Days	Mar	Apr	May	Jun	Jul	Total Days
1	Lucknow (AP)	1					1	1	8		2		11
2	Barabanki	1					1		13		4		17
3	Hardoi (ob)					2	2		2		2		4
4	Kanpur(city)	1				3	4		5		5		10
5	L.Kheri		2				2		7				7
6	Varanasi AP	1					1	1	12		8		21
7	Varanasi BHU	1					1	1	13	2	8		24
8	Ballia						0		2		2		4
9	Churk	1					1	1	11	3	5		20
10	Prayagraj (ALB)	2					2	3	18	8	13		42
11	Fatehpur						0			2	4		6
12	Banda	1	2			3	6		3	7	11	6	27
13	Sultanpur						0		5		9	1	15
14	Ghazipur						0						0
15	Fatehgarh				1	7	8		11	3	9	4	27
16	Jhansi	2	2		2	6	12	3	15	9	8		35
17	Orai						0		13	5	3		21
18	Hamirpur	1					1	1	4	4		1	10
19	Shahajhanpur					1	1		12		6		18
20	Najibabad		4			2	6						0
21	Muzaffarnagar						0		3				3
22	Meerut				1	1	2		6	1	5		12
23	Etawah						0			1			1
24	Agra Taj	2	2			5	9	3	21	6	6		36
25	Aligarh				1	1	2	2	12				14
	Total	14	12	0	5	31	62	16	196	51	110	12	385

2. Uttar Pradesh State Heat Action Plan

The prolonged and extensive heat, combined with lower-than-average rainfall, adversely affected hundreds of millions of individuals in Uttar Pradesh, one of the most densely populated states in India. The Uttar Pradesh State Disaster Management Authority (UPSDMA) is the nodal agency for developing disaster risk reduction action plans in the state of Uttar Pradesh. Recognizing the threat of extreme heat events on the population health, economy and livelihood of the state the UPSDMA has developed and implemented Uttar Pradesh State Heat Action Plan for better preparedness and planning. The goal of the heat action plan is to mitigate the health risks associated with the current and anticipated high temperatures. It also aims to raise public and key stakeholder awareness, encourage the adoption of protective behaviours, and lower morbidity and mortality rates by providing an early warning and heat health communication system for proactive response to assist vulnerable populations.

Recent heatwaves in Uttar Pradesh have had serious consequences for public health and the state's agricultural landscape, necessitating the development of a comprehensive strategy to address the multifaceted challenges that have emerged. Prolonged exposure to high temperatures has resulted in an increase in heat-related illnesses, such as heatstroke and dehydration, which can be fatal. Vulnerable populations, such as the elderly, children, and those with pre-existing medical conditions, are particularly vulnerable, necessitating targeted interventions to ensure their wellbeing.

Simultaneously, heatwaves pose significant threats to Uttar Pradesh's economy, which is heavily reliant on agriculture. Crop failures, reduced agricultural productivity, and a threat to farmers' livelihoods are among the consequences. This dual impact not only compromises food security but also exacerbates water shortages and livestock stress, putting additional strain on the state's agrarian sector.

Understanding heatwaves becomes critical in light of these challenges, particularly in the context of Uttar Pradesh and its unique vulnerabilities. The expected increase in both the frequency and intensity of heatwaves as temperatures rise globally emphasises the importance of taking proactive measures in this region, in conjunction with broader climate change mitigation efforts.

Investigating the complexities of heatwaves in Uttar Pradesh serves a dual purpose. For starters, it allows for a more nuanced assessment of the localised effects of climate change, providing insights into the state's specific vulnerabilities and adaptive capacities. Second, and perhaps more importantly, it provides policymakers and stakeholders with the knowledge and tools they need to address impending challenges.

2.1 Rationale of Uttar Pradesh State Heat Action Plan

Integrating resilience into health systems is a critical strategy for mitigating the effects of heatwaves on public health. This entails two major approaches:

- To begin, we can improve preparedness by improving forecasting capabilities and making strategic investments in vulnerability assessments. These assessments provide valuable insights to risk management and make practical recommendations more accessible, particularly to vulnerable populations. This proactive measure aims to effectively reduce heat-related risks.

