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***Research Article***

# FLOOD INTENSITY AND POTENTIAL FLOOD LOSS ESTIMATION IN DWARKA RIVER BASIN OF EASTERN INDIA

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## ABSTRACT

This paper aims to show the flood intensity, flood allometry and flood trend in Dwarka river basin. At the same time how flood carries potential flood loss on the flood plain areas. Results shows that flood intensity is high in the confluence of Dwarka river and the confluence of its major twin tributary. Flood allmetry is gaining and trend is high in the confluence area of major tributary ‘Brahmani’ due to potential supply of water from two rivers and often huge water from Deucha barrage and Baidhara barrage. About 50% of the basin area is frequently affected by flood. Out of total seven severe flood affected blocks, five blocks are highly developed from over all resource points of view. So, there is collision between flood rise and resource potentials. Along with loss flood also carries some benefits for the concerned regions and promote agricultural production and ecological sustainability.

***Key Words:** Flood Intensity, Flood Allometry, Flood Trend, Potential flood Loss, Cost Benefit of Flood*

## Introduction

River basin is one of the most important and lucrative habitat of human being. Within a basin a large set of hydrological phenomena has been working on in its own way. Over pressure of population and their behavioural change has been altering the normal pattern of hydrological phenomena Mukhopadhyay and Pal (2009). As per normal law people again has been getting back its negative result. One of the most important modified hydrological phenomena in Dwarka river basin is flood.

Once a time flood was seemed to be beneficial for human civilization when fertile silt carried out by the rivers enriched the production ability of an agriculture land and flood phenomena was fruitfully rhythmic in manner. But now a day due to desperate invention of human being through construction of dam, across river, embankment along river to draw immediate profit from river the intensity of flood has increased many times and it carries huge sand instead of fertile silt and now flood is considered as human fears. As a result, problem of flood today become great challenge to our society, economy as well as sustain the status of development. Prof. M.N.Saha (1935) was also concerned about the obnoxious effect of dams and embankments on the hydrological character of the rivers while explaining the causes of the flood problems of Bengal (Collected Works of M.N.Saha Vol I). Sir William Wilcox (1930) while dealing the flood problem of lower Damodar accused the river side embankments as the ‘Satanic chains’.

Flood loss potentiality refers to the estimated total loss is claimed by flood. Estimation should be done using major properties of the land concerned. Major properties mean human lives, domestic resources, land properties, agricultural properties, settlement, road, fisheries etc. All kind of losses have not been quantified in monetary cost due to lack of proper quantifying standard base. But it is true enough that if parameters are shown in respect to flood claim area, it will help one to understand what will be the cost.

This paper aims to examine the flood intensity zones using major flood periods, allometric trend of spatial flood growth and estimate spatial pattern of aggregate development including agricultural, settlement, domestic, fishing and other infrastructures. With the help of comparative analysis between flood intensity and aggregate development, estimation of potential flood loss will be done.

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### Study Area

The Dwarka River - a tributary of Mayurakshi is a well known name in the river atlas of Rarh Bengal including parts of West Bengal and Jharkhand states of India. Originating at Kushpahari of Santhal Parganas of Jharkhand it has been flowing through Mayureswar and Rampurhat police station areas of Birbhum district and ultimately joins the Mayurakshi near Hizole wetland in Kandi Police station of Murshidabad district, West Bengal.

Its basin area can be delimited by 23°58' to 24°29' North latitudes and 87 °18' to 88°12' East longitudes covering an area of 3500.76 km$^2$. Total length of the river is 156.54 km.

Administratively, the study region includes Pakur and Dumka districts of Jharkhand and Birbhum and Murshidabad districts of West Bengal and 12 CD blocks of the same districts.

