A study on Hydroelectric and Irrigation potential of Dikhow river, Assam

Punit Al Barik[1], Mriganka Mazumdar[1], Mrinal Kr. Dutta[2]
[1.2]Department of Civil Engineering
Jorhat Engineering College, Jorhat - 785007, Assam, India
punitalbarik@gmail.com

Abstract - ***Hydropower as a form of renewable resource is very essential in the sustainable development of a country. On the basis of various studies made on Dikhow a perennial river of length of 255.8 km using GIS and Remote sensing an attempt has been made to locate suitable sites for dams for generating power or supplying water for irrigation and other purposes. The river Dikhow originates at Assam-Nagaland border at 26.08°N latitudes and 94.56°E longitudes and flows though the plains of Assam and finally to the mighty Brahmaputra at 26.99°N latitudes and 94.45°E longitudes covering an area of 4128.42 km^2. An attempt has been made to create a thematic assessment map to locate suitable sites for dam using remote sensing and geographic information system (GIS). The characteristics of these thematic maps have been derived with the help of different softwares (Arc GIS 10.1, and Global Mapper 11). A database of the catchment area is constructed to decide the locations of the proposed dams. From the three locations(site 1,2 and 3) chosen, site 1 has been considered suitable for irrigation purposes whereas out of the sites 2 and 3 are chosen for Hydropower generation, site 2 has been considered more suitable for the purpose, because of its more reservoir storage, lesser width of the channel and presence of suitable foundation material required for dam construction.***

Keywords - GIS, Remote sensing, Dams sites selection, catchment area, ArcGIS, Global Mapper.

1. Introduction

Water is a basic resource on earth for all living beings including human beings and also for survival of plants and its importance is increasing due to the high population growth. As the main livelihood of people of Assam is agriculture the demand has been growing for more agricultural production to ensure food security. Thus, the need to construct dams has been growing vastly to meet the requirement of water supply, clean hydroelectric energy and irrigation. Remote sensing and GIS are widely used for delineation of terrain parameters such as slope, aspect, drainage network, watershed boundaries etc. The information about terrain surface and relief are often required for dam site selection. The derivation of topography watershed data and maps using remote sensing and GIS is fast, accurate and provide more reproducible measurement than traditional techniques compared to topographic maps. Significant effort has been devoted in recent years to derive terrain maps for engineering planning. In this study an attempt has been made to investigate the application of remote sensing and GIS techniques for suitable sites selection of the proposed dams by using remote sensing and GIS technology. The Dikhow river basin lies in the geographical territories of Assam and Nagaland and finally flows into the Brahmaputra as a southern sub-tributary of Brahmaputra. Due to its perennial course and presence of active flood plains the river has an immense potential for hydroelectric and irrigation purposes. Geographically, the basin lies between 26.99°and 26.08° north latitudes and 94.45°and 94.56°east longitudes and covers an area of 4128.42km2 both plains and hills within it. Remote sensing and GIS has been used to asses landuse management in various resource sectorslike agricultural planning, settlement surveys, environmental studies and operational planning (Li and Shen, 1973; Khoram and John, 1991; Jayakumar and Arockiasamy, 2003; Shamsudheen et al. 2005; Abushandi Eyad, 2015). Thanoon and Ahmed (2013) applied remote sensing and GIS techniques for suitable sites selection of the proposed dams in Al-Tharthar basin northern. By using capability of remote sensing and GIS technology they prepared a detailed hydrological impact analysis of the proposed dam's sites which play a vital role in analysis of any watersheds.

2. Methodology

1. For delineation of Basin Area of Dikhow river the survey of India toposheets Nos 83 J9, J10, J12, J11, J14, J15, J5, J7, J13, J8, I8, I12, N1, N2, N3 and N6 at 1:50000 scales of 1975 were scanned, georeferenced, mosaiced and used as resource maps. Using the various tools of Arc GIS software digitization of mosaic maps are done to delineate basin area of the river Dikhow and its tributaries are demarcated. (fig 1).
2. DEM of the said area has been collected from USGS. Using the DEM and with the help of ArcGIS software contour maps, aspect maps, slope maps, fill sinks map and flow direction maps are also extracted.
Finally on the basis of the above studies an attempt has been made to locate suitable sites of dams both for irrigation and hydroelectric purposes.