- Second, by prioritizing intersectoral collaboration and implementing responsible practices, heat interventions can be improved. This includes creating comprehensive heat-health action plans (HHAPs) that include elements like a heat wave early warning system (HEWS) and emergency public health interventions. Globally, such plans are being implemented to address the growing challenges posed by heatwaves.

The Uttar Pradesh State Heat Action Plan, serve as the key policy document that outline the processes, duties, early warnings, and reaction mechanisms for line departments and other organizations during a heat wave, are crucial adaptation measures to protect communities and preserve lives from excessive heat.

2.2 Purpose and key strategies of Uttar Pradesh State Heat Action Plan

The Uttar Pradesh State Heat Action Plan aims to provide a framework for the implementation (Figure-5), coordination, and evaluation of extreme heat response activities in the State for reducing the negative impact of extreme heat event. The Plan's primary objective is to develop and implement heat health communication specially targeted towards vulnerable population, those most at risk of heat-related illness. This plan will also involve the inter-departmental coordination framework, which is multidimensional in nature for enhancing collaboration and coordination between all line departments for efficient implementation of State Heat Action Plan. The Standard Operating Procedures have also been laid down by the UPSDMA for the prevention and management of heat related illnesses.

- *Early Warning System* to alert residents on predicted high and extreme temperatures.

- *Inter-Agency Coordination and stakeholder engagement* to improve the coordination between various line departments for an effective Disaster Risk Reduction Approach. The Inter-agency Coordination framework lined

down the roles and responsibilities for key departments, especially for health.

- *Capacity building/training programme:* These are very important for mitigation and disaster Risk Reduction. Training of the medical community on various aspects of heat wave–related health hazards is essential to recognize and respond to heat-related illnesses, particularly during extreme heat events. Heat stroke is the medical emergency and training on the identification of heatstroke cases and the process of patient stabilization before further evacuation should be imparted to the medical community.

- *Adaptation and mitigation* measured to enhance resilience against extreme heat

- *Community vulnerability assessment and hotspot identification:* All age groups and a variety of conditions can have an impact on one's health, but some people are more susceptible than others are to heat-related illnesses and even mortality. Therefore, it is pivotal to identify population at risk and hotspot for a targeted and effective action.

- **Community awareness and outreach:** Using a multifaceted approach that includes print, electronic, and social media channels, vital public awareness messages to protect against extreme heatwaves are disseminated. Using a variety of Information, Education, and Communication (IEC) materials such as pamphlets, posters, and advertisements, as well as producing short video films and Television Commercials (TVCs). These resources are intended to educate the public on important Do's and Don'ts as well as effective treatment methods for heat-related illnesses.

- *Collaboration with non-government and civil society:* Developing alliances with nongovernmental organizations and civil society organizations to improve infrastructure and response capabilities. This collaborative effort includes the enhancement of facilities such as bus stops, the provision of temporary shelters as needed, and the implementation of improved water delivery systems in public spaces. Collectively investigating innovative measures ensures a comprehensive strategy for addressing the challenges posed by heatwave conditions.

3. Objectives of the Uttar Pradesh State Heat Action Plan

a) Develop and implement comprehensive strategies to effectively address the challenges posed by extreme heat events.

