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Analytical Study of Kerala Floods

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Abstract: ***This paper is focusing on the analytical study of floods in Kerala state in 2018, by which natural resources are disturbed. Kerala is the 3rd most populated state in India and It has 47% of the land occupied by Western Ghats mountain chain. This region experiences an annual average rainfall as high as 500 cm through the South-West, North-East and Pre-Monsoon. This region is full of natural resources and these natural assets are getting captured by people. So natural disasters had happened in this natural area. Eventually, these phenomena are affecting the population, property and natural assets.Kerala has experienced 53% above normal rainfall during August 2018, all this is happened due to the extreme precipitation and rainfall. Due to the flood disaster, this state has faced several issues like human wastage, crop wastage, infrastructure affects etc. This disaster is happened due to reasons like illegal activities in the Western Ghats and natural assets, quarrying, unplanned reservoir regulation, poor drainage capacity etc. This paper focuses on detailed reasons for the flood further this paper discusses the after-effects due to disaster and in the end, shows the measures are taken by the state and centre level concerned authorities. This stage will discuss the planning measures which steps should be taken for the future so that this type of disaster would not be taken place. Coastal cities like Busan in South Korea and San Francisco in California are developed with detailed disaster risk management plans. Like most coastal cities they are prone to typhoons and cyclones, flooding and earthquakes. These have advanced flood forecasting techniques and use underground tanks, submersible pumps, levees, stream gates to handle such eventualities. Indian coastal towns have no such preparedness and usually a two-day warning by IMD to manage the fury of nature. India will have such type of intervention for protecting the environment.***

This research paper is showing the overall analysis of the flood disaster in Kerala state and discuss the possible solutions for retaining the ecologically sustainable environment. All parameters would have the best level potential to restore the natural assets in flood-affected areas in Kerala.

Index Terms: Natural Resources, Western Ghats mountain chain, natural disasters, illegal activities, IMD (Indian Metrological Department) etc.

I. INTRODUCTION

Rainfall occurs when moisture contained air rises above the earth's surface and cools to form clouds which in turn precipitate to fall as rain. This precipitation can reach earth's surface as rain, snow, hail depends on the pressure variations across the region. This phenomenon is a varied place to place, Rain occurs when the water droplets or moisture are moving across the multi-dimensional temperature moisture in the environment. Extreme precipitation and flooding have become among the costliest natural disasters in India and other regions of the globe. The major factors which have a direct impact on the amount of rain received over a region. Kerala has an average annual precipitation of about 3000 mm in a year. The rainfall is controlled by the South-west and North-east monsoons in Kerala (Mishra, 2018).

In August 2018, Kerala faced abnormal High rainfall, this resulted flooding in 13 districts as The day-1 rainfall of 398 mm, 305 mm, 255 mm, 254 mm, 211 mm and 214 mm were recorded at Nilambur in Malappuram district, Mananthavadi in Wayanad district, Peermade, Munnar KSEB and Myladumparain in Idukki district and Pallakad in Pallakad district respectively. This led to further flooding at several places in Mananthavadi and Vythiri in Wayanad district. Water was released from several dams due to heavy rainfall in their catchments. The water levels in several reservoirs were almost near their Full Reservoir Level (FRL) due to continuous rainfall. The water spread between Periyar and Pamba sub-basins in Kerala which means whole Kerala was full of water (Directorate, 2018).

Kerala state has 47% of the land is dedicated to the Western Ghats as an Ecologically sensitive area which is rich in Natural resources. The Western Ghats is considered one of the eight hottest hot spots of biodiversity. Due to climate change and human interference in these areas, biodiversity is getting disturbed. The Western Ghats has a large tribal population in Wayanad tracts (Foundation, 2013). Under the consideration of protection on biodiversity, WGEEP prepared a forecast report for floods in Kerala but the state did not take any action in respect of the report (Kerala tragedy partly man made: Madhav Gadgil,expert who headed Western Ghats report, 2018).

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A. *Problem Discussion*

Most of the Indian cities lack in basic infrastructure planning. Many built up settings are boomed up with no physical planning. Disaster Management is not available for planning consideration for rural and urban areas.

The same thing is happening with Kerala, every city has unplanned growth, high migrated population, depilated infrastructure and this unplanned growth is spreading towards the biodiversity areas as well. So, the natural areas are getting affected.

