Challenges and Issues of Management of Flood Disaster Risk Reduction in North Bihar: Building Flood Resilient Society as a Solution

Prof.. Nizamuddin Khan, Dr. Ashish Parashari, Dr. Firoj Biswas, A.Rehman
Post Doctor Fellow, Department of Geography, A.M.U.Aligarh
Sr. Research Scholar, Department of Geography, A.M.U.Aligarh
Research Associate, Department of Geography, A.M.U.Aligarh

Abstract- Bihar is the most affected flood prone area caused by overflowing of the rivers generating from Siwalik range of Himalayas located in the north. Ganga and Kosi are the main culprits of flood occurrence in the north Bihar. The geographic features as landforms, slope, rivers and the socio economic backwardness of people are main factors of floods. Different measures have been adopted by government, public servant, NGO's to prevent and reduce the flood impact in the area but still great success could be achieved. The present paper is descriptive and effort is made to explore the existing challenges and issues to resolve the problem of flood disaster in Bihar. Lack of awareness, dishonesty in resource utilization in flood controlling process, deficiency of sense of accountability and poor level of education for flood disaster regulation methods among the general population were serious lacuna in following the guidelines of Disaster Flood Management in the study area. Building resilient society at grassroots level to disaster and management of vulnerability is the most important effort to manage the flood and its associated problems.

Key words: Floods, rivers, Resilient, sustainable, Development

INTRODUCTION

Floods are a serious form of hydro-meteorological disaster/hazard which occurs at the global level every year in different parts of the world at different points of time. They do not always be levelled as disasters like the other i.e. cyclone, earthquakes, landslides, tsunamis, high tides, and so on the basis of mere virtue of their happening.(Ghapar, A.A, et, al. 2018).They could be declared disasters when they cause damage or harm to people, lives, properties, infrastructure, and livelihoods in a negative way at different scales. Floods are widely spread and have been occurring since antiquity. History of floods might be traced back to Noah (Prophet) Nation when the whole earth was drowned except the Arch (boat) and people and animals boarded it (Khan, N. et.al.2022, *Surah Al-A' araf, As' shurah*;). Floods, extreme weather, and other forms of water-related disasters are continuously expanding in frequency and severity as well intensity on a global scale, especially in South and Southeast Asian nations on account of global warming and climate change (Bloschi, G.et.al.2019; Laulcas, A. et.al 2021). Floods are very disastrous phenomena that cause tosses to lives, livelihood, infrastructure, and public properties affecting the sustainable development of the region. There are various forms of flood disasters such as riverine tsunamis, flush rain, local, and regional (Blake, E.S. et.al. 2011, Dodman, D. et.al. 2012).

The floods are common in Tamilnadu, Maharashtra, Gujarat, Kerala, Assam, West Bengal, and U.P. in India. Bihar is one of the worst flood-affected areas which shares about 16 percent of the flood-prone area of the country. Flood is an attribute of the physical environment and thus is an important component of the hydrological cycle of the drainage basin. The National Flood Commission reported that about 40 million hectares area out of the total area of 329 million hectare area in the country is flood affected. Ganga and Brahmaputra basins mainly in Uttar Pradesh, Assam, West Bengal, and Bihar are badly affected having 25-50 percent of their total area as flood-prone. Flood disasters have had very devastating impacts on societies and have destroyed livelihoods and investments of staggering monetary value and importance to development. However, adequate involvement of technology is leading to the creation of

people-cantered early warning systems that enhances residents' awareness and preparedness to flood events to significantly reduce the adverse impacts of these disasters on people.

Floods are not only playing negative roles but also enrich the soil fertility with new alluvium deposition, increase fish production, provide water for irrigation and drinking purpose in the region of water deficiency through constructed canals/ channels linking water surplus rivers to dry or sub-humid areas. Formation of new reservoirs, lakes formed by meandering rivers, waterlogged areas, etc is also important potential water bodies for aquaculture, *makhana* production, and cultivation of late harvesting varieties of paddy cultivation in flood-prone areas, especially in Bihar. The study of flood and related issues and challenges in north Bihar is of utmost importance to assess the severity and risk of flood disasters and the level of vulnerability of people, area, and environment of Bihar especially North Bihar. Long and short-duration policies and measures at the grassroots level are also to be explored for the sustainable development and rehabilitation of affected people, resources, and the environment in flood-prone regions.

The present paper aimed to understand the geographical prospective and genesis of floods during different periods of time in the study area. The effort is also made to evaluate and highlight the measures taken by the Government of Bihar and different disaster managing agencies to minimize the loss and damage of lives, properties, infrastructure, and fauna and flora in the flood-affected areas of the state. A human-society and cultural-oriented approach has been suggested for optimum and sustainable management of flood disasters to reduce vulnerability, and risk occurrence, and improve the level of response, preparedness, response, and mitigation, important components of disaster management. Paper is a descriptive and qualitative form of research work. It is based on secondary sources of information.

