# Application of Information and Communication Technologies in Natural Disasters: The Case of Kerala Floods

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*Abstract* - **The floods which hit Kerala in August 2018 has killed more than 370 people, displaced over 800,000, and led to an estimated infrastructure loss of $3 billion. In response to this unprecedented tragedy, there came to fore many instances of ingenuity and collaboration, which allowed for the generosity of individuals to scale. One also witnessed how Kerala used a new model of rescue and rehabilitation during its worst flood of the century.**

**The Kerala floods demonstrated the role of Information Technology (IT) and social media in developing a self-evolving data crowd sourced platform that greatly helped rescue and rehabilitation. Crowdsourcing is the method of obtaining information or input into a task by making use of the services of a large number of people or devices, either paid or unpaid, typically via the Internet. Kerala, being one of the states with high digital literacy in India, has a large number of smartphone users. The telecom operators made efforts to keep the networks intact that helped the relief works immensely. Many operators announced free calls and data packs over their networks during the floods to avoid any hindrance to the rescue operations.**

**The IEEE (Institute of Electrical and Electronics Engineers) with the support of the state run Kerala IT Mission, developed a portal keralarescue.in to collect help across the state. As the rescue operations progressed, new features that could help the operation were added, and coordination was done using the popular cloud based collaboration platform Slack. Popular and active facebook pages with regional influence used their platform for posting help requests. Large and small groups were formed both inside and outside India to collect messages, and to spread these messages after verifying through phone calls, assigning priority by considering the number and ages of people trapped, and to prepare proper SOS messages with geo-tags to pass on to the rescue teams through the volunteers in the district level administration.**

**The active deployment of technology saved many lives and yet again demonstrated the utility of GIS and geospatial technologies in disaster management. Throughout the world, remote sensing, GIS, and satellite imagery are increasingly being used to assess post-disaster scenario, find the level of damage and provide exact information about people.**

**In the case of Kerala floods too these technologies are playing a crucial role in disaster management. A set of remote sensing satellites and radar satellites were used for clicking high-resolution images of the areas worst affected by the flood. Remote sensing using microwave satellites was also beneficial in these unforeseen situations. There is no better way than location technology and GPS to know about the whereabouts of a person in a region hit by floods or any other natural disaster. With the help of location and tracking services of Google, rescue workers and volunteers were able to locate people in remote and inaccessible locations. Interactive maps and citizen initiatives helps everyone to learn about the extent of damage, areas least affected and the areas where maximum damage has occurred. This paper highlights all these technologies that played a crucial role in disaster management, in the case of Kerala floods.**

***Index Terms - crowdsourcing, information technology, remote sensing, geospacial technologies, interactive maps.***

## I. INTRODUCTION

Information Technology is considered a prerequisite for the effective control of disasters. India and its immediate neighborhood have experienced successive series of a variety of natural as well as manmade disasters in last two decades resulting in widespread devastation in the form of substantial loss of life, livelihood, human suffering, damage/destruction of property and environment. Among all the natural disasters that country faces, river floods are the most frequent and often devastating.

The heavy monsoon rainfall that hit Kerala last year, raised water levels in the 44 dams which were simultaneously opened, causing the worst flood of the century in the coastal state of Kerala in August 2018. This article highlights the various technologies that played a crucial role in disaster management in the wake of Kerala floods.

## II. LITERATURE REVIEW

Extreme precipitation events, landslides, and floods are the most common natural disasters that affect human society and economy (Coumou and Rahmstorf, 2012; Crozier, 2010; Hirabayashi et al., 2008; Roxy et al., 2017).

Frequent extreme precipitation events cause flooding (Fowler et al., 2010), which have become common in India (Mohapatra and Singh, 2003). The frequency of great floods and extreme precipitation events has substantially increased under the warming climate, which is consistent with the observations as well as climate model projections (Ali and Mishra, 2018; Milly et al., 2002). India has witnessed some of the most unprecedented extreme precipitation events that caused flooding and loss of lives in the recent past. For instance, extreme precipitation in Uttarakhand in 2013 resulted in large flooding with the death of more than 6000 people and economic loss of more than 3.8 billion USD ("Rapidly Assessing Flood Damage in Uttarakhand, India," 2014). Houze et al. (2017) argued that the 2013 extreme precipitation event was different than the historic flood producing events that occurred in the Himalayan region and was not caused by the convective storm. The heavy rain event occurred in 2015 caused flooding in Chennai and led to the estimated damage of

$3 billion (van Oldenborgh et al., 2016). Similarly, heavy rain in Mumbai in 2005 caused the death of more than 1000 people (Kumar et al., 2008). Extreme precipitation and flooding have become among the costliest natural disasters in India and other regions of the globe (The Human Cost of Natural Disasters 2015: A Global Perspective). Human losses from flooding are projected to increase by 70-80% if the global mean temperature increases above 1.5 Dottori et al., (2018) reported that the future flood impacts are likely to have uneven regional distribution, with the highest losses are to occur in Asia.

