EXTRACTION OF HYDRO-MORPHOLOGICAL FEATURES FROM GEO-SPATIAL DATASETS

A Study for Ghataprabha River Basin, Karnataka

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ABSTRACT

Remote Sensing (RS), Geographical Information System (GIS) and Global Positioning System (GPS) have proved to be an efficient tool to extract information from the spatial datasets like Topographical maps, Satellite imageries about drainage pattern, surface hydrology and hydro-morphology of an area. In the present study, an attempt has been made to extract the hydro-morphological features of Ghataprabha River Left Bank Canal (GLBC) Command Area (CA) in Karnataka, India from the spatial datasets using SIT. The study region lies between 16° 12' 16'' N to 16° 30' 1'' N latitude and 74° 45' 18'' E to 75° 44' 58'' E longitude of northern Karnataka. The spatial datasets namely, CARTOSAT-1 DEM data, RESOURCESAT -2 LISS III along with Survey of India (SOI) Toposheets at 1:50,000 scale have been used to create various thematic maps of surface morphology with the help of Erdas Imagine and ArcGIS software's for the study area. The resulted drainage pattern, landuse/ landcover, slope, contour and DEM maps of this analysis would be useful in determining the effect of hydro-morphological characteristics such as contour, slope of the area and distribution of stream network within the command area which intern useful for planning command area management.

Keywords*: *Command Area, Ghataprabha River, Hydro- Morphology, Satellite Data, Remote Sensing

I INTRODUCTION

Spatial data sets including satellite data and topographical maps are useful for extracting various required information for hydro-geomorphological features and the study of slopes, aspects, drainage network and landuse/landcover pattern represents the hydrogeology and helps in categorization of the landforms into different hydro-geomorphological classes representing the relationship of the geological structures and the surface water occurrence. As the area taken for this study is predominant in agricultural activities, it is necessary to study the existing surface hydrological features and their role on surface drainage pattern. Realizing the present situation, it has been considered feasible to undertake a systematic hydro-geological and geomorphological investigation of surface water in Ghataprabha river basin. As the study area comprises mainly of basaltic lava flows of Deccan Traps, the main challenge on water sector is in hard rock areas involving the problems of water conservation and its management inclusive of planning of the water resources.

In this study, RESOURCESAT- 2 LISS III, Digital Elevation Models (DEMs) from CARTOSAT-1 along with Survey of India Toposheets No: E43V01, VO3, V04, V06, V07, V10, V11, V12 and V16 at 1:50,000 scale have been used to create various thematic maps with the help of Erdas Imagine and ArcGIS software for Deccan Traps of Ghataprabha River basin, Karnataka, India. The surface drainage pattern is vectorised from the Toposheets using Erdas Imagine software. LISS III satellite data was used to extract the Landuse- Landcover pattern of the command area. CARTOSAT DEM was used to extract the contour and slope of the study area. The satellite data derived geo-morphometric and hydro-geomorphic features assist in managing the surface water resources to plan for water harvestings structures, and drinking water sources. This study enlighten the general capabilities of Remote Sensing techniques to obtain geomorphic data and to examine Remote Sensing as a possible aid in extracting geomorphic features which will help in the study of geomorphology, hydrogeology and water management planning in the future.

II STUDY AREA

In this present study, parts of Ghataprabha River Left Bank Canal Command Area, Karnataka, India has been chosen as study area shown in Fig. 1. It extends from 16° 12’ 16’’ N to 16° 30’ 1’’ N latitude and from74° 45’ 18’’ E to 75° 44’ 58’’ E longitude and covers 4 Taluks in Belgaum and 3 Taluks of Bagalkot districts.

