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Lal Bahadur Shastri
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CENTRE FOR DISASTER MANAGEMENT (CDM)
Lal Bahadur Shastri National Academy of Administration (LBSNAA),
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DIRECTOR'S MESSAGE

Abhiram G. Sankar,

Director,

Centre for Disaster Management, LBSNAA, Mussoorie

Disaster have adversely affected human civilization since the down of our existence. Natural 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 the recurrence of major natural and human induced disasters. In response, various strategies have been formulated and implemented with regards to mitigation, prevention, response, rehabilitation and reconstruction during pre-disaster periods. All these efforts have the same goal: Disaster Management and Disaster Governance.

No administration can afford the luxury of waiting for 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 s of Disaster Management.

It gives me immense pleasure to note that Centre for Disaster Management, LBSNAA is bringing out an edited Journal "Disaster-Response and Management" Volume 8, Issue 1 for the year 2020-21 under the project "Capacity Building on Disaster Management for IAS/Central Civil Services Officers" sponsored by National Disaster Management Authority (NDMA, Government of India.

This is a compilation of research articles providing insights in recent trends in disaster management. I hope this volume will add to knowledge base for disaster management in the country and will be useful for both the trainees and the administrators in the field. It can also serve as a good reference material for ATIs and CTIs for their in -house courses.

(Abhiram G. Sankar)

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CONTENTS

A Case study related to the Accident during Transportation of a Medical Radioisotope in General Public Area

Shashank S. Saindane[1], S. Murali[2], Sanjay D Dhole[3] and N. R. Karmalkar[4]

Abstract

This study aims to present hypothetical incidents during transportation of radioisotope to a nuclear medicine hospital from the airport or the radioisotope supplying unit, through a local municipal services perspective. The results help to present general consequences arising due to this radioisotope, while establishing a precise method of relevant incident management at Municipal level. Some scenarios pertaining to a single radioisotope is illustrated or demonstrated with the results in first few minutes which is a time frame to assess direct radiological effects on human beings which depends upon the wind speed, direction, terrain and can influence areas maximum about 1 km from the site of incident. The Iodine-131 (131I) radiation scenario is typically an incident in the public domain, regarding the radiation protection levels of the employee associated with transportation and the public gathering around the incident area. The use of HotSpot 3.1 model has indicated a type of protection that will mandatorily fulfill specific standards around the area. After research and referring to various references we faced significant lacking in briefing issues concerning local administrative bodies, when in parallel, administrative legal voids, lack of awareness and basic legislative measures were noted. This study will lead to creation of plan and implementation of special radiation protection plan in the public area from the radiological threat. The plan proposed can be affected by the municipal bodies to handle an emergency if it arises in their respective zone.

Keywords: *transportation, radioisotope, radiation protection, legislative, radiological*

1. Introduction

Nuclear medicine uses radiation to provide information about the functioning of a person's specific organs, or to treat disease. There is widespread awareness

of the use of radiation and radioisotopes in medicine, particularly for diagnosis (identification) and therapy (treatment) of various medical conditions. Over 10,000 hospitals worldwide use radioisotopes in medicine, and about 90% of the procedures are for diagnosis. Among developed countries (a quarter of the world population) about one person in 50 uses diagnostic nuclear medicine each year, and the frequency of therapy with radioisotopes is about one-tenth of this. In most cases, the information is used by physicians to make a quick diagnosis of the patient's illness. The thyroid, bones, heart, liver, and many other organs can be easily imaged, and disorders in their function revealed. In some cases, radiation can be used to treat diseased organs, or tumours.

Many radioisotopes are generated in nuclear reactors and also some in cyclotrons. Generally, neutron-rich ones and those resulting from nuclear fission need to be generated in reactors; neutron-depleted ones are generated in cyclotrons. To name some of the radioisotopes originating from reactors are Bismuth-213, Caesium-137, Iodine-131, Cobalt-60, Phosphorus-32 and Molybdenum-99 generating Technetium-99m and other isotopes generated from accelerators are Fluorine-18, Indium-111, Iodine-123, Iodine-124, Krypton-81m (13 sec) from Rubidium-81, Rubidium-82 etc.

The medical use of radio-iodine is for the diagnosis and treatment of various thyroid disorders. There are two isotopes of iodine, used viz., 123 I, primarily a gamma-emitter with a short radiological half-life of 13 hrs, and 131 I, a beta and gamma-emitter with a longer radiological half-life of 8 days. Since greater cellular damage or cell death is feasible due to high energy beta emissions of 131 I than by the gamma emissions of either isotope, 123 I is now the preferred choice for diagnostic studies of the thyroid. Its short half-life and its mainly gamma emission reduce potential radiation effects on the thyroid.

In this study one of the nuclear medicine radioisotope 131 I is considered as it is the most commonly used iodine radioisotope, and it decays mostly by beta-emission (606 keV; 90%). It is well-known for causing death of cells because it can penetrate other cells up to several mm away. For this very reason, 131I is used for the treatment of thyro-toxicosis (hyperthyroidism) and some types of thyroid cancer that absorb iodine. 131I isotope is also used as a radioactive label for certain radiopharmaceutical therapies, e.g., 131I-meta-iodo-benzyl-guanidine (131I-MIBG) for treating pheo-chromocytoma and neuro-blastoma. 131 I also emits high energy gamma radiation (364 keV; 10%) that can be used for imaging. Adverse reactions with the use of 131I include myelotoxicity, swelling and tenderness of salivary glands, nausea, vomiting, dry mouth, and hypothyroidism.

In India, Atomic Energy Regulatory Board (AERB) is the national regulatory authority for enforcement of the regulations for safe handling of radiation sources and transport of radioactive materials. The concern during transportation is for 131I with respect to 123I due to its half-life.

2. Hypothesis

Hypothetical scenario is formulated to present simplified scientific information of a radiological incident, to a non-specialist or non-technical government servant enabling to comprehend and act upon. Also due to data confidentiality, we limited our scenarios at a level accessible to local civil servants. Data is used at primary conceptual and practical level. The case study focuses on estimating consequences of a radiological incident within a Municipality area it also shows potential feedback to a local emergency plan, concerning civil protection and self-protective measures in accordance with scientific and civil protection services instructions.

Basic hypothesis is as follows: A transport carrier carrying radioisotope 131I met with an accident. Three potential cases are feasible, as follows:

1) Truck toppled down while the 131I isotope package kept intact or 131I consignment came off from the package / container.
2) Fire in the 131I consignment as the transport carrier met with an accident.
3) Due to impact of the accident an explosion occurred involving 131I.

The three scenarios mentioned above are the likely events which can take place and consequences are found for a 3 to 5 sq.km area, after taking into account meteorological data, terrain and natural properties of the emitted material are calculated. A time frame of 15-45 minutes after the incident is considered vital, in order to inform citizens promptly and effectively, therefore immediate information about the expanded results of a radiation release is of great significance. Scenarios are selected on the basis of larger impact scenario. Then, results are stated into three conditions, utilizing essential meteorological data of the region and mainly the maximum wind intensity in a city.

2.1. Brief description: An Incident involving transportation of 131I

Facilities that use radioactive iodine in research, medical diagnosis, and medical treatment and vehicles that transport the material could also be sources of exposure as a result of an incident. However, such processing laboratory/ nuclear medicine facilities or vehicles would not involve the quantities of radioiodine as that is

present in an accident originating from operating Nuclear Power Plant (NPP). Principle of assessing the radiological impact/ consequences and developing response plans for all potential types of incidents associated are the same as those of NPPs. Objective of emergency response to incidents that involve these types of facilities including NPPs are the same: to ensure public safety and to minimize the radiation exposure effects.

An analysis (Hotspot 3.1, 2017) that simulated release of large quantities of 131I from a transport fire showed that the evacuation zone for a 50 mGy (5 rad) dose to the thyroid was within the normal area of evacuation for a fire of the size that would be needed to release all the radio-iodine typically in such a facility. A radiological dispersal device (dirty bomb) scenario associated with a transportation incident also indicated that the evacuation zone for a 50 mGy (5 rad) dose to the thyroid was in the normal area of evacuation. In general, the large-fire scenario results in more dispersion of the radioactive iodine than a dirty bomb containing approximately the same amount. Therefore, existing actions on emergency response by local first responders to these incidents constitute a sound basis of an emergency response.

Many packages containing radioactive materials are transported to, from and within the country annually. Accidents and incidents involving these shipments are rare. However, there is always the potential for such an event, which could lead to a release of the contents of a package or an increase in radiation level caused by damaged shielding. These events could result in radiological consequences for personnel involved in transport. As transportation of any radio-consignment occurs in the public environment, such events could also lead to radiological consequences for the members of public.

Department of Atomic Energy (DAE) together with AERB and Radiation Emergency Response Centre (RERC) are in loop during the transport of radioisotopes. The installation of radiation detection equipment (RDE) at all ports, airports and portable type radiation sensors installed in police patrolling vehicle in major metro cities is a relatively recent development. There were few events of incidents involving the radioactive material. Some of these were detected by installed RDE at ports, and some by the police agency. The step of installation of monitors has increased the detection level and thus has not resulted in any radiological consequences.

The typical possibilities that could arise during the transportation accident are:

i. Transport consignment getting involved in the fire event

ii. Transport consignment involved in an explosion due to accident impact

iii. Transport carrier overturned and the shipment got into loss of containment, leaked from the container.

iv. Theft of the radio-consignment from the incident area

3. Results and Discussions

During the transportation of radioisotope 131I the scenarios envisaged have been indicated earlier. The assumptions made for calculations are that the source term is of 3.7 E+10 Bq, wind speed is 4.16 m/s and results are calculated using HOTSPOT ver 3.1.

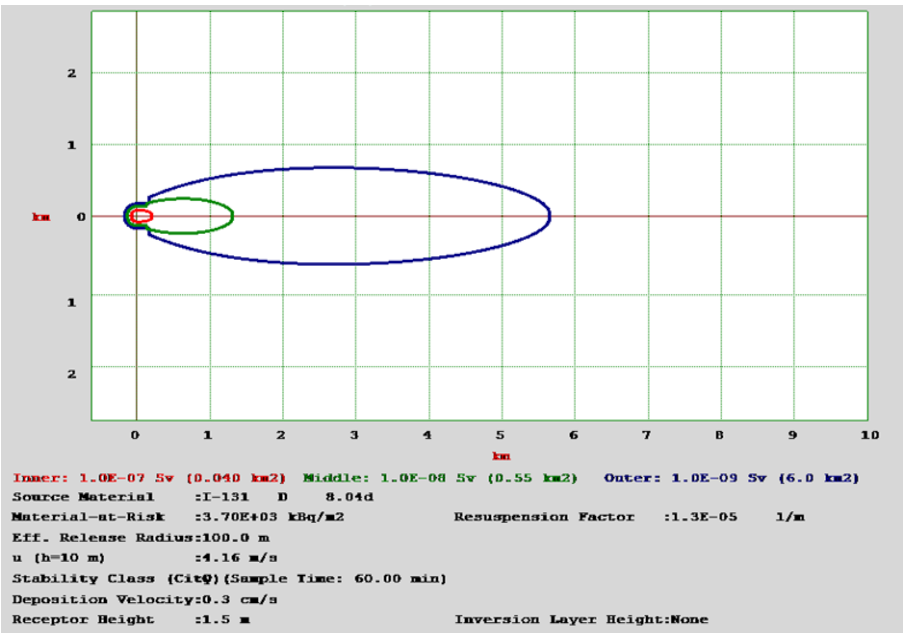

Figure 1: *Effect of plume contour –TEDE (Sv) during spilled incident displayed on grid*

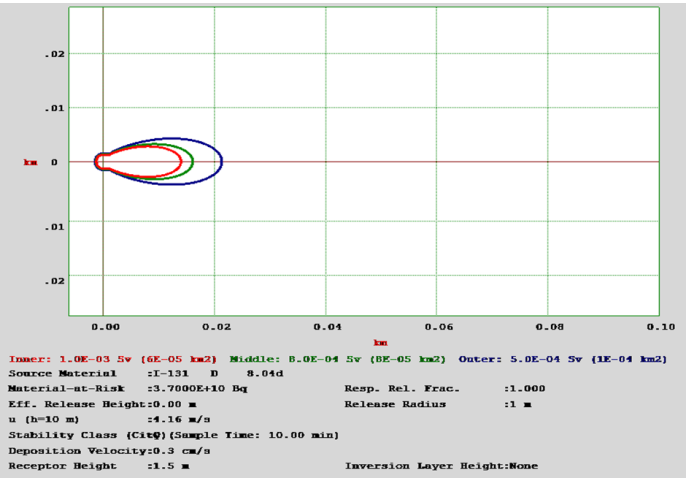

Figure 2: *Effect of plume contour –TEDE (Sv) during fire incident displayed on grid*

Case 1 is if the source is spilled in the accident and the contamination level is 3.70E+03 kBq/m^2 then maximum Total Effective Dose Equivalent (TEDE) will be 3.33E-07 Sv at 10 m. The relevant parameters considered for the calculations are listed in the plume contour (as shown in figure 1). Case 2 - If the transport catches fire then the Maximum TEDE will be 1.63E-03Sv at 10 m and is illustrated in figure 2. Case 3: If the truck containing radioisotope explodes then the TEDE at 10 m will be 6.22E-05 Sv the effect is shown in figure 3 and the area affected is shown in figure 4. The summarized interference from the output of Hotspot is tabulated in table 1

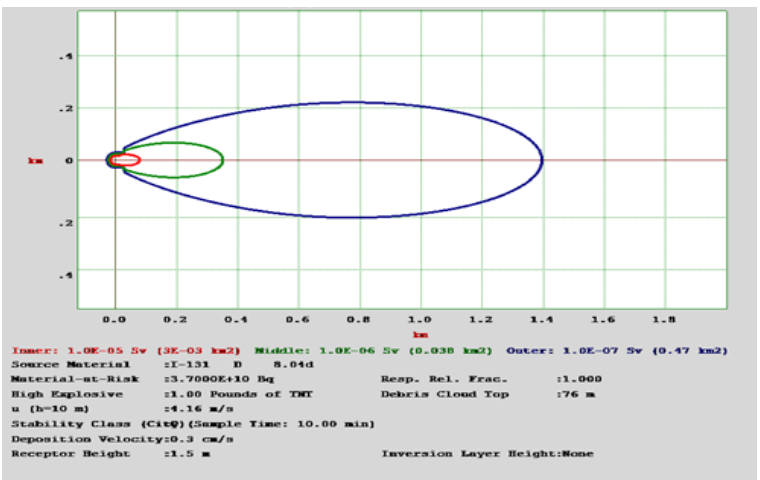

Figure 3: *Effect of plume contour –TEDE (Sv) during explosion due to head-on collision during transportation*

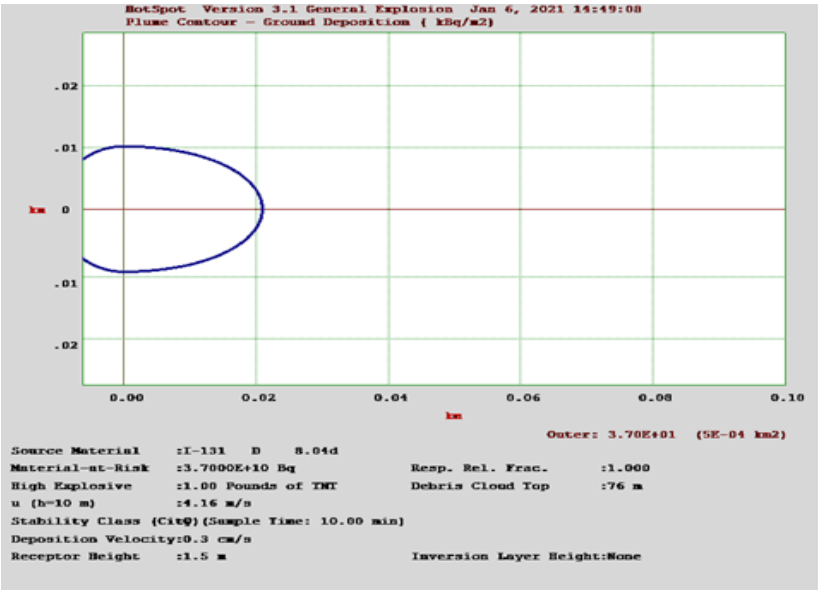

Figure 4: *Contaminated area in the plume area after the explosion due to head-on collision during transportation*

Table 1: Summarized effect due to three different types of incidents

Type of incident	Dose and area affected in terms of different cordon zone			Maximum Total Effective Dose Equivalent
Spillage	IC – 1.0E-7 Sv (0.04 km^2)	MC- 1.0E-8 Sv (0.55 km^2)	OC -3.33E-7 Sv (6 km^2)	TEDE 3.33E-7 Sv (at 0.01 km)
Fire in the transport	IC – 1.0E-3 Sv (6E-05 km^2)	MC- 8.0E-4 Sv (8E-5 km^2)	OC -5.0E-4 Sv (1 E -4 km^2)	TEDE 1.63E-3 Sv (at 0.10 km)
Transport explosion	IC – 1.0E-5 Sv (3E-03 km^2)	MC- 1.0E-6 Sv (0.03 km^2)	OC -1E-7 Sv (0.47 km^2)	TEDE 6.22E-5 Sv (at 0.10 km)

Where IC is Inner cordon; MC is Middle cordon, OC is outer cordon and TEDE is Total Effective Dose Equivalent is the sum of dose received from materials outside and inside (mainly inhalation) to an average human-being.

Observations

The general problems faced by response agencies during such incidents are:

1. Lack of information / awareness about these type of incidents to legal agencies.

2. Fear of radiation while handling the situation.
3. Creates panic in the public place.
4. Though information is specified on the back of container regarding contact agency details, then also mistakes are made.
5. Lack of radiation monitoring instruments / gadgets with police / fire agency to respond to this type of emergency.
6. Handling of contaminated casualties in case there is spillage of radioisotope.
7. Cordoning the area and maintaining law order is a challenge in the public place.
8. Proper media management should be there to avoid panic situation in the public.
9. Timely communication, coordination with CMG-DAE, AERB, NDRF-ERCs.
10. Coordination among different government agencies during such type of response.
11. Bringing the situation back to normal is the biggest task.

4. Conclusion

Scenarios stipulate radioactivity exposure which during the first ten minutes may have large spatial results. Depending on weather conditions, Municipal area may be more or less effected. Radionuclide expected to affect the area will initially affect individuals by inhalation and ultimately by ground deposition. A municipal body can use basic tools for a primary assessment of radiation emergency event and perform mock exercises on scenarios, to be prepared. Local civil servants, as they are not familiar with full dimensions of radiological incident, they need to admit that a plan – which enables immediate contact with relevant scientific and emergency response authorities – is actually of vital importance. Consequently, a local emergency response plan for the Municipal region has to be implemented, focusing on timely and effective actions and being based on coordination (basic principle of emergency treatment and management). Municipal civil services should be aware of the possible risks affecting their area and have a working emergency response plan, in order to establish procedures which will enable prompt cooperation with

competent authorities and appropriate assistance to their work. The plan must also take into consideration a recovery phase, promoting cooperation including decontamination of the site and psychological support of victims, families. The standard operating procedure (SOP) needs to be formulated emphasizing on coordination, cooperation among competent operators, distributing precise roles, before, during and after an event.

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2. https://www.aerb.gov.in/images/PDF/CodesGuides/RadiationFacility/Transport/1.pdf
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The Tragedy of Lightning Deaths in India

Paras Nath Rai, IPS (Retd.)[1] and Neeraj Kr Singh[2]

Abstract

Lightning is a common natural disaster in India accounting for large number of deaths every year in many states. The year 2020, saw an unprecedented number of deaths by lighting in the state of Bihar and parts of UP triggered by extreme weather in months of June and July. Consequently, the weeks ranging from the end of June to the beginning of July reported the highest number of deaths by lightning in the year. Lack of awareness and preventive action in rural areas are primary reasons for such deaths in India. There is urgent need to study this disaster and shifting focus from response to disaster risk reduction activities to address lightning deaths more effectively.

***Keywords*:** *Lightning, Death, Awareness and Disaster Risk Reduction*

Introduction

Lightning is a major natural disaster in India where most of the deaths occur in rural areas, with low levels of literacy and few buildings with lightning protection. "Out of 8,145 accidental deaths attributable to forces of nature, 35.3% deaths were reported due to 'Lightning', 15.6% deaths due to 'Heat/Sun Stroke' and 11.6% deaths due to 'Flood'." (Accidental Deaths & Suicides in India 2019, NCRB)[1]. Lightning is short duration and sporadic event and therefore it gets little attention except when several deaths happen on a single day. While floods or extreme temperature conditions last for longer duration and hence, both people and governments see those as threats.

Lightning is "Beautiful, but deadly". Viewed from a safe distance, lightning may seem poetically beautiful. At the same time lightning strikes have long been a leader in deaths caused by natural calamities, including floods and cyclones. Statistics from the National Crime Record Bureau show that more than 2000 people have died every year due to lightning strikes since 2005. As we do not have details of loss of livestock, economic loss and infrastructure damage from lightning it is not possible to write about them.

While lightning strikes do tend to affect the tropics more- the fatalities are unusually during extreme weather conditions. India is more prone to lightning because of its geographical layout too. In contrast, large number of cyclones occur

in USA but the average number of deaths per year is 49 only. Hence, even though storms are universal phenomenon, the high number of lightning strike related deaths in India show that lightning strikes tend to affect developing countries to a disproportionate degree, due to a lack of infrastructure and disproportionate reliance on outdoor work.

1 The Problem Statements

1.1 As mentioned above lightning deaths are reported every year in many states of India. Some of the states affected are Bihar, Madhya Pradesh, Jharkhand, and Uttar Pradesh according to data available with NCRB. However, year 2020 has been too bad specially for Bihar and eastern part of UP as the monsoon has been too good where a mix of meteorological and behavioural factors led to a very high number of deaths. This year there has been lot of convective or thunder cloud formation in the region along with extremely heavy and widespread rains, unusual for June and July. This is compounded by poor awareness of preventive safety measures among rural folks.

1.2 Bihar lost over 400 lives which is much more than previous years. June 25, 2020 was extremely sad day as no less than 100 People fell prey to this natural phenomena. In fact, the week June 24 to July 4 saw maximum number of deaths. There were 28 deaths on July 2 and again 27 people were killed on next day. There are clear connection between weather conditions and lightning deaths. Monsoon rains that have been both deficient and delayed in most of recent years was rather bountiful this year as Bihar received 66% excess rains from June 1 to July 2 and 77% excess in the week of June 24 to July 1 (Bihar Rainfall Statistics, India Meteorological Department)[2]. East Uttar Pradesh received 72% excess rains in the same period with 79% excess only in June 24 to July 1 week. Therefore when timely monsoons arrived this year farmers moved to their fields quickly to take advantage and fell prey to lightening.

1.3 Therefore most of the casualties are farmers, labourers and unfortunately children. The government of Bihar has announced ex-gratia of four lakh rupees each to the next of the kin of the deceased. Government arranged free treatment of injured persons too.

2. This called for a study to investigate the reasons that may have contributed to this phenomenon. The lightning incidents were studied on various parameters: details of incidents, background of victim, status of access to early warning, geographical features etc for better understanding of the disaster in order to develop preventive and mitigation measures in focussed manner for the most affected communities and areas. The findings are summarised below.