The recent extreme rainfall and widespread flooding in Kerala exemplify the enormity of extreme rainfall and large-scale floods in India. The persistent and extreme rainfall occurred in August 2018 in Kerala affected all the aspects of human lives including socioeconomic conditions, transportation, infrastructure, agriculture, and livelihood. The Kerala flood of 2018 has already attracted attention from the media, scientific community, and policymakers, which is probably the worst flood in a century (The Independent, 16 August 2018). As per the preliminary estimates, the Kerala flood caused the death of more than 440 people (Gulf News, 30th August 2018) and economic damage exceeding $3 billion (News18, 17 August 2018).

Climate-related hazards such as flooding, droughts, and windstorms are collectively responsible for the majority of recent disaster losses globally (IPCC 2012; UNISDR 2015) with floods affecting more people globally than any other type of natural disaster. This is partially a result of the rising trend in urbanization, which is altering land use and increasing the number of people living in areas that are highly exposed to the effects of natural hazards, such as communities located in river basins and coastal areas (Mileti 1999; Hallegatte 2011; GFDRR 2015).

Technologies such as crowdsourcing [literally defined as outsourcing tasks to the crowd (Howe 2006)] is increasingly playing a role in DRR. In addition, social media services such as Twitter and Facebook are frequently used to monitor public reaction to floods, earthquakes, and fires (Abel et al. 2012; Earle et al. 2012; Kongthon et al. 2012), and volunteered geographic information (VGI) tools are now frequently used to complement official channels of humanitarian relief operations, as seen in the 2010 Haiti Earthquake (Norheim-Hagtun and Meier 2010; Zook et al. 2010), Hurricane Sandy in New York, 2012 (Schnebele et al. 2014), and the 2015 Nepal Earthquake (Clark 2015). The recent Kerala floods also witnessed the deployment of many technologies.

## III. OBJECTIVES

The study focuses on achieving the following objectives:

- To gain an awareness about natural and man-made disasters in the Indian scenario
- To throw light into flood preparedness
- To discuss the application of Information and Communication Technology in Flood disasters.
- Analyse technology deployment during Kerala floods.

## IV. INDIAN SCENARIO OF NATURAL DISASTERS

Disaster Management (DM) has witnessed a paradigm shift from the traditional 'reactive and relief centric' approach to a more holistic approach with greater emphasis on the proactive strategy consisting of 'Prevention, Mitigation and Preparedness' in the pre-disaster phase.

Among all the natural disasters that country faces, river floods are the most frequent and often devastating. The shortfall in the rainfall cause droughts or drought like situation in various parts of the country. India has faced some severe earthquakes causing widespread damage to the life and property. The country has a coastline of about 8000 km, which is prone to very severe cyclonic formations in the Arabian Sea and Bay of Bengal. Usually more cyclones form in the Bay of Bengal then in the Arabian Sea. Another major problem faced by the country is in the form of landslides and avalanches . During the last eighty years, India has lost 70,000 lives due to earthquakes or an average of about 900 lives per year. The corresponding average of the whole world is about 18,000 lives per year. Around 30,000 lives have perished in matter of seconds in an earthquake, as in Gujarat earthquake on 26th January 2001.

Figure 1 shows the major disasters in India from 1980 to 2009.


*Figure 1.0 Major Indian disasters*

It is true that many parts of India and its immediate neighborhood are at high risk for a number of natural calamities like Earthquake, Floods, Urban floods, Landslides, Cyclones, Tsunamis and Heat waves mainly because of terrain and climatic conditions. Hazard vulnerability profile of India indicates that earthquakes account for 57% of all natural disasters followed by droughts (16%), floods (12%), high speed winds/cyclones (8%) and landslides (3%).1 Although each of the above mentioned disasters would need to be dealt in a specific manner, all major disasters have a common principle of effective management.