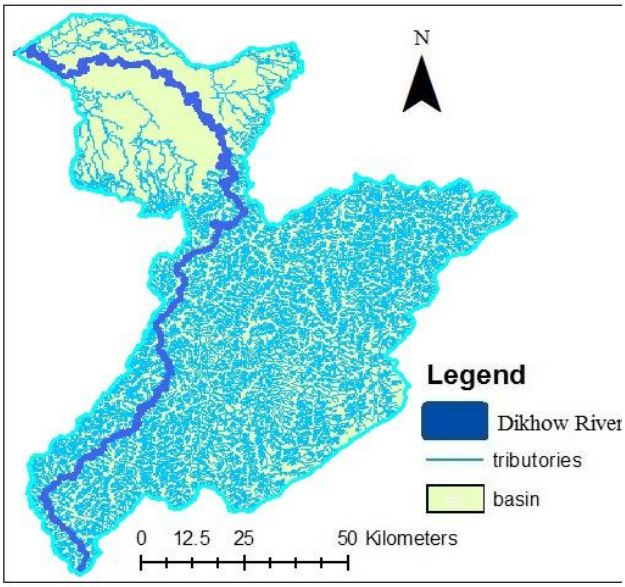

Figure. 1. Digitized map of Dikhow river basin and its Tributaries along with its boundaries

3. Observations

A. Basin Characteristics

A drainage basin is the area which contributes water to a particular set of channel of different orders. The Dikhow river basin includes the geographical territories of both Assam and Nagaland. The part of the basin within Nagaland in general is formed by hills of 1900 m above msl (mean sea level), but the southeast part of the basin has an elevation of 2600 m above msl. The Dikhow river flows from the tertiary hills of Nagaland to the plain area of Assam and the basin comprises the floodplains of Brahmaputra on the north and the Tertiary hills of the Naga-Patkai range on the south.

From the source to summit, the total length of the channel of Dikhow is 255.80 km. The first 150.06 km of the channel from the source is located in the hills. The length of the river channel in the plains is about 105.74 km. Finally traversing for a length of 255.80 km and draining water from an area of 4128.42 km^2, river Dikhow pours its discharge to Bhramaputra at Dikhowmukh.

Of the total basin area of 4128.42 km^2, 2982.83 sq km spans over the foothills of Assam-Nagaland border and 1145.59 sq km area of the basin falls on the plains of Assam.

The basin is V-shaped bending towards east and its central portion is highly squeezed (Fig.1) where the width of the basin is about 14.28 km. This width gradually increases towards downstream of the river. A general westward slope of the basin in the Shivasagar district compels several streams of the area to flow westward to meet Brahmaputra. The central portion of the basin becomes narrow and the width gradually increases towards north and south.

B. The course of the river Dikhow

(i) The Hilly Course

The Dikhow river has its source in the Zunheboto district of Nagaland and the source has an elevation of about 1900 m above mean sea level. The river is totally a rain fed river. Its source is the point where 26.08°N latitudes and 94.56°E longitudes meet each other. For the first few kilometers, the river flows from south to north following the steep slope of a hill ridge. This has a steep elevation varying from 1900m at source to 100m above msl. at Assam Nagaland border. The channel flows nearly 150.06 km along the valley from north-east to south-west. At this point, the channel of the river crosses the 100 m contour and takes a sharp turn. After this it starts to flow from south-west to north-east., which acts as the inter-state boundary between Assam and Nagaland.

The entire hilly course of the river traverses through the terrain dotted with scattered human settlements and covered by thick vegetation cover which is now degraded due to human interference. In the hills, a large number of streams meet the channel of Dikhow on both right bank and left bank Some of the streams are seasonal while some others flow throught the year.

(ii) The Plain Course

The river enters the plain of Assam at Naginimara. The river Dikhow enters the plains of Assam, at an elevation of 100 m. Reaching the plains of Assam, the river starts flowing northward and reaches

Sivasagar city. At the plain course of the river passes a large number of villages and two urban centres, While meandering through the plains, the river leaves more than fifteen abandoned channels at different places. Many of these are ox-bow lakes. The longest abandoned channel of Dikhow has a length of 20 km and it is extending from Naginimara to Namdang river through the Hatipati Tea Estate and is known as Mori-Dikhow (Sharma, 2008). Entering into the plains Dikhow meets river Santak. The Dorika was a tributary of Dikhow, but presently it meets Brahmaputra independently. At the foot of the hills the course of Dorika is known as Namsai. Dorika also has few abandoned channels at places. River Namdang also has its source in the foothills. Like Dorika, it was also a tributary of Dikhow. But its water is now diverted to flow to Mitong river near Gaurisagar. While travelling through Nagaland, the channel of Dikhow is known by different names at different places. The part of the Dikhow basin in the plains shows that all the streams flow from south-east to north-west direction which signifies a general north-westward slope in the area.