Kerala State has the potential of the land to sustain natural resources like bio-diversity in the form of Western Ghats, these areas have a cover of evergreen forests, rich tropical rain forests. There are several reasons for flood disaster like heavy rainfall in 70 years, landslides, quarrying, unplanned dams regulations, poor drainage capacity etc. After finding severe issues, which are the main causes of floods but the possible solutions would take place for protecting future floods.

In 2011, Gadgill committee suggests recommendations for some ecologically fragile regions in Western ghats, especially for Kerala state. As per Report, there is highest no of vulnerable zones which are majorly due to human interference with nature, But concerned Authorities did not take any action for the same and with the time this disaster has happened.

The Kerala State Disaster Management Authority placed the State on a red alert as a result of the intense flooding. State pollution control board is also active for improving the condition of the environment which was affected due to the post-disaster. India has severe issues related to the management of biodiversity, other countries like South Korea and San Francisco have done solutions for preserving the biodiversity and stood out as Examples for others. The possible solutions would take place for conserving the water, flora and fauna in ecologically sensitive areas.

II. LITERATURE REVIEW

Kerala has almost 50 % of the land of natural resources assets which means this has ecological sustained environment but the present picture is different. The entire Western Ghats are to be declared as an Ecologically Sensitive Area. This State has 3 types of ecologically sensitive zones ESZ1, ESZ2, ESZ3, where 63 taluks come under these zones. For managing the ecology of the region and to ensuring its sustainable development, Western Ghats Ecology Authority is situated. This Authority is appointed by the Ministry Of Environment and Forests, GOI under the Environment Protection Act 1986. This Authority interacts with the State Biodiversity Boards, Pollution Control Boards, State Planning departments (D, 2011). In this region, 11 different types of evergreen vegetation spread in 3 regions. Around 4000 flowering plants species, 645 evergreen trees are presented here. Along with this, 500 species of birds and 120 species of mammals are found here (Foundation, 2013). The rainfall is maximum as compared to surrounding states, this state is affected by the flood disaster in 2018. Climate change dressed the rainfall in an unpredictable manner. Extreme precipitation events, landslides, and floods are the most common natural disasters that affect human society and Economy. The flooding has affected hundreds of villages, destroyed the infrastructure. The situation was regularly monitored by the State Government, Central Government, and National Crisis Management Committee which also coordinated the rescue and relief operations (Nandargi, 2018). Kerala is having 57 large dams, 4 dams are operated by Government of Tamil Nadu. The release of water from Idduki was planned a fortnight before the disaster (Directorate, 2018). Kerala is rich in water aspects but lacks in management concerns. There is no planning and monitoring with reservoirs regulations. This flood attracted attention from the media, scientific community, and policymakers, which were not looking as precautions earlier especially Policymakers and Planners. Floods affected all the aspects of human lives including socioeconomic conditions, transportation, infrastructure, agriculture, and livelihood and caused the death of more than 440 people and economic damage exceeding $3 billion (al., 2018).

A right mix of policy, institutional arrangements and use of technology provide the framework for a country's approach to floods disaster mitigation. Decentralization approach should follow for mitigating the floods disaster. Disaster Management Division, Government of India, responds to natural disasters, in a concise and convenient form, a list of major executive actions involved in responding to natural disasters and necessary measures for preparedness, response and relief required to be taken. There are lots of concerned authorities were engaged for mitigating the flood in Kerala.

The extreme precipitation events because flooding like 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. The heavy rain event occurred in 2015 caused flooding in Chennai and led to the estimated damage of $3 billion. Similarly, heavy rain in Mumbai in 2005 caused the death of more than 1000 people, the same cases happen in other countries as well (al., 2018).

For mitigating these disasters, the government and concerned authority should take precautions and follow the forecasting reports for saving the biodiversity in these areas. So that these natural landscapes can be saved for the future.

