Int. J. Exp. Res. Rev., Vol. 8: 74-80 (2016)

International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online) *Original Article*

Received: 10th November, 2016; **Accepted:** 18th December, 2016; **Published:** 30th December, 2016

Monitoring and assessment of flood risk in lower Damodar basin of Bengal delta, India

Lipika Mandal

Assistant Professor, Department of Geography, Belda College, Belda,
Paschim Medinipur- 721424, West Bengal, India

Author's E-mail: lipikamandal23@rediffmail.com

Abstract

The river Damodar is known as 'sorrow of Bengal' due to its flood ravages in entire Damodar valley caused much unhappiness and distress in lower Damodar region. The intense rainfall during monsoon and discharge from upland reservoir leads to severe flooding in various parts of the area in varying magnitude almost every year. The hydro-meteorological condition of the study area is dominated by monsoon confined to four months in a year. The damage due to flood in terms of economic loss and the probability of flood occurrences is used for assessing flood risk in the study area. This study analyses the risk from flood influencing Government authorities to adopt both structural in lower Damodar Basin, in Bengal Delta.The adopted structural measures in this area have not yielded sufficient results to mitigate the chronic flood problems. Therefore, some non-structural measures flood mitigation strategies are taken into consideration like flood forecasting, alternative cropping arrangements and capacity building through self-help-group.The main goal of the present study is to analyze the flood risk assessment,risk perception and risk reduction combined in the managerial adjustment made by the society to flood hazard in lower Damodar basin.

Keywords: Economic loss, flood risk, sorrow of Bengal, risk reduction.

Introduction

The term risk encompasses the probability and the amount of harmful consequences or expected losses resulting from interactions between natural or human induced hazards and vulnerable conditions. Risk arises at two levels - at village level i.e., loss of infrastructure, loss of communication and at individual level- loss of crops, house damaged, short of health care facilities, loss of domestic goods, lack of proper hygiene, sanitation & drinking water supply, long term loss in productivity and livelihood. The advent of civilization, pressure of increasing population and consequent pressure on natural resource is forcing people to carry out their socio-economic activities in areas exposed to natural hazard, compelling them to take higher risk in search of livelihood.

The hydrological regime of the river Damodar brings flood every year in its lower course. During last 100 years the Lower Damodar area of West Bengal experiences more than 25 serious devastating floods. The study area of Bengal Delta experiences many of the great floods of the Damodar are recorded in history – 1770, 1855, 1866, 1873-74, 1875-76, 1884-85, 1891-92, 1897, 1900, 1907, 1913, 1927, 1930, 1935 and 1943, 1956, 1970, 1978, 2000,2005, 2007, 2011. People living in the low lying areas of Lower Damodar basin have learnt to live with flood risk from very early days. They used to welcome flood, which left behind fertile silt on the field for winter crops. With the rapid socio-economic changes in the area flood sometime bring in heavy loss of life, damage to property and disruption in public utility services.

Excessively heavy and prolonged rainfall and very heavy discharge from upland reservoir are important causes of flood in lower Damodar basin. The age long notoriety of flood in lower Damodar basin causing immense damage to the agricultural economy and settlements.The present study relates to the flood risk of Lower Damodar basin, which is characterized by the predominance of agricultural activities. A greater theoretical perspectives regarding flood hazard has been sharpened by a new generation of text books (i.e., White, 1974; Starr and Whipple, 1980; Alexander, 1993; Cutter, 1993; Blaikie et al., 1994). Risk is the actual exposure of something of human value to a hazard and is often regarded as the combination of probability of loss (Okrent, 1980) and 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 of risk assessment. Risk reduction is defined as a reduction of the probability and the severity of adverse effects of hazard. The fundamental risk management is expressed by Zeckhauser and Shepard (1984). Smith (1998) discusses various ways of human adjustment to different hazardous events like flood. Meaningful involvement and participation of the community for risk reduction empowers people to take right decision (Murshed, 2003; Shaw and Krishnamurty, 2009).

Aims and objectives

- To assess the risk of flood in lower Damodar basin.
- To find out the possible range of human response and community participation, risk reduction and adjustment to flood.

