DISASTER
Governance in India

Series-8, Issue 1

CENTRE FOR DISASTER MANAGEMENT
Lal Bahadur Shastri National Academy of Administration, Mussoorie

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Centre for Disaster Management (CDM)
Lal Bahadur Shastri National Academy of Administration (LBSNAA),
Mussoorie - 248179, Uttarakhand
Telefax: 0135-2632655; 0135-2222000 (Extn-2385)
EPABX: 0135-2632489, Fax: 0135-2632350, 2632720
Email: cdm.lbsnaa@nic.in

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E-mail: chandupress@gmail.com

Sriram Taranikanti, IAS
Director,
Lal Bahadur Shastri National Academy of Administration,
Mussoorie-248179

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.

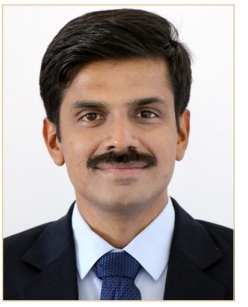
By virtue of the DM Act 2005, the District Magistrate/ Divisional Commissioner play a pivotal role as head of the District Disaster Management Authority (DDMA) and hence, it is essential that he /she should be well versed in the various aspects of Disaster Management.

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-8, Issue 1 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)

Abhiram G. Sankar, IAS
Deputy Director & Director
Centre for Disaster Management



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-8, Issue 1 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-8.

(Abhiram G. Sankar)

Contents

Technology-led Transparent and Accountable Mechanism for Direct Benefit Transfer to Disaster Affected Population in Bihar

Sanjay Kumar Agarwal, IAS and Amrita Dhiman*

Abstract

In the year 2019, the month of September, the state had an interface with floods. Out of the total 38 districts in the state, 27 were battling floods, including Patna, the state capital. The Disaster Management Department in the state was on its toes and doing everything under the disaster response mechanism while using the measures created during the preparedness activities. This year led to a revolutionary transformation in transferring Gratuitous Relief to the disaster-affected people. Initiation of 'Aapda Sampoorti Portal,' a technology led transparent mechanism that ensures accountability while providing direct digital transfer of the benefits to the disaster-affected people as an indication of good e-governance. This has also led to the paradigm shift in gratuitous transfer from mere disaster response to disaster preparedness.

Key words: *Disaster Response, Preparedness, Technology led innovation, Transparency & accountability, e-Governance*

1. Introduction

It is empirical that July and August are the peak months for floods in Bihar, the flood water would begin to recede by September with the withdrawal of the southwest monsoon, and the situation is expected to move towards normalcy by November. However, in the year 2019, the central and eastern parts of the state received heavy downpours more than 1.5 times the average usual rainfall, resulting in accentuated moisture levels in the soil by 19 per cent and thus resulting in floods in a larger part of the state (C. M. Bhatt, Gupta, Roy, Dalal, & Chauhan, 2021). Out of the total 38 districts in the state, 27 were battling floods, including Patna, the state capital.

The Disaster Management Department in the state was actively engaged in disaster response and was ensuring relief and rehabilitation measures for the affected population like previous years. In 2019, more than 500 thousand dry

ration packets[1] were distributed in the flood-affected areas and more than 1.05 million people were living in safe shelters created as an alternative for safe relocation to provide shelter for displaced communities amidst disaster.[2]

Bihar is muti-hazard prone state. Floods, Drought, Lightning, and other disasters wreak havoc causing loss of life and property in the state. Floods are the most devastating ones amidst all disasters in the state, causing severe loss of life and property and impacting the activities in the state for around four months, July to October.

Bihar has several rivers crossing its territory and thus forming a dense network of rivers in the state. There are thirteen major identified river systems in the state as per the Water Resources Department, Government of Bihar. The direction-wise major rivers systems are as mentioned in table 1.

Sl. No	Northern	Western/Central	Southern
1.	Mahananda	Ghaghra	Son
2.	Kosi	Ganga	Punpun
3.	Kamla	Karmnasa	Kiul-Harohar
4.	Bagmati-Adhwara		Chir-Chandan (Ghoghe)
5.	Gandak		
6.	Burhi Gandak		

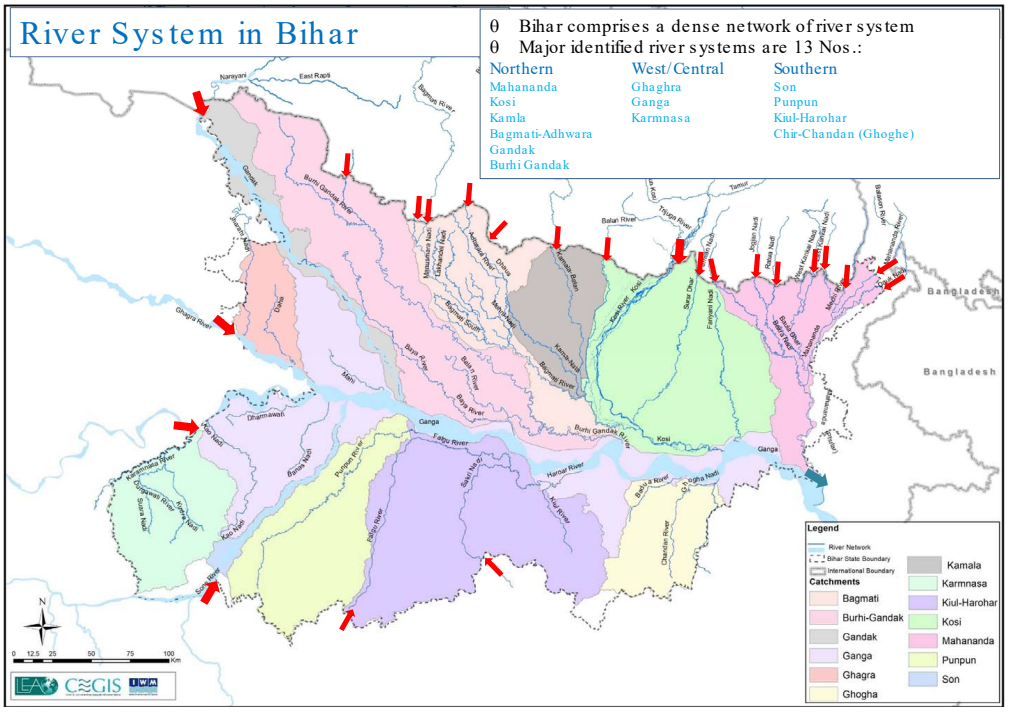
The susceptibility of the state to recurring floods is evident from presence of numerous river systems in the state. Figure 1 further elaborates on the vulnerability of the communities in Bihar to floods.

As per the reports available from the Disaster Management Department in the Government of Bihar, the crop area affected by floods in the state was 357 thousand hectares and 517 thousand hectares in 2019 and 2020 respectively. The land mass prone to frequent floods is around 75% of the total land mass of the state. 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).

[1] Corresponding author; Dry ration packets include gram, salt, pressed rice, flour of roasted gram, jiggery, matches, candles etc. readily useful materials for the people stranded amidst flood waters

[2] Data from the Flood Report 2019 of the Disaster Management Department, Govt. of Bihar

Hence, it demands for reducing the negative effects of floods on human lives and property by putting disaster risk reduction measures in place. This in turn emphasizes the need for pushing non-structural and technology-led innovative measures other than the structural measures like construction of embankments, flood retention walls etc. mostly being carried out under flood management in the state (Kansal, Kishore, & Kumar, 2017).



2. Issues

The state government has been aiding the disaster affected people whose lives and livelihoods are severely affected by disaster. As shared by Mr. Sandeep Kumar, Officer-on-Special Duty in Disaster Management Department, recollecting his experience of being a Circle Officer in Aurai Block in Muzaffarpur district in Bihar "cash payments were made to the disaster affected people in 2006, which was a tedious process. The panchayat level functionaries had the mandate to organize camps for disbursing the cash of the gratuitous relief for the disaster affected people."

The process involved a significant number of manual interventions, leading to delays in reaching ultimately to the beneficiary. People had to travel to the camps or the block offices for collecting the amount of the GR payments. Sometimes,

due to submergence in the flood waters, it was almost impossible for the people to come to the camps to collect the amount.

Later, the system of gratuitous relief payments got changed as Real Time Gross Settlement (RTGS), advice-based payments through banks. Even this system had a significant degree of manual intervention and was lacking any cross-verification mechanism and hence often resulted in errors. There were issues in terms of beneficiary bank account being inactive. At times, the details shared by the beneficiary like account number, IFSC code etc. were wrong. There were instances of mismatch in the bank account holder's name and account number, also. The failure was to the tune of 20 to 30 per cent in payment of gratuitous relief to disaster affected people through RTGS. The other issue related to this was delay in receiving the information of failed payments from the bank, which resulted in money lying unused in the bank's suspended accounts, even though the money was debited from the account of the Circle officer (CO). The inability of the bank manager to inform about the failed payments led to further delays in paying the gratuitous relief amount to the disaster affected people. At times, the Circle Office had to pursue with the bank branch for getting the information, so that corrective measures can be taken accordingly.

In disasters for instance floods other than distributing dry ration, fodder and polythene, the state government has been providing financial assistance as 'Gratuitous Grant' (GR) of Rs. Six thousand (6000) to every family whose lives are affected by floods since 2015. Though, the RTGS based system of GR payment was better, it still had issues which demanded for a solution like the ensuring the accuracy in collating and compiling the information about the beneficiary in time and the regular monitoring sans manual intervention.

The entire process of GR release to the flood affected people was cumbersome and time-consuming. The multiplicity of manual intervention and possibility of errors and delays also postulated the scope for the emergence of middlemen in the process. The non-availability of the relief measure at the right time was rather exasperating the vulnerabilities of the disaster affected people.

3. Innovation of ASP

To address the issues faced in distributing the GR to the disaster affected people, the Disaster Management Department took recourse to technology. It led to an innovation christened as *"Aapda Sampoorti Portal" (ASP)*, an integrated management information system for disaster compensation disbursement. It

was designed keeping the centrality of the issues faced in distributing the GR to the disaster affected people particularly in floods.

For eight years, 2002 to 2010, the GR rate was Rs.20 per adult and Rs.15 per child, which got revised in 2015 as Rs.60 per adult and Rs.45 per child by the Ministry of Home Affairs, Government of India as per the items and norms for assistance under the State Disaster Response Fund (SDR Fund) and the National Disaster Response Fund (NDR Fund) for disaster affected people. State Executive Committee takes the decision on the implementation of the items and norms for assistance under the SDR Fund and the NDR Fund for the disaster affected people in the state. Upon the closure of the open market sales scheme by the Government of India, the amount eventually got translated to Rs.6000 of assistance as gratuitous relief for disaster affected families. Since 2019, the disaster management department has been using the ASP for GR payment to the disaster affected communities in the state of Bihar.

Table 1: Year wise GR payments through ASP in Bihar

Sl. no	Year	Number of families (Receiving GR through ASP) (in million)	GR Amount (in million)
1.	2019	3.31	20035.6
2.	2020	2.3	13755.7
3.	2021	1.65	9875.1

The technology enabled ASP system is in use since 2019 for transferring the gratuitous relief to disaster affected families. In the year 2019, GR amount of more than 20 billion was transmitted to the bank accounts of more than 3.3 million families in the state. During the pandemic times in 2020 and 2021, the ASP was very helpful in transferring the relief money to the affected families. In the year 2020 and 2021 the amount of GR provided through technology led initiative of ASP is Rs.13755.7 million and Rs.9875.1 million to 2.3 million and 1.65 million families, respectively.

The initiation of the strategic technology led innovation of ASP has transformed the activity of gratuitous relief from absolute disaster response to disaster preparedness. The entire process is done is a highly democratic and participatory manner under a bottom-up approach, in turn ensuring the correctness of information fed into the system of ASP.

4. Integrated process of ASP

The onus lies on the primary unit of local governance as the Ward Sabha[3] or the ward level monitoring committee headed by the ward member. The process of collecting and compiling the correct data of the projected beneficiary is completed before the onset of monsoon every year. Out of the total of 38 districts, 28 districts are declared flood prone in the state, wherein the data is collected proactively as a preparedness measure to ensure timely availability of relief for the disaster affected people if disaster occur. The data collected from the surveys is published and disseminated through various mediums like district websites to providing the information collated up to the panchayat level and ward members.

The flow chart of GR payment under the portal is elaborated in the figure 2.

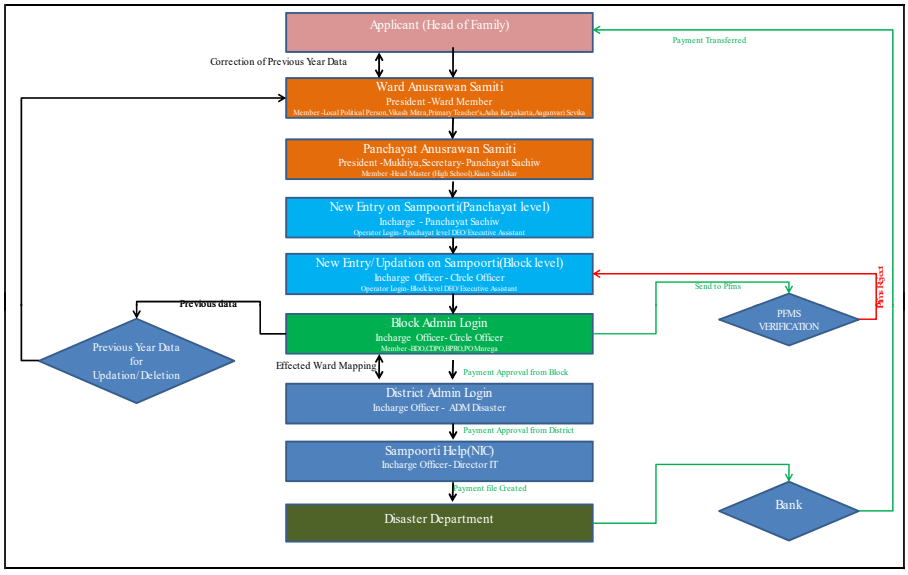


Figure 2: Flow chart of GR payment under Aapda Sampoorti Portal

Based on the information available from the previous years, the corrections or assertions as required are entered into the electronic system. The access login for the ASP is provided up to the panchayat level to ensure decentralized entering of information, which is verified at the block level and then at the district level for correctness of information fed in compliance with the requirements under this new in initiative. The entire process of ASP is designed and developed in compliance with the Public Financial Management System (PFMS) symbolizing

[3] Bihar Panchayat Raj (amendment) Act, 2015 - Ward Sabha became the primary unit of local governance in Bihar

a significant step in e-governance by the Disaster Management Department in Bihar. The steps involved in brief are:

1. ***Ward level monitoring committee/Panchayat level monitoring committee:*** It is primary unit under this decentralized technology led innovative initiative of ASP. It ensures the entering of data for those who were left out. Like some families migrate etc. It ensures to rectify the data like if change in head of the family due to death or so. Data is entered for more than one member from the same family etc. Around ten to fifteen days of time is given for calling the objections on the published information. The final list, after the objection period, is entered into the Aapda Sampoorti Portal, which has been developed with the support of the National Informatics Centre (NIC) and integrated with the PFMS. The one of the most information compiled in the survey is the correctness of the Aadhaar numbers of the people.

2. ***Block level online entry:*** The data entered under the ward/panchayat login is reviewed at the block level by the Circle Officer. At the block level the duplicate data if remaining in the system is removed and Aadhaar numbers are duly verified for correctness. In case, any further correctness is required in the name, Aadhaar and bank account details, it is done at the block level. Like if due to some reason, name mismatch happened at the Panchayat level, it can be corrected at the block level based on the application received from the beneficiary. The portal has in-built mechanism for tracing the entry or editing of data. Thus, it ensures transparency and accountability as where in what data has been edited or entered.

3. ***District level:*** Block verified data is visible under the district login to the Additional District Magistrate (ADM), In-charge of Disaster Management in the district. The ADM sends the final verified information from the district to the NIC headquarters in Patna through the ASP.

4. ***Sampoorti help at NIC, Patna:*** The NIC pushes the data file through PFMS portal. The amount is approved and debited from the account of the Disaster Management Department and released into the bank accounts of the disaster affected people. The system highlights in case any amount could not be pushed forward to the beneficiary account due to any mismatch in information like name and account number, incorrect Aadhaar number etc. The cognizance for this is immediately taken at the district and the correct information is forwarded through the portal to NIC. The action is taken as per the correct details for GR payment and the correct information is locked into the system for future use and becomes accessible under the block login.

5. Unique features and benefits of ASP

Exhaustive granular data availability: The data captured in ASP is granular with availability of exhaustive in-depth information of even the ward details. When floods occur, the CO marks the flood affected Wards and Gram panchayats to the District Magistrate. Upon approval by the District Magistrate, the marked list is printed, and field level verification is done to zero down onto the real disaster affected people. Then as marked on the ASP, the file is forwarded by the block to the district for payment. District level login led by the ADM, then approves and pushes for payment. Payment file gets generated and eventually pushed by NIC to PFMS. PFMS sends to department for approval and the payment gets released directly into the bank accounts of the disaster affected people by the banks.

Transparency: The beneficiary receives the payment information by the bank. However, the ASP also ensures the availability of payment information to the people through the integrated feature of bulk message sending service. The mobile numbers are anyway mandatorily captured in the first step of the process. The same mobile number is also used to provide the payment information to the disaster affected people. The ASP management information system reflects the information about this that how many of the messages are delivered.

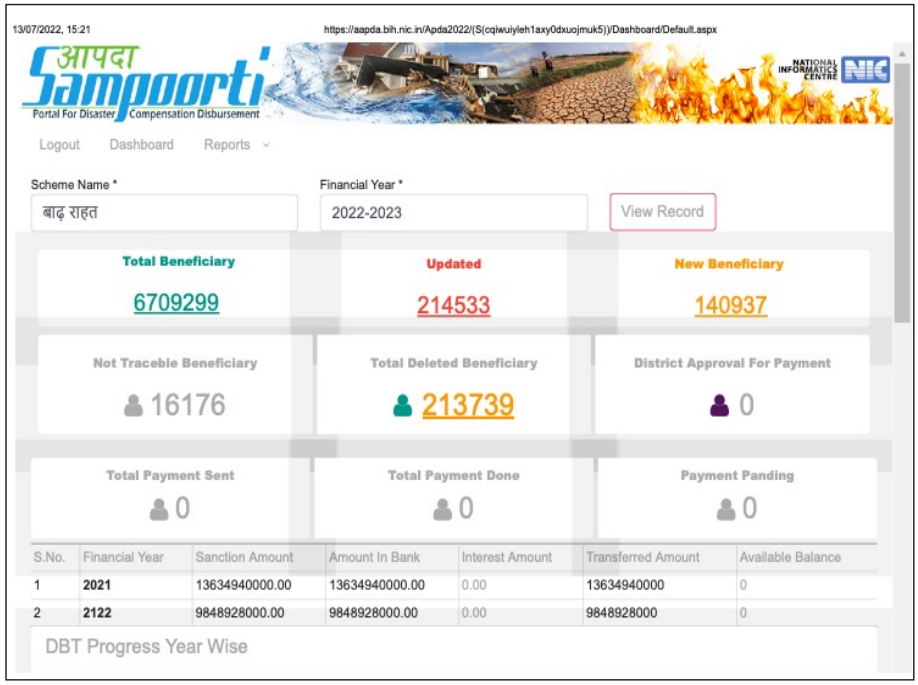


Figure 3: Dashboard visual of Aapda Sampoorti Portal

Tracing Mechanism to ensure accountability: The integrated tracing mechanism in the ASP further reinforces the emphasis laid on transparency. Any editing done in the data file can be traced and corrective steps as required can be taken.

Time saving with minimal manual intervention: The ASP is thus time saving and requires minimal manual intervention. The availability of decentralized access of ASP up to the ward/panchayat level makes it citizen friendly and ensures ease of access for the community.

The ASP has simplified the process of GR transfer to the beneficiary in terms of ease of payment transfer, transparency in information availability and the omission of middlemen. It ensures the direct transfer of benefit to the people through their bank/post office accounts. It facilitates in timely transfer of the benefits to the disaster affected people in an efficient, effective, transparent, and accountable manner under this e-governance strategic technology led initiative of ASP. The ASP reduces delays in payments and ensures accuracy in targeting the beneficiaries. Hence, preventing duplication and leakages.

6. Feedback from the beneficiary and the users to conclude

Based on the feedback from the beneficiary and the users of the ASP, the system is mostly used for all kinds of disaster related payment transfers to the disaster affected people by the department.

- Putul Devi of Dayalchak village shares that it was very helpful for her as the money was easily received in time at the time of floods in her area. With the presence of customer service points in the village, she could easily benefit from the GR payment.
- Skratiya Devi of Dayalchak agrees to the remarks shared by Putul Devi. She said that earlier it was difficult to visit camps at the time of floods. With the new system, she need not go to the block or any other office as the payment comes directly into her bank account.
- Om Prakash Singh of Kotwapatti in Rampur Gram Panchayat shares that he has received the GR payment in 2021 in his bank account. He further shared that while he did not move to the shelter camp when floods water had inundated his village, he received the GR payment of Rs. 6000 in his bank account.
- Shri Gagan Kumar, ADM, Saran shared that the system has improved transparency and accountability and has proved to be a very good e-governance

tool ensuring timely transfer of benefits to the beneficiary at the time of disaster.