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Sl.No.	Name of Reservoir	Live Storage Capacity (MCM)
1.	Idukki	1460
2.	Idamalayar	1018
3.	Kallada	488
4.	Kakki	447
5.	Parambikulam (for use of TN)	380
6.	Mullaperiyar (for use of TN)	271
7.	Malampuzha	227

Table 1 List of Reservoirs (Directorate, 2018)

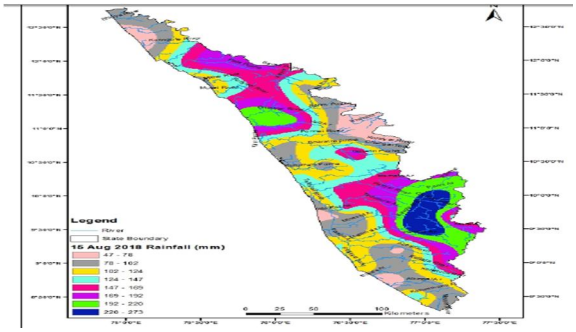


Figure 1 Flood Map in Kerala (Directorate, 2018)

III. METHODOLOGY

The Collection of data and information for a subject like Disaster Management, which is uncertain and unpredictable to a great extent. Even the research design has to be a mix of description and experimental. The primary data has been collected from site related and interviewing people. Along with this, the secondary data help a lot like various reports pre and post-disaster-related, new paper articles, concerned authority's information, research papers, journals etc. the various types of analyzing tools like software.

For the analytical study of Kerala floods, both types of data required. Majorly data has been analyzed with the help of published reports, newspaper articles, Research papers, journals etc. The primary data has been collected from site related and interviews. The results have been found that natural spaces are required to protect so that the future generation would be able to feel. Along with this, planning and policy need to revive and work in favour to preserve the biodiversity. At the state level, the concerned authority needs to take action for the same.

Climatic related data collected from the India Meteorological Department. Gridded daily rainfall from IMD has been widely used in hydro-climatic studies as well as for analysis of extreme rainfall over India. For the reservoir condition before the flood event, reservoirs storage information for the seven major reservoirs (Idukki, Idamalyar, Kakki, Kallada, Malampuzha, Parambikulam, and Periyar) from India Water Resources Information System till 2018 (Directorate, 2018).

A. Study Area

Kerala has a natural heritage setting, this State is the 3rd highly populated state in India; the population is 3.48 cr. With a total area of 38,863 km. As like other Indian cities, the cities of this state are also in an unplanned manner and this growth is directly affecting the existing natural setting. As Kerala has 47% of the land is dedicated to the Western Ghats in the biodiversity section, there is a need to protect this section (Directorate, 2018).

In August 2018, this rich area was affected by floods, the whole state was full of water. The History of landslide susceptibility and driving forces of landslides in The Western Ghats (Kuriakose, 2009). This state has large no of river basins like Periyar, Chalakudy and Pamba etc. and maximum destruction has happened along the rivers of Periyar, Chalakudy and Pamba, which all having multiple dams (Banerjee, 2018).

Apart from the flood in Kerala, Landslides use to happen here. Kerala is densely populated region and as a result, proper measures to be taken and the rivers of Kerala have been increasingly polluted from the industrial and domestic wastes and from pesticides and fertilizers in agriculture, these are the factors which affect the biodiversity.

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B. Reasons

Above seasonal rainfall, high reservoir storage, and unprecedented rainfall in the catchments where reservoirs are located created a most favourable situation for massive flooding in Kerala. The frequency and intensity of extreme precipitation events have increased in India. The capacity of reservoirs was not sufficient. The other factor can be land use land cover change in the state, earlier there was less builtup setting and nowdays this setting is increased even in biodiversity areas, and this is the direct factor of major flooding in cities. Another factor is the low capacity of the drainage system which connects to Dams or reservoirs (Banerjee, 2018). If the research looks into the detail, the flood happened due to many reasons like less infiltration into the ground. During the initial phase of the monsoons, the entire water will be absorbed by the soil and it will be recharging the groundwater. Once the water table approaches the surface, multiple flow pathways will be activated including soil pipes (Madhusoodhanan, 2019). It is observed that the contributing area for pipe flow increases with the magnitude and duration of rainfall. If the management will not work, this types of disaster will take place in the very worst form so there is lack of preparation/inaction/late action from the DMAs can cause havoc and immense suffering to the people and the state's economy (Narayan, 2018). The urban areas don't have adequate infrastructure for drainage the water, so this type of disasters use to occur. As per LULC studies, it is cleared that cities of this state have increased built setting as compared to earlier and most of them are disturbing the natural setting. Various illegal activities are set up in these Western Ghats sides like mining activities, large constructions, thermal power plants, and highly polluting industries etc. noticed by Kasturirangan committee (SEN, 2018).