Methods and Materials

Hydrological information is generated from the meteorological center, Alipore and from the Block Seed Farms in the districts. River discharge data is obtained from the gauging station at Durgapur Barrage. Discharge data on river water from different gauging stations are obtained from the DVC Authorities particularly in the lower reaches of the river. The data required for the present study comprised topographical maps, block maps, satellite images and demographic and damage details.

These methods are used for this study:

- Flood damage analysis offers the key to proper measures for disaster mitigation and damage reduction.
- The risk analysis is based on mathematical theories of probability and scientific methods of identifying causal links between different types of hazardous activities and resultant adverse consequences.
- A field survey was conducted to determine the extent of vulnerability, perception and community participation in the study area.

Study area

The Present study area Lower Damodar Basin which lies in the Southern part of West

Bengal of Eastern India is bounded by latitude $22^0$15'N to $23^0$00'N and longitude $87^0$55'E to $88^0$05'E. This region starts from Begua where the river bifurcates into two branches Mundeswari and Damodar. Its southern extension ends at a point where the river Damodar meets Hooghly River at Shyampur near Falta. The entire area is an elongated one with a North-South extension of approximately 96.35 km and East -West extension of 30.50km.

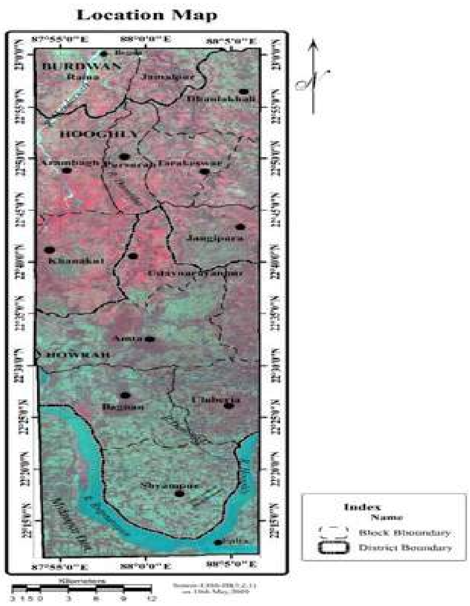

Fig. 1. Study area.

The total geographical area of the region is about 2365 sq km. The lower Damodar Basin experiences flood from Damodar, Kana Nadi, Mundeswari and Rupnarayan almost every year resulting in substantial damages of life and property. Administratively the lower Damodar basin falls under parts of Burdwan, Hooghly and Howrah district (Figure 1). The river Damodar originating from Chotanagpur plateau flows in an easterly and south-easterly direction through Bihar and West Bengal and merges into alluvial plain near Kamalpur village in Burdwan district. Further below Jamalpur near Begua the Damodar bifurcates into two channels; the Mundeswari and the main Damodar channel or Amta channel with a close third distributaries i.e., Kana Damodar which is silted up but connected at present with the help of canals.

Results and Discussion

Nature of Flood

The river Damodar, a rain fed river, has its origin in Chotanagpur plateau. It has a wide catchment area of 37000 sq. km. of which 63.6% contributes upper catchment and only 36.4% contributes lower catchment in West Bengal. The wide elliptical upper catchment taper down to a narrow elongated basin in the form of a funnel which paved the path of onrush surface runoff of the upper catchment to the lower with an obvious chronic hazards of annual flood from time immemorial.

Flood behaviour of river Damodar is influenced by a range of factors that vary significantly with location and that need to be understood and managed locally. Catchment size, shape, slope development and vegetation all significantly influence the hydrological processes, in particular the conversion of rainfall into runoff. The speed of conversion from rainfall to runoff, the volume water, all influence flood behaviour and the length of time a flood will last.

The normal track of the monsoon depression from Bay of Bengal towards West Bengal lies to the south of the Damodar valley. The catchment area of the Damodar river experiences seasonal rains due to the South-West Monsoon every year and depending upon 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 region experiences flood by heavy rainfall in the catchment area and the release of excess water from the upstream reservoir during the monsoon months adds severity to flood situation in lower Damodar basin. Rainfall pattern for upstream of Damodar basin is presented in Table 1 and Figure 3. Analysis of

Table 1. Rainfall character in Damodar Catchment Area.