Bihar as a Geographic Entity

Bihar is one of the eastern states of India which is bounded by Nepal to the north and by the West Bengal to the northeast and Uttar Pradesh to the west and Jharkhand in the south and South Eastside. It covers an area of 94,163 square Km and was inhabited by 104.10 million persons in 2011. It is divided into 38 administrative districts, 101 subdivisions, and 534 CD blocks. It ranked 3rd. in population and 12th in area.

Fig. 1

Bihar has a tropical monsoon climate with the average maximum and minimum temperature ranges between 24–25 ◦C and 8–10 ◦C, respectively. The hottest months are from April to June, whilst the coldest is from December to January. Most of the rainfall (80–90%) is concentrated during the monsoon season (mid–June to mid– October) and these months are very important for agriculture in this region. Annual rainfall is 1027mm or 102 cm, though on 22 June 2021, she received 26.93 cm in one day. Fluctuation in rainfall is a very normal phenomenon. 2020, 21 received excess surplus rainfall in the months of June and July. Bihar is geographically characterized by variations in various geomorphologic as well as geological structures (Tirpathi, G.et.al 2019).Shiwalik Range, Plains, and southern Plateau region are important physiographic features as shown in figure 2&3. Shiwalik range covers small areas in the north-western part of the state. It is sub-divided into Ram Nagar Dun ,Someshwar range, and Harha Valley. Southern plateau region formed of old rocks of the Vindhyan and Dharwad systems. The Bihar plain is a very extensive area, formed by the deposition of sediments brought by Ganga and its tributaries over a long period of geological and geomorphologic history. It is further divided as north and south Bihar plain demarcated by the Ganga River.

