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Digital Elevation Model is a Tool for Terrain Analysis: Implication and Interpretation with Reference to Kuya River Basin

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***Abstract:** This paper aims to present terrain characteristics of Kuya river basin specially relief zoning, aspect analysis, hill shade view, its relation with drainage conditions etc. Analysis of SRTM data in ERDAS Imagine and Arc GIS software reveals that there is no siginificant relief difference between upper and lower catchment of the basin but distinction between upper and lower catchments is very clear by topographic break of slope along 80 m. contour level. Aspect analysis propounds the fact that there is very clear cut difference between upper and lower catchment which is demarcated by coarse aspect texture in upper and fine aspect texture in lower catchments. Accordance between topographic character and drainage character shows there is no remarkable structural control on drainage alignment.*

Keywords: **Digital Elevation Model, Relief Classification, Aspect Zoning, Drainage Draping on Hill Shade, Hill Shade Analysis.**

I. INTRODUCTION

Digital Elevation Model is simply called digital description of earth’s surface or terrain condition of earth as a whole or part of it (Bolstad & Stowe, 1994). DEM is a generic term for digital topographic and/ or bathymetric data, in all its various form. It is called a "model" because computers can use such data to model and automatically analyze the Earth's topography in 3-dimensions, minimizing the need for labor-intensive human interpretation. Unless specifically referenced as a Digital Surface Model (DSM), the generic DEM normally implies elevation of terrain (bare earth z-values) void of vegetation and manmade features. This bare-earth DEM is generally synonymous with a Digital Terrain Model (DTM). As used by U.S. Geological Survey (USGS), a DEM is the digital cartographic representation of the elevation of the terrain at regularly spaced intervals in x and y directions, using z-values referenced to a common vertical datum (Maune, 2001). It does not include only the representation of the relief itself but also its descriptions, as slope, aspects, contour lines, break lines, peaks, and the other characteristics points. The following components are needed for complete definition of DEM/DTM (Digital Terrain Model), data elements, structural information, continuous functions, quality information, and methods for implication functions analyses (Lin et al., 1994; Martinoni and Bernhard, 1998). A general review of the technique is given in Rosen et al. (2000) and Richards (2007).

The aspect identifies the down slope directions of the maximum rate of change in value from each cell to its neighbours. In geography, aspects generally refer to the directions to which a slope faces, measured in degrees from North in a clockwise direction. For example, a hillside facing north has a northern aspect. The values of the output grid after analysis are the compass directions of the aspect.

Hill shade analysis obtains the hypothetical illumination of a surface by determining illumination values of each cell in a raster (Bhatta, 2008). This is done by setting a position for a light source and calculating illumination values of each cell in relation to neighbouring cells. It can clearly enhance the visualization of a surface for further analysis. Graphical view of this analysis provides an attractive and realistic backdrop. It can produce a very good relational link with other features of the basin. Aspect of slope is very important both from geomorphological and ecological point of views. Site quality, drainage types, sunlight availability, plant and animal types their behaviour etc. are determined by aspect quality of any area. This paper has attempted to highlight the terrain characters with special reference to relief classes, aspect characters and topography-drainage discordance.

II. LOCATION OF THE 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 Gorbhanga 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 1555.2 sq.km. Or 149355.5 hactares (Fig. 1). Total length of the river is 176.4

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km. About 24.64 km. is semi permanent. Total length of its main tributary- Brakeswar (Twin river of Kopai: Kopai and Brakeswar together have made Kuya river) is 82.98 km. out of which 10.57 km. is semi permanent and rest portion is semi permanent. The lower segment has embanked to restrict the over spilling tendency of the river.

Politically, two states (Jharkhand and West Bengal), three districts (Dumka district of Jharkhand, Birbhum and Murshidabad districts of West Bengal) and 15 CD blocks like (Khundahit, Rajnagar, Dubrajpur, Khoirasole, Suri II, Illambazar, Bolpur Srinikatan, Nanoor, Labpur, Burwan, Kandi, Bharatpur I, Bharatpur II, Ketugram I) are covering the entire basin.

Maximum elevation of this basin is 156m. And lowest is about 14m. at the confluence region. At the upper catchment relief varies from 12-20m. But it is too low in the confluence region (<2m.)

