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Research Article

Empirical Data Based Flood Zoning in Kuya River Basin

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Abstract

This paper aims to examine the nature of flood character in different parts of the basin taking some relevant flood parameters like flood frequency, flood affected area, flood statgnation period, flood level height. Inference has drawn regarding flood intensity zones based on major flood years since 1978 to 2011. It is found that flood 2000 was the most devastating flood after that flood intensity and affected areas have declined. Out of total basin 21% land is highly affected by flood and it is mainly concentrated in the depressed wetland tract in the lower part of the basin.

Keywords: Flood intensity, flood frequency, flood stagnation period, flood level height, flood affected areas

Introduction

Ven Te Chow (1956) defined floods as "a relatively high flow which overtakes the natural channel provided for runoff." Winter, and Brater (1959) considered that flood is a "high stage of the river when the excess water overspills the banks and spreads out vast stretches of water on either sides of the flood plain." Rostredt (1968) and others defined a flood as "any high stream flow which overlaps the natural or artificial banks of a stream". Ward (1978) defined a flood as, "a body of water which rises to overflow land which is not normally submerged." This definition is most widely acceptable by the geomorphologists.

Flood zoning based on geographic areas have been successfully completed in a wide range of environments around world (Magura and Wood, 1980, Yashino and Yaskikow, 1985). Each hazardous event may be judged by characteristics such as magnitude, frequency, velocity, affected area, speed of onset, and duration. These characteristics influence the nature of human response (Burton, Kates and White, 1978). So many parameters can be applied for micro level flood zoning. Actually the lower part of Kuya river basin is highly flood affected but in this present study attempts have been taken to identify flood intensity zones of whole Kuya river basin. For this operation a) flood water level or depth of flood water b) duration of flood stagnation c) frequency of flood occurrence in a particular time period have been taken. Flood induced loss of lives and properties, standing crops are also some good parameters for measuring the flood intensity but due to lack of consequent data regarding flood claimed loss in mouza and village level this parameter is not being included in the composite process of measurement.

Study Area

Kuya River is a well known name in the riverine landscape of Eastern India. Taking start from a large pond of Khajuri village, Jharkhand and flowing S-E direction over Birbhum and Murshidabad districts of West Bengal it joins the Babla River near Sabitrinagar of Murshidabad district. Total length of the river is 176.4 km. The basin area can be delimited by 23º26′18″ North to 23º56′30″ North latitude and 87º13′ East to 88º09′30″ East longitudes covering an area of 1555.2sq.km.