The above voices shared by a sample of the beneficiary and the officials using the ASP reconfirms that the usage of technology as ASP has proved very effective and efficient in timely transfer of the GR payment to the disaster affected people while improving transparency and accountability in the governance system. The initiation of the technology led innovation triggered a paradigm change in the orientation of endeavours of the department from disaster response to preparedness. There are plans to expand its usage to undertake comprehensive coverage of all relief transfers to disaster affected people through the portal effectively and efficiently with transparency and ensuring accountability.

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Super Cyclone AMPHAN over West Bengal-Impact Based Forecast, Preparedness and Response during peak Corona 2020 period

Dushyant Nariala, IAS and Ganesh Kumar Das*

Abstract

West Bengal has witnessed a massive damage of property and loss of life in coastal districts associated with Super Cyclonic Storm (SuCS) AMPHAN during lockdown period of May 2020.This study highlights about the Impact Based Early Weather Warning from IMD and quick response and rehabilitation undertaken by the Department of Disaster Management and Civil Defence (DMCD), Government of West Bengal before, during and after landfall of SuCS AMPHAN.

Key words: Super Cyclone, AMPHAN, Impact Based Weather Warning, Disaster Management Department

1. Introduction

Tropical cyclone is one of most important national calamity of a tropical country like India. They originate and intensify over tropical oceans and cross over towards land and dissipate. During the process, they cause extensive damage to property and life over tropical country. The North Indian Ocean accounts for only 6% of the tropical cyclones globally (Neumann 1993; Ali 1999). Despite the relatively smaller number of cyclones, more than 80% of global fatalities occur due to tropical cyclones in this region, mostly due to coastal flooding (Beal et al. 2020). East coast of India is frequently affected by tropical cyclones. During the period 1891-2022, about 253 tropical cyclones crossed West Bengal/Odisha/Bangladesh coast of India (IMD, Atlas of storm track 2022) having direct or indirect impact over the state of West Bengal. The forecast of the cyclone tracks and landfall positions of the North Indian Ocean cyclones have significantly improved with time and human fatalities have reduced in the recent period (Mohapatra et al. 2013b, 2015; Ray et al. 2021).

The Department of Disaster Management and Civil Defence (DMCD) has been entrusted by Government of West Bengal with enforcement of Disaster Management Act 2005. Its aim is to establish necessary systems, structures, programs, resources, capabilities and guiding principles for reducing disaster risks and preparing for and responding to disasters and threats of disasters in the State of West Bengal in order to save lives and property, avoid disruption of economic activity and damage to the environment and to ensure the continuity and sustainability of development. In recent times, DMCD has successfully managed the impacts of tropical cyclone BULBUL (2019), AMPHAN (2020), YAAS (2021) and SITRANG (2022).

In this study accurate Impact Based Forecast and effective cyclone management from DMCD, has been discussed for SuCS AMPHAN during peak period of COVID 19 Pandemic.

2. Brief History of Super Cyclone AMPHAN (IMD, RSMC New Delhi/ Publications)

The Super Cyclonic Storm (SuCS) AMPHAN was first seen as Low Pressure Area over Southeast (SE) Bay of Bengal (BoB) and adjoining area on 13th May 2020.Due to favourable conditions, it concentrated into a Depression (D) over southeast BoB in the early morning (0000 UTC) of 16th May and further intensified into a deep depression (DD) in the afternoon (0900 UTC) of the same day.

1. It moved north- northwestwards and intensified into Cyclonic Storm "AMPHAN" (pronounced as UM-PUN) over Southeast BoB in the evening (1200 UTC) of 16th May, 2020. Moving nearly northwards, it further intensified into a Severe Cyclonic Storm (SCS) over Southeast BoB in the morning (0300 UTC) of 17th May.

2. It underwent rapid intensification during subsequent 24 hours and accordingly intensified into a Very Severe Cyclonic Storm (VSCS) by the afternoon (0900 UTC) of 17th, Extremely Severe Cyclonic Storm (ESCS) in the early hours of 18th (2100 UTC of 17th May) and into a Super Cyclonic Storm (SuCS) in the forenoon of 18th May, 2020.

3. It maintained the intensity of SuCS over west-central BoB for nearly 24 hours during 0600 UTC of 18th-19th, before weakening into an ESCS over west-central BoB around noon (0600 UTC) of 19th May.

4. Thereafter, it weakened slightly and crossed West Bengal – Bangladesh coasts as a VSCS, across Sundarbans, near latitude 21.65°N and longitude

88.3°E during 1530-1730 hrs IST (1000-1200 UTC) of 20th May, with maximum sustained wind speed of 155 – 165 kmph gusting to 185 kmph. It lay over West Bengal as a VSCS, gradually moving north-northeastwards during late evening to night (1200 – 1500 UTC) of 20th May.

5. Moving further north-northeastwards, it weakened into an SCS over Bangladesh & adjoining West Bengal around mid-night (1800 UTC) of 20th May, weakened further into a CS over Bangladesh in the early hours (2100 UTC of 20th) of 21st May, into Deep Depression over Bangladesh around noon of 21st May and into a Depression over north Bangladesh in the evening (1200 UTC) of the same day.

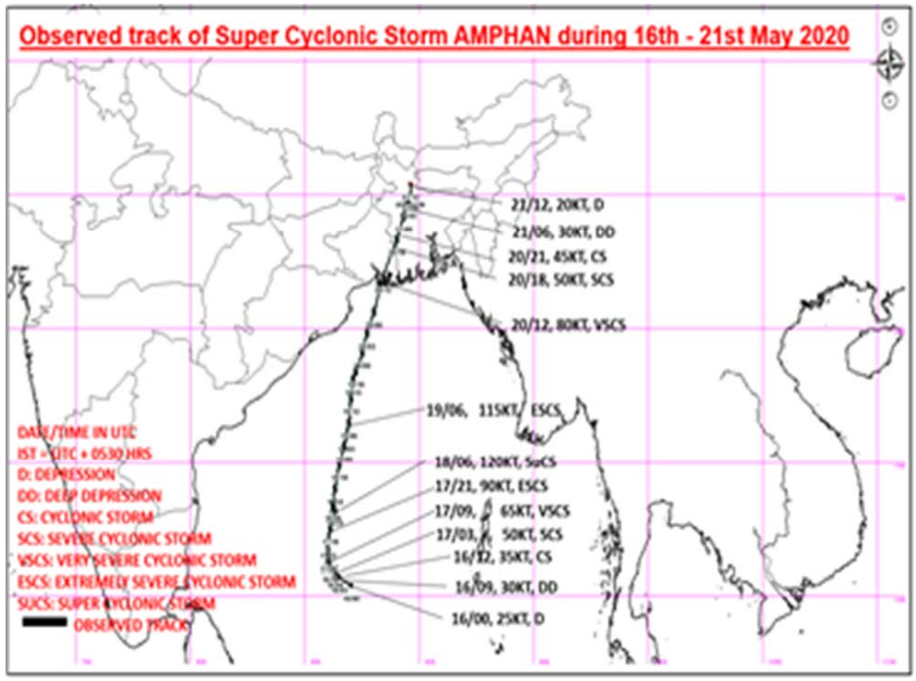

Fig.1: Observed track of SuCS 'AMPHAN' over the southeast Bay of Bengal (16-21 May, 2020)

3. Realised weather

3.1 Rainfall associated with SuCS AMPHAN: Heavy to very heavy rainfall along with extremely heavy rainfall was observed over coastal districts of West Bengal namely Kolkata, Howrah, Hooghly, North and South 24 Paraganas, East Medinipur. Heavy to very heavy rainfall was also realised over Nadia, West Medinipur, and Nadia. Rest districts of South Bengal reported heavy rainfall only.

Significant Rainfall amount (in cm) is given below (IMD, RSMC New Delhi/Publications): Joka-47, Ratan Babu Ghat-40, Behala FC-31, Ultadanga-26, New Market-25, Alipore-24, Palmer Bridge-22, Dum Dum-20, Harinkhola & Debagram-13 each, Burdwan-10, Manteswar & Digha-9 each and Mohanpur, Kharagpur, Suri, Mangalkote, Bankura, Lalgarh & Midnapore-7 each.

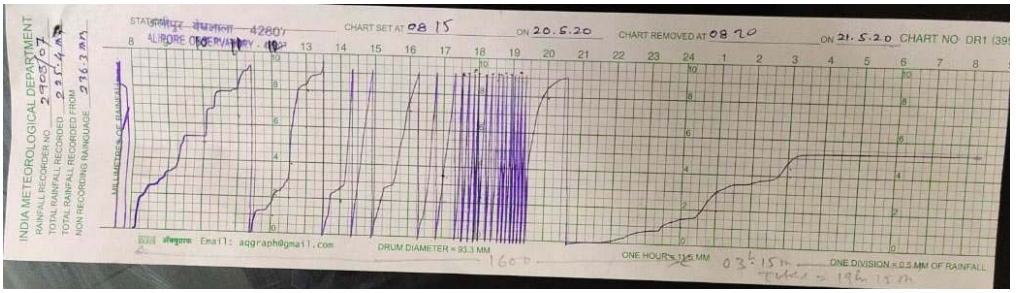

Fig.2: Hourly rainfall observed at IMD Observatory, Alipore (Kolkata) dated 20.05.2020

3.2. Realised wind (IMD, RSMC New Delhi/Publications): Kolkata (Dum Dum) reported 130 kmph at 1855 hrs IST (1325 UTC) and Kolkata (Alipore) 112 kmph at 1752 hrs IST (1222 UTC) of 20th May. Also Paradip reported 106 kmph at 0630 hrs IST (0100 UTC), Chandbali, 80 kmph at 0830 hrs IST (0300 UTC) and Balasore 91 kmph during 1330 – 1430 hrs IST (0800 - 0900 UTC) of 20th May. Maximum sustained wind speed recordings from Automated Weather Stations (AWS) at Canning, Nimpith and Sagar Islands on 20th May are shown in Fig.4.

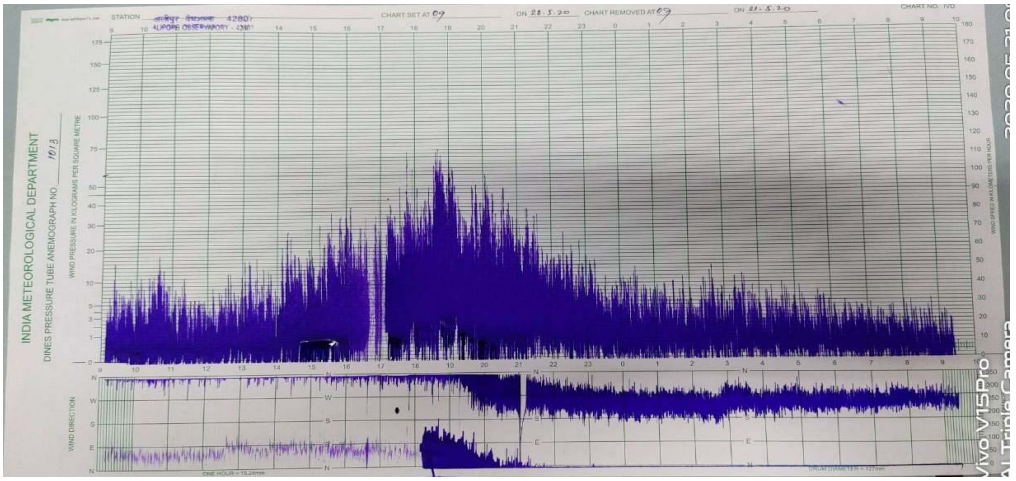

Fig.3: Wind Anemograph showing hourly wind speed and direction at IMD Observatory, Alipore (Kolkata) dated 20.05.2020

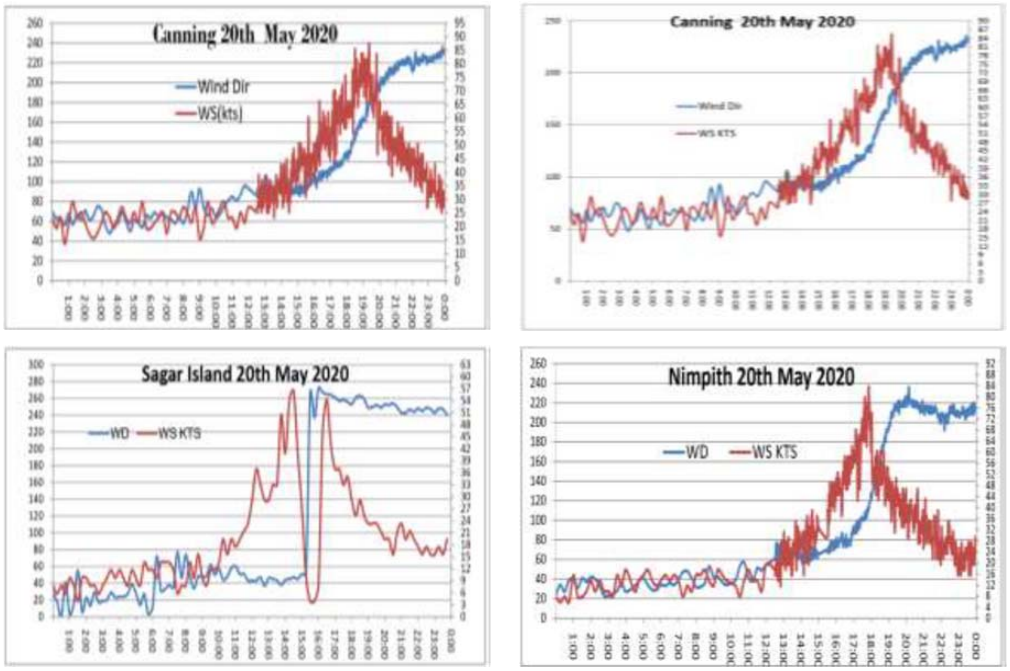

Fig.4: AWS data from Canning, Sagar Island & Nimpith on 20th May 2020

3.3. Realised storm surge: As per the Post Cyclone landfall survey conducted by ACWC Kolkata, Tidal waves of 15 Feet height have inundated low lying areas of the coastal Districts of West Bengal.

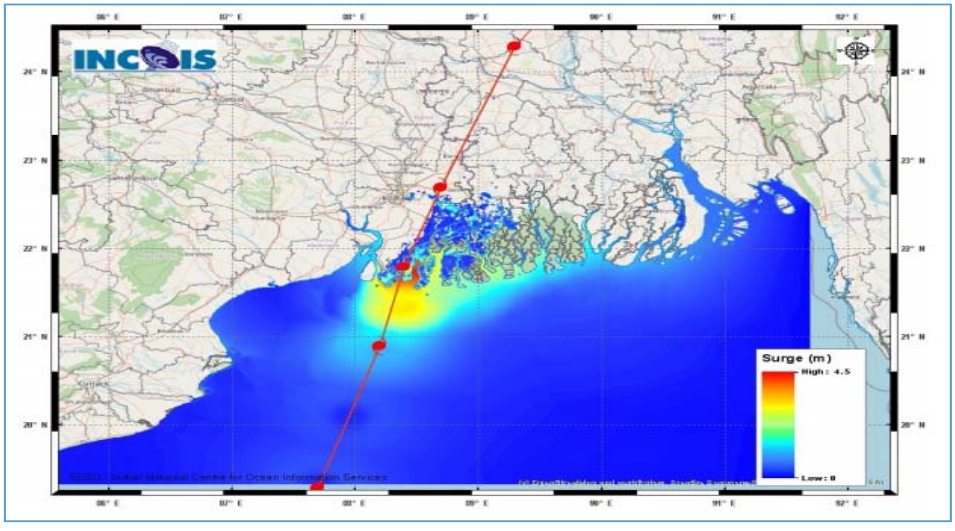

Fig.5: Estimated Storm Surge over Sunderban Area at the time of landfall (Source: INCOIS)

4. Regular Correspondence between IMD Kolkata and DMD, Government of West Bengal

First information bulletin regarding this system has been issued on 13th May 2023 indicating of formation of a low pressure area over Southeast Bay of Bengal and has potential to become depression on 15th May and further into a Tropical Cyclone by 16th evening. On 16th May, Pre-Cyclone Watch has been issued with Depression over Southeast Bay of Bengal and likely rapid intensification into a cyclonic storm by 16th evening. It has finally intensified into a cyclonic storm at 1730 hrs IST of 16th May. Following major warnings have been issued from IMD Kolkata starting from 14th May onwards and updated three hourly till afternoon of 20th May and then hourly bulletin have been issued till weakening of the system.

a) ***Heavy rainfall Warning:*** Warnings of Heavy to very heavy rainfall (7-20 cm) at few places over all the districts of Gangetic West Bengal with extremely heavy rainfall (>20 cm) at one or two places Over East and West Midnapur, North& South Paraganas, Howrah, Hooghly and Kolkata have been given for 20th May. Heavy rainfall at one or two places was also predicted over North & South 24 Paraganas on 21st May.

b) ***Wind Warning:*** Gale Wind speed reaching 155 to 165 kmph gusting to 185 kmph has been predicted along and off east Midnapur, North & South 24 Paraganas at the time of landfall on 20th May. Wind speed of 110-120 kmph gusting to 130 kmph forecasted over Kolkata, Howrah, Hooghly, Nadia and West Midnapur has been predicted at the time of landfall on 20th May.

c) ***Storm Surge Warning:*** Storm Surge of about 4-5 metres above astronomical Tide has been predicted over districts of North & South 24 Paraganas and about 3-4 metres over low lying areas of East Midnapur at the time of landfall.

d) ***Fishermen Warning:*** Fishermen of West Bengal has been advised on 14th May for not to venture into the sea from 16th May onward till 21st May.

e) ***Damage expected and Action suggested*** (East Midnapur, South & North 24 Paraganas, Kolkata, Howrah and Hooghly): Following expected damage and action suggested has been given from IMD Kolkata and updated three hourly basis.

- Extensive damage to all types of kutcha houses, some damage to old badly managed Pucca structures. Potential threat from flying objects.
- Extensive uprooting of communication and power poles.
- Disruption of rail/road link at several places.

- Extensive damage to standing crops, plantations, orchards.
- Blowing down of Palm and coconut trees.
- Uprooting of large bushy trees.
- Large boats and ships may get torn from their moorings.

f) Action suggested:

- Total suspension of fishing operations up to 21st May 2020
- Diversion or suspension of rail and road traffic
- People in affected areas advised to remain indoors. Mobilise evacuation from low lying areas
- Movement in motor boats and small ships not advisable
- Total suspension of water borne activities in beach areas of West Bengal
- Total suspension of ferry services in coastal districts of South Bengal
- All the establishments and markets of Kolkata and adjoining areas to be closed and public movement to be restricted on 20th May 2020

g) Statistics of Bulletins issued in association with SuCS AMPHAN during 17-20 May 2020

Sl.no.	Type of Bulletin	No. of Bulletins issued
1.	Sea Area Bulletins	38
2.	Coastal Weather Bulletins	38
3.	Fishermen Warnings issued	31
4.	Port Warnings	31
5.	Heavy Rainfall Warning	33
6.	Gale Wind Warning	31
7.	Storm Surge Warning	16
8.	Information & Warning issued to State Government and other Agencies	Bulletin-35 Briefing over phone-Around 500
9	No. of Press releases	All Special Bulletin (18 nos.) Communicated to Press & Media group.
10.	No. of WhatsApp messages	70,000 (approximately)
11.	No. of updates on Facebook	30
12.	No. of updates on twitter	10
13.	Press conference	4
14.	Press & Media briefing	50
15.	FM Radio/AIR	10

5. Disaster Response and preparedness measures during SuCS AMPHAN

The DMCD department alerted the South Bengal Districts immediately about IMD bulletins. The earlier cyclones Bulbul and FANI transited over the same region had kept the coastal districts ready for further such emergency. All departments like Health, PWD, PHE, Power, ARD, Forest, I&CA were ready to handle such emergencies. However, lockdown during COVID pandemic was being enforced and all departments and districts were working with limited staff. State and district level meetings were held and NDRF and SDRF teams were deployed.

6. Relief and Rehabilitation measures post AMPHAN

After the very impactful few hours of Amphan on 20.05.2020, the Kolkata Metropolitan Area and surrounding districts were devastated. Thousands of trees fell, power was shut and mobile connectivity was down (Fig-6(a-d))

Fig-6(a)

Fig-6(b)

Fig-6(c)

Fig-6(d)

Fig-6(a-d)): Damage associated with SuCS AMPHAN over coastal districts of West Bengal

The administration immediately started relief and rehabilitation. Before landfall, 15 Lakh people were evacuated. They were kept in Cyclone shelters and flood shelters. Immediately after the SuCS Amphan crossed over the territory of West Bengal, the removal of tree was a major problem as they blocked most roads.

KMC and other Districts Magistrates worked day and night to remove trees and restore connectivity. Hon'ble Prime Minister visited and did aerial survey along with Hon'ble Chief Minister. They both held a meeting in Basirhat, North 24 Parganas to assess the damage (Fig-7(a-d)).