Recognizing the need of the hour, the decade 1990-99 was declared as "International Decade for Natural Disaster Reduction" with a main objective to focus on disaster management planning for prevention, reduction, mitigation, preparedness and response to reduce the loss of life and property due to natural disasters. India's high risk and vulnerability is highlighted by the fact that 40 million hectares out of a geographical area of 328 million hectares is prone to floods. On an average every year, 75 lakh hectares of land is affected, 1600 lives are lost and the damage caused to crops, houses and public utilities is about Rs.2000 crores due to floods. The maximum number of lives (11,316) was lost in the year 1977. The frequency of major floods is more than once in five years. Floods have also occurred in areas, which were earlier not considered flood prone. Eighty per cent of the

precipitation takes place in the monsoon months from June to September. The rivers bring heavy sediment load from the catchments. These, factors coupled with inadequate carrying capacity of the rivers are responsible for causing floods, drainage congestion and erosion of river-banks

The Disaster Management cycle is broadly divided into two phases: the Pre-Disaster phase consisting of Prevention, Mitigation and Preparedness; and the Post- Disaster phase consisting of Response, Rehabilitation and Reconstruction. The Pre-Disaster phase is essentially aimed at capacity development and readiness to deal with any such eventualities. In earlier days, DM focused mainly on the effectiveness of the post disaster phase. In contrary, the present day DM lays significant importance on the capacity development leading to preparedness and readiness to tackle a disaster.

## V. FLOOD PREPAREDNESS

Floods, which are a natural hazard, need not become a disaster, if we are prepared and are aware of how to deal with them. This would reduce the losses of life and minimize human suffering. This guide list simple thing one can do to stay safe and protect one from floods.

A. Before flooding occurs
- oThe route to the nearest safe shelters is to be known.
- oThe First Aid Kit is to be ready with extra medication for snake bite and diarrhea.
- o Strong ropes should be available for tying things.
- o A radio, torch and spare batteries are to be arranged.
- o Fresh water, dry food, candles, matchbox, kerosene etc are to be stocked.
- o Umbrellas and bamboo sticks are also necessary to protect from snakes).
- o Higher ground is to be selected for stay where people and animals can take shelter.

B. After hearing a flood warning
- oFlood warning and advice may be easily obtained through radio and television.
- oWe must keep vigil of flood warning given by local authorities.
- oDry food and drinking water and warm clothes are made to be ready.
- oEmergency kit must be checked.

C. At the time of evacuation
- oPack clothing, essential medication, valuables, personal papers etc in water proof bags to be taken to the safe shelter.
- oRaise furniture, appliances on beds and tables.
- oPut sandbags in the toilet bowl and cover all drain holesto prevent sewage backflow.
- oDo not get into water of unknown depth and current.
- oLock your house and take the recommended or known evacuation routes for your area of safe shelter.

D. During Floods
- oBoiled water or use of halogen tablet to purify water must be used.
- oFood should be covered.
- oChildren are not allowed to remain on empty stomach.
- oBleaching powder and lime are to be used to disinfect the surroundings.
- oEntry in flood waters may be avoided. If one need to enter then proper foot wear may be used.
- oWater over knee level may be avoided.

D. After a Flood
- oOne has to be in touch with local radio.
- oChildren may not be allowed to play in, or near, floodwaters.
- oOne has to be stay away from drains, culverts.
- oElectrical appliances should not be used.
- oFood of floodwaters must be avoided

## V. USE OF ICT IN FLOOD DISASTERS

In an emergency situation like disaster events, effective communication and collaboration are the major issues. Responding emergency situations is not such an easy task. Responding efforts efficiency can be enhance by adopting ICT at the time of handling emergency situation like natural disaster management . All most all the developed countries are extensively using ICT nd ICT based applications for managing natural disaster.

Similarly, GIS-based systems improve the quality of analysis of hazard vulnerability and capacity assessments, guide development planning and assist planners in the selection of mitigation measures. Communication systems have also become indispensable for providing emergency communication and timely relief and response measures.

### A. GIS IN DISASTER MANAGEMENT

During any emergency situation, the role of a reliable Decision Support System is very crucial for effective response and recovery. Geographic Information System (GIS) provide most versatile platform for Decision Support by furnishing multilayer geo-referenced information which includes hazard zoning, incident mapping, natural resources and critical infrastructure at risk, available resources for response, real time satellite imagery etc. GIS-based information tools allow disaster managers to quickly assess the impact of the disaster/emergency on geographic platform and plan adequate resource mobilization in most efficient way. Thus, a reliable GIS-based database will ensure the mobilization of right resources to right locations within least response time. Such database would also play a fundamental role in planning and implementation of large scale preparedness and mitigation initiatives. The Ministry of Home Affairs have initiated the development of a GIS-based National Database for Emergency Management (NDEM) in collaboration with various Govt. Ministries/agencies such as Dept. of Space, Dept. of Science & Technology and Ministry of Communications & IT. The Ministry with technical support from UNDP is also in process of developing GIS based tools for emergency management on pilot basis.