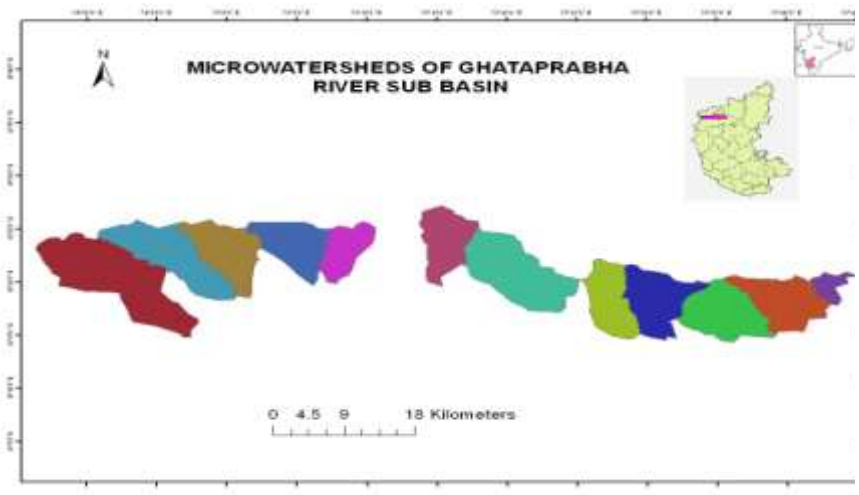

Figure1. Location map of the study area

2.1 Transportation

The area is well connected by road and rail to other parts of the state. The Pune - Bangalore National Highway and the Banagalore - Miraj line passes through the area. The interior part of the study area is well connected to both district headquarters at Belgaumand Bagalkot by weather roads.

2.2 Ghataprabha River

The River Ghataprabha has its source in the main hill range of Sahyadri near Chowkul, a village situated about 50 Kms of West of Belgaum town. The entire valley of the Ghataprabha including that of Tamraparni consists of hilly terrain having large patches of forest growth at higher levels and cultivated land at lower levels. The total length of Ghataprabha river up to the confluence with the Krishna river is about 260 Kms.

2.3 Climate

The rainfall in this region is confined to monsoon season from June to October the precipitation usually being most intensive during July and August. The climate is mostly temperate. Temperatures vary from a minimum of 7 degree in winter to about 41 degree Celsius in summer.

2.4 Geology and Ground water potential of the command area

Geologically the entire study area consists mainly of Deccan Traps (covering more than 95 %) and the rest by quartzites of Kaladagi Age. Deccan traps are the intrusive igneous rocks and when fresh serves as poor receptacles because of their massive and impervious nature. Accumulation of ground water is confined only to the weathered and the joints present in the rocks. Depth of weathering in traps range from 3 to 10 m thickness and of hole bed varies from 1 to 2 m. Zeolite traps found at few places have indicated dependable source of ground water. Groundwater occurs under water table conditions and the depth of water table ranges from 3 to 12 m. Ground water recharge take place through precipitation of rain water and morphological features of ground surface.

2.5 Rainfall in the command area

Annual rainfall is a quite uniform between 550 and 500 mm, with a pocket below 500 mm on the North West of the study area. The general gradient East- West which has a significant effect in the watershed from 500 mm up to 1200 mm at Belgaum does not seem to affect the area.

2.6 External sources of water

The external sources of water to the area are mainly from surface streams (small) and from the aquifers of the two major rivers Krishna and Ghataprabha bordering the command area.

One of the essential aspects in that regard is to estimate an accurate figure of the contribution of external sources in the overall balance. It is not easy because direct measurements are not possible and the estimation of the external sources comes as the closure of the water balance with high uncertainty. So, here the spatial technology is playing a vital role.

2.7 Irrigated agriculture

As per design the gross command area amounts to 1, 81,000 ha while the net irrigable area is 1, 61,000 ha. The only source of data which is available is the Remote sensing GIS survey made in 2001, in which they say that the command area spans over 280,000 ha, that is hundred thousands more that the initial Gross Command Area (GCA). A more recent analysis made as a follow up of the Masscote workshop shows that the total irrigated cropped area is about 220,000 ha.

III MATERIALS USED

In this study, RESOURCESAT- 2 LISS III of spatial resolution 23.6 m and Digital Elevation Model (DEM) (Fig. 2) from CARTOSAT-1 (Fig. 3) along with Survey of India Toposheets (Fig. 4)No: E43V01, VO3, V04, V06, V07, V10, V11, V12 and V16 at 1:50,000 scale (Fig. 5) have been used to create various thematic maps with the help of Erdas and ArcGIS software for Deccan Traps of Ghataprabha River basin, Karnataka, India. The used data are here under:

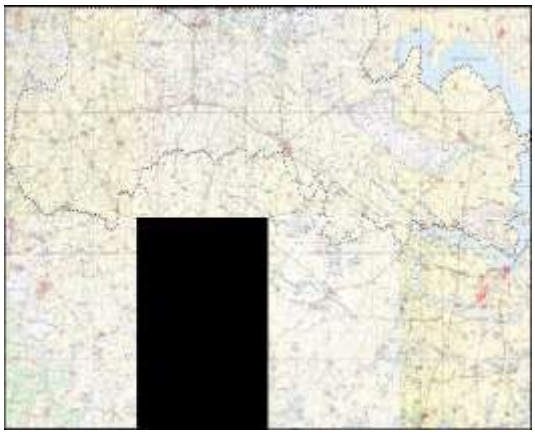

Figure 2. Toposheets of the study area

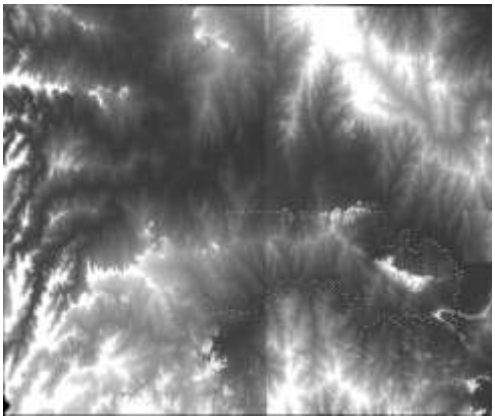

Figure 3. CARTOSAT-1 DEM data downloaded from NRSC website

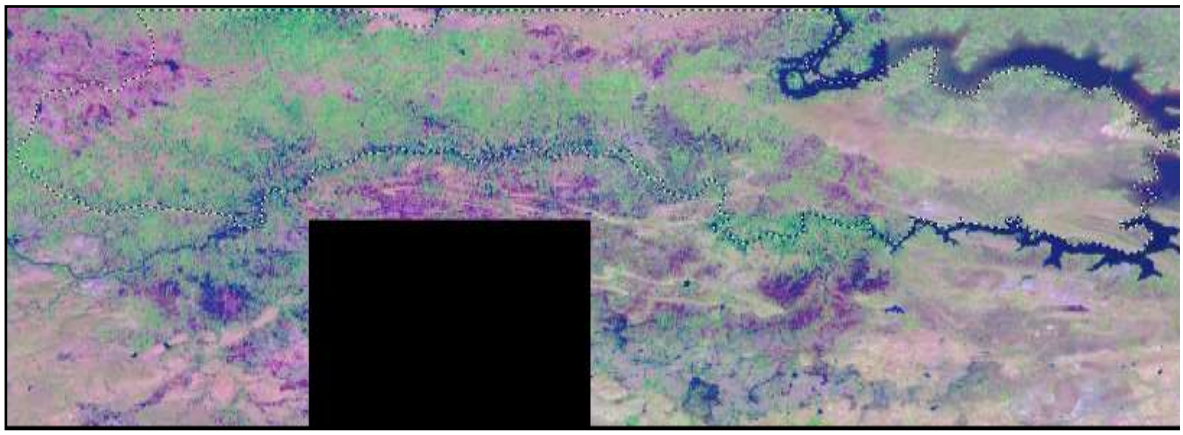

Figure 4. Downloaded RESOURCESAT-2 LISS III satellite imagery of the study area

IV INFORMATION EXTRACTION FROM THE SPATIAL DATASETS

The SOI Toposheets were geo- referenced and LISS III satellite imagery, CARTOSAT- DEM have been to geo-registered to UTM projection with the datum and spheroid as WGS84, Zone:44. From the Toposheets, Drainage Network (Fig. 5) has been digitized. The contours were vectorised from both the LISS III (Fig. 6) and CARTOSAT DEM (Fig. 7).