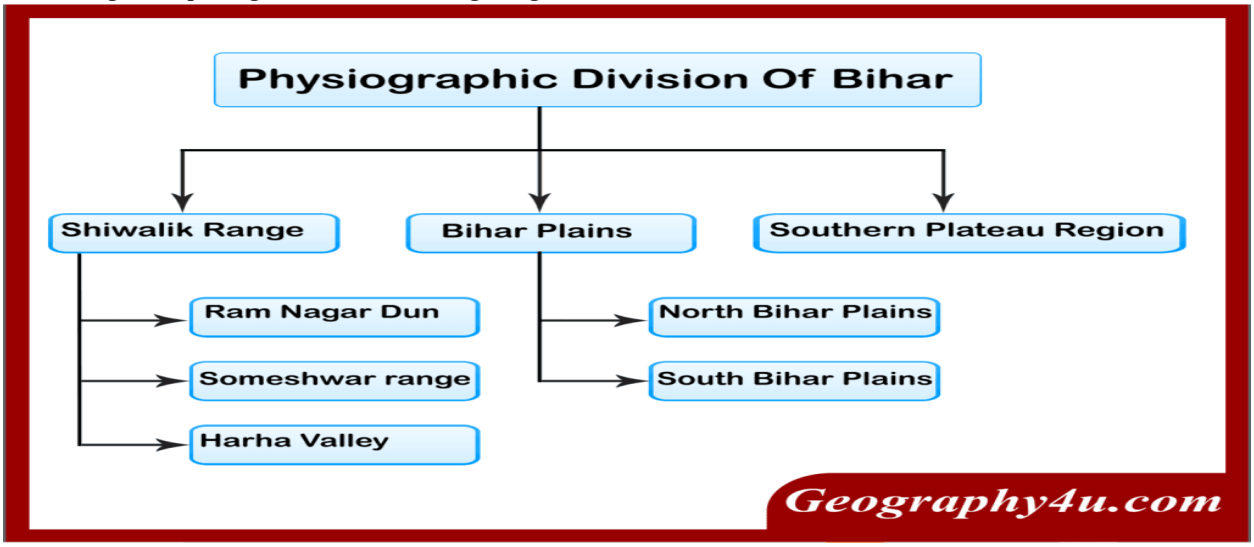


Fig. 2

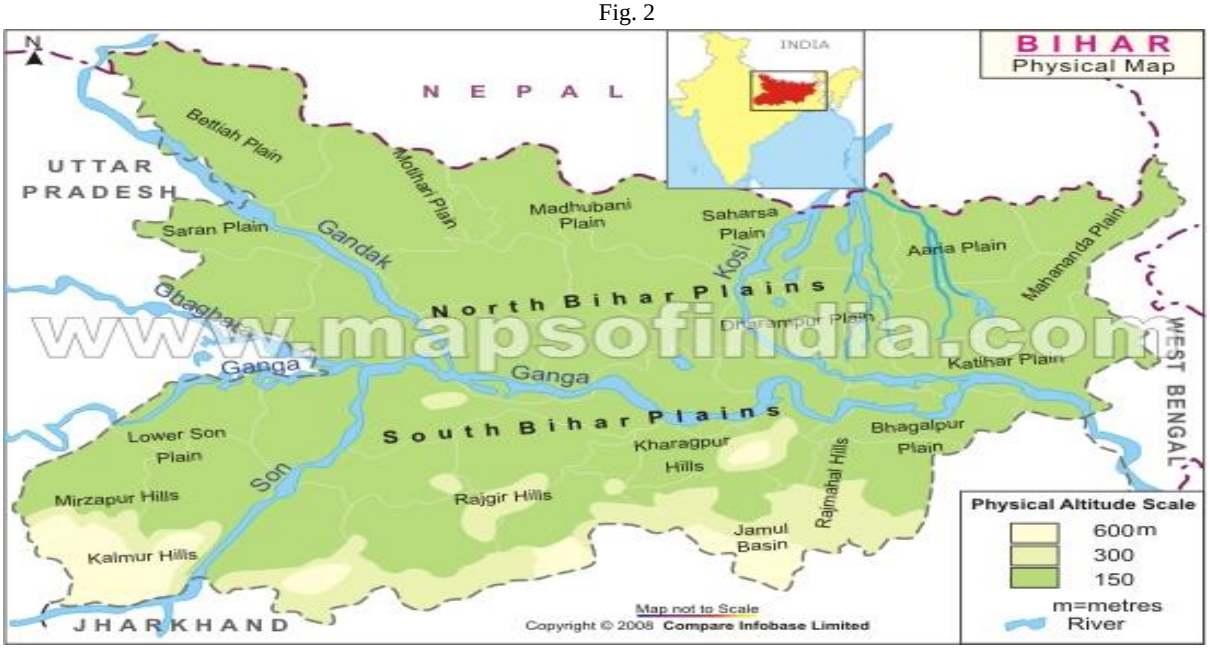


Fig.3

North Bihar is world known flood prone area which is located north of the Ganga River with a geographical area of 54,223.02 km2.It is distributed over 57.6% of the total geographical area of the state and consists of 21 districts out of 38. The region is drained by numerous rivers originating from the Siwalik ranges in Tibet and Nepal. Ganges and Kosi are the main rivers, supplying most of the water to this state. Bihar is divided into two parts (i.e., North Bihar and South Bihar) by the river Ganges that passes through the middle from west to east. North Bihar has very dynamic rivers including seasonal and some *nalas* which are more than 250 *in number (Gaurav, K. et.al.2015, Pandey. A.C. et.al. 2010)*. The major rivers are Kosi, Ghaghra, Gandak, BurhiGangpdak, Mahananda, Kamla, and Baghmati, causing severe floods frequently in North Bihar. The southern part also experiences floods but toa modest degree and it is washed by Karma Nasa, Pun Pun, Sone, Phalgu, Kiul, and Ajay rivers, which mostly are seasonal (Fig. 3).

Fig. 4

Flood is the Prominent Features of Bihar

The hydro-meteorological disaster like floods, drought, and weather extreme have been increasing in frequency as well as in intensity at the global level, especially in South and Southeast tropical monsoon countries like India (Tripathi, G. et.al.2019; Samela, C. et.al.2017). In India Chennai, Kerala, West Bengal, Maharashtra, Gujarat Assam, and Bihar have been facing such challenges frequently. Bihar is India's most flood-prone state sharing 16% of the country's flooded area. According to Bihar Disaster Management Authority (BSDMA), geographically, 73.63% of the area of north Bihar is prone to floods. Out of 38 districts of Bihar, 28 districts are affected by floods which cause a huge loss of property, lives, and Infrastructure. Out of 28 flood-affected districts of Bihar, 15 districts are worst affected. As per Rashtriya BarhAayog (2006), it has been estimated that about 24% of the total flood-affected population of India resides in the flood plains of Bihar. According to government data, in the previous year (2020) also, about 12 districts of North Bihar witnessed a very disastrous flood that took the life of 130 people and more than 83 lakh people were affected. The damage to crops was estimated at Rs. 353 Crore and besides those infrastructural damages were in addition.

The frequent flood occurrences in the study region are the combined effects of geographical features including drainage pattern and system, geomorphologic attributes and geological structure, and anthropogenic interference of population in the area (Tripathi, G. et.al. 2019).Nepal and Siwalik located in the north of the state played very significant roles in the genesis and spreading of severe floods in North Bihar.According to the government of Bihar Flood Management Information System Cell, five causes are identified for the flooding of Bihar. They are flush floods in Nepal due to abundant rainfall, river floods, congestion of rivers at confluence points, and permanent water logging area. The plain of North Bihar is mainly drained by two rivers i.e. Gandak& Kosi (fig. 4) along with Ghaghara, Burhi-Gandak,

and Mahanadi, part of the catchment of these rivers falls in the Himalayan glacial region of Nepal and Tibet. They are snow-fed and perennial rivers and during the monsoon periods, the flow in these rivers increases 50 to 90 times, leading to flooding in the plains of Bihar. The plains of Bihar, adjoining Nepal, are drained by rivers that carry high discharge and very high sediment loads. Gradients of these rivers vary from 22 cm per km to 7.5 cm per km. at Indo Nepal boundary and at the point of confluence with the Ganga respectively (Sinha, R. et. al., 2009, 2012).When the rivers like Kosi reach the plain causing meanders and change course.One of the main culprits is the Koshi Barrage on Koshi in Nepal, which has to be opened during an overload of water in the river, which brings floods in Supaul and other districts of its basin(Adam, A.G.2008)

