International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

National Conference on Recent Advances in Civil Engineering Infrastructure (rACEi-2021)

A Case Study on Kerala Floods

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Received 05 Aug2021, Accepted 10 Aug 2021, Available online15 Aug June 2021, **Special Issue-9 (Aug 2021)**

Abstract

Flood is among the deadliest disasters in India. The frequency of floods and extreme precipitation events is projected to increase under the warming climate. The frequency of floods in India varies geographically as some regions are more prone to floods than the others. In Kerala, floods occurred in the year 1923, 1924, 1961, 2018, 2019, 2020 and 2021. In these, the flood in the year 2018 was the most highly devastating floods, despite the Kerala State Disaster Management Authority framing a Disaster Management Plan, in 2016.Dam failure is the main cause for 2018 flood. This flood caused enormous economic damage, affected millions of people, and resulted in the death of more than 400 people. The other causes for this flood may be due to poor land use/ land cover change, antecedent hydrologic conditions, reservoir storage and operations, encroachment of flood plains, and other natural factors. However, the Flood management played an important role in Kerala 2018 floods. The Disaster Management strategies include Mitigation, Preparedness, Rescue and Recovery. Through this study, we would like to suggest that the Sponge Cities and Flood Resistant Buildings are the most appropriate Risk reducing Strategies, which can reduce Flood hazard risk in areas like Kerala.

Keywords: *Flood, Mitigation, Preparedness, Rescue, Recovery.*

1. Introduction

According to World Health Organization (WHO), a disaster can be defined as any occurrence that causes damage, ecological disruption, loss of human life, deterioration of health and health services on a scale, sufficient to warrant an extraordinary response from outside the affected community or area.

The two types of Disasters are as follows:

1.Natural Disasters
2.Man-Made Disasters

Natural Disasters: When disasters occur due to natural forces, they are called Natural disasters. Ex: Floods, Hurricanes, Tsunamis, Storms, and other geologic processes. Man-made Disasters: When the disasters are due to carelessness of human or mishandling of dangerous equipment's they are called manmade disasters Ex: Chemical Spills, fires, groundwater contamination, transportation, accidents, structural failures.

Floods

Overflow of water that submerges land which is usually dry.

Types

Flash floods are caused by rapid and excessive rainfall that raises water heights quickly, and rivers, streams, channels, or roads may be overtaken.

Riverine floods are caused when consistent rain or snow melt forces a river to exceed capacity.

Coastal floods are caused by storm surges associated with tropical cyclones and tsunami.

Causes of floods

There are plenty of different causes of flooding.

Heavy rainfall: When there is too much rain or it happens too fast, there just isn't a place for it to go.

Lack of vegetation

Vegetation can help slow runoff and prevent flooding. When there is a lack of vegetation, there is little to stop water from running off and overflowing riverbanks and streams.

Melting snow and ice

When a large amount of snow and/or ice melts quickly, it often doesn't have somewhere to go except low-lying areas.

Channels

Flooding often occurs when there is fast runoff into lakes, rivers, and other basins. This is often the case with rivers and other channels that feature steep sides.

Flooding effects

Loss of Lives

Floods have claimed thousands of lives throughout history. Floods kill by carrying people away in fast-moving water or drowning them. It only takes six inches of water to wash a person away.

Property Damage

Flooding also causes property damage to buildings by blowing out windows, sweeping away doors, corroding walls and foundations, and sending debris into infrastructure at a fast pace.

Economic Impacts

The economic impact of flooding can be devastating to a community. This comes from damage and disruption to things like communication towers, power plants, roads, and bridges.

1.1 Kerala

Kerala is formed on 1 st November 1956 and its capital is Thiruvananthapuram. Situated between Arabian Sea to the West & Western Ghats to the East Kerala share borders with Karnataka and Tamil Nadu. 44 rivers in Kerala out of which 3 flows to east and remaining to west. Kerala has an area of 38,863 sq.km (15005 sq. Miles) with a population of 3.4 crores.

Economical source is Agriculture.

Literacy is 94% with 14 Districts.