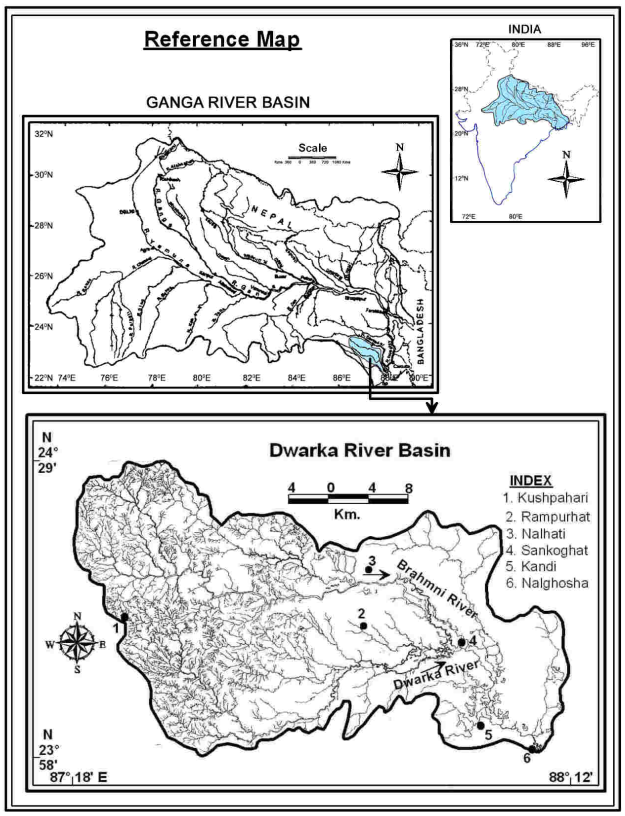


**Figure 1: Location Map of the Study Area**

### Materials and Methods

Flood data has collected from Sechpatra of different years, Government Flood Relief offices, empirical field survey and the response of the basin dwellers.

On the basis of the data collected from statistical hand book of different districts, Economic Review, West Bengal, Human Resource Development Report, District Census Book etc. qualitatively the aggregate development has determined.

According to Magura and Wood (1980) hazardous flood event may be judged by characteristics such as magnitude, frequency, velocity, affected area, speed of onset, and duration. Integrated flood intensity map has prepared using three parameters e.g. flood level high, flood frequency and flood stagnation period. Total Basin has subdivided into 67 grids and analysis of data has done accordingly. Weighted score method has applied to estimate the variability of flood intensity in different parts of the basin.

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

Where M = Maximum value of column
N = variable

Allometric growth means proportional growth of all limbs of the body over time. This word is borrowed from biology. Here allometric growth has implied to measure the overall growth of flood height and flood stagnation. In this calculation, in respect to gross pattern of flood growth, how flood of each and every individual sub regions are growing over different time frames altogether has analyzed. *Power regression law* has applied for this kind of calculation. If allometric value is 1 which means there is no disparity of flood growth between total basin as a whole and individual sub region in particular; <1 means growth rate in sub region is less; >1 means sub region grows with faster rate in compare to growth in total basin. Flood records (flood level height and flood stagnation) of seven major flood years 1978, 1984, 1995, 1998, 2000, 2006 and 2007 have incorporated for predefined 67 grids of the basin (sub region).

Trend of flood has measured using simple least square trend equation.

Aggregate development of different region has done using 36 relevant developmental parameters. These parameters have taken from demographic, settlement, agriculture, resource quantity and quality etc. grounds. Population density, total population, number of educational institutions, banks, main road density, rail road density, factories, settlement density, gross area of fisheries, net sown area, gross crop area, agricultural productivities for different crops, cattle density and so many others parameter have included to measure the degree of development. Taxonomic method has employed for assessing the level of development. Greater composite index means level of development is less and vice versa.

In this method the indicators were made scale free by converting them into standardized values, where,

*Z is Xij — X^/ Sj*

where t = 1, 2, 3,.. n districts

*j* = 1, 2, 3,..., 36 indicators

and $X^{\wedge}$ and *Sj*, were the mean and standard deviation respectively for each indicator.

In the next stage an ideal state for each indicator was identified by taking the highest standardized value of that indicator. And subsequently the deviation for each district was taken for indicators. After this, the pattern of standard of living of each district was determined through the following formula:

$$P_{io} = \sqrt{\sum_{p=1}^{K} (Z_{ip} - Z_{op})^2}$$

Where $P_{io}$ = Pattern of development for the $i^{th}$ district.

$Z_{ip}$ = the standardized value of the $i^{th}$ district and $k^{th}$ indicator.

$Z_{op}$ = the highest standardized value of the $k^{th}$ indicator.

## RESULTS AND DISCUSSION

### Flood Intensity

On the basis of said methodology, integration of flood parameters has done and resulted score has been classified four broad flood zone namely (i) intensive flood zone (>240) (ii) Moderate flood zone (80-240) (iii) low flood zone (<80) (iv) no flood zone (0).

Basically the confluence catchment area of Dwarka River basin counts under intensive flood zone. Almost all the mouzas of Kandi block are experienced by intensive flood. About 32 mouzas of lower catchment is ghastly lashed by flood damage. Total area of intense flood zone is about 207.40 $km^2$. Moreover, eastern part of Birbhum district is also significantly damaged by flood ferocity. In extreme upper portion of the catchment area where there is no broad river, where surface flow is more common

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than any channel flow the occurrences of flood is almost nil. Total coverage of this kind of no flood zone is 1554.28 sq.km.

