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Risk Reduction and Recovery from Flood Hazard- A Case of Human Adjustment in Lower Damodar Basin, West Bengal

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Abstract

The study investigates the risk of flood hazards in the lower Damodar basin, focusing on human perception and adjustment strategies to mitigate and recover from the societal risk posed by these hazards. The river Damodar is known as 'the sorrow of Bengal' due to its flood ravages in the entire Damodar valley, which caused much unhappiness and distress in the lower Damodar region. In this area, the main flood-causing agents are rainfall and discharge from upland reservoirs. In the study, the annual peak flow is used to determine the flood frequency analysis. Flood inundation mapping analysis revealed that Amta and Khanakul blocks of Hooghly district are most vulnerable to maximum flood inundation during monsoon months. The damage due to floods in terms of economic loss and the probability of flood occurrences are used for assessing flood risk and the magnitude of vulnerability in the study area. The adopted structural measures in this area have not yielded sufficient results to mitigate the chronic flood problems. Therefore, some non-structural measures, particularly human adjustment strategies, are taken into consideration, like flood forecasting, alternative cropping arrangements, choices for other livelihood options, and capacity building through self-help- groups.

***Keywords*— flood hazard, Damodar Valley Corporation (DVC), risk, reduction, vulnerability, perception, human adjustment, capacity building.**

I. INTRODUCTION

Any event that adversely affects the environment is called a "hazard." Seasonal or annual fluctuations of the biosphere, hydrosphere, and atmosphere constitute a hazard to man. From time immemorial, the river Damodar has earned a flood risk of its own in the lower Damodar basin, West Bengal. The main goal of the present study is to analyze the risk assessment and risk perception combined in the managerial adjustment made by society to flood hazards in the lower Damodar basin. Flood risk at a location depends on the frequency of flooding and the associated consequences for the community. The hydrological regime of the river Damodar causes floods every year in its lower course. During the last 100 years, the Lower Damodar area of West Bengal has experienced more than 20 serious and devastating floods. This has led to an annual flood in the area for some time, causing significant loss of life, property damage, and disruption in public utility services.

People living in the low-lying areas of the Lower Damodar basin have learned to live with flood risk from very early days. With the rapid socio-economic changes in the area over the last century, there have also been substantial physical changes in the drainage system in the lower Damodar basin. As a possible range of human adjustment to the flood hazard, they used to welcome floods, which left behind fertile silt on the field, which is

invaluable for winter crop production to maintain their lives and livelihoods.

Systematic research into natural hazards really began with the work of Gilbert White (1945), who was the pioneer to recognize that engineering schemes were not the only way to tackle flood problems in the U.S.A. Thus, in the 1970s, the North American Research School, inspired by White (1974), published several important books. A new generation of text books (Alexander 1993, Cutter 1993, Blaikie et al. 1994) sharpened theoretical perspectives and increased awareness of environmental hazards in the late 20th century. Risk, often defined as the combination of probability and loss, refers to the actual exposure of something of human value to a hazard. Okrent (1980) provided a clear illustration of this. Generally speaking, risk assessment is such a complex concept that a single scientifically repeatable solution will rarely satisfy all the political, social realities of the decision-making process (Smith, 1998). Kates and Kasperson (1983), however, provided detailed steps for risk assessment. Hewapathirane (1978) regards all individual perceptions as equally valid evaluations of risk, and each individual chooses their own response to any given threat. Zeckhauser and Shepard (1984) express the fundamentals of risk management. Smith (1998) discusses various methods of human adjustment to hazardous events, such as floods.

Aims and Objectives

The main objectives of the study are:

- To assess the risk of flooding in the lower Damodar basin.
- To identify the risk, vulnerability, and perception of flooding.
- To find out the possible range of risk reduction, recovery, and human adjustment to flooding.

