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Delineation of Mahanadi River Basin by Using GIS and ArcSWAT

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Abstract: *Precipitation is the significant segment of hydrologic cycle and this essential wellspring of overflow. In hydrological models precipitation as information, release is mimicked at the outlet of a watershed. Exactness of release re-enactment relies on drainage zone of the watershed. Therefore in the present work Mahanadi river basin lying within Odisha (drainage area approximately 65000 sq. km.) has been delineated in to five sub-basins based on the five CWC operated discharge sites in Odisha. In the present work Arc-Swat has been used to delineate the watershed with the help of the (digital elevation model) DEM. At last as indicated by area of release locales, the aggregate study range was isolated into five sub-basins in particular Kesinga, Kantamal, Salebhata, Sundergarh and Tikarpada. It was observed that number of sub-watersheds into which the study area is being depicted relies on number of outlets and density of drainage. For a specific number of outlets, the thick is the density of drainage the more is the quantity of sub-watershed and the other way around.*
Keywords: *ArcSWAT, DEM, GIS, Runoff simulation, Watershed Delineation..*

I. Introduction

Evaluation, recreation and expectation of precipitation and comparing overflow are vital for stake holders and approach creators to arrange or receive the required strategies. There are different strategies accessible in the writing to evaluate, simulate and anticipate hydrological variables. Numerous hydrological models have been produced before (Singh 1989; Singh and Frevert 2006) for changes of precipitation into stream in view of simple accessibility of precipitation information for more eras at various areas. In a considerable lot of these models, soil conservation service curve number (SCS-CN) model has been broadly utilized for surface runoff calculations.3

II. Literature Review

Arnold et al. (1993) arranged a model named SWAT (Soil and Water Evaluation Apparatus) with the help of CN method and Geographic Information System. Utilizing SWAT he estimated runoff of Mississippi substantial catchment region. To evaluate the hydro-natural loss of precipitation water as surface runoff, needful topical layer of soil type of study zone is readied utilizing geographical study of India and LANDSAT-7 ETM+ (2006) picture is utilized for processing of land use/land cover classes of study territory. They utilized the Curve Number strategy for the estimation of runoff. At long last they got the outcome to set up an appropriate arrangement for the hydro-ecological losses held in the basin area.

Numerous specialists like White 1988; Stuebe and Johnston 1990; Chowdary et al., 2004; Pandey et al., 2008 utilized land use/land cover data got from satellite information of Landsat, SPOT, and Indian Remote Sensing Satellite (IRS) and incorporated them with GIS to calculate SCS-CNs and runoff. They have taken here the abstraction ratio according to the American study 0.2 which is the ordinarily taken or expected. As per Beven, 1985 the portrayal of the flow process in the various distributed Rainfall-Runoff models might be characterized into two fundamental sorts. One is the kinematic wave approach for simulating the direct flow and channel flow Abbott et al., 1986; Morris, 1980. The other is the conceptual storage approach Diskin et al., 1984; Beven et al., 1984. They concluded the significance of parameterization issues included while anticipating the watershed stream runoff.

III. Study Area

Mahanadi river is the second real stream in peninsular India after Godavari as for the water potential and surge delivering limit and is situated in East Focal India inside land co-ordinates of 80º30' to 86º50' E and 19º20' to 23º35' N (Figure 3.1). Mahanadi river basin is the biggest river of Odisha State and reaches out over an area of 141589 Sq Km. The river enters in Odisha through Jharsuguda district subsequent to covering about portion of its aggregate length. Before Sambalpur, it meets its tributary Ib. The Ib, which is the third biggest tributary of Mahanadi, ascends in town Pandrapat, Region Raigarh (Chhattisgarh) and channels Raigarh region of Chhattisgarh and three district of Orissa, to be specific Sundargarh, Jharsuguda and Sambalpur. After Sambalpur

Mahanadi Stream takes a southerly turn and it is joined by the Ong. The Ong flows towards Sartaipali, Padampur and Bijepur territory of Balangir and Bargarh areas of Odisha. The southernly turn of the river proceeds up to Sonepur, where it meets with its tributary the Tel. The Tel, which is the second biggest tributary of Mahanadi Stream and the biggest of the study range, ascends in town Jorigam of Koraput region of Odisha and flows Deobhog, Bhawanipatna and Balangir territory of six locale of Odisha to be specific Rayagada, Kalahandi, Nuapada, Balangir, Boudh and Kandhamal. Different tributaries meeting the stream in Odisha in this segment are Jeera and Bheden.