Climatic condition

- The climate of Kerala is equable and varies little from season to season. Throughout the capitalize year, daily temperatures usually rise from the low 70s F (low 20s C) into the 80s F (27 to 32 °C).
- The state is directly exposed to the southwest monsoon, which prevails from July through September, but it also receives rain from the reverse (northeast) monsoon, which blows in October and November.
- Precipitation averages about 115 inches (3,000 mm) annually statewide, with some slopes receiving more than 200 inches (5,000 mm).

2. Methodology

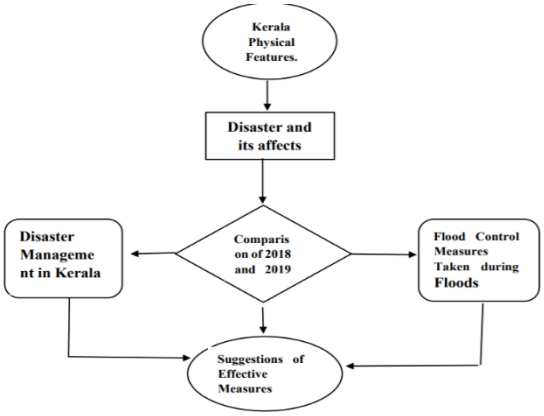

Fig.1 Methodology

3. Floods in Kerala

Following are the List of Floods occurred in Kerala.

1907: Occurred during July and August. Kerala received 175% higher than the normal rainfall. It was almost 1780 mm rainfall. Idukki district received highest rainfall of 1380 mm.

1924: The Great Flood of 99' occurred in the month of July. This is mainly occurred due to opening of Sluice valves of Periyar dam without proper warning. Kerala received 3,368 mm of rain, 64% higher the normal which is highest rainfall of Kerala. Districts mostly affected are Thrissur, Ernakulam, Iddukki, Kottayam, Alphuzza, Chittanad. Kundala Railway was destroyed, a huge mountain called Karinthiri Mala was washed away.

1961: It is occurred from 4 th June to 21 August. Kerala received 50% more than normal rainfall and the rainfall is 2387mm. Chernvellor, VarapuzhaPakuthy and Kodangallur villages about 3500 acres, 3,803 acres, 3,862 acres of land respectively got affected. 1974: Flood occurred in the months of July & august received 2266 mm of rainfall. Idukki District received highest rainfall of 854 mm. More than 300 people died, thousands have been left homeless.

1992: Rains lasted on 10th -11th October. Due to this flood Alappuzha, Kollam, Trivandrum districts were completely affected. This is occurred due to influence of a well-marked low pressure over Madhya Pradesh.

2003: Flood occurred on 24th June. Kerala received 1722.6 mm rainfall. Caused due to heavy rains and Landslides. This flood affected 11 out of 14 districts (116 villages) and flood damaged 488 houses and 8 members lost their life.

2013: Flood occurred during 1 st June to 8 th August, caused by landslides, flash floods and water logging in many places and 26/35 dams are opened.250

landslides had been reported. Kerala received a rainfall of 2561.2 mm. More than 20,000 houses got destroyed and 10,000 kms of road had been damaged and 30,000 people are moved to govt relief camps.

2016: The situation slightly improved in 2016, but Kasaragod was the only district to receive more than 2000 mm of rainfall. Ten districts out of 14 received a rainfall between 1055 mm – 1854 mm, while 3 districts are below 1000m. In result of dam filling to their maximum capacities these floods occurred.

2017: Increased in 2017 with 12 districts received rainfall between 1015 mm to 2120 mm. Deforestation is the mainly responsible for the phenomenon and climate change which caused this flood. More than 350 people died and more than a million have evacuated over 4000 relief camps.

Summary on 2018 and 2019 FLOODS

Heavy down pouring in Kerala during August and September in 2018 & 2019 have a widespread effect in socio economic lively hood of the people in Kerala. If had affected the people in different manner. Vast destruction caused by the flood and related natural calamities during the monsoon season has had a widespread affect, but the actual impacts are not yet revealed. While analyzing the effects of natural calamities on different socio-economic aspects of the people it is to be noticedthat a permanent monitoring system is to be implemented to detect disaster prone geographical areas and rehabilitate the people from the risk ridden to the safe place.

4.1 Sisaster risk reduction

Disaster risk reduction (DRR) is a systematic approach to identifying, assessing, and reducing the risks of disaster.