4. Results and Discussions

Digital elevation model (Figure 2) generated from United States Geological Survey (USGS) data for the Dikhow Basin area are used as elevation reference. From the digital elevation model it has been observed that the northern parts of the basin have the lower elevations than the middle and southern parts i.e Nagaland Hills have the highest elevation. The elevation of the basin varies from 100 to 2600 m.

Slope and aspect maps of the basin (Figure 3 and 4)are generated from the DEM. Slope map shows that the basin is characterized by variable slope ranging between 0 to 87.61 degrees in certain locations. Aspect maps which is very important for determining water flow in the basin shows that the basin mostly faces towards north.

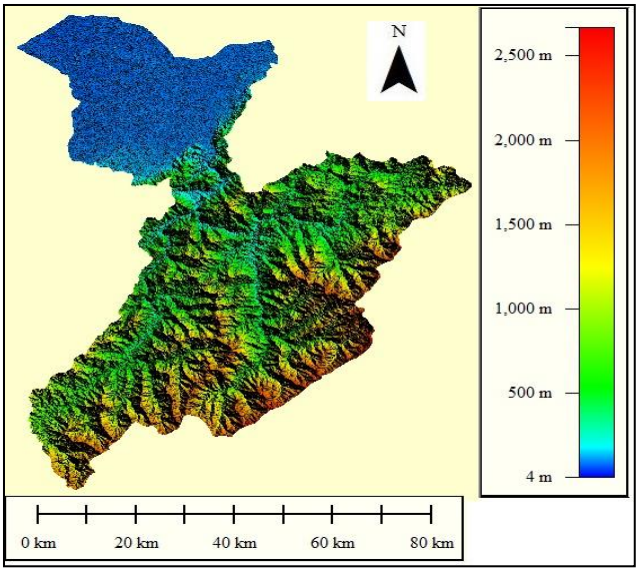

Fig. 2. DEM of the Dikhow basin

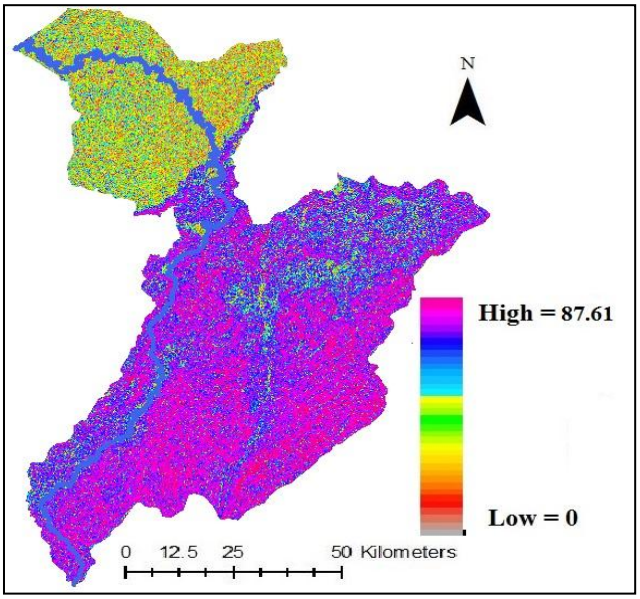

Fig. 3. Slope Map of the Dikhow basin

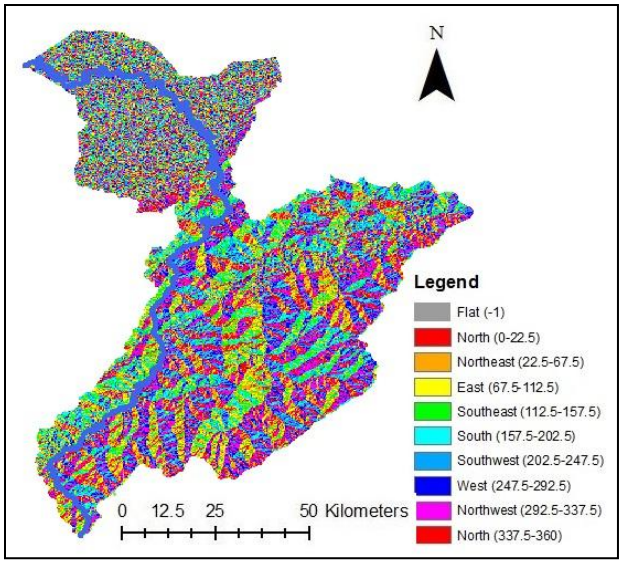

Figure. 4. Aspect Map of the Dikhow basin

The flow directions as illustrated in figure 5 are also determined from the DEM by searching the relations between the neighboring cells with the rule that water will flow to the neighboring cell which has the highest downward slope. The drainages flow in different direction and connected together in one main stream. The drainage network is characterized by dendritic patterns.