Year	Rainfall of Upper Catchment Area of Lower Damodar Basin
2000	1780.77
2001	1530.2
2002	1354.3
2003	1512.4
2004	1482.6
2005	1792.8
2006	1541.6
2007	2282.1
2008	2077.8
2009	1505.8
2010	1345.2
2011	1989.99

Source: Irrigation & Waterways Dept, Govt. of W.B.

the figure 3 reveals that 2010 was marked by lowest rainfall at upper catchment area. August is the rainiest month when average daily rainfall sometimes reaches as high as 56 cm. The year 2000 recorded the ever highest rainfall (1780.77mm) at Panchet though in many years the rainfall has crossed 1250mm. but that has not been reflected in enormity of flooding at lower Damodar region as compared to the year 1978. River discharge from upland reservoir adds severity to flood situation in the study area (Table 2). Climate change is likely to impact climate variability making extreme events severe and more frequent.

Delineation of flood risk zone

Deliniation of flood risk zone is an assessment of land relative to its susceptibility of flooding. Every year a substantial portion of area is flooded where flood water remains for days together. In the water-logged area the depth of water varies greatly due to variation in topography and prevailing drainage condition. Analysis of flood data on water depth and duration of inundation indicates that the study area is a flood prone zone. Nearly 899.50 sq. Km. of the total study area

Table 2. Flood Risk Assessment in Post-Dam Period.

Year	Discharge Below Durgapur Barrage (in Cumec)	Economic Loss (%)	Probability	Risk Factor (R= p*L)
1978	10919	80.80	0.44	35.74
1979	413	Nil	-	Nil
1980	4210	15.79	0.49	7.73
1981	1635	27.67	0.51	14.13
1982	666	18.65	0.53	9.92
1983	2096	22.61	0.55	12.51
1984	4512	23.99	0.57	13.79
1985	3317	29.03	0.60	17.3
1986	3355	32.15	0.62	19.85
1987	4567	44.99	0.64	18.91
1988	1632	29.68	0.66	19.58
1989	1933	38.03	0.68	25.86
1990	3146	32.93	0.70	23.12
1991	2104	17.04	0.72	12.33
1992	1443	Nil	-	Nil
1993	3816	42.96	0.77	32.92
1994	3296	38.31	0.79	16.01
1995	6255	64.38	0.81	24.59
1996	3627	21.38	0.83	17.74
1997	2329	37.34	0.85	31.78
1998	4104	Nil	-	Nil
1999	6128	23.29	0.89	20.72
2000	6323	40.02	0.92	36.81
2001	566	17.94	0.72	12.92
2002	952	Nil	-	Nil
2003	1634	26.67	0.55	14.67
2004	629	15.22	0.70	10.65
2005	3223	33.55	0.80	26.84
2006	675	14.98	0.53	7.93
2007	4094	35.97	0.78	28.05
2008	3114	32.12	0.75	24.09
2009	2834	21.98	0.63	13.84
2010	681	14.99	0.54	8.09
2011	3074	30.80	0.68	20.94

Source: Irrigation& Waterways Dept. Govt of W.B.

is under severe flood risk zone (Table 3 and Figure 2). Khanakul block of Hoogly district and Amta and Udayanarayanpur blocks of Howrah district lies in a geomorphologically depressed zone which has highest inundation time of 26 days with a water depth of 2m. Except it, parts of Raina and Jamalpur blocks of Burdwan district, Pursurah, Arambagh,

Table 3. Flood Prone Zone of Lower Damodar Basin.

Type of Flood Prone Zone	Area (in sq. km.)	Percentage
Severe	899.50	38
Moderate	1079.50	46
Low	386.00	16
Total	2365.00	100

Source: Compiled from Different Sources.

Tarakeswar, Jangipara, blocks of Hooghly district, Bagnan, Uluberia of Howrah district are included into different magnitude of flood risk zone.