It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them. Disaster risk Disaster risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster in each period

DR= H x V,

Where
DR - Disaster risk
Hazard - (H)
A Hazard is a potential source of harm or adverse health effect on a person or persons.
Vulnerability - (V)

Vulnerability is the inability to resist a hazard or to respond when a disaster has occurred. For instance, people who live on plains are more vulnerable to floods than people who live higher up.

4.2 Disaster management

Disaster Management involves a continuous and integrated process of planning, organizing, coordinating, and implementing measures for Effective flood Control. There are 4 phases involved in Disaster Management.
They are.

1. Mitigation
2. Preparedness
3. Rescue
4. Recovery

Mitigation

There are 2 types of Mitigation.
They are.

1. Structural Measures
2. Non-Structural Measures

4.2.1 Structural measures

1. Dams and Reservoirs

- Dam design has ecological aspects for flood regulation and are built to supply water to communities as well as to reduce flood events.
- To reduce the risk of flooding, the design of the dam should consider the consequences of climate change.
- The design capacity of the dam is affected by future hydrological events because of climate change.
- Dam safety includes structural, operative, and emergency strategies.
- Most dam failures and associated fatalities result from flood events.

2. Channel improvements
Channel improvement refers to changes made to the river channel or canal to increase its capacity to hold back water or to enable the water to flow quickly. River channels and canals can be widened and deepened so that they can carry more storm water away. They can also be straightened so that water can be carried away quickly. This will help to prevent water in the river channel and canals from overflowing.

3. Watershed Management
They can also be straightened so that water can be carried away quickly. This will help to prevent water in the river channel and canals from overflowing. Watershed Management practices Vegetative measure /Agronomical measure, Strip cropping, Pasture cropping, Grass land cropping, Woodlands Engineering measure/structural practices, Contour budding, Terracing, Construction of check dames, Construction of farm ponds, Gull controlling structure.

4. Flood embankment

Embankments are the oldest known forms of flood protection works and have been used extensively for this purpose. These serve to prevent inundation, when the stream spills over its natural section, and safeguard lands, villages, and other properties against damages 5. Design of bank revetment River passing through populated/agricultural areas necessitates protection of adjacent lands and properties threatened by the erosion. The protection of riverbank from the threat of erosion comes under Anti Erosion works. The purpose of bank protection may be training of river, protection of adjacent land and properties, protection of nearby hydraulic structures like embankments etc.

4.2.2 Non-structural measures

The non-structural methods to mitigate the flood damages are as 6 under:

1) *Flood Plain Zoning*
   Flood plain zoning means dividing the entire flood area into different zones and to restrict the occupancy of the different zones of the flood plain to uses which will suffer little or no damage during floods.
   .
2) *Flood Forecasting*
   Forecasting, based on mathematical modelling, allows converting the information on the past- to present rainfall, river flow, status of moisture and snow cover into a river flow forecast a better intergovernmental cooperation toward the improvement of existing alert systems and the installation of common flood forecasting and warning systems is extremely important.

3) *Flood Proofing:*

   Floodproofing means to remodel or rebuild using materials and methods that will prevent or minimize damage from future floods. Dry floodproofing Dry floodproofing means sealing a building to keep floodwaters out. All areas below the flood protection level are made watertight. Walls are coated with plastic or rubberized sheeting or special waterproofing compounds. Openings such as doors, windows, sewer lines, and vents are closed permanently, or can be temporarily sealed with removable shields or sandbags.

   Wet floodproofing

   Wet floodproofing means modifying a building so that floodwaters will cause only minimal damage to the building and contents. Building materials below the flood protection level are replaced with materials that are resistant to water. Floodwaters are allowed into the building to counteract the pressure of the water on the out-side of the walls.

4.3 Preparedness

Preparedness refers to measures taken to prepare for and reduce the effects.

- Preparedness Include Public Awareness
- Flood Warning System
- Temporary Shelter Management
- Search and Rescue planning
- Livelihood Planning
- Water, Sanitation and Health Care planning

4.4 Response Operations

It is a reaction to the occurrence of a catastrophic disaster or Emergency. The effectiveness of flood response is based on the following key components:

a) Effective Coordination: Extensive coordination among all agencies taking part in emergency response activities dictate the success of any emergency response operations, guaranteeing minimum overlap of roles and responsibilities and maximum effective utilization of available resources. A focal agency should be deployed as the principal coordinating body.
b) Effective Logistics Management: It is critical in any disaster situation to quickly identify the resources needed, i.e., the response team, equipment, and commodities, as well as mobilize and transport them to the right place at the right time.
c) Level of Responsiveness of the Community: The more aware the community is of the risks they face with regards to flooding and the actions to be taken, the more effective and significant the impact of the emergency response will be.