III. MATERIALS AND METHODS

SRTM data has been used to assess the terrain conditions of Kuya River basin. SRTM data is one of the convenient products as 3D image or pseudo 3D image (Rabus et al., 2003). Shuttle radar topographic mission (SRTM) has created an unparalleled data set of global elevations that is freely available for modeling and environmental applications. The global availability (almost 80% of the Earth surface) of SRTM data provides baseline information for many types of the worldwide research (Gorokhovich and Voustianiouk, 2006).

DEM has extracted from SRTM data and classified method has used to classify Kuya river basin into 10 relief zones with distinct classes.

Topographic analysis tool specially aspect analysis has been used to present slope direction in very micro level. Hill shade analysis method has been executed to visualize psedo 3D DEM in actual 3D morphology. Drainage layer has been prepared from image through simple digitization method and it has been draped on hill shade to assess the level of topography-drainage discordance or accordance. For all these analysis, Arc GIS soft ware has been used.

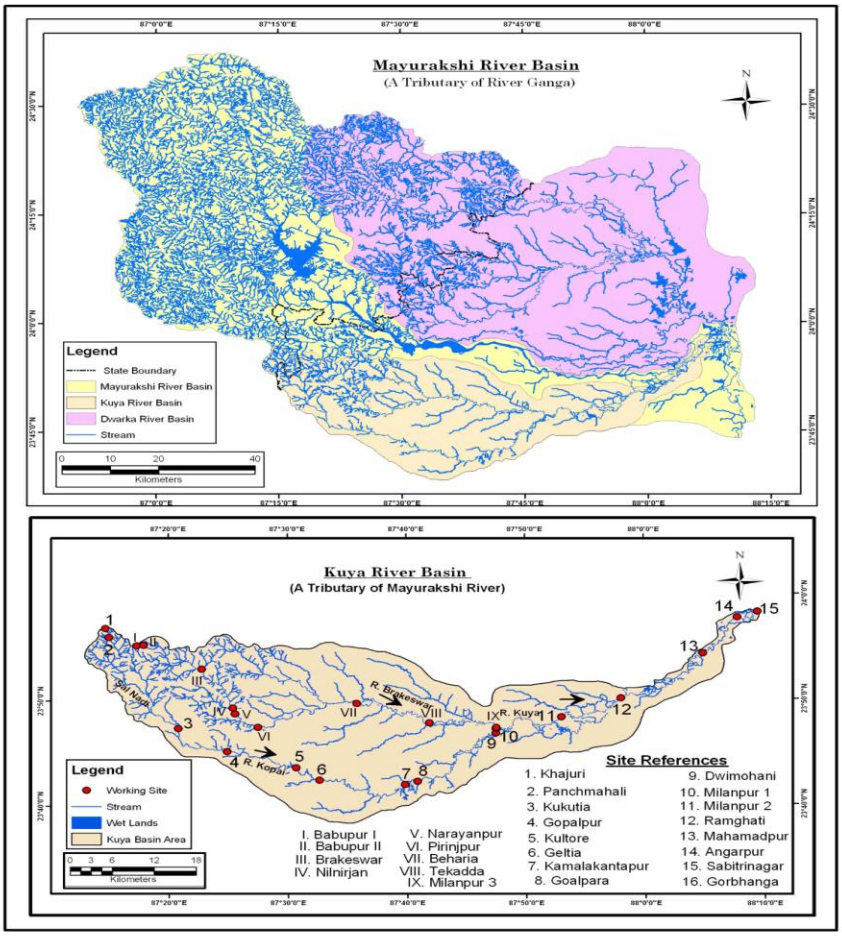

Fig. 1

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IV. RESULTS AND DISCUSSION

Generation of Digital Elevation Model

Digital elevation model (DEM) has generated from SRTM data. Rough terrain character of the basin is clear from colour defined DEM. This DEM fairly views the alignment character of the streams. It is noticed that distribution of basin area between left and right hand side of the basin is highly asymmetric because maximum proportion of area is found in left hand catchment of the basin.