b) Establish and implement an early warning system in collaboration with the Indian Meteorological Department (IMD) to alert populations at risk.
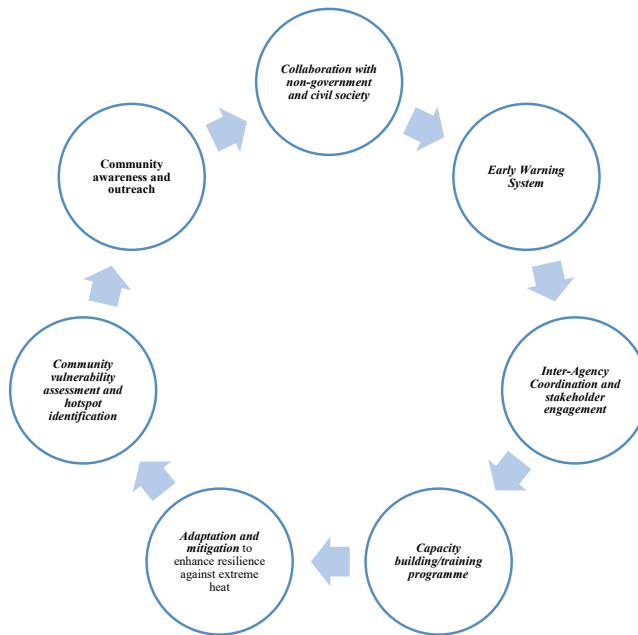
Figure 4: Uttar Pradesh State Heat Action Plan Components

Ensure timely communication and coordinated activities by relevant line departments.

c) Implement appropriate measures for the prevention and mitigation of heat-related illnesses, prioritizing the well-being of vulnerable populations.

d) Strengthen the capacity of state and district-level inter-departmental officials to ensure the efficient and coordinated execution of the State Heat Action Plan.

e) Optimize the utilization of adaptation and mitigation strategies to diminish the impact of heatwaves on human health, livelihoods, and the economy.

f) Identify vulnerable populations and heat hotspots through thorough assessment and analysis.

g) Strategically reduce the incidence of heat-related illnesses through targeted interventions and awareness campaigns.

h) Enhance the resilience of communities against the adverse effects of extreme heat events, fostering a proactive approach to mitigating risks.

i) Foster measures to augment the overall resilience of Uttar Pradesh state against the impacts of extreme heat waves, ensuring a comprehensive and sustainable response.

4. Heat Alert Warning Systems in State of Uttar Pradesh

Early warning systems play a critical role in improving decision-makers' preparedness by keeping them informed and ready to capitalize on favorable weather conditions. The foundation of effective natural disaster early warning systems is a combination of solid scientific and technical knowledge.

- *Accurate and Timely Alerts:* The importance of accurate and timely alerts cannot be overstated. Collaboration with the India Meteorological Department (IMD) is critical for the development of Heat Warning Systems (HWS). This collaborative effort entails determining actionable thresholds for triggering warnings, as well as effectively communicating associated risks.

- *The IMD's Role:* Using the heat index based on temperature and humidity, the IMD issues timely warnings. Email is used to reach key authorities such as the Relief Commissioner (RC), District Magistrates, Doordarshan, and All India Radio (AIR).
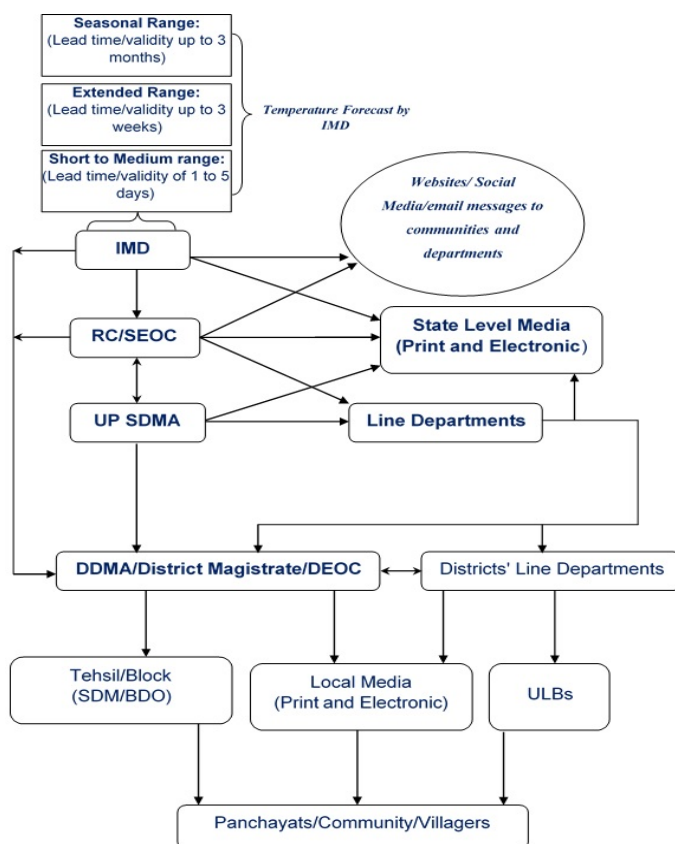
Figure 5: Early Warning Communication System