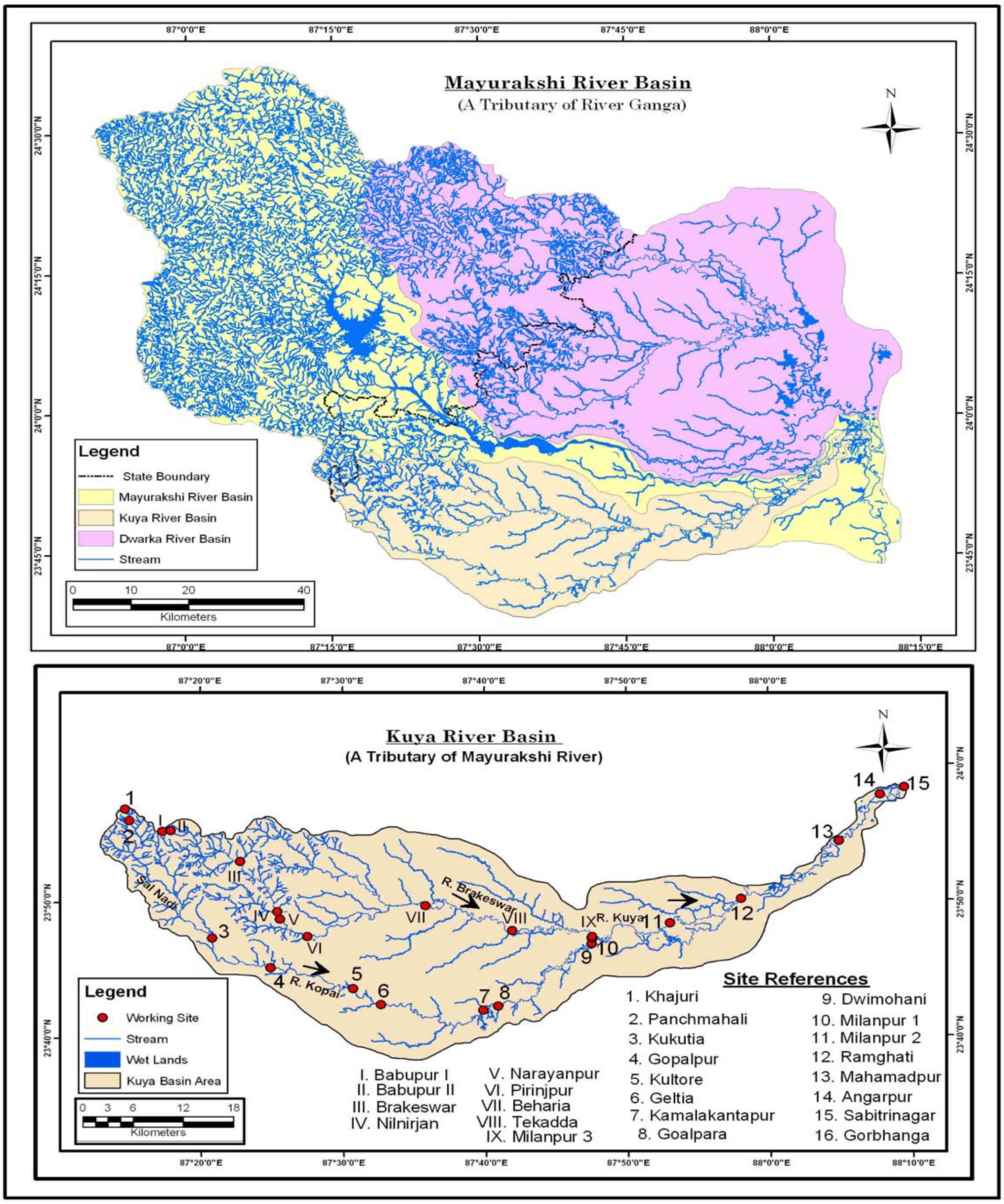

Fig. 1

Materials and Methods

Entire basin has been subdivided into 82 equal size grids (25 sq.km of each) and flood frequency, flood height, flood water stagnation etc. data have been collected on the basis of each and every individual grid.

In this paper average condition of flood frequency, flood water height, flood water stagnation of some seven major floods since 1978 to 2010 have been calculated and plotted on map. Flood frequency has been initially calculated as like 1flood/5years or 1flood/2year or alike. But for the convenience of discussion, all flood frequency data has been converted in respect to 1 year. For example, 1flood/1year means value is 1; 1flood/2years means value is 0.5.

For year wise flood intensity zoning two parameters have been selected namely 1. Flood water level height and 2. Flood stagnation period. Weighted composite score method has been employed to integrate the flood data for each affected mouza (small administrative land unit).

Integrated flood map has been prepared using three parameters namely flood level height, flood frequency and flood stagnation period. These indicators differ in their basic unit and their relative importance is also different. To change into comparable standard unit the standard score is calculated using weighted score method.

$$\text{Weighted score} = \frac{M}{n} \times 100$$

Where M = Maximum value of column; n = Number of variables

Weighted score values are added together to show the composite weighted score. On the basis of composite weighted score, the entire basin area has been divided into four broad flood zones namely (i) intensive flood zone (<50) (ii) moderate flood zone (50-100) (iii) low flood zone (100-150) (iv) no flood zone (>150).