C. Effects

As per the India Meteorological Department, Aftermath of the floods, there is decrease in water level in rivers, drains etc., this phenomenon is happened due to the reduction/absence of precipitation for a longer period of time and other is happened due to the landslides, groundwater level is used to deceased in these regions (Madhusoodhanan, 2019).

Due to heavy monsoon rainfall, landslides happened and that caused significant damage to property in the state (Kuriakose, 2009). Flood waste may be contaminated by hazardous materials, sewage, carcasses and medical waste. Since debris would be wet, there is an increased chance of decay within a shorter time. With the time, the contamination process would happen and this will affect the soil and water. Ultimately these things proceed towards environmental pollution and health issues would reflect after some time.

D. Measures

After floods, there are chances for draughts, so for mitigating these disasters, the government should take action for mitigating related issues. The Govt. of India introduced the Disaster Management Act in 2005 for preparing, preventing, mitigating and managing risks of extreme events and disasters. DMAs are responsible for preparing state and detailed district-level disaster management plans which should also be reviewed. For this time, it provides an opportunity for the DMAs to review and update the DMPs through Local Self Governments (LSGs), ensuring people's participation and using their expertise. The National Disaster Management Authority has prepared separate guidelines for flooding and urban flooding, but these directives focus more on the planning, preparedness and capacity building aspects of disaster management (WELDODE, 2018). There is a need to separate water governing actions between the states under the water policy. The rescue and relief work over, the people of the state and the Government have to deal with rehabilitation of thousands, after the most devastating flood. There is a need to avoid environment pollution due to stagnant wastes in water. Concerned Authorities and campaigns would help them find appropriate solutions for each type of waste such as a disposal, incineration, reuse, or recycling. Apart from future precautions, there were immediate steps are to be taken like the immediate relief response, medical treatment, medical supplies, food, non-food and Water, Sanitation & Hygiene (WaSH) support was provided to the 32,245 affected families (SEN, 2018).

For the future, some measures should be considered:

1) There would be clear and early warning to the public about the disaster for mitigating planning and activities.
2) It is needed to map the vulnerabilities and should take actions to mitigate them in advance so that those would not be worst form.
3) There is a need for short and long term actions plans to combat disasters.
4) The watershed management of humid tropical regions should be developed on the regeneration of the natural setting.
5) Western Ghats section in Biodiversity should not be disturbed by human.
6) There is a need to regenerate riparian forests and riverine vegetation which are crucial for the regulation of water outflow from hill slopes and for moderating river water flows.

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7) There should be a decentralization approach for Sector-wise (agriculture, energy, industry, domestic, health, etc.) preparedness and action plan with public and local self-government participation for managing the natural resources.

The year-long demands of environmentalists forced the Union Ministry of Environment and Forests (MoEF) to set up a committee to study and analysis to seek possibilities to protect the biodiversity.

IV. RESULTS

Rainfall during August 2018 in Kerala departs significantly from the averaged mass curve. Kerala has many other small and medium size reservoirs that might have had high storage before the flooding. Most of the major reservoirs were almost full before the extreme rainfall. The reservoirs did not have the capacity to accommodate the additional flow generated by extreme rainfall.

After analyzing the various reports related to Kerala Floods, many issues get to know about the management of infrastructure at the state level. The state has a natural heritage setting which needs to protect for future under Gadgill Committee Report recommendations. For mitigating the future floods disasters, there is need to take precautions and conserve the natural belts. There is a need to work among the stakeholders in a decentralized and ineffective manner so that management related issues can be resolved at project level. By applying above, disasters would take place and biodiversity would conserve for the future.

V. CONCLUSION

Kerala received above normal rainfall in the monsoon season of 2018, which contributed to reservoirs storage significantly but the capacity was not enough. Unprecedented extreme rain in the catchments upstream to major reservoirs might have played a significant role in the large-scale flooding in Kerala.