- *Coordination of Emergency Response:* When warnings are received, the state and district Emergency Operation Centres act immediately, using various media outlets to broadcast alerts. Departments of Health and Family Welfare, Education, Labour, and Transportation, among others, remain on high alert and are implementing necessary emergency measures.

- In the event of a Heat Wave, the Relief Commissioner's Office issues directives to all concerned governmental organizations for immediate action. Furthermore, this office is actively involved in the development of the *Heat Wave-related Mortality Recording System.*

- *Heat wave forecasts* are sent to Divisional Commissioners, District Magistrates, and other relevant authorities via email and fax by the State Control Room. Closed User Group (CUG) phones are provided to critical officials to ensure timely communication. All are sent mass SMS alerts, and the information is shared with All India Radio and Doordarshan for widespread distribution via their respective platforms.

- *Public Awareness:* The Department of Information plays an important role in public awareness by publishing guidelines (Do's and Don'ts) in state-level and local Hindi/English daily newspapers, as well as various electronic media outlets.

- *The IMD's Multi-Hazard Early Warning System* provides forecasts and warnings for all weather-related hazards in the short to medium term, covering the next five days. This multihazard early warning system is updated four times per day to ensure timely and relevant information for effective decision-making.

This comprehensive operational system of weather forecasts and warnings is encapsulated in the summarized chart provided below (Figure 6).

4.1 Declaring Heat wave for the Uttar Pradesh State During 2023: For declaring the heat wave, the above criteria should be met for at least at two stations in a Meteorological sub-division for at least two consecutive days. A heat wave will be declared on the second day. The early warning would be communicated to line department from UPSDMA through Heat Wave Early Warning Communication System (Figure 6).

4.2 Monitoring and Evaluation: The monitoring and evaluation process is of utmost importance in enhancing the caliber and efficacy of public programmes and services. The process aids in the identification of both strengths and weaknesses within systems, offering valuable information that can drive evidence-based decision-making on resource allocation, intervention design, and the enhancement of healthcare outcomes. Furthermore, the utilization of

technology can contribute to enhancing accountability and transparency within the public sector. This is achieved by providing comprehensive information regarding the performance of providers and systems.

Recognizing the importance of Monitoring and Evaluation in enhancing the effectiveness and efficiency of the Uttar Pradesh Heat Action Plan, the UPSDAM has developed a monitoring and evaluation system. The main aim of this system is to track the implementation of various strategies of Uttar Pradesh State Heat Action Plan at district level. Following are the main components of the monitoring and evaluation systems.

- *Action Taken Report (ATR):* The UPSDMA has developed a framework in which every district has to submit the ATR at periodic interval. Each district must report activities carried out per the heat action plan. The important activities districts need to record and report are number of hotspot and vulnerable areas identified, capacity building and training, community awareness, best practices and special actions for vulnerable population, and inter-agency coordination, amongst others.

- *Evaluation of District Heat Action Plan and Action Taken Report:* The evaluation of various activities is very essential component of monitoring system. The UPSDMA has established a system for ranking the district based on district heat action plan and action taken reports. Each district is to be evaluated on various criteria like, how effectively the district has implemented inter-agency coordination, number of the training programme, IEC activities, community awareness, special attention to vulnerable communities, best practices and the development of a heat action plan.

4.3 Impact of the Heat Action Plan (HAP): In the state of Uttar Pradesh, HAP has been implemented by the UPSDMA and district administrations. The strategy piloted an early warning system and an interagency disaster risk reduction coordination structure to protect citizens from the risk of catastrophic heat events. This concept offers a framework for other Indian states to be emulated and shielded from intense heat. Building awareness of and training medical professionals, municipal agencies, and vulnerable populations for excessive heat dangers to health may have already saved many lives in the state of Uttar Pradesh and offered early warnings and interventions when heat waves strike.