2.1 ***Spatial analysis:*** Bihar is a state of 38 districts. Of these, ten districts - Jamui, Saran, Banka, Gaya, Purnea, Nawada, Rohtas, Patna, Nalanda and Bhojpur, account for more than 50% of lightning deaths in the state (As per report of SEOC, Disaster Management Department Patna)[3]. As the map below indicates, the most affected districts are in western Bihar (Saran, Patna, Bhojpur and Rohtas). Incidentally, areas in the state of Uttar Pradesh adjoining the mentioned districts also reported a high number of deaths by lightning. A few districts in the south and east- Jamui, Purnia and Gaya also reported high numbers of deaths by lightning. Fatality districts, however, are spread across the state.

As there seems to be no pattern geographically, it is difficult to establish any correlation between districts to understand common causative factor. This geographical phenomenon needs to be studied. Could there be a correlation between the number of deaths/strikes and intensity of rainfall? Yes, there is a correlation between the number of deaths/strikes and intensity of rainfall.

2.1 ***Seasonal profile:*** Most deaths occurred in months of June and July which are the main monsoon months. Incidents of lightning deaths have also taken place in pre monsoon months of April and May. In 2020, months of June and July recorded 65% of reported deaths by lightning. This is consistent with data from previous years (2018 and 2019) where monsoon months of June and July have usually recorded highest number of deaths (As per report of SEOC, Disaster Management Department Patna)[3]. This is discernible from the graphical representation of month- wise data (Figure 2) of reported deaths by lightning in Bihar.

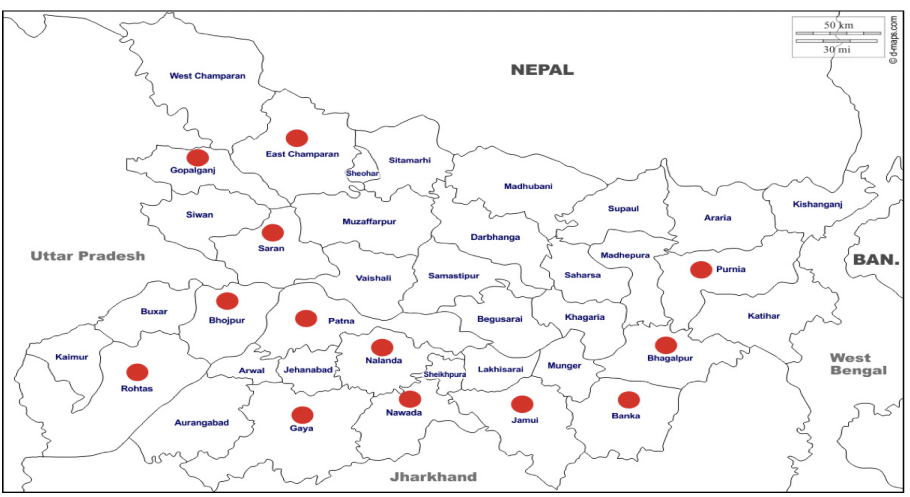

Figure 1: *Districts marked in red reported highest number of deaths*

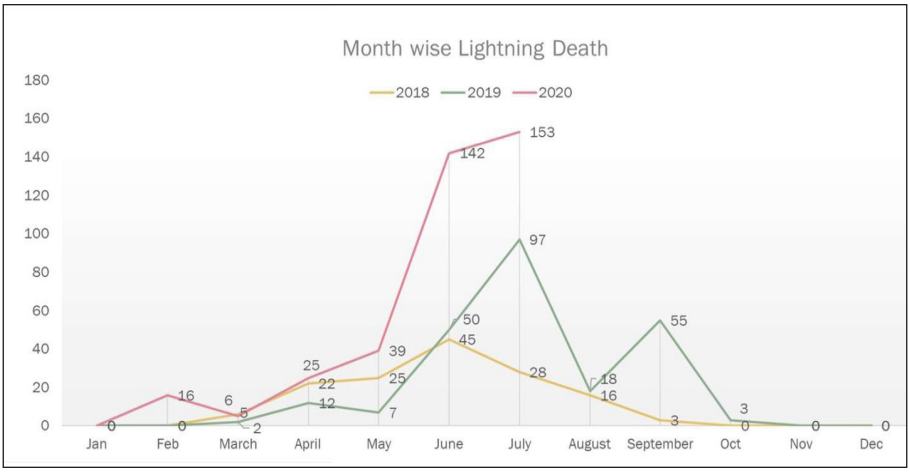

Figure 2: *Distribution of month-wise deaths by lightning reported across three years (2018-2020)*

2.3 ***Gender/Age profile of victims***: Most of the deceased (75 to 80%) are males between the age 10 - 50 years. Unusually large number, 70% children between age group 10-20 have been victim in 2020 (As per report of District Disaster Management Authority)[3]. This is rather unfortunate. The children were either assisting their families in farming activities or grazing of cattle or maybe they were simply playing/enjoying monsoon weather. The schools, colleges being closed due to Covid 19 has also contributed to such behavior. Significantly girls or women are less affected. This is not explainable. While it is true that women stay home for household work but many do join in the field as paddy plantation required intensive labor work.

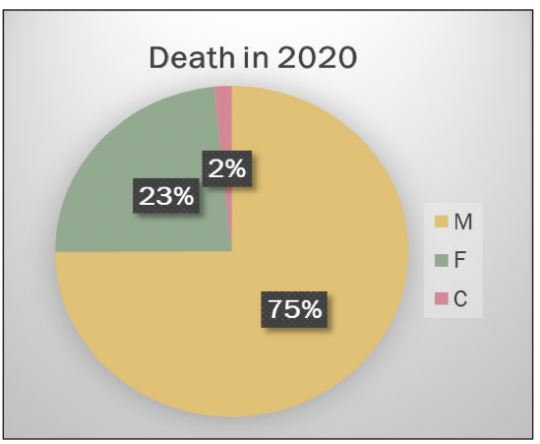

Figure 3: *Gender wise distribution (%) of reported deaths by lightning in 2020*

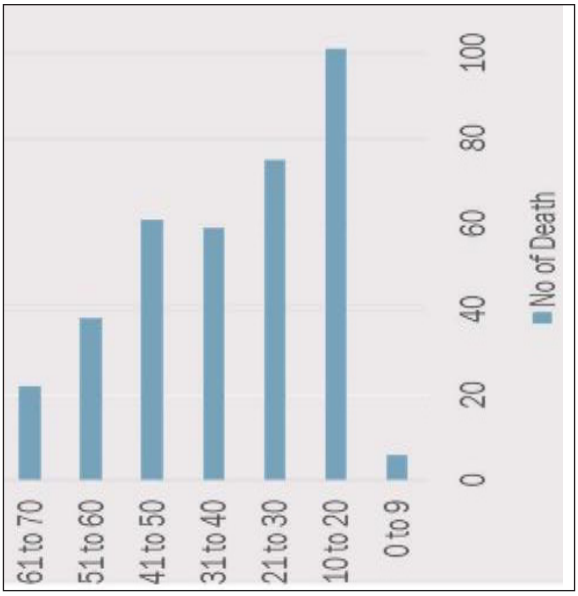

Figure 4: *Age-wise distribution (%) of reported deaths by lightning in 2020*

2.4 ***Time Frame:*** Majority of deaths happened during the period 1200-1600 indicating that afternoon is most vulnerable time for lightning than early morning and late evening (Figure 5). This, incidently is the main working time. Would there be any meterological relationship between time of the day and lightning strike. This needs to be studied.

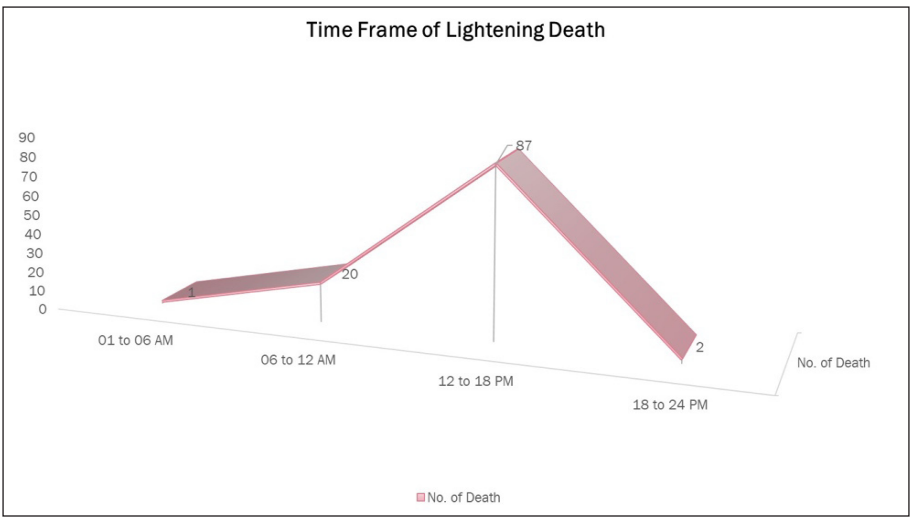

Figure 5: *Time-wise distribution of reported deaths by lightning in 2020*

2.5 *Circumstances of death:* Majority of incidents have been reported among those working outdoor in agricultural fields or related outdoor activity (Figure 6). June and July are the most active agricultural time of the year. Very few cases related to those inside house/building.

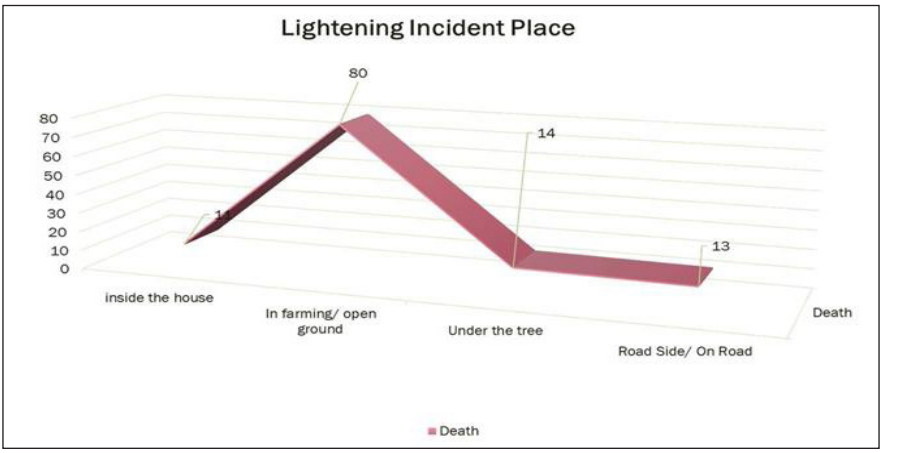

Figure 6 : *Representation of reported numbers of deaths by lightning based on location*

2.6 *Rural vs urban:* Analysis of data reveal that lightning is a rural phenomenon as 89 % of deaths are happening in villages ("Lightning Incidents Reports" of District Disaster Management Authority)[4](Figure 7). These deaths have occurred among people who were engaged in farming and related activities like grazing of cattle. A strong sense of ignorance of staying indoors in such adverse weather conditions is visible. Agreed that the villager's workplace being open area, they are exposed to the perils of lightning. There are very negligible number of deaths inside buildings/ homes or in urban areas. In urban areas people mostly stay indoors in their work place or homes. other reason could be that urban households are more aware of safety measures.

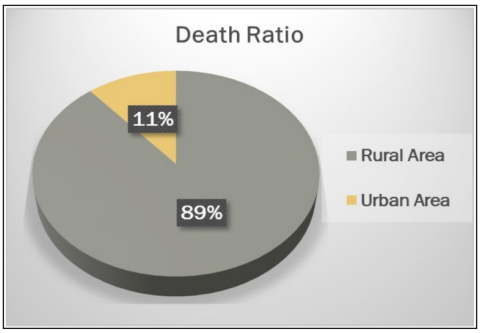

Figure 7: *Ratio of lightning Deaths in Rural versus Urban areas*

2.7 *Early warning:* Early warning is critical input in prevention and mitigation of the impact of thunderstorms/lightning. This could save many lives. Bihar has established lightning sensors for alerting the people through the application known as Indra vajra (https://state.bihar.gov.in/disastermgmt)[5]. This alert is available about 30 minutes prior to the lightning. This is being popularized. The concern is to reach those without android phones too. The IMD also issues "nowcast" early warning about thunderstorms, lightning. It is accepted fact that reaching such alert to people in villages specially the target group in a serious concern. Now early warning protocols are being developed. We hope for better tomorrow.

3. Conclusion: The study has revealed that lightning is a rural phenomenon with majority of deaths happening in villages among people working outdoors in monsoon times. They represent more than 80% of the total deaths. Further, it is seen that men were more affected as they were more likely to have engaged in outdoor agricultural activities in monsoon months prone to lightning. The afternoons were found to be more fatal. Further, the extreme weather events specifically excess rainfall with thunderstorms have aggravated the impact of this disaster. The study also identifies lack of awareness and preventive action in rural areas contributing to deaths by lightning in the state. To conclude, this report calls for increased investment in disaster risk reduction activities to address lightning deaths more effectively. The key to being safe in a thunderstorm is not to venture out for outdoor activities. In case one needed to go out, locate a safe place nearby and know how to stay safe while in the open. Although there is no data on deaths during fishing, boating, such activities, quite common in this period should be discouraged and fishermen/boatmen need to be advised to return to the safe places quickly.

4. What needs to be done: Central and state governments are seriously engaged in reducing the impact. We have national lightning action plan and state plans which cover short and long term activities including education, responsibilities of various departments and agencies and early warning. They are being implemented by states. Some of the important interventions are being discussed here.

- The **most critical intervention is promotion of behavioural change** among people- discouraging them to go out when weather is not favourable as there is poor education on how to safely respond to lightning. Most farmers, labourers and others wait for the storm to pass in their open fields or seek shelter under trees: the worst places to be. Sustained awareness compaign by village administration will do immense good. So will timely and accurate weather information.

- ***Early warning:*** Unlike the US, India lacks an effective lightning warning system that would inform farmers and labourers in fields. Timely and effective early warning is critical for preventing such deaths. However, predicting a thunderstorm over a pinpointed location is not possible. Nor is it possible to predict the exact time of a likely lightning strike. IMD can forecast approaching thunderstorms two to three days in advance but cannot pinpoint the location of lightning strikes that much ahead of time; its "nowcast" feature predicts the location of lightning, rains and thunder about 3 hours in advance. Most of the forecast is broad based- district level which is not very useful help to those responsible for dissemination of alert and preventive action on ground.

- Bihar and some other states Odisha and Telangana have established sensor based early warning system. Bihar has established 'Indravajra' recently which alerts people half an before the lightning. Ministry of Earth Sciences has developed Damini, though not very popular. However, as mobile phone penetration in certain areas may be low with not everyone having access to android phones and connectivity, serious and sustained effort is required to reach them. Thus there are serious concerns of accessibility of the alert to farmers, labourers etc working in field or engaged outside homes in this short time. Hopefully the alert system Indra vajra will be of immense help in coming days.

- In the given scenario, the following actions may help reach the alert to the vulnerable:

  - We need to install sirens in public/private buildings to alert people without android phone or not having access to mobile.

  - Loudspeakers in schools, temples, mosques or buildings will help disseminate the early warning.

  - L**ightning sensors and arresters** to protect building from lightning strikes. However, the urgent need is to install them in areas around working fields. These could be made from local resources ie bamboo, cycle rim. Arresters on School buildings, panchayat bhawans and in open space near working fields etc. Panchayats should be encouraged to install them. State Disaster Response Fund could be used to install them.

  - The high number of deaths by lightning among children is alarming and, therefore, adequate steps must be taken by community, families, schools and colleges to educate and protect children.

- ***Challenge of data:*** Even though lightning is the biggest contributor to accidental deaths due to natural causes, yet it remains among the least studied disaster. Occurrences of lightning are not tracked in India, as there is simply not enough data for scientists. States maintain details of death for purpose of paying ex gratia. However, good data including linkage to geographical features if any, weather conditions, profile of deceased and circumstances of death, accessibility to early warning and preparation of community can help the local administration to identify most affected places and communities and develop FOCUSSED ACTION for them.

- Since the impact is pre dominantly in rural areas, **capacity building of panchayats** is another critical area of work that requires attention.

- Building byelaws needs to be reviewed whether they contain sufficient provisions for safety against lightning specially for villages and semi urban places where the approval for a building is either not required or not obtained.

- In conclusion, promotion of behavioural change - stay indoors when there is threat of thunderstorm and lightning, supported by timely and specific weather information/ early warning from IMD and other sources is absolute must. The concern of large number of death of youngsters should be taken seriously and the community, schools and colleges be sensitized to protect their children. In addition, it must be emphasized that, as with other disasters there is urgent need for long term investments in prevention, mitigation and education. The funds available for mitigation and response in states must be suitably utilised. Finally, the disaster needs to be studied to derive policy interventions.

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The NAJAFGARH JHEEL
The Past, Present and Future of an Ancient Wetland

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Abstract

While the 19th century records mention a spread of 55 – 88 square miles during monsoon floods, changes in the hydrology of its catchments and particularly the drying up of the Sahibi river has reduced the flow into the Najafgarh Jheel. This study assesses the spread of the Najafgarh Jheel from historical records in the 19th and 20th centuries and satellite imagery and google earth images from 1977 to 2018 based on a visual assessment. Water spread areas are identified visually and their extent digitized on the images, to arrive at the extent of flooding in different years. Contour levels are also digitized to calculate area flooded at different contour levels. This study assesses the flooding level particularly in the last 10 years and finds that the 209 m AMSL which is about 900 acres is almost completely flooded in the monsoon months in most years. Within that a core area of about 400 acres is flooded almost all year around. In good monsoon years water can reach 210 m AMSL or more and the high flood level is 212.5 m. The study recommends that the (i) core area of around 400 acres which is mostly submerged be acquired as the core Jheel area, (ii) that the area with the 209 m contour is declared a No Construction zone, and treated to increase its water retention and natural water purification capacity. (iii) and that a moratorium is placed on construction in the buffer zone from 209-2012.5 m for at least 5 years till the hydrology of the area is stabilized.

Introduction

The Najafgarh jheel is a shallow wetland in the low-lying areas on the borders of Gurgaon district of Haryana and the National Capital Territory of Delhi between the 208 and 211m contour lines above mean sea level. The Jheel swells in area during the monsoon due to rainwater runoff from a large catchment of the Badshapur nullah, the Indori and Sahibi nadis in the southern Haryana and northern Rajasthan districts, and shrinks to a small core in the summer.

The Gurgaon district has sub-tropical continental monsoon climate. The rainfall is comparatively low and is mainly concentrated during the monsoons. Hot summer,

cool winter and unreliable rainfall are the peculiarity of the district. Gurgaon is a rolling plain dominated by the extensions of Aravallis. Aravalli offshoots are along the western parts of the district and extend up to the union territory of Delhi in north-east to south-west direction. These rocks are one of the oldest mountain systems of the world. The hillocks are dissected by rain fed torrents. The underground water levels in the district and especially in city, is decreasing drastically. The Central Ground Water Board has declared Gurgaon district as dark zone. Only about 20% of the rainwater Gurugram receives goes towards groundwater recharge, rest flowing into the city's storm water drains and the badshahpur nullah, which drains into the Najafgarh Jheel.

The city's rapid development has disrupted the natural surface hydrology and the flow of flood water, leading to drainage issues at several points. The city topography is such that there is a lot of difference between the highest and lowest point causing huge rainwater run-off. With the result, the area around the NH 8 around Hero Honda Chowk, Basai, Dhankot, Sector-37 etc. have massive urban floods. This has been accentuated by the severe changes in the surface hydrology of the area which has destroyed old, natural flow-lines of stormwater. Urbanization and concretization of large parts of the city has also greatly increased the surface runoff. Gurugram's Ghata Jheel, Badshahpur Jheel, Khansa Talab, etc acted as stormwater buffers and the first line of defence and which drained into the Najafgarh Jheel, through the Badshahpur nullah, and ultimately into the Yamuna river. However, many of the natural water channels and drains, natural water bodies, and green areas no longer exist, forcing stormwater along new channels and causing frequent waterlogging within the city.

The Najafgarh jheel or waterbody is a low-lying area of vast expanse situated on NCT Delhi -Gurugram (Haryana) border. It is spread in Ghummanhera, Shikarpur and Jhatikra villages in NCT Delhi, and Budhera, Dhankot, Kherki Majra and Daulatabad villages of Haryana, together forming the largest seasonal wetland of this region. Historical records, based on 12 feet rise in water level observed at Nanak Heri water gauge in Delhi, puts the extent of this jheel between 52 ½ (1833) and 88 ½ square miles in the 19th century (Delhi Gazetteer, 1883). The water flows in this jheel primarily from the Sahibi river system, which originates in the Rajasthan Aravalli hills near Jaipur and passes through Alwar, Rewari and Gurugram districts. In recent decades the flow in the Sahibi river has considerably reduced due to construction of dams in Rajasthan part, thereby reducing water flow into the jheel. However, Badshahpur Nullah, which drains the Gurugram city, is now contributing significant water flow to the jheel. Due to rapid urbanization and increase in concretized impervious surfaces in Gurugram city, this runoff increases substantially during the monsoons. Further, discharge of treated (and untreated) sewage happens throughout the year and adds to the baseload.

1. Review of Najafgarh Jheel

Instances of heavy flooding have been recorded in the Sahibi Basin during the years 1967 and 1977. The cataclysmic floods of 1977 caused huge disruption and kept parts of Delhi and Gurugram under water for more than 14 weeks. The water levels in the Sahibi river arose dangerously after 2 heavy downpours in the months of July and August during 1977 that led to the drain breaching in 6 places between Dhansa and Kakraula. Najafgarh Jheel experienced immense pressure carrying a discharge of about 6000 to 6500 cusecs against its capacity of 3000 cusecs (GoI, 2014). Flood like situation was again created during the 2010 heavy monsoons (OGD, 2010) when more than 4000 acre area in and around the Najafgarh Jheel was inundated.

The rains of July 28, 2016 in Gurugram saw the worst flooding observed during recent times. A precipitation of 46 mm left Gurugram city gridlocked and created a traffic jam that lasted more than 5-20 hours in various parts. The ordeal is now an urban event in the collective memory of the city having earned the infamous name of "Gurujam". Backflow from the Nullah caused havoc in the city as several points along the Badshahpur Nullah were blocked from silt deposits and constrained due to narrow width near Hero Honda chowk on national highway NH 48. As the natural water flow into the Najafgarh Nullah was blocked, the water flooded streets of the city. Haryana Government blamed the Delhi government for shutting down the sluice gates of the Najafgarh drain that led to the Badshahpur Nullah filling up to the brim, though the Delhi government denied having done so. Last year in 2018, heavy rainfalls again flooded the roads and the city witnessed bumper to bumper traffic.

A major reason for this unprecedented flood has been the increase in construction activities since 2003 onwards in and around the Najafgarh Jheel depression and the upstream catchment. The Jheel has historically acted as a storm water regulator for the entire region and ignoring this role of this waterbody and other waterbodies by city planners has proved disastrous for the city- a scenario that many cities in the new, urbanized India are facing and realizing to their detriment. Sector 108, Gurugram and nearby areas, which were flooded and submerged in 2010, have since been brought under construction. This sector lies directly in the core flood-zone and has always served as a holding area for floodwaters. Urbanization should have been carefully planned in this area by factoring in the surface hydrology and historical submergence data.

In fact, owing to its position as the largest natural creek in the region, Najafgarh drain has always plays a vital role as the main regulator of excess floodwaters for both Gurugram and Delhi. Smaller natural creeks like Badshahpur Nullah which traverse through the whole Gurugram city from Ghata in Aravallis in the east to Khandsa in the west, eventually drains into the Najafgarh drain. Natural

topography of the city funnels all the water down from Aravalli Hills into the Badshahpur drain, and ultimately to Najafgarh jheel. The Jheel has historically acted as a temporary holding area for these stormwaters before infiltration into the ground or onward draining into the Yamuna river.