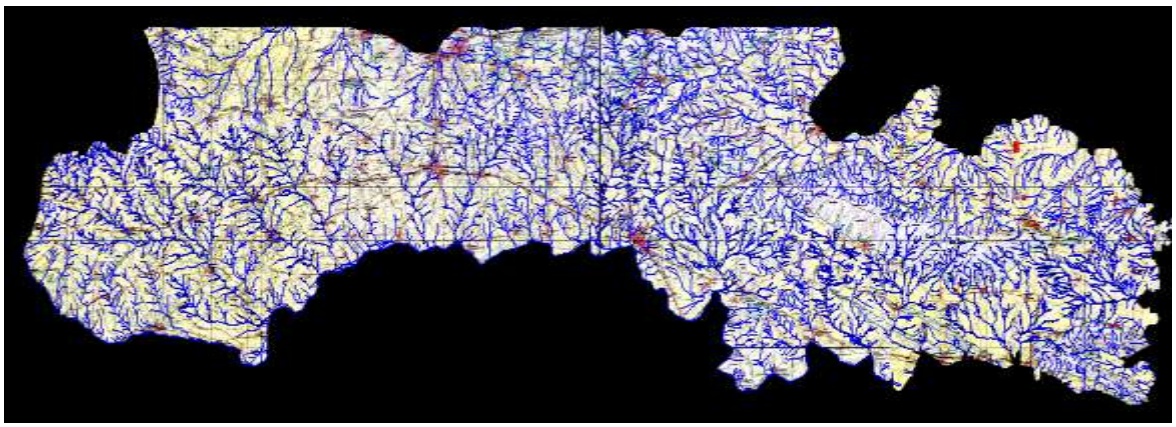

Figure 5. Extraction of Drainage network of the study area from SOI Toposheets in Erdas Imagine software

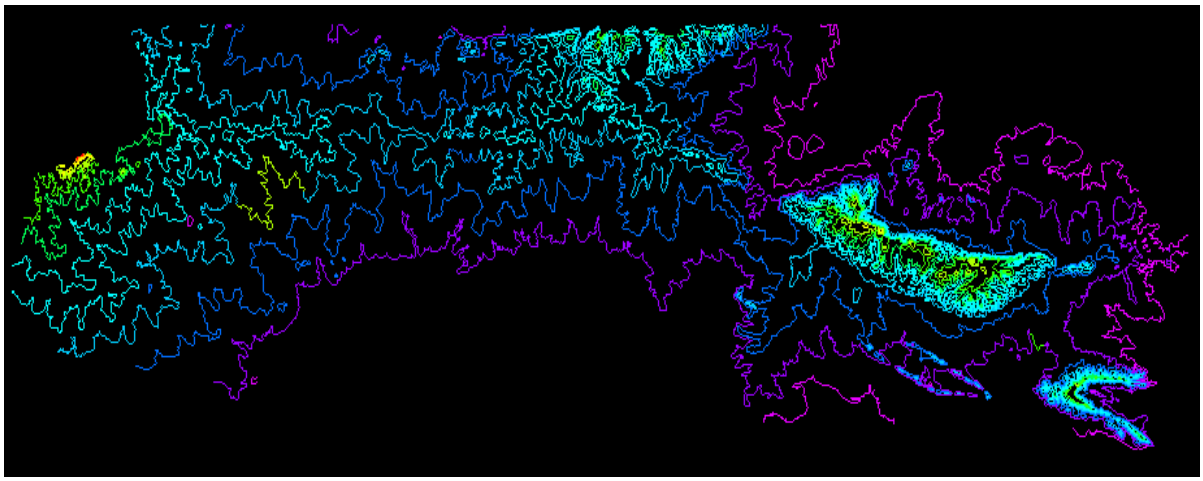

Figure 6. Extraction of Contours of the study area from SOI Toposheets in Erdas Imagine software