5. Recommendations

Government funding should be allocated towards enhancing the accessibility of health-related data, similar to how IMD provides climatic data. In addition to enhancing comprehension regarding the effects of heat waves on morbidity

and mortality, this would facilitate the development of a heat stress index and threshold code specific to each city. Information could be incorporated into new thresholds for the issuance of heat-related warnings, taking into account combinations of temperature and humidity. Additionally, scientific endeavors ought to be focused on the development of a heat stress index that is specific to India.

A nodal person trained in environmental public health should be appointed to each Municipal Corporation or city level to coordinate the various activities of the heat action plan with line departments. This is because the successful and efficient implementation of HAPs necessitates collaboration and coordination among multiple stakeholders. Cities ought to oversee and assess heat-action strategies. Effective strategies necessitate ongoing monitoring and evaluation in order to enhance both the processes and the results. The plan should be revised annually. In rural regions, the expansion of heat-warning systems by the government would serve to safeguard rural economies, livestock, and communities against extreme heat events.

6. Conclusion

The impact of climate change is already evident in India, as seen by the observed increase in summer temperatures. During the period following the year 2000, it has been observed that 16 out of the 18 summers with the highest recorded temperatures during the past century have taken place. It is anticipated that each successive year would exhibit higher temperatures compared to the preceding year. The accuracy of heat-related mortality and reporting precision is compromised by factors such as incomplete recording of causes of death and underreporting of deaths among homeless individuals. The heat action plan encompasses various measures, including the implementation of an early warning system during heat waves, the dissemination of health education and promotion initiatives targeting vulnerable communities to prevent heat-related illnesses, awareness programmes in educational institutions, inter-departmental coordination to notify citizens of anticipated high temperatures, training programmes for healthcare professionals to effectively prevent and treat heat-related illnesses, the creation of innovative information, education, and communication (IEC) materials in local languages, and the identification and mapping of high-risk areas and communities. The implementation of a comprehensive strategy that includes public awareness campaigns, medical staff training, and straightforward regulatory reforms has the potential to significantly reduce mortality rates at a cost-effective level. The case study offers a comprehensive and evidence-based framework for public health officials worldwide. Its aim is to enhance the resilience of communities in the face of high-heat events and to effectively prevent and manage heat-related disorders.

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The Kharghar Sunstroke Incident: Gaps Identified & Lessons Learned

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Abstract

According to a recent study by the Indian Meteorological Department (IMD), heat waves are the leading cause of death among natural hazards. The most vulnerable groups are children and the elderly, particularly those with conditions like heart and lung diseases, kidney problems, and psychiatric problems. A few regions in India have experienced Heatwaves during summer through abnormally high temperatures of 4 to 5 degrees Celsius (39.2- and 41 degrees Fahrenheit) above the normal. Worldwide, heatwaves are more common in urban regions than rural. According to a study conducted by the Union Ministry of Earth Sciences, India experienced an average temperature rise of 0.67 degrees Celsius between 1901 and 2018. The study predicts that by 2100, temperatures in India will climb by 4.3 degrees Celsius and that the frequency and length of heatwaves will increase by a factor of two or three in comparison to the those between 1976–2005. With this background, the author of this document has tried to understand the details of the Maharashtra Bhushan Award conferring program held in Kharghar, Maharashtra on April 16, 2023, that led to many people falling ill and a few of them losing their lives after prolonged exposure to high temperature. The objective of this document is to highlight the lessons learned from this incident.

Key words: Kharghar, Heatwave, Incident Management.

1. Introduction

The Maharashtra Bhushan Award conferring program was held at Kharghar in Navi Mumbai on April 16, 2023. It was during this event that around 40 people fell critically ill and more than 10 people lost their lives because of prolonged exposure to heatwave (heat exhaustion & and sunstroke). In addition to highlighting the areas for future improvement, this work strives to develop deeper insights into the preparedness and mitigation measures that were put in place by the concerned authorities at the site.