As an adaptation to the changes, many farmers on south side of the Najafgarh Nullah have deepened their land and created permanent water bodies which are used for fishing and irrigation. They often plough back the water hyacinth. Every year during monsoons, large portions of these lands are flooded over and above the identified levels of permanent water bodies.

This study analyses the extent of inundation in recent years by visual interpretation of Landsat satellite images as well as Google Earth images. This has been cross referenced and collated with the contour levels depicted in Survey of India Map of 1966, 1976 and later years.

The Najafgarh Nullah and Jheel area has become a biodiversity hotspot and shelters many endangered species of water birds and also aquatic plants. (ToI, 2018). It has a bird species sighting count of 277 (from E-bird-2019)., the highest count of all locations in Delhi

2. Objectives

a. Establish the historical behaviour of the water body.

b. Establish changes due to change in surface terrain in recent times due to urbanization.

c. Explore possible solution to enhance/preserve the traditional role of this waterbody in ground water table of the region.

d. Explore the possibility of establishment of a bio-diversity rich habitat with participation of the local villagers.

3. Scope of the Study

Ecologically, the Najafgarh Nallah and Jheel have acted like a seasonal wetland since times immemorial and have always supported a rich flora and fauna. The drainage of Southern Haryana, i.e., specifically the historical Gurgaon district has been dominated by the water flowing from the Aravallis. The British found a network of 'Badshahi' Bunds in this region in various states of repair and disrepair and made serious attempts to drain the two major depressions of the area- the Kotla and the Najafgarh Dahars.

The first scientifically detailed account of the drainage and bundh network of the area was the Memo dated. 29th March, 1890 by Mr. J.R. Machonachie. In 1938 Captain Duran constructed a canal to carry off and drain the jheel into the Yamuna. This was only partly successful and the surplus waters from the Jharsa-

Ghata-Gwalpahari-Rajokri-Nathupur- Gairatpurbas-Behrampur chain of bundhs as well as the excess waters from the Sahibi system continued to drain into the jheel. The extent of these waters can be gauged from the fact that the 1943 report by Sh. Akhtar Hussain, ICS states that when the Ghata bundh is full then it covers four square miles' area (640 x 4 = 2560 acres) with water of average depth of three feet and is twenty-two feet at its deepest.

In a nutshell, the Najafgarh jheel has always been an important natural feature of this region and has played important multiple roles as a storm water regulator, water storage buffer and with a defining role in maintaining groundwater levels of the region. This waterbody is today even more critical for climate change mitigation and for the preservation of a biodiversity hotspot in a highly urbanized and populated part of India. The present paper seeks to establish the crucial role such natural structures played in the ecological stability of the region and the effects of its destruction/neglect.

4. Data Collection

Keeping in view the objectives of the paper, following documents were collected as primary, secondary & tertiary data:

i. Review of Survey of India maps of 1969-70, 1977-78.

ii. Landsat images of 1977.

iii. Google earth images 2010, 2012, 2013, 2016, 2017 & 2018.

iv. UAV Drone data (from the Gurugram Metropolitan Development Authority, 2018).

The UAV primary data was collected through drone imageries of the area by the Gurgaon Metropolitan Development Authorities (GMDA) during April/May, 2018. The same was geo-rectified and DEM's generated from the same. The other primary data was collected from Google earth imageries dated 2010, 2012, 2013, 2016, 2017 & 2018.

Landsat MSS data of 24th September, 1977 along with secondary and tertiary data were collected from Government documents like survey of India, Irrigation department Haryana etc. Survey of India Maps of 1969-70 and 1977-78 were reviewed to establish the boundary of the water body and contour levels.

Sahibi Basin Survey carried out by the Irrigation Department was also used in determination of the extent of the area under seasonal in emendation.

5. Results

i) The area enclosed by different contours

The area enclosed by the contours of 209, 210, 211 and 212.5m is depicted in the Google Earth imagery shown in Figure 1. In this region, Najafgarh drain comprises

the state boundary between Delhi (on north side) and Haryana (on south side). The contours lines enclose area of the Sahibi River basin on both side of the state boundary as given in Table 1.

Table 1: Area within different contour lines

Contour	Haryana	Delhi	Total
211 m	5349 acres	8143 acres	13492 acres
210 m	3436 acres	2805 acres	6214 acres
209 m	917 acres	1638 acres	2555 acres

ii) Area flooded in 1977

The extent of submergence in post monsoon period of the year 1977 is depicted in the Landsat MSS image given in Figure 2. The water is fully covering the 211m contour level and rising further. The 212.5m contour is drawn only on south side i.e., only Haryana side of the Najafgarh drain. The area computation shows that the water submerged a total of 84786 acres on both sides. An area of 39795 acres was submerged below the Najafgarh Nullah (of which 33392 acres are in Haryana) and 44991 acres above the Nullah, i.e., in Delhi. During this year, an area of 12871 acres was flooded in Gurugram district.

iii) Extent of water logging in the past decade

The extent of area flooded in years 2010, 2013, 2016, 2017 and 2018 as digitized in the Google Earth images are depicted in following Figures 3-7. In addition to the above mentioned five specific images, three more images of post monsoon days i.e., 12.10.2011, 09.09.2016 and 27.11.2016, available on Google Earth and these were also referred for assessment of the submergence area. These images are placed in the Figures 5-10. The lean season submergence area references were taken from one summer season image of 29th June 2012 (Figure 11) and another winter season image of 28th February 2013 (Figure 12).

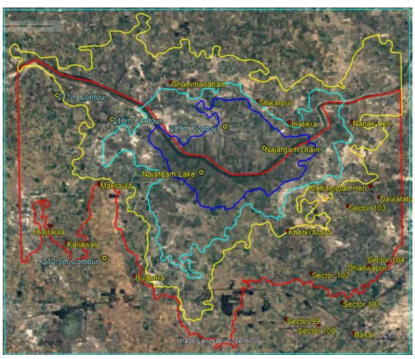

Figure 1: *Area enclosed by 209, 210, 211 and 212.5 m contours*

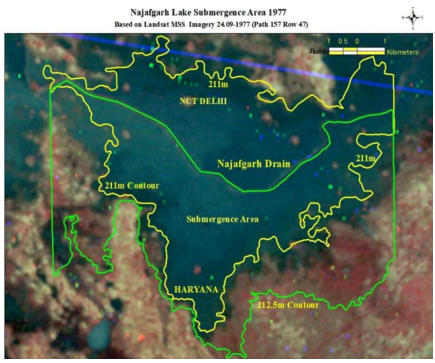

Figure 2: *Inundation of 1977 floods captured in Landsat MSS imagery*

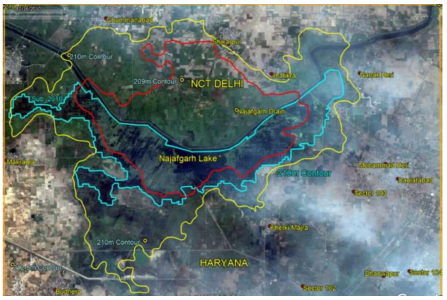

Figure 3: *Submergence in 2010*

Figure 4: *Submergence in 2013*

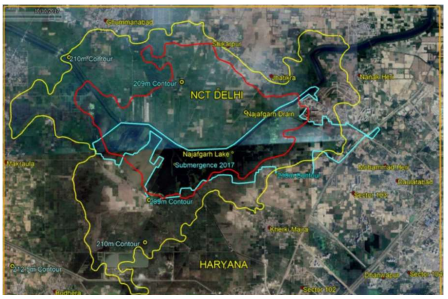

Figure 5: *Submergence in 2017*

Figure 6: *Submergence in 2016*

Figure 7: *Submergence on 12.10.2011*

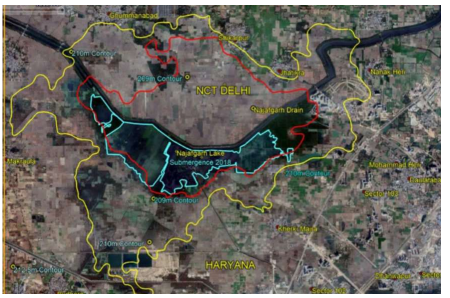

Figure 8: *Submergence in 2018*

Figure 9: *Submergence on 27.11.2016*

Figure 10: *Submergence on 09.09.2016*

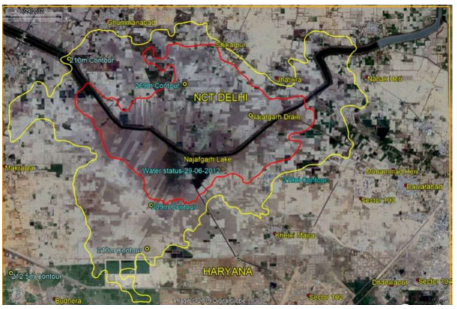

Figure 11: *Summer season submergence on 29.06.2012*

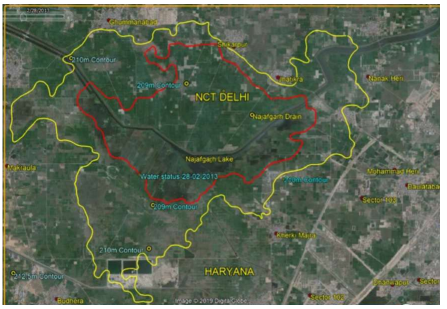

Figure 12: *Winter season submergence on 28.02.2013*

iv) Average post monsoon submergence

From the above-described extraction of submerged area from the time series satellite data, it emerges that on an average about 1400 acres of area on south (Haryana) side of the Najafgarh Nullah undergoes periodic flooding in the post monsoon periods. Maximum flooding happened during 1977 and thereafter in 2010. The figures are summarised in Table 2.

Table 2: Summary of year-wise flooding

Year with Significant Flooding	*24/09/ 1977*	*16/10/ 2010*	*12/10/ 2011*	*17/11/ 2013*	*09/09/ 2016*	*14/10/ 2016*	*27/11/ 2016*	*10/10/ 2017*	*11/25/ 2018*
Area (acres)	12871	3186	697	1188	1776	1420	628	1431	1408

v) Lean season submergence

Images from the summer and winter season satellite data revealed that historically the minimum area under submergence before the onset of the monsoons varied between 177- 333 acres, in 2012 and 2013. It is summarised in Table 3.

Table 3: Lean season submergence area

Submerged in Pre-monsoon period during winter and summer (Dates)	**Area (acres)**
28/02/2013	333
29/06/2012	177

vi) Submergence below and above the 209 m contour line

The 209m contour line, which mostly remains submerged under water, makes it a critical reference point for further analysis and benchmarking. In order to establish empirically the mean levels of flooding over the years, the extent of water logging within the 209m contour line was analysed for the past decade. It is summarised in Table 4.

Table 4: Submergence Area in relation to 209m contour

Year/Dates with Significant Flooding	Total Extent (acres)	Within 209m (acres)	Percentage of Contour line 209m water logged	Above 209m contour
1977	*12871*	*892*	100.00	*11979*
2010	*3186*	*892*	100.00	*3824*
2011	*697*	*582.76*	66	*108.24*
2013	*1188*	*745*	83.52	*443*
2016 Sep	*1776*	*892*	100.00	*884*
2016 Oct	*1420*	*784*	87.89	*636*
2016 Nov	*628*	*316*	35.43	*312*
2017	*1431*	*759*	85.09	*672*
2018	*1408*	*875*	98.09	*533*

The data indicates that during 2010-2018 on an average 92% of the land within the 209m contour experienced waterlogging post monsoon. In 2010, the entire area within 209m contour was flooded. It can be inferred from the available data its analysis that the entire area within this contour is invariably vulnerable to submergence during monsoons. *The critical point here is that barring the flood years of 1977 and 2010, the submergence area usually remains within the 209 m contour line and therefore this becomes the de-facto minimum area of the seasonal wetland. This is the conclusion that can be inferred from the data based on sound scientific principles and would form a viable solution for the demarcation of the boundaries of this wetland.*

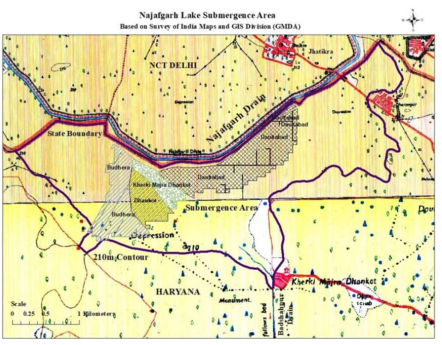

Figure 13: *Villages in submergence area (2013)*

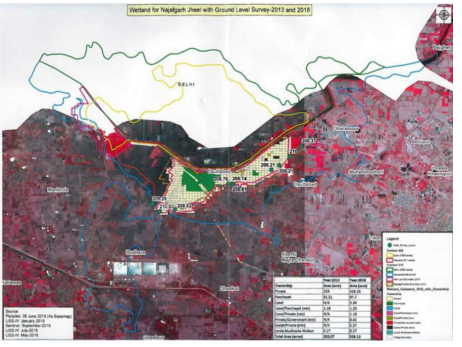

Figure 14: *Area and ownership of submerged areas*

vii) Land Ownership within the 209 M Contours

The land under this area of interest belongs to six villages and is owned by Gram Panchayats, as well as private owners. The ownership details are tabulated in Figure 14.

6. Discussions and Findings

In order to make an objective assessment of the scenario, the SOI map sheet no. 53 D/14/6 of scale 1:15000 which was specially prepared by the SOI for Sahibi river basin has been analysed in detail along with a series of satellite maps. This SOI map is based on the ground survey carried out in 1969-70 followed by a verification survey in 1977-78 before final publication in 1978. As the map depicts contour lines at one meter interval, the contour levels of 209, 210 and 211 meter which comprise the elevation around the Najafgarh jheel were reviewed for further analysis. The area enclosed by each of these contours from the submergence area of the Najafgarh jheel depending upon monsoons in the respective years. The study has been reinforced with a Landsat image of 1977 and a time-series of high-resolution satellite images available at the Google Earth website, besides other SoI maps and revenue records.

1) **Extent of flooding in year 1977:** The year of 1977 was a high flood year in the region. The Landsat multispectral scanner (MSS) imagery (path 157 row 47) acquired on 24th September, 1977 formed an ideal source for mapping the distribution and extent of inundation in that period for assessing the post monsoon scenario in the area (Source: USGS Earth Resources Observation and Science (EROS) Centre website). The extent of inundation visible in the Landsat image was interpreted visually and digitized.

2) **Extent of flooding in the past decade:** An attempt was made to study the trend of inundation in the area in the previous decade from the Google earth images. It was found that 33 images of this region for the period 31.01.2010 - 25.11.2018 are available at Google Earth website. However, only eight out of the 33 images pertain to post monsoon season, i. e. the months of September, October and November of the years 2010, 2012, 2013, 2016, 2017 and 2018. Therefore, the extent of inundation in these was also digitised for further analysis using the imageries of these dates.

3) **Area under present and past flooding:** The digitized contour lines (209, 210 and 211m) were overlaid on the flooded areas of 2010, 2013, 2016, 2017, and

2018. The historical submerged flooded area falling within 209m contour line was calculated by subtracting the dry areas within 209m contour from the total area encompassed by this contour line.

4) **Area under 100 years High Flood Level (HFL):** The full reservoir level (FRL) for the Dhansa regulator is 212.5m which is generally accepted as the 100-year flood level. It is pertinent to note here that as per the Delhi (Irrigation Department) website, the water levels crossed this level on 6th of August 1977 and reached 213.575m (700.71 ft.) level.

7. Conclusion

It is clear that the Najafgarh jheel has been an important seasonal wetland of the Yamuna-Sahibi basin which acted as a natural floodwater regulating and groundwater recharging area due to its unique topography. Over the years changes in the surface hydrology in its catchment has led to issues relating to flooding and there is an urgent need to ecologically restore and preserve this lake to the extent possible in the present scenario.

The Gurgaon final development plans of 2021, 2025, and 2031 have not taken due cognisance of the 100-year flood level or the FRL (212.5m) during allocation of land to different sectors, particularly residential sectors. Even the 209 m contour level, which is almost always submerged has not been factored in. Infact, the Haryana SEIAA has devised a debatable condition for granting Environmental Clearances (EC) to projects in the area asking them to keep the plinth level above the 100-year flood level of the Jheel, i.e.

"The project proponent shall ensure plinth level of the building block is 1.5 metres above 100 years flood level of the said Najafgarh Jheel".

A simple examination of the above condition will reveal that buildings being built, for instance within the area falling within the 209 m contour level, shall have to ensure that the plinth level is at 214 m (212.5 metre HFL +1.5 m) or 5 metre above ground level. This is not only ludicrous but will be greatly detrimental to the public at large and home-buyers in particular.

Instead, a pragmatic approach is needed which would be practical and as well as ecologically sound. It is necessary to find a solution to the problem rather than only talk about the problems. Based on the above data and its analysis the following options seem viable:

Area under 209 m contour line: The area falling within the 209m contour is invariably submerged seasonally during most of the years. This is approx. 917 acres. Therefore, due to its status as a seasonal wetland, the area within 209m level may be treated as core area of Najafgarh jheel and could be classified as a Nature Conservation Zone (NCZ) as per the guidelines of the NCRPB. In addition to this, the area could be declared as a 'No Construction Zone' under the relevant act and should be maintained as such. This Zoning will ensure that there would not be a need to acquire large chunks of land. As this area is already waterlogged for a large part of the year, such a zoning would only reflect the present situation of the land classifications in the jamabandis and thus minimize litigation. Only Agriculture, Forestry, pisciculture and horticulture should be allowed within this zone.

Area under minimum submergence, i.e., Summer 2012 - 2013: This is the smallest area historically covered by the lake. This is about 177 in 2012 and 333 acres in 2013. Thus, an area of approximately 400 acres that is under almost permanent water coverage. The feasibility of acquiring only this land (400 acres out of the 917 acres that falls within 209 m contour) can be examined by the Irrigation Department. Out of this, 92 acres of land is under ownership of the Panchayats and therefore the land acquisition issue would not be so problematic. Moreover, given that agriculture too is constrained by submergence in this area, the option of land acquisition directly at the low market prices from the farmers at a fairly moderate price maybe possible and also give farmers a reasonable exit option. Delhi Govt. is paying rental to farmers for areas along the Yamuna and that is another model that can be tried.

This area could then be managed for water by creating flood levees as well as deepened and shaped to enhance it buffering and water holding capacities and managed as a permanent water body fed either by storm water or even excess waters from the Yamuna by utilising the Gurgaon canal system, as well as treated sewage from Gurgaon. Zonation into NCZ would, in any case, result in extinguishing the realty related possibilities in this area preventing speculation in land prices.

The Area between the 209-212.5 m contours can be declared as periodic flood prone area and its use can be regulated. New constructions should not be allowed in this area for five years. Once the area under 209m contour level has been protected and reached some degree of hydrological stability then changes in the land use of this 209-212.5 m area could be considered, along with safeguards

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Disaster Relief as India's Soft Power Diplomacy: A Case of Super Cyclonic Storm Amphan in Coastal areas of India and Bangladesh

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Abstract

Natural disaster emergencies are part of non-traditional threats that must be faced by the almost all countries in the world. To handle this issue, the worldwide community should improve their relations through international cooperation. On 20 May 2020, Cyclone Amphan cut a swath through the northern part of the Indian state of Odisha, before bearing down on the state of West Bengal, with a wind speed of 185 kmph resulted in casualties and damage in the region. On behalf of humanity, India, as a country with great attention to man-made disaster and who has the same of local brotherhood provide disaster relief to coastal regions in India. The method used is qualitative. This paper attempts to answer how the process of providing disaster relief by India to coastal regions and how disaster relief can be seen as a form of India's soft power diplomacy to coastal region. Data was obtained through in-depth interviews and literature study. The results showed the process of disaster relief is carried out in accordance with the three stages in the Emergency Decision Making Process which are assessing the situation and needs; determining goal and assistance; and implementing of response plans. Disaster relief is also a kind of India soft power diplomacy to coastal regions of India and neighborhood countries to show a sense of humanity, to enhance friendship, and to maintain the integrity of the Republic of India sovereignty. After the disaster relief given by Indian government, relations between India, Bangladesh and Srilanka are starting to show shades of improvement. Super Cyclone Amphan that happened in coastal areas of India and nearby countries can be seen as a catalyst to improve the chances of good relations between India, Bangladesh and Srilanka and building cooperation in disaster management.

Keywords: *Natural Disaster, DRR Soft diplomacy, Bilateral Issue, Relief.*

1. Introduction

Regionalism, globalism and complexity: a stimulus towards global IR has been focused. The main assumption of this paper is that regionalism as a set of policies and economic measures could be considered as an obvious output as well as a

consequence of a strategic path-breaking behavior adopted by international actors in the context of a changing global world order (Barbier, 2019). This is also supported by a Examining Intergovernmental Relations in Response to Catastrophic Disasters (Kapucu, 2014). International cooperation to reduce disaster risks formed by international life covering various areas such as ideology, political, economic, social, environmental, cultural, defense and security which led to various needs of each state entity (Solar O, 2010). The appearance of safety threats which has an increasingly broad spectrum also becomes an encouragement for countries to strengthen their relations. Countries should deal with not only traditional but also non-traditional threats that threaten human sufferings, such as natural disaster.

Currently, the impact of natural disasters on vulnerability of social groups, their livelihoods, peace and the role of the state in disaster management in context of human security is much prevalent (Zeeshan, 2018). The widespread of disaster impacts may be one reason why this issue becomes the attention of the international community. Tsunami in Nicobar Islands in 2004 is an example of how the international community shows solidarity to India. As part of the international community, India, not only become the beneficiary of the assistance but also elaborates the effects of the December 2004 Indian Ocean Tsunami on the Indian Mainland (Alpa Sheth, 2006). It is in accordance with the India's foreign policy which is free and active.

The structure of peninsular India is complex because of the varied geology, faults, and fractures. More than a third of this area is covered by basaltic flows called the Deccan Trap. The thickness is 2 – 3 km on the west coast and decreases toward the east. The rest of the peninsula is covered by Precambrian rocks and sedimentation formation of later eras had made India a disaster-prone area, therefore, the efforts to reduce disaster risk continue to be done. These have appreciated as Global Champion for Disaster Risk Reduction in 2008 by the United Nations (Global assessment report on disaster risk reduction , 2011). It proves that the Indi's efforts and experiences in disaster management receive recognition in the international level so that it can be an asset for government in conducting diplomacy. In May, 2020, coastal areas of India were hit by Cyclone Amphan. According to United Nations Office for the Coordination of Humanitarian Affairs report, the cyclone has the UN Country Team in India reported that Cyclone Amphan, which caused widespread damage around Calcutta, is now considered even more destructive than Cyclone Aila, which slammed the region in May 2009. Amphan hit seven districts badly, namely South 24 Paraganas, North 24 Paraganas, East Medinipur, West Medinipur, Howrah, Hooghly and Kolkata, with damages also reported in the district of Birbhum. Bangladesh are impacted by the cyclone, with half a million families potentially having lost their homes https (Management, 2020).

On behalf of humanity due to the impact of the destructive Cyclone Amphan and solidarity as a country that has the same ethnicity of Bengalis, India send disaster relief to Bangladesh.