**Table 1: Distribution of Flood Affected Area**

| Flood zone | Area | % of area to total |
|---|---|---|
| Intensive flood zone | 207.40km$^2$ | 5.81 |
| Moderate flood zone | 898.51 km$^2$ | 25.17 |
| Low flood zone | 909.57 km$^2$ | 25.48 |
| No flood zone | 1554.28 km$^2$ | 43.54 |

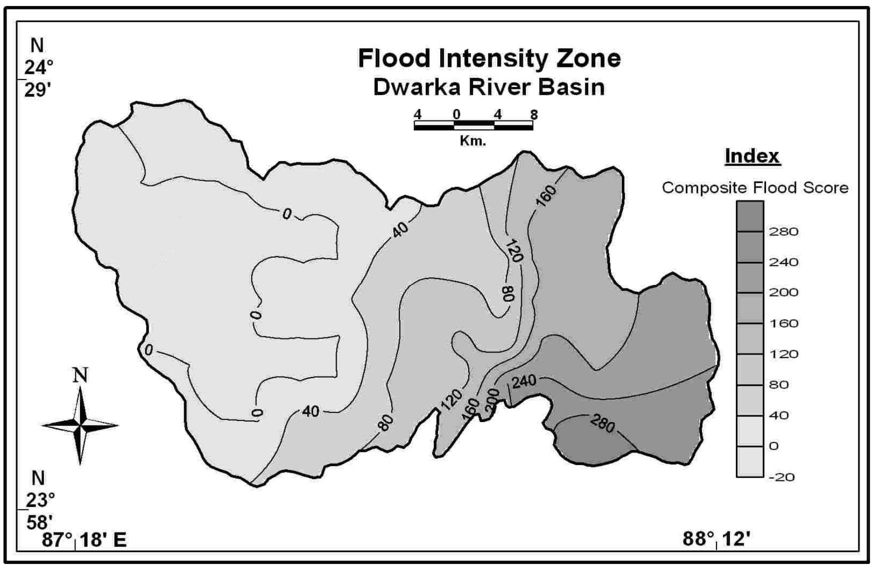


**Figure 2: Spatial Zonation Map of Study Area According to Flood Intensity**

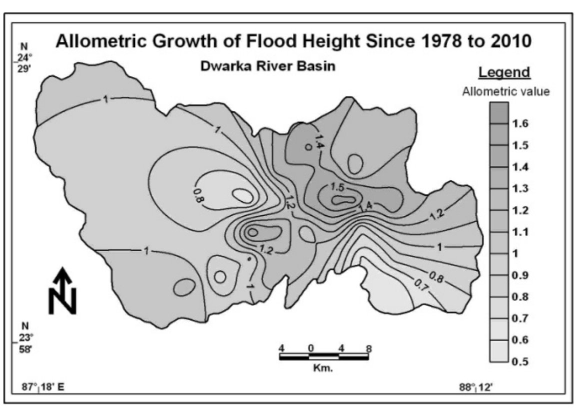


**Figure 3: Flood Gaining or Loosing Tendency over Time**

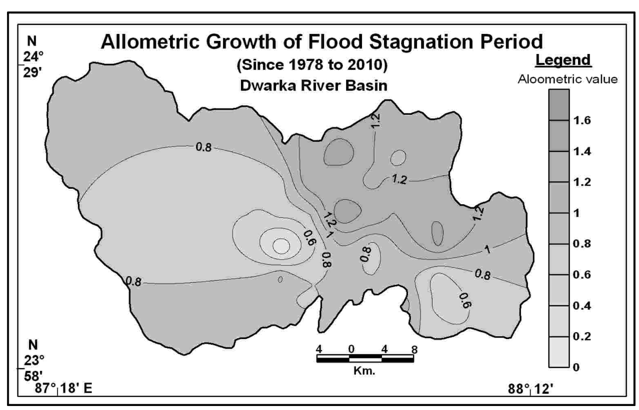


**Figure 4: Spatial Growth Pattern of Flood Stagnation**

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**Spatial Pattern of Allometric Growth of Flood Height and Stagnation Since 1978 to 2007**

At the confluence area of Dwarka river flood height and flood stagnation were more right from the beginning because this portion is a depressed wetland. But at the confluence area of Brahmni, the rate of flood growth is significantly high as cumulative discharges of both Dwarka and Brahmni rivers jointly spit flood fury in this area. Upper part of the basin is defined by 1 value because flood level and stagnation duration were 0 for all the seven years.