This work aligns with the PM's 10-Point agenda which states, "Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster". As per the spirit of PM's 10-Point Agenda, following the tragedy, the Department of Disaster Management, Relief and Rehabilitation, Government of Maharashtra has initiated a brief study

of the event to identify the gaps, and to document the key lessons from the disaster for future course correction and preparedness planning, response and mitigation and improve overall risk governance in the state. (Sendai Framework Priority 4) i.e., Enhancing Disaster Preparedness.

This case study is based on both secondary and primary data. The district administration officials of Raigad were consulted for the primary data, and secondary data was gathered from credible press articles and reports.

2. The Kharghar Heatstroke Incident

Maharashtra's Raigad district is prone to several hazards. The region is susceptible to heat waves in addition to cyclones and heavy rainfall. On April 16, 2023, renowned social worker Shri. Appasaheb Dharmadhikari was conferred with the Maharashtra Bhushan award at the Corporate Park ground in Kharghar, Navi Mumbai in the presence of senior ministers and important dignitaries. Considering the popularity of Shri Dharmadhikari and his following among the masses, the Raigad district administration and the organizers had anticipated that close to twenty lakh people, traveling from various parts of Maharashtra, would reach Kharghar on the day of the event. On their part, the district administration displayed their preparedness, which included forming 32 subject-wise sub-committees assigned with key responsibilities, coordination mechanism and communication mechanism for the event. The key officials of the district administration and the entire event management team were oriented under the guidance of domain experts such as YASHADA. Lightning arrester and reflectors were installed with the support of MSEB. Additionally, two NDRF teams was deployed at the venue. Anticipating a gathering of a large number of people, seven Private hospitals were equipped with 610 common ward beds and 170 ICU beds. Around 32 Heath Centres in 5 Sections were set up at the event venue, with 23 Health Centres at the parking arrangements. The arrangement also included 80 types of medicines in medical kits and oral rehydration therapy. Overall, 310 Doctors (including 102 special experts), 150 Nurses, 150 Pharmacists, and 600 support staff were available to provide medical support. 76 ambulances were available at the venue (32 out of which were kept ready at the PHCs including 14 Cardiac Ambulance with specialist doctors.). Around 2300 water tap connections were provided for water arrangement at the venue. Also 303 water tankers having 50 MLD water were made available at the site. There were 65 Syntex water tanks provided as well. Around 110 plumbers were present at the site for repair and maintenance anticipating an emergency. Around 350 toilet blocks made available at the venue. Additionally, 15 HAM radio operators were available at the event venue and in the control room for establishing reliable communication in case of emergency. There was a range of other preparedness measures undertaken by district officials such as the availability of 26 woodcutters, steel cutters, rope cutters, etc., that could be

used in case of a stampede-like situation. Deployment of 5000 local volunteers and 100 Aapada Mitras (with 50 Aapada Mitras deployed at the control room and 50 at the venue). Even before the program, the district administration had created awareness about the heatwave hazard through major local newspapers. The senior ministers and dignitaries of the district were at the forefront of writing elaborate and informative articles in the district newspapers.

The venue was spread over an area of 206 acres and apart from the seating arrangement for the visitors, the administration had responded with an arrangement for parking facilities for close to forty thousand vehicles. The program was expected to begin at 10 a.m. and end by noon. Many people travelled overnight from various places across the state and reached the venue two days prior to the event.

The pandal created for the event could not accommodate the enormous number of people who had assembled at the event. The pandal was reserved only for a few people closer to the stage, which included VIPs, special invitees, and the organizers associated with the event. The majority of people were outside the pandal and were directly exposed to the heat.

However, the program got delayed by almost ninety minutes leading to continued large-scale exposure to severe heat leading to sunstroke and exhaustion. People thronged the nearest drinking water and toilet facilities after being without food and water for a long time. The food and water they were carrying were consumed long before the beginning of the event.