Disaster relief provided by India to Bangladesh is interesting to be studied, especially from the soft power perspective. India not only has the vision to become a world-class center of excellence in disaster management but also to strengthen bilateral relations. India has had cooperation with Bangladesh in various fields, such as politics, economics, education, agriculture, and social culture. But, that various cooperation still does not close the possibility of the emergence of a challenge for India. This challenge is particularly related to the improvement of political relations with Bangladesh. The India's Foreign Policy under Modi Government quite often has an impact on foreign policy to India (Kumar, 2014).

Diplomatic relations between India and Bangladesh can be considered important and strategic as one of the implementation of Indi's look east policy. Geographically, Bangladesh is bordered on the west, north, and east by a 2,400-kilometer land frontier with India and, in the southeast, by a short land and water frontier (193 kilometers) with Burma. On the south is a highly irregular deltaic coastline of about 600 kilometers, fissured by many rivers and streams flowing into the Bay of Bengal. The territorial waters of Bangladesh extend 12 nautical miles, and the exclusive economic zone of the country is 200 nautical miles. In addition, both Bangladesh and India have had their relations shaped by history, culture, geography, economics and, above all, geopolitics. While India is a geopolitical, economic and military giant involved in the affairs of the world, over the years Bangladesh has been struggling to ensure the sustenance and preservation of human security within its borders. India's contribution towards Bangladesh's War of Liberation in 1971 was critical to the latter's birth (Karim, 2009). According to Md. Nazmul Islam identification, identifies what kind of policy can develop further strengthen the bilateral relations between India and Bangladesh (Islam, 2017). However, the current diplomatic relations more viewed from the perspective of a political rather than economic. In this regard, India requires international diplomacy not only to preserve the sovereignty and integrity but also to promote prosperity and a more active role in international relations to obtain a positive image with the use of soft power (Hall, 2012). Therefore, as a country that plays an active role in international relations as well as disaster management through humanitarian aid, the study will attempt to analyze how the process of disaster relief provided by India and how it can be seen as soft power diplomacy to country like Bangladesh.

A. Why is Eastern region Important to India?

To analyze about the India's disaster relief to Bangladesh, it is important to understand the importance of the East or South east for India. It attempts to

describe a comprehensive overview that the bilateral relations of a country cannot be separated from the area where the country is located. Bangladesh is a country located in the South East region so it is necessary to know its policy and India's foreign relations in the region. According to the study of South Asia Analysis Group, Five Indian states have common borders with Bangladesh, something which can be made into a win-win situation through connectivity and trade. Of course, there will be opposition from different interest groups for different reasons. These must be overcome in due course but two major ones need immediate attention (Jha, 2014).

Using a concentric circle geostrategic approach to setting region priorities in the implementation of India's foreign policy, the South East region is an area bordered directly to India and also the nearest neighbor after the West Asia. Therefore, it is right to assign this region to become one of India's foreign policy priorities. In general, Eastern South Asia is a sub region of South Asia. It includes the countries of Bangladesh, Bhutan, India (specifically east India and northeast India), and Nepal. Geographically, it lies between the Eastern Himalayas and the Bay of Bengal. Two of the world's largest rivers, the Ganges and the Brahmaputra, flow into the sea through Eastern South Asia. The region includes the world's highest mountainous terrain and the world's largest delta, and has a climate ranging from alpine and subalpine to subtropical and tropical. Since Nepal, Bhutan, and northeast India are landlocked, the coastlines of Bangladesh and East India serve as the principal gateways to the region..

The Bangladesh population has physical characteristics, such as, a semi dark-skinned in accordance with the meaning of the term Bangla is derived from Bengali. Bangladesh is the only country in the world that was created on the basis of language and ethnicity. The Bengalis make up 98% of the total population of Bangladesh, making it one of the most ethnically homogeneous states in the world. The large Muslim population of Bangladesh makes it the third-largest Muslim-majority country. The constitution declares Bangladesh a secular state, while establishing Islam as a state religion. As a middle power in world politics, Bangladesh is a unitary parliamentary democracy and constitutional republic following the Westminster system of governance.

India views the Eastern South Asia region as relative peace region (Limaye, 2020). However, most countries in the Eastern South Asia region have unstable governance and domestic political problems. Thus, international community; including India view this region is vulnerable to political instability (Sikri, 2009). Seeing such conditions, India still opens cooperation with countries in the Eastern South Asia. In the last ten years, India used soft power approach through cooperation to enhance the relations in the Eastern South Asia.

On the other hand, it does not mean that the relations between India in the Eastern South Asia region always go hand in hand. The possibility of disruption towards political stability and security of India still remains (Pant, 2008). According to Pant, "the aspirations of certain areas in India to secede may invite the sympathy of some countries in the South Pacific region". Therefore, the Eastern South Asia region has a strategic value, especially related to India's efforts to maintain the sovereignty so it is important to continue to preserve its relations with countries in the Eastern South Asia region (Jonah Blank, 2015).

B. Bilateral Relations between India and Bangladesh

Diplomatic Relations between the two countries was followed by the visit of Indian Prime Minister Indira Gandhi on 19 March 1972, at Dhaka, where there she had signed the Indo-Bangladesh Treaty of Friendship, Co-operation and Peace Relations, popularly known as the 'Indira-Mujib Treaty of 1972, with then Prime Minister of Bangladesh S M Rahman. The relations between the two countries have usually been friendly, although sometimes there are border disputes. The historic land boundary agreement was signed on 6 June 2015 which opened a new era in the relations and further stopped all irritants in ties. They are common members of SAARC, BIMSTEC, IORA and the Commonwealth. The two countries share many cultural ties. In particular, Bangladesh and the East Indian state of West Bengal are Bengali-speaking. Bangladesh has a High Commission in New Delhi with Deputy and Assistant High Commissions in Mumbai, Kolkata, Guwahati and Agartala. India has a High Commission in Dhaka with Assistant High Commissions in Khulna, Rajshahi and Chittagong.

According to the Bangladesh Foreign Affairs, a visit to Bangladesh on 11 and 12 May 2016 by India's Foreign Secretary Dr. S. Jaishankar happened at a time when the country was marred by the rise of militancy and its relationship with Pakistan was at nadir because of reasons rooted in its liberation war of 1971. To a great extent, the two are interrelated. One of the prime reasons of the rise of militancy in Bangladesh is the revival of groups which supported the Pakistan Armed forces to carry out all forms of brutalities against the Bengali speaking people in East Pakistan. They were against the liberation of the Eastern wing and formation of Bangladesh. Even after forty-five years of mass violence, these groups have not been apologetic for their actions. Instead, they violently attack those who raise questions against their politics and ideology. Unfortunately, in post Mujib period, the military regimes and political parties in Bangladesh had provided patronage to these groups, which helped them to settle down and religiously radicalize civil society. Some of the members of Jamat-i-Islami (JI) held important political offices during military regimes and Bangladesh Nationalist Party (BNP) led democratic government.

In such a background, the visit by the Indian Foreign Secretary to Bangladesh and his discussions over the issue of militancy has been significant to both countries. Repeatedly, although it is an internal matter, India has voiced its concern over the killing of minorities in Bangladesh. According to Bangladesh's national daily, The Daily Star, the Bharatiya Janata Party (BJP) led National Democratic Alliance in India has voiced concern over the recent killings of religious minority people, particularly the Hindus, attacks on temples and grabbing of their properties in Bangladesh and called for an immediate halt to such incidents. The report in paper, quoting leaders of Hindu community in Bangladesh, wrote that a few days before the visit by the Indian Foreign Secretary, representation from Bangladesh Hindu-Bouddha-Christian-Oikya Parishad had a meeting with the Indian High Commissioner in Dhaka. During the meeting, the minority community leaders informed the Indian envoy about the repression on religious minorities. "I believe he High Commissioner would brief his Foreign Secretary about the situation the religious minorities in Bangladesh are faced with," the leader of the group said. On April 22, the rights body at a press conference in the city claimed that ten religious minority people were killed, 366 injured and eight women were raped across the country in the first three months of this year. In most of the cases, the perpetrators used political power and influence to oppress the religious minorities, said a report titled, "Human Rights Situation of Minorities in Bangladesh – Jan-March 2016", which was launched at the press conference. On March 5, the Oikya Parishad at another press conference claimed that around 24 religious minorities were killed and 1,562 families were affected in 262 incidents of attack and repression last year.

Besides discussing the issue of militancy, the two countries also took stock of the bilateral issues and developments over the agreements entered into during the Indian Prime Minister's visit to Bangladesh in June 2015. On the latter issue, the Indian Foreign Secretary said, "So we sat down to look at the progress in all those issues. I must tell you we had a very good report to present, we have really moved forward in a number of areas." After a meeting with the Prime Minister of Bangladesh, the Foreign Secretary said that India and Bangladesh have set "a model" in bilateral cooperation as he called. He said, "The model is being highly appreciated in India."The Foreign Secretary told the Premier that India made commitments during Prime Minister Narendra Modi's Dhaka visit in June 2015 and eight of them have been fulfilled (Ranjan, 2017). "We have made good progress as eight commitments have already been fulfilled in nearly one year and we are vigorously working to meet other pledges," Jaishankar said, particularly pointing out notable developments in cooperation in energy and power sector. Sheikh Hasina said, "The bilateral ties between the two neighbouring countries reached a new height following his (Modi) visit ... we are in fact enjoying the best

of relations." The Foreign Secretary also thanked the Bangladesh government for its support to India for its initiatives for launching the SAARC Satellite. On a question about Modi's letter to Hasina, he said that the Indian Prime Minister invited the Bangladesh Prime Minister to attend a summit of BIMSTEC member countries on the sideline of the BRICS Summit to be held in Goa in mid October. He said that the Prime Minister has decided in principle to attend. Responding to a question on the Teesta water sharing issue, the Foreign Secretary said that problems regarding water, drought and the environment have been discussed.

Facing a campaign conducted by the Government of Bangladesh, the Indian government prefers to take a softer approach through the diplomatic track. This paper does not specifically discuss the Chittgong issue, but try to describe how the situation of the relations between India and Bangladesh and how India's efforts to improve the relations using soft power. The measures taken by India do not disregard Bangladesh but rather attempts to strengthen their relations through cooperation. The disaster that occurred in Bangladesh in March 2015 may open opportunity for India to strengthen the diplomatic relations which have disrupted by the statement of the Prime Minister of Bangladesh in 2014 and to improve the image of India.

Research Question

This paper has research questions as follows,

1. How is the process of disaster relief provided by India to Bangladesh?
2. How can disaster relief be analyzed as soft power diplomacy India to Bangladesh?

Framework

Problem identification in Figure 1 begins by describing the predicaments faced by both countries. Bangladesh is a country that supports self-determination for Bengali peoples, which are part of the India sovereignty (Suresh.D, 2015). This support is delivered through a speech by Prime Minister during visit to India wherein she quotes what is being seen as an assurance to India, Bangladesh termed bilateral ties as "rock solid", adding that in the past few years both countries "have scripted a golden chapter ('Sonali Adhyaya')" under the leadership of Bangladesh Prime Minister Sheikh Hasina and Prime Minister Narendra Modi (Sonali Adhyay: A Goldeb Chapter in India-Bangladesh Relationship, 2021).

The remarks by Bangladesh Foreign Minister A.K. Abdul Momen was on the occasion of a Virtual ceremony that marked India's handing over of 10 Broad Gauge (BG) locomotives to Dhaka to boost rail connectivity between the two nations, seen by both countries as a "vital element of bilateral cooperation in promoting

trade and connectivity and in boosting the economic partnership". This becomes a threat to the national integrity and the image of India in the world because the domestic issue rose at the international level. Therefore, it is important for India to enhance friendship with Bangladesh. However, in May 2020, Bangladesh was hit by Cyclone Amphan disaster that so the government makes policies to accept international assistance (Cyclone Amphan).

The Indian experiences in disaster management and seeing the condition of Bangladesh who needs assistance to address the Cyclone Amphan gives opportunities for India to strengthen friendly relations with Bangladesh and to maintain the sovereignty. India also wants to show that they have a Bengali bond with Bangladesh through disaster relief. This paper observed that the assistance is part of the use of soft power by India through disaster diplomacy. This effort is analyzed as an attempt to obtain a positive image of India in the world as well as an effort to counter the Bangladesh support for self-determination to Bangladeshi people.

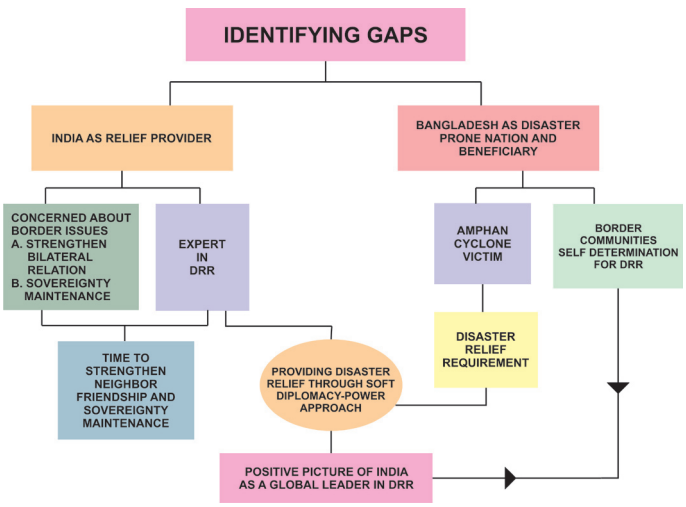

Figure 1: *Gap Identification*

Theory: Signifying Relief in Disasters, Decision Making Process for Emeregncy Response, Diplomacy and Soft Power

This research used three concepts and one theory to answer the research question. The concepts are relief in disasters, decision making process for emergency response, and diplomacy. The theory is soft power.

Disaster relief or other terms called emergency management/humanitarian aid refers to the process of responding to disaster situations, providing humanitarian assistance to the people and communities who suffered from the disaster. Disaster relief is goods or services available to individuals and communities who suffered

because of disasters (Disaster relief). Another definition according to the United States Legal, disaster relief is rapid assistance to relieve the suffering of disaster victims which aims to meet the urgent needs of them (Cheatham, 2020). Based on the definitions, we can conclude that disaster relief is a humanitarian response to alleviate the suffering of disaster victims by providing goods or services.

Furthermore, emergency or disaster response plan generally consists of three phases as described below.

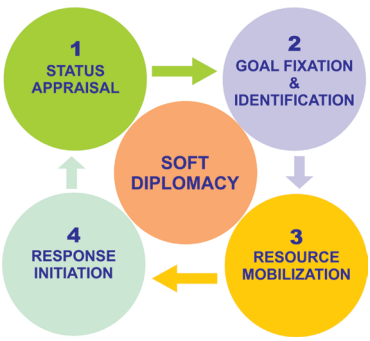

Figure 2: *Emergency Response Decision Making Process*

In Figure 2, we can see that Emergency or Disaster Response Decision Making Process according to IFRC includes three stages which are situation assessment and disaster victim requirements, ascertaining objectives and identifying the assistance that will be required, provided, and implementing response based on the assessment and the objectives (International Federation of Red Cross and Red Crescent Societies, 2000). This describes how the decision ideally is made in an emergency or catastrophic situation.

According to Human Development Report 2007/2008, the humanitarian assistance is rooted in a shared belief that there is a moral imperative to assist people in times of stress makes it a highly reactive field. For those countries that already have experience of dealing with mega-disaster, these countries have the opportunity to assist other countries in coping with disaster risk (Coppola, 2006).What the state do to help other countries that affected by the disaster can be called a diplomacy.

Diplomacy is the instrument of communication, not the message communicated. George Kennan, who thought about his profession as seriously as he did about foreign affairs and foreign policy, noted that "This is the classic function of diplomacy: to effect the communications between one's own government and other governments or individuals abroad, and to do this with maximum accuracy, imagination, tact, and good sense." In other words the medium is not the message. Still, the widespread

confusion between the two obliged the legendary academic student of international politics, Hans Morgenthau, to comment that there was a common "confusion of functions between the foreign office and the diplomatic representative". It is a tool that countries do to establish international relations, both bilateral and multilateral (Frankel, 1971). Other definitions state that diplomacy is simply defined as wisdom, skill or proficiency in dealing with others. The other view according to Geoffrey Berridge, suggests that diplomacy consists of communication between officials designed to promote the foreign policy either through formal agreements or tacit adjustment' (Berridge, 2015). From the aforementioned definitions, we can conclude that diplomacy is a method or art owned by people who have the capability to negotiate in conducting international relations among countries to conduct foreign policy in order to achieve its national interests. The meaning of diplomacy is further complicated as even in its purest sense, the word has two general meanings: in the policy sense, that is " a government's diplomacy"; or the operational sense, the conduct of business between and among governments, conducted through bureaucratic institutions and processes. The former is loosely intended to refer to a country's "foreign policy", hence the confusion, while latter is the activity of a country's foreign policy bureaucracy.

According to Joseph Nye, "soft power is the ability to get what you want through attraction rather than coercion or payments. It arises the attractiveness of a country's culture, political ideals, and policies" (Joseph S. Nye, 2008). Soft power is the derived from the culture, domestic policy (political value), and foreign policy. Talking about the context of national interests, Joseph Nye has an opinion that "winning the peace is more difficult than winning the war and soft power is essential to win the peace" (Joseph S. Nye, 2008).

The correlation between disaster and international cooperation as an implementation of soft power that is undertaken by a country, Ilan Kelman in Hutabarat found a diplomatic process as a bridge to achieve cooperation in the field of disaster risk reduction (Wati, Sari, & Sutisna, 2018). Scholars such as Fox, Lending, Cummings and Mitchell set out a range of administrative mechanisms through which cultural diplomacy is delivered, including government ministries and departments, independent agencies, and private, not-for-profit foundations, but it is not always clear how the non-government entities contribute to a country's diplomacy. Disasters can be a catalyst in the process of diplomacy. That is, disaster may open opportunities to reduce conflict and disaster risk in the framework of cooperation.

Based on the depiction of the theory and concepts that have been elaborated, the knowledge and capability of disaster risk reduction are a soft power that India owned and could be used to help Bangladesh to overcome the effects of Cyclone

Amphan through disaster relief. Furthermore, the analysis will be examined on how disaster relief can be understood as India soft power diplomacy to Bangladesh.

2. Method

This study used qualitative research process. The reason of qualitative research is to discover and understand the meaning of a phenomenon and then the results are described in a sequence of events or textual form (Creswell, 1998). To obtain the necessary data, this research takes the online primary and secondary data sources due to corona phase. Primary data gathered through interviews technique using snowball sampling method. The informants were chosen specifically and qualified in about the research and directly involved in the delivery of disaster relief in Bangladesh. Meanwhile, secondary data sources are from the official situation report issued by the Bangladesh government, UNOCHA, IFRC, government reports, documents, and official publication of the relevant institutions. In addition, secondary data was also collected through newspaper articles, books, and other academic writings. This research used data collection techniques through in-depth interviews and literature study. Meanwhile, data analysis used Miles, Huberman, and Saldaña's Qualitative Data Analysis model, including data collection, data reduction, data display, and conclusion (Matthew B. Miles, 2014). This research has limitations in obtaining data because it cannot interview directly the Bangladesh government. This is due to limited access to the data. This research was conducted in 2020 after Cyclone Hamphan occurred in India and Bangladesh.

3. Result and Discussion

A. Disaster Relief Process Provided by India to Bangladesh

The process of emergency relief by India to Bangladesh will be discussed using the concept of Emergency Decision Making Process, which carried by IFRC which consists of three stages: assessing the situation and needs; determining goals and identifying forms of assistance; and implementing of response plans (International Federation of Red Cross, 2000).

First stage is evaluating situation and requirements. Before determining the purpose and identifying assistance, Indian government should assess the situation after Cyclone Amphan hit coastal regions of India and Bangladesh and identify the needs of the disaster victims. Apart of that there was a special team NDRF from India who directly assessed situation and needs of the victim to the field. The information was obtained by India government through the assessment process was assisted by the Indian Embassy in Bangladesh, Ministry

of Home Affairs, National Disaster Management Authority, Indian Red Cross, and UN OCHA.

Basically, the assessment which conducted by Indian government already described the top priority needs of the Amphan disaster victim that is required by IFRC. But, the Indian government has yet to assess in some specific sectors such as psychological and social aspects yet. Based on the result of the assessment in Bangladesh coastal regions, the Indian government has set that food and nonfood sectors become the priority of disaster relief. Indian government also faced the obstacles in assessing the situation and needs. The obstacles come from the geographic factor and limited access and resources. Bangladesh is an archipelagic country. When the Cyclone stroke the country, the infrastructure was paralyzed and the transportation was limited to reach the affected area. It influenced to the assessment process so the information about situation and needs which was obtained by Indian government was not much details.

The second stage is determining purpose and identifying assistance. Indian has humanitarian mission to alleviate the suffering of the disaster affected people and to rehabilitate the damaged infrastructure after the vicious cyclone happened. Based on the result of situation and needs assessment in affected area, India determined to provide food and non-food sectors as priority that will be given. Bangladesh needed a help to meet the basic needs of instant foods, nutrient-added foods, tents, blankets and also to restore existing infrastructure. The intention is delivering logistics assistance to those in need and financial assistance to the Bangladesh government. This mission is in line with the requirements of Bangladesh to reduce fatalities, to meet basic needs, and to rehabilitate and reconstruct all infrastructures. Furthermore, the objectives and the assistance provided by India to Bangladesh meet the concept of disaster relief according the New World Encyclopedia and United States Legal, which is to alleviate the suffering of the victims, to meet the immediate needs of disaster victims and to rebuild the communities.

The last stage is implementing the robust response plan. The assistance was symbolically given by the Prime Minister of India, Narendra Modi to the Prime Minister of Bangladesh. A brief meeting was held between the Delegates of India Embassy and the Bangladesh government, including Foreign Affairs Minister of Bangladesh. In the meeting, Prime Minister of Bangladesh, expressed his gratefulness from Bangladesh people for the aid from India. Indian Ambassador to Bangladesh also emphasized that the humanitarian mission and aid provided by India is to express that Bangladesh is India's close friend. There are some obstacles that faced by India team in implementing the response plan such as administration

and financial related problem, technical problem, and field situation related to political-matter.

B. Disaster Relief as Indian Soft Power-Diplomacy to Bangladesh in Addressing Cyclone Amphan

Why disaster relief process is referred to as diplomacy. It can be understood based on the basic notion of diplomacy as it concerns bilateral relations between the two countries. India's disaster relief provided to Bangladesh is an effort of doing international relations as stated by (Frankel, 1971). India is able to make its experiences in disaster risk reduction as capital to manage the relations with other countries; it is in line with the definition of diplomacy expressed by Young (Young, 2008). Disaster relief provided by India may also be understood as the implementation of Indi's look east policy. India has a special attention to countries in East nations, including Bangladesh. Look East Policy is a guide for India in managing the relations with Bangladesh.

The modifiable thing in this study is how diplomacy by a country can be understood as an attempt to achieve the national interest. Disaster relief provided by India has main reason to show solidarity and humanity to Bangladesh. This was stated by Indian Foreign Minister, in joy and sorrow that Bangladesh is a friend of India. However, this paper analyzes other considerations why India provides relief to Bangladesh. The consideration is based on the national interests of India includes two things, enhance friendship with Bangladesh within the framework of the Bengali's culture and maintaining the sovereignty of the India's homeland.

Meanwhile, in some provinces in the eastern region of India such as the coastal districts of Odisha and West Bengal in India. They have physical characteristics similar to the people of Bangladesh. Therefore, the Indian government wants to assert that the country is part of Bengalis. The assistance provided by India to Bangladesh also is based on considerations to strengthen friendship as a fellow nation that has the same ethnic. Disaster relief provided by India has a desire to give an understanding to the people and government of Bangladesh that India has always been a companion in any situation and work together.