Fig-7(a)

Fig-7(b)

Fig-7(c)

Fig-7(d)

Fig-7(a-d)): Relief associated with SuCS AMPHAN over coastal districts of West Bengal

The Health, Power, PHE, ARD, Forest, Irrigation etc. all worked day and night to restore normalcy immediately. Though 99 lives were lost, thousands of lives were saved due to timely evacuations. UN Chief A. Guterres (UN, News, 2020) appreciated the evacuation work due. The relief distribution was swift and MHA allotted Rs. 2200 crore for Amphan. The house building and other relief was distributed in orderly manner. The size and scale of Amphan was equivalent to two Cyclone. Moreover, the rescue evacuation of relief had to be done during lock down and following COVID norms. Masks and sanitizer were used during evacuation. In relief camps, social distancing was maintained. Mask and sanitizer were distributed in affected areas of the state. Despite tough challenges, West Bengal managed multiple disasters of COVID and Amphan simultaneously.

7. Conclusions

Following broad conclusion can be drawn from the study:

1. SuCS AMPHAN was the first super cyclone over Bay of Bengal after the super cyclone of Odisha of 1999. It has been forecasted accurately 7 days in advance by IMD and impact based warning has been provided.
2. Based on impact based forecast, all possible measures have been taken from DMD, Government of West Bengal. A total of 1.07 million people have been evacuated by State Administration based on accurate track forecast of SuCS AMPHAN.
3. In the case of Odisha super cyclone (1999), there were 10000 fatalities due to gale wind speed, coastal flooding and storm surge (Mohapatra et al., 2002). However, due to accurate forecasting, effective co-ordination and prompt action of DMD, Government of West Bengal, and loss of life has been reduced to double digit (99).
4. SuCS AMPHAN has given an opportunity to DMD, Government of West Bengal to handle multiple disasters simultaneously as AMPHAN made landfall during the peak period of pandemic COVID-2020.

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Role of Field Functionaries in Disaster Response: A Case Study of UGHS (Upper Gradation High School) Wall Collapse in Gangabada Village, Gajapati district (Odisha)

Additional District Magistrate, Gajapati district, Government of Odisha

Abstract

In any incident or Emergency the first responders are field administrators/ functionaries in that area. The School Student Hostel Wall Collapse, due to heavy rains on 19 Sept 2023 in Gangabada, highlighted critical role played by local first responders. The field functionaries at Gangabad Gram Panchayat level managed the emergency efficiently, they not only managed the emergency but ensured that the students staying in the hostel are rehabilated in such a way that they were able to perform the same activities in a better way- a Classiic example of "Build Back Better".

Key words: Wall Collapse, Emergency, First responders, Field Functionaries, Gram Panchayat

1. Introduction

The 73rd Amendment Act was passed by the Indian Parliament in 1992, and it is also known as the Panchayati Raj Act. The main aim of this act was to decentralise powers to Gram Panchayats in management of village level administration. The Guidelines on Village Level Disaster Management Plans by National Disaster Management Authority, lays down guidelines for village level functionaries in developing village level plans for multi-hazard scenario, taking into consideration various contingencies and responding to such contingencies. In this paper the response by field functionaries at Gangabada Gram Panchayat, Gajpati Tehsil, level in mitigating an incident of School Building wall collapse and not only that but ensuring "Business Continuity" in shortest possible time is an example of thorough preparedness at grass root level.

2. Profile of Gangabada Village, Rayagada Block in Gajapati district

Gangabada village, in Rayagada Block in Gajapati district is one the disaster prone district in Odisha, in past the district has been witnessing multiple disaster like –

landslide, cyclone, and forest fire, heavy rain, Flash Floods and Landslides. More than 60 percent of land mass is situated in hilly terrain and high lands and enjoys annual rainfall o1403.03 mm. Loss of lives and damage to livelihood, property, infrastructure and public utilities are the result of disaster for which we need to have a better preparedness and response at all level with the available resources. With an aim to protect the life and property of the people. Gangabada is one of the highly vulnerable GP due to its geographical location as the Gram Panchayat stands surrounded by hills and mountains. In 2018 a total of 46 people died in Gangabada Gram Panchayat due to landslide caused due to severe impact of cyclonic storm TITILI.

Fig-1: Location of Gangabada Village

Fig-2: UGHS (Upper Gradation High School) in Gangabada Village

3. School Building Tragedy

Due to incessant rain from 18th September 2023 morning to till 19th =September 2023 evening the UGHS (Upper Gradation High School) wall of Boys Hostel collapsed in Gangabada Village of Rayagada block. The incident occurred at around 4:00 PM when there were no students present inside hostel as few students were out due to Ganesh Chaturthi festival.

4. Response by Field Functionaries

The Hon'ble Supreme Court vide orders of dated 14.08.2017 in WP(C) 483/2004, directs vide letter no 2437/2004/SC/PIL/(WRIT) dt. 23.08.2017 that the School Safety Policy (SSP) 2016 guidelines issued by NDMA are statutory in nature and shall be implemented in letter and spirit by all concerned authorities for all schools. Accordingly, as per State Government directives a detailed School Safety plans were prepared in consultation with all stakeholders and disseminated to all concerned.

On receiving the intimation of Wall Collapse of boy's hostel of UGHS School. The response mechanism (immediate responders) to include field functionaries

comprising of The Panchayat Executive Officer (PEO), Head Master, MBK–OLM, PRI members got activated. Since the days were of Ganesh Chaturthi celebrations and students being local (within 4 to 5 km radius), there was no physical damage.

Immediately after the incidents the field functionaries took timely decision to shift hostel students to the newly constructed Multipurpose Cyclone Shelter. The higher authorities i.e., Rayagad Block administration, was apprised and confirmation obtained. The Panchayat Executive Officer (PEO), Head Master, MBK–OLM, PRI members distributed responsibilities and relocated the students from collapsed site to safe shelter. Rayagada Block administration closely monitored the shifting progress.

Fig-3: Hostel Block of UGHS (Upper Gradation High School) and the collapsed wall in Gangabada Village

5. Relief and Rehabilitation

BDO–Rayagada also inquired about the matter and instructed local PEO/ GRS and other staffs for all round safety and security of the students to be alert in 24x7 to tackle any untoward situation without further delay also appraise the district administration. PEO & HM arranged cooked food & snacks for the students immediately with water basic sanitation arrangement at shelter points. Cots, Beds sleeping mattress were arranged for the students. Local Line Department Officers coordinated with the Electrical Department to supply on priority electricity to cyclone shelter. The power supply was connected to shelter building so that students could read and write in night. On temporary basis one care taker engaged by the local authority to monitor the student's mobility and discipline.

6. Appreciation

Sub Collector, Paralakhemundi visited the school and multipurpose cyclone shelter to take the stock of the situation. Appreciated the great effort of the

field functionaries and personally congratulated Mr. Jayasena Parichha, PEO –Gangabada PEO –Gangabada and Mr. Ram Babu, Head Master, Upper Gradation High School. Collector & District Magistrate of Gajapati, was taking periodic review of the situation and expressed his deep satisfaction on timely interventions by the field functionaries.

7. Conclusion

The paradigm Shift in the approach towards DM, lay emphasis on preparedness. In Gangabada incident the pre activities undertaken by the field functionaries of Gangabada village, helped in expediting mitigation activities in more systematic manner. The incident was related to school children and to ensure that student's day to day activities are not jeopardised, the decision making by field functionary to shift them in Cyclone Shelter ensured the principle of "Business Continuity". Now students are safely staying at Multipurpose Cyclone shelter and attending the class on regular basis.

Application of Science and Technology in Disaster Management

Paras Nath Rai, IPS (retd.)

Abstract

India due to its geological location is highly vulnerable to various natural, manmade and human-induced disasters. The recurrence of these disasters, is creating havoc with the lives of people, livelihood and causing immense damage to critical infrastructure as well as public and private property. Significant progress has been made towards providing early warnings with enough lead-time about the impending extreme weather events like Cyclone, Floods, Heatwaves, Cold wave, Forest Fires, etc., facilitating timely effective response and minimizing loss of life. However, such technologies and practices are yet to be implemented by the authorities on a wide scale and adopted by the community. There are several new tools available within the country itself that could be employed for disaster management. The field-level responders need to be made aware of such tools and provide hands-on training so that they can make use as and when necessary.

Key words: Early Warning system, National Building Code 2016, Remote Sensing, Geographic Information System, Cell on Wheels

1. Introduction: Disaster Profile –Indian Scenario

India is highly vulnerable to various natural and human-induced disasters. About 85% of the geographical area of the country is vulnerable to one or the other disaster, wherein natural disasters, both geological and hydro-meteorological are dominant and recurring. Nearly 58 % of the geographical area of the country is prone to earthquakes, 12% vulnerable to landslides, 12 % to floods and erosion. As large as 68 % of the cultivable area is vulnerable to Drought, a creeping hydro-meteorological hazard. It is also very important to note that, in some regions, both floods and drought have been occurring simultaneously during the same season. For instance, northern districts of Bihar are subjected to severe floods and southern districts are prone to Drought. Similarly, many districts in North Interior Karnataka are subjected to both Drought and Flood within the same season.

About 7500 Km of India's coastline which includes the east and west coast of the mainland, Lakshadweep Islands, Andaman, and the Nicobar Islands is prone

to cyclones, storm surges, coastal erosion, and tsunamis. Especially, the states bordering the east coast of India viz. Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal are highly vulnerable to severe tropical cyclones. Phailin (2013), Hudhud (2014), Amphan (2020) are some of the major cyclones that hit the east coast of India in the last decade. The recurring genesis of cyclones in the Arabian Sea in recent years has renewed the concern of cyclone risk on the west coast of India as well. The coastal districts of India are also vulnerable to Tsunami and experienced a devastating Tsunami triggered by a Sumatra-Andaman Earthquake in 2004.

The mountainous region in the Western Ghats, Eastern Ghats, and the Himalayas are highly vulnerable to landslides. High intensity and heavy rainfall are some of the key triggering factors for these landslides. The Himalayan range is prone to avalanches.

The recurrence of extreme weather events, attributed to global warming/ Climate Change, is creating havoc with the lives of people, livelihood and causing immense damage to critical infrastructure as well as public and private property. The Ministry of Home Affairs, the nodal ministry of the Government of India for Disaster Management, has informed the parliament that 1045 people lost their lives in 2019 alone due to the adverse impact of extreme climate.

Extreme weather events have caused flash floods in hitherto unknown areas in addition to existing vulnerable areas. Kerala flood in 2018 is one such example. Kerala witnessed such devastating floods after about 100 years. Similarly, flash floods in 2017 in Araria and the Kishanganj districts of Bihar cost 514 lives. In 2019, Maharashtra, Karnataka experienced record-breaking rainfall in a short period causing huge damage to infrastructure, crops, housing, and loss of livelihood. 243 people died in Bihar 2019 flood. The cyclone Fani in Odisha was the worst disaster in 2019. Even though the human casualty remained low due to proactive preparedness supported with a good early warning, there was a huge loss of livelihood and infrastructure.

Heatwave is yet another Hydro-Meteorological Hazard causing loss of human lives and livestock. For instance, more than 100 people died due to Heatwave in three districts viz. Aurangabad, Gaya & Nawada of Bihar in 2019. The extreme heatwave resulted in an acute shortage of water was observed in many states across the country. The surface water bodies were dry and as the groundwater levels also were depleted to the lowest level, the hand pumps were also not yielding any more water. As a mitigation measure, special Trains were operated for supplying water to the Heatwave affected states. Subsequently, the water was supplied to the people in the villages through smaller water tanker vehicles. Such a grave

water crisis compelled the Government of India and State Governments to take ambitious water conservation programs, on mission mode. While the Government of Bihar started implementing a program named "***Jal, Jeevan and Haryali***" the Government of India constituted a separate ministry "***Jal Sakti Mantrayala***" to ensure a safe and adequate water supply to the people, especially in the rural areas.

2. Early Warning Measures

Significant progress has been made towards providing early warnings with enough lead-time about the impending extreme weather events like Cyclone, Floods, Heatwaves, Cold wave, Forest Fires, etc., facilitating timely effective response and minimizing loss of life. For example, as a consequence of early warning reaching the local administration and the vulnerable community much before the event, the death toll was relatively minimal (only 46 lives were lost) during severe cyclone Fani in Odisha in 2019, whereas about 2 decades earlier i.e., in 1999 several thousands of lives were lost due to the impact of a super cyclone in the same region.

New technologies have been developed for enhancing energy and water efficiency/conservation in irrigation and for promoting resilient agriculture to withstand the impact of drought or any other adverse weather condition and protect the livelihood of the farming community. However, such technologies and practices are yet to be implemented by the authorities on a wide scale and adopted by the community.

Similarly, tremendous progress has been made in developing disaster resilient technologies for the construction of safe houses and various types of critical infrastructure, which can significantly reduce the damage and losses. However, there are formidable challenges in the implementation of standards and specifications of such technology-driven codes including the National Building Code 2016.

The COVID-19 Pandemic forced the authorities and researchers to explore and open new frontiers of research for effectively dealing with pandemics and epidemics and significantly reducing mortalities and disabilities through a robust health management system.

3. Holistic use of Technology in Management of Disasters

Although there are considerable advancements in developing science and technology-based tools and methodologies for mitigating the impact of various disasters, still there is a long way to go in harvesting the optimal potential of

science and technology and also reaching the benefit of the same to the disaster vulnerable community at last-mile.

Thus, given the prevailing scenario and prognosis of not so bright future, it is of vital importance to optimise the application of scientific and technological capabilities to understand, reduce and effectively manage disasters. There are several new tools available within the country itself that could be employed for disaster management. The field-level responders need to be made aware of such tools and provide hands-on training so that they can make use as and when necessary. Further, policymakers, disaster managers, and the scientific community need to strive towards developing appropriate policies, S&T tools, and techniques to mitigate the impacts of disasters looming as a consequence of Climate Change. Such techniques and tools will facilitate the stakeholders to proactively address the Disaster Risk, instead of going for crisis management which is a reactive measure.

In this article, we have made an effort to provide a glimpse of Science and Technology based tools available in the country and their usefulness in all 4 phases of Disaster management viz. Preparedness, Response, Recovery, and Mitigation. The tools and techniques discussed have been effectively utilised by the authorities in some areas in the country and elsewhere.

4. Application of Global Positioning System (GPS)

The GPS is a satellite-based radio navigation system that provides information on geo-location with a time-stamp. It is used for providing real-time information of any location with high precision that can help in the management of any disaster whether during pre-disaster, during a disaster, or post-disaster. The GPS can be used for the following during any disaster:

- Geo-Tagging and Mapping any location on the earth-surface
- Navigation between multiple points
- Tracking resources and movement

Pre Disaster: GPS supports accurate mapping -from mountains and rivers to streets and buildings to utility lines and other resources. The data obtained through GPS can be populated on a GIS platform which enables the users to store the data, generate customised maps with different layers, and provide real-time display through a dashboard. Accurately Mapping disaster-prone areas using GPS will be extremely helpful for responders at all administrative levels in planning and implementing appropriate measures of preparedness, prevention, response, and mitigation. The state and District level Disaster Management Plan based on

the Geo-tagged resource data will guide the field officers to manage the disasters effectively.

During Disaster: The GPS can play a critical role in any rescue operation and its success. The district administration and each department working at the district level and down below should get its resources mapped and geo-tagged so that they can be located and used with ease and quickly. Real-time access to Geo-tagged resource data helps in the allocation and re-allocation of resources based on the need on the ground. For example, the places and the approach roots of the places identified to be utilised as the relief camps in flood vulnerable areas should be Geo-tagged and data made available through a real-time dashboard to the field officers at all levels.

- An important application of GPS during disaster management is the tracking of emergency vehicles or resources/supplies. GPS can facilitate the movement of first responders including police, fire, specialised rescue forces NDRF and SDRF, and vehicles of other departments and agencies involved in the management of the event. State-of-Art GPS facility in the boats would be of great help in navigating and reaching the right place without wasting time ferreting around. Location information provided by GPS, coupled with automation reduces delay in the dispatch/response of emergency services. Thus, the DM managers are advised to equip vehicles used during disasters with GPS for efficient operation.
- The GPS has played a vital role in relief efforts during major disasters such as the tsunami that struck in the Indian Ocean region in 2004, the Pakistan-India earthquake in 2005, etc. Search and rescue teams used GPS, Geographic Information System (GIS), and remote sensing technology to map disaster-affected areas which helped during rescue and aid operations, as well as to assess the damage.

Post disaster: The GPS has played a vital role in relief efforts during major disasters such as the tsunami that struck in the Indian Ocean region in 2004, the Pakistan-India earthquake in 2005, etc. Search and rescue teams used GPS, Geographic Information System (GIS), and remote sensing technology to map disaster-affected areas which helped during rescue and aid operations, as well as to assess the damage.

Command and Control: Enabling GPS in every mobile phone empowers the user with an emergency location capability. The Control and Command Center (CCC) can easily monitor every GPS point, track, communication, and command. In India, as almost 50% of mobile phones are GPS enabled, they can be used to

communicate area-specific Alerts, Early warnings, Advisories and also use to track individuals struck in unknown terrains and guide the rescue team to reach and evacuate them. As the mobile operators can easily provide the numbers and location of mobile users before, during, and after a disaster, such data can be used in carrying out a preliminary assessment of affected people and also for Post-Disaster Need Assessment (PDNA).

GPS was successfully used during Kosi Floods 2008 (Bihar). Some of the areas were not accessible either by road or boat. The DM authorities were not able to carry out rescue and relief there. So, Chetak helicopters equipped with GPS were used for locating, identifying, and mapping the marooned areas where people were stranded and rescuing them safely.

5. RS and GIS (Remote Sensing and Geographic Information System)

Map of a geographic area has been of great importance for strategic decisions making since the early days. After a physical survey, the data sets were used to generate maps showing different and important features on the surface, contours are drawn to help users to understand the morphological and other features of the area of their importance. It was a cumbersome process and time-consuming as well. Now in the era of science and technology,

Fig 1: Elements of GIS (Source: GIS Geography)

Remote sensing (RS) and GIS has emerged as popular tool for generating customised maps in digital format compatible to be used for many purposes. Large datasets can be processed and high-resolution maps can be generated with

ease and fast. Different layers of maps depicting various types of attribute data sets can be generated using GIS applications.

Further, the data generated through Remote Sensing (RS) platforms viz. Satellites, Aircraft, Unmanned Arial Vehicles (UAVs), Drones, etc., can also be processed, derive various information or indices, and generate maps customised to the user requirements. The significant feature of Remote Sensing data is its spatial-, temporal- and spectral resolution. Once such data is generated, the GIS enables the integration of already available field observation with those derived from remote sensing (RS) and other ancillary information to arrive at an appropriate decision in the management of disasters. It is used to generate various Vulnerability and Hazard maps, resource maps, etc. Vulnerability Atlas of India has been prepared using RS-GIS. The use of RS-GIS during various phases of DM are as under:

- The satellites can detect the early stages of disasters as images are available at regular short time intervals, and can be used for the prediction of both rapid and slow disasters such as floods, drought, cyclones, etc.
- Remote sensing also allows monitoring the event during the emergent, peak, and subsiding stages. The vantage position of satellites makes it ideal for us to think of, plan for, and operationally monitor the event. RS-GIS is used as a tool for the planning of evacuation routes, designing centers for emergency operations, and designing disaster early warning systems.
- In the disaster ***Relief phase***, GIS is extremely useful in combination with Global Positioning Systems (GPS) in search and rescue operations in areas that have been devastated and where it is difficult to orientate.
- During the ***Rehabilitation phase***, the RS-GIS is used to map the new situation and update the databases used for the reconstruction of an area, and can help to prevent such a disaster occurs again.
- In ***Prevention/mitigation phase*** also the RS-GIS helps in the evaluation of one or more hazards in an area, compute and develop risk scenarios and estimate the extent of impact and damage. Such information helps in decision-making in accordance with developing scenarios and future, and also the optimum way to mitigate the impact

6. Use of Drones in Disaster Management

Besides satellites imagery, unmanned aerial vehicles popularly known as Drones are new means of imagery. Even though drones are often seen now being used in certain places for specific purposes like surveillance during major public gatherings with potential law and order problems, they have huge potential to

be used for other purposes as well. The UAVs can be used for identifying and mapping private assets- houses and lands for fixing ownership, earmarking places of strategic importance, surveying areas for developing critical infrastructure, and also periodically assessing their condition. Drones can be extremely useful in damages assessment after disasters like Drought, floods, landslides, Earthquakes, Tsunamis, etc.

As the drones are remotely operated and have a stable platform to capture unambiguous data, they are useful in mapping even the toughest terrains with almost spatial-, temporal- and spectral resolution with minimum annual intervention and within a short period. Thus, such data enables the administration to quickly assess the damage, identify the affected people, and disburse the relief or compensation swiftly thereby installing confidence in the affected community about the timely support.

Drones were successfully used during gas leakage in Vishakhapatnam in May 2020 for communicating and assuring the people that the leakage has stopped since rumors had spread that it has not stopped. It was used for mapping the area to know the spread of the gas in the neighborhood. Drones paired with high-definition cameras work together with gas sensors to provide real-time images and videos. Some advanced drones with reporting will also show the leaked gas concentration and GPS coordinates of the leakage. This enables the teams to identify areas with gas presence and even estimate the levels and rate of emission. Adding other technologies such as infrared thermal imaging enhances the gas detection capability, hence the ability to identify and reduce leakages. Drones are being designed in our own country and are easily available, not too costly. Hence, they can be procured and used at all levels. Drones can even supply equipment to critical places.

