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Flood Frequency Analysis of Subrnarekha River

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***Abstract:* -- Floods are plausibly the most revenant, far-flung, disastrous, and frequent natural hazards of the world. India is one of the worst flood-affected countries. The problem of flood in the Indian state called Odisha is well known and every year it becomes a recurring problem to the entire region. This paper is centred towards the Subarnarekha River which is an inter-state river and at the South of Dantan it enters the Balasore district and finally falls into the Bay of Bengal near Kirtania, Odisha. However, it is also among the most susceptible areas in India which are prone to flooding. Flood forecasting & flood warning, flood hazard mapping and flood risk zoning are quite effective non-structural procedures in managing floods that decreases the risks and disasters floods may cause. This study introduces the parameterization of hydrologic modeling for simulation of runoff and Arc GIS software for mapping. Various analysis of hydrological data has been done to look for the rainfall and runoff behavior in Subarnarekha Basin and their cross-correlation. With the help of GIS, various maps like digital elevation map, flow accumulation map and land use/land cover map have been generated for further modeling.**

***Keywords*: - Digital Elevation Map (DEM), Flood hazard mapping, Geographical data systems (GIS), Hydrologic modeling.**

I. INTRODUCTION

Globally, floods area unit viewed as a result of the greatest damaging of all naturally caused disasters. Usually this can be often nominal by knowledgeable flood losses that exceed simple fraction of the calculated total worth related to all disaster events triggered by natural hazards. Floods square measure generally caused by serious downfall with deep depressions (low pressure) and cyclones in areas having lean evacuation. The perceptible and unperceivable losses because of floods in India square measure increasing remaining to the fast growth of population and inflated developments of the flood plains for habitation, agriculture and completely different process activities. This paper tries to estimate come periods related to flood peaks of various magnitudes from recorded historical floods using method. Flood inundation downside in Subarnarekha stream is of main important to mining firms. Geographical data systems (GIS) based techniques wide use for analysis, planning and framing of evacuation strategies. Flood frequency analysis involves the fitting of a likelihood model to the sample of annual flood peaks recorded over an amount of observation, for a structure of a given region. The model parameters established will then be used to predict the acute events of huge return interval (Pegram and Parak, 2004) Reliable flood frequency estimates area unit important for champaign management; to guard the public, minimize flood connected costs to government and personal enterprises, for planning and locating hydraulic Structures and assessing hazards associated with the development of flood plains (Tumbare, 2000). However, to determine flood flows at completely different return intervals for a site or group of sites could be a common challenge in hydrology. In the present work, HEC-GeoHMS and Arc GIS models have been used for rainfall-runoff modeling and to obtain the flood inundated areas in Subrnarekha Basin.

II. STUDY AREA

The Subarnarekha stream is one in all the main north-east flowing rivers within the dry land India, the basin is delimited by the Chhotanagpur highland on the north and therefore the west, by the ridges separating it from Baitarani basin on the south, by the Bay of geographic region on the south-east and by the Kasai river natural depression of Kangsabati River on the east. The Subarnarekha basin extends over States of Jharkhand, Odisha and relatively smaller part in West Bengal having a complete area of 29,196 Sq.km with a most length and dimension of regarding 297 kilometer and 119 kilometer. It lies between 85°8’ to 87°32’ east longitudes and 21°15’ to 23°34’ north latitudes.

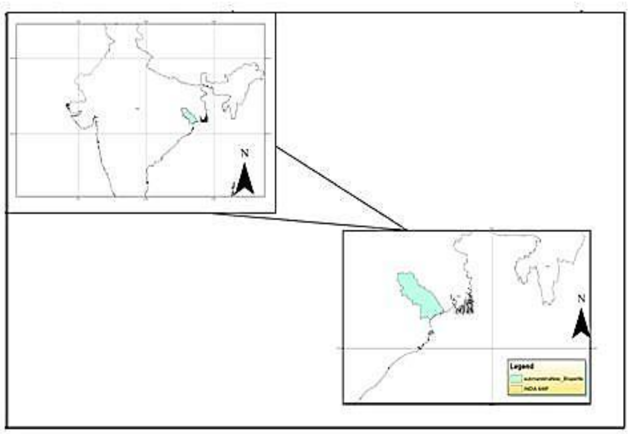

Fig.1 Study area of Subarnarekha River Basin

A. Soil-

Soil has four important properties namely texture, erosion, slope and its productivity respectively. Further texture is classified into four groups such as fine, medium, coarse and rocky. The slope map shows that only 3% of the soil has steep slope. Around 43% is nearly leveled and 40% is gently sloping. Out of the basin area for which data is available, around 20% which is under deltaic area is highly productive and 17.21% of area is moderately productive.