The water in the rivers of the region also becomes very excessive on account of rainfall in their catchment areas and it exceeds its total carrying capacity as a result, some of the water flows outside the normal perimeter of the water body. Floods occur in most parts of Bihar with different intensities and effects. The Ganga and its tributaries 'carrying capacity of water is reduced due to increasing loads in the beds of channels and overflow and flooding occur.North Bihar's recurrent floods are mostly due to extreme rainfall-induced riverine floods, and some of the major flood events in the study region are 1987, 1998, 2000, 2001, 2003, 2004, 2008, 2010, 2013, 2017, 2018, and 2020 (Manjusree, P. et.al. 2015; Tripathi, G. et.al. 2020). Floods happen when soil and vegetation cannot absorb water from downpours. Floods also occur when a river outbursts its banks and the water spills onto the floodplain. Increasing urbanization, land use patternsin settlement areas without proper arrangement, and management of internal drainage and sewage system are human-induced causes of flooding too (Zang W. et.al. 2018, . A large number of waterlogged areas, lakes, *tals, and tanks* are also responsible for spreading foods when over flooded with heavy rains. The southern rivers comprising the Karmanasa, Sone, Punpun, Kiul, Badua, and Chandranaremainly rain-fed and are either dry or carry little flow during the flood period in the north as shown in Fig.5&6.

Fig. 5 Flood Prone Area in Bihar

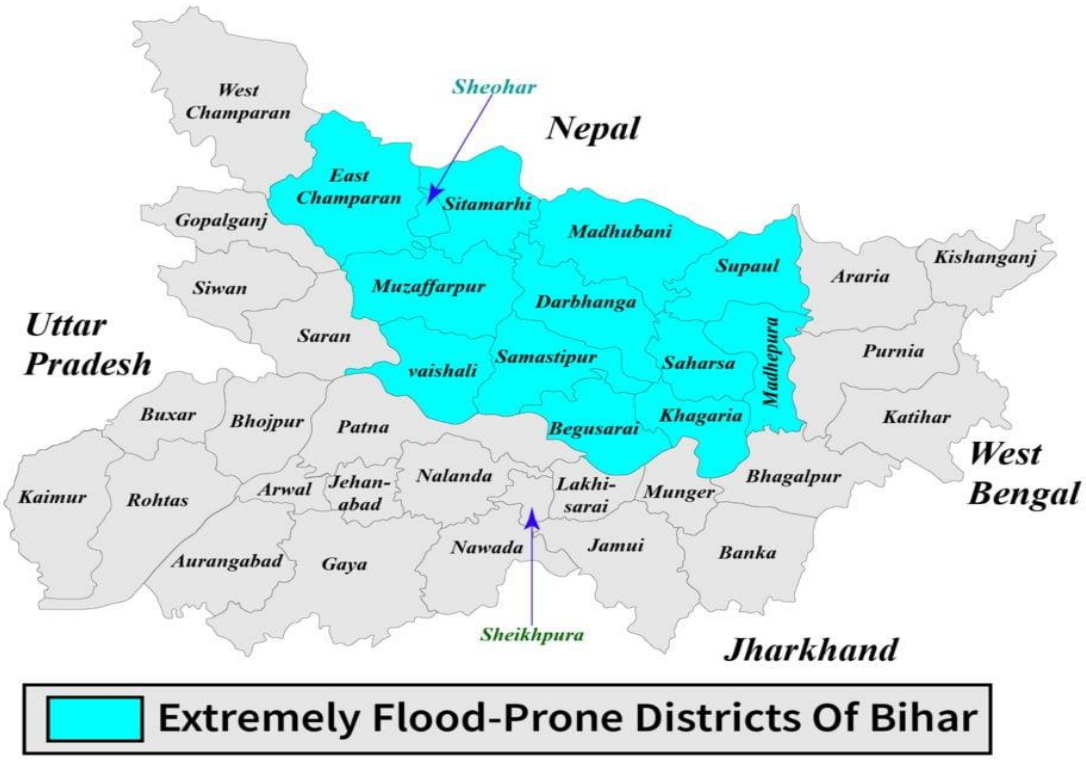


Fig. 6

Government Initiatives to reduce the floods of Bihar

The government of Bihar has been regularly active for providing aid of various natures during pre and post-flood occurrences every year. It provided the modern rescue operation kits to the flood-prone districts for prompt action when floods occur. The following aid provisions are provided by government agencies to flood-prone areas and affected people.