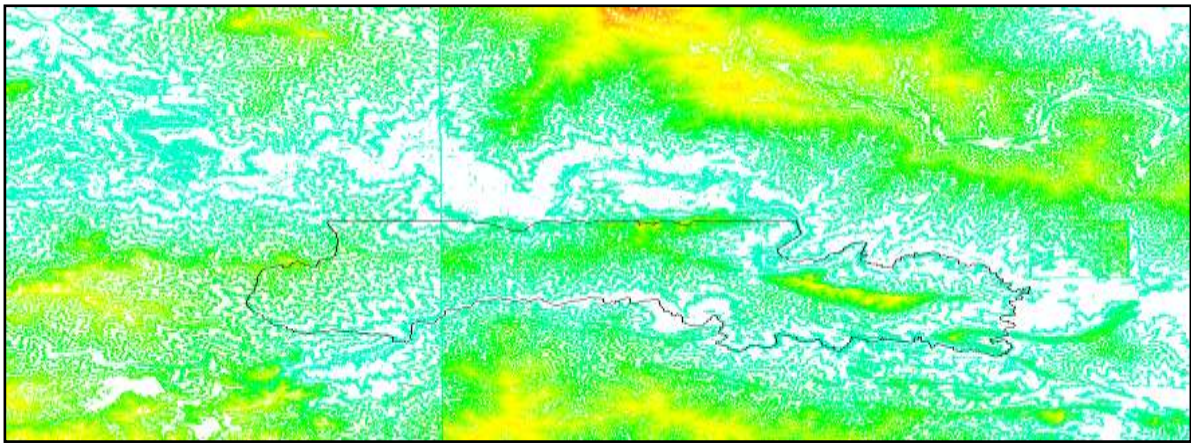

Figure 7. Extraction of Contours of the study area from CARTOSAT-1 DEM in ArcGIS software

4.1 Study Area map

The LISS-III camera used in IRS P6 satellite is a medium resolution multi-spectral camera operating in three spectral bands (B2, B3, B4). Each band is a set of data file values for a specific portion of the electromagnetic spectrum of reflected light or emitted heat (red, green, blue, near-infrared, infrared, thermal, etc.) or some other user-defined information created by combining or enhancing the original bands, or creating new bands from other sources. Tiff image was generated from LISS III MSS bands 2, 3, 4 using Erdas Imagine software.

Geo-referencing is the process of assigning map coordinates to image data. The image data may already be projected onto the desired plane, but not yet referenced to the proper coordinate system. The tiff image is then geo referenced to UTM with WGS 84 as datum and spheroid.

Many satellite images used cover a large area, while the actual area being studied can only cover a small portion of the image. To save on disk space and processing time, a subset is created of the entire data set. Subset of the

required area covering the geo coordinates ranging from latitude 6°12'16'' N to 16°30'1'' N and longitude 74°45'18'' E to 75°44'58''was created which is shown in Fig. 8.

Figure 8. Topographical map of the study area

4.2 Supervised Classification for Landuse/ Landcover identification

Supervised training is closely controlled by the analyst. In this process, pixels is selected that represent patterns or land cover features that you recognize, or that you can identify with help from other sources, such as aerial photos, ground truth data, or maps. Knowledge of the data, and of the classes desired, is required before classification. In supervised training, it is important to have a set of desired classes in mind, and then create the appropriate signatures from the data. Ground truth data are considered to be the most accurate (true) data available about the area of study. They should be collected at the same time as the remotely sensed data, so that the data correspond as much as possible. In command area, a classified image is a land cover map, showing vegetation, waste land, water body, settlements etc.

Supervised Classification was performed by classifying the pixels into different classes like,

- Settlement
- Agriculture
- Water
- Deep vegetation
- Low vegetation
- Scrub land
- Waste land(The classified image is show in Fig. 9)

From the classified map, it is found that the study area is predominantly having the Agricultural area followed by the poor vegetation. Less than 10% of the area is covered by the open scrub land which comes under the reserved forest area. Settlements are seen in a clustered manner which mainly concentrated in the town areas.

4.3 Contour map

The base maps (Toposheets) are digitized to get the contour lines. From the M.S.L. the study area lies between 500 m to 780m elevation. It is shown in Fig. 10.

4.4 Slope map

The contour map is processed in ERDAS Imagine 9.1 software and slope map is generated. It is observed that the command area is having the highest slope in the open scrub areas and the agricultural area is lying in the flat terrain. Slope map is shown in Fig. 11

4.5 Digital Elevation Model

Digital Elevation Model (DEM) is created using the contour values and the result is displayed in Fig. 12. The DEM is displayed in the Virtual GIS Viewer of ERDAS Imagine 9.1 software for the visual interpretation of the elevation variations of the study area topography.