### B NATIONAL EMERGENCY COMMUNICATION PLAN

In emergency response and management, it is extremely important to have the communication links operational between decision makers at various levels and operational response teams/personnel on the site. Unfortunately at the time of emergency situations such as natural or man-made disasters, the first casualty is the regular telecommunications infrastructure of public wired and wireless

(GSM/CDMA) telephones. Considering the crucial role of MHA during such emergencies, it is essential to set-up reliable information and communication network employing both terrestrial and satellite-based communication technologies with redundancies to establish a network for emergency communications

Information and Communication Technologies in form of Internet, GIS, Remote Sensing, Satellite communication etc. are indispensable in planning and successful implementation of most Disaster Risk Reduction initiatives. However, the potential of most advanced technologies is required to be harnessed in early warning, preparedness and response systems along with adequate emphasis on building human capacities to use these tools and technologies.

## VI. THE CASE OF KERALA FLOODS: TECHNOLOGY DEPLOYMENT

The heavy monsoon rainfall that hit Kerala last year, raised water levels in the 44 dams which were simultaneously opened, causing the worst flood of the century in the coastal state of Kerala in August 2018. 483 people were killed and the total loss of the state was estimated to be 282.2 million US dollars. The National Disaster Response Force along with the Indian Army and Indian Navy launched one of their largest rescue missions evacuating over 10,000 people. The response to the incident was lauded as a unique self-help mission due to the way in which the survivors and victims worked together in the relief and rehabilitation process. The fishermen in the coastal state of Kerala with their fishing boats played an important role and the helped rescue mission by shifting a large number of people to safer areas.

The Kerala floods demonstrated the role of Information Technology (IT) and social media (backed by public volunteering) in developing a self-evolving data crowdsourced platform that greatly helped rescue and rehabilitation. Crowdsourcing is the method of obtaining information or input into a task by making use of the services of a large number of people or devices, either paid or unpaid, typically via the Internet. Kerala, being one of the states with high digital literacy in India, has a large number of smartphone users.

The active deployment of technology saved many lives and yet again demonstrated the utility of GIS and geospatial technologies in disaster management.

Throughout the world, remote sensing, GIS, and satellite imagery are increasingly being used to assess post-disaster scenario, find the level of damage and provide exact info about people. In the case of Kerala floods too these technologies are playing a crucial role in disaster management.

### A. Crowdsourcing as a tool

The IEEE with the support of the state run Kerala IT Mission, developed a portal **keralarescue.in** to collect help across the state. The Chief Minister of Kerala released it as the official online portal for the state's rescue mission. Volunteers, majorly consisting of NGO (Non Governmental Organisation) activists and the energetic youth of Kerala, made phone calls to verify the legitimacy of inflowing requests and escalated the issue regional wise to the authorities.

About 2000 people were working day and night to improve and maintain the rescue portal. Engineers around the world worked from different time zones to ensure development and maintenance round the clock. Many IT companies dedicated their development teams. As the rescue operations progressed, new features that could help the operation were added, and coordination was done using the popular cloud based collaboration platform Slack. A total of 54,933 people registered themselves as volunteers in the website who helped in the rescue work. A total of 1,363,704 people visited the website and 45,587 requests were posted through the portal.

### B. Social Media Platforms

People started posting whatsapp messages and live videos in facebook asking for help. Popular and active facebook pages with regional influence used their platform for posting help requests. Large and small groups were formed both inside and outside India to collect messages, and to spread these messages after verifying through phone calls, assigning priority by considering the number and ages of people trapped, and to prepare proper SOS messages with geo-tags to pass on to the rescue teams through the volunteers in the district level administration. Rescue requests were updated continuously. Volunteers were handling an average of 100 calls per day on identifying and verifying requests.

Volunteering groups took up the initiative and gave support to government officials by deploying a network using Whatsapp groups where the requirements of relief camps were mapped with people who were ready to provide the supplies. Massive supplies and relief materials were brought in by the public at different hubs located at the drier regions which were less affected from the floods. These hubs acted as central collection points from which materials were redirected to camps as per demand. Almost 500 truck loads of such relief materials collected from the public were supplied from the state capital Trivandrum, and more supplies came in from the neighbouring states and cities by road, rail and air. The efficient communication between the collection points and public through social media made sure that the public brought only those materials which were required in the camps.

Administrators, celebrities and public figures also appealed for public support in different forms through the social media. The response of the public on the ground level was overwhelming. Almost all sections of people including truck drivers, grocers and textile store owners helped in the relief activities.