- Ten motorboats to each of the 28 flood-prone districts of Bihar are distributed.
- The national disaster response force (NDRF) team is proving training to the home guards of Bihar.
- The construction of 200 flood shelters in the flood-affected districts of Biharhas been started.
- Master trainers have been trained by NDRF in Bihar for search and rescue operations, first aid, capacity building, and awareness campaign.
- The projects for interlinking rivers and construction of canals for reducing the flood water have been planned and they are under the action plan.
- The National Water Development Agency (NWDA) has proposed thirty major river link canals in India to transfer the water from the surplus region to the water deficit region. Out of these 30 major river link canals, six are directly related to Bihar. These interlinking canals are as
- Kosi-Mechi Link Canal.
- Kosi-Ghaghara Link Canal
- Sone dam-southern tributaries of Ganga Link Canal.
- Chunar-Sone Barrage Link Canal.
- Brahmaputra-Ganga (Manas-Sankosh-Teesta-Ganga) Link canal.
- Gandak-Ganga Canal

Moreover, the government has also made efforts toprepare of map of hazards, identification of risk and vulnerability zones as well as an estimate of loss caused by floods on different occasions. The first version of the Bihar Flood Hazards Atlas was published in 2013 using data from 1998-to 2010 by NRSC. ISRO.

- Flood Hazards Zonation Map was also prepared using data 1998-2019 and five classes ranging from very low to very high hazard zones, based on criteria by the hazard committee (Begum,A. et.al.2020)
- The state has made a tremendous and positive change in the monitoring and assessment of the flood hazards with the help of the Flood

Management Information System Centre (FMISC) and State Disaster Management Authority, Patna (BSDMA).

- The open-source remote sensing satellite images in near real-time are also serving as vital information for emergency response support. Conventional methods like field survey and aerial observations for flood extent mapping require extensive work, large manpower, and more time, and combined makes it costly in comparison to Remote Sensing and GIS approaches.
- The capability of remote sensing made it more reliable and applicable in monitoring and assessing the impact of floods over land and urban areas during and immediately after the occurrence of flood events

Steps to control floods in Bihar

The natural hazards/ disaster of any nature could not be stopped but their ill effect could be minimized through human efforts and scientific planning. Human-induced factors of disturbing natural ecology can be controlled and surely management of risk reduction and vulnerability and degree of disaster adverse effect will be done successfully after following the solutions given below.

- The aforestation in the upper catchment areas is one of the concrete solutions. It will reduce the magnitude of floods in Bihar by binding the soil to the roots of trees.
- Construction of reservoirs, lakes, tanks, and other water bodies in flood-prone areas and out of it for reducing flood water through its distribution to different water bodies during flood season.
- Cleaning the sediments and deepening the river's channels to accommodate excess water in their channels.
- By reducing the slopes of the topography of the flood-affected area of Bihar.
- Construction of small channels in the flood prone area to allow quick discharge of water.
- Construction of terraces along steep slope to reduce flow of water.
- By increasing the flood-affected area under mangroves.
- Using modern and precise estimating and forecasting tools.
- Cementation of both sides of the riverbank to reduce the chances of lateral erosion caused by the river.
- Diversion of floodwater in the low-lying areas or artificial channels by dykes, walls, and stone spurs
- Embankment construction along the river to spread flood in inhabited areas.

Components of Flood Disaster Management

Floods are indeed a natural phenomenon and one cannot entirely get rid of them but, their frequency and impact can be reduced through proper management by using human resources, better warning systems, and various control measures. There is a need to make resilient each and every stakeholder in the process of flood disaster management. Preparedness, response, and recovery, as well as mitigation/ prevention components of disaster management, could not perform satisfactorily unless strong will, a sense of responsibility, and accountability are generated among the people involved in the process of management of disasters in any way.

Preparedness is the research-based set of activities that are taken as precautionary measures in the face of potential disasters. Both physical preparations (such as emergency supplies depots, or adapting buildings to survive floods) and training for emergency action are the most important to be included in the preparedness. Disaster response is the second phase of the disaster management cycle which includes warning/evacuation, search and rescue, providing immediate assistance, assessing damage, continuing assistance, and the immediate restoration or construction of infrastructure. The main works of response are to provide immediate assistance for maintaining life, improving health, and supporting the morale of the affected population. Rescue, relocation, provision of food and water provision of emergency health care prevention of disease and disability repairing vital services e.g. telecommunications, transport provision of temporary shelter are important works of response. Disaster Recovery is related to those programs which go beyond the provision of immediate relief to assist those who have suffered the full impact of a disaster. Rebuilding Infrastructure e.g. homes, schools, hospitals, roads health care, and rehabilitation development activities e.g. building human resources for health development policies and practices to avoid or mitigate similar situations in the

future. Moreover\, mitigation includes all actions taken before a disaster to reduce its impacts. There are two types of mitigation activities viz. structural mitigation and non-structural mitigation. *Structural mitigation refers* to construction projects which reduce economic and social impacts. *Non-structural mitigation* involves the policies and practices which raise awareness of hazards or encourage developments to reduce the impact of disasters