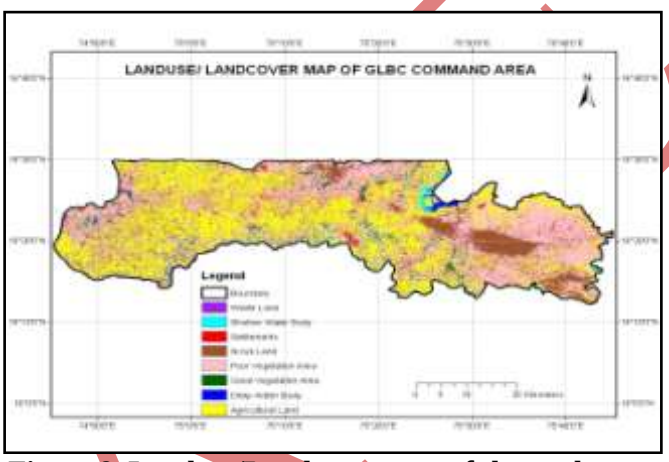

Figure 9. Landuse/Landcover map of the study area

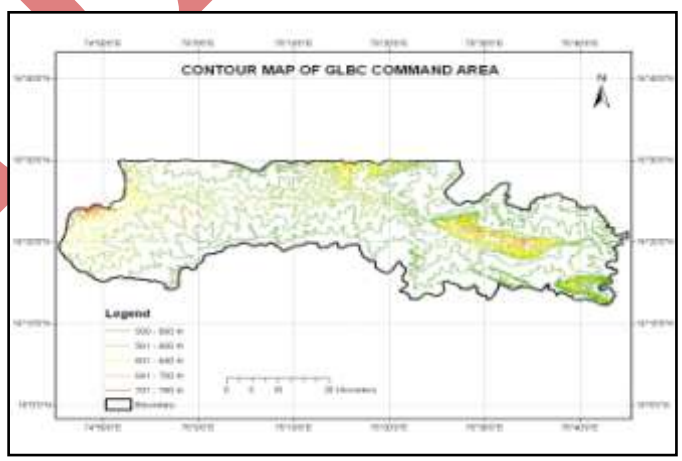

Figure 10. Contour map of the study area

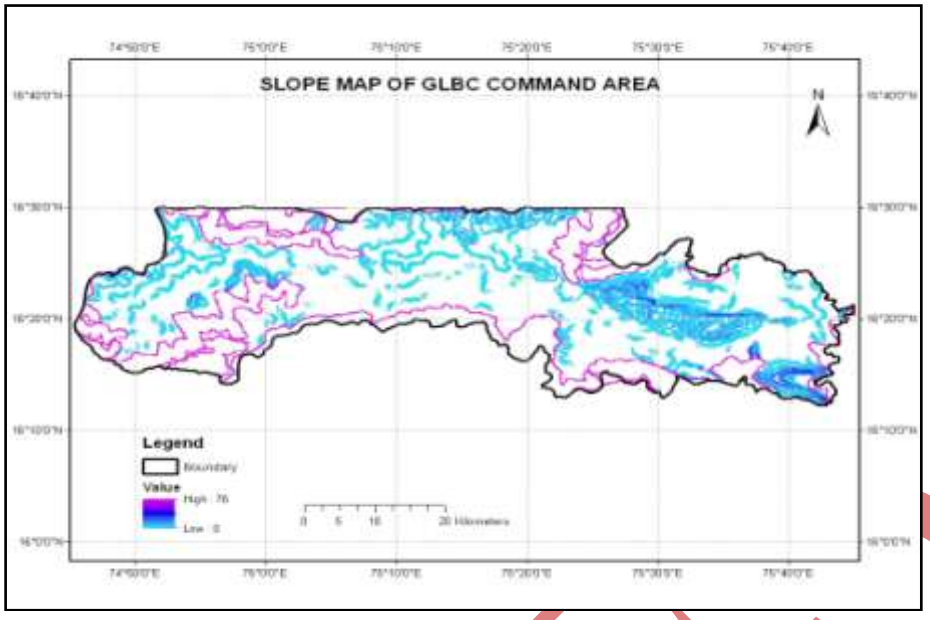

Figure 11. Slope map of the study area

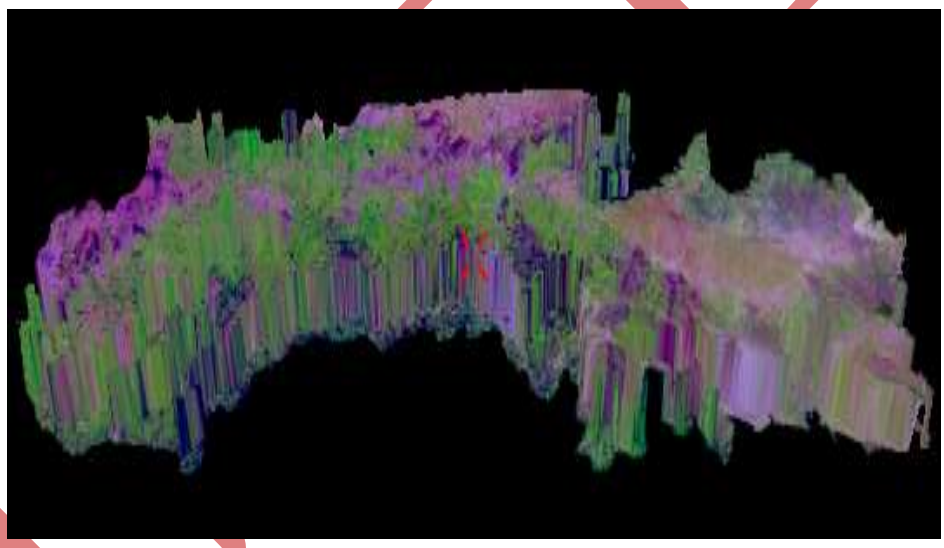

Figure 12. Digital Elevation Model of the study area

4.6 Drainage map

A drainage map is a plan of all streams or river systems in a drainage basin. It presents some characteristics of drainage basins through drainage pattern and drainage texture. It is possible to deduce the geology of the basin, the strike and dip of depositional rocks, existence of faults and other information about geological structure from drainage patterns. Drainage texture reflects climate, permeability of rocks, vegetation, and relief ratio, etc.

In this study the ordering of streams is done using the Horton's method because it is considered to be the most suitable ordering method for flat terrain. As the study area is a relatively flat, Horton method is adopted. The streams are ordered and the drainage map has been generated (shown in Fig. 13). By using the stream ordering,

the drainage morphological characteristics are calculated. There are various mathematical ratios are applied for analyzing the drainage morphology. They are calculated using ArcGIS Spatial Analyst tool.