On the other hand, India's bilateral relations with Bangladesh have its own dynamics. There are times when relations between the two countries have a roller coaster situation due to dynamics of countries like Pakistan and China. This is due to the domestic political struggle in the government of Bangladesh. The political instability in Bangladesh government system leads to a challenge for India. The successions of leaders often happen in Bangladesh affect its foreign policy to India.

Moreover, Bangladesh also has special attention towards infiltration issue that showed through international forum, such as in UN meeting.

The Bangladesh Prime Minister's speech that stated about human rights issues and their support to self-determination of the Bangla peoples is a big problem for India because it touches India sovereignty. In addition, it also affects the image of India in international level for bringing domestic issues to the international arena. Policies that India applies to Bangladesh certainly cannot be separated from the corridor of Indi's national interests to maintain its integrity.

India choose not to use effort through compulsion or payment in facing the dynamics of bilateral relations with Bangladesh, particularly in response to a campaign on self-determination for the Bengali community by the former Prime Minister of Bangladesh. The approach used is to remain embraced Bangladesh as a friendly country. The assistance provided by India can be analyzed as an effort to reach Bangladesh society. India wants to show as a country that has a sense of great sympathy and concern towards his brother, Bengalies in Bangladesh who are victims of Cyclone Amphan. India's approach can be understood as the use of soft power as described by Joseph Nye (Joseph S. Nye, 2008). Then, the question that arises is whether the disaster relief is part of the attraction to obtain India's interest. Reviewing the significance of the South Eastern region for India, bilateral relations between India with Bangladesh, and also the experiences of India in disaster management, the disaster relief can be analyzed as an attraction to achieve India's interest. As explanation before, there are three interests that India desire to achieve; showing its solidarity and humanity; strengthening bilateral relations; and maintaining its integrity.

According to Nye, there are three sources of soft power, namely culture, political values and foreign policy (JR, 2004). First, when we observed in disaster relief given by India is also bringing cultural elements. India always stresses that most of its region have the same culture of Bengalis as Bangladesh. The approach taken is rooted in the same Bengalis ethnic between India and Bangladesh.

Second, the basis of soft power is political values. India is trying to show that they are a democratic country that upholds human rights. The disaster relief that was given to the society is a great concern to help to alleviate the suffering of Cyclone Amphan victims. India wants to show its solidarity and humanity to the people of Bangladesh. In this term, India wants to implicitly convey the message that they concerned with society outside the country just as they care for people in their own sovereign territory. India was already several times to give relief not only to Bangladesh but also to some countries, such as Indonesia and the Philippines. It

can be analyzed as an attempt to counter the voice delivered by Mr. Carcasses in a speech at the UN Human Rights Council in Geneva.

Third, India has, look east policy that wants to be consistently implemented. The assistance provided by India to Bangladesh is one example of implementation of this international policy. This policy provides guidance to India to improve its relations with countries in the Eastern South Asia region, including Bangladesh. Disaster relief can be understood as the ability of India through the framework of humanitarian aid as stated by Joseph Nye to achieve the objective. Disaster relief in dealing with the impact of Cyclone Amphan has objectives to show a sense of humanity, to promote friendship as a nation that has the same Bengalis culture and to maintain the integrity of the Republic of India. This assistance can also be understood as a form of soft power diplomacy India to obtain a positive image. Having a sense of high sympathy to the suffering country is the image that intended to be formed by India.

Relation between India and Bangladesh at that time also began to show shades of improvement. A group from India was well welcomed by officials at the Foreign Ministry of Bangladesh, including greeted by Prime Minister. This shows a fairly good interaction. Foreign Minister of Bangladesh conveyed his gratitude to the assistance given by the India Government.

However, the intention to assist of Bangladesh post disaster cannot be realized until now because there is no official request from the government of Bangladesh and it will take a long process. In addition, diplomats of Bangladesh have a great attention to the issue of border residents and has not time to make a visit to India. Bangladesh also frequent changes their leadership and does not have one voice in determining its foreign policy toward India so it takes a long-term efforts and continuous to be done to maintain friendly relations with Bangladesh. However, the gesture conveyed by Bangladesh Minister Conference has a special meaning for India. There is a better approach process between Bangladesh and India. Therefore, Cyclone Amphan can be seen as a catalyst which, according to Kelman may open opportunities to promote good relations between India and Bangladesh and also more concrete cooperation particularly in disaster risk reduction (Kelman, 2006).

4. Conclusion

This study has conclusion as follows:

1. The process of relief post disaster by India to Bangladesh to overcome the effects of Cyclone Amphan is in line with the stages in Disaster Emergency Response Decision Making Process. They are assessing the situation and needs; determining goal and assistance; and implementing of response plans. Based on the assessment

process, the Indian government determines food and non food sectors as a priority assistance of the disaster victims. The disaster relief objectives are to reduce the suffering of the affected people and to rehabilitate the damaged infrastructure. The assistance was symbolically given by the Ambassador of the Republic of India. India was well welcomed by government of Bangladesh.

2. The provision of relief post disaster to Bangladesh is part of India's effort to conduct diplomacy. In this term, India use soft power in doing bilateral relations with Bangladesh. It can be analyzed from the three main sources of soft power; culture, value, and foreign policy. Disaster relief which was provided by India to Bangladesh post and during crisis creates an opportunity to approach Bangladesh government for a better relations in the future especially related to the border issue.

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Web-based Geospatial Data Services for Disaster Management Activities in Odisha

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Abstract

Web-based Geo-spatial services at state level are gradually accepted in decision making process by State administrations over last few years. This involves integrated depiction of desired outputs using space based remotely sensed images, GPS based location data, that may involve recent advance tools of big data analytics and advance web-based data dissemination. GPS based collected positional information, satellite imageries, Information Technology, can be integrated in a web-based platform for the collection, storage, manipulation and visualization of spatial information to facilitate disaster management in six major aspects i.e., preparedness, prevention, mitigation, risk reduction, recovery, and response. The technology-based services are effectively been used in Odisha for the visualisation of pre and post disaster information. It helps in effective planning to mitigate, effectively deploy rescue team and undertake post disaster reconstruction and rehabilitation. The present paper emphasizes on effort of Govt. of Odisha in developing Web-based Geospatial Data services for Pre and Post Disaster Management activities in Odisha besides activities undertaken at central govt level. The Geo-Spatial data services in Odisha are under use by OSDMA (Odisha State Disaster Management Authority), Special Relief Commissioner and several line departments. The web-based services are created by Odisha Space Applications Centre (ORSAC) which acts as the State nodal agencies for remote sensing applications. Most of the necessary datasets related to disaster are created by central agencies at the block, district and state level. Considering the importance of geospatial data in disaster management, Govt of Odisha through ORSAC has created its own geo-spatial services in cadastral or village level to assist in disaster mitigation and planning.

1. Introduction

Disaster is one of the greatest threats to the development and socio-economic well-being of the people. It retards development and particularly affects the poor people severely. The frequency and magnitude of natural disaster and emergencies are constantly increasing along the Odisha coast and have grave consequences on the state economy. In general, we can classify the phases of disaster management into three phases, viz., (i) pre-disaster phase, (ii) the disaster phase and (iii) the

post disaster phase. Remote sensing, GIS and GPS is widely used in collecting spatio-temporal data for various applications including disaster management. However, for a real time visualization and manipulation of data to effectively plan and implement various activities a web-based integrated system is often desirable for sharing information with multiple users. The web-based data visualization can fulfil multiple actions related to the preparedness, prevention, mitigation, risk reduction, recovery, and response for above mentioned three phases of disaster. The web-based services are mainly used for the visualisation of the effect of disaster, pre-disaster planning, to mitigate disaster, effectively deploy rescue team and undertake post disaster reconstruction and rehabilitation.

Space based earth observation data and GIS based data analytics are reliable tools that have been used in the evaluation of natural and manmade disasters by providing synoptic coverage of affected area in a cost-effective way, which overcomes the bottlenecks and limitations caused by the conventional ground observation methods in recording physical, hydrological, environmental and infrastructure information during an extreme event. Moreover, remote sensing and GIS technology provide decision support tools to state administrators for the assessment of geo-environmental and manmade disasters, which profoundly facilitated the advancement of evacuation of human and bovine population from affected locations, disaster susceptibility mapping, flood risk assessment, evaluation of infrastructure risk, damage assessment, rescue planning, scheduling of relief operations and long-term disaster prevention planning.

Earth observation (EO) satellites capture images at various wavelengths that assist rapid-mapping in all phases of the disaster management cycle as mentioned below:

- Mitigation of potential risks in disaster prone areas, preparedness for eventual disasters, immediate response to a disaster event, and the recovery/ reconstruction efforts following it.
- Global navigation satellite systems (GNSS) such as the Global Positioning System (GPS) assist all the phases by providing precise location and navigation data, helping manage land resources and infrastructures, and aiding rescue crews coordinate their search efforts.
- Communications via satellites (SATCOM) allow the transfer of data (voice, images/ maps, video) when usual communications infrastructures are disabled by the disaster event.
- The satellite-based emergency communication systems are particularly useful during immediate response activities, including damage assessment, search and rescue efforts, news reporting, aid coordination, and telemedicine activities.

The Disaster Management Support (DMS) Programme of ISRO, provides timely support and services from aerospace systems, both imaging and communications, towards efficient management of disasters in the country. The DMS programme addresses disasters such as flood, cyclone, drought, forest fire, landslide and Earthquake. These include the creation of a digital data base for facilitating hazard zonation, damage assessment, monitoring of major natural disasters; development of appropriate techniques and tools for decision support, establishing satellite based reliable communication network, deployment of emergency communication equipment and R&D towards early warning of disasters. To support the total cycle of disaster/ emergency management for the country, in near real time, the database creation is addressed through National Database for Emergency Management (NDEM), a GIS based repository of data. NDEM is envisaged to have core data, hazard-specific data, and dynamic data in spatial as well as non-spatial form.

Spatial technologies enable effective disaster risk management to assess and map extent of natural events such as floods, cyclones, tsunami, landslide, earthquake, forest fire etc. These disaster products derived from space-based inputs generated in near/real time are extremely useful for planning and decision making. However, building spatial database system is a complex task because of key challenges. The concept of spatial data integration is defined by its effective integration procedures, storage methods, analysis, and dissemination of these inputs as web services for decision support tools for effective disaster/emergency management. (Bhanumurthy V. et al 2003).

The present paper emphasizes on the effort of Govt. of Odisha in developing Web-based Geospatial Data services for Pre and Post Disaster Management activities in Odisha besides activities undertaken at the central govt level. The Geo-Spatial data services in Odisha are under use by OSDMA (Odisha State Disaster Management Authority), Special Relief Commissioner and several line departments. The services are created and maintained by the Odisha Space Applications Centre (ORSAC).

2. Geo-spatial Data for Disaster Management in Odisha

Disaster management is a complex phenomenon and requires specific database elements for decision making. mitigation, preparedness, relief and response and recovery phases across multidisciplinary functions involving number of departments. The database available in these organizations may not be uniform, consistent, and complete. In Odisha, during the nineties there were no institutional arrangements to create centralized geo-spatial data repository for which there was the inability to access exact information quickly. It also suffered the problem of data standardization and poor coordination for accessing data quickly to help decision making and preparedness. The database should address appropriate data supply for handling the majority type of disaster and rapid sharing of the database along

with decision support tools to analyze the situation for taking appropriate and site-specific decision. It requires a compressive geoportal or GIS based information system for providing a set of data base elements, integrated with dynamic data, satellite imagery, non-spatial data, utility tools, decision support tools along with contingency plans.

2.1 ISRO/NRSC and ORSAC collaboration in Geo-spatial data generation for Disaster Management: For Odisha state NRSC, Dept. of Space provides flood-inundated maps to Special Relief Commissioner, Govt. of Orissa and the Defense personnel engaged in the relief and rescue operations during last two decades.

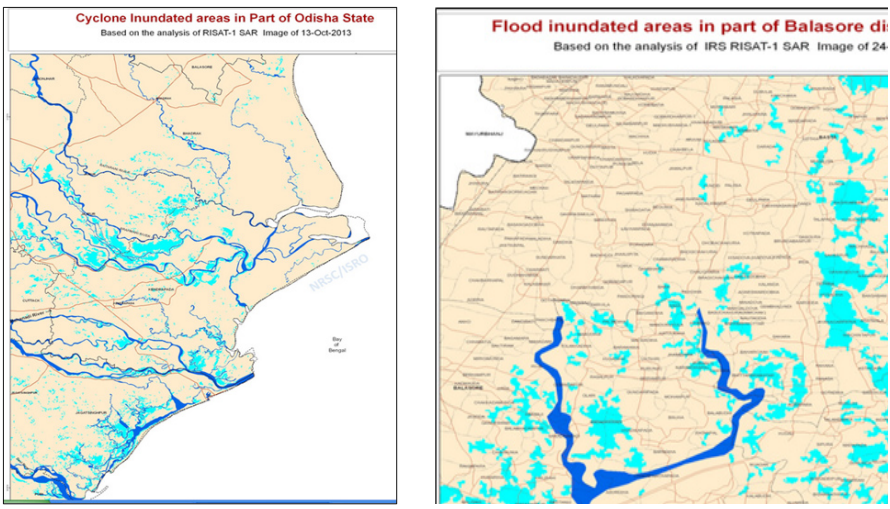


Figure 1: *Flood layer datasets with state and Block boundary data*
*(**Source:** NRSC, Dept. Of Space, Govt. of India)*

These maps depicted inundated infrastructures like Road Network, Railway Network and Settlement etc. NRSC also provides damage assessment maps related to crop loss, infrastructure loss etc to various departments for effective management of damage control action by Government. Following are few points relating to preparedness and data access of Govt. of Odisha during disaster situation of the State:

- National Database for Emergency Management (NDEM) serves as national repository of GIS based database for entire country coupled with set of Decision Support System tools to assist the State / Central Disaster Management Authorities in decision making during emergency situations. (https://www.nrsc.gov.in/EO_Objective) Department of Space, Govt. of India generates satellite image derived flood layer dataset of Odisha if any cyclone/flood disaster occurs. The flood layer dataset is generated using the near real time satellite pass over the area during the disaster. Various satellites

of India and other countries are used for generating a flood layer dataset of disaster affected area in the quickest possible time and sent to state nodal centers, Special Relief Commissioner and OSDMA. The flood area dataset received by SRC/OSDMA/ORSAC through e-mail/internet is connected to a map format with a projection system and scale. The achieved digital vector data available at state centers (Block/ village boundary, settlement, road, rivers/ permanent water bodies etc.) are over laid on the flood layer data and a flood map is generated to visualize the submerged area. The maps and datasets are then immediately submitted to SRC and Principal Secretary to Govt. of Orissa, Revenue Department for information and necessary action by the Government agencies.

- ORSAC in collaboration with NRSC, Dept. of Space houses digital database under National (Natural) Resources Information System (NRIS), Disaster Management System (DMS) and SIS-DP (Space-based Information System for Decentralised Planning) covering primary datasets on natural resources, environment, demography and social-economic condition. These data sets are also used regularly for disaster management activities of the state.

- NRSC has an archival of optical and microwave satellite data (all weather data acquisition capabilities) of Orissa. During 2004, Space Applications Centre (SAC), Dept. of Space, Govt. of India acquired airborne SAR data (Synthetic Aperture Radar – Microwave data) of several flood prone areas of coastal districts. The purpose of the acquisition of these data was to compare the acquired data set with the dataset to be acquired during the flood period in future or coming years.

- Govt. of Odisha in collaboration with SAC/NRSC, Dept. of Space has wide area network under GRAMSAT programme having 30 Districts, 314 Blocks (SIT Connectivity-Two-way video and Audio) and 1179 Grampanchayats connectivity under DRS (Direct Reception System) network facility. This network was also used during 2008 to 2016 for awareness during natural disasters and post disaster reconstruction work monitoring.

- Under NADAMS programme of NRSC, Dept. of Space, Block wise NDVI images are generated during cropping season at regular interval for early assessment of drought occurrence. In Orissa, a special programme FASAL is undertaken to forecast crop acreage and yield for Kharif and Rabi Rice and Rabi Groundnut every year. Four-time forecast is made every crop season and any crop failure or other disaster is reported to the state government.

- Under MODIS data utilisation programme of NRSC, Dept. of Space, MODIS sensor data are used (optical and infra-red band data) to detect forest fire in

the country on regular basis and the dissemination of information is done through NRSC website. User organizations can download data from the website at any point of time.

Most of these datasets are created at the level of block, district and state. However, efforts are being made to generate geospatial datasets at village level.

3. Govt. of Odisha Geo-spatial Portals for Disaster Management:

Existing disaster management related data sets lie with respective designated organisations and authorities and lacks data sharing options. Many of these data sets needs to be processed to make flawless and coherent for integrating with mainstream disaster management services. Various data resources generated and distributed in heterogeneous environment makes the utility of data difficult when such type of data resources is required in a specific format at a desired scale. Therefore, disaster specific database is essential for disaster management purposes by the block, district, state and country level officials with good positional accuracy. Base layers are the primary layers that are required for disaster event planning, navigation of manpower and equipment, and for various monitoring and relief activities. Amongst base layers, administrative boundaries provide jurisdiction of the event of occurrence to inform corresponding administrative authority for taking care of the affected population and carrying out relief and rescue operations. The administrative boundary generally is available as village, block, district and state. Transport network like road (covering national highway, state highway, district road, town road, village road etc.) and rail, power network and power infrastructure location information, canal networks and communication network spatial info is also vital component that is used for transportation planning or evacuation process from a disaster incident place to the relief shelters or hospitals. Land use land cover, Physiography, Geomorphology, Contour, Elevation, settlement spread and higher ground spatial information is of great resource to take many decisions in the case of natural and manmade disaster. Information about the land utilization status gives inputs to disaster monitoring and relief operations. Parameter derived from natural resources geo-spatial data is extremely useful for many disaster specific applications.

Considering the importance of such type of geospatial data, Govt of Odisha through ORSAC generated its own geo-spatial services for catering to the need of disaster management cycles for state administration.

3.1 Odisha Sampad Geo-portal as state Geospatial Data repository: "Odisha Sampad" portal (http://www.odishasampad.orsac.gov.in/) is the repository of the State's Geospatial Datasets consisting of administrative information, natural resources data layers, geocoordinate / georeferenced infrastructure details and other socio-economic parameters. The portal aims to cater to the need of geo-spatial data need of State Administrators, Decision Makers, Resource Managers

and Planners at the time of disaster management. The portal is also used for planning, especially for community development at block level by using a scientific database containing geo-spatial natural resources and infrastructure profile at various level.

During 2007-08, the Centre undertook 'Block Level Resource Atlas & GIS Database Generation' project using satellite remote sensing data for all the Blocks of the State. The Center has aptly demonstrated the application of Space and IT technology for generating inputs for development planning through preparation of this Digital Web-Atlas as ODISHA SAMPAD (Ver 1.0). The portal was updated again in 2012 as Ver 2.0 by updating the information in various layers.

Growth of IT technology particularly web-based services in e-governance, adoption of advanced Geo-ICT technology at ORSAC and approval of Odisha State Data Policy (OSDP) led the foundation for creation of ODISHA SAMPAD (Ver 3.0) in 2018.

ODISHA SAMPAD (Ver 3.0) facilitates easy access and sharing of Government owned Geospatial data in open format for supporting sustainable and inclusive governance, and effective planning. Odisha Sampad Web-portal is supported by an online platform that provides authoritative spatial data at Block and District scales having an authentication data integrity framework and a set of on-line tools to visualize, analyse and access Geospatial Data. Odisha Sampad Ver 3.0 is expanded to provide spatial data through an administrative search query mode.

Figure 2: *Odisha Sampad Geoportal*

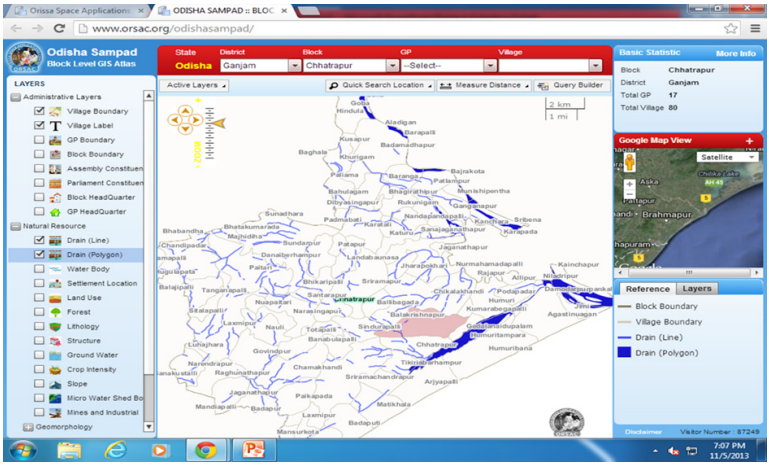
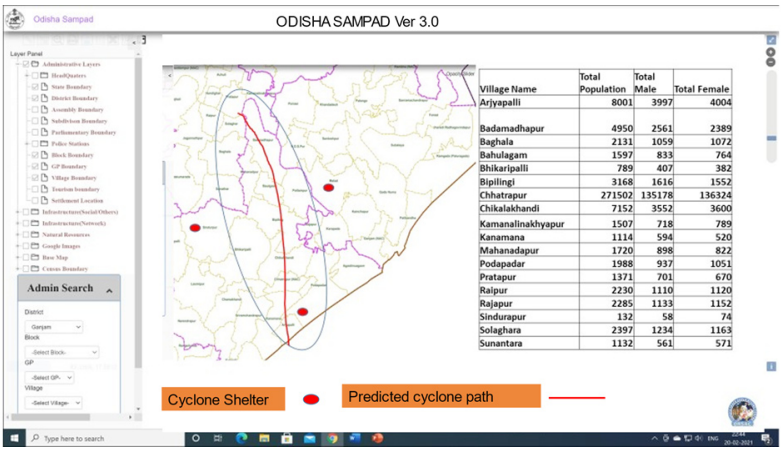


Figure 3: *Odisha Sampad Geoportal (http://odishasampad.orsac.gov.in/)*

The portal is particularly used for planning for evacuation of human and bovine population in probable affected areas once IMD announces disaster in Coastal districts and during high precipitation in hinterlands. The IMD predicted path is overplayed on the existing geospatial datasets and the required data relating to Demography, Animal resources, Emergency infrastructure and adjacent facilities/ utilities are derived for the probable affected area for the local, district and state administration. The evacuation planning and shifting of population and property are immediately made based on the buffer geospatial data obtained from the geo-portal. The Fig 2,3,4 depicts the map and portal view of the activities. The Odisha Sampad Geoportal is open for public viewing and can be assed http:// odishasampad.orsac.gov.in/



Village Name	Total Population	Total Male	Total Female
Arjyapalli	8001	3997	4004
Badamadhapur	4950	2561	2389
Baghala	2131	1059	1072
Bahulagam	1597	833	764
Bhikaripalli	789	407	382
Bipilingi	3168	1616	1552
Chhatrapur	271502	135178	136324
Chikalakhandi	7152	3552	3600
Kamanalinakhyapur	1507	718	789
Kanamana	1114	594	520
Mahanadapur	1720	898	822
Podapadar	1988	937	1051
Pratapur	1371	701	670
Raipur	2230	1110	1120
Rajapur	2285	1133	1152
Sindurapur	132	58	74
Solaghara	2397	1234	1163
Sunantara	1132	561	571

Figure 4: *Odisha Sampad Geoportal*

3.2 Odisha 4K Geo Services for Disaster Management: Under a state funded Geospatial Technology project, the Centre created the Geo-referenced cadastral database and Land Use Database of entire state at 1:4000 scale after georeferencing all the Revenue Cadastral maps of the State. During 2018-19, the center decided to put all these Datasets under a Web-GIS based Portal for visualization, data dissemination, data access and for providing inputs to disaster management and mitigation planning activities by the State Departments. The objective is to develop a dynamic application with support for generating queries, both generic and specific and working as a Decision Support System (DSS). This is also used as an Asset Data Portal and for Programme Scheme Monitoring System for Odisha State at 1:4000 scale by State Finance Department. All the infrastructures / utilities / amenities created under Government schemes are to be incorporated into the portal via a dedicated server and Mobile-App based architecture.