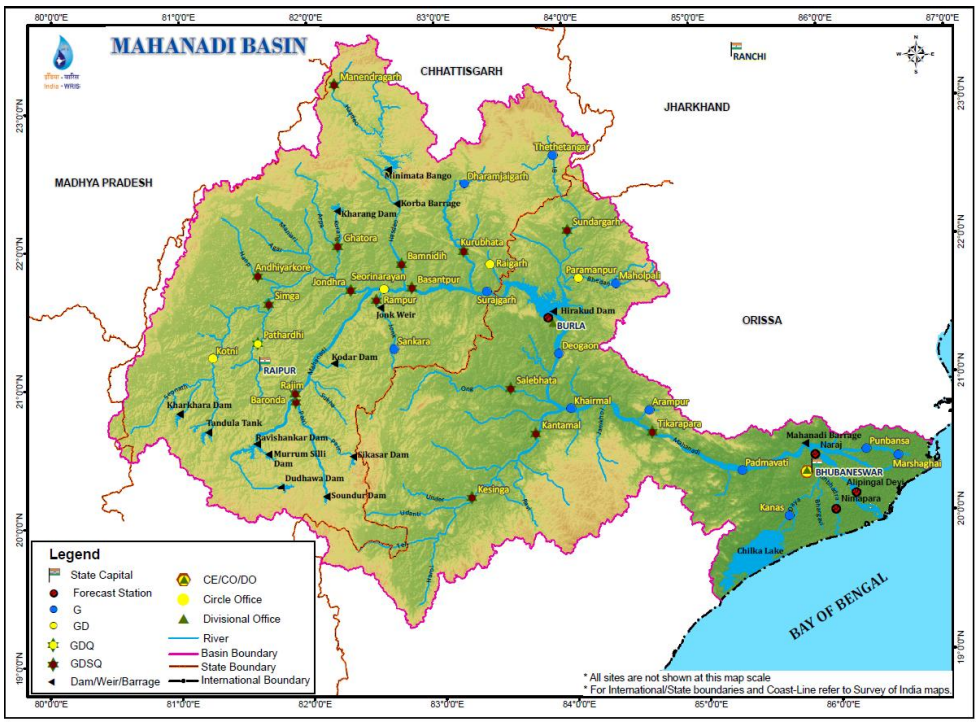

Figure-1: study area map(map is being downloaded from google.)

IV. Methodology

4.1 Utilization of DEM

A Digital Elevation Model (DEM) is a digital cartographic/geographic dataset of elevations in xyz coordinates. The terrain rises from ground positions are tested at consistently dispersed even interims. DEMs are derived from hypsographic data (contour lines) and/or photogrammetric methods using USGS 7.5-minute, 15-minute, 2-arc-second (30- by 60-minute), and 1-degree (1:250,000-scale) topographic quadrangle maps.

This elevation data is represented in PCs as elevation information in a computerized design. This configuration is generally called Digital Elevation Models (DEM). Along these lines a DEM is a modernized representation of the Earths elevation. Diverse organizations exist, among the most usual are Triangulated Irregular Systems (TIN), Tagged Image File Format (TIFF) regular grids, contour lines and scattered information system. A DEM is typically described either by a wire frame model or a image matrix in which the estimation of every pixel is connected with a particular topographic elevation.

In the present work, the basin area of Mahanadi river framework lying in Orissa is taken as study territory. This region is to be first made a polygon shapefile with the utilization of Arc Catalog which is a tool of ArcGIS. At that point the aggregate region or the shapefile is to be kept in the projected co-ordinate system framework in polyconic and the geographic co-ordinate system to be kept in India-Everest-Nepal. Here by the digitization procedure begins on, with the aggregate Mahanadi basin lying under Orissa is to be digitized. The elevation of the study territory assesses the stream of the water in full catchment. The elevation of the area can be known from the DEM maps, which we can get in different particulars. The DEM's are accessible for the all aspects of the world, which are partitioned into little square regions normally known as tiles. The DEM was taken from the site http://eros.usgs.gov/elevation-product, by selecting the longitude and latitude of the territory then the tiles are chosen to cover the region lastly the DEM is taken. Presently after the map was taken it was amassed in the place then the mosaicing is done. This procedure was finished by the tool mosaic. At that point the spatial analyst tool extraction of mask is utilized to extract the study area from the mossaiced DEM with the assistance of the polygon shapefile digitized before. After every one of these procedures now the basin and the sub-basin maps are to be drawn.