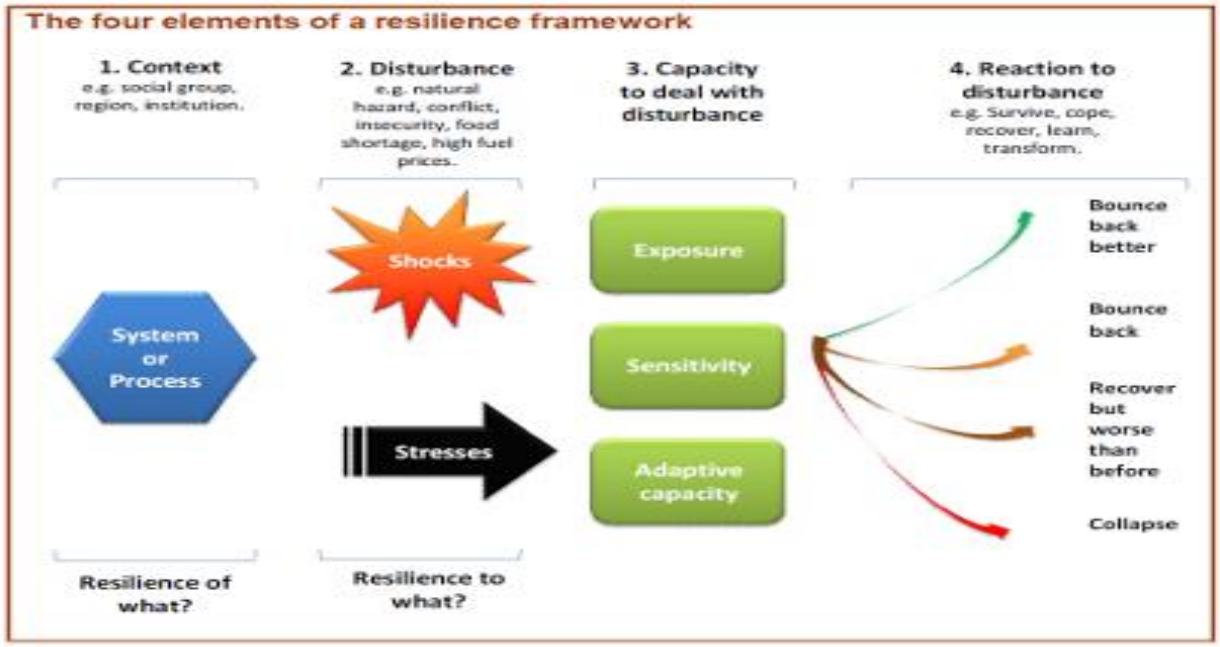
Nevertheless, disaster management is to reduce the risk and bad effects which is very much related to the degree of vulnerability and nature of hazards occurring in any area. Fig.7 reflects the level of risk as to the result of these two components of disaster. Past occurrence interval, future probability, speed of onset, magnitude, duration, spatial extent, and intensity are attributes of any hazards that contribute to the level of risk assessment. Vulnerability refers to the level of incapability of individuals, communities, society and geographical areas, and the environment to face the challenge of hazards. People, education, economy, essential service, social structure, political support as well as the degree of awareness regarding hazards are important attributes that determine the degree of vulnerability towards any hazard.

Fig. 7

Building Flood Resilience

The concept of resiliencerefers as to resist, absorb, accommodating to, and recovering from the effects of a hazard in a timely and efficient manner (UNISDR, 2005). DFID (2011) looked the resilience as the process of building the capability and ability of countries, communities, and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses – such as earthquakes, drought floods, or violent conflict – without compromising their long-term prospects. The growing level of vulnerability, insecurity, and complexity in everyday human life increased the credence of resilience building in the policy of response for disaster management. The Malta convention (2015), in which civil societies from commonwealth nations assembled to discuss the issues of how the societies could be made resilient to disasters (OECD 2015). Four interweaving threads of inquiry were identified as essential components of building a resilient society. Transformation, inclusion and responsiveness, transparency and accountability, and gender could be taken into consideration by asking the query for resilient building. Different forms of disaster building resilience like society, community, government, economy, environment, science, and

institution are urgently needed for sustainable management of disaster-affected people and sustainable development of affected areas. The four elements of the resilience framework i.e. context, disturbance, capacity to deal with disturbance, and reaction to disturbance, and their role and contribution in building the resilience process are discussed well in the figure.8



Source: DFID 2011

Fig.8

The building of flood resilience policy and strategy need well understanding of geographic and geomorphic features of flood effected region especially the lower river basin and its catchment areas along with existing socio-economic and cultural profiles and milieus as well as physical structure and environment. Flood risk management faces different difficulties in preparing and designing any resilient risk reduction strategy. It involves distinct forms of uncertainties i.e. where and when a flood will occur, how are infrastructure status both physical and cultural, the behaviour of river in changing flow line, etc. Variability in rainfall and discharge of water and the capacity and capability of people to resist and adapt, call upon very scientific, socially relevant, and sustainable flood resilience and resistance strategies in the affected areas. Holling (1973) defined resilience as the ability of the system to maintain its integrity under disturbances. It is the characteristic to withstand disturbances without any irritation and reaction. Local flood protection embankment, formation of community organization for mainly livelihood enhancement, providing warning, helping households relocate during the flood and to access relief and rehabilitation services, and management of seasonal migration of men particularly in urban areas have been important issues to be considered while resilient strategy is designed to manage risk

The measures used in a resilience strategy may differ for different parts of the system in order to maximize the resilience of the whole system. In certain parts of the area, floods may have to be prevented, while in other less vulnerable areas, floods may be accepted but flood impact mitigating measures are advised. Measures can thus be structural or non-structural and change the hazard or the vulnerability. Both types of measures increase the resilience of the system as a whole because expected damages are lowered, recovery is enhanced and the reaction to peak discharges is more gradual. In contrast, resistance strategies aim at flood prevention by structural measures

Resilient flood-risk management allows flooding but tries to minimize the damage caused by these floods. Resistant flood risk management strategies focus on flood prevention only.