Relief Zoning

From classified relief map it is found that maximum elevation of this basin is 156 m. and minimum relief is only 15m. Upper and lower catchments of the basin are demarcated by 80 m. contour which seems a major topographical break of slope.

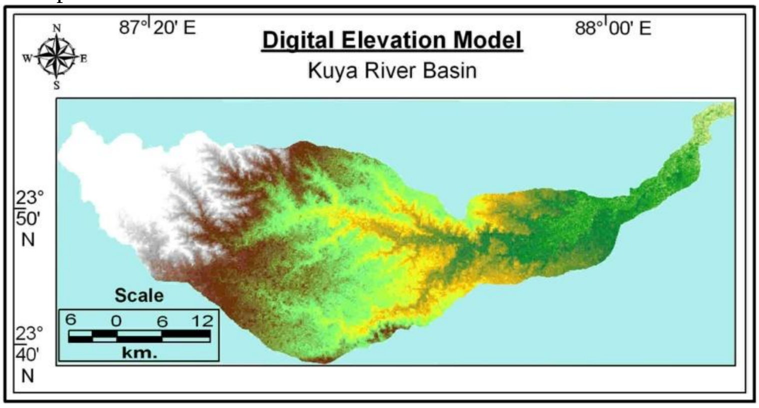

Fig. 2

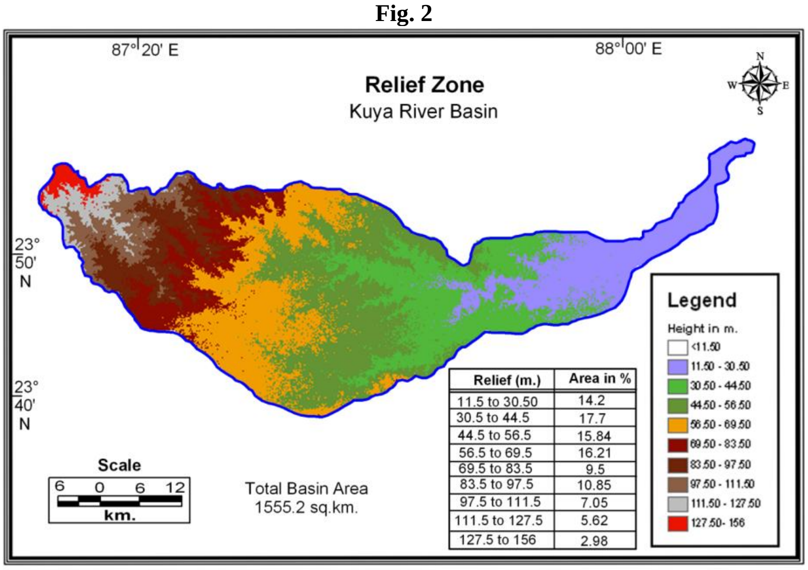

Fig. 3

Upper catchment of this basin is confined within very 30% area of the basin. Middle catchment area is separated with lower catchment along 30 m. contour level but no significant topographic break of slope is noticed along this contour. Middle catchment in between 30 m. to 80 m. contours cover about 50% of the basin area. Figure 3 describes the areal proportion under different relief zones.

Aspect Analysis

A good relationship is found between elevation character and aspect character. The area having greater elevation is characterized by coarse elevation and vice versa. In the upper catchment (above 80 m. contour) the texture of aspect is coarse and it is significantly fine in the middle and lower catchment of the basin. The distinction of aspect character between middle and lower catchment is not very clear due to continuous elevation lowering and proximate terrain characters. This relationship is not only true in different catchments, but also it is noticed between left and right hand catchments of the basin. Hill shade map has highlighted that left hand catchment is elevated than right hand catchment and in accordance with it coarseness of the former catchment is more than later. Coarse texture aspect means relatively larger area which has same slope direction and vice versa.

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Maximum proportion of slope direction is south and south easterly facing which is resemble to the trajectory of the main river. Significant slope direction is only noticed in upper catchment of the basin.

Hypothetically, it is true that in mountainous area slope diversity and direction diversity of slope is more but in this basin the result is quite opposite. Actually, the elevation in the upper catchment is not high as usually happened for a large basin with mountainous start. Moreover in the mountainous area slope limb stretches for a long distance but in plain area micro slope may change frequently.

