International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2015 Vol. 5 (2) May-August, pp. 18-25/Singh
Research Article

TERRAIN EVALUATION: AN APPROACH USING REMOTE SENSING &GIS TECHNIQUES, IN REWA DISTRICT, M.P., INDIA

***Vimla Singh**
Department of Geography, GIS & RS Division, University of Allahabad, Allahabad, India
**Author for Correspondence*

ABSTRACT
Remote Sensing and GIS provides geospatial techniques to assess, monitor and evaluation of terrain. It is essential to monitor the changes in the status of terrain and assess the dynamic of change over the space and time. The advancement in the field of GIS and Remote Sensing enable us to terrain evaluation. An integrated approach with Remote Sensing and Geographic Information Systems (GIS) technique was adopted inevaluationof terrain characteristics such as topography, drainage and land use pattern of the study area.Terrain and its evaluation for a particular aims come underthe sub-branch of geomorphology i.e. AppliedGeomorphology. Terrain evaluation is very vital for landuse planning to depict the land suitability. This paper focuses on the study ofthe terrain, major land features and to provide an overview of RS and GIS in terrain evaluation of Naina – Gorma river basin of Rewa districtof Madhya Pradesh, India.

Keywords: *Remote Sensing, Geographic Information Systems, Geospatial Techniques, Terrain Evaluation, Geomorphology*

INTRODUCTION
This study is carried out with the help of GIS and Remote Sensing techniques to know the characteristic of the land surface of the study area. Terrain, or land relief, is the vertical and horizontal dimension of land surface. Geomorphic resources are the natural phenomena on the earth's surface, which have originated due to the active geomorphic processes. The resources directly or indirectly control various anthropogenic activities to a great extent. Geomorphic resource study and analysis are very much essential to understand the availability of natural resources which in turn influence the probability of economic and social development of the region (Prakasam and Biplab, 2012). Evaluations of these resources are considered essential for implementation of any type of regional and economic planning. Terrain evaluation is very important for land use planning as it depicts the land suitability, e.g. while agriculture tends to favors flat fertile areas of little aesthetic charm, recreational and residential developments prefer the proximity of hilly or rocky areas (Nageshwar and Rumki, 2011).Digital elevation model (DEM) is a raster representation that used to determine the features of drainage networks and slope of drainage network and to determine the characteristics of basins.

Remote Sensing has been used for acquiring large volume of spatial data for inventorying, monitoring and gaining a new site into the complexity of natural system. Remote Sensing has been widely used in many part of the world, many institute and agencies are working in this field. It has broad application in many fields like terrain evaluation, ecosystem analysis, vegetation composition, biomass estimation, resources management and watershed management. Geographic Information System (G.I.S.) is a computer data processing and analysis system for the geographic information from different origin. GIS and Remote Sensing is very useful in the formulation and implementation of the spatial and temporal changes which are essential components of regional planning of basin ecosystem to ensure the sustainable development. So these techniques are the most effective in evaluation of terrain characteristics of the study area through the remote sensing imagery corrected from satellites.

Remote sensing data, including those derived from aerial photographs, are used for terrain evaluation and landform studies (Thomas, 1999). Remote Sensing images are used for the study of fluvial and form, rock types, geological structures, water bodies and stream networks. The terrain of a region largely determines its suitability for human settlement; flatter, alluvial plains tend to have better farming soils than steeper,

rockier uplands. Understanding the terrain of an area enables the understanding ofwatershed boundaries, drainage characteristics, water movement, and impacts on water quality. Understanding terrain also supports on soil conservation, especially in agriculture. Land use of a region isdirectly influenced by the terrain characteristics.

MATERIALS AND METHODS

Study Area

The study area is extended in the Rewa district of the state Madhya Pradesh and its extension is 24° 35' 00'' N to 24° 57' 30'' N and 81° 37' 30''E to 82°15' 00'' E. The adjoining district of the area is Allahabad.