As the event continued, the temperature soared up to four degrees higher than the 34–35 degrees Celsius that the Meteorological Department (IMD) had predicted. Additionally, the state's minimum temperatures were above normal, with much higher heatwave-like conditions observed in April and May 2023. The Thane-Belapur Industrial Association weather observatory[1] (thermometer) in Rabale, Navi Mumbai (closest from Kharghar, at 21 km) recorded the temperature for the day as 38° C[3]. However, as this weather station is only about six years old and has not generated sufficient data, the preferred weather stations are in Bhira, Mangaon (100 km from Kharghar), and the ones at Colaba and Santacruz (both, almost 40 km from Kharghar)[2]. The desired weather-related information was communicated to all the district officials for their necessary action. According to the Indian Meteorological Department, these weather stations had shown normal temperatures on the day of the event and hence the administration missed anticipating a heatwave condition.

The programme finished at 1:30 PM, post which a few visitors experienced symptoms of heat stroke. Some of the visitors found it difficult to stand still, and a few others began vomiting and had trouble in breathing. The medical team

was quick to respond in providing medical aid. Around 474 people were shifted to hospitals where the district administration had made prior arrangements. Out of 474, the 68 people who experienced severe symptoms were the first to be moved to the Hospital. Around 54 people were discharged after receiving proper treatment. Despite providing aid, 14 people lost their life. The summary of hospitalised patients is presented in the below table.

The district administration provided support through a continuous follow up with medical teams and these efforts ensured that around 7000 visitors received first aid on the site with support from 55 Medical centres.

3. Gaps Identified

The following gaps emerged during the consultation with the District Disaster Management Authority for Raigad:

- The District Collector office or the District Disaster Management Authority could not issue a heatwave early warning or a heat-wave bulletin for Kharghar as neither Panvel nor Kharghar has an operational weather observatory (Thermometer) yet. The nearest thermometer for the Raigad district is at Bhira, Mangaon (almost 100 km from Kharghar). The weather station nearest to Kharghar is in Rabale, Navi Mumbai (mentioned in the previous section), but it is only about six years old. The other weather stations are at Colaba and Santacruz. These locations, due to their long distance from Kharghar, often display discrepancies and inconsistencies with the local weather. A taluka-specific or a more localized weather observatory (thermometers) could help the administration for any such events in the near future. On the other hand, rain-gauge stations that are present in every taluka headquarters help the district administration with early warning concerning rainfall. Thus, there is a need for localized instruments at the circle level. As attendees turned out in lakhs on the day of the event, it was impossible for the district administration to mount a pandal and accommodate everyone. However, the Programme could have been conducted after 4 PM.

- To mitigate the harmful effects of heatwaves, both, the National Guidelines for Heatwave, and the State's Heatwave Action Plan advocate raising people's knowledge and creating awareness about a potential disaster. Against this background, the administration could have publicly displayed DOs and DON'Ts guidelines for heatstroke or simple messages encouraging people to take appropriate action in case they faced discomfort or needed immediate access to food, water, or toilet facilities.

4. Lessons Learned

- Maharashtra is one of the states which is prone to heatwave. Against this background, it is imperative for the administration, ranging from those in the state to districts, blocks, and villages, to seriously follow the heatwave-related warnings issued by the Indian Meteorological Department. They will be helpful in case there are open-air public events during the months ranging from March to May.

- While it is recommended that organizing large-scale (or even small-scale) open-air public events during the heatwave-prone months should be prohibited, in case there is an urgent need for a public assembly, the district administration should insist that it should begin early and end by eleven in the morning or begin at five in the evening to avoid the scorching midday and the afternoon heat. Additionally, there should be a cap on the number of people attending these events so that accommodating everyone under a shade or a pandal is possible. Further, access to medical facilities, water, and toilet facilities can be more efficient.

- In case the event begins in the early hours of the morning, there is always a likelihood that owing to a delayed beginning, it would continue into the afternoon and eventually expose the attendees to the heat. Hence, ensuring enough room with proper social distancing norms would help in ventilation. Also, events commencing in the early hours of the evening and continuing into the night are safer option to go for.