Following are some more hazard-specific examples of the direct utility of the above-mentioned Science and Technology based tools and techniques.

7. Crisis Communication

Communication Cell on wheels (COW) is being used by NDRF and some others to restore communication in the disaster-affected area where communication was disrupted due to the breakdown of mobile towers and cable/fiber networks. This means of restoring emergency communication has been highly successful. Each response agency and relevant departments such as energy, roads, food, etc. could also procure them. Mobile telecoms too have maintained an inventory of COWs that are pressed in service whenever normal channels fail.

8. Disaster specific Applications of Technology

8.1 Earthquake: Different regions of our country have different levels of vulnerability to earthquakes. If the earthquake occurs in a seismic zone IV or V

and that too in habited areas, it may cause many deaths of people and livestock, injure a large number of people, and extensive damage to critical infrastructure, public and private property. Though satellite-based remote sensing does not play a major operational role in the management of earthquakes, it can play a role in the mapping of lineaments and faults. The most important data for seismic hazard zonation is derived from seismic monitoring sensors network data. Zonation helps to identify potentially dangerous areas in advance such that required structural design to withstand the impact of an earthquake can be done.

Hazard mapping is the most important utility of GIS. Information of proneness of an area can help to develop earthquake and wind-resistant houses, bridges, etc. and organize proper community response. The details of building height, densely populated areas, roads, etc. will help in evacuation planning, damage assessment in the shortest time. Below is given a 2014 USGS National Seismic Hazard Map, displaying the intensity of potential ground shaking from an earthquake in 50 years (which is the typical lifetime of a building).

Although earthquake prediction is still not possible, we can apply the scientific knowledge and technical know-how that we inform the people in the vulnerable areas which are likely to be affected in advance to help them preventive action. Bihar is establishing a telemetry network (BSTN) with 10 stations in earthquake-prone districts, especially along with the Himalayan ranges and a central receiving station on the Patna University campus which will provide information on local, regional, and teleseismic activities. A network of Earthquake alert systems can also be established for providing early warning, based on the micro-seismic activity data. Remote sensing is useful for post-earthquake damage assessment in improved spatial and temporal resolution also.

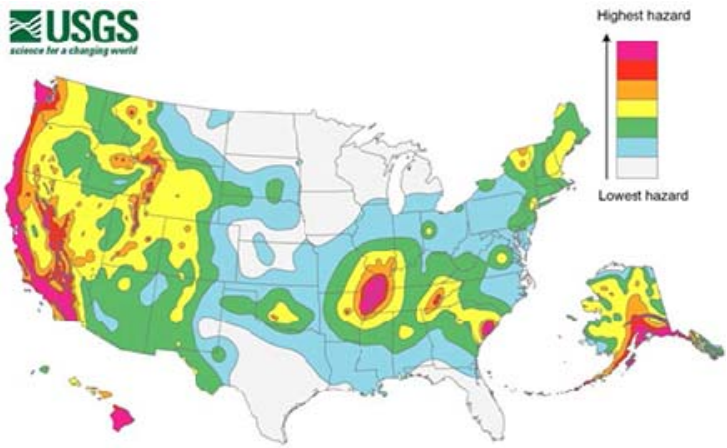

Fig. 2: National Seismic Hazard Map, displaying the intensity of potential ground shaking from an earthquake in

50 years (which is the typical lifetime of a building) (Source: USGS, 2014)

8.2 Flood: District administration can use GIS technology very effectively in flood management at every stage. They can have the map of flood-prone areas which can be part of the District Disaster Management Plan (DDMP) and the SOPs for responding to floods. Attribute data depicted in the map gives sufficient information for decision-making authorities to take the right decision proactively for mitigation, preparedness, response, recovery, etc. This along with historical data on flooding will help prepare a rescue/response plan for the likely affected population. Prior geo-tagging of relief camps & cattle camps sites, approach-roads for movement of necessary resources can also be done with this. When the boats and rescue vehicles are equipped with GPS, rescue and relief personnel will have easy access to the affected area and relief camps and carry out necessary operations effectively. Guided by the Satellite imagery, helicopters working for relief operations, locate appropriate places within marooned areas for dropping food and other essential supplies. NDRF and SDRF and other boats deployed by the District/Block/Taluk administration should be enabled with GPS etc to facilitate a quick and effective response.

8.2 Drought: GIS technology is extremely useful for drought management. With the help of such data and forecast regarding rainfall, suitable steps can be initiated in any district before the situation become critical. GIS can provide a block/taluk/panchayat-wise map of groundwater level in any district. Central Ground Water Commission provides such data for groundwater. Concerned authorities from agriculture and related field, water supply, and animal husbandry departments can take help of such data to monitor the position of groundwater and in case it is seen to be depleting to undesirable levels they can initiate mitigation measures including:

- Provision of seeds for contingency crop, support for private pumping stations overcome drought impact.
- Provision of diesel subsidy in Bihar.
- Activation of animal shelter camps with the fodder and water facility.
- Arrangement of fodder.
- Arrangement for water supply as hand pumps and other sources dry up.
- Drinking water supply to the affected villages through water tankers.

Geotagging of all waterbodies viz. ponds, wells, and other water sources and shelters for human and livestock, etc district administration can use the same in the most optimized and organized way.

8.3 Cyclone: Satellite imagery, sensors have been very effective in providing accurate and timely information/forecast of meteorological events. The people responsible for the management of cyclone Fani knew much in advance as to where cyclone Fani will make landfall and at what speed. This was of great help in planning and organizing response activities much in time as a result the death count was minimal as compared to previous cyclones. This was due to accurate data from IMD. Satellite imagery, airborne radar provided a real-time, etc. 3D map of blocked roads, felled trees, electric poles, etc which facilitated the NDRF and ODRF and other agencies to engage in the clearance of roads on a priority basis i.e. clear those first which required for rescue and relief work.

8.4 Fire: The Digital map of the district, especially highly vulnerable areas, is of immense help in mitigation and response. Fire services can determine different areas as per the degree of vulnerability and prepare management plans accordingly. E.g. areas with high-rise buildings, areas with narrow streets, petrol pumps, slums with houses made of fire susceptible material, etc. can be identified as high-risk areas. Many a time, fire tenders are not able to reach fire incidents in time as the firemen are not familiar with the area and routes, etc. Mapping supported by GPS-enabled tenders and GPS-enabled mobile phones can be a great asset to support operations. The fire tenders would be able to reach the incident in time. Geo-tagging of available water sources (pond, well, river, tank, etc) of the whole area on the map would make firefighting more effective. Besides this, the information regarding the direction of wind blow can also be taken from the weather data and the same can also be utilized for effective firefighting. The Fire services should take advantage of weather information - dryness of air and direction of the wind.

9. Weather Forecast Technology (Indian Meteorological Department)

It is very important to note that the "weather" is foremost amongst all the factors that influence Sustainable development. It is the most common and important factor which directly or indirectly influences the intrinsic feature of many SDGs. For instance, extreme weather adversely impacts food security, food price volatility, health, critical infrastructure, etc. The favourable weather condition is an advantage for sustainable development but the vagaries of weather hamper the development process.

Many countries across the world have observed over the years that weather-related (Hydro-Meteorological) Disasters are a threat to sustainable development. These natural disasters diminish the gain in development and also disrupt the development momentum as scarce resources are diverted towards relief and

reconstruction activity, thereby increasing the vulnerability of the community which is already in peril.

Drought, Flood, Cyclone, Heatwave, Coldwave, Thunderstorm & Lightning, Coastal erosion, and Sea level rise are some of the major Hydro-Meteorological hazards impeding the development of society across the world. Further, there has been a sharp rise in the number of these natural disasters, which has been attributed to Climate change in recent decades.

International Panel on Climate Change Working Group II report suggests that extreme weather events are likely to recur often and be severe, particularly on regional and local scales (IPCC 2021). Consequently, devastating weather phenomena like successive droughts, torrential rainfall associated with lightning strikes, hailstorms, strong surface winds, and intense vertical wind shear are to increase and cause loss of life and property. As a mitigation measure, it has been recommended to plan and implement monitoring systems and sector-oriented early warning systems for the communities at risk. Therefore, the stakeholders of development should focus on preparedness to mitigate the impact of these weather-related natural hazards. It is highly essential to develop and strengthen Early Warning System (EWS). Timely and effective warnings and their wide dissemination will help in creating a safer community.

India Meteorology Department (IMD) has a wide range of products that provide very useful information, forecast, and early warning about impending extreme weather events. The "Nowcast" provides a warning on 3 hourly formats about thunderstorm lightning, hailstorm, and heavy rainfall. Even longer assessment -weekly and fortnightly is also available for management of likely events including mitigation. For instance, in the event of likely flood situation concerned departments such as agriculture, etc can start processes of arranging necessary material for a suitable alternative crop, and related advisory to people. Public health-related agencies can start looking at water sources and how to arrange safe potable water if and when floods come, mitigating water-borne diseases.

However, the existing spatial resolution and clarity of information are not sufficient enough to make an intended impact on the ground. As weather parameters, especially the spatial and temporal distribution of rainfall is highly variable in tropical sub-tropical countries like India, the weather monitoring and forecasting mechanism also should be prepared with matching resolution.

Thus, by sensing the need, the Government of Bihar is establishing an institutional mechanism, with the following facilities for providing improvised weather services with high impact potential.

- A dense network of weather monitoring stations up to panchayath level for collecting high spatial and temporal resolution weather data
- A system for generating mesoscale weather forecast, especially rainfall forecast up to Panchayath level.

- A robust information dissemination system with last-mile connectivity for providing weather-related information, forecast, early warning with related advisories directly to the vulnerable community.

The above-mention system of data collection, processing, analysis, report generation, and dissemination is associated with remote sensing data and the entire process is carried out on the GIS platform. Observed Rainfall data in conjunction with the forecast in flood-prone areas can help them to take the right decision at right time including the generation of early warnings to people. This may help in smooth evacuation and accommodation of humans & livestock besides optimized use of resources in the most organized way with minimum loss of life and property

10. Information dissemination

Social media like WhatsApp, Facebook, Twitter we need to look at establishing visual communication from the incident site so that decision-makers at the district/state level are in a position to decide strategy and tactics. Now popular web-based applications such as ZOOM, Webex, Google team, etc. can be handy in establishing video footage from the scene of the incident to decision-makers.

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11. Use of Information and Communication Technology

People tracking applications have been developed. Arogya Setu is being used for tracking corona-affected persons in the country. Arogya setu is a good example of information technology. It can give information on hot spot areas and help prepare containment plans etc About 1 crore Indians have registered in the application. Similar people tracking systems like Google tracking system- Google people finder is available. China used color-coded tracking was used to locate corona-positive persons and alert others close by. This was highly successful in containing the virus spread. Such applications can be used to segregate corona-positive people in flood-affected areas and therefore ensure safe evacuation and relief activities. All frontline responders especially civil administration, police, fire services, medical and specialized forces must join Arogya Setu.

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Mass messaging: Mass messaging is now widely used during the pre-disaster phase to sensitize people and make them aware/ready for the disaster. Based on the information available through IMD, RS-GIS, and other sources, different stages of disaster can be predicted and required information can be disseminated to the right people before the disaster. Even during and after the disaster, it can be used to make affected people aware of various government measures.

The above instances of actual application of technological tools indicate that technology can be an efficiency multiplier. Besides this use of the Internet of Things (IoT) and Data Analytics also add flavor in enhancing capabilities for disaster management.

12. Conclusion

Technology can certainly be a game-changer in building resilience and capabilities for the management of disasters. However, this would require dissemination of knowledge and availability of such technology among all including policymakers at the state level and actual frontline responders at district and below.

Of course, it also requires synergy between scientists and responders including policymakers for the transfer of technologies. The nation as a whole and states in particular also require making enhanced investments in fundamental and applied research for the development of new technologies of dealing with the existing and emerging risks of disasters. The Covid-19 has thrown up tremendous challenges to humanity. As of now, there are many technologies available in the country which can be used for the management of disasters. There is an urgent need to sensitize all stakeholders including policymakers and those responding to actual disasters on a day-to-day basis.

Effective Role of Administration in Disaster Management: A Case Study of Flood in District Udham Singh Nagar, Uttarakhand

Yugal Kishor Pant, IAS,*
Lalit Narayan Mishra, Umashankar Negi and Vineet Pal

Abstract

Flood has been considered as the most intermittent and frequent disaster. Due to its intermittent prevalence, the loss of life and economic loss caused by it has taken a toll than any other disaster. Floods incidents have been increasing due to climate change, cloud burst, poor river management and silting etc. As the natural disaster cannot be prevented measures need to be taken to reduce the extent of damage. Disaster management has a very organized structure of programme and policies that help in mitigation, preparedness, recovery and rehabilitation of any type of disaster. It was on 19-10-2021 when post monsoon rains started the district had a phenomenal increase in the percentage of rainfall in last 24hrs from 40.5% (18-10-2021) to 185% (19-10-2021) which has led to flooding in the district Udham Singh Nagar. This case study is an analysis of the trend and preparedness measures by team of administration taken during the flood Situation.

Key words: Early Warning, intermittent, prevalence, mitigation, preparedness, recovery, rehabilitation.

1. Introduction

Udham Singh Nagar is a district of Uttarakhand state and part of kumaon division. With major industrial, religious places and dams, the district has blossomed as a multihued city of India. The district of Udham Singh Nagar was established on September 29, 1995 before the district was a part of Nainital. The district touches 5 district of Uttar Pradesh (Bijnor, Bareilly, Pilibhit, Rampur, Moradabad and Champawat) and international border with Nepal. The district is named after the great liberator of the freedom struggle Saheed Udham Singh.

2. Administrative Division and Area

The geographical area of Udham Singh Nagar district is 2542 sq. km. The length of the district from east to west is 170 km and from north to south is 29 km.

According to the 2011 census, the population was 16, 48,367(8, 58,906 males and 7, 89,461 females), with a literacy rate of 65.73 percent. The current estimated population is 21,43,572.On the basis of the statistical assessment for the year 2018-19, the agricultural area under the district is 2,802,269 ha, the forest area is 93,837 ha, and barren land is 3720 ha, while the length of canals is 1020 km.

There are 8 Tehsils, 1 Sub Tehsil, 07 Development Blocks, 27 Nayay Panchayats, 375 revenue Villages, 02 Municipal Corporations, 07 Nagar Palika Parishads, and 07 Nagar Panchayats in the district, and 2 Nagar Panchayats have been formed in the hall itself.

3. Climate and Rainfall

The highest temperature in the district is 40.8°C, and the minimum temperature is 1.7°C. Whereas the average rainfall in the district is 267.65 mm in the month of 2021-22 in the month of July, 234.63 mm in the month of August, 30.44 mm in the month of September and 263.75 mm in the month of October.

4. Social and Economic Scenarios

People of the Tharu and Buxa tribes live together in this district, apart from Hindus, Muslims, Sikhs, Christians, Bengalis, Kumaoni, Garhwali, Punjabi and Purvanchal. Not only does the state of Uttarakhand have a record production of paddy, wheat, and sugarcane, but it has always been at the forefront of strengthening the country's economy. Along with the Green Revolution, progressive farmers and livestock farmers have set new records in agriculture, animal husbandry, and milk business for the White Revolution. This district is also the major industrial and business management district of Uttarakhand.

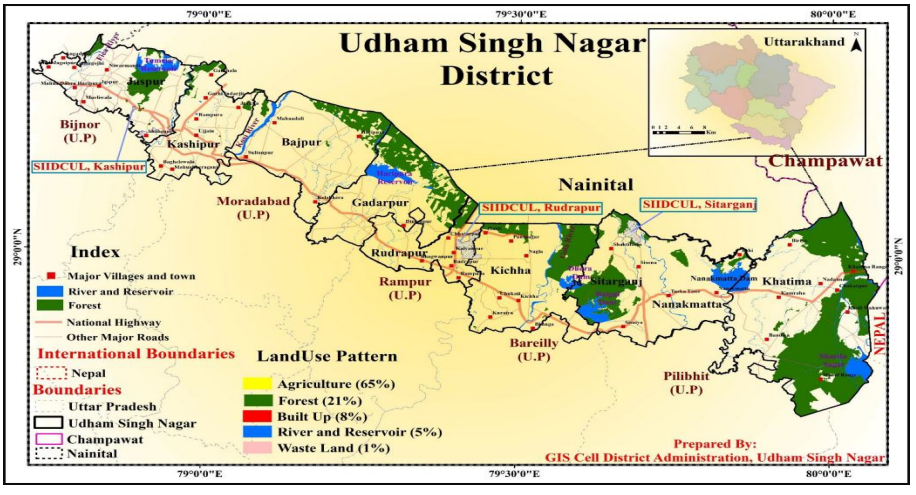


Fig.1. District Map of Udham Singh Nagar

5. Methodology

Quick Response Mechanism: In case of a disaster, the employees/officers working in various departments will be under the direct control of the District Magistrate during the relief work and will follow all the instructions given with immediate effect. The staff of important departments will also be attached to the District Officer for relief works as above, e.g., Zilla Parishad, Municipality, Electricity Board, Water Corporation, Water Institute, Public Works Department, State Road Transport Corporation/Transport Company, Irrigation Department, Supply Department, Medical Department, and other necessary departments.

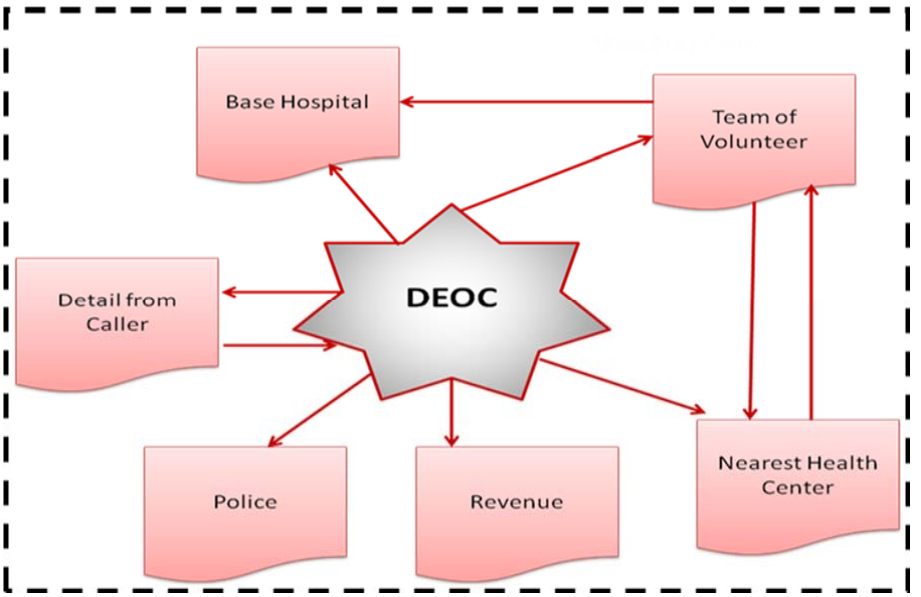


Fig. 2: Quick Response Mechanism

Sensitive to the disasters of the district and in view of the danger, the relevant sections of the Disaster Management Act-2005 to carry out the tasks of disaster management by establishing the highest coordination among various departments in the search and rescue, relief and rehabilitation works after the disaster at the time of the disaster. To deal with disasters at the district level, the incident response system has been constituted, in which the officers of the district have been appointed as Chief Operation Officer, Chief Planning Officer, Chief Logistic Officer, Chief Service Officer, and Chief Finance Officer for disasters at the field level. Better disaster management will be accomplished by performing various tasks, for which the roles of various officers at the district level have been prepared as shown in the table below:

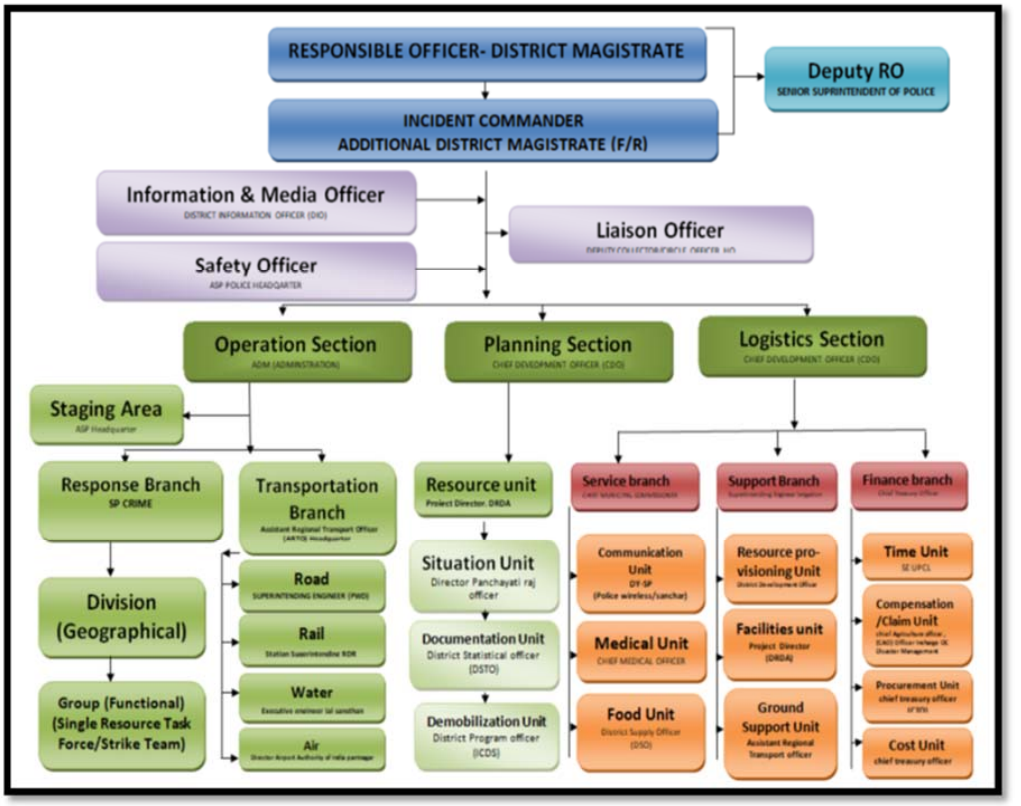


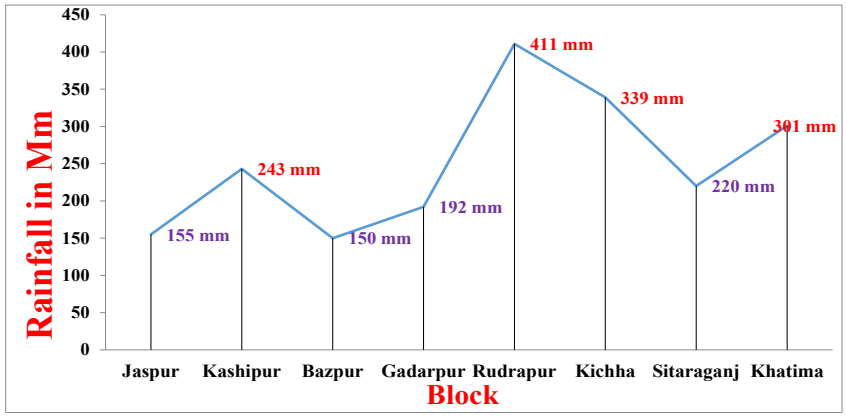
Fig. 3: Incident Response System (Work Flow Chart)

The primary causes of excessive rainfall and flooding in the district on October 18th and 19th, 2021: District Udham Singh Nagar is an agricultural, industrial, and business-oriented district situated between the Shivalik mountain range and the special geographical belt of Terai Bhabar between the plains of the Ganges. There is an abundance of rivers, ponds, and reservoirs/dams due to unorganised loamy soil and shallow underground water levels, and the district has been sensitive to water logging. But such situations have often arisen during the monsoon period in the previous years. Due to western disturbances in the month of October, 2021, during the 24 hours on October 18th and 19th, 2021, Rudrapur received 366 mm of rainfall, which was the highest rainfall in the history of the district. The details of the rainfall in the district, including the above, are as follow0s:

Table 1: Rainfall from 17/10/2021 to 20/10/2021

Date	17/10/2021	18/10/2021	19/10/2021	20/10/2021	Total Rain
Jaspur	0	25	125	5	155
Kashipur	0	70	166	7	**243**
Bazpur	0	40	110	0	150
Gadarpur	0	20	172	0	192
Rudrapur	0	45	366	0	**411**
Kichha	0	75	260	4	**339**
Sitaraganj	0	49	154	17	**220**
Khatima	0	83	127	91	**301**

Graph 1: Rainfall Trend 17/10/2021 to 20/10/2021



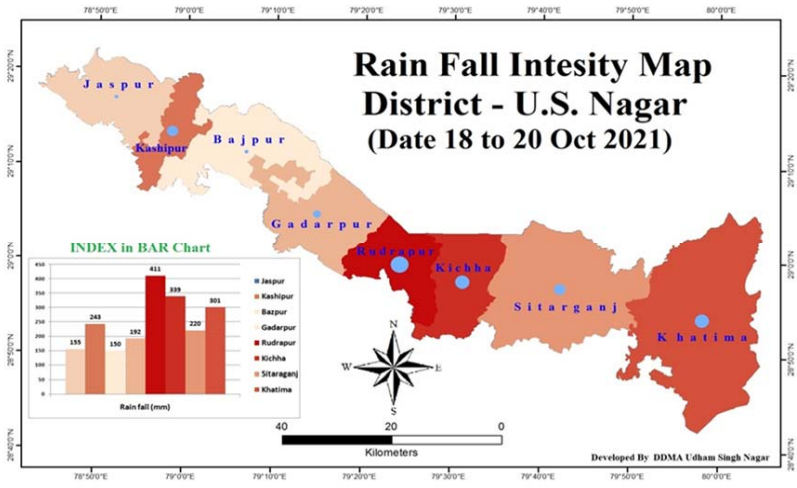


Fig. 4: Rainfall intensity map of District Udham Singh Nagar (18-20 October, 2021)

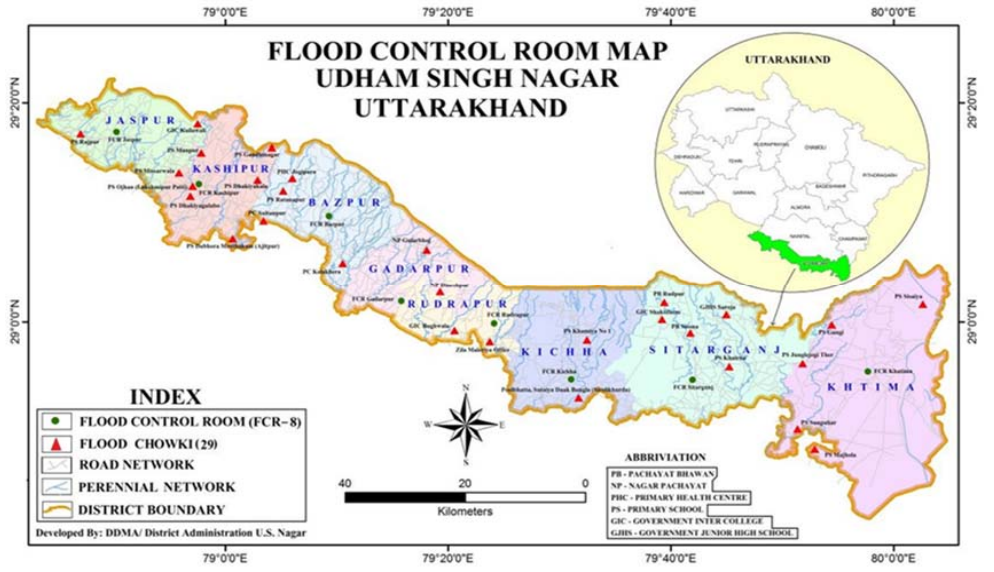


Fig. 4: Flood Control Room Map of District Udham Singh Nagar

6. Action Taken for Prevention, Mitigation and Restoration

S. No	Action Duration	Action Taken
01	Prior to Rainfall (17 Oct 2021)	**01**-Warning received from Meteorological Department Dehradun was disseminated in important district level investigation and through email and communication medium, all district level officers were informed for pre-preparation district emergency operations accordingly. The centre and the police control room remained active. **02**-Keeping in view the weather forecast, a holiday has been declared for students from classes 01 to 12 of all government, semi-government, and government-aided private schools through the office **03**-In view of the possible waterlogging, the District Supply Officer was directed to check the availability of food items, petrol, diesel, etc. Similarly, instructions were issued to the Chief Medical Officer, Udham Singh Nagar, to maintain the entire health system. **04**- Instructions have been issued to all Head of Office/Head of Department and all IRS nominated nodal officers of the district to keep mobile phones on and remain in the district headquarters. **05**- Officers has been deployed in the District Disaster Management Control Room on the lines of 24*7.

S. No	Action Duration	Action Taken
		06-In the meeting of the IRS system in the District Disaster Management Authority under the chairmanship of Madam District Magistrate, important instructions were given to the concerned officers, Public Works Department, Electricity Department, Irrigation Department, National Highways, Drinking Water Supply etc. departments with emergency management equipment with emergency responsibility. **07**-In-charges of paddy purchasing centers were instructed to take precautions and safety measures so that the work related to the purchase of paddy should not be affected in view of excessive rainfall. **08**-The Hon'ble Chief Minister, Uttarakhand, in the VC held under the chairmanship of the District Magistrate, was apprised of the possibility of disaster in the district and the present situation and preparedness, and all concerned were directed to be prepared and active to deal with the possible disaster.
02	During rainfall (18 to 20 Oct 2021)	**01**-In view of the unusual weather on October 1, 2021, the Chief Medical Officer /Chief Medical Superintendent and all the community centres in-charge, Udham Singh Nagar, were directed in order to that in the event of disaster, Ambulance and emergency medical arrangements should be made for management. **02**- Order directed the Chief Veterinary Officer, Udham Singh Nagar, for the safety and medical treatment of destitute animals and pets. **03**- Action has been taken in order to maintain immediate arrangements for the Agriculture Department, Horticulture, District Registrar, Co-operative Society, District Supply, District Panchayat, and Sugarcane Department etc. Instructions were given to send information and photographs to the District Control Room every hour. **04**-In view of the seriousness of the damage caused to the Commander, National Disaster Response Force (NDRF), 15th Corps, Gadarpur, Order 04**-** additional assistance to the VI Teams engaged in search and rescue operations It was requested to be provided by phone and letter.

S. No	Action Duration	Action Taken
		05-For the smooth operation of drainage and blocked roads under the district 3 teams were formed in order, through which the information about blocked roads was given to the disaster control room. **06**-In the order for distribution of food items in Bhutbangla, Jagatpura, and Mukherjee, Kheda and waterlogged areas, the duty of 20 officers with immediate effect was to put three water etc. **07**- Officer designated Airport Authority Pantnagar and Air Force for coordination/air operations in search and rescue operations. **08**- **11** relief centers were established in the district, in which nodal/in-charge officers were appointed for the successful operation of the relief centers. **09**-Letter of Request for providing additional assistance to NDRF was given and talks took place. **10**- Directions were issued to all telecom service provider firms by BSNL to keep the telephone lines and internet communication services active in the district.
03	After Rainfall (21 Oct 2021 and onward)	**1-** Prompt and effective action was taken by the IRS team already constituted at the district level on October 18th and 19th, 2021 to deal with the impact of the disaster in the relief and rescue work during the heavy rains on October 18th and 19th, 2021. I have 6 teams of 6th & 2nd teams of PAC, 2 teams of PAC, 2 teams of firefighters, 2150 police personnel, 22 teams of revenue and disaster, 17 teams of medical department, of municipal body, 21 teams and others (PRD/Home Guard), 13 teams that performed their responsibilities The affected people were evacuated from waterlogged areas to safer areas, and arrangements for food, medicine, etc. were made. **2-** Two-day and night meals were arranged for the affected people by the community kitchen. Nodal officers have been posted in the affected wards and sectors. In the waterlogged areas of urban and rural areas, instructions were given for the fogging and cleaning of drains to prevent mosquitoes and waterborne diseases. On site visit by Madam District Magistrate, Udham Singh Nagar, Superintendent of Police, Udham Singh Nagar, Chief Development Officer, Udham Singh Nagar, Additional District Magistrate, Udham Singh Nagar, other Deputy District Magistrates, Udham Singh Nagar, reviewed by Udham Singh Nagar.

S. No	Action Duration	Action Taken
		3- In this sequence, the Municipal Commissioner, Municipal Corporation, Rudrapur was authorized to bury the dead animals in the Tanda forest due to the danger of spreading diseases in the general public due to the animals that died due to water logging in the district. **4-**In view of public health in the affected areas, 19 medical teams and 13 veterinary teams were sent in view of the affected animals. A field visit to the disaster-affected areas was made by the central team in the district on October 22-23, 2021. The situation of the disaster and relief works were reviewed by the Hon'ble Union Minister of State, Defense, and Tourism, Shri Ajay Bhatt. **5-** Hon'ble Chief Minister, Uttarakhand, Hon'ble Minister in-charge, Hon'ble Education Minister, and Hon'ble MLAs visited the disaster affected areas and reviewed them. The District Magistrate, Udham Singh Nagar, on October 24, 2021, reviewed the relief work being done for the affected by heavy rains and water logging in the disaster control room with the officials of IRS and instructions for distribution of food grains and relief materials were provided. The Hon'ble Commissioner, Kumaon Division, Nainital has given instructions for survey and assessment of other extensive damage caused to the public due to the disaster. **06-** In view of public health in the affected areas, the number of medical teams has been increased to 20 from 19 and the number of veterinarians from 13 to 24. **07-** At present, according to SDRF standards, the payable amount has started to be distributed through checks to the families affected by heavy rains. For this, coordination was established with the banks. **08-**Assessment of damages related to departmental assets has been done. Further action is in progress.

7. Completion of Difficult Tasks

1. The abutment of the bridge situated on the Kalyani River was in a state of being cut due to water logging. The bridge was saved by controlling the direction of water withdrawal by machines at the site itself at night. This also helped in protecting the population from waterlogging.

2. About 3,450 people who were surrounded by water logging at various places in Rudrapur city were evacuated on time by teams of police, NDRF, SDRF, and fire brigade.

Table 2: Number-wise Details of Teams Engaged in Disaster Management Search-and-Rescue Operations

Sl. no.	Department	Number of Teams
1	Police Department	42
2	SDRF	2
3	NDRF	6
4	P A C	05 Company
5	Fire Brigade	07 Teams
6	Potential teams of revenue, municipal bodies and departments	78
Total		**140 Teams**

3. People surrounded by water logging at places like Rampura, Sanjaynagar, Bhootbangla, Mukherjee, Jagatpura, Kheda, Teenpani, Balmiki Nagar, Shivnagar, Kichha, Pantnagar, Nagla, Khatima, and Pulbhatta etc. of Rudrapur were evacuated in time.

4. In Rudrapur, Kichha, Bajpur, Gadarpur, Khatima and urban bodies, the situation of waterlogging continued for about three days and there was an immediate crisis of food items among the affected people. For this, 25 to 30 thousand people were provided food daily. 33 relief centers and 19 langars were set up for this.

5. Due to water logging in the district, 125 roads were badly affected, of which 120 roads were opened in 96 hours, 24 to 48 hours after the disaster.

6. In view of the possibility and condition of the current due to submergence of electric poles, water filling of transformers and generators in waterlogged areas, the power system was automatically blocked and the electricity system was restored after the disaster by making alternative arrangements.

7. The communication medium in the district was also heavily affected due to heavy rains, due to which the barriers in the exchange of information had to be faced. In view of the priority of the work, the communication services were fixed promptly by the Department of Communications.

8. During the disaster, 79 big and 30 small animals and 31650 poultry were killed. Their safe disposal and warning were also taken jointly by the municipal bodies, forest department and animal husbandry department and disposed of in safe places.

9. After the situation of massive waterlogging in the district, public health problems and water and germ-borne diseases like dengue, malaria, etc. had arisen. For this, health camps were organized at 20 places and medical teams were sent for excursions. Water logging and contaminated water-borne diseases were controlled through fogging and sanitation work.

10. In view of the challenge of assessing the damage of thousands of affected (21681) families after the major disaster and providing immediate assistance, 85 teams were formed and sent on an excursion.

Table 3: Teams Engaged in Relief Work after a Disaster

Sl. no.	Revenue Administration and Joint Departmental Team	86
1	Medical team	21
2	Veterinary team	15
3	Team from the city council	21
4	Provincial Guard and Home Guard	13

11. It was challenging to maintain the telephone services during the disaster and to keep the internet active continuously. For this reason, the telephone and internet services were kept active by following the instructions.

12. After the disaster, on-site visits and reviews of the affected areas were conducted by special public representatives, Hon'ble Ministers, Chief Ministers and high officials. For the above, due documentation and presentation of the information/reports was done and the subjects/ problems that came to notice during the visits and reviews were resolved.

8. Results

As the geo-climatic conditions of the Uttarakhand has always been vulnerable to offset of natural calamities like land slide, cyclones, earthquakes and flood. Administration play vital role to stabilize the situation. Administration Adopt IRS Mechanism and developed the GIS based system for district which helped in planning during flood, relief and rescue operation which led to no loss of life in the area. The support from Police, NDRF, SDRF, NGO's, and local organization response was quick which helped in speedy Recovery, Response and Preparedness work.

In the waterlogged areas in the district Udham Singh Nagar 22 teams of revenue and disaster, 1250 policemen, 6 teams of NDRF, 02 teams of SDRF, 5 companies of PAC, 7 teams of fire department, 21 teams of medical department, 21 teams of municipal body, 13 teams of Home Guards and PRD continuous rescue work was done at 21 identified places. After drainage by the Health Department, 21

health teams were formed in the district to prevent the infection of water-borne diseases and after conducting health check-up of the affected people, medicines were distributed to 2197 affected people.

A total of 3,461 people were rescued due to the tireless efforts of the district administration, police, NDRF and SDRF. In the district, 01 loss of life occurred in Tehsil Bajpur, 3 persons were injured in Tehsil Kichha and a total of 81 large animals, 27 small animals and 15,135 poultry and ducks died. 5 pucca houses were completely damaged, 19 kutcha houses were partially damaged and 51 huts were completely damaged. Damage of 44700 hectares of paddy, 70 hectares of urd, 60 hectares of Lahi/mustard and 20 hectares of sugarcane in the district, 745 acres of peas, 220 acres of vegetables, 40 acres of guava and 4 acres of Gerbera production under Posi House under Horticulture Department and 25.33 lakh was assessed under Animal Husbandry Department. A total amount of 99 crore 64 lakh 99 thousand rupees was provisionally assessed for loss of livestock, sugarcane, agriculture and horticulture crops in the district.

On the basis of department-wise damage assessment, 309.62 lakhs of Electricity Department, 1583.00 lakhs of Public Works Department, 3.75 lakhs of Water Institute, 21.50 lakhs of Sugarcane Development Department, 652.94 lakhs of Municipal Corporation, 192.05 lakhs of Mandi Parishad, 110.95 lakhs of Cooperative Department. , Irrigation Department 1491.28 lakh, Animal Husbandry Department 18.00 lakh, Medical Department 11.00 lakh, Industry Department 5.00 lakh, Panchayati Raj Department 320.00 lakh, Little Irrigation Department 580.00 lakh, Education Department 152.00 lakh, Rural Construction Department 23.71 Provisional damage assessed totaling Rs.05476.00 lakh.

The work of spraying insecticides, bleaching powder and fogging was done by 1254 environmental friends in 33 relief centers of the district by the municipal bodies and the process of lifting 81 dead animals from populated areas and burying them at appropriate places was completed. In rural areas, taking cooperation from the village heads through the development block, drainage, cleaning and spraying of insecticides was done from the waterlogged areas. After water logging, sodium hypochlorite and fogging are being organized by forming 9 teams to prevent water borne diseases like dengue, malaria, etc. and publicity was done through social media and hoardings.

Due to water logging in the district, power supply was stopped at 13 places for safety and out of 53 damaged power lines and 107 transformers, 53 power lines and 102 transformers have been re-installed. For the people affected by excessive rain and water logging, arrangements have been made to provide food twice a day

to 44 thousand 7 hundred affected people from October 20, 2021, while providing langar at 19 different places in the district. Apart from this, 17,810 cooked food packets were distributed in the district.

Fig. 5: Glimpses of floods scenarios in the District Udham Singh Nagar

Fig. 6: Loss of Paddy Crop in village Bagwala, Rudrapur Animal Loss in Village Jagatpura, Rudrapur

Fig. 7: Relief Distribution Work (Gratuitous relief Distribution)

Conclusion

It is evident from the case study presented in this Unit that floods can have different ramifications in different regions of the country. That is why typical cases have been taken in this unit representing three different regions of the country in each of which the flood generating phenomenon has different. The cases have been discussed in fair detail including the response that was generated in each case. The lessons learnt, specific as well as general, have been brought out.

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A Case Study on Landslides in South West Khasi Hills District, Mawkyrwat, Meghalaya (India) in 2022: Lesson Learnt

Ebormi S. Langshiang and Ambiangmiki S. Langshiang*

Abstract

Landslides are the most dangerous hazard in the South West Khasi Hills district of Meghalaya during the monsoon season, owing to heavy rainfall. The recent landslides that occurred in the months of May and June 2022 were the worst in the district's history, as the damages to life and property were extremely dangerous. A precise estimation of rainfall thresholds that can reactivate dormant landslides or increase the ground movement rates of active landslides is critical in the context of hazard assessment and risk mitigation, particularly for prevention and warning activities. The paper examines a landslide-prone slope in Meghalaya's South West Khasi Hills district. Due to heavy precipitation that resulted from a cloud burst, total rainfall for the most recent landslip was 4380.8 mm, which resulted in 2 fatalities. Slope failures occurred frequently as a result, and rivers were overflowing with large amounts of water and debris, which led to both property damage and fatalities. The purpose of this study was to determine the relationship between land-use and land-cover (LULC) and the occurrence of mass movements during an extreme rainfall event. In these types of remote locations, land use planning should be done by developing fool proof utilities for the use of water, regulating blasting operations and debris in the neighbourhood, and creating better alternative living spaces close to workplaces. The impact of landslides can be significantly reduced by early warning, dissemination of the early warning, community awareness, Do's and Don'ts, sharing of IEC material in local language, and pre-disaster training at the community level, which can ultimately help in creating communities that are landslide disaster resilient.