Odisha 4k Geo portal (Figure 5) provides availability of data sharing framework; Standardized, Structured & Updated Geo-spatial Data; Infrastructure for seamless integration of data of multiple-sources; Standard mechanism for ensuring Data integrity; Web-based data supply on emergency situations; Technology for dynamically updating of real-time data & live feeds and finally Geo-coordinated location-based data and GIS-based Maps for effective Decision Support.

The portal module "Landuse and Landcover" provides an opportunity to users to access map and data as per the Administrative hierarchy i.e., District, Block, GP and Village. The maps can also be viewed with satellite data and cadastral (Revenue) maps in the background. The portal module "Asset" provides facilities to view the departmental assets (collected through the Mobile App – Mobile Asset Mapper) as per the administrative hierarchy basis and department wise data viewing.

Figure 5: *Odisha 4K Geoportal (www.odisha4kgeo.in)*

Odisha 4k GEO provides:

- *Structured storage,*
- *Multi-source Data Integration,*
- *Web-enabling of Data,*
- *Mobile App for Data capturing*
- *Data analytics,*
- *Query module creation,*
- *Dashboard based information visualization,*
- *Net based dissemination and*
- *On-demand Decision Support provisions*

Mobile Apps using Odisha 4k GEO infrastructure: Under Odisha 4k GEO, a module ASSET is created to capture Departmental Asset Data as per the requirement of State Finance Dept. Asset module is a Data analytics based web-based services through integration of ORSAC's OSDI and Odisha 4k GEO Validated GIS Data layers with Departmental Asset data.

The Odisha 4K Geo Services which provides data at Plot/Revenue or Cadastral scale are used for both Pre and Post disaster management cycle particularly for evacuation planning, relief operation, site-specific damage assessment and evaluation of impacts on habitation and livelihood.

3.3 Odisha KYL (Know Your Location): ODISHA KYL (Know Your Location) (https://odishakyl.in/) is a locational Intelligence App developed by ORSAC utilising the "Odisha 4K Geo" geospatial services. The App is developed by utilising georeferenced and geotagged administrative boundary and location data of "Odisha 4K Geo" and "OSDI". The App is very user friendly and on opening the App (the person holding the Mobile on any location inside the State of Odisha) it gives the following locational information.

https://odishakyl.in/

- District Name
- Block Name
- GP Name
- Village Name & Code
- Thana Name & Code
- Legislative Assembly Constituency Name
- Parliamentary Constituency Name
- If inside forest – Forest Name
- Plot Number
- Khatian Number
- Latitude
- Longitude
- Altitude
- CRZ info and Nearest social infrastructure

The backend service of KYL app is embedded with plot level geo-spatial datasets of the state generated in 1:4000 scale. Georeferenced cadastral maps merged with High Resolution Satellite Image (Orthoimages) and time to time modified administrative boundary layers are used to generate the digital geospatial database of the state along with linking of Revenue cadastral level info. The App is extensively used by the center during field validation and geotagged data collection for projects sponsored by various State Departments. The App is also integrated as a service into various Mobile App based applications for Department of Water Resources, Department of Farmers Empowerment & Agriculture and Department of Forest & Environment and OSDMA etc. This App is extremely useful to send location-based info and images to central server at ORSAC Bhubaneswar during disaster cycle for decision making. The android and iOS version is available in Google Play store and App store (Figure 6).

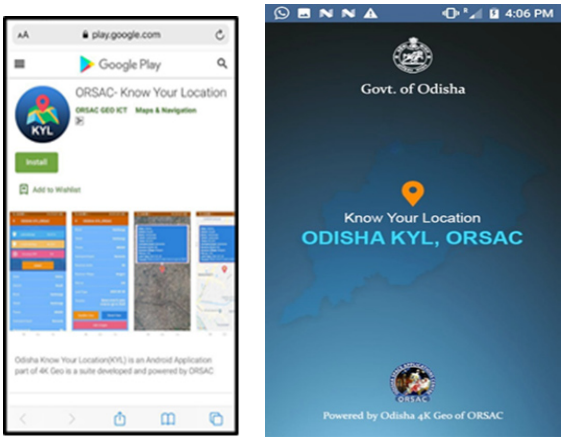
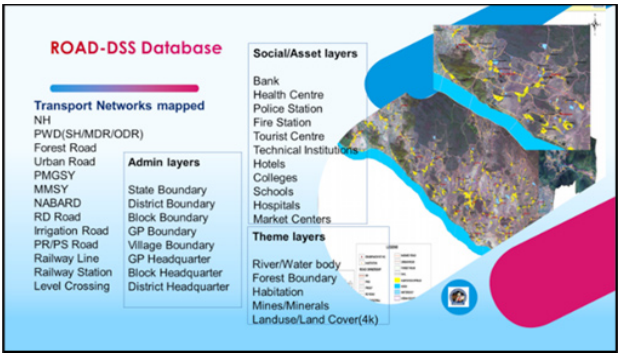


Figure 6: *Odisha KYL (Know Your Location) (www.odisha4kgeo.in)*

3.4 Geospatial Road DSS use in Disaster management: The Odisha Road Information System is a Web-GIS portal of all roads of all departments of Odisha. Besides depicting all road types of the state with its ownership and connectivity, Geospatial Road DSS is prepared to expand the practice of asset management state-wide to enhance the productivity of investing in roads and bridges. Part of the portal aim is to gather physical inventory and condition data for all roads and bridges in Odisha. There is also GIS-based mobile applications that allow department officers to report asset information. Mobile App (Odisha Road Explorer) based data collection mechanism is developed to report on the current condition of the roads and bridges and other social & infrastructural info in the road catchment. The Geo-database of all roads is also designed for all applications storing, editing, or accessing data for management purposes. One central portal for all road data allows several agencies to work cooperatively rather than competitively. Information can be produced for distribution to the public from one central location. There is also a dashboard feature that shows extent of roads as per administrative divisions, Department and scheme-wise road network distribution and all infrastructure in its buffer zone, bridge and attribute data relating to road condition.

The portal contains functions powered by GIS analysis tools that utilize geospatial data to correlate asset data with geographic data and other data sets (e.g., socio-economic, asset & infrastructure data). Automated GIS analysis tools allow departments to develop better designs and more efficient operating and maintenance plans, assess asset performance against safety measures, undertake disaster planning, and database programs for automatic analyzing asset data against other data sets. The Road Database provides emergency services and route planning during disaster management. Post disaster images and information are also overplayed to asses the damage caused during disaster and the plan for restoration and alternate route planning.

Figure 7 : *Odisha Road Portal*



3.5 Odisha Irrigation Information System (ODIIS) portal use in disaster situations: Data from Dept. of Water Resources, (Irrigation Dept.-Major, Medium, Minor, Creek, Watershed Mission, OLIC-Odisha Lift Irrigation Corporation and Mega Lift); Dept. of Agriculture (Jalanidhi-I, OAIC- Jalanidhi-II, Horticulture); Dept. of SC/ST (ITDA) and Dept. of Panchayatiraj (DRDA /Block) are collected and GIS database is generated. Sanitization of the data is undertaken by Dept. of Water Resources after departmental vetting. High Resolution 0.5 m World-View data of all blocks of the state are georeferenced using orthorectified cadastral data of Revenue Dept. for interpreting agricultural area to generate agricultural area extent of each village/Block. The irrigated area and cultivated area data are later on used to generate Odisha Irrigation information System web-portal developed as ODIIS, which is under operational use by DoWR Dept. only for official purposes.

ODIIS constitutes several modules. Ayacut Info Service provides user to query information about ayacuts of any Department or Organisation by District / Blockwise, River basin wise and as per Department ownership basis. All ayacut and scheme implemented info of 11 agencies of 4 departments are web hosted in the portal in query-based modules.

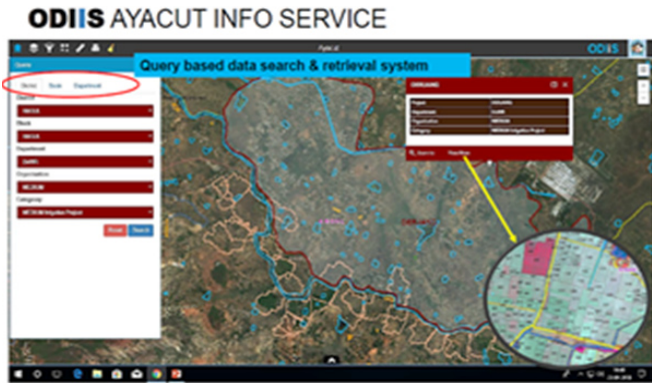


Figure 8: *ODIiS Geo-Portal Ayacut Info Service*

Landuse Info Service provides land utilisation in Ayacut and extension of cultivable lands. The portal also provides information on extent of cultivable land for all 314 blocks as interpreted from high resolution satellite data. Canal Info Service provides Georeferenced canal network map as interpreted from high resolution image along with all its attribute info. The portal also provides information on extent of canal upto tail end and coverage of revenue plots. Odisha Agri-GEO Database (Web-portal of Agriculture & FE Dept.) and ODIIS is integrated to provide information on actual croplands inside ayacuts in Kharif, Zaid & Rabi season.

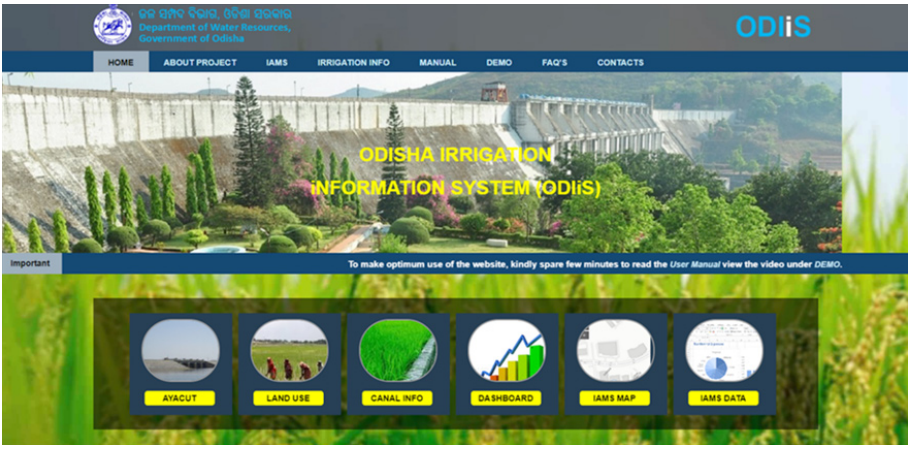


Figure 9: *ODIiS Geo-Portal (Odisha Irrigation Information System)*
http://odishairrigation.gov.in

ODIIS geospatial datasets are extensively used to know the extent of damage to crop lands in disaster time. Further the Agriculture geospatial database portal (portal which generates crop acreage info of all blocks of the state by using temporal Sentinel data) are integrated to ODIIS portal to know the crop condition in Ayacuts and further planning in drought and emergency situations are planned.

3.6 Odisha Power network Geo-Portal: Generation of GIS enabled Web Based Power Atlas for Odisha State is created under the OPTCL sponsored project. Survey of EHT Towers; mapping of Land Use and Land Cover of the portion of the land under the power-line corridor and area covering the Grids and Substations; integration of existing MIS/ERP data with the spatial data; updating of the infrastructures through crowd sourcing; integration of cadastral parcel level information and other infrastructures crossing through the power-line corridor etc. are undertaken. The main components of the projects are Survey covering 95 EHT

(400kV, 220kV & 132kV) Sub Stations, EHT Lines having 24,289 Towers covering 6952.975 route km having 3-5-meter accuracy, Generation of GIS Data base and integration of Survey data and MIS Data integration. Web Based customization was done using Geospatial Server. Oracle 11g R2 and ASP.NET Technology. A user-friendly GUI was developed for easy access of Web Based Power Atlas and for Crowd Sourcing facility.

The Web Based GIS System is able to respond to user-based queries. These queries are based on spatial and non-spatial data. The queries are generated on any of layers of the system. Standard Spatial queries cover all spatial operators, including proximity / neighborhood analysis, thematic analysis, shortest and optimal Routing, multi-criteria and multi-objective analysis etc. The power GIS Geo-portal is of important use in case of cyclone-initiated disasters and damage caused during summer period Kal-baisakhi thunderstorms.

Figure 10: *Odisha Power Network Geo-Portal*

4. Odisha Spatial Data Infrastructure (SDI) disaster management

Decision-making is a complicated process in disaster related crisis situations. Good support in decision-making when disaster occurs is of critical importance to react accurately, fast, and effectively. Good decision-making helps to control damage, save lives and resources, and reduce unwanted consequences of a crisis. Spatial Data Infrastructure (SDI) is increasingly considered a critical aspect of decision-making in disaster management.

Figure 11: *Odisha Spatial Data Infrastructure Portal (http://osdi.orsac.gov.in)*

Odisha Spatial Data Infrastructure (OSDI), a single window based Geospatial Clearing house, was established in the line of National Spatial Data Infrastructure (NSDI) of Govt. of India to access, share and disseminate GIS Datasets available with various Government agencies in Odisha through OGC compatible web-services. It is one of the nodes of the National Spatial Data Infrastructure (NSDI) like other State data Infrastructures of the Country. Odisha Space Applications Centre (ORSAC) is identified by the Govt. of Odisha as the nodal agency to design, develop and update the OSDI and it is hosted at State Data Centre. Odisha Spatial Data Infrastructure (OSDI) aims to position itself as an essential instrument to support decision-making by Geographic Information.

5. Conclusion

The frequency and magnitude of the natural and human-induced disaster and emergencies are constantly becoming unpredictable and have grave consequences. Disaster constitutes one of the greatest threats to the development and socio-economic well-being. The rapidly increasing frequency of disasters has become a menace to the people of Odisha during the last two decades. Effective disaster risk reduction and management can be achieved through the deployment of geospatial data for all the phases of disaster management, including prevention, mitigation, preparedness, vulnerability reduction, response, and relief.

This paper depicted how the state of Odisha is building the Geo-spatial platform for its application and use during disaster response and relief efforts. The advancement

of recent geospatial technology has been used effectively by the state after integration of multiple information in a web-based system for developing a better disaster response system. Conventional GIS disaster responses by governmental agencies and relief response organizations and the means for geospatial data sharing have been transformed into a more dynamic, more transparent, and more decentralized form, one that incorporates a much wider range of participation. Web mapping and geospatial data browsing with high-resolution satellite images and advanced data exchange have combined professional expertise and public involvement in ways unimaginable even a decade ago. This paper, however, represents the initial steps of Odisha outlining the ways in which geospatial technologies could be used for disaster relief and response.

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Role of Weather Advisory Services in Disaster Prevention, Mitigation and Management

Rohit Thapliyal*

Abstract

Uttarakhand's typical geographical location and topography make it vulnerable to extreme weather events, and its orographic geology makes it extremely vulnerable to natural disasters. In this study, the characteristics of these severe or extreme weather events in terms of frequency of occurrence of these weather events in different seasons, the natural disasters triggered by these extreme events and general as well as specific measures to be taken to prevent the damages/losses/disasters are discussed. The India Meteorological Department (IMD) is the national meteorological agency for India, which renders meteorological, seismological and allied services to disaster management, water resource management, aviation, road/rail transport, marine, agriculture, tourism, power sectors and the general public. Meteorological Centre, Dehradun provides different weather forecasting & warning products for Uttarakhand at a different spatial scale and lead time. The significant role of these forecasts in disaster prevention, & mitigation are discussed in this study.

Keywords: *Extreme weather events; forecast products; heavy rainfall; thunderstorm*

1. Introduction

The state of Uttarakhand lies on the southern slope of the Himalayan ranges and due to its geographical location, it is extremely vulnerable to natural disasters that occur due to extreme weather phenomena. A weather event such as cyclone, thunderstorm/ dust-storm, lightning, fog, heavy rainfall/snowfall, hailstorm, gale winds/ squall, cold wave, frost, heat wave, etc. which can cause loss of life and property is termed as a severe weather event or disastrous weather event. Based on the different weather features and characteristics of weather parameters, a year in India is meteorologically divided into four seasons, viz. Winter Season (January to February), Pre-monsoon Season (March to May), Monsoon or South-west monsoon Season (June to September) and Post-monsoon or North-east monsoon Season (October-December). Some of the most common & frequently occurring extreme weather events in Uttarakhand are Heavy rainfall, Thunderstorm and Lightning, whereas some of the less frequent but equally disastrous weather events that mainly occur during a particular season are Heavy snowfall, Cold wave, squall, Hailstorm, Heat wave, Frost and Fog. Every year these severe weather events trigger

natural disasters like landslides, lightning, avalanches, flash floods, forest fires, etc., causing loss of life and property. Therefore, the study of characteristics, duration, season of occurrence and disasters associated with a severe weather event along with the measures for disaster prevention and mitigation is critical for effective disaster management.

2. Result and discussion

i) Thunderstorm and lightning:

A thunderstorm is a mesoscale phenomenon described as one or more sudden electrical discharges, manifested by a flash of light (lightning) and a sharp or rumbling sound (thunder). It exhibits intra-cloud, cloud to cloud and cloud to ground lightning discharges. Strong surface winds as gusty winds or squall and hailstorm are often associated with a thunderstorm. Tyagi in 2007 prepared thunderstorm climatology of different cities of India and for Uttarakhand, it showed that the annual mean number of thunderstorm days over Dehradun is highest, i.e., 66.5 days followed by Mukteshwar (63), Tehri (43), Mussoorie (41.1), Dharchula (41), Roorkee (35.3) and Joshimath (8.5). The number of thundery days in the monsoon season is highest, followed by pre-monsoon, winter and post-monsoon seasons.

Cloud to ground lightning associated with a thunderstorm can cause damage to tall structures, electrical & telecommunication installations and is fatal to human and animal lives. Different studies show different numbers of fatalities due to lightning as it is difficult to ascertain the exact number of deaths, but every year hundreds of human and animal lives are lost due to this. According to a study by Selvi and Rajapandian in 2016, around 75000 to 80000 fatalities have occurred due to lightning in India from 1967 to 2012. According to Singh & Singh (2015), 5259 human lives have been lost by lightning strikes in India from 1979 to 2011, and the maximum number of lightning fatalities was observed in the state of Maharashtra, followed by West Bengal and Uttar Pradesh. They ranked Uttarakhand 20 among all the states in the number of causalities that have occurred during the period. The lightning fatalities were found to be highest in the month of June, followed by July.

The strong surface winds associated with a thunderstorm can reach up to gale wind speed. They can cause damages to the standing crops, power and communication lines, Kutcha houses and blow away loose/unsecured structures. These thunderstorms accompanied with strong surface winds are most common in the pre-monsoon season. However, on a few occasions, mostly restricted to the winter, pre-monsoon and initial phase of monsoon seasons, the conditions become favourable for the occurrence of hailstorm over Uttarakhand. Though the spatial and temporal scale of a hailstorm event is very small, the damage caused to the life and property is very high.

Convective activity is responsible for the formation of cumulonimbus clouds, and these clouds cause thunderstorms and its associated severe weather phenomena. The spatial scale of a thunderstorm is a few hundreds of meters to tens of kilometers. In case of supercell or squall lines, the spatial scale may go up to a few hundred kilometers. The temporal scale is of a few minutes to a couple of hours in case of a supercell thunderstorm. Therefore, the general advice for safety is to stay away from weak walls and structures and take shelter in pukka structures during the occurrence of a thunderstorm. It is advised to remain indoors and avoid water bodies and flying projectiles in the affected areas. Farming operations may be temporarily suspended during the occurrence of such events.

2. Heavy rainfall

The accumulated amount and intensity of rainfall are two important rainfall measures that determine the extension of damages to life and property. However, both precipitation measures are responsible for similar disasters like flash floods, inundation of low-lying areas, and landslides in hills. Uttarakhand receives more rain in terms of total annual and monsoon rainfall compared to the other mainland states. In precipitation ranking, it comes after north-eastern states, Goa, Kerala, and West-Bengal. Uttarakhand receives 75-80% of the total annual rainfall in just four months of the monsoon season. Table 1 shows the district wise excessive (annual rainfall ≥ 125% of the normal) rainfall years and the highest annual rainfall (expresses as percentage of normal) with the year of occurrence during the period 1961- 2010 [ADGM(R), 2014].

Table 1: District wise excessive rainfall years and the highest annual rainfall with the year of occurrence. Source:" Climate of Uttarakhand, 2014"

District	Years of excessive rainfall	Highest amount of Annual Rainfall in cm (expressed as % of normal with year)			Annual rainfall in cm.
Almora	1961, 1962, 1963, 1964, 1969, 1970, 1998.	147.8	153	1963	96.6
Chamoli	1969, 1971, 1973, 1974, 1975, 1986, 1987.	195.4	172	1969	113.6
Champawat	1961, 1962, 1981, 1983, 1985, 1986, 1990, 1993, 1998, 2000, 2002, 2003, 2007.	261.9	173	1993	151.4
Dehra dun	1961, 1963, 1964, 1966, 1967, 1971, 1973, 1977, 1978, 1999, 2001, 2010.	313.4	192	1971	163.2
Hardwar	1978, 1989, 1990, 1998, 2000, 2010.	196.1	163	1998	120.3
Nainital	1961, 1963, 1967, 1969, 1971, 1980.	238.8	157	1971	152.1
Pauri Garhwal	1961, 1962, 1963, 1964, 1965, 1966, 1967, 1989, 1999.	203.9	196	1989	104.0
Pithoragarh	1961, 1964, 1967, 1975, 1976, 1978, 1979, 1980, 1983, 1984, 1985, 1993, 1994, 2000, 2003, 2004, 2007.	412.6	223	2007	177.5
Rudraprayag	1961, 1962, 1964, 1966, 1968, 1969, 1970, 1989.	292.2	189	1970	154.6
Tehri garhwal	1961, 1966, 1970, 1978, 1981, 1993, 2002, 2003, 2004, 2007.	189.9	156	2007	121.7
Udhamsighnagar	1961, 1969, 1997, 1998, 1999, 2000, 2003, 2004, 2005, 2007.	203.5	190	2003	107.1
Uttarkashi	1962, 1963, 1969, 1988, 1994, 1998.	243.6	189	1969	128.9

The average frequency of heavy rainfall days during the monsoon season in Uttarakhand based on the daily rainfall data from 1989 to 2018 is shown in figure 1. The maximum number of heavy rainfall days during June to September lies in the range of 3.5 to 4 days, especially in some parts of Pithoragarh, Nainital, Pauri Garhwal and Dehradun districts. While the minimum number of Heavy rainfall days lies in the range of 1 to 2 days especially in some parts of Uttarkashi, Chamoli, Tehri Garhwal, Pauri Garhwal, Almora and Pithoragarh districts. Whereas in the remaining districts, the number of Heavy rainfall days lies in the range of 2 to 3.5 days (Guhathakurta *et al*., 2020).