Results and Analysis

Flood Frequency

Flood frequency means how many floods occur per unit period of time. Flood frequency depends on the frequency of downpour in basin area, controlled discharge of water from dam or barrage etc. Flood frequency is maximum in the confluence catchment and Kopai Brakeswar confluence area. Hizole wetland and Laghata wetland supports water stagnation in the said consecutive two places.

In the confluence area average flood frequency is 1/year. Sometimes it is also noticed that flood frequency surpasses once a year. For example, during 2007, three consecutive floods were lashed in the Kuya confluence zone. Out of total basin area, 19% basin command area is claimed by severe flood intensity.

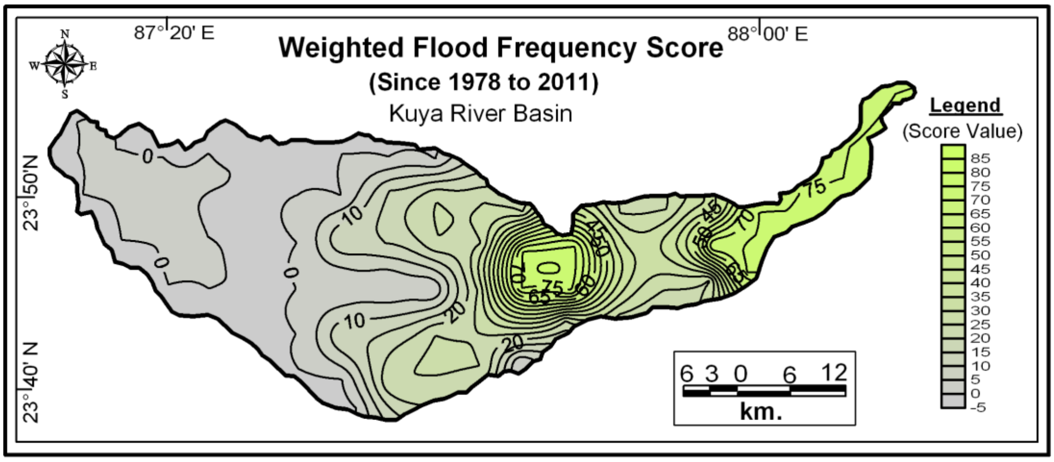

Fig. 2

Weighted score of the flood frequency since 1978 to 2011 as much the data were available reflects that weighted score of the flood frequency is high in the confluence area and the confluence of the major tributary. Supply of huge water carried by Brakeswar and linked canal water from Mayurakshi canal command area intensifies flood condition in the downstream.

Flood Affected Area

Table 1 clearly shows that flood affected areas have been decreasing over time. But if relative rate of flood affected area in respect to available rainfall is analyzed, it would be found that flood affected area has been increasing. In last century 1978 flood year was the greatest in as per flood extension and damage records. But flood year 2000 has broken down all the previous records and accounted the most extensive flood character. Figure 3 and 4 respectively show the status of most intensive flood limit and maximum flood affected limits in different years. It is noticed that flood 2000 not only submerged the lower basin but also inundated extensive part of middle catchment. Intensive flood is confined principally within wetland tract (Laghata-Langalhata-Hizole wetland) of this basin.

Table 1: Distribution of Flood Affected Area

Flood zone	**1978**		**2000**		**2007**		**2011**	
	Area (km^2)	**%**	**Area** (km^2)	**%**	**Area** (km^2)	**%**	**Area** (km^2)	**%**
Flood affected zone	692.14	44.51	706.05	45.4	551.29	35.44	537.84	34.56
No flood zone	863.06	55.49	849.13	54.6	1001.91	64.42	1017.36	65.41