Drainage Overlay on Shaded Relief

Two interactive layers have superimposed to assess the relation between relief and drainage. It is cleared from the figure 5 that drainage is fitted with topographic character of the basin. Slope breaker zone shows sudden intermingling of streams and high spatial bifurcation. Major tributary Brakeswar is flowing along the margin of the elevated parts of the basin making bloated interfluves at its right hand. This trajectory is guided by topographic elevation because no fracture zone or fault line is noticed there. At the confluence region the stream formation is so interwoven that it often creates difficulties to find stream hierarchy. Depressed topography at the confluence area has generated an extensive wetland where Main River and tributary system spill water and makes the situation complex.

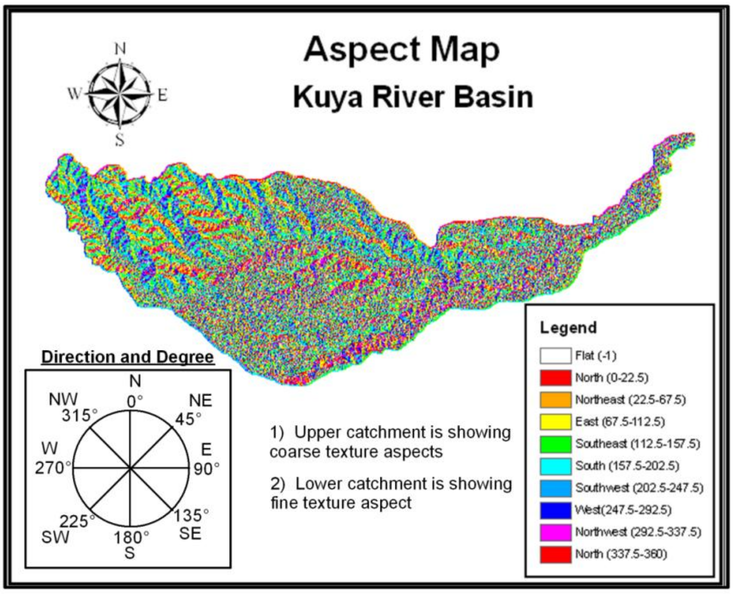

Fig. 4

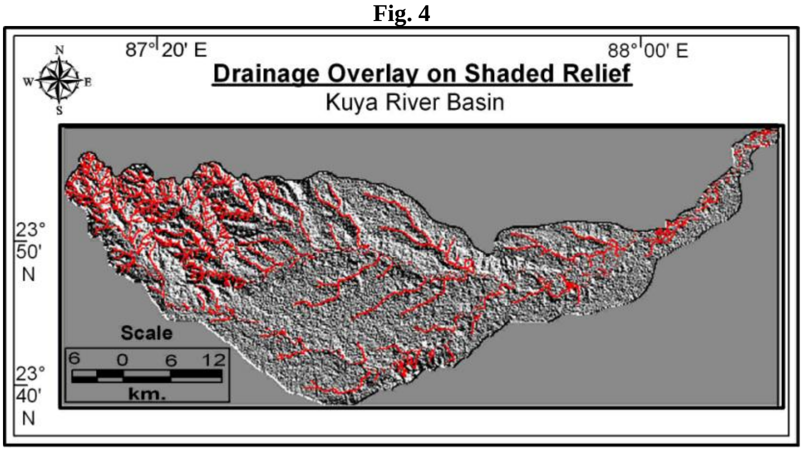

Fig. 5

V. CONCLUSION

In fine it can be said that SRTM based DEM data is successfully explain different terrain characteristics of the basin. Relief zoning, aspect mapping, hill shading etc. not only explain characteristics of geomorphological feature but also support a good data base for different other economic and ecological planning. Frequent

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elevation change with very short distance means greater slope which supports greater potentiality of soil erosion, fast sub soil exposure etc. so, it is susceptible for hazards. Longer stretch of slope segment in the upper catchment also resolves the above mentioned statement. However, with the help of DEM analysis, geomorphologist can predict ensuing landscape diversity in different parts of the basin; planner can also chalk out sustainable plans in different parts of the terrain.

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