A very large amount of rainfall in just four months and the topography of Uttarakhand makes the state vulnerable to natural disasters. One of the most severe natural disasters in recent decades is the Uttarakhand flash floods that occurred in June 2013. Due to this, the state incurred a loss of 4,190 (dead and missing) human lives (Satendra *et al*., 2014). Figure 2 shows the human casualties and observed monsoon rainfall over Uttarakhand from 2005 to 2015, and it can be seen that higher monsoon rainfall causes more human losses. Heavy rainfall or intense moderate rainfall can trigger landslides in hills, inundation of low-lying areas and overflows of streams/rivulets. Therefore, Settlements/people residing near the banks of rivulets, low-lying areas, streams and landslide-prone areas should remain cautious during extreme rainfall events. New settlements and townships should be made in safer areas away from streams/rivulets, steep slopes and landslide-prone areas.

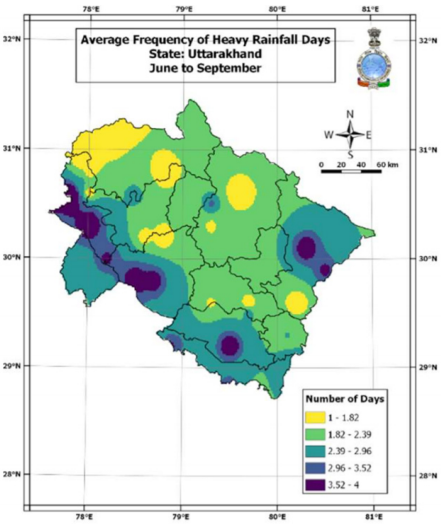

Figure 1: *Average frequency of heavy rainfall days in Uttarakhand from June to September.*

Source: "Observed Rainfall Variability and Changes over Uttarakhand State, 2020"

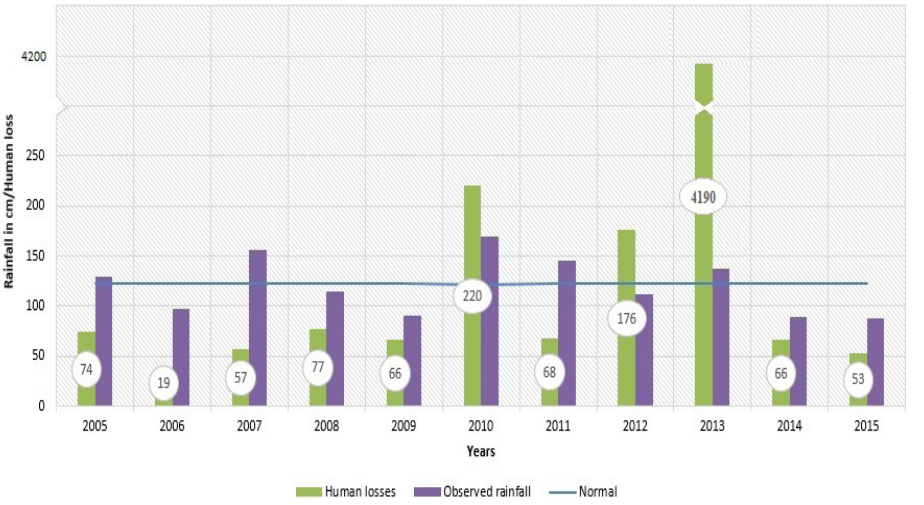

Figure 2: *Relationship between human losses and monsoon rainfall in Uttarakhand (2005 to 2015).*

iii) Other weather phenomena

Uttarakhand experiences heat wave to severe heat wave on a few days during the pre-monsoon and early monsoon season especially in the month of April to June. Figure 3 illustrates the seasonal climatology of Heat and Severe Heat waves over India (Pai *et al*., 2013). It can be seen from the climatology that heat wave is experienced on ≥8 days at isolated places, around 6 to 8 days at a few places and about 4 to 6 days at isolated places in India during the hot weather season. The number of severe heat wave days is around 1 to 2 days in Uttarakhand. However, the impact of heat on the human body is greatly determined by other meteorological (R.H., wind, sun exposure, etc.), social (Clothing, occupation, etc.) and physiological factors (age, health, etc.). Some of the adverse health effects of hot weather and heat-waves are Heat rash, heat cramps, heat exhaustion, heatstroke, etc. These are mostly preventable by taking suitable measures to reduce heat exposure and keep the body temperature normal. Similarly, on a few days during the cold weather season (December to February) cold to severe cold waves are experienced in Uttarakhand. Heavy snowfall during this period can cause damage to the weak structures and blocking of roads, slippery roads which can cause vehicular accidents.

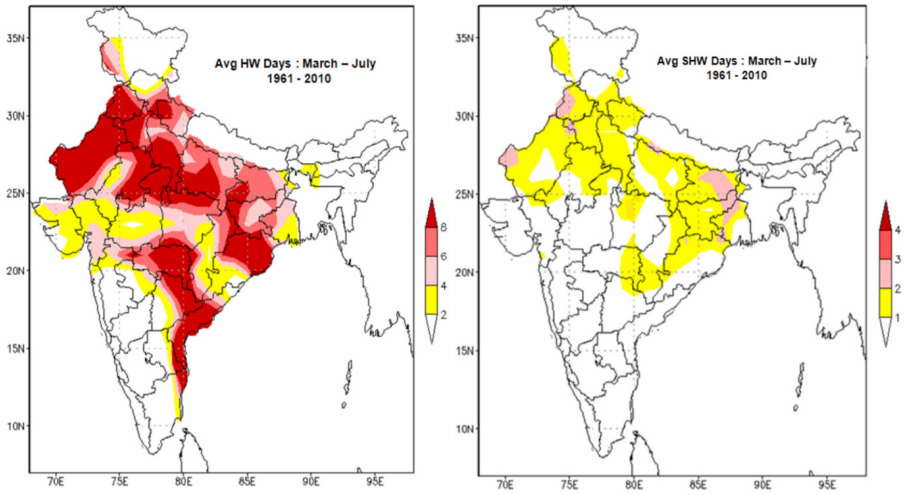

Figure 3: *Seasonal climatology map of the number of Heat Wave days and Severe Heat Wave days over India during the hot weather season (March - July). The climatology was computed by averaging the number of HW days for the period 1961-2010 (Source: Pai et al., 2013)*

Another severe weather phenomenon that is mostly experienced in the post-monsoon and winter season especially in the plains of Uttarakhand, is Fog. However, in hills it is experience throughout the year. The Haridwar, Udham Singh Nagar and plains of Dehradun, Pauri & Nainital districts are mostly affected by the fog. The atmospheric stability, light to calm winds, sufficient humidity, clear skies, low temperatures, etc. during these months reduces the air temperature below the dew point, resulting in Fog formation. Generally, the fog occurs in the early morning and prevails till late afternoon. Fog makes aviation, road and rail transport vulnerable to accidents. It can also cause breathing problems in the elderly and people who have asthma.

iv) Earthquake

Earthquake is a natural disaster not related to the weather but Uttarakhand is prone to seismic activity and the state comes under seismic zone IV and V. Table 2 shows the details of earthquakes of the intensity of 5.0 or more at Richter scale having epicentre of the highest intensity earthquake month wise in the state between the year 1862 and 2013 (ADGM(R), 2014). The highest intensity of the earthquake was experienced in August 1916 which was of 7.5 on the Richter scale having an epicentre at 30° 00' N latitude and 81° 00' E longitude.

Table 2: List of earthquakes of the intensity 5.0 or more at Richter scale having epicentre within Uttarakhand state during the years 1862-2013. Source:" Climate of Uttarakhand, 2014".

MONTHS	YEARS	FREQU-ENCY	EARTHQUAKE OF HIGHEST INTENSITY			EPICENTRE			
			INTENSITY AT RICHTER SCALE	DEPTH IN km	YEAR	LATI-TUDE-N		LONGI-TUDE-E	
						DEG	MIN	DEG	MIN
JANUARY	1963 1968 1997	3	5.6	33.0	1997	29	50	80	32
FEBRUARY	1949 1984 2006 2012	4	5.5	0.0	1949	31	12	79	54
MARCH	1844 1935 1935 1965 1969 1981 1996 1999 1999	9	6.8	21.0	1999	30	25	79	25
APRIL	1843 1999 1999 2011	4	5.5	9.0	2011	29	35	80	53
MAY	1816 1883 1968 1979 2006	5	6.5	0.0	1816	30	0	80	0
JUNE	1902 1906 1945 1966 1966 1966 1966 1966 1966	10	6.5	0.0	1945	30	18	80	0
JULY	1926 1962 1962 1980 1986 2007	6	6.1	0.0	1980	29	38	81	5
AUGUST	1916 1947 19661972	4	7.5	0.0	1916	30	0	81	0
SEPTEMBER	1964 1990 2008 2009	4	5.8	50.0	1964	29	58	80	28
OCTOBER	1927 1937 1964 1991 2004	5	6.6	13.0	1991	30	45	78	52
NOVEMBER	1963	1	5.1	33.0	1963	30	48	79	6
DECEMBER	1908 1958 1958 1961 1964 1964 1966 1966 1979	9	6.3	0.0	1958	30	1	79	56
OTHER	1803 1809 1809	3	6.5	0.0	1803	30	0	80	0
TOTAL		**67**	**7.5**	**0**	**1916**	**30**	**0**	**81**	**0**

v) Weather forecast in disaster prevention

Weather is defined as the complete instantaneous state of the atmosphere at a particular place. The parameters that are generally used to determine the state of the atmosphere are wind speed, wind direction, ambient air temperature, atmospheric pressure, atmospheric relative humidity and sky condition. India Meteorological Department (IMD) is the principal government agency that provides weather services to different sectors like agriculture, irrigation, shipping, transport, aviation, offshore oil exploration, etc. IMD also supply, update and archive climatological data of India for research and development purposes. A few services rendered by IMD are Agrometeorological, Astronomical, Aviation, Hydro-meteorological, Environmental monitoring, Cyclone monitoring, Seismological, Marine, Climatological and Severe weather monitoring services**.** To provide aviation, agrometeorological, seismological and weather services Meteorological Centre (MC) was established at Dehradun in 2002 after the formation of Uttarakhand state. Though the meteorological observatory at Dehradun was established on January 1st, 1967 in the Geodetic and Research branch campus of Survey of India and in the initial years it worked under the Meteorological Centre, Lucknow. MC,

Dehradun generates different forecast products for the disaster management, aviation, agriculture, transportation, pilgrimage and tourism sectors. Timely and accurate weather forecasts can prevent losses due to natural disasters. Different predictions with different lead times have a role in pre, during and post-disaster operations. The weather forecast and warning products and their role in disaster prevention are listed in table 3.

Table 3: Weather forecast & warnings products and their role in disaster prevention, management & mitigation.

Forecast products	Description	Role
Medium range weather forecast	The district-wise weather forecast and warnings bulletin contains five days weather forecast and warning for Uttarakhand with a subsequent two days outlook.	Disaster preparedness & planning: The warnings with 3 to 5 days lead time can be used for medium-term planning. The planning may include the deployment of necessary resources like excavators/backhoes, fuel & food storage, personnel, etc. at the strategic locations near the regions expected to be affected by the severe weather. Similarly, in the agriculture sector, the farmers can prepare their fields to minimize damage due to such events. They can make drainages for excess water, delay irrigation/pesticide spray, plan sowing, etc.
Nowcast	Nowcast and warnings are issued for major cities and all the districts of Uttarakhand at three-hourly intervals.	**Disaster prevention & mitigation:** The warnings with 1 to 2 hours lead time is useful for very short-term planning and rescue operations. Nowcast is useful when the action can be taken within a very short span of time, like in the aviation sector, agriculture sector, helicopter operations, movement to safer places, start/halt of weather-sensitive operations in affected areas, etc.
City/ Tourism forecast	7- days City forecast of maximum, minimum temperature and weather conditions is being issued for different cities of Uttarakhand. A special tourist forecast is issued for Char Dham, Hemkund Sahib and Kailash Mansarovar Yatra.	**Loss prevention:** The tourists, pilgrims, etc., can schedule their journey according to the issued forecast and warnings. This can prevent unnecessary load on government machinery and help in better rescue & response operations in case of a mishap.

Forecast products	Description	Role
Forecast for Railway/ Road transport	Forecasts and warnings are issued to Northern Railways, State transport department, DMMC, etc.	**Optimize operations and disaster prevention**
Agromet bulletin and value-added forecast	Agro-meteorological advisory and district-wise value-added weather forecasts for the farmers are issued every Tuesday and Friday. The Agromet bulletin contains weather-based crop advisories. The value-added forecast includes the forecast of different weather parameters like maximum & minimum temperature, relative humidity, wind speed & direction, cloud cover, and rainfall for the next five days.	**Improve agriculture yield and loss prevention:** The district-wise weather-based crop advisories are issued with the help of Agromet Field Units in Uttarakhand. The appropriate actions taken on Agro-meteorological advisories & warnings can improve the agriculture yield and prevent damages/ losses.

3. Conclusion

Based on several previous studies on Uttarakhand disasters, it is evident that the state is prone to natural disasters. The characteristics of natural disasters triggered by severe weather events and possible measures to mitigate or prevent the damages/losses are discussed in the previous sections. Some of the most common & frequently occurring extreme weather events in Uttarakhand are Heavy rainfall, Thunderstorm and Lightning, whereas some of the less frequent but equally disastrous weather events that mainly occur during a particular season are Heavy snowfall, Cold wave, squall, Hailstorm, Heat wave, Frost and Fog. Besides weather-induced natural disasters, the state is located in a zone of high seismic activities. The state receives a significant part (75-80%) of the total annual rainfall in just four months of monsoon season, which further increases the vulnerability to the disaster. Thus, the damages/losses due to weather-related natural disasters are high in the monsoon season, followed by the pre-monsoon season. IMD is the principal government agency that provided weather forecasts & warnings for severe weather events. Different forecasts with different lead time generated by Meteorological Centre Dehradun have a significant role in pre, during and post-disaster operations.

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Gender Mainstreaming and Disaster Risk Reduction in India

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Abstract

Gender mainstreaming is a concept that is easy to agree but difficult to implement or follow and same happen when it comes to mainstreaming gender perspective in Disaster Risk Reduction policy plan and action. Thus, in order to achieve sustainable development disaster resilience may be built in both men and women. It is important to institutionalize gender sensitive risk assessments, early warning system and use gender-sensitive indicators to monitor gender mainstreaming in progress. Gender mainstreaming emphasized upon developing increased understanding of gender concerns and developing government capacity. This is to address gender issues and integrate gender perspectives into DRR legislations, policies and programme for creating sustainable community resilience.

Keywords: *Gender mainstreaming, Sustainable Development, Disaster Risk Reduction.*

1. Introduction

Women and men live in a society that does not provide them with equitable opportunities for personal growth and empowerment as human being. Often power structure creates imbalances between two sexes leading to inequitable control on resources and opportunity including exclusion of one gender from decision/policy making process or leadership. Gender equity recognizes that different approaches may be required to foster a just society for all human being based on individual aptitudes, abilities and interest regardless of gender.

India is vulnerable, to a large number of natural as well as man-made disasters. In the context of human vulnerability to disasters, the economically and socially weaker segments of the population are the ones that are most seriously affected. Women in disasters are often the most vulnerable group because of their exposure to higher risks. For instance, disasters lower women's life expectancy more than men's, according to data from 141 countries affected by disaster between 1981 and 2002. Studies have shown that disaster fatality rates are much higher for women

than for men. This gendered asymmetry in vulnerability to disaster risk is rooted primarily in geographic, economic, social, educational/ informational and political power imbalances in societies. Pre-disaster vulnerabilities among women play a major role in determining the impacts of disasters. Their special needs, in fact especially those of pregnant and lactating women, are ignored. Thereafter, post-disaster women are held back from a faster rate of recovery and from regaining their confidence. Due to the social setup in India women are considered prime caregivers for children and as a result of this the differentiated impact of disasters on women translates to higher vulnerabilities for children in disasters. Gender discrimination is a systematic discrimination against women that limits their capabilities and renders them vulnerable to exploitation and abuse of all forms. It calls for a specific emphasis on the participation of women in all processes which design and build programmes and policies for disaster management and mitigation as well as for disaster relief and response as well as post–disaster reconstruction. There has recently been critical shift in the mainstreaming of gender perspectives in to DRR from women focus to gender focus approach, based on the premise that the roles and relationships of women and men in DRR should be analysed within the overall gendered socioeconomic and culture context. On the top of this shift the strategic focus of disaster management has changed from reactive disaster response to long term proactive disaster risk and vulnerability reduction, where gender and DRR are considered necessary to achieve sustainable development. Effective gender mainstreaming in disaster management as well as in post-disaster programming also calls for legal and policy reforms that would transform gender relations in order to make them more equitable and to offer women guarantees for equality in dignity and in rights.

In reality, while women's vulnerability to disasters is often highlighted, their actual and potential roles in disaster risk reduction (DRR) have often been overlooked. Thus, there is a need to enhance skills Women in view of DRR so that they can be equal partners during relief and rescue process.

Gender differences in society make women more vulnerable to disasters through their socially constructed roles. Women are highly represented in the agriculture and informal economies. Both of these industries are often seriously impacted by natural disasters, as a result of which women comprise the majority of the unemployed after disasters. In addition, they are often underpaid and have little access to benefits.

According to Byrne and Baden (1995), if gender is not considered there is a danger that women may become invisible in relief programs, with men receiving most

resources and participating in the planning and implementation of programs. This leads to increased gender inequality and reduce the effectiveness of relief programs, resulting in women's capacities remaining underutilized and their needs not met. Conversely, a focus on women alone (rather than gender relations) may lead to women being seen as the primary victims of emergencies, arising in failure to recognize men's and women's different needs and capacities, contributing to increased gender conflict.

Hence, it is important to have a clear understanding of the difference between the Women in Development (WID) approach and the Gender and Development (GAD) approach in the analysis of emergencies. The WID approach is reflected to some extent in relief practice through the recognition of some of the needs of women in food distribution, health care, and the importance of their role as mothers. But GAD approaches and the associated analysis of the distribution of power and resources as well as the process of change in relations between men and women are poorly articulated in emergency policy and practice.

National Policy on Disaster Management, 2009 encourages participation of women in decision making committees and action groups for management of disasters. National Disaster Management Plan of 2019 provides a framework for inclusive approach for Disaster Risk Reduction. The Prime Minister's 10-point agenda also emphasises on In the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR) 2016, which was held in New Delhi, Hon'ble Prime Minister of India had listed the ten point's agenda during his inaugural speech. All-inclusive agenda presents a holistic approach to disaster risk management and addresses a whole range of issues including greater involvement and leadership of women in disaster risk management.

2. Why gender mainstreaming in DRR programme

A natural hazard in itself is not a disaster but turn into a disaster when individual/ community does not have adequate capacity to respond in a way that saves life and property. The lack of capacities is not predetermined to the sex of the person but they are the result of prevailing social, economic and political inequalities. Prevailing gender role and power relations determine to a great degree the nature and extent of capacities present in any community or society. Gender role and power relations directly influence how resources and opportunities are distributed and controlled and who make the decisions. Thus, gender inequality is often considered a root cause of social vulnerability during disaster and recovery process in most of the countries. It mainly, attributed to their subordinate position,

patriarchy and culture. When gender issues are not addressed fully or sufficiently, in both development and disaster context, they perpetuate gender-based inequities. These make the women or men more vulnerable to various hazards as their specific need are not meet especially when it compounded with other social inequalities or problems. Like poverty which is known to be a key factor in the vulnerability of both men and women during hazard events, but there can be gender differences among poor that further compound the risk. For instance, poor women may have heightened vulnerability to hazard events that occur during the daytime, as many live-in unsafe areas and houses and tend to spend more time indoor or near the house than their male relations. As men usually form the majority of poor migrant laborers, their wives and children as well as older people remaining in the family home may be more exposed to the impacts of local disaster.

3. Factors affecting gender mainstreaming in Disaster Risk Reduction

Major disasters that have occurred over the past decade, such as the Indian Ocean Tsumani, Hurricane Katrina and the Kashmir Earthquake, have highlighted the gendered aspects of disaster risk and vulnerability. For example, response and recovery programmes encountered heavy criticism for gender insensitive practices that often made the situation for women worse. As a result, the issue now receives greater attention from researchers, academics, relief and recovery agencies.

4. Factors determining differentiated impact on women

Gender shapes capacity as well as vulnerability. The increased vulnerability of women can be attributed to:

Social and economic situations: During 'normal' times women may have a lower social and economic standing with limited access to education and information in some societies, leading to a lack of knowledge regarding evacuation routes, facilities and other disaster risk reduction (DRR) information. This leads to an inability to appropriately react when disasters occur. Also, since men commonly hold decision-making power, women are unable to make timely decisions, which may delay their evacuation.

Gender norms: The inability to relocate to evacuation centers/points without the accompaniment of one's husband or other male family member, the limited mobility of female attire such as a sari, and other particular gender norms or patterns of behavior may be influential in a disaster. Gender norms shape basic survival capabilities as well. For example, women accounted for 70–80 percent of fatalities in the 2004 Indian Ocean tsunami, because men were taught how to swim and climb trees at young ages, while women were not.

Cultural norms: Household chores are considered primary responsibility of women. Post-disaster this burden further increases on women.

5. Challenges post a disaster

Aggravated poverty: Poverty intensifies in the affected regions as women and girls are compelled to stay at home. Destruction of homes and communities expose them to further risk of impoverishment. It has been also seen that post disaster aids are majorly cornered by men as they constitute majority of the property owners, bank account holders, perceived heads of households and formal sector workers.

Violence: In disasters and conflicts, women sheltered in rehabilitation camps are easy targets for abduction, sexual exploitation, violence, and rape. Early and forced marriages increase due to post-disaster poverty

Infringement of Privacy: The biological needs of women to maintain privacy during menstruation causes a very high level of stress among women in such living conditions, with an absolute loss of personal home space, including privacy and comfort. Under such conditions women are subjected to higher rates of culturally inappropriate exposure. After Cyclone Fani hit Odisha, in the absence of gender-sensitive disaster response mechanism, women in several affected villages were left with just one cloth to cover body and manage menstruation

Health: Reproductive health issues and psychosocial stress are very closely associated. Post disaster trauma and stress added burden of duty and responsibility make the women more vulnerable to physical, mental and emotional stress.

Socio-cultural consequences: Burden of household chores greatly increases post-disaster as the women has to ignore her losses and assume the role of caretaker. Further added to this is the difficulty in securing energy sources, food, and water.

Yet, the same destructive forces of disasters also create opportunities for women as agents of change. Disasters can also provide an opportunity to redress gender disparities. For example, during the recovery period following a disaster, longstanding biases against women can be challenged by programmes that are sensitive to their needs and that involve them as equal partners in recovery work.

6. Gender Mainstreaming during various phases of Disaster Risk Reduction

Disaster Preparedness and mitigation:

Community Based Disaster Risk Reduction starts from community. An understanding of the various local hazards and characteristics of community

in terms of demography, male female ratio their strength and weaknesses are created. Preparedness may include spreading awareness of a "culture of safety" and developing community capacities for promoting that attitude. The issues faced and processes require ensuring that CBDRR activities should be sensitive to and inclusion of gender and diversity. Like men women may also get trained in other lifesaving skills -Search and rescue technique like climbing or swimming along with training in first aid.