**Spatial Trend of Flood and Flood Projection**

Flood records (flood level height and flood stagnation) of seven major flood years (1978, 1984, 1995, 1998, 2000, 2006 and 2007) have incorporated for predefined 67 grids of the basin to predict spatial flood trend. So now prediction and projection of flood have done individually for each grid. This analysis will provide detail idea about spatial flood trend behaviour.

**A. For Flood Height:**

Results say that flood level height has been increasing slowly over time mainly in the confluence area. But, the region where the main tributary Brahmni river influxes with Dwarka river flood accretion is significantly high. From the last 40 year's record it can be said that flood level will not be raised up outstandingly high in very immediate future. A few sporadic isolated patch of the basin is observed under low flood intensity zone where flood rise tendency is significantly high. Rise of flood level does not prove that it is rain staking rather it is due to gradual degradation of drainage quality.

**B. For Flood Stagnation:**

In comparison to flood level rise, increase of flood water stagnation period has been mounting over time. Flood year 2007 was less significant than flood year 2000 in discharge magnitude and rainfall volume point of view but duration of flood stagnation was high. It is because of upheaval of the river bed level, wetland bed level and resistance provided by external drainage against free influx of water. In the confluence area the flood stagnation days has been lingering in very significant rate. In the wetland area the rate is remarkably increasing.

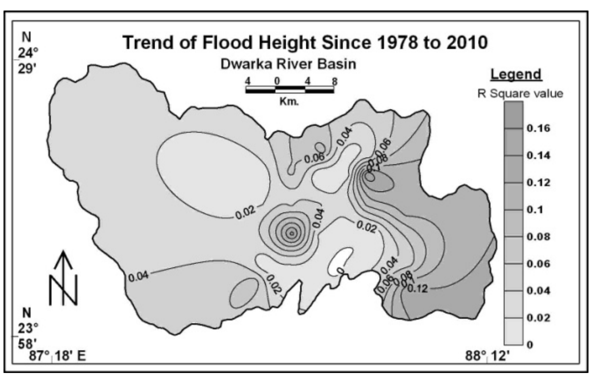


**Figure 5: Flood Height Map**

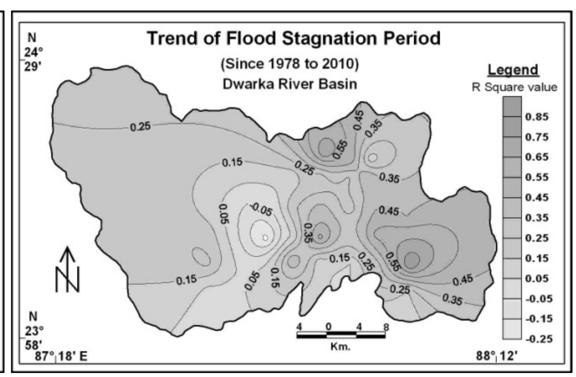


**Figure 6: Flood Stagnation Map**

**Aggregate Development by Taxonomic Analysis**

Spatial pattern of agricultural development shows that the downstream and middle catchment areas are the most develop part of the basin. Fertile agriculture land, location of town or semi town type settlements, high population density, good infrastructure etc. are providing enough scope for overall development or resource potentials.

As most part of the basin is comprised with main river and its twin tributary Brahmni river, so the region where the level of development is more, the flood loss potentiality is also more and vice versa. Gravity point of settlement, population etc. are encroaching toward modal flood zones (Pal, 2011). Out of total, seven blocks are existing within exceptionally high flood loss risk potential areas (Fig. 2 & 7 ). Out of

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seven high flood prone blocks, five are highly developed and two are moderately developed blocks. So, from these findings one could easily predict the vulnerable conditions of the existing material and immaterial resources within flood prone zones. Upper catchment is not normally flood infested therefore, chance of land, life and property loss is either nil or minimum due to this calamity.