As exhibited in figure 6 the contour map is derived from the DEM using Arc-GIS in order to observe the terrain elevation of the basin. The contour map reveals that the south eastern part of the basin has the highest elevation whereas in the northern and north western part the basin have the lowest elevation. The contour value varies from 100 to 2600.

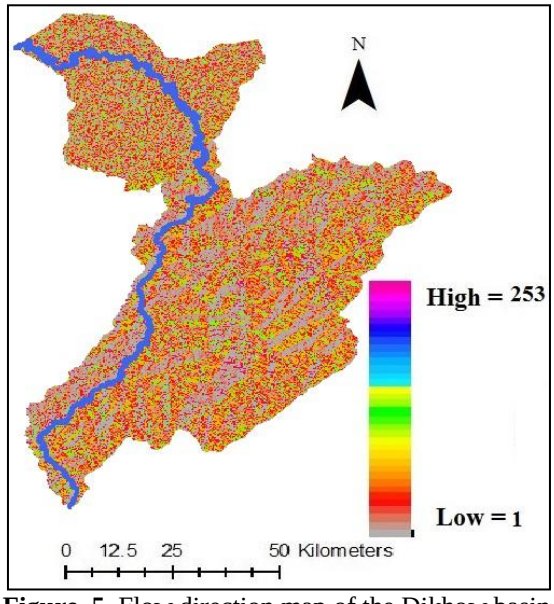

Figure. 5. Flow direction map of the Dikhow basin

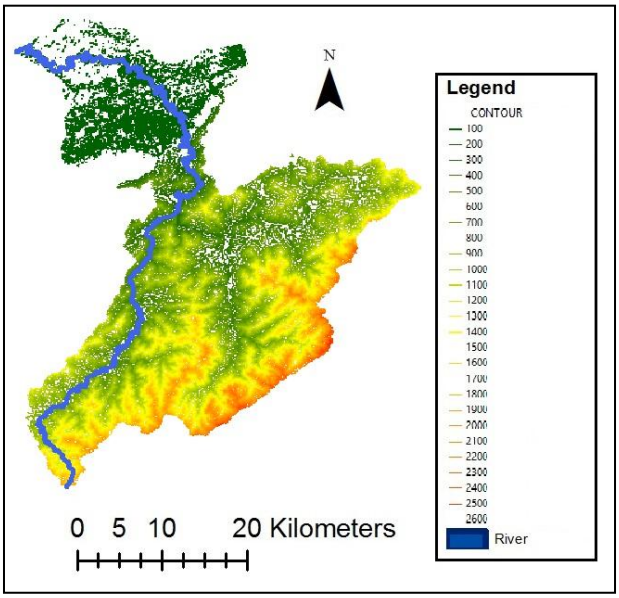

Figure. 6. Contour Map of the Dikhow basin

After studying the various parameters of the basin, three locations were chosen in the south part of the basin. The locations of dams had been decided based on the land- use and land-cover map, geomorphology of the basin, contour map, slope map, aspect map, flow direction map and length and abutment of the dams.

The 1st site is considered ideal for an irrigation project whereas site 2 and 3 are ideal for generation of hydroelectricity.