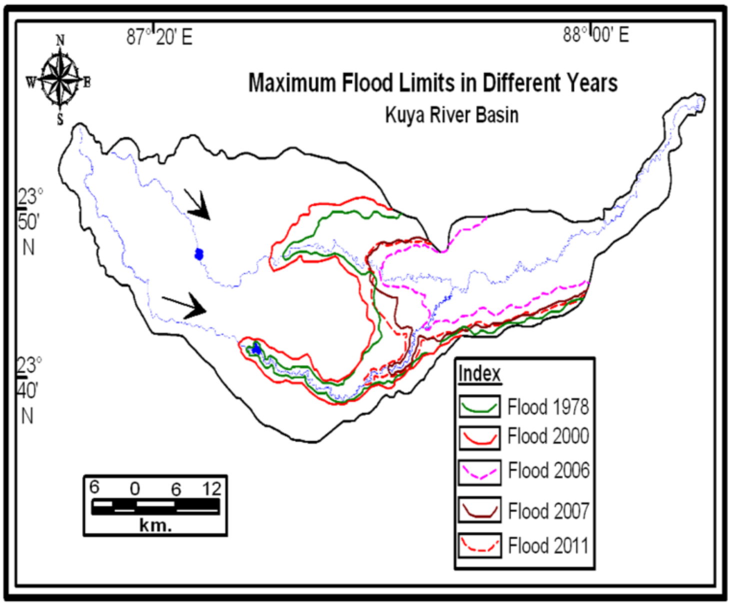

Fig. 3

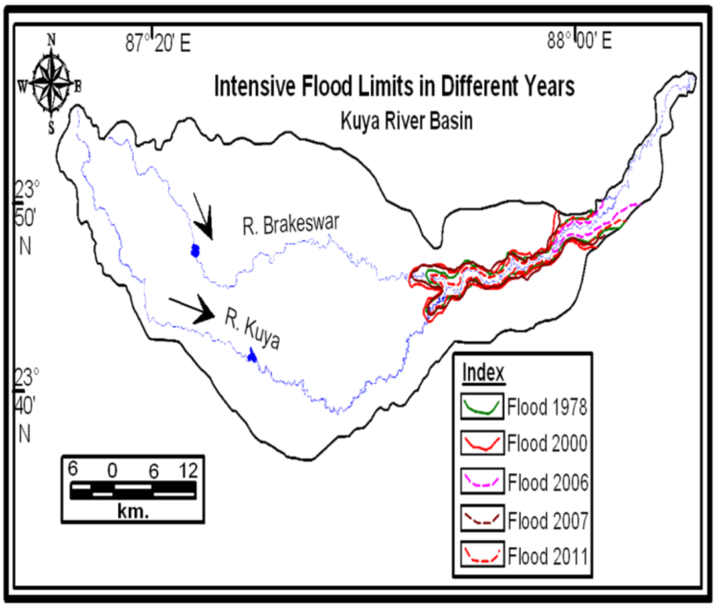

Fig. 4

Flood Stagnation Period

Flood stagnation indicates how long flood water remains stagnant in a particular area. Where there is poor system of water through passing, depressed land, poor drainage, very gentle slope, meeting large number of tributaries within very low range of area, flood stagnation period will be high.

In lower catchment area of Kuya river basin the period of flood stagnation sometime more than 10 days. The tendency of stagnation is relatively greater in right hand catchment of the lower basin. In upper catchment area as there is significant slope and highly accessible channel for draining of water, so the stagnation period either marginal or completely nil.

During flood 2000, the stagnation period was as long 14 days at the downstream catchment of the basin and long durated stagnation is confined within the wetland tract and neighbourbing land. Large volume of rainfall and discharged water from associated dams and barrages are mainly responsible for long stagnated water.