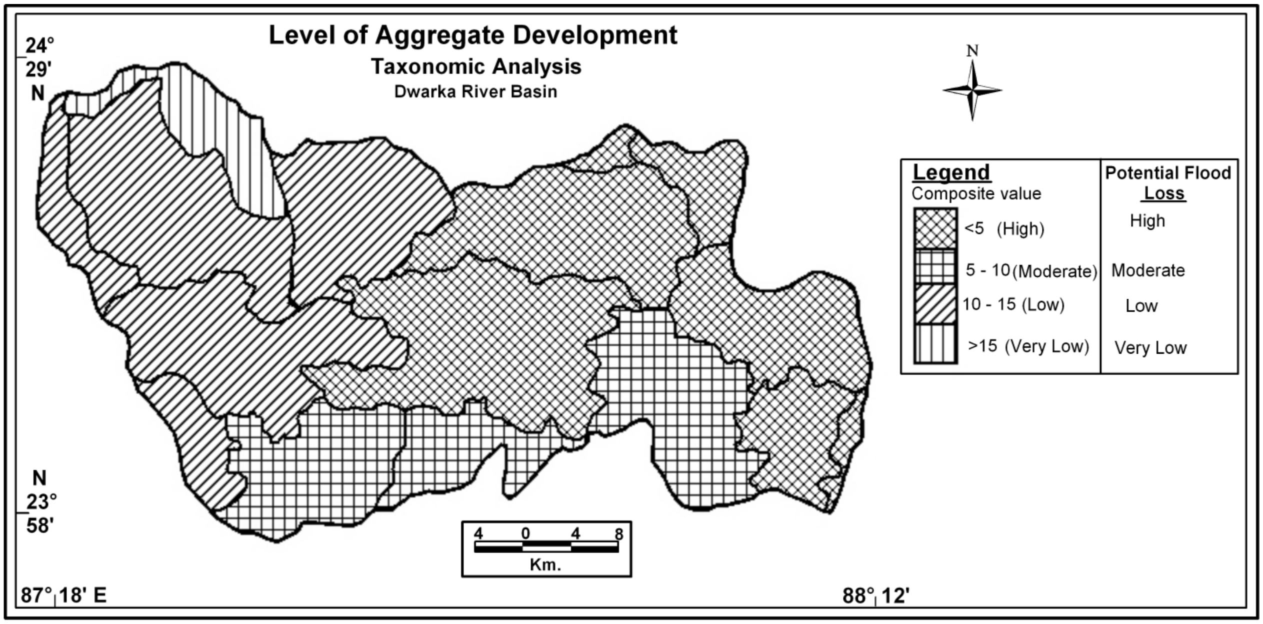


**Figure 7: Spatial Pattern of Aggregate Development**

**Estimation Cost Benefit of Flood**

It is difficult to estimate cost claimed by flood and benefit yielded by the same, because large numbers of estimating parameters are difficult to quantify. Similarly, in the country like India no such proper quantitative and qualitative measurement is done till now. In Dwarka river basin any big flood claims about 50% agricultural land and most of the cases loss is more intensive in lower part of the basin. In the block like Khargram, Kandi, Nabagram. Sagardighi, Berhampore etc. flood claims more than 80% of the agricultural land entirely and rest 20% land produces only about 30-45% productivity on that kharif season in compare to normal level of productivity. In the blocks like Nalhati, Rapurhat, Mahammadbazar etc. flood devour 45% agricultural land and rest 55% land produces 50 to 55% production than normal. In this way if calculation is executed for entire basin. Total agricultural loss in current price during kharif season is approximately $5,0000000 to 6,0000000.

Apart from agricultural loss, loss of fisheries, paralyzing of land due to sand cover for next few years, sand spread on agricultural land and qualitative degradation of soil, loss of embankment, road, buildings, domestic animals etc. also bring colossal failure in economy. If a rough and average estimation can be done the value will be $7,0000000 to 85000000.

In return flood encourage better rate of productivity for rabi crop on that year. The productivity level in post flood period increases up to 14% than the normal. But these are limited within lower reach of the basin, more specifically the silt spilled land. Mention worthy, J. Marlowe (1966) has stated the benefits of floods on the life and prosperity of the Nile river valley. Due to natural fertility renewal, kharif production specially paddy increases up to 7% in consecutive two years. In the confluence area farmers used very marginal amount of chemical fertilizers in after flood years. Flood water encourages greater ground water recharge. Recharge estimation results that in flood years according to nature of rainfall intensity and ponding time of flood, volume of recharge increases up to 5 to 12% than non flood year. Flood boosts up flood plain ecology and better survival of wetland hydrological cycle and riparian ecology overall ecological sustainability. If all these beneficial aspects turn into monetary form, it will subsidized flood loss to some extent but will not definitely compensate all the loss incurred in present flood.

**Conclusion**

The sufferers of the flood are encroaching toward the flood zones indicate that people find something benefits from flood prone zone. So, any plan in aim to restrict flood will not be any wise step. Rather planning should be formulated with flood and flood plain dwellers. It will be better to subsidize ensuing flood irregularities ensuring resilience of the traditional flood rhythm as much as possible. Change of cropping pattern in accordance with flood intensity to some extent can help to reduce the level of flood loss. Basically, flood occurs in this area during September and October month. So, this period should be lean or some flood withstanding crops could be cultivated. Settlement should be made either very concrete or just like portable house. These kinds of adjustments may ensure less flood loss.

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