Efficient disaster management is still an evolving agenda of the government of decentralization system. There is a need to work among the stakeholders in a decentralized and ineffective manner so that management related issues can be resolved at the project level. All the concerned authorities and NGO's should work in decentralized manner. Long term prevention and mitigation measures like retrofitting of existing public utility and other critical buildings, construction of new buildings in accordance with resistant construction technologies and non-structural measures such as building bye-laws and zoning regulations, enforcement of building bye-laws, fiscal incentives for retrofitting of building etc. need to be implemented. By applying above, disasters would take place and biodiversity would conserve for future and disasters would not take place. If there is nature protection, it can survive for many generations.

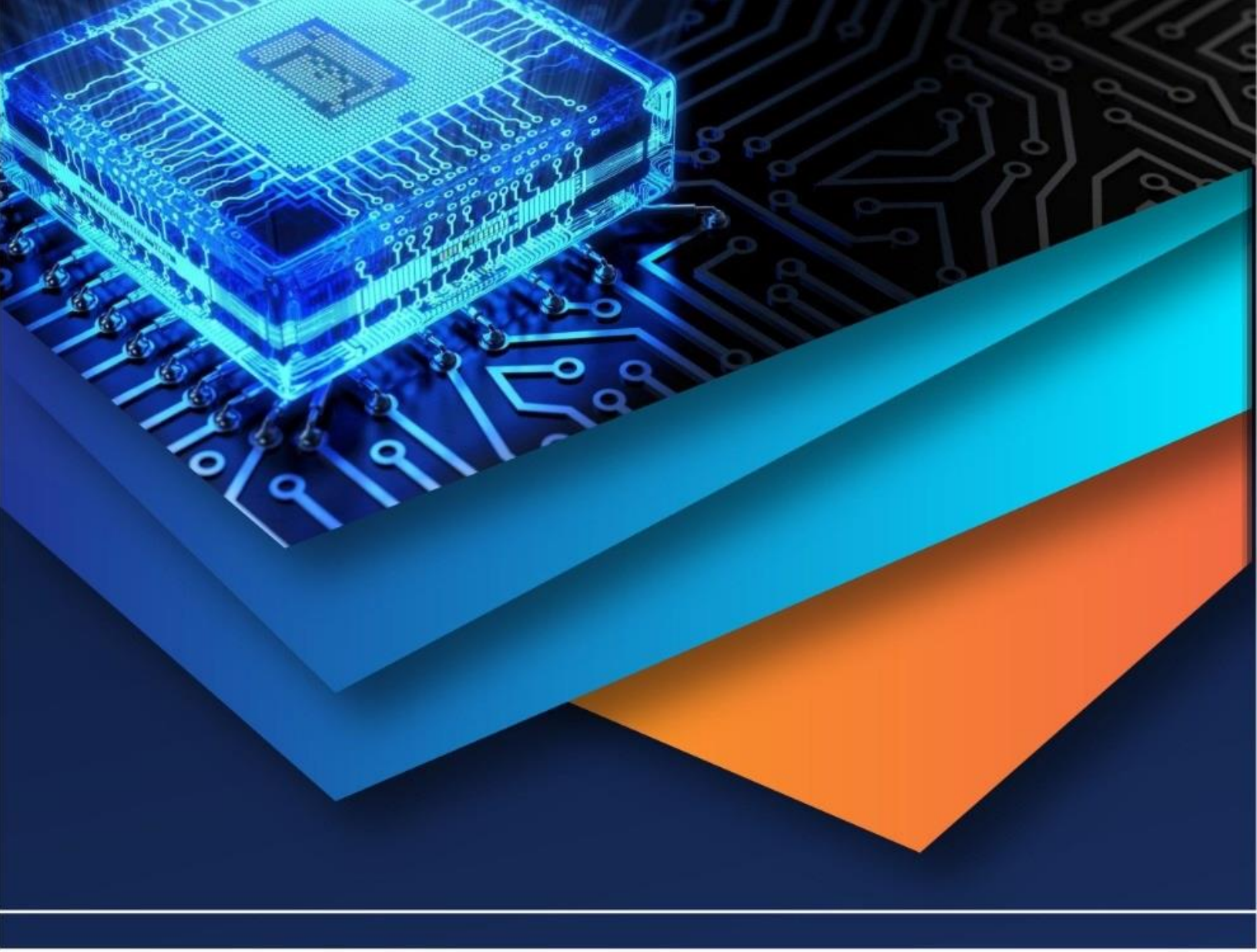
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