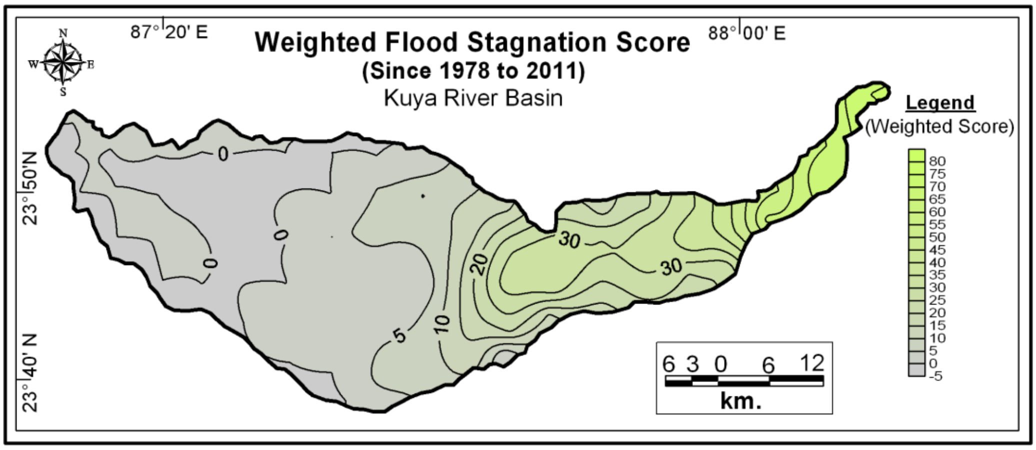

Fig. 5

Flood Water Height

Flood height is the function of volume of discharge, topographical character, period of water accumulation, etc. The region where the height of flood is more, possibility of flood devastation is also high. All over the basin area generally flood character is not similar because of topographical differences, differences in hydrological density etc.

In Kuya River basin the maximum flood height is noticed at the confluence area where flood height is more than 1.4 m. Depressed land, long water stagnation period etc. are influential factors for such greater flood height. In the upper catchment area, flood height is nil because there is no sign of flood. Average flood water height map including flood height of major floods show the spatial pattern of flood water depth. On an average about 12-15% of the basin area is affected by >1m. flood water height. Individual year specific flood height map shows some differences in flood height. For example, during flood year 2000, flood water height was as maximum as >1.5m. in the confluence zone.

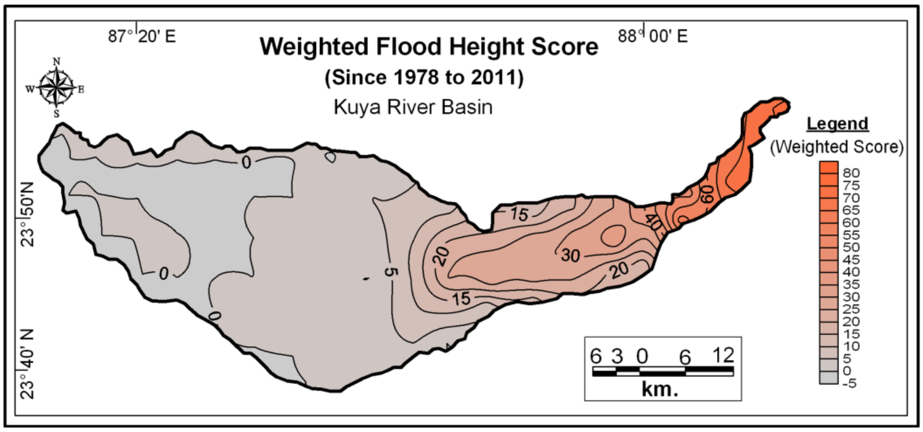

Fig. 6

Flood Year Specific Intensity Analysis

Flood Intensity during 2000

During 2000 the most devastating flood has been recorded in Kuya River basin. The main causes for such intense flood in 2000 were huge amount of downpour with very short span of time, discharge of large amount of water from barrages all on a sudden, bringing of huge amount of water by tributaries to the main river, poor drainage condition etc. About 155 mouzas were affected by the flood which is about 44.65% of the total basin area. Gross records of loss including lives and properties was maximum during flood year 2000.