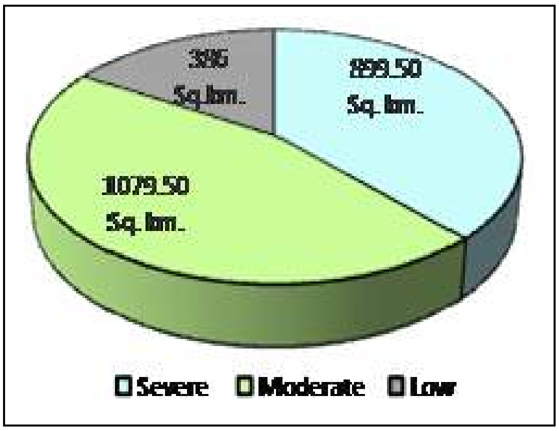

Fig. 2. Flood affected area.

Flood risk assessment

Risk is exposure to anundesired event. It can be expressed in probability that the event will happen, often during acalendar year. Risk encompasses the probability and the amount of harmful consequences or expected losses resulting from interactions between natural or human induced hazards and vulnerable conditions. Risk is not the only inherentconsequences of flood. The weak infrastructure are more at risk. The magnitude of risk depends on fury of hazard as well as the vulnerability of the affected area.

The concept of vulnerability implies a measure of risk combined with the level of social and economic ability to cope with the resulting event in order to resist disruption or loss. This study revealed that during flood the livelihood related to the inhabitants of lower Damodar basin are severely disrupted as their basic economic activity is thrown out of gear due to flood. 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, families living near to the river etc. are vulnerable population and cattle livestock, livelihood assets, standing crops, drinking water sources, communication system etc. are considered as vulnerable property in respect of flood hazard.

The hydrological regime of the river Damodar brings flood hazard every year in its lower course. During last 100 years the lower Damodar area of West Bengal experiences more than 20 serious devastating floods. These have been destructive to life not only because of the casualties and but also the associated diseases and livelihood disruption. Flood risk at a location depends upon the frequency of flooding and the associated consequences to the community. People living in the low lying areas of Lower Damodar basin have learnt to live with flood risk from very early days. They used to welcome flood, which left behind fertile silt on the field for winter crops. With the rapid socio-economic changes in the area flood sometimes brings heavy loss of life, damage to property and disruption in public utility services. The aim of present endeavour is to analyze the flood risk assessment, risk perception and risk reduction through capacity building of the community combined in Lower Damodar Basin.

The occupancy or use of flood-prone areas involves a degree of risk. Probability is a numerical index of risk; it is a measure of the likelihood that the undesirable event will occur. If the event is sure to occur, the probability is 1.0; if it cannot occur, the probability is 0.0. The mathematical definition of risk is the probability of harmful consequences or expected loss resulting from interaction between hazard and vulnerability.

Here, Risk = Probability x Economic loss.

The Table 3 represents risk factor in percentages associated with flood for 33 years considered under present study. The study revealed that 1978 & 2000 accounts for maximum economicloss with higher risk factor i.e., 35.74% and 35.61% (Table 2 and Figure 4). The damage from natural hazard can be minimized by the way of comprehensive preparedness plan.

Structural and Non-Structural Adjustment to flood risk

Human beings are the most sufferers due to flood. It brings not only miseries to them but totally disrupts their economic activity. To mitigate the flood problem of study area the Government of India initiated a project to reduce flood effect in the lower part of Damodar basin. The river Damodar was selected first in independent India for multipurpose project according to Tennesse valley Authority of U.S.A.

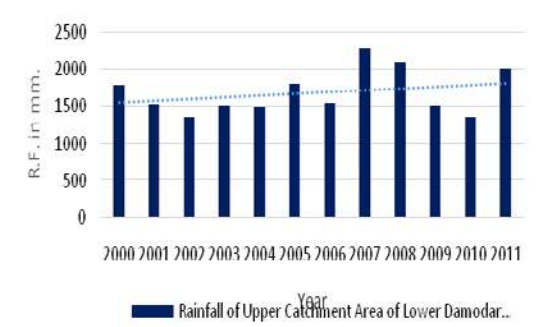

Fig. 3. Rainfall of upper catchment area of lower Damodar basin.

hundred years flood frequency. But yet in the year of 1978 devastating flood had occurred as a greatest disaster of the century after commissioning of 4 multipurpose dams out of proposed 7 multipurpose dams, low diversion channels on Damodar. The devastating flood during 1978 has changed the old concept of flood by adopting structural measures only.