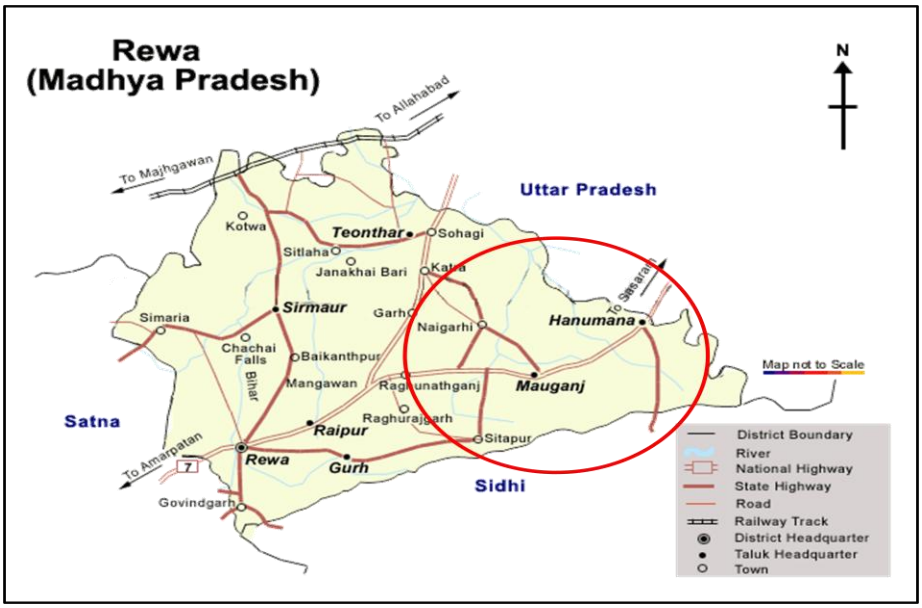

Figure 1: (a) Location of the Study Area

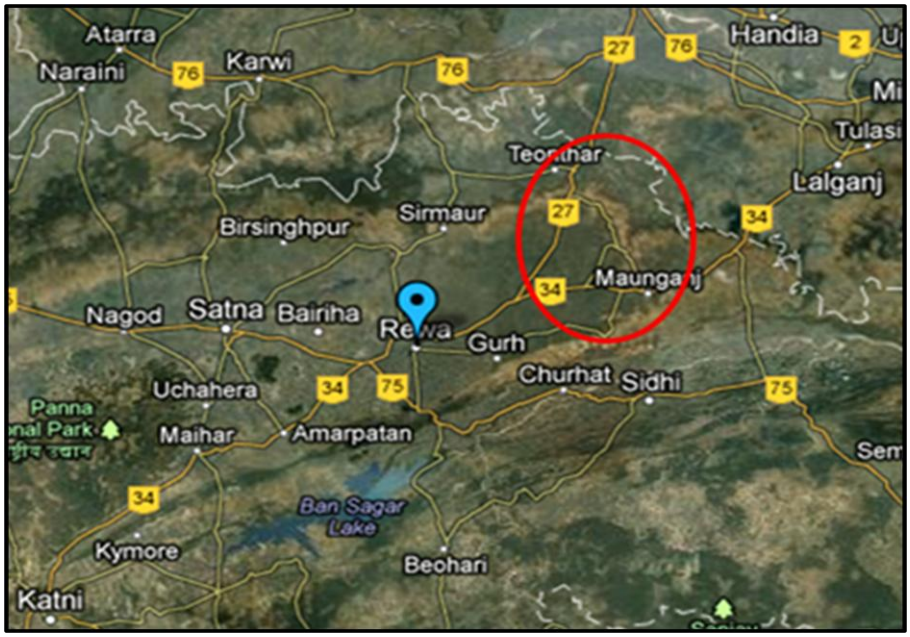

Figure 1: (b) Location of the Study Area on Google Earth Image

The basin boundary of the area mainly comprises in the Rewa district, Naina and Gorma rivers are the Tributaries of the Belan River and study area includes the river basin of Naina and Gorma. The study region is characterized by sub-humid warm subtropical monsoon climate with hot-moist climate and cold-dry winters. The region experiences highest temperatures in May. The Mean maximum temperature of the summer season is about 42.9^{o}C and Mean minimum temperature of the winter season goes up to about 6.4^{o}C. Figure 1 (a) & (b).