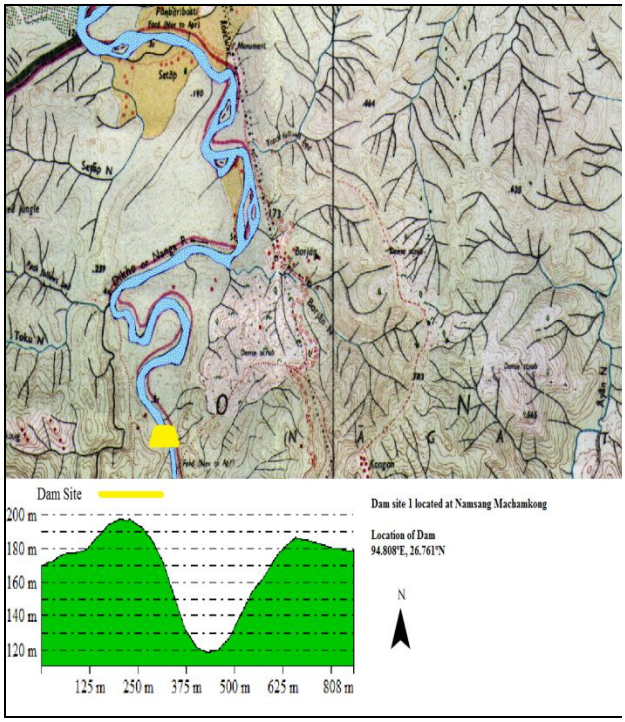

Fig. 7. Dam site located at Namchang Machamkong

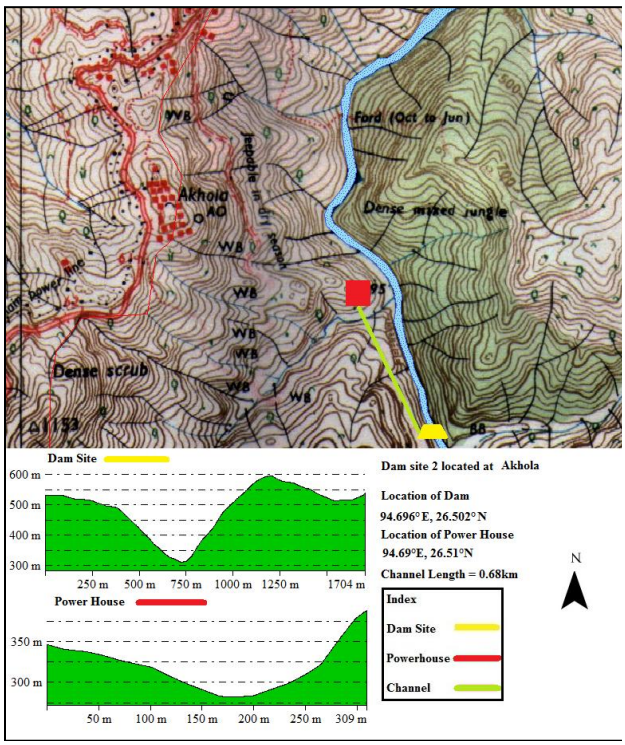

Fig. 8. Dam site located at Akhola

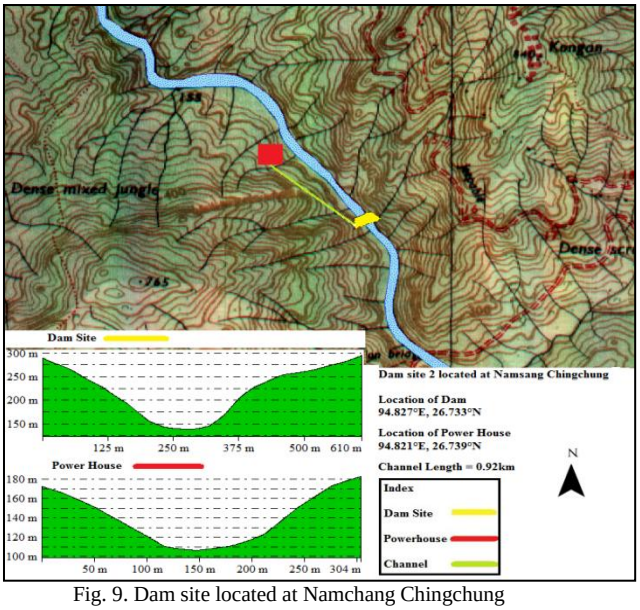

Fig. 9. Dam site located at Namchang Chingchung

I. **TABLE I.** DETAILS OF THE 3 LOCATIONS

Site	Location	Purpose	Length of Channel
1	Namchang Macham-kong (94.808ºN, 26.761ºE)	Irrigation	-
2	Akhola (94.696ºN, 26.502ºE)	Hydropower	680m
3	Namchang Ching-chung (94.827ºN, 26.739ºE)	Hydropower	920m

5. Scope and Summary

By demarcating the basin area of Dikhow River it will be helpful in determining drainage basin of the river and find the overall area of the river basin. From the studies made site 2 can be considered as an ideal site for hydroelectric project. This is because its cross section width is less which can be considered ideal for constructing a dam and also the difference of elevation between the dam site and power house site is high which will further enhance in power generation. Also Site 1 is considered as ideal for constructing a dam for irrigation purpose.

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Website links

i) https://en.wikipedia.org/wiki/Hydroelectricity

ii) https://en.wikipedia.org/wiki/Irrigation

iii)http://shodhganga.inflibnet.ac.in/bitstream/10603/5500/13/13_chapter%208.pdf