II. MATERIALS AND METHODS

Hazards are an inevitable part of life. It is viewed as a naturally occurring and man-induced event with the potential to create loss, which is a general source of danger. The rapid population growth and higher concentration in hazardous environments have increased the frequency and severity of natural disasters. The study is based on hydrological information. The meteorological centre in Alipore and the block seed farms in the districts generate hydrological information. We obtain river discharge data from the gauging stations at Durgapur Barrage, Panchet, and Maithon reservoirs. We use surveys of India's topographical maps and satellite imagery to gather information on relief slopes and drainage characteristics. Published maps on the administrative division of West Bengal are taken to depict the block boundaries falling in the lower Damodar basin. The Damodar Valley Corporation (DVC) authorities provide discharge data on river water from various gauging stations, especially in the lower reaches of the river. A flood frequency study is a statistical method for assessing flood flows. Flood inundation mapping assists with flood magnitude measurements and land use planning. Flood risk zoning refers to restricting any human activity in a river's flood plains. Flood damage analysis offers the key to proper measures for disaster mitigation and damage reduction. The statistical analysis is based on mathematical probability theories and scientific methods for identifying causal links between different types of hazardous activity and their resulting adverse consequences. The concept of vulnerability implies a measure of risk combined with the social and economic ability to cope with the resulting event.

III. STUDY AREA

The current study area the Lower Damodar Basin, which lies in the southern part of West Bengal in eastern India, is bounded by latitudes $22^o15'$N to $23^o00'$N & longitudes $87^o55'$E to $88^o05'$E. This region starts in Begua, where the river bifurcates into two branches: Mundeswari and Damodar. Its southern extension ends at a point where the Damodar River meets the Hooghly River at Shyampur, near Falta. The entire area extends approximately 96.35 km north-south and 30.50 km east-west. The region's total geographical area is approximately 2365 square kilometers. Administratively, the lower Damodar basin falls under parts of Raina-I and Raina-II and Jamalpur blocks of Burdwan district, Pursurah, Khanakul-I and Khanakul-II, Arambagh, Tarakeswar, Jangipura, blocks of Hooghly district, Amta-I and II, Udaynarayanpur, Bagnan I and Bagnan II, Uluberia-I and Uluberia-II, and Shyampur-I and Shyampur-II of Howrah district. The lower Damodar Basin experiences floods from Damodar, Kana Nadi, Mundeswari, and Rupnarayan almost every year, resulting in substantial damage to life and property. The river Damodar, which originates from the Chotanagpur plateau, flows in an easterly and south-easterly direction through Bihar and West Bengal before

merging into an alluvial plain near Kamalpur village in Burdwan district. The Damodar bifurcates into two channels further below Jamalpur near Begua: the Mundeswari and the main Damodar channel, also known as the Amta channel, with a close third distributary, Kana Damodar, currently silted up but connected by canals (DVC 2000).

Table 1

IV. DISCUSSION

Every year, the catchment area of the Damodar River experiences seasonal rains due to the South-West Monsoon, and depending on the intensity of the storms, floods occur. During the monsoon season, the rainfall in the area is mainly due to either the passage of depressions over and near the area or active monsoon conditions. The normal track of the monsoon depression from the Bay of Bengal towards West Bengal lies south of the Damodar valley. Flooding in the West Bengal region typically occurs when a heavy storm precedes another, primarily due to the long-standing silting process. As a result, the lower Damodar's cross-section in the delta area has significantly decreased, thereby decreasing its capacity for drainage. The region experiences flooding from heavy rainfall in the catchment area, and the release of excess water from the upstream reservoir during the monsoon months adds severity to the flood situation in the lower Damodar basin. August is the wettest month, with the daily average rainfall sometimes reaching as high as 56 cm. This shows the rainfall pattern of the Damodar basin in Maithon and Panchet. According to the rainfall data, the year 2000 recorded the ever-highest rainfall (1780.77mm) at Panchet, though in many years the rainfall has crossed 1250mm. However, the flooding in the lower Damodar region is not as severe as it was in 2000 (rainfall data from Block Seed Farm, 2000, 2005, 2008, 2015, 2021). The same is true for Maithon, which recorded the ever-highest rainfall (1605.20 mm) during a 30-year period of observation. Climate change is likely to impact climate variability, making extreme events more severe and frequent. Aside from that, discharge from upland reservoirs adds severity to the flood situation in the study area.