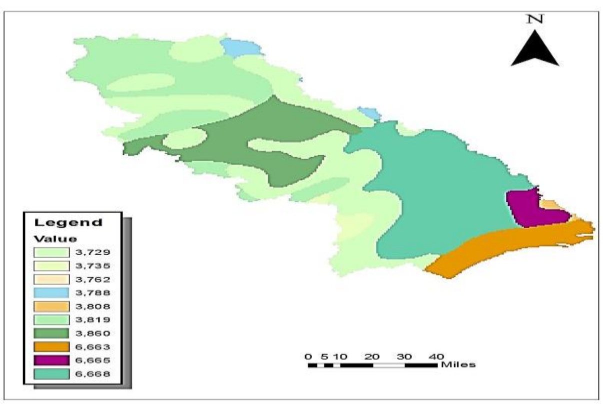

Fig. 2 Soil Map of Subrnarekha River Basin

B. Land Use/ Land Cover

Agricultural land covers the major part of the basin (54%) followed by forested area (30%) which is mainly dominated by deciduous forests. The presence of alluvial soil in the basin attributes to extensive agriculture in the lower reaches of basin. The land use/ land cover in the region has not undergone very significant changes over the last decade with agriculture and forests covering the major part of the region. The built up area (8%), water bodies (2.5%) and barren land (5.5%) are the other main categories of land use/ land cover of the area.

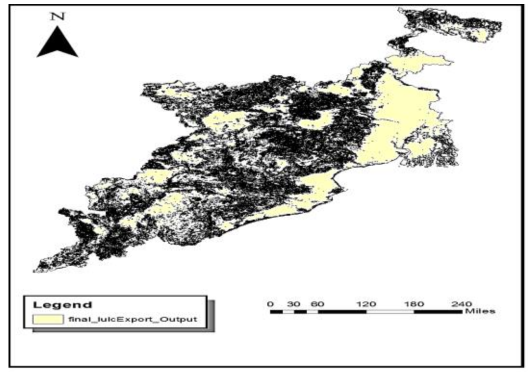

Fig. 3 Land use land cover Map of Subarnarekha river basin

III. METHODOLOGY

Meteorologic model in HEC-HMS is that the major component that's liable for the definition of the meteorological boundary conditions for the sub basins. It includes precipitation, evapotranspiration and snowmelt ways to be utilized in simulations. Digital Elevation Model is that the geographic grid of a region wherever the contents of every grid cell provides an outline of the elevation of any purpose at a given location and specific abstraction resolution in type of a digital file. It's one among the essential abstraction inputs essential for delineation of watershed in to variety of sub basins on the idea of elevation in HEC-HMS model. during this work, a DEM map of 1:50,000 scale and a 30m x 30m resolution has been obtained from SRTM digital elevation knowledge created by NASA originally in type of tiles from the planet knowledge base.

A. Basic Modeling Methods for HEC-HMS

For each model component, HEC-HMS offers of type of strategies to calculate the hydrological response to input file, as well as precipitation. This section can introduce the strategies obtainable for each model component. Only those strategies chosen for this study are going to be mentioned very well.

B. Sub-basin parts strategies

Surface technique – represents the bottom surface wherever all water accumulate in depression storage areas. Web precipitation accumulated within the depression storage areas additionally as infiltration of the soil has that has the capability to just accept water, thereby reducing the precipitation obtainable for direct flow.

Loss technique – loss technique uses infiltration calculations. Twelve totally different loss strategies are obtainable. One of that was investigated to be used in study. They're the Soil conservation service (SCS) Curve number (CN).