The telecom operators made efforts to keep the networks intact that helped the relief works immensely. Many operators announced free calls and data packs over their networks during the floods to avoid any hindrance to the rescue operations.

### C. Remote Sensing and Satellite Imagery

A set of remote sensing satellites and radar satellites clicked many high-resolution images of the areas worst affected by the flood. The images have been captured from a distance of 400-800 kilometers from the earth's surface. Once the data is analyzed and processed, it becomes easy to predict the level of rainfalls in the next few hours and whether the situation would remain as alarming.

ISRO's ResourceSat-2 satellite has proven to be beneficial in clicking pictures of vegetation, water bodies and other terrains. Another satellite, Insat 3D, conveys the information about cloud positioning and enables us to reach to a conclusion about wind velocity. Insat is geostationary satellites relaying information to the ground station every 30 minutes.
Remote sensing using Microwave satellites is also beneficial in these unforeseen situations. The electromagnetic waves can penetrate the cloud and get info on surface hydrology.

### D. Location Technology

There is no better way than location technology and GPS to know about the whereabouts of a person in a region hit by floods or any other natural disaster. Often using GPS, one gets to know whether the person is trapped somewhere or is safe. But one major problem is the loss of internet and mobile signals during a disaster. Google has found a way around this by introducing Plus Codes that can be accessed when one is offline too.
Kerala flood victims could use their Android smartphones or tablets to generate and share the plus code of their exact location with their friends, relatives or rescuers. This will point to the exact location and help save time of those conducting rescue operations. Plus codes can also be shared over an emergency voice call or SMS.
Plus code is an alphanumeric code that can be accessed from Google Maps by clicking on a location, pinning it and then scrolling down to find the Plus Code. For searching the location of a Plus Code, one just needs to type the given Plus Code in the search box of Google Maps.
Another feature called Google Person Finder would also be helpful. Google has its own database to look for the last location of the person you are searching. If there is no record of a particular person, a manual entry can be made and information submitted that the person is being looked. This would be public domain and visible to anyone who visits Person Finder. Photographs of the concerned person can also be added for ease of identification.
With the help of location and tracking services of Google, rescue workers and volunteers were able to locate people in remote and inaccessible locations during Kerala Floods.

### E. Interactive Maps and Citizen Initiatives

On Kerala Rescue and Mango Map, one can locate the areas damaged and also the location of relief shelters.

Keralarescue.in is an initiative by the state government which allows people to both seek and offer relief. After visiting the website, one can request for help, make a donation, find a relief center, get important contact information, and/or volunteer for their services.
Microid by OpenStreetMap is a crowdsourced initiative to map inundated streets and roads in Kerala. All the data available in Microid is open source and a flooded street can be reported by zooming into the map and clicking on it. Similarly, a road can be marked as safe once it's safe.
There is also a map on Kerala rains that provides the location of people who are stranded and are eagerly looking for help.

## VII. THE ROAD AHEAD

- Drones or unmanned aerial vehicles can be used to map terrain more effectively particularly in inaccessible areas, allow authorities to assess damage in real time or monitor a rescue mission, provide greater feedback with mapping and imagery and the more powerful drones can even be used to move items from one point to another.
- If infrared cameras and advanced listening systems are mounted on drones, they can be used to hunt for hints of survivors from beneath tonnes of rubble.
- GIS can improve the quality and power of analysis of natural hazards assessments, guide development activities and assist planners in the selection of mitigation measures and in the implementation of emergency preparedness and response action.
- Remote Sensing, on the other hand, as a tool can very effectively contribute towards identification of hazardous areas, monitor the planet for its changes on a real time basis and give early warning to many impending disasters.
- Communication satellites have become vital for providing emergency communication and timely relief measures. Integration of space technology inputs into natural disaster monitoring and mitigation mechanisms is critical for hazard reduction.
- Awareness and training in Information technology in a much greater measure is required to develop human resources. There should be a greater emphasis on development of new technologies in disaster mitigation.

## VIII. CONCLUSION

In the future , the world will be moving to a technology driven disaster management system. The disaster preparedness and awareness is the only effective way of mitigating the impact of future disasters.
The Kerala floods demonstrated the role of Information Technology (IT) and social media (backed by public volunteering) in developing a self-evolving data crowd

sourced platform that greatly helped rescue and rehabilitation. Disaster management activities depend on large volumes of accurate, relevant, on-time geoinformation that various organizations systematically create and maintain. The advancement in Information and Communication Technology in the form of Internet, GIS, Remote Sensing, Satellite communication, etc. can help a great deal in planning and implementation of hazards reduction schemes.

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