- Senior citizens, pregnant women, young children, and people with morbidities are more vulnerable to heatstroke and these vulnerabilities could manifest into serious medical conditions on exposure to severe heat. It is advisable to prohibit these vulnerable population groups from being a part of open-air public events during the heatwave-vulnerable months. Large-scale public awareness is needed on this front so that these groups do not travel to the event location from faraway places and a tragedy is averted well in advance.

- The administration should ensure a staggered arrangement of food, water, and medical facilities for every seating cluster to make it easily accessible. Against this background, it must be mentioned that the district administration attempted to station the water supply at various locations within the seating arrangement, thereby ensuring smoother access for the attendees. However, the vast number of people at the venue marred these efforts.

- While there are rain-gauge stations at every taluka headquarters, there is no such provision for thermometers and the entire district (in this case Raigad) relies only on the one equipment at Mangaon. Likewise,

thermometers should be made available at every taluka place for more accurate prediction and early warning for the rise in temperature and probable heatwave.

• Decentralized use of technology should be adopted so that such major events can be live streamed on YouTube at the village/taluka level, preventing the need for people to travel farther distances during the summer months.

Quotes

1. "Set up in 2017, this (Thane-Belapur Industrial Association's weather observatory) is a new observatory, and we need at least one decade of data to ascertain the departure for the location. All our other observatories were showing normal temperatures, hence not qualifying for a heatwave condition." – Sushma Nair, scientist, Indian Meteorological Department, Mumbai.

2. "Colaba and Santacruz weather stations are located closer to the sea and do not depict the correct picture of the higher temperatures observed in the interiors during peak summers. Also, the day temperatures recorded are in the air, while the spectators at the event were closer to the ground, where the heat may have been higher."– Abhijit Modak, amateur forecaster, Konkan weather blog.

3. "The perceived temperature would be much more than 38 degrees C as reported by the IMD. The higher temperature led to excessive sweating followed by severe dehydration, responsible for the heat stroke-related mortality. Announcements about drinking more water at rallies are important for preventing such disasters." – Professor Mahaveer Golechha, Indian Institute of Public Health, Gujarat.

पुढारी

१४/०४/२०२३

महाराष्ट्रभूषण पुरस्कार सोहळा पूर्वतयारी वेगात
तीव्र उन्हाच्या पार्श्वभूमीवर विशेष आरोग्य व्यवस्था

अलिबाग : पुढारी वृत्तसेवा

रुग्णवाहिका व्यवस्थापन
- कार्यक्रमस्थळी एकूण ५९ रुग्णवाहिका
- त्यापैकी ३२ रुग्णवाहिका वैद्यकीय केंद्रांवर तैनात
- दोन रुग्णवाहिका पार्किंगच्या ठिकाणी आहेत
- कार्डियाक रुग्णवाहिका चौदा तैनात आहेत.
- सात अतिदक्षता वैद्यकीय केंद्रात तर २ आमराईच्या ठिकाणी तैनात
- पाच कार्डियाक रुग्णवाहिका राखीव

रुग्णालयात बेडचे आरक्षण
- एमजीएम, रिलायन्स, फोर्टिस, अपोलो रुग्णालयात १०० साधे व १० आयसीयू बेड आरक्षित.
- अन्य साध्या रुग्णालयांमध्ये २५ टक्के बेड आरक्षित
- उन्हामुळे निर्जलीकरणाची शक्यता लक्षात घेऊन मुबलक पाणी व ओआरएसची व्यवस्था.

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newspaper.pudhari.co.in

Preparedness of the event featured in the newspaper 'Pudhari.'

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उन्हाच्या चटक्यांनी अंगाची लाही लाही!
उष्माघाताची भीती; नागरिकांना खबरदारीचे आवाहन

अलिबाग : रामप्रहर वृत

– डॉ. सुहास माने,
जिल्हा शल्यचिकित्सक, जिल्हा सामान्य रुग्णालय

District Surgeon, Dr Suhas's article in Dainik Ramprahar

Article by Division Information Office, Navi Mumbai in Dainik Ramprahar

Fig.1: Snapshots of various media articles regarding the incident

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