C. SCS-CN Loss Method

The sub-basin SCS CN rule of thumb, HEC-HMS calculates the progressive precipitation around a success by re-calculating the infiltration non-fiction at the accomplish of every predate interim supported the CN and % secure area of the sub-basin. The competition in every time interim in infiltration is that the divided loyalty in novel at the conclude of 2 adjacent time intervals. Runoff mistreatment the SCS CN technique is set by the subsequent equation:

$$Q = \frac{\left[P-0.2\left(\frac{1000}{CN}-10\right)\right]^2}{P+0.8\left(\frac{1000}{CN}-10\right)} \ldots\ldots [1]$$

Where Q is runoff (mm) and P is precipitation (mm) (NRCS, 1986). The SCS loss technique is meant for event simulations.

D. Reach Element Method

- **Routing Method**

Routing is procedure to predict the changing magnitude, speed and shape of flood wave as s function of time at the points along the watercourse. Routing is classified into lumped and distributed. Hydrologic routing belongs to the lumped routing and Hydraulics routing belongs to distributed routing (Maidment, 1993). This study adopted the Muskingum routing method of hydrologic routing method.

- **Muskingum River Routing**

Muskingum routing is based on the storage-outflow relationship and relates the storage to both inflow and outflow. Muskingum routing method is represented as follow

$$S = \left(K(xI + (1-x)O)\right) \quad \ldots.. \quad [2]$$

$$O_2 = C_1 I_1 + C_2 I_2 + C_3 I_3 \quad \ldots\ldots \quad [3]$$

Where S=Storage, I= Inflow, O=Outflow

$$C_1 = \frac{0.5\Delta t - Kx}{K - Kx + 0.5\Delta t} \quad \ldots.. \quad [4]$$

$$C_2 = \frac{0.5\Delta t + Kx}{K - Kx + 0.5\Delta t} \quad \ldots\ldots \quad [5]$$

$$C_3 = \frac{K - Kx - 0.5\Delta t}{K - Kx + 0.5\Delta t} \quad \ldots\ldots \quad [6]$$

$$C_1 + C_2 + C_3 = 0 \quad \ldots\ldots \quad [7]$$

IV. RESULTS

A. HEC-HMS and HEC-GeoHMS Model

The input data required for modelings were downloaded, analyzed and delineated using Arc-GIS. SRTM 90m Digital Elevation Model (DEM) of the Subarnarekha Basin has been used as input data to generate HEC-HMS model input files in Figure 4. The Figure 5 represent map of basin catchment. Fill sinks, Flow direction, flow accumulation, stream definition and catchment grid delineation, catchment polygon, watershed aggregation, project setup, stream and sub-basin characteristics, HEC-HMS schematic maps are shown in Figure 6.

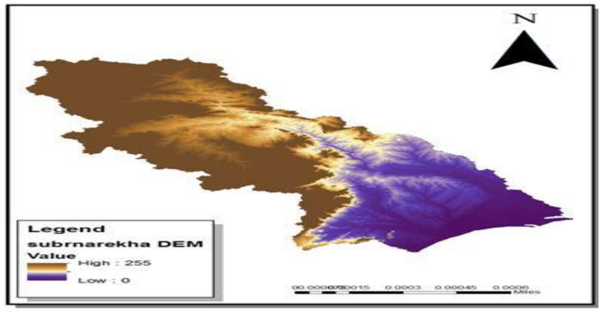

Fig. 4 SRTM 90m DEM Subrnarekha Basin River

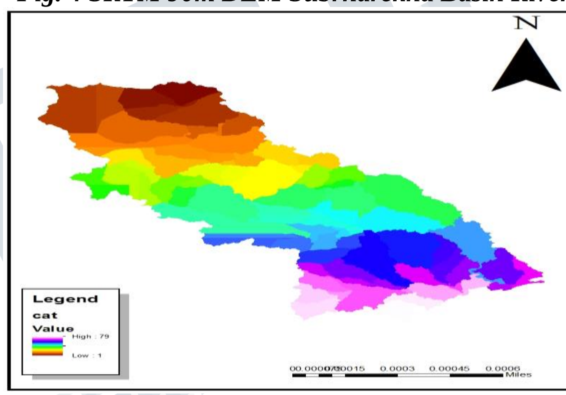

Fig.5 Basin Catchment Map

A. HEC-HMS MODEL

In this model open the project files created by Geo-HMS using HEC-HMS. After that the basin model and the meteorological model will be added to the watershed explorer in HEC-HMS. Then after expanding the basin model, it will show the schematic map. Then add the river and basin shape files in the watershed as shown in below and basin along with its sub-basins, streams, links and junctions as shown in Figure 6.