As a part of preparedness activity women may also get trained in *Early Warning System* as trained women task force may support in ensuring that vital information reaching to all the segments of the community.

Information Education and Communication

A gender analysis of the situation of both men and women can help in developing interventions that better meet their different roles, needs and are mutually reinforcing in increasing the overall safety and resilience of the household and community. The gender- related issues involved in the development of physical mitigation works be it the building check dams or health clinic. Women may also get involved or trained in other non-traditional areas such as cyclone resistance roof construction, which may contribute to both family income and community safety.

Disaster Response

Disaster impact men and women differently (even within the same household) because of social, economic, physical and biological differences. Having information about their situations is essential when developing responses that better meet their specific needs. Consulting with socially and economically representative cross section of affected men and women is essential for effective targeting as is their participation in decision making during response process.

Immediate Need Assessment

In a quick onset of disaster, rapid assessment normally takes place within the first 24to 72 hours of the emergency. At the minimum, sex disaggregated data should be collected at this time. I possible this data should be supplemented with any available information on the pre-existing gender and socio-economic context and on the impact previous disaster may have had on different group.

Emergency Response Teams

Assessment and response team should include equal number of male and female members in order to facilitate accessing women and men separately during need assessments. If these teams are kept in the same balance throughout the operation, they will also be better able to address the respective needs of women and men.

Beneficiaries registration and relief distribution system

Procedures for relief registration and distribution should recognize the need for, and ensure access to assistance by all types of vulnerable and needy household as well as individual households. There have been many instances of women and other vulnerable group missing out on relief assistance particularly when government and relief agencies have registered households based on their male heads.

Appropriateness of relief items:

Gender and culture-specific needs should be taken into consideration when designing relief packages. Women and men of the communities should be consulted while designing the relief packages. Like sanitary need of women and older girls may be taken into consideration. Similarly, pregnant and lactating women have special needs for crucial nutrients and vitamins supplements that can be incorporated into family or mother or baby assistance package. Specific health issue of pregnant women may be addressed. During the Uttarakhand flash flood and landslide disaster, 2013 in absence of any female gynaecologist women delivered babies in unhygienic and unsafe conditions.

Ensuring appropriate Safety in relief centers

After any disaster relief camp and shelters planning needs to take into account the socio-cultural needs and preferences of both men and women in consideration with safety. It should provide enough privacy to female members of affected population. Bathing and toilet arrangement needs to be adequately and culturally safe and appropriate.

Disaster Recovery

During the recovery process if the gender issues are to be addressed with sensitivity to local contexts, it can contributed to boosting the economy and promoting safety, prosperity and decision-making power of the women. A careful planning and

analysis is to be done for recovery process that contribute to addressing existing gender and social inequalities.

Housing, human settlement and water and sanitation

It is vital that women and men from all social and economic grouping in disaster affected communities actively participate in the design and location of new housing and communal infrastructure, such as water and sanitation facilities and community halls, as well as repair of existing structures. Many reconstruction programmes have resulted in nearly empty settlements or the re-creation of unsafe living conditions, because of a lack of understanding of the livelihood and social need of the inhabitants.

Challenges for gender mainstreaming in DRR

Poor understanding of gender in DRR linkages at the policy and practitioner levels: Gender equality in DRR does not mean merely addressing women's issues - it means addressing concerns of both men and women, the relations between them and the root causes of imbalances.

Gender issues are often institutionally marginalized within organizations: The vogue for Gender Focal Points or Gender Desks results in easily marginalized positions with not enough authority to advance the issue organization-wide in a multi-disciplinary way. This, in effect, is the opposite of mainstreaming. Gender issues become perfunctorily treated as 'just women's issues', there is a notable absence of male champions, and gender 'expertise' is applied in isolation from development processes like DRR.

Gender continues to be identified as an 'add on' aspect, rather than an integral component: The development and DRR fields are now addressing relatively new priority programming issues such as climate change that compete with other programmes for donors. This means that gender and DRR can be de-prioritized when they are not understood to be cross-cutting issues.

There is a lack of genuine political accountability and financial resources for global advocacy and action on gender and DRR. Commitment to the issue largely remains in the documentation alone. There have been no significant moves to translate words into actions in terms of concrete policies, finances, substantive programmes or accountability measures. Gender mainstreaming in DRR remains a free choice with no accountability, no checks and balances, no ownership, and no medium or long-term commitment.

Gender events have not been adequately linked with inter-governmental DRR processes. Recommendations on mainstreaming gender into DRR that are being produced have a limited impact because they are not being considered or implemented by national governments and UN agencies.

Lack of institutional and individual capacities and tools for mainstreaming gender in DRR. Gender and DRR knowledge and capacity are still possessed by only a relatively small group of professionals and practitioners working in these two areas. The majority of disaster professional often lack the knowledge required to address gender issues in DRR.

7. Conclusion

To address a gender perspective in DRR requires change in the mindsets and attitude of policy makers and implementers. Every citizen has a role to play in reducing disaster risk, but government is best positioned to create an enabling environment for gender equality in DRR. Successful implementation of any development programme requires the full and active and balanced participation of men and women. Governments play an important role in promoting gender equality and building disaster resilience at community and national levels. Thus, serious action needs to be taken and more efforts need to be made for promoting gender inclusive disaster risk reduction. Each action is an effort to shift the identity of women from beneficiaries to key actors in building, shaping and sustaining resilient communities.

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Winter Challenges: A case study of Recent snowfall in Kashmir

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Abstract

Snowfall in Kashmir has always posed challenges for the public in general and Administration in particular since times immemorial. While people are used to witness snowfall from November to March every year but the extreme winter conditions usually prevail in the months of December and January. This winter, in line with the Weather Forecast issued by the local Met Office of the IMD on 2nd January, 2021, the snowfall started on 3rd and continued up to 6th of January,2021 thereby throwing life out of gear and warranting a quick response from those at the helm of affairs. The biggest challenge for the Administration has always been to restore the emergency and essential services including communication, health services, power, water supply and civil supplies and so on. Kashmir was cut off from rest of India as the lifeline of the region -the Jammu-Srinagar National Highway as well as the Mughal Road remained closed, while as air traffic was suspended in view of the heavy snowfall across the valley. Although snow clearance operations were started from day one itself, however, it proved to be of little help owing to the fact that it continued to snow at a stretch for more than four days. In addition to large scale damages to public and private property, there were some casualties with regard to loss of life as well. In view of the damages witnessed on account of this heavy snowfall, the UT Government under the Lieutenant Governor declared it as a State specific Natural Calamity to enable the administration to provide ex-gratia to the victims under SDRF. The closure of the National Highway resulted in forcing the Divisional Administration to order for rationing of essential supplies including fuel and LPG. However, yet again, it was exhibited by the dedicated teams of officers and officials at different levels of Administration that coordination to address the problems posed by such disaster situations is the only way out. Monitoring of snow clearing operations in the midst of night by the Deputy Commissioners themselves has been a remarkable effort and hailed by all sections of society. An effort has been made in this paper to highlight the event and the response of the Government and the suggestions to further improve our preparedness and response strategies to minimise the impacts of such calamities in future.

Keywords: *Snowfall, Calamity, Mechanical, Forecast, Preparedness*

1. Introduction

Moderate to Heavy Snow falls are endemic to the Kashmir Valley during winter and accessibility becomes of paramount importance for the government to avoid disturbances in day-to-day activities. Despite the fact that the local populace as well as the administration have always been preparing for the winter in the summer months itself, yet the challenges are tremendous and vary from area to area and one season to another. Jammu and Kashmir has been witnessing different disasters in different shapes and sizes from ancient times some of which have local ramifications while as others have had regional implications (the Snow Storm of February ,2005 and the Kashmir Earthquake of October,2005 being the live examples).With regard to Winter Preparedness and the impacts on account of heavy snowfall, the Public Works (R&B) Department under its Mechanical Wing has a fleet of Snow Clearing Vehicles which effectively prepares itself before the season begins to respond to predictive forecasting of inclement weather by the India Meteorological Department.

2. The Event- Heavy Snowfall (January 3-6, 2021)

It was on 2nd of January,2021 that the Met Department issued the extended forecast for the week and in line with the forecast it started snowing mildly on 3rd of January in different parts of Kashmir valley with rains in parts of Jammu Division. A look at the forecast gives an idea of the pattern of the snowfall for the four days which resulted in large scale disruption to the normal functioning of life particularly in Kashmir.

Weather Forecast issued by IMD

Dated: 02.01.2021	Time of issue: 1000 hrs. IST

Forecast for next 24 hrs.

Isolated very light rain/snow on upper reaches of J&K and mainly dry weather in Ladakh and Gilgit-Baltistan regions.

Outlook for subsequent 2 days

scattered to fairly widespread light to moderate rain/snow/thundershowers.

(Forecast from 0830 hrs. of 02.01.2021 to 0830 hrs. of 09.01.2021)

Days	D1	D2	D3	D4	D5	D6	D7
Date	02.01.2021	03.01.2021	04.01.2021	05.01.2021	06.01.2021	07.01.2021	08.01.2021
KASHMIR	ISOL	SCT	FWS	WS	SCT	DRY	DRY
JAMMU	ISOL	FWS	WS	WS	SCT	DRY	DRY

LADAKH	DRY	ISOL	ISOL	SCT	ISOL	DRY	DRY
GILGIT-BALTISTAN	DRY	DRY	DRY	SCT	DRY	DRY	DRY

Weather Warning During Next 5 Days

Table 1: Weather Forecast for the Union Territories of J&K and Ladakh

Days	D1	D2	D3	D4	D5
Dates	02.01.2021	03.01.2021	04.01.2021	05.01.2021	06.01.2021
KASHMIR	NIL	NIL	NIL	Scattered heavy rain/ snow/ thundershowers	NIL
JAMMU	NIL	NIL	Isolated heavy rain/snow/ thundershowers	Scattered heavy rain/ snow/ thundershowers	NIL
LADAKH	NIL	NIL	NIL	Isolated heavy snow	NIL

In accordance with the forecast a strong Western Disturbance impacted J&K and adjoining areas during 3rd January to 6th January, 2021. Under the influence of this system, moderate widespread rain/snow over Western Himalayan region during 04th - 06th January, 2021 with its peak intensity on 4th & 5th January with heavy to very heavy rain/snow over Jammu Division & Kashmir Valley was observed. A look at the data given in the table 2. Table 2 below indicates that the pattern was almost parallel to the forecast issued by the MeT Office. Since the precipitation was widely distributed over four days as such the snow clearance operations witnessed tremendous hiccups as the roads cleared on the first day had to be cleared again on the subsequent days. The above spell is one of the heaviest spells in last 10 years in terms of snow depth accumulated during 4 consecutive days, although in terms of precipitation (water equivalent in mm), it may not be the heaviest as per data available with IMD. A comparison of current spell with previous year's data is given in table 3.

Table 2: Cumulative precipitation data of current spell (Kashmir Division)

Station	03-Jan	04-Jan	05-Jan	06-Jan	Total precipitation (mm)	Total snow depth (cm)
Srinagar	6	16	8	34.7	108.5	**64.7**
Qazigund	21.2	52	30	33.7	152.4	**136.9**
Pahalgam	11.5	21	18	29	111.7	**79.5**
Kupwara	1	3.5	2	22	51	**28.5**
Kukernag	19	32	26	17	124	**94**
Gulmarg	5	3.8	21	28	84.6	**57.8**
Konibal	7	37.5	21	30	117	**95.5**

Source: Met Office (IMD), Srinagar, 2021

Table 3: A comparison of current spell with previous year's data

Station	Current year (cumulative 4 days (3-6 Jan, 2021) precipitation amount in mm)	Last 10 years	All Time Record
Qazigund	152.4 mm	79.8mm/ (14.1.2020)	120.8mm/ (13.1.1969)
Kukernag	124 mm	105mm/26.1.2017)	105mm/ (26.1.2017)
Pahalgam	111 mm	146mm/ (7.1.2012)	146mm/ (7.1.2012)
Srinagar	108 mm	62.1mm/ (14.1.2020)	147.8mm/ (31.1.1930)

Source: Met Office (IMD) Srinagar, 2021

From the tables it is clear that Southern parts of Kashmir recorded more precipitation in the form of snow as compared to the northern districts thereby posing more challenges for the administration as it is through the southern districts that the Valley of Kashmir is connected to the rest of the country by the Jammu Srinagar National Highway- the lifeline of Kashmir. However, the challenges subsequently got multiplied when the efforts to restore the National Highway suffered a setback on account of a portion of a bridge near Kela Morh getting swept away in a mudslide forcing the authorities to close the road for more than a week till a bailey bridge was erected and one way traffic got restored. This was possible only with the joint efforts of the Civil Administration, Traffic Police, Army, Border Roads Organisation and the NHAI. However, the post snowfall challenges on account of chances of Avalanches in the snow bound hilly areas of the Union Territory along-with evacuation and shifting of expected mothers to the health facilities was organised smoothly by the administration in different districts. It may be worthwhile to mention here that all the District Disaster Management Authorities headed by the respective Deputy Commissioners who were personally monitoring the snow clearance operations throughout nights, by all standards deserves to be acknowledged. However, again with night temperature falling further and cold wave conditions tightening its grip, the challenges got doubled on account of the following issues:

1. Communication Blockade which resulted in almost near halt of almost all normal activities which among others, included postponement of various examinations scheduled for the period under reference.

2. Power breakdown on account of large-scale damages to the power lines.

3. Water Supply disruptions due to damage to the source, pipes and head works.

4. These issues coupled with freezing night temperatures which made snow

clearance operations very difficult and also resulted in freezing of water pipes as well as water bodies including the world-famous Dal lake, prompted the authorities to issue advisories like "People are advised not to venture out for fun or sport on the frozen Dal Lake and other water bodies", etc.

5. On account of blockade of the National Highway for a longer period due to damage to a bridge thereby effecting supplies, to keep an eye on occasional hoarding and black marketing of essentials became another challenge for the authorities. The Divisional Administration as a timely intervention issued a circular ordering rationing of essential supplies like petrol, diesel and LPG etc. This was done in spite of the fact that usually the essentials are stocked to suffice for a considerable amount of time.

3. Snow Clearance Mechanism

As stated above, due to occasional heavy snowfall in the Kashmir Valley during winter, connectivity and accessibility become of paramount importance for the government to maintain smooth functioning of day-to-day activities. The roads have accordingly been categorised into different groups on account of priority and various agencies have been tasked to clear the snow as and when need arises. While most of the roads are cleared off snow mechanically, there are some roads, lanes and bye-lanes which are cleared manually and are entrusted to the Public Works Department and Local Bodies (Municipalities) in view of the fact that the machinery available with the MED on the one hand is limited and on the other hand these lanes and bye-lanes are too narrow to allow any mechanical clearance of snow. However, the Municipalities have recently acquired some small snow cutters which can enter a sizeable number of lanes but again these are too less in number against the requirements thereby results in delayed snow clearance.

As stated above that the Public Works (R&B) Department under its Mechanical Wing has a fleet of Snow Clearing Vehicles which effectively prepares itself before the season begins to respond to inclement weather during the winter months. The Department has a well-established system in place to respond to the situation which may be detailed as under:

The Mechanized Snow Clearance operations are divided into three zones- Central, South and North Zones under the control of the respective Mechanical Divisions with their Divisional / Sub Division Control and Command Rooms (MED,2021).

The Snow Clearance Machinery consisting of Truck Driven-Snow Ploughs, Tractor Mounted Snow Blades and heavy Snow Cutters (Blowers) and front-end Wheeled Loaders is placed with each Division and the respective road length earmarked for Mechanized Snow Clearance for the current Winter Season is detailed in table 4.

Table 4: Details of Snow Clearance machinery in Kashmir Division

S. no.	Zone	Districts Covered	Snow Clearance Machinery Units deployed	Road Length entrusted for Mechanised Clearance
1.	Central (Srinagar)	Srinagar, Budgam and Ganderbal	Srinagar= 25 Budgam= 13 44 Units Ganderbal=06	1258 Kms. 1200 Kms. 0182 Kms.
2.	South (Anantnag)	Anantnag, Kulgam, Shopian and Pulwama	Anantnag=27 Kulgam =15 Shopian=11 64 Units Pulwama=11	1383 Kms. 0507 Kms. 0587 Kms. 0676 Kms.
3.	North (Baramulla)	Baramulla, Kupwara, and Bandipora	Baramulla=25 Kupwara=15 Bandipora=12 74 Units Gurez=08 Tangmarg=14	0460 Kms. 0086 Kms. 0479 Kms.
			Total Units =182 Units	**7515 Kms.**

Source: Mechanical Engineering Department Kashmir

However, the experiences gained in the recent snow clearance operations reveal that in spite of the fact that a total of 182 units of snow cutters/ machines have been kept at different locations yet given the amount of snow that had accumulated in the region for the period under reference and the increasing road length and population density, it seems considerably inadequate. As such there is a dire need to augment the Mechanical Engineering Department with more Machines as well as the manpower to ensure a quick response whenever required. Snow clearance operations were carried out not only during the day time but during the midst of nights for several days. All these operations were being monitored personally by the respective Deputy Commissioners alongside the staff of MED and other agencies.

Photo 1: *Modern Snow Blower of MED clearing the road*

Photo 2: *Snow Clearance operations at the Srinagar International Airport*

Photo 3: *Restoration of Road linkages of Health Services facilities has to be the Priority*

Photo 4: *The Linemen at work restoring the power supply in Anantnag and Budgam under tough conditions*

Photo 5: *Restoration of Power Supply*

Photo 6: *Food items being distributed among the stranded drivers and passengers on the National Highway at various spots from Bijbihara to Qazigund by the DDMA and the locals*

Photo 7: *Amid Covid-19 precautions, health check-up of stranded drivers and other stranded people in progress*

Photo 8: *Snow Clearance Operations*

Photo 9: *MED men and machinery busy in Snow clearance in Srinagar*

Photo 10: *How beautiful nature can be – Bright sunshine after heavy snowfall, men and machinery ready to clear the road in an area of Bandipora district in north Kashmir*

The men and machinery deployed by the Mechanical Engineering Department in the nook and corner had the greatest challenge ahead of them as the restoration works of all other departments depend on the accessibility to different facilities through road connectivity. Even if the air traffic resumes, it ultimately depends upon the work of the agencies responsible for snow clearance whether the flyers will be in a position to reach the airport or to leave the airport. As such the prioritisation of roads for snow clearance operations is of vital importance and the concerned stakeholders have considerablymet this challenge. In spite of all this, there were areas which remained cut off for days together as the equipment (Men and Machinery) available with the MED is far inadequate than the requirements. As such there is an urgent need to further strengthen this organisation through more men and machinery. The Department needs to be considered equally important during the summer season even though there is no snowfall so that all preparedness measures are put in place during the summer months itself. Otherwise, we come across news items in the local newspapers like *"Lack of Equipment hampers Snow Clearance in South Kashmir" (the Daily Greater Kashmir, January, 7,2021)*

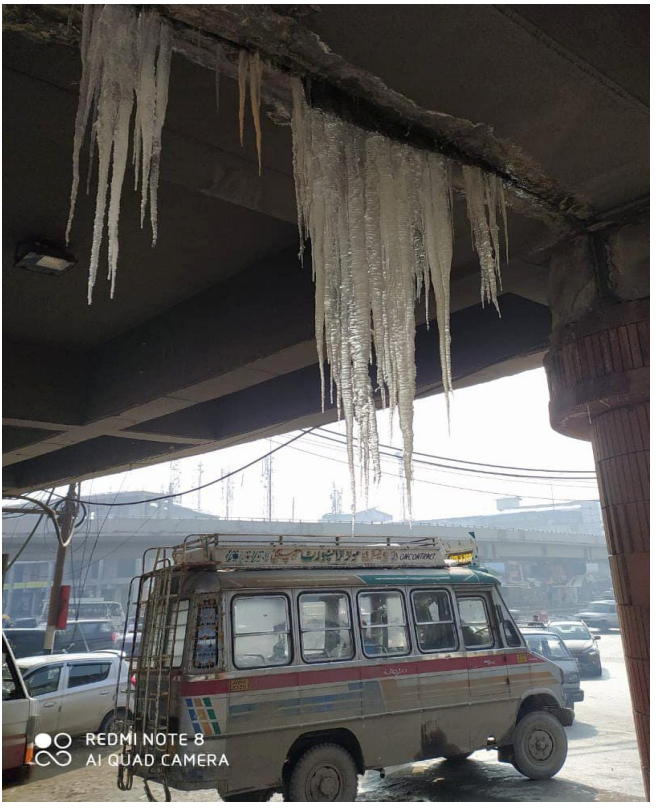

Photo 11: *Icecles hanging from the flyover in Srinagar*

There is no denying the fact that the heavy Snowfall had temporarily thrown life out of gear, yet the administration tried its level best to restore normal functioning at the earliest. Despite the fact that the Jammu & Kashmir Power Distribution Company Limited (JKPDCL) of the Power Development Department tried its best to restore the electricity at the earliest and to a great extent succeeded in it, while also losing one of its linemen, yet there were occasional protests against the Department from areas where restoration of power supply was delayed due to one or the other reason.

Same was the case with the Jal Shakti (Public Health Engineering Department) wherein due to extensive damages to the different Water Supply Schemes, water supply got disturbed in some areas. However, as a matter of fact, on observing the staff of the Jal Shakti Department restoring the services despite harsh climatic conditions, there cannot be any reason to believe that had there been no timely

interventions of the concerned stakeholders, things would have been far more difficult.

In freezing temperature the Icecles hanging from the Rambagh flyover in Srinagar had to be removed manually as they posed a threat to the vehicles as well as the commuters.This would not have even been thought of by anyone that the concerned officials would need to engage labour to remove the icecles manually. There are always such unforeseen challenges in such situations. It is interesting to note that the authorities had at several occasions, to arrange salt and urea for spreading on the icy and frost bound roads to mitigate the risk and thus avoid accidents. This was more challenging during small amounts of snowfall in freezing night temperatures which would otherwise turn the roads into marble sheets or glass like surfaces making it slippery and very difficult for the drivers to lower speed or apply brakes.

4. Damages to public and Private property

The heavy snowfall has caused widespread damages to both public and private property throughout the region. While on the one side there have been damages to infrastructure like roads, powerlines, transformers,water supply schemes etc. there have been extensive damages of varying nature to private houses especially in the hilly areas. Even some houses suffered extensive damages to the rooftops and upper storeys in ares like Srinagar. In addition, a few lives were lost in areas like Kupwara, Srinagar, Rajouri etc. In view of the fact that Heavy Snowfall is not covered in the list of Natural Calamities as per the NDRF norms, the UT Administration under the leadership of the LG on 10th of January itself, *declared the Heavy Snowfall as a State specific Natural Calamity* to enable the Administration to process the ex-gratia relief cases under the SDRF norms and also to meet out the expenditure on account of restoration works of emergent nature. The exact quantum of damages was being worked out by the concerned agencies accordingly.

5. Conclusion

There in no denying of the fact that heavy snowfall during winter is nothing new in Kashmir but the challenges on account of the same vary with every new event with increasing vulnerabilty. Despite the fact that lot of preparations are always in place, yet the inadequacy of resources- both men and machinery available with the concerned agencies needs to be addressed on priority. The timely intervention of the authorities of the Disaster Management Authority headed by the Lieutenant Governor declaring the Heavy Snowfall as a state specific Natural Calamity to be covered under SDRF was a great solace for all the stakeholders especially the affected people. The dedication and the team work displayed by the functionaries of various agencies has been remarkable but that does not exonerate them from

the reality that there are still many gaps which will have to be addressed for such a spell of heavy snowfall or a similar calamity in future.

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