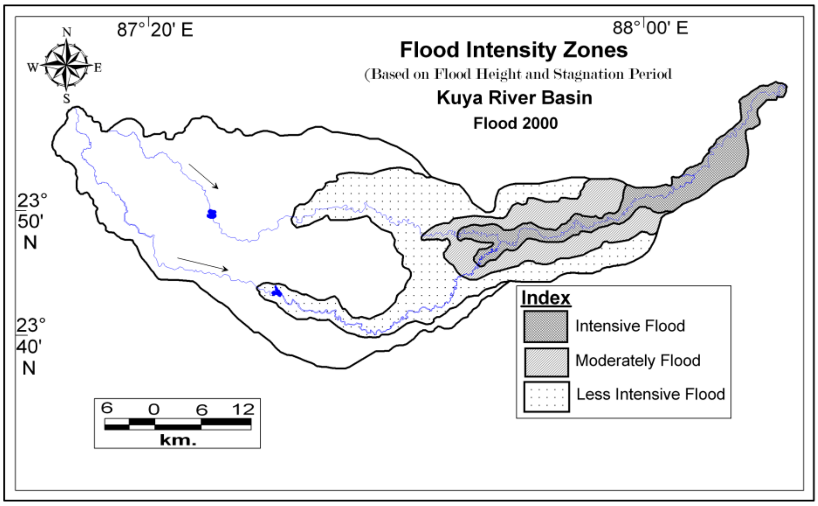

Fig. 7

Table 2: Area within Different Flood Intensity Zones, 2000

Flood zone	Composite Score	Area	% to total area
Intensive flood zone	<50	174.18 km^2	11.2
Moderate flood zone	50-100	150.85 km^2	9.7
Low flood zone	100-150	381.02 km^2	24.5
No flood zone	>150	849.13 km^2	54.6

Flood Intensity during 2011

Flood 2011 is the repetition of flood 2007. About 130 mouzas were fully or partially affected by the flood during this year which is about 34.59% of the total Kuya River basin. All the mouzas of Murshidbad district within Kuya river basin is severely affected by flood and most of the mouzas are lying within intensive flood zone.

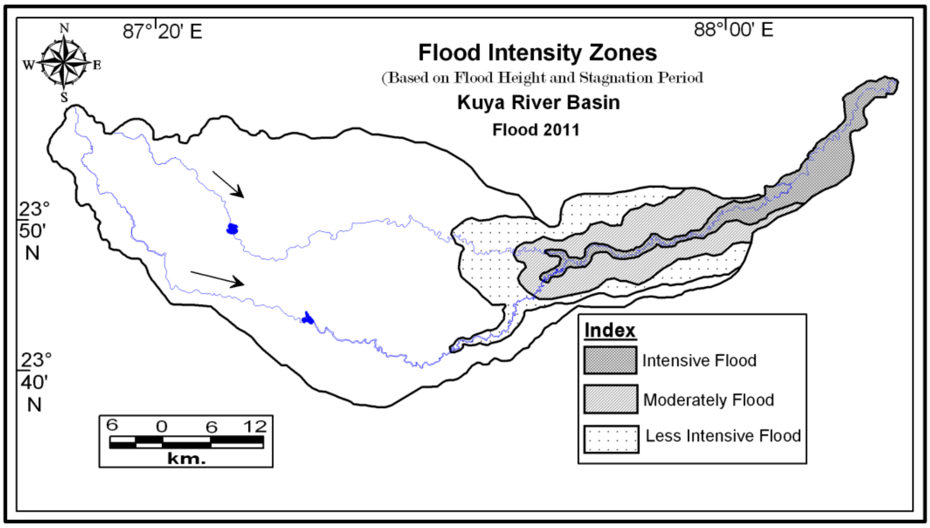

Fig. 8

Table 3: Area within Different Flood Intensity Zones, 2011

Flood zone	Composite Score	Area	% to total area
Intensive flood zone	<50	151.27 km^2	9.72
Moderate flood zone	50-100	153.32 km^2	9.85
Low flood zone	100-150	233.25 km^2	14.99
No flood zone	>150	1017.36 km^2	65.41

Integrated Flood Intensity Zones

Integration of different parameters for the measurement of flood can provide a detail picture of spatial flood character at a glance.