Key words: Landslide; Rainfall; Land Use and Land Cover; South West Khasi Hills; Resilience; Community awareness

1 Introduction

Landslides are one of the most devastating and expensive natural disasters, claiming thousands of lives and causing billions of dollars in damage each year

(Froude & Petley, 2018; Petley, 2012; Schuster et al., 2001). Landslides are defined broadly as debris flows, rock falls, avalanches, mudslides, and any other downward movement of soil, rock, or debris caused by gravity (Cruden & Varnes, 1996; Hungr et al., 2014; Varnes, 1954, 1978). Although landslides can occur in a variety of lithologies, climates, hydrological regimes, and land use types (Kirschbaum et al., 2015), the majority are precipitation-triggered (Petley et al., 2005).

However, additional complex atmospheric, surface, and subsurface conditions also contribute to the slope's failure by strengthening the underlying slope and/or amplifying the effects of down gradient forces for the majority of landslides caused by precipitation (Sidle & Ochiai, 2006; Terzaghi, 1950). Therefore, separating the influence of precipitation from these confounding variables is crucial for improving our basic comprehension of landslides as well as for assessing how climate change affects slope failure.

Climate change is primarily expected to affect the risk of landslides by increasing precipitation (Chiang & Chang, 2011; Handwerger et al., 2019; Huggel et al., 2012; Jakob & Lambert, 2009). There are several physical mechanisms through which this shift towards heavier precipitation events (Davenport et al., 2021; Singh et al., 2013) could reduce slope stability, including changes to drainage conditions, through flow, infiltration rates, and/or the hydraulic conductivities of slope materials (Crozier, 2010; Gariano & Guzzetti, 2017; Iverson, 2000). Slope stability is probably impacted by variations in precipitation over both daily-to-weekly and monthly-to-yearly timescales (Iverson & Major, 1987; Schmidt & Dikau, 2004). Importantly, different mechanisms may trigger different types of landslides (Van Asch et al., 1999).

Major natural hazards, landslides, are caused by the movement of a mass of rock, rubble, or dirt down a slope (Cruden, 1991). Landslides are often caused by intense rainfall, cloudburst, earthquake, storm waves, fast stream erosion, or other stimuli that raise or decrease shear stress in slope-forming materials (Yao, Tham, & Dai, 2008). Human activities, particularly deforestation and slope excavation for road and building construction, have become key landslip triggers as development expands into unstable hill slope areas (Li, Wang, & Mao, 2020).

Meghalaya, a state in north-eastern (NE) India, is susceptible to a variety of natural disasters. The common calamities that the inhabitants of Meghalaya have experienced over a long period of time include flashfloods, landslides, earthquakes, high winds, and lightning (Singh, 2005). The state's unique geological settings and tectonic environment may play a role in some natural disasters (Baruah et al., 2021). According to geotechnical analysis, Meghalaya, as well as all of Northeast

India, is located in seismic zone V (Kayal, 2008). Tropical cyclones that influence the Bay of Bengal region pass through Meghalaya, causing flooding, flash flood and severe rains. The state is also situated in one of the wettest monsoon belts in the world, which induces it at risk for landslides and flash floods during the monsoon season.

In this study, we aim to draw attention to the potential causes of the landslides and identify a few crucial corrective tactics to prevent or lessen the effects of landslides in the future. Given Meghalaya's susceptibility to natural catastrophes, having a strong disaster management system in place is crucial. The government should take the necessary steps to prevent disasters, such as creating early warning systems, putting infrastructure development plans into action, and regularly assessing risk. In order to create community-based disaster management strategies that take into account the particular needs and vulnerabilities of various groups, including indigenous people, the authorities must also work closely with communities.

The area, which is home to one of the wettest monsoon belts in the world and is subject to extreme tectonic stress due to sedimentary geological formation, is highly susceptible to landslides and demonstrates environmental determinism. Additionally, widespread development projects that involve extensive slope excavation and deforestation point to potential action. Both of these actions combined to cause the large-scale mass wasting disaster.

2. Study Area and Data

The South West Khasi Hills district was formed on August 3, 2012, from the West Khasi Hills district. The district has a land area of 1,341 square kilometres and is located at 25.3106° N, 91.2059° E. The district is bounded to the north by West Khasi Hills District, to the south by Bangladesh, to the east by East Khasi Hills District, and to the west by West Khasi Hills and South Garo Hills District. According to the 2011 Census, the total population of the district is 1, 10,152 people. The district is divided into two Community & Rural Development Blocks: Ranikor and Mawkyrwat with Literacy Rate of 76.84 %. South West Khasi Hills District of Meghalaya at an elevation of about 6000 ft and is approximately 75 kilometers from Shillong, the capital city of Meghalaya. The terrain of the South West Khasi Hills is of rolling hills impeded with boulders some of which are gigantic.

3. Methodology: Landslide mapping

Three components comprised the study: i. Field investigation was conducted on June 23, 2022, to document the landslides that occurred. ii. Field investigation to

determine how landslides affect the socioeconomic conditions in the area under study. iii. To determine how various contributing factors relate to the landslides that happened in the study area. Participatory field mapping was used to create an event-based landslip inventory (April to July and September to October 2022). We reviewed newspaper articles and spoke with officials from the District Disaster Management Authority South West Khasi Hills District to determine where field mapping would take place.

3. Data processing and analysis

The collected quantitative data were checked and then entered into the spreadsheet in MS Excel. Using statistical software SPSS (Statistical Package for Social Science, version 16.0), descriptive statistics including mean, frequency and percentage were analyzed from the collected data according to the objectives. The results are presented mostly in tabular forms along with graphs.

5. Result and discussion

Landslide and Rainfall Distribution - Aftermath and Causes: According to the studies, Meghalaya's South West Khasi Hills district witnessed a number of landslides (n=142) during the 2022 monsoon season, with 6199 mm of rainfall (Table 1 & Fig 1). In the South West Khasi Hills District from April to July, as well as in September and October of 2022, heavy rainfall was the primary cause of landslides. There were two fatalities as well as significant damage to livestock, public buildings and agricultural land as a result of landslide in the South West Khasi Hills District. Approximately 630 households (Fig 1A) with a total population of 3887 have been affected, nine (9) livestock have been killed, as well as 61 roads, 101 ha of agricultural land, and 52 gravity main lines have been washed away (Table 2).

Table 1: Occurrence of landslides due to heavy rainfall in South West Khasi Hills, Meghalaya

Index	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Amount of rainfall (mm)	17	99	49	585	1566	2815	377	268	474	423	0	0
No. of landslides (times)	0	0	0	10	34	85	2	0	7	4	0	0

Table 2: Damages/loss due to Flash floods/Landslides in South West Khasi Hills District 2022.

Sl. no	Block affected	No. of Household affected	No. of population affected	No. of Person died	No. of Animal died	Roads (Nos)	Agriculture (ha)	PHE (main line)
1	Ranikor C & RD Block	627	3758	1	1	39	13	33
2	Mawkyrwat C & RD Block	23	129	1	9	23	88	19
Total		630	3887	2	9	61	101	52

Fig. 1 shows the distribution map of average monthly rainfall and number of landslides. It was found that the number of landslides in the month of April was 10 times, May was 34 times, June was 85 times which is the highest and the most destructive leads to damage of roads (Fig.1B), Agricultural land (Fig.1C) and the gravity main lines (Fig. 1D). The probability and quantity of landslide occurrence have positive correlation with the rainfall, and the quantity is large when the rainfall is large.

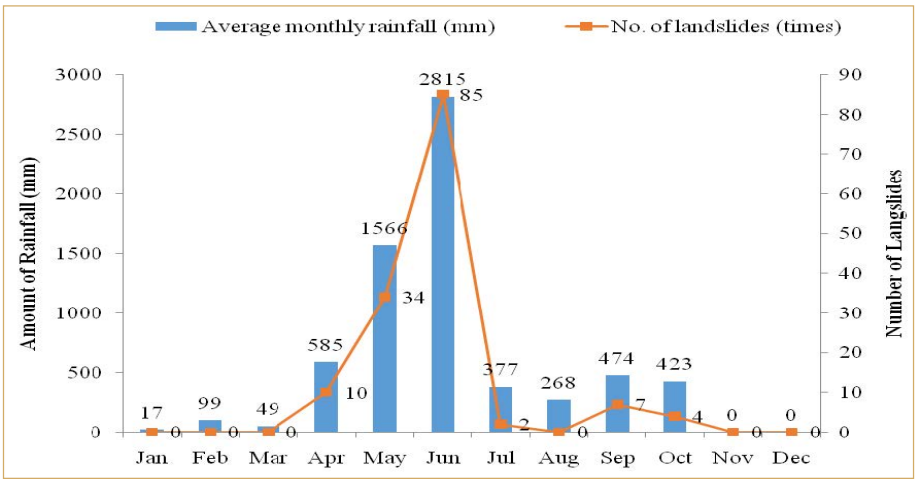

Fig. 1 Occurrence of monthly rainfall and number of landslides in South West Khasi Hills, Meghalaya in 2022.

Figure 1 depicts the distribution map of average monthly rainfall and the number of landslides. It was found that there were 10 landslides in April, 34 in May, and 85 in June—the highest and most destructive which resulted in damage to roads (Fig. 3), agricultural land (Fig. 4), and gravity main lines (Fig.5). Rainfall has a positive correlation with both the probability and the quantity of landslides; the quantity increases with increased rainfall.

As shown in figure 2 and table 3, coal comprises 0.07% of the study area, followed by fallow 15.83%, dense forest 8.77%, moderate forest 17.12%, open forest 25.42%, grass 9.5%, shrubs 1.53%, settlements 0.80%, water bodies 0.57%, and others 20.63%. This study discovered that the growth of vegetation had slowed. Rapid population growth, shifting cultivation, broomstick cultivation, and road construction all contribute to a decline in vegetation growth.

In this study, we evaluated the effect of LULC on landslip susceptibility mapping in the South West Khasi Hills district using LULC scenarios. In the study area, LULC is not the primary cause of landslides. Its dynamic nature, on the other hand, may have an effect on landslip vulnerability. Furthermore, well-planned LULC can prevent the expansion of high susceptibility zones. As a result, LULC modification influences future landslip susceptibility. According to our research, elevation and rainfall is the primary causative factor in the study area because people prefer to carry out anthropogenic activities like infrastructure development in low-lying areas.

Furthermore, the probability of landslides rises with elevation; however, the probability of landslides decreases after a certain elevation because of rock structure and geomorphic conditions. In the study's area, landslides were significantly influenced by elevation. Conversely, the function of LULC varied depending on the scenario. In comparison to the suggested LULC scenario, it was more critical for the simulated and real-world LULC scenario. This suggests that planned LULC would lessen the effect of LULC change on susceptibility to landslides in the scenario that has been suggested.

According to our studies, LULC will have a greater impact in the future. The quality of the landslip susceptibility map is determined by the accuracy and quality of the landslip inventory, as well as the causative factors. These landslides were covered in newspapers and official reports because they caused casualties and infrastructure damage.

Our study concentrated solely at the effect of LULC changes on landslip susceptibility, assuming that all other factors remained constant. We recognise that other dynamic factors may also have an impact on the landslip susceptibility scenario. If the pattern of mean annual rainfall changes in the future as a result of climate change, it will affect landslip susceptibility. Landslides in our study area are primarily caused by heavy rain, and climate change may result in more or less intense rainfall events. More research is needed to determine the effect of climate change on landslip susceptibility, as well as the role of changing rainfall as a triggering factor.

Table 3: Land use and land cover (LULC) Map of South West Khasi Hills

Classes	Area (ha)	Area %
Coal	86.78	0.07
Fallow	19600.59	15.83
Forest dense	10866.78	8.77
Forest moderate	21217.81	17.12
Forest open	31507.38	25.42
Grass	11466.82	9.25
Shrubs	1892.51	1.53
Settlements	996.13	0.8
Water bodies	707.71	0.57
Others	21169.07	20.63

Fig 1A: Specimen photographs capturing devastation caused by rain and landslides at the Maheskhola South West Khasi Hills, Meghalaya (Source: DDMA, SWKH).

Fig 1B: Specimen photographs of eroded section of roads and bridges (Sources: DDMA, SWKH).

Fig 1C: Specimen photographs of eroded section of Agricultural land (Sources: DDMA, SWKH).

Fig 1D: Specimen photographs of eroded section of gravity main pipe lines (Sources: DDMA, SWKH).

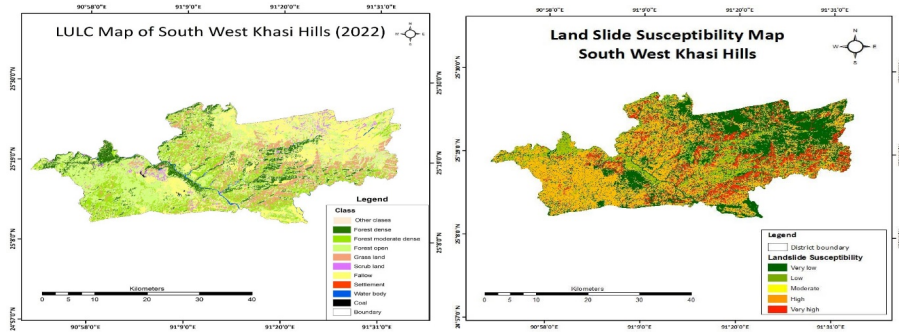

Fig 2: LULC and landslide susceptibility map of South West Khasi Hills district.

Mitigation Measures for Future Landslides: A Proactive Approach: To mitigate future landslides in the South West Khasi Hills district and other district of Meghalaya, a proactive approach is necessary. Here are some potential mitigation measures that can be implemented:

- ***Hazard Mapping and Assessment:*** Conduct a comprehensive hazard mapping and assessment of the area to identify high-risk zones and vulnerable areas prone to landslides. This will help in developing targeted mitigation strategies and land-use planning.

- ***Early Warning Systems:*** Establish an effective early warning system that can detect and alert residents about potential landslide events. This can include monitoring rainfall patterns, ground movement, and other relevant indicators to provide timely warnings to the community.
- ***Slope Stabilization and Engineering Measures:*** Implement slope stabilization techniques such as terracing, retaining walls, and slope reinforcement to prevent slope failures and reduce the risk of landslides. Engineering measures like drainage systems and erosion control structures can also help in managing water runoff and preventing soil erosion.
- ***Land-use Planning and Regulation:*** Develop and enforce land-use regulations that restrict construction and development in high-risk landslide areas. This can include zoning regulations, building codes, and guidelines for safe construction practices to minimize the vulnerability of structures to landslides.
- ***Reforestation and Vegetation Management:*** Promote reforestation efforts and vegetation management in the region. Trees and vegetation help stabilize slopes, reduce soil erosion, and enhance the overall stability of the landscape.
- ***Public Awareness and Education:*** Conduct public awareness campaigns and educational programs to inform residents about the risks and hazards associated with landslides. This can include providing information on early warning signs, evacuation procedures, and safe practices during landslide events.
- ***Collaboration and Community Engagement:*** Foster collaboration among government agencies, non-governmental organizations, community leaders, and the general public to work together in implementing and sustaining landslide mitigation measures. Community participation and engagement are crucial for the success of any mitigation efforts.

It is important to note that these measures should be tailored to the specific characteristics and needs of the South West Khasi Hills district. Regular monitoring, evaluation, and adaptation of these measures based on changing conditions and new knowledge are also essential for effective landslide mitigation.

5. Conclusion

Based on the provided information, the South West Khasi Hills district of Meghalaya experienced numerous landslides during the monsoon season of 2022. These landslides caused significant damage to newly constructed communication infrastructure and resulted in major property loss. The landslides were triggered by both natural and man-made factors. Additionally, the area experiences extreme tectonic stress and has a sedimentary geological formation, further contributing to its vulnerability to landslides.

The development of roads in the area may have also played a role in increasing the risk of landslides. The construction of roads can destabilize slopes, making them more prone to landslides. Excavation work for road construction may have further exacerbated the severity of the landslides by altering the natural dynamics of the slopes.

It emphasizes the importance of damage mitigation by identifying corrective procedures to prevent or minimize the impact of future landslides. Effective communication and collaboration among the government, non-governmental organizations, community leaders, and the general public are crucial for reducing the risk of natural disasters and promoting long-term development in landslide-prone areas.

Efforts by the Meghalaya State Disaster Management Authority and other relevant authorities are crucial in providing relief and support to the affected communities. Disaster management measures, including early warning systems, infrastructure resilience, and community preparedness, are essential in mitigating the impact of such natural disasters in the future.

The tragedy in the South West Khasi Hills has taught a lesson and should be used as a case study for assessing additional local parameters and developing site-specific scientific and engineering solutions. All development projects in a seismically active region like the North East must undergo a thorough safety and environmental review. It is critical that this disastrous course be reversed as soon as possible. Otherwise, similar disasters will undoubtedly occur in the future

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Case Study on Train Accident at Bahanaga Bazar Railway Station, Balasore District (Odisha)

Commandant
3rd Bn. NDRF Mundali, Cuttack, Odisha

Abstract

India is one among the nations where a dedicated force for Disaster Management exist- Natonal Disaster Response Force (NDRF). NDRF is a specialised force, well trained adequately equipped and experienced force. Bahanaga Multi (three trains) Rail accident (02 Jun 2023 at 1855 h) was a major disaster, widely spread out and Golden hour activities were hampered due to darkness. Notwithstanding, NDRF carried SAR activities relentlessly in a planned and methodical manner. The efficient execution minimised human losses. During the operation Community's supportive role was a great boon.

Key words: Response; NDRF; SAR; Rail accident; Golden hour; Community role

1. Introduction- National Disaster Response Force (NDRF)

DRF is a specialised Force to meet any threatening disaster in the Country. NDRF is also deployed in the foreign countries in disaster situations as a helping hand for managing rescue activities. NDRF has 16 Battalions (Bn.) manned by persons on deputation form various para military forces of India. Each Bn. is capable of providing 18 self-contained specialist SAR teams (Search and Rescue teams) of 45 personnel including engineers, paramedics, dog handlers etc.

The 3rd Bn. NDRF is located at Mundali, Dist. Cuttack, Odisha and its area of responsibility is Odisha and Chhattisgarh. The 3rd Bn. has two RRC's (Regional Response Centre) one at Balasore (Odisha) and other at Bhilai (Dist. Durg, Chhattisgarh). Also the Bn. has two on-wheel SAR teams to respond to any disaster round the clock. The 1st SAR team will have to leave from Bn. to the disaster site with-in 20 minutes after receiving the message. The other team will leave within 30 minutes. Fortunately our RRC at Balasore which is located approx. 35 KMs away from the incident site of Bahanaga Bazar Rail incident, rushed immediately and rescued 32 live victim and recovered 32 dead bodies.

2. Train Accident at Bahanaga Railway Station

a. Introduction of the incident:

- **Nature of Incident:** Rail accident (Collision)

- **Date & Time of the incident:** On dated 02.06.2023 at about 1855 hrs the train accident occurred and News channel (ODTV) flashed news about the train tragedy (Coromandel Superfast Express) at Bahanaga Bazar Railway Station, Distt. Balasore (Odisha) at about 1930 hrs.
- **Place or location of incident (Co-ordinates):** Bahanaga bazaar railway station (Bahanaga Block, Dist. Balasore, Odisha):
  - Latitude: 21º20'17"N
  - Longitude: 86º45'52"E

b. ***Topography of the affected areas:*** The area of Bahanaga Bazar, Distt-Balasore (Odisha) is plain. Bahanaga Bazar is well connected by road and rail; all major trains pass towards Vijaywada, Chennai, Banglore and other southern cities via Bhubaneswar through this route. Bahanaga Railway Station is a railway station on Kharagpur-Puri line, part of the Howrah-Chennai main line under Kharagpur Railway Division of South Eastern Railway Zone. The station serves 14 passenger trains and several goods train daily. This is also an important route for Indian iron and coal mines connecting to factories.

3. Brief details of the incident

On dated 02.06.2023 at around 1855 hrs. train No (12841) Coromandel Super-Fast Express running from Shalimar to Chennai left designated main line and entered into the loop line where it collided with parked goods train (loaded with iron ores) at an approximate speed of 128 kmph that its engine mounted on the top of the 4th coach of the freight train. Its 17 coaches got derailed and hit the last two bogies of the Yashwantpur Super-Fast Express No. (12864) which was also crossing from opposite direction, coming from Bangalore to Howrah at the approximate speed of 126 kmph. Resulting in the colossal loss of lives.

a) ***Impact and damage assessment:*** The triple train accident involved Bangalore-Howrah Express, the Coromandel Express and Goods train at Bahanaga Bazar Rly Station, Distt. Balasore (Odisha). 17 Coaches of these two trains have been de-railed & severely damaged.