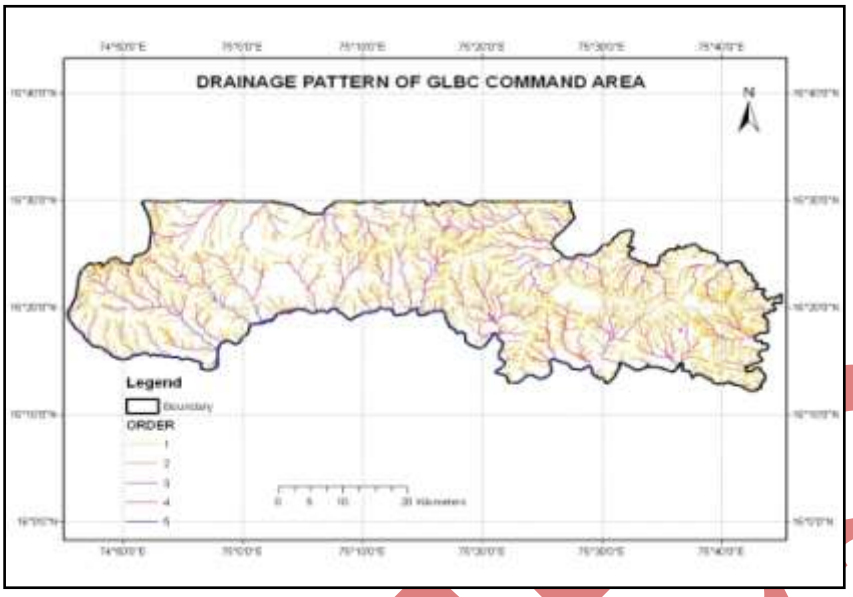

Figure 13. Drainage map of the study area

V CONCLUSION

The hydrogeology and geomorphology of any area can be studied by the extracted layers as contour, drainage, slope, landuse/landcover and irrigation are very important to study. The RESOURCESAT-2 LISS III data and the CARTOSAT-1 DEM are available as open source data which can be readily used by hydrologists and geomorphologists. The satellite imagery derived landuse/landcover map will give the surface coverage of the natural and manmade features which can be used to study and estimate the surface water availability. The drainage pattern and the slope map will furnish the information about surface and sub-surface morphology. Contour and DEM products of CARTOSAT-1 data will help to know the surface and groundwater flow of any area, similarly the drainage and contour will give the information regarding and topology of the area. Thus it is concluded that the satellite imageries and toposheets can be used as an efficient spatial datasets for extracting the morphological and topographical information in case of using the Spatial Information Technologies.

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