Flood Prone Zone

Each year, a significant part of the region experiences flooding, with floodwater persisting for several days. In the water-logged area, the depth of water varies greatly due to variations in topography and the prevailing drainage conditions. Flood data analysis on water depth and duration of inundation indicates that the study area is a flood-prone zone. Nearly 38% of the area is in a severe flood risk zone. Khanakul block of Hoogly district lies in a geomorphologically depressed zone with the highest inundation time of 26 days and a water depth of 2 m.

A relatively large number of yearly records can evaluate a river's flood potential and the frequency of a flood at a given magnitude over a certain interval of time (Gumble, 1941). We analyzed the flood frequency using a sequence of recorded peak flow events spanning 100 years. We designed the DVC project to control floods in the river Damodar with a 100-year flood frequency.

Flood Risk, Vulnerability and Perception

Vulnerability to flooding is defined as the extent to which a community, structure, or service in any area is likely to be damaged by the impact of a flood hazard. The concept of vulnerability implies a measure of risk combined with a level of social and economic ability to cope with the resulting event in order to resist disruption or loss. This study revealed that floods severely disrupt the livelihoods of the inhabitants of the lower Damodar basin, throwing their basic economic activity out of gear. The study area is mostly inhabited by the villagers. The economically weaker people, i.e., the marginal farmer, daily wage earner, and artisans, are the most vulnerable sector of a society. Elderly people, disabled children, pregnant women, sick and ailing people, widows, and families living near rivers are vulnerable populations. Additionally, properties such as cattle, livestock, livelihood assets, standing crops, drinking water sources, and communication systems are considered vulnerable to flood hazards. It was found that most of the study area's blocks perceived floods as detrimental to their livelihoods. Risk is a complex and curious concept in relation to flood hazards. The mathematical definition of risk is the probability of harmful consequences or expected loss resulting from the interaction between hazard and vulnerability. The present study considered the risk factor as a percentage associated with floods over a 25-year period. The study revealed that 1978, 2000, and 2015 account for the maximum risk factor, i.e., 35.74%, 35.61%, and 28.91%. A comprehensive preparedness plan can minimise the damage from natural hazards.

Flood Risk and Possible Range of Adjustment

Human beings are the most affected by flooding. It brings not only misery to them but totally disrupts their economic activity (Okerant, 1980). The Government of India initiated a project to mitigate the flood problem in the study area, with the goal of reducing the flood effect

in the lower part of the Damodar basin. The proposal called for the construction of seven multipurpose dams with low diversion channels on the Damodar. The devastating flood of 1978 has changed the old concept of flooding by adopting only structural measures. Today, the ideas of non-structural measures are taken into consideration. Farmers who depend on cropping activities face a severe economic crisis due to crop loss during flood season. To overcome this situation, farmers themselves have adopted a new cropping system or alternative cropping arrangement in the study area.

V. CONCLUSION

Flooding is a recurrent phenomenon in the study area. This region is crisscrossed by branches of the Damodar River. The geomorphological feature is also one of the causes of flooding in the study area. Except for rainfall and river discharge from upland reservoirs, these are the main agents of flooding. Since time immemorial, the inhabitants of the study area have experienced flooding. Prior to the DVC's commissioning, severe flooding devastated the area, resulting in significant property and human loss. The DVC was visualised to alleviate the flood problem in the lower Damodar basin. Over time, observations reveal that the DVC's ability to alleviate the flood problem has diminished. The perception study undertaken among the flood victims revealed that more emphasis is placed on the people self-organising themselves rather than depending on government authority. Self-organization is evident in developing self-awareness through community-based organisations, other livelihood options, and alternative cropping arrangements to reduce and recover the risk of flooding in the study area.

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