- No. of Human Casualty : 292
- No. of person Injured : 1289
- No. of patients Treated : 1289

(Above data received from bulletin of Special Relief Commissioner Odisha.)

b) NDRF Response:

i. Mobilization

Phase-I: On dated 02.06.2023 at about 1930 hrs. Control Room received information about the Train accident at Bahanaga Bazar Rly. Station, Distt. Balasore (Odisha). Forthwith, Msg. passed to the team commander RRC Balasore by the commanding officer of 3rd Bn. NDRF and was also accordingly briefed about the rescue activities that should be carried out. Then the team stationed at RRC Balasore mobilized, rushed to the incident site, reported to Collector of the district and launched rescue operation at 2030 hrs. Further, on wheel SAR teams (02 teams) from The Bn. HQr were also mobilized and proceeded to the incident site.

Phase-II: Further, 04 additional SAR teams with required Equipment were also mobilized at the Bn. HQRs. and proceed to the incident site at 2200 hrs with other 04 officers. Besides, 02 additional SAR teams from 02nd Bn. NDRF Kolkata proceeded and reached at the incident site at 0800 hrs. on 03.06.2023 and started search and rescue operation with the 3rd Bn. teams.

ii. Deployment

The following NDRF teams were deployed for search and rescue operation at Bahanaga Bazar Rly. Station, District Balasore:

Table 1: NDRF teams deployed for search and rescue operation at Bahanaga Bazar Rly. Station

Sl. no	Location	No of teams 03 Bn.	No of teams other Bns.	Total
1.	Bahanaga Bazar Rly. Station, Balasore (Odisha)	07 teams of 03 Bn. (including 01 team from RRC Balasore)	02 teams (02 Bn.) By road	09
	Total	**07 Teams (03 Bn.)**	**02 Teams (02 Bn.)**	**09**

Table 2: Deployment of Strength Battalion wise

Sl. no	Name of the Bn.	No of teams	Strength
01	03 Bn. NDRF, Mundali	07	221
02	02 Bn. NDRF Kolkata	02	81
	Total	**09**	**302**

(The teams worked under the overall supervision of Commandant, 3rd Bn. NDRF)

iii. Planning of Operation

- Direction was issued by Commandant 03 Bn. NDRF to DC Ops and all the officers available at Bn.
- Team of RRC Balasore directed to attend the incident site at the earliest.
- On wheel alert teams of Bn. Hq. directed to move after collecting all the special cutting equipment's.
- Officers were detailed to move to the incident site except one officer at Bn. Hq.
- Logistics i.e. water, ration, additional tents etc were dispatched in due course.

iv. Execution of the Operation

- **Safety and security:** Safety of rescuers and trapped victims was ensured to avoid any injury and security of logistics was ensured by establishing logistics area.
- **Initial Assessment**
  - **Information Collection**: On reaching at incident site team commander reported to the Collector Balasore and initial information gathered from local and available persons at the incident place. It was an accident of huge magnitude and numbers of trapped victims/ dead bodies were in large numbers.
  - **Command post**; A centralised command post established at incident site and one gazetted officer was detailed to look after the function of command post.
  - **Operational objective:** Operational objective were set based on information gathered and seeing the gravity of incident. First priority was given to rescue live victims from trapped railway bogies followed by extrication of dead bodies.
- **Assigned task**
  - Team 3A was the first team of NDRF reported at incident site and team divided into 3 sub teams, each sub team headed by a sub officer and task was assigned accordingly by the team commander.
  - Search and locate: Searching for live victims was done manually followed by use of dog squad. Firstly such victims were rescued who could be easily reached out (surface victims). Most of the surface victims were rescued by locals also

- **Gained access to the trapped victims**
  - Many victims were trapped in bogies in a very difficult position.
  - Cutting equipment's used to cut the railway bogies were plasma cutter, hydraulic spreader cum cutter, oxy fuel cutting, RP Saw etc.
- **Stabilized and extricated the patient**
  - Trapped victims were stabilized before extrication.
  - Provided medical assistance to the needy victims.
  - Applied all rescue techniques to extricate live victims.
  - Handed over the victims to the medical teams.
  - Some bogies were required to be moved by cranes to search the dead bodies.

- **Equipment Details**

Table 3: Equipment Details

S.N	EQUIPMENT	TEAM ID								
		3L	3I	3M	3S	3A	3Q	3R	2G	2J
01	Plasma	01	01	01	01	--	01	--	03	01
02	Rr Saw	03	03	03	03	03	03	03	07	05
03	Oxy Fuel	--	01	--	01	--	--	--	03	--
04	Spreader	01	01	01	--	01	--	--	02	01
05	Rp Saw	02	02	02	02	02	03	03	10	02
06	Angle Cutter	03	04	03	04	04	04	03	03	06
07	Hond Gen. Set.	02	02	02	02	02	02	01	01	01
08	Vhf/Hf/Hand Held	03	02	02	02	03	03	03	09	11
09	Air Lifting Bag	--	--	01	--	01	--	--	02	01
10	Aska Light	01	01	01	01	01	01	01	01	--
11	Qda	--	--	01	--	--	--	--	01	01
12	Satellite Ph.	01	01	--	--	--	--	--	--	01
13	Body Worn Cam.	--	--	01	01	01	01	--	01	01

v. Summary of activities as on 21.06.2023 (source SRC)

- No. of Human Casualty : 292
- No. of person admitted : 1289
- No. of patients discharged from the hospital : 1153
- No. of patients presently in hospital : 136

- No. of dead bodies identified : 211
- No. of dead bodies handed over to NOK : 211

vi. De-induction of NDRF teams

After completion of search and rescue operation, all the NDRF teams were relieved by the Special Relief Commissioner, Odisha on 04.06.2023 at 1700 hrs.

c) ***Inter-Agency Co-ordination:*** There was very good co-ordination among the all sister agencies /stake holders resultantly the operation was successfully completed without loss/damage of NDRF personnel/equipment.

d) ***Medical camp:*** There were several medical camps established near incident site, rescued victims were handed over to them for further treatment and to refer for higher medical care at SCB hospital, AIIMS and other hospitals. Apart from camp, there were teams of medical and NGOs to manage the dead bodies.

e) ***Media Coverage:*** Live telecast of the entire operation was covered by the local/national media throughout the day and night. The media disseminated the ground situation minute to minute. The response and efforts taken by various teams of NDRF/ODRAF/Fire during rescue operation were highlighted by the print and electronic media.


एनडीआरएफ के 300 से अधिक कर्मी बचाव अभियान में जुटे

बालेश्वर ट्रेन त्रासदी के वे दृश्य जो रहे हैं भीषण परिणाम

कोरोमंडल ट्रेन हा
स्पेशल बसों


ମୁଣ୍ଡଳି ଏନ୍‌ଡିଆରଏଫ ବଖାଣିଲେ କାଳରାତ୍ରି କାହାଣୀ

f) VVIP/VIP Visit and Response

- Hon'ble Prime Minister visited the accident site and reviewed the situation with Hon'ble Minister, Railway and Hon'ble Minister of Education, GOI. He met injured passengers at District Headquarter hospital, Balasore.
- Hon'ble Governor of Odisha visited the accident site and met injured passengers at CHC hospital in Soro and Balasore.

- Hon'ble Chief Minister of Odisha visited the accident site and took the stock of the situation and met injured passengers at District Headquarter hospital, Balasore.
- Hon'ble Chief Minister of West Bengal visited the accident site to take the stock of the situation.
- Hon'ble Chief Minister of Odisha reviewed the situation with Chief Secretary, Development Commissioner, Secretary Transport and Secretary I & PR and other Senior Officers in the office of Special Relief Commissioner, Rajiv Bhawan, Bhubaneswar on 02.06.23 evening.
- Hon'ble DG NDRF along with officers visited and interacted with the teams at the incident site.

g) NDRF Introspection

- Challenges Faced
  - o The rescue operation was carried out in very harsh weather condition.
  - o Huge public gathering.
  - o Extrication of live victim from inside a crushed coach.
  - o Light weight battery/electric operated equipment's would have worked better to reach the confined space inside the coach.
  - o Non availability of foldable stretcher with the teams in such ops for carrying decomposed and stiff bodies.
  - o The entire operation was conducted on inclined coaches throughout Day (40° C & high humidity) & Night lasting for 40 Hrs.
  - o Large No. of live victims/dead bodies.
- New Initiative
  - o After de-inducted the rescue teams form the ops, a psychological motivational counselling session was organised at the Bn. HQr., by the team of doctors, SCB hospital Cuttack (OD). A motivational session was also conducted to the rescuers by Brahm Kumaris.
- ***Lesson Learnt***
  - o Response time of 1st team 3A RRC Balasore was good.

- Officers were in good numbers (05) which enhanced the operational capability of rescuers due to better supervision.
- Saving of lives done by 1st team (RRC Balasore, Team ID 3A) was commendable.
- Nearby villagers/social workers were heartily involved in saving the lives. They continuously facilitated the rescuers with water bottles, OR's and other eatable items which motivated rescuers.
- Use of all cutting equipment by rescuers throughout the ops effectively.
- No injury was reported to our rescuers in one of the most difficult rescue ops under harsh sweltering condition.
- Coordination among railway teams, ODRAF, fire services and other agencies involved in the rescue was good during the operation.
- Use of canine and lady rescuers enhanced the search and rescue operation.

- ***Suggestions (if any) to be incorporated in training after studying gaps and challenges with proper justification***
  - Requirement of manpower (GD, Technical, Medical staff. etc.) as per authorization.
  - Updated battery operated equipments instead of internal combustible equipment may be provided to teams.
  - Foldable stretchers may be made available to teams.
  - Mobile toilet should be made available with the team.
  - One set of two pieces Dungaree (upper & lower) may be issued to the rescuers.
  - Trucks may be modified with Tray/Rack system for proper placing of equipment's it will help easy access of equipment during ops time.
  - Train accidents are not similar to other CSSR Ops, instead of hard toe shank boot light weight non-slippery safety shoes may be provided.
  - To conduct regular mock exercise on realistic scenarios also sensitization of Rly staff on DM courses may be imparted.

4. Management of Train Accident in Balasore

1. *Prevention/Mitigation*

- **Capacity Building:** - The Joint Railway mock exercises are being conducted with the all sister/response agencies of the State/District throughout the year. Regular training of the NDRF personnel is being imparted on multiple scenarios. Apart from the Mock drills, various equipment handling and its hands on training are given to all the personnel to enhance the capacity building.

- **Disaster Risk Reduction:** -Technical upgradation may be brought to avoid accidents in future. Also train accident occurs due to sabotage of Railway tracks, this can be prevented by sensitizing the local community to be eyes and ears to report any suspicious activity related to sabotage of tracks to concerned department of railways. NDRF conducts FAMEx programme in all districts of their AOR in which they teach the local communities about how to mitigate/respond to various disaster.

- **Community Based Disaster Response:** -The local community near Bahanaga station responded promptly and helped in the rescue operation. Also many NGOs, RSS, Volunteers helped NDRF by providing food, water and also temporary toilets were set up at the site. Also not only the local community, the people near the adjacent areas volunteered for blood donation, charity works, etc.

2. ***Contingency Planning and Resource Mobilization:*** To meet any contingency in its AOR, the NDRF has 2 dedicated on wheel teams round the clock, with all requisite disaster equipment already loaded in the truck. The 1st on-wheel SAR team will have to leave from Bn. to the disaster site with-in 20 minutes after receiving the message. The other team will leave within the 30 minutes. Each NDRF team comprises of 47 personnel which includes 26 rescuers, 6 technical personnel, 3 Dog squad, 2 para medical & remaining supportive staffs.

3. ***Search and Rescue:*** One search and Rescue team (SAR) team is permanently stationed at Balasore which is around 38km from accident area. As soon as the message was received the on wheel team immediately rushed to the spot with all requisite equipment and were engaged in rescue operation. The team was fully equipped with modern cutting equipment like plasma cutter, hydraulic spreader cutter, etc. Also the team had Basic first aid medical materials needed for pre hospital treatment. All the NDRF personnel are

MFR Trained. The canine team of NDRF was useful in identifying the live victims who were trapped inside the coach. The 9 teams of NDRF rescued 44 live victims and 121 dead bodies.

4. ***Coordination:*** As soon as the NDRF reaches the incident site it coordinates with the local agencies like SDRF(State Disaster Response Force),Local police, RPF(Railway Protection Force),ODRAF(Odisha Disaster Rapid Action Force)),OFS(Odisha Fire Service).A command post will be established by the district management under the head of District Collector. All human resource management, Equipment management, rescue tasks will be assigned by the command post to all the agencies.

5. ***Restoration of services*****:** Two days after the accident the restoration works were geared up with 1000+ Manpower working tirelessly. More than 7 Poclain Machines, 2 Accident Relief Trains, and 3-4 Railways and Road Cranes have been deployed for early restoration. Railway officials said that all 21 coaches which were capsized due to the derailment of trains at Bahanaga Bazar station have been grounded. After having completed all the restoration works a relief train was run from Bhadrak on June 4th at 1300hrs.

6. ***Community recovery:*** Various Organisations, like Disabilities organizations, Reliance foundation etc. came forward to provide free rehabilitation services to the victims who were hospitalized. Also counselling sessions were provided to the relatives of the victims at BMC office and in AIIMs Bhubaneshwar. The NDRF personnel who were involved in rescue operation underwent Post Traumatic Stress disorder (PTSD) programmes conducted by experts of AIIMs. At the battalion Premises team wise counselling session was conducted by the Psychologists of SCB hospital.

Effective Disaster Response and Disaster Risk Reduction: A Case Study of Flood in Silchar (Assam) in 2022

Aruni Kumar

Abstract

Disasters are a common phenomenon in any country or in any region. It takes toll of human lives and has significant adverse impact on economic activities of that particular country or the region. It has many forms. In this paper the author will discuss at length, the disaster risk response mechanism and disaster risk reduction with special reference to the flood in Silchar of Cachar district of Assam in the year 2022. In this paper, various measures for prevention/ mitigation of disaster, planning and preparedness to cope with disaster, way to respond effectively and building back better to recovery, rehabilitation and reconstruction of destructions caused by the disaster has been discussed.

Key words: Disaster risk response, Disaster risk reduction, Prevention, Mitigation, Economic impact, Rehabilitation

1. Introduction

A disaster can be defined as "**A serious disruption in the functioning of the community or a society causing wide spread material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources**[1]". A disaster is a result from the combination of hazard, vulnerability and insufficient capacity or measures to reduce the potential chances of risk. It happens when a hazard impacts on the vulnerable population and causes damage, casualties and disruption. Any hazard – flood, earthquake or cyclone which is a triggering event along with greater vulnerability (inadequate access to resources, sick and old people, lack of awareness etc) would lead to disaster causing greater loss to life and property.

As per the **Disaster Management Act, 2005** disaster is defined as *"**a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area**".*

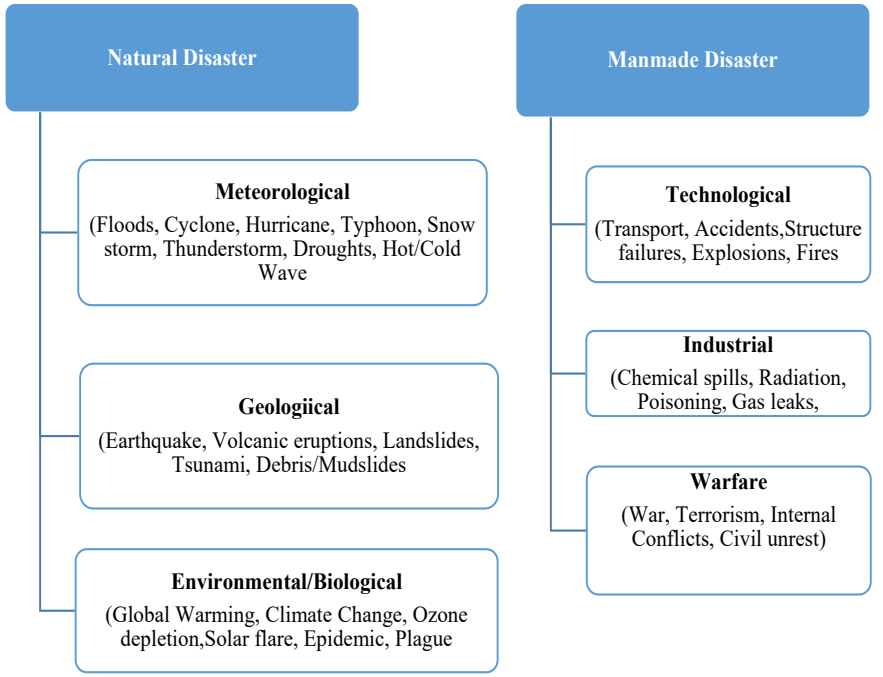

Fig.1: Various types of Disasters

Source:https://www.ifrc.org/our-work/disasters-climate-and-crises

2. History of Study of Disasters

In 1970, having observed that actual and potential consequences of natural hazards were becoming so severe, and were of such a scale, that much greater emphasis on pre-disaster planning and prevention was imperative, the United Nations Disaster Relief Coordinator convened an International Expert Group Meeting in July 1979 to review six years' worth of work developing a methodology for risk and vulnerability analysis.

In 1980, this work laid the foundations for the development of the International Framework of Action for the International Decade for Natural Disaster Reduction (IDNDR), beginning on 1 January 1990. In 1990, supported by a Secretariat established at the United Nations Office in Geneva, IDNDR was intended to reduce – through concerted international action – loss of life, damage to property, and social and economic disruption caused by "natural disasters", especially in developing countries. With a strong emphasis on engaging and deploying existing scientific and technical knowledge, IDNDR succeeded in raising public

awareness – notably of governments – to move away from fatalism and to reduce disaster losses and impacts. A pivotal moment in IDNDR in 1994 was the adoption of the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation, containing the Principles, the Strategy and the Plan of Action (Yokohama Strategy) at the World Conference on Natural Disaster Reduction. In 1994, the Yokohama Strategy marked the beginning of a significant shift in the political and analytical context within which disaster reduction was being considered. While IDNDR was largely influenced by scientific and technical approaches, the Yokohama Strategy attributed great importance to socioeconomic vulnerability in disaster risk analysis, emphasizing the crucial role of human actions in reducing the vulnerability of societies to natural hazards and disasters. Member States determined in 1999 that IDNDR would be succeeded by the International Strategy for Disaster Reduction (ISDR). This would seek to:

- Enable communities to become resilient to the effects of natural hazards, and related technological and environmental disasters, thus reducing the compound risk posed to social and economic vulnerabilities within modern societies, and
- Proceed from protection against hazards to the management of risk, by integrating risk prevention strategies into sustainable development activities.

At the end of the period covered by the Yokohama Strategy, in 2004 and 2005, the Yokohama Review found evidence of greater official and public understanding of the effects of disasters on the economic, social and political fabric of societies, and stated that "significantly greater commitment in practice is required". [Source: GAR 2019]. The adoption of the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) at the third United Nations World Conference on Disaster Reduction (WCDR) – and its subsequent endorsement by the General Assembly of the United Nations (Resolution A/RES/69/283) in June 2015 – marked the culmination of a process formally started in the 1970s. Disaster management plans are multi-layered, and are planned to address issues such as floods, hurricanes/cyclones, fire, mass failure of utilities (blackouts) and the rapid spread of disease (pandemic).

From a meteorological standpoint, India is especially vulnerable to natural disasters due to its unique location, surrounded by the Himalayas in north and Indian Ocean in south, west and east, as well as its geo-climatic conditions and varied landscapes. Monsoons, subsequent landslides and floods, droughts, famine, wildfires, cyclones, and earthquakes are all experienced to varying degrees on the

Subcontinent, in addition to areas of dense overpopulation being at greater risk for disease outbreak and sanitation concerns, in the event of a natural disaster.

The new approach started from the conviction that development cannot be sustained unless mitigation is built into the development process. Another cornerstone of the approach is that mitigation must be multi-disciplinary, spanning across all sectors of development. The new policy also emanates from the belief that investments in mitigation are much more cost effective than expenditure on relief and rehabilitation. Disaster management occupies an important place in India's policy framework, as poor people are most affected by disaster and they are India's predominant population.

The approach that explains steps taken by the Government, has been outlined above. The approach has been translated into a National Disaster Framework (a roadmap) covering institutional mechanisms, disaster prevention strategy, early warning systems, disaster mitigation, preparedness and response and human resource development. The expected inputs, areas of intervention and agencies to be involved at the National, State and district levels have been identified and listed in the roadmap. This roadmap has been shared with all the State Governments and Union Territory Administrations. Ministries and Departments of the Government of India and the State Governments/Union Territory Administrations have been advised to develop their respective roadmaps taking the national roadmap as a broad guideline. There is, therefore, now a common strategy underpinning the action being taken by all the participating organisations/stakeholders.

2.1 The Disaster Management Act, 2005: The Disaster Management Act was passed by the Lok Sabha on 28 November 2005, and by the Rajya Sabha on 12 December 2005. It received the assent of the President of India on 9 January 2006. The Act calls for the establishment of a National Disaster Management Authority (NDMA), with the Prime Minister of India as chairperson. The NDMA has no more than nine members at a time, including a Vice-Chairperson. The tenure of the members of the NDMA is 5 years. The NDMA which was initially established on 30 May 2005 by an executive order was constituted under Section-3(1) of the Disaster Management Act, on 27 September 2005. The NDMA is responsible for "**laying down the policies, plans and guidelines for disaster management and to ensure very timely and effective response to disaster**". Under section 6 of the Act it is responsible for laying "down guidelines to be followed by the State Authorities in drawing up the country Plans".