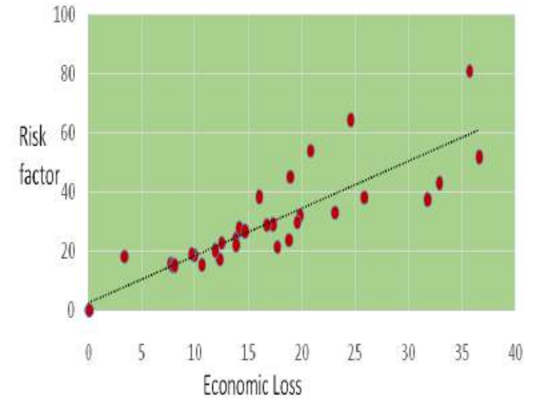

Fig. 4. Co-relation between economic loss and flood risk.

Today the ideas of non-structural measures are taken into consideration. As a part of non-structural adjustment, disseminationof flood warning by installing RTO system is taken on priority basis. The study indicate that community based organizational capacity is a significant factor for sensitizing local communities and diversification of livelihood options for risk reduction. A community or village with sufficient number of local members would be formed CBO or community based organization for flood hazard management. They can organize awareness program at village level making the people to understand the vulnerability and risk of flood and define the roles and responsibilities of the CBO members to prevent the threat from flood. The CBO members have given particular responsibility like dissemination of flood warning, rescue, relief and other preparedness. The decision making of community groups could be positive, resulting in resilience-enhancing actions.

Alternative cropping arrangements

Farmers who depend on the 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. Normally flood event disturb the existing cropping system of any particular area. Food security with alternative cropping arrangements play a vital role to reduce risk of the vulnerable people of the study area. They can practice alternative cropping arrangements i.e., Kharif to Rabi and lastly by land use planning.

Conclusion

Flood in various magnitude is a recurrent phenomenon in the study area. This region is crisscrossed by branches of river Damodar. The geomorphological feature is also one of the factors for causing flood in the study area. Except rainfall, river discharge from upland reservoir is the main occurring agent of flood. The inhabitants of the study area have been experiencing flood since time immemorial. Before commissioning of the DVC, the area was subjected to severe flood causing immense loss of property and life. The DVC was visualized to alleviate the flood problem in lower Damodar basin. With the passage of time it has been observed that the DVC is unable to alleviate the flood problem. The perception study undertaken among the flood victims revealed that more emphasis is put by the people in self-organizing themselves rather than depending on government authority. A culture of coping with flood, crisis management, strengthening flood warning system and flood risk reduction through Community Based Organization, and alternative cropping arrangement is evident in lower Damodar basin.

References

Alexander, D. (1993). Natural Disasters, UCI press Ltd. London.

Blaikie, P., Canon, T., Devis, I. and Winser, B. (1994). At Risk; natural Hazards, people's vulnerability and Disasters. Routledge, London and New York.

Cutter, S. L. (1993). Living with Risk. In: *The Geography of Technological Hazards* E. Arnold, London and New York.

Kates, R. W and Kasperson, J. X (1983). Comparative risk analysis of technological hazard (a review). In: *Procedings of National Academy of Science,* USA. 80: 7027-7038.

Murshed, Z. (2003). Community capacity building for risk reduction in south Asia. In: Shani, P. and Ariyabandu, M. M. (eds). *Disaster Risk Reduction in south Asia*. Prentice hall of India. New Delhi, India.

Okrent, D. (1980). Comment and social risk. *Science.* 208: 372-375.

Shaw, R. and Krishnamurty, R. R. (2009). Disaster management, Global challenges and local solution, University press (India) Private Ltd., India.

Starr, C. and Whipple, C. (1980). Risk of Risk Decisions. *Science.* 208: 1114-1119.

Smith, K. (1998). Environmental Hazards, Second Editions, *Assessing Risk and Reducing Disaster*, Routledge, London and New York.

White, G. F. (1974). *Natural Hazards: Local, National, Global*. Oxford University Press, New York.

Zeckhauser, R. and Shepard, D. S. (1984). Principles for saving and valuing lives. In Ricci, P. E. Sagan I. A. and Whipple, C.G. (ed). *Technological Risk Assessment.* NATO advanced science identities Series. Martinus Mijhoff, The Hague. Pp. 133-168.