4.2. Delineation of watershed by using ArcSWAT

In the present study, the basin area of Mahanadi River lying in Orissa and its sub-basins are delineated utilizing ArcSWAT (soil and water easement tool). The ArcSWAT is a tool of GIS. ArcSWAT is graphical interface of SWAT, which delineates study territory into sub-basins and hydrologic reaction units utilizing the DEM's, land use or land cover, soil maps, slope maps. Swat can be utilized to simulate a solitary watershed or an arrangement of numerous hydrologically associated watersheds. Every watershed is initially partitioned into sub-basins and afterward in hydrologic reaction units(HRUs) in light of the area utilize and soil appropriation. The utilization of sub-basins in a simulation is surely beneficial when different area of they are dominated by different soil type effect on hydrology. The ArcSWAT requires an information set that is digital elevation model, which is made in Polyconic projection with determination and height in meter, with having a horizontal grid basin of 30 arc seconds (around 1 km) as composed beforehand the study region is extricated from the U.S.Geological survey's centre for Earth Resources Observation and Science (EROS) and imported to the ArcGIS programming for delineation into sub-basins using "watershed outline" tool.

The watershed delineation carries out advance GIS capacity to help the client in sectioning watershed into a several hydrologically associated sub-watersheds for use in watersheds demonstrating with SWAT. This apparatus utilize and grows ArcGIS and spatial analyst extention function to perform watershed delineations. The delineation procedure requires a Digital Elevation model (DEM) in ESRI grid format. It additionally has a choice of importing and utilizing a pre-characterized digital stream system in ArcGIS shapefile or geodatabase feature class (polyline) format. In this tool a dialogue box appears which partitioned to five segments in particular DEM setup, stream definition, outlet and inlet definition, watershed outlet selection and definition and calculation of sub-basin parameters. They are being described below:

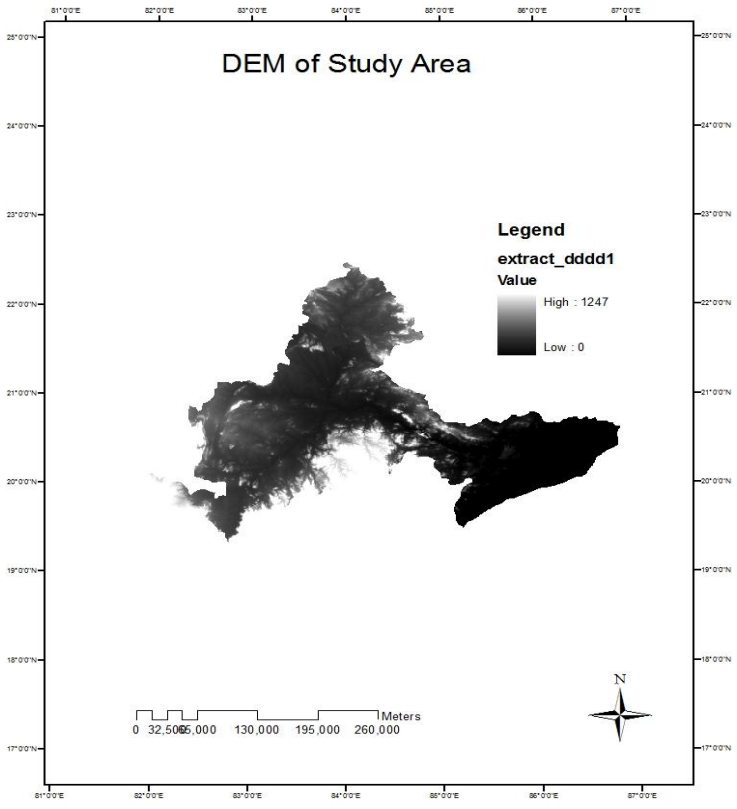

Figure-2: DEM of the study area extracted using ArcGIS

- In the step one DEM network guide is transported in to figure all sub-basin parameters. Here two checkbox are there which is, create as mask and burn in stream data set. In the burn in stream dataset can be superimposed into the DEM to characterize the area of the stream system. This component is most valuable in circumstance where the DEM doesn't give enough points of interest to permit the interface to precisely foresee the area of the stream network. Burning in a stream system enhances hydrographic division and sub watershed boundary delineation. The process must be a polyline shapefile or highlight class.