2.2 Disaster Management Plan: On 1 June 2016, Shri Narendra Modi, the Prime Minister of India, launched the Disaster Management Plan of India,

which seeks to provide a frame work and direction to government agencies for prevention, mitigation and management of disasters. This is the first plan nationally since the enactment of the Disaster Management Act of 2005.

2.3 About the Authority: National Disaster Management Authority (NDMA) is an agency of the Ministry of Home Affairs whose primary purpose is to coordinate response to natural or man-made disasters and for capacity-building in disaster resiliency and crisis response. NDMA was established through the Disaster Management Act, enacted by the Government of India in December 2005.The Prime Minister is the ex-officio chairperson of NDMA. The agency is responsible for framing policies, laying down guidelines and best-practices and coordinating with the State Disaster Management Authorities (SDMAs) management.

3. Impact of Disaster

Disasters affect human being adversely in the short run and in the long run too. It is also understood that disasters are social constructs. People are vulnerable to the impacts of various types of disasters. They are vulnerable not just due to their geographical context, but their financial, social status, cultural status, gender status, access to services, level of poverty, access to decision making, and their access to justice. Good development is good adaptation and its good risk reduction. Globally, it is well recognized that natural and man-made disasters and the associated losses have increased manifolds in the last two decades. The increasing frequency and intensity of disasters have led to tremendous loss of life, property, and ecosystem while undoing and eroding the gains from development interventions.. Climate change has become a significant stimulating factor in many environmental disasters. Climate disasters refer to events that are either caused or worsened by climate change effects, including rising temperatures, changing rainfall patterns, sea level rise, and frequent violent weather which harm human societies and ecosystems in countless ways leading to loss of life, displacement, economic harm, and food scarcity.

4. Silchar Floods, 2022

Silchar town is the economic gateway to the state of Mizoram and part of Manipur. It is situated 420 kilometres south east of Guwahati. Silchar is situated between longitudes 92º24' E and 93º15' E and latitudes 24º22'N and25º8'N East and 35 meters above mean sea level.

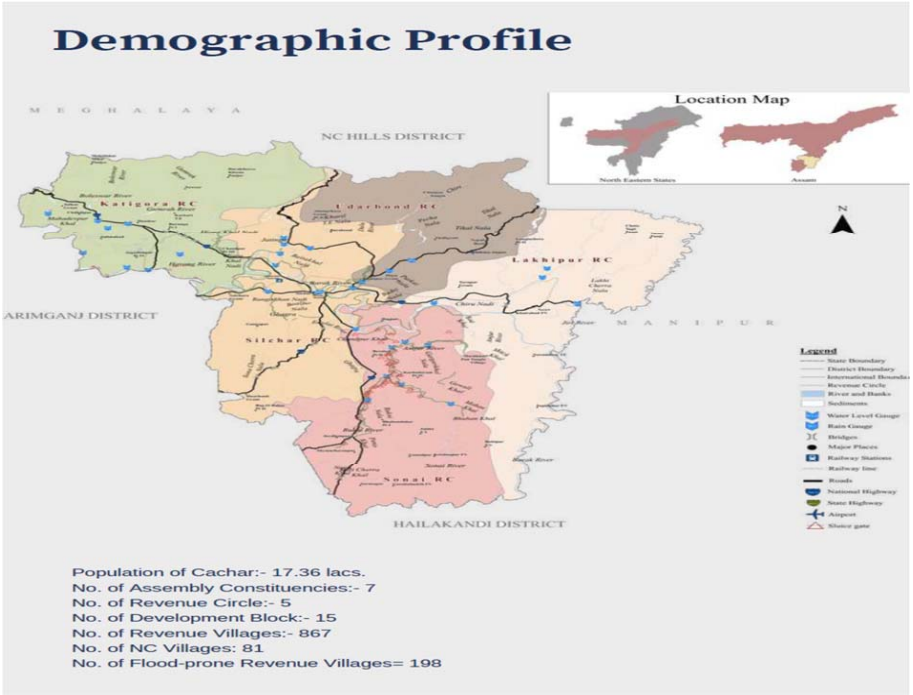

Fig. -1: Demographic profile of the Silchar town (Source:https://cachar.gov.in/sites/default/files/swf_utility_folder/departments/cachar_epr_amtron_in_oid_2/menu/departments/flood_management_2022.pdf)

4.1 Mise-en-scene: Assam located in the North Eastern part of the India, brags a vast river system comprising the Brahmaputra, Barak and their tributaries. Although these rivers provide fertile land for agriculture and efficient transport system, they make the state vulnerable to frequent floods too. Heavy rainfall upstream causes the rivers and their tributaries to overflow and submerges the surrounding areas, leading to recurring floods. Assam experiences devastating floods almost every year, and some regions are more susceptible to flooding. Floods are not strange to Assam because most of the districts of this state are flood-prone. However, the floods in 2022 were particularly devastating, affecting millions of people and causing significant damages in different districts of Assam.

On 19 June 2022, in the late evening, the Betkundi dyke on the river collapsed as a result large parts of Silchar, the second largest town in terms of population in Assam was completely inundated. The most affected areas of the town were Sonai Road, Link Road, Rangirkhari and NH-306 connecting Silchar with Aizawl. Plying of vehicle became risky.

Apart from southern Silchar, many areas, including Shillongpatty, Ambikapatty, Church Road, Malugram, Vivekananda Road, Hailakandi Road, National Highway and numbers of lanes and bye-lanes were waterlogged. Many educational institutions and business establishments were under water, leading to extreme sufferings of people. Due to sudden surge of water people were left with no other option than to scramble for dry land and saving themselves. By June 20, Silchar start facing the problem of no electricity and no communication and connectivity. Many area was submerged and rest places water was flowing upto chest level.

4.2 Prefatory extrication, response and support: The next ten days, the situation was grim and the inundated situation continued to be grave for the next ten days, with water gushing in from the broken dyke on the Barak River. The situation of people worsened with no access to water, food, medicine, electricity, or communication. The mobile phones and water purifiers became useless because of unavailability of power supply.

The first responder to this condition was the people of Silchar themselves. Later on 20 Jun 2022, they were associated with different citizen groups and Civil Society Organizations (CSOs). Since, the CSOs were with limited resources and with those limited resources they focused mainly on such people who were struggling in the standing water, especially families with elderly and children. A handful of CSOs and citizen groups who were equipped with boats, rescued people from inundated situations and transferred critical patients and pregnant women to hospitals. Many people were rescued and moved to higher grounds, local hotels, or administrative buildings.

Fig. 2: Impact of flood in Silchar
Source: https://www.preventionweb.net/walk-though-history-disaster-risk-reduction

There was severe adverse impact on roads, railways, and air connectivity and it was cumbersome to make those operationalised in that condition.

The State Government in its swift response managed to make Silchar airport operational to provide an opportunity to ensure a speedy inflow of supplies and evacuation of the most vulnerable or who required tertiary level medical care. The challenge was to reach the airport. It is worth mentioning that those who travelled during the period had to wade through standing water which was up to chest level for more than 2-3 km to reach to the place from where they could get taxi etc.

4.2.1 Response by the State Govt. /District authorities and others: Swift response from the Govt. machinery was praiseworthy. Eight NDRF teams consisting of approximately 200 personnels and an army unit of approximately 150 personnels were deployed on June 21 for immediate rescue operations and aid distribution. The Assam government had also requisitioned the Indian Air Force (IAF) to airlift petrol, diesel, and geo-bags to Silchar to address the flood situation. Dry foods, water, and other essentials were air-dropped by the Mi-17 Helicopters of the Indian Air Force (IAF) in several places of the city, bringing immediate respite to the people without food and water for days. The State's humanitarian response was in consonance. The DC of Cachar managed boats and these were used to rescue people who were entirely in water. The district authorities were able to rescue many elderlies, ailing and pregnant women, and helped them to reach safe places and hospitals."

Many families including mine had no access to food and potable water for many days and had no means to boil or purify the water for drinking. We used to restore rainwater for drinking. The condition of the children was very deplorable, with no food, water and medicines. Over time, some Civil societies, such as BSS, Team Milaap, Rising Youth Society, Khalsa Aid, Marwari Yuva Manch, Hemkunt Foundation, Eco Alarmist, Jubashakti, and Robinhood Army, etc. started providing necessary items. Most of these CSOs were present on spot from day one. It was really challenging to distribute relief materials in that situation. In view of the ongoing flood problem Project '**Suraksha'** was initiated by District Administration in coordination with Impact Weaver to help out the distressed and connect with the people in need. Supply of drinking water and other essentials to affected families marooned by the flood was of utmost priority. So, DDMA Cachar pressed **Drone services** from Garuda Aerospace, Chennai for aerial transportation of those essentials to the needy.

The supply of clean and safe drinking water to the affected people in the midst of the flood crisis was effectively met by the Department of Public

Health Engineering with the active support of DDMA, Cachar despite the damages in river water ducts due to strong water currents. Large stock of packaged drinking water, chemical packets, halogen tablets and bulk water supplies were carried out together with construction of makeshift toilets.

Department of Health and Family Welfare supported by DDMA, Cachar rendered necessary health services to victims in relief camps/centres, camp like habitats and standalone community make-shift mobile centres. Special awareness cum response measures were undertaken by the department to prevent post-flood health outbreaks.

Number of Medical Camp Held: 2317 (approx.)

Number of Patient Treated: 2, 36,555 (approx.)

4.2.2 Water, sanitisation and hygiene: It is understood fact that public health is adversely affected in floods due to lack of clean water, absence of proper sanitation. It was time now to face challenges of clearing the debris, mud, silt, and dead bodies as the stagnant water recede in the city. Several families were forced to discharge dead bodies in the flood water with severe inundation and no access to the cremation ground and dry woods. The contamination of water bodies made water quality questionable and increased the risk of water-borne diseases in the city and nearby areas. The State pressed 13 water pumps into service to clear the water-logged areas. Another challenge as the water started receding was restoring the water supply and ensuring proper sanitation in public places. It was found that most of sources of water were contaminated and toilets were useless owing to water and choking. Agencies involved in relief were distributing bottles and pouches of drinking water. All the relief agencies provided packaged drinking water to the people. Tankers and Water Bowsers were made available by the District administrative and NGOs involved. But there was no arrangement of portable toilets.

4.2.3 Food, nutrition and health: It is evident and worth mentioning that access to food and potable water was severely disrupted during the flood and further accentuated due to closed roads, railways, etc. The only source of food and water was the supplies made by the administration, CSOs, and the Indian Army in the initial days. As the water recedes, there was a high risk of food shortage and malnutrition, especially amongst the poorer section of society. With most of the vegetables and crops destroyed, tillable lands covered with flood residues, sledges, and loss of other livelihood means,

access to food and proper nutrition was a big challenge for the near future.

Along with possible food insecurity, there was a high risk of water-borne diseases and other ailments. The human and animal dead bodies washed away in the flood water contaminated the water bodies and underground water. Another immediate challenge was access to prescribed medicines, as most of the pharmacies were closed. Those functional could only partially met the demands as the leading distributors' storehouses were inaccessible. The Silchar Medical College and Silchar Civil Hospital were functional but with skeletal staff. The Medical Officers, in many cases, could not reach their duty location. Several CSOs used boats and braved standing water to distribute medicines in the initial days and later organized medical camps in the most underserved localities. There was an urgent need to prevent disease spread due to widespread debris, contaminated water, rotting plants, animals, and human bodies.

Dr. Rupam Das, MD who had volunteered for the several medical camps organized by various Civil Societies affirmed that they were trying to provide medicines (both curative and preventive) on a case-by-case basis. Most people had complained of gastric issues, skin irritation, fever, cold, and loss of appetite. Fever and scabies are common among children. This had furthered health issues among many. One of the volunteered Doctor revealed that it was tough for the pregnant women considering the special care required at that time. Many women reported UTI, tingling sensations, weakness, loss of appetite, and menstrual problems. It would be pertinent to mention that, it became challenging to address the increased risk of mental stress and post-traumatic disorders, especially amongst the vulnerable sections of the city.

5. Post Disaster Livelihood and Economy

The discussion with the flood-affected families revealed that there was widespread loss of productive assets, employment, and income sources, and widespread loss of resources to restart livelihoods. Agriculture, one of the prominent livelihoods of the area, was badly affected. The entire investment in land preparation was lost, and the farmers were unsure of sowing crops after the water receded. Many lost their entire vegetable crop (such as ridge gourd, lady's finger, chilly, etc.), which was ready to harvest.

It was noticed that, as the water started entering into Silchar city, people on the outskirts started evacuating their animals to higher grounds or left them on national highways. However, many animals died from hunger as they were

stranded on higher grounds and roads for a long time. A poultry farmer said, that no sooner they came to know water level in Barak is reaching the danger level, they started selling their birds at substantially low rates. They could not recover the input cost. Pissiculture as reported was affected adversely. One of the residents added that it would be tough for people into pisciculture and poultry to bounce back and restart their livelihoods in immediate future.

Due to unavailability of data pertaining to total loss and the impact on the economy as well as the life of the people it is difficult to present the figure of estimated loss, however, it is not hard to predict that the economy of the area is severely affected due to the flood and bouncing back to normalcy would take humungous effort from the State and time. In the coming days, the failed crops and uncertainty has pushed people of the city into poverty and add to the food crisis.

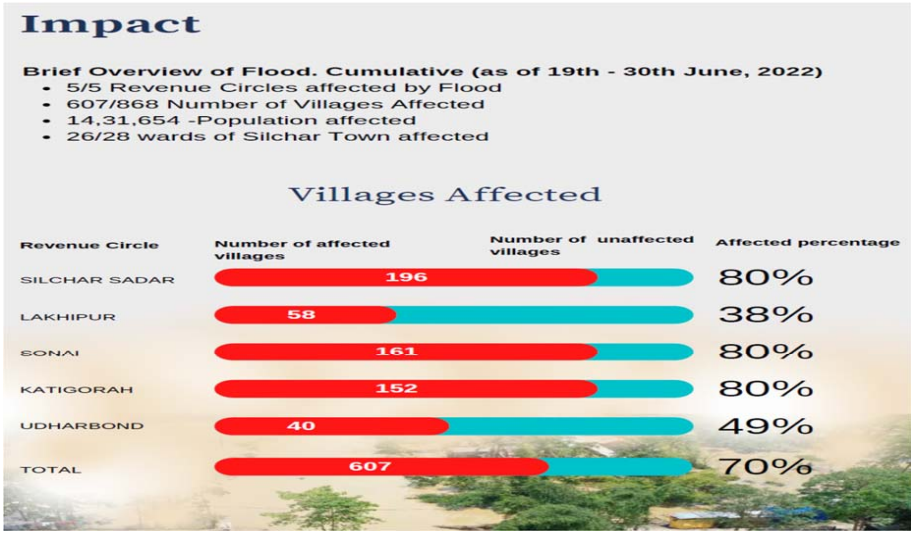

Fig. 4: Cumulative impact of Silchar flood, 2022
(Source:https://cachar.gov.in/sites/default/files/swf_utility_folder/departments/cachar_epr_amtron_in_oid_2/menu/departments/flood_management_2022.pdf)

6. Lesson Learnt and Way Ahead

Every disaster makes us to learn lessons and lessons learnt are of great help in Disaster Risk Response (DRR) in future. In the Case study in this paper, the flood scenario of Silchar in 2022 has been discussed. Though, anticipating floods of this scale in the region was challenging but being flood prone area, it cannot be out rightly said that it was unpredictable. Now a days technology in the field has advanced and with the proper use of the technology in place it could have been predicted in advance, if it was natural. The District Disaster Management

Authority (DDMA) has access to advanced technology [Flood Reporting and Information Management System (FRIMS)] and flood inundation mapping by NRSC for a real-time flood reporting system. Proper use of such advanced technology by developing proper know how could be instrumental in developing disaster preparedness plans thereby reducing the adverse impact on the people's lives, livelihoods, health, education, and financial assets. There is need to establish such system in even the remote areas.

It is understood that, immediate and quick response during any disaster is critical for effective disaster management, and if the community is empowered with knowhow of the technology in place and strategy to be adopted then the response time can be reduced considerably. To have a community-led response, it was a critical lesson learnt by the local civil administration and the health system. It was also learnt that there was need to have plan ready along with institutionalized community-based risk reduction mechanisms. Inter-agency cooperation is also needed. Timely response from NDRF, Air Force, Army, CSOs, and citizens emphasizes the criticality of the inter-agency cooperation for search, rescue, and extending humanitarian aid. Such inter-agency coordinated effort should result in a local "Rapid Disaster Risk Response Team" comprising of professionals (healthcare, fire-fighters, and rescue), civil administration and police, representatives of the local community, panchayat/corporation, and CSOs. Such actions must agree with the guidelines and protocols on Disaster Risk Preparedness, Disaster Risk Response, and Disaster Risk Response issued by the NDMA of India.

There is need to emphasize on conducting Hazard Risk and Vulnerability Analysis (HRVA) at regular interval and that too in a systematic manner. Toward dynamic disaster risk reduction strategies for the region and the State or in any part of the country, along with conducting HRVA, educating the community on risk reduction and an early response would be equally essential. With the experience of flood in Sichar in 2022, a fact has been re-established that the community if empowered adequately can be the first agency to respond to any disaster. If the community is educated well then in the long run, it will lead to an empowered set of citizens ready for effective and immediate flood response.

Another critical aspect that needs to be addressed is to develop an in built appropriate preparedness plans and capacities within the health system at micro level. Contentious capacity building for medical team is appropriate and this priority should be addressed. These are essential and non-negotiable. Ultimately, strengthening the disaster risk governance is paramount. Investment and political will is also required to enhance the resilience of communities and promote effective Disaster Risk Response (DRR) and Disaster Risk Reduction (DRR).

Human behaviour during the disaster is critical. The panicky and lawless

behaviour of the affected population, which is widely discussed academically, was observed in Silchar. Several cases were reported where relief materials were snatched away, or boats carrying relief materials were diverted. Several localities reported attempted burglary cases. It highlights crucial considerations for disaster preparedness. Thus, for effective disaster risk reduction and preparedness, it is necessary to develop a mechanism through people to be counselled towards their behaviour during any disaster.

Despite all there was an overwhelming pro-social and altruistic behaviour of citizen groups and CSOs aimed at promoting the welfare and protection of fellow citizens. Such experiences highlight the importance of investment in bolstering social capital, reciprocity, and resilience within the community. The presence of formal and informal networks at the disaster site resulted in an instant trigger of the support mechanisms and thus calls for an investment in a more planned system to be in place and in education towards Disaster management.

After the Disaster recovery is important and there is always need of V shaped recovery instead of U shaped recovery. For speedy recovery, it is suggested that people should learn from such disaster and they must take insurance (life, assets, health, crops, and general categories) to protect their livelihood resources, life, and houses. It re-emphasizes the importance of crop and other insurances for people living in high disaster risk zones and highlights the role of the State in ensuring the social security of the citizens, especially those who are particularly poor and vulnerable.

6. Conclusion

As geographical condition, India is traditionally vulnerable to natural disasters. Floods, droughts, cyclone, earthquake and landslides have been a recurrent phenomenon. The vulnerability in our country is more as comparison to the developed countries. Due to this there is huge loss in terms of human, financial, environmental and livelihood every year. Disasters owing to climatic events like floods, landslides, earthquakes create great negative impact. Due to its unique topography and location, various places of the country and particularly Silchar (place under study) located in the Northeast India is vulnerable to climate disasters. A wide range of disasters, including floods, landslides, and earthquakes, significantly keep affecting the region.

Further, in order to prevent disasters and reduce their effects, there is need to invest in resources including investment in both technologies for tracking and predicting disasters, such as, weather forecasting tools, and sturdy and long-lasting infrastructure and safety monitoring device. In addition, the administration must understand the potential dangers and difficulties of various disasters to adjust their reaction strategies. So far North Eastern region is concerned, it is feasible

to assume philosophically that environmental determinism is a significant factor to development in Northeast India. However, policy interventions at different levels have created possible probability, which might reduce the disaster risks in the region. It is also suggested that improving communication during the events, e.g., targeting people in rural and remote areas with prevention messages (Peden et al., 2017), and social media may play an important role.

It is evident from the outcomes of various research and practitioners' experiences that the impact of any disaster on individuals, households and societies is not one-dimensional but it is multidimensional. Any attempt to reduce the impacts would include conscious interventions towards understanding vulnerabilities, reducing risk, enhancing resilience, and strengthening community preparedness, while mainstreaming disaster risk reduction (DRR) measures into development thinking and planning.

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Centre for Disaster Management (CDM)
Lal Bahadur Shastri National Academy of Administration (LBSNAA),
Mussoorie - 248179, Uttarakhand
Telefax: 0135-2632655; 0135-2222000 (Extn-2385)
EPABX: 0135-2632489, Fax: 0135-2632350, 2632720
Email: cdm.lbsnaa@nic.in