Building structures to control floods will quickly stimulate the economy, but introduce the risk of failure

of the structures and large economic damage. The challenge for these areas is to find a strategy for flood risk management that fits in the socio-economic development process of the region, without creating very dangerous situations. This seems possible when a whole systems approach and a long-term view are adapted.

BUILDING LOCAL CAPACITY AND ACCELERATING PROGRESS: RESILIENCE FROM THE BOTTOM UP

The planning of the strategy for the development of society and area at the grassroots level has been usually operated through top rank in the hierarchy and experiences tell the failure or less effective performance to achieve the target. It is because the planners are very less concerned and experienced with local issues, problems, and resource development. Down to top strategy and flood resilience should be encouraged for reducing disaster risk and managing aid and facilities after the disasters for sustainable development of people and the area concerned. Some following universal steps can aid local communities in making progress to increase their resilience and include:

- Engaging the whole community in disaster policy-making and planning;
- Linking public and private infrastructure performance and interests to resilience goals
- Improving public and private infrastructure and essential services (such as health and education
- Communicating risks, connecting community networks, and promoting a culture of resilience;
- Organizing communities, neighborhoods, and families to prepare for disasters;
- Adopting sound land-use planning practices; and
- Adopting and enforcing building codes and standards appropriate to existing hazards

Measures to Develop Resilient Society to Disaster

The problems and suffering faced by any community could not be removed only through making policy but need an honest and sincere action and persuasion and motivation of the targeted population for coming forward to receive the benefits designed for them. Following suggestions are recommended to build a resilient society to disasters, especially floods. (Khan, N. et.al., 2018, 2022)

- To develop a spirit of sacrifice and service for poor and venerable communities
- Humanitarian approach development to tackle hazards and disaster effects.
- Honesty, sincerity, and transparency in thinking and approach for help to people.
- Awareness and well training to people to handle situations during pre, present, and post of disaster occurrence.
- Knowledge of cultural heritage and indigenous methods of preventing, reducing recovery, and rehabilitation techniques applied by local communities in the past.
- Communication linkage understanding and utilization methods needed for the safety of life and property due to hazards
- Understanding of health care facilities and services available in the area especially for disaster periods.
- Knowledge about various government and private institutions dealing with aid, relief work, rehabilitation work, and medical aid.
- Knowledge about various NGOs, and global agencies providing physical, financial, and technological help to deal with disaster situations.

CONCLUSION

Flood disaster is a very unpredictable and uncontrolled phenomenon which has been regulated by climate change, the erratic and variable nature of rainfall in time and space. The Bihar floods are of riverine origin, controlled by flush rain and geographic feature of Nepal in the North and Bihar itself. The increasing frequency and intensity of floods over the last several decades resulted in an alarming situation for people, government as well as NGOs to handle, manage and reduce flood risk hazards in the flood-prone area. Disaster management making resilient nations, communities, society, government, and other stakeholders towards reduction of vulnerability and risk are the need of time for sustainable development of affected areas. The use and application of geospatial technology for assessment and estimation of loss incurred due to flood; identification and location of flood-affected zones of different intensity; proposing new safe areas for rehabilitation of people and livestock and rational use of flood affected area for different economic activities after receding back of

floodwater is urgently required for getting valuable result for planning flood and water resource management in Bihar. Moreover, the morality, humanity, honesty, sincerity, and accountability of bureaucrats, government agencies, public representatives, individuals, society, and religious leaders would be very effective tools for achieving the successful target of the reduction of flood hazard risk and management of different components of disaster management.

REFERENCE

1- Adam,A.G. (2008) Adams, A.G. (2008). Perennial flooding in the Accra Metropolis: The human factor. (Unpublished Master of Science Thesis). Kwame Nkrumah University of Science and Technology, Kumasi

2- Ahmad, K., &Moeeni, S. (2019). A recent flood risk scenario of Bihar: APreventive Strategy. NDCWWC Journal (A Half-Yearly Journal of New Delhi Centre of WWC), Vol. 8 , No.2 pp.3-14

3- Begum, A., Rao, K.H.V.D. & Rao, P.V.N (2020) Flood Hazards Atlas, Bihar- A Geospatial Approach, NRSC-RSA-DMSG-March 2020. 7R-505-V2.0

4- Blake, E. S., Landsea, C. W., & Gibney, E. J. (2011). The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2010. NOAA Technical Memorandum NWS NHC-6, NOAA National Hurricane Centre. Dept. of Commerce.