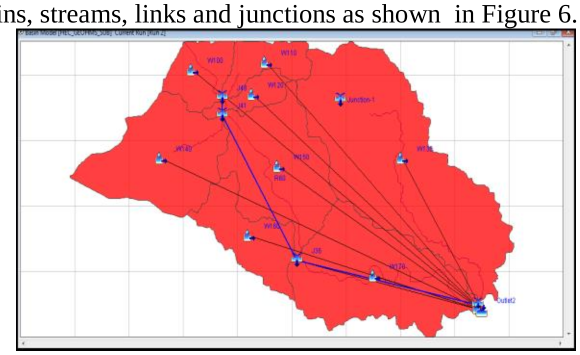

Fig.6. HEC-HMS Schematic Map (Basin Model)

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All this information, which is now independent of GIS, is extracted from attributes that has been created in HEC-Geo HMS. The Fig.7 to Fig.11represents different variations of flows and depths against the different sub-basins.

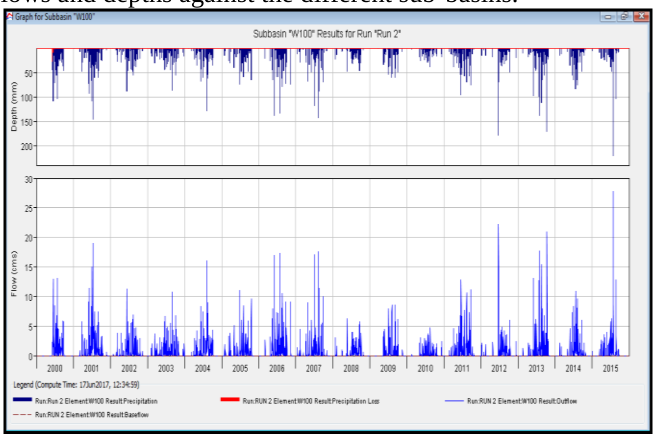

Fig.7 Graph of sub basin W100

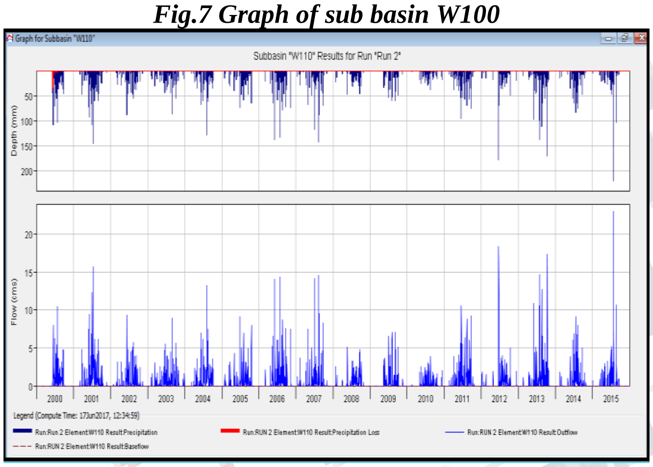

Fig.8 Graph of sub basin W110

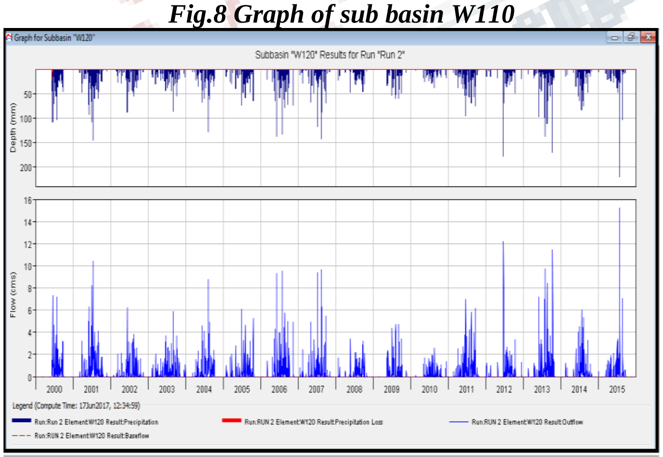

Fig.9 Graph of sub basin W120

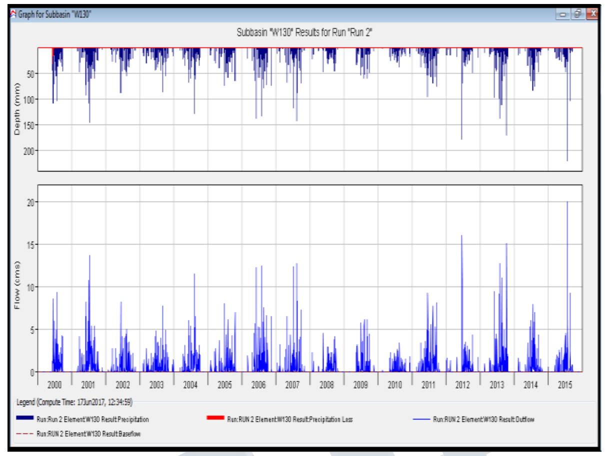

Fig.10 Graph of sub basin W130

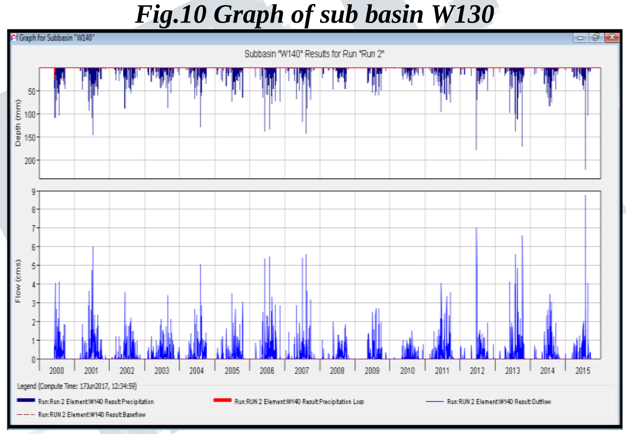

Fig.11 Graph of sub basin W140

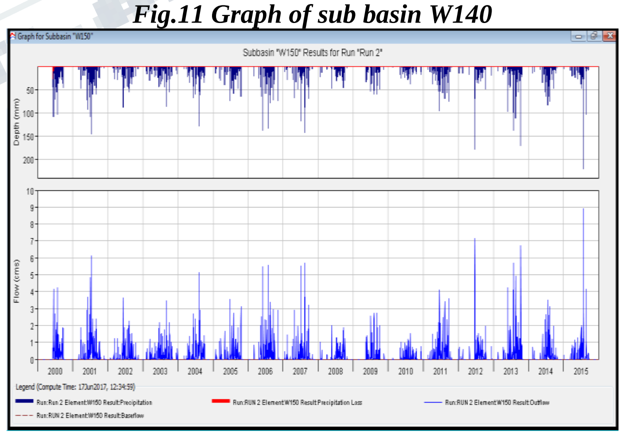

Fig.12 Graph of sub basin W150

V. CONCLUSIONS

ArcGIS, Arc Hydro and HEC-Geo HMS provide efficient and pragmatic environmental to calculate Hydrologic parameters that have spatial characteristic. Especially, Arc Hydro and

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HEC-Geo HMS provide easy and simple technique to treat the raster data for Hydrologic computing. Hydrological modeling (rainfall – runoff analysis) was successfully performed using HEC HMS computer software version 3.5. After developing the basin model component using HEC GeoHMS in ArcGIS environment, populating the meteorological model and defining the control specifications the model output results were the quantified runoff floods that resulted from input rainfall data.

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