- In the second step the stream defination of the watershed delineation dialog box, the initial stream system and sub-basin outlets are characterized. In this area of stream definition DEM based catch is to be clicked. This capacity assumes a vital part in deciding the point of interest of the stream maker. After that flow direction and accumulation option helps the DEM by filling sinks and computing the flow direction and flow accumulation grid network. Then the stream network option helps to create the reach (the current synthetic drainage network) and monitoring point or stream junction point.
- In the third step the outlet and inlet defination of the watershed delineation add, delete, redefine the drainage inlets and sub-watershed outlets. The outlets and inlets were being set manually.
- In the watershed outlet selection and definition sub-watersheds delineation is finished. Here the watersheds outlet was chosen and the point source or inlet of flowing watershed was additionally chosen. Here the watershed and basin layer is added to the map. The watershed layer will contain all the sub-basins and the basin layer will contain the full watershed limit.
- In the calculation step the capacity for ascertaining geomorphic attributes of the sub-basins and reaches are discovered. The consequence of the count is available in the corresponding attribute table.

V. Result And Discussion

In the present work the study area is being analysed properly as per its characteristics like the soil type, land use type, the elevation and the process of draining of water. Here the soil type, HSG (Hydrologic Soil Group) and the percentage of the different type soil type of the study area is being shown in the table-1. This soil data is being found out by the help of the soil map in the grid pattern and was determined by the calculation and viewed in the attribute table after delineation.

Table 1: Soil Classification Statistics of Study Area

Soil	**Orthic Acrisols**	**Lithosols**	**Ferric Luvisols**	**Chromic Luvisols**	**Eutric Nitosols**	**Chromic Vertisols**	**Water Bodies**
Texture Class	Sandy Clay Loam	Sandy Clay Loam	Sandy Loam	Sandy Clay Loam	Sandy Clay Loam	Clay	
HSG	C	C	A	C	C	D	
Percentage	0.33	0.85	38.05	18.34	27.76	14.25	0.43

In the present work the DEM is taken of the study area and being delineated by the assistance of the ArcSWAT and small watersheds are being shaped according to the release of the water in the study zone. By the assistance of these small watersheds we can get a concrete idea for the flow of water direction and the occurance of the slope in the watershed. Here in the figure 2 we can clearly view the delineation procedure, basin boundary, watersheds, watershed reach, linking stream added outlet, manually added outlet and the formation of the watersheds.

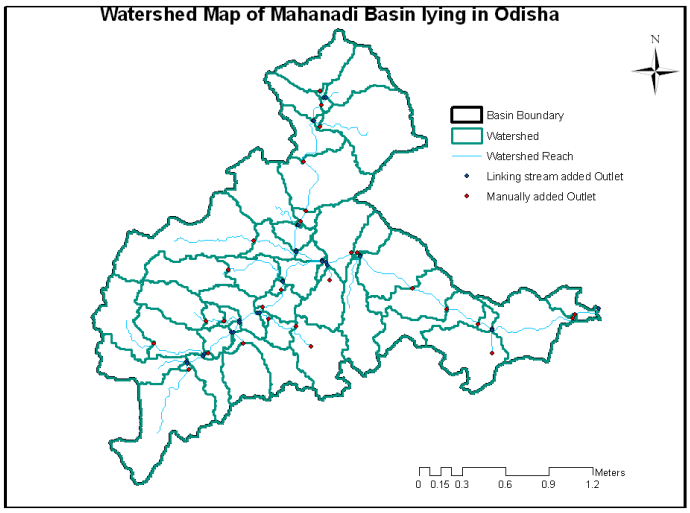

Figure 3: Watersheds division map with outlet points of the study area

VI. Conclusion

From the above discussions we can conclude that the delineation part is helping in the analysis of the flow of the water, slope of the area and by this we can analyze the travel time of the water and the condition of the flow and many more. If the flow pattern and the slope is being known then the travel time calculation is being easier and we can get an idea that how and when can we get the discharge in the outlet point.

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