5- Blöschl, G.; Hall, J., Viglione, A., Perdigão, R.A.P., Parajka, J., Merz, B., Lun, D., Arheimer, B., Aronica, G.T., Bilibashi, A.; et al.(2019) Changing Climate Both Increases and Decreases European River Floods. Nature, 573, 108–111.

6- Dodman, D., Bicknell, J., & Satterthwaite, D. (2012). Unjust Waters: Climate Change, Flooding and the Urban Poor in Africa: in Ian Douglas, KurshidAlam, MaryAnneMaghenda, Yasmin McDonnell, Louise McLean and Jack Campbell (edits) In Adapting Cities to Climate Change (pp. 216-238). Routledge

7- DFID (2011) Defining Disaster Resilience: A DFID Approach Paper, DFID

8- Ghapar, A.A., Yusoff, S. & Abu Bakar, A. (2018) Internet of Things(IoT) Architecture for Flood Data Management, International Journal of Future Generation Communication & Networking, Vol.11, No.1, pp.55-62

9- Gaurav, K.; Métivier, F.; Devauchelle, O.; Sinha, R.; Chauvet, H.; Houssais, M.; Bouquerel, H.(2015) Morphology of the Kosi Megafan Channels. Earth Surface Dynamics, Vol. 3, pp.321–331.

10- Holy quran, surah Al' araf, No.7 verses 59-67; Surah, As'Surah, No.26, verses 118-120,128-129

11- Holling (1973) Resilience and Stability of Ecological System, Annals Review of ecology and Systematics, Vol.4, pp.1-23

12- Khan.N., Ahemmed, I. & Shamim,K.S. (2022) Disaster Management and Religious Insight : A comprehensive Analysis, International Journal of Current Research, Vol.14, No.1, pp.20472-20479

13- Khan, N. & Shamim, K.S.(2018) Building Resilience and Management of Vulnerability: Solution for Reduction of Risk of Disasters, International Journal Creative Research Thought (IJCRT), Vol.6, No.2, pp.667-682

14- Pandey, A.C.; Singh, S.K.; Nathawat, M.S. (2010) Waterlogging and Flood Hazards Vulnerability and Risk Assessment in Indo Gangetic Plain. Natural Hazards, Vol., 55, pp. 273–289.

15- Loukas, A.; Garrote, L.; Vasiliades, L. (2021) Hydrological and Hydro-Meteorological Extremes and Related Risk and Uncertainty. Water, 13, 377.

16- Manjusree, P., Bhatt, C.M., Begum, A., Rao, G.S., Bhanumurthy, V. A Decadal (2015) Historical Satellite Data Analysis for Flood Hazard Evaluation: A Case Study of Bihar (North India), Singapore Journal of Tropical Geography. Vol. 36, pp.308–323.

17- OECD (2015) UN World Conference on Disaster Risk Reduction, Sendai, Japan.

18- Samela, C.; Manfreda, S.; Troy, T.J. (2017) Dataset of 100-Year Flood Susceptibility Maps for the Continental U.S. Derived with a Geomorphic Method. Data Brief, Vol.12, pp. 203–207.

19- Sinha, R.; Bapalu, G.V.; Singh, L.K.; Rath, B.(2008) Flood Risk Analysis in the Kosi River Basin, North Bihar Using Multi-Parametric Approach of Analytical Hierarchy Process (AHP). J. Indian Soc. Remote Sens., Vol. 36, PP. 335–349.

20- Sinha, R., Burton,M., Tiwari, G. (2012) Strengthening Institutional Network for Flood and Water Management in Bihar, International Growth Centre, London.
21- Tripathi, G.; Pandey, A.C.; Parida, B.R.; Shakya, A.(2020) Comparative Flood Inundation Mapping Utilizing Multi-Temporal Optical and SAR Satellite Data Over North Bihar Region: A Case Study of 2019 Flooding Event Over North Bihar. In Spatial Information Science for Natural Resource Management; Advances in Environmental Engineering and Green Technologies; IGI Publisher: Hershey, PA, USA,
22- Tripathi, G.; Pandey, A.C.; Parida, B.R.; Kumar, A.(2020) Flood Inundation Mapping and Impact Assessment Using Multi-Temporal Optical and SAR Satellite Data: A Case Study of 2017 Flood in Darbhanga District, Bihar, India., Water Resource Management, Vol. 34, pp. 1871–1892.
23- UNISDR (2005)Hyogo Framework for Action 2005-2015; Building the Resilience of Nations and Communities to Disasters, World Conference on Disaster Reduction, 18-22 January 2005, Kobe-Hyogo, Japan
24- Zhang, W., Villarini, G., Vecchi, G. A., & Smith, J. A. (2018). Urbanization Exacerbated the Rainfall and Flooding Caused by Hurricane Harvey in Houston. Nature, Vol. 563(7731), pp. 384-388