The following are involved in Response.

- Army, Airforce, Navy
- BSF, (NDRF),
- Public work department,
  - Helicopters were used to rescue people,
  - Activists of optical and social organizations are also involved in the rescue and management of relief centers.

4.5 Recovery

Recovery is the restoration of all aspects of the disaster's impact on a community and the return of the local economy to some sense of normalcy. These are the following steps in Recovery.
Post Disaster Damage Assessment: Damage assessment helps in identifying specific recovery programs.
Key elements of post-flood damage assessment are summarized below:

Standardization of formats, assessment codes and procedures for assessing and reporting damage for consistent representation.

Environmental Cleaning: With the intention of preventing any outbreak of diseases or any further injury caused by debris, the cleaning up process must be undertaken immediately after the flooding recedes.

Restoration of Basic Infrastructure:

Reconstruction offers a great chance to reduce vulnerability at no or little extra- costs. This phase is a particular challenge to local authorities, as the reconstruction period, which leads to a higher and sustainable safety level, needs planning time in the face of urgent needs of the affected people.

5. Suggestions based on our study

Based on the analysis of the recent floods in 2018 & 2019 we suggest the following measures for an effective mitigation.

5.1 Flood Resistant Building

Flood resistant building is one that is designed to resist flood water ingress.

- ❖ Flood Resistant Buildings are evolved from a concept called Flood Proofing.
- ❖ These budlings withstand coastal flooding, erosion.
- ❖ Methods to make a building flood resistant are.

    - Rising the Elevation
    - Wet Flood Proofing
    - Building the lower levels watertight.

Foundation Requirements of Flood Resistant Structures The foundation of flood resistant structures needs to be designed and constructed in such a way that withstands design flood circumstances. It should have adequate capacity to resist flotation, collapse, and permanent lateral movement under the critical load combinations that provided by ASCE. Other Factors for Flood Resistant Building Structures Other factors that need to be accounted for during the design and construction of flood resistant structures include use of flood resistant damage materials, flood proofing, means of egress, utilities, and adverse impact to surrounding structures.

5.2 Sponge City

A sponge city is a city that is designed to passively, absorb, clean, and use rainfall in an eco - friendly way that reduce hazardous runoff.

There are three main facets to developing such systems:

Protection focuses on the city's original ecologically sensitive areas, such as rivers, lakes, and ditches. Natural vegetation, soil, and microorganisms are used to gradually treat the aquatic environment and restore the damaged urban ecosystem.

Restoration measures include identifying ecological patches, constructing ecological corridors, strengthening the connections between the patches, forming a network, and delineating the blue and green lines to restore the aquatic ecological environment. Mandatory measures apply to urban roads, urban green spaces, urban water systems, residential areas, and specific buildings to protect ecological patches, maintain their storage capacity, strengthen source control, and form ecological sponges of different scales.

- It includes permeable roads, rooftop gardens, rainwater harvesting, rain gardens, green space and blue space like ponds and lakes.
- The 'sponge city' concept can prove useful for cities like Kochi in Kerala.
- This sponge cities may manage 60 % of rainfall initially and finally 80 % rainfall in cities.

Conclusions

A re-examination of our development priorities, its ecological implications, and social ramifications is the need of the hour, as the state embarks on the disaster recovery process. The role of central, state and local governments in restoring services, reconstructing houses, supporting local economic recovery, and other public services will go a long way not only in restoring normalcy but also in rebuilding a resilient Kerala.

- The flood and landslides that took place in August 2018 and 2019 were a major disaster for Kerala's infrastructure and economy.
- From our study, we suggest that for flood prone areas like Kerala, Sponge cities and Flood Resistant Buildings are the main resilient measures for flood mitigation.
- The state government has also started building flood-resistant houses in flood-prone areas under the Life Mission Scheme.

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