Intensive Flood Zone

Basically the confluence catchment area of Kuya River basin counts under intensive flood zone. Almost all the mouzas of Kandi block, Bharatpur block are experienced by intensive flood. Parts of Mouza no. of 40, 52, 99, 98, 43, 41, 56 etc. are ghastly lashed by flood damage. Total area of intense flood zone is about 330.79 km^2 (21.27% of the total basin).

Low lying topography, wetland like character, poor drainage system, convergence of large number of meso level rivers etc. are mainly responsible for intensive flood.

Moderate Flood Zone

Relatively upper part of Kuya River basin specially the western part of Murshidabad district, eastern part of Birbhum district come under this category. Total area of moderate flood coverage is 331.25 km^2.

Extensive river command area, convergence of meso rivers (twin tributary Brakeswar), deposition of river bed, influx of water from the other river basin etc. are mainly responsible for the nature of flood in this zone.

Table 4: Distribution of Flood Affected Area

Flood zone	Composite Score	Area	% of area to total
Intensive flood zone	<50	330.79 km^2	21.27
Moderate flood zone	50-100	331.25 km^2	21.30
Low flood zone	100-150	347.43 km^2	22.34
No flood zone	>150	545.71 km^2	35.09

Low Flood Zone

In relatively upper part of this river basin specially the some parts of western Birbhum district comes under this flood zone. Total areal coverage is 347.43 km^2.

Relatively greater degree of slope, high relief less dense population, less cropping intensity, all are responsible for low flood and marginal flood loss.

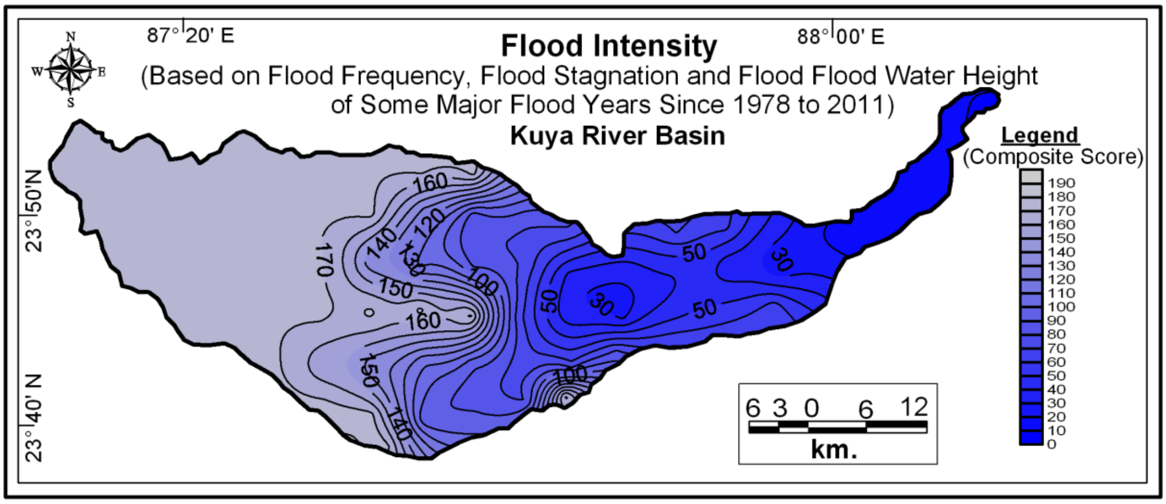

Fig. 9

No Flood Zone

In extreme upper portion of the catchment area where there is no large and broad river, surface flow is more common than any channel flow the occurrences of flood is almost nil or rarely found. For example in the memorable flood history, only during flood year 2000, some portion of no flood zone was marginally affected. Total coverage of this kind of no flood zone is 545.71 km^2 sq.km.

From the above analysis, it is found that flood intensity is very high in the confluence area of Kuya river and the confluence area of Brakeswar river. Out of total basin area one fifth of the basin is highly flood affected. Analysis of flood for some major flood years helps to conclude that flood intensity zone and flood intensity scale have been declining over time. Less volume of rainfall is the principal cause behind such deceleration of flood.

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