Aim and Objectives

The present study is carried on with the following aim and objectives-

- Study the main characteristics of geomorphic feature of basin and preparation of geomorphic map.
- Drainage map and DEM preparation.
- Explain the role of watershed analysis.
- To suggest appropriate mitigate measures for the area.

MATERIALS AND METHODS

Methodology

Topographic Sheets 63H/9, 63H/10, 63H/13, 63H/14, 63L/1 and 63L/2 of SOI on 1:50,000 scale used for delineation of basin boundary of the study area. Digitization of contours and drainage of the study area have been completed with the help of ILWIS 3.3 software for the study purpose. Datum WGS 84 is used in coordinate system. Contours are lines that connect to the area having similar elevation. Contour map helps in evaluation of geomorphology of the study area. Drainage in the study area belongs to 7th order stream, Strahler (1964) stream ordering method used in delineation of stream ordering of drainage.

In the drainage basin analysis of the study area the first step is to determine the stream orders. In this study, the channel segment of the drainage basin has been ranked according to Strahler's stream ordering system. According to Strahler (1964), the smallest fingertip tributaries are designated as 1st order streams. Where two first order streams join, a stream segment of 2ndorder is formed, where two of order 2nd join, stream segment of order 3rdis formed, and so forth. The trunk stream through which all discharge of water and sediment passes is the highest order of stream segment. The study area has a 7thorder drainage basin (Figure 2). The total number of 2966streams identified of which 2383are 1st order streams, 451 are 2nd order, 102 are 3rd order, 22 in 4thorder, 6 in 5th,3 in 6thand 1 is indicating 7th order streams.

RESULTS AND DISCUSSION

Drainage System and Drainage Pattern

The study region is drained by two major river Naina and Gorma, tributaries of Belanriver. Naina and Gormariver covering a distance of 77 km & 65 km respectively. The Nainariveris the largest tributary of Belan river followed by the Adwa (110 km) Figure 2.

The source stream of Naina - Gorma, while coming out of the Kaimur range have formed dendritic drainage pattern over Rewa plateau. Drainage map of the study region denotes the fact that drainage largely has been controlled by both structure and lithology. **"**Stream order is a measure of stream in the hierarchy of tributaries" (Leopold *et al.,* 1969), where in the branching pattern of stream segments of all orders within given watershed are analyzed.

Drainage pattern means the 'form' (geometrical form) of the drainage systems and spatial arrangements of streams in particular locality or region. Drainage trend patterns of stream network of the basin have been observed as mainly dendritic type which indicates the homogeneity in texture and lack of structural control. This pattern is characterized by a tree like pattern with branches that intersect primarily at acute angles. While in some parts of the basin represent parallel and radial types trend pattern indicate that the topographical features are dipping, folded and highly jointed in the hilly terrains. A parallel drainage pattern consists of tributaries that flow nearly parallel to one another and all the tributaries join the main channel at approximately the same angle, parallel drainage suggest that the area has a gentle, uniform slopes and with less resistant bed rock, a radial drainage pattern forms when water flows downward or outward from a hill or dome(Rao, 2010). The radial drainage pattern of channels produced can be linked

to a wheel consisting of a circular network of parallel channels flowing away from a central high point (Jensen, 2006). The properties of the stream networks are very important to study the landform making process (Strahler and Strahler, 2002).

The drainage pattern of the study area is dendritic and study area has 7th order stream. It is well known that the stream head location and drainage density will change progressively over the time of span. Valley gradient increases initially with increase in stream order and then decreases. Increase in slope length with stream order importantly is the reason for such relations to mean gradient and steam order. In case of expanding drainage network, generally the slope length and drainage density increases. Slopes in drainage basin undergo evolution in response to the change in local relief. Slope and aspect play the important role in determining the shape of a surface.

Table 1:Stream Order & Stream Number of Drainage Basin

S. No	Totalno.of Streams	Stream Order I	Stream Order II	Stream Order III	Stream Order IV	Stream Order V	Stream Order VI	Stream Order VII
Stream Number	2966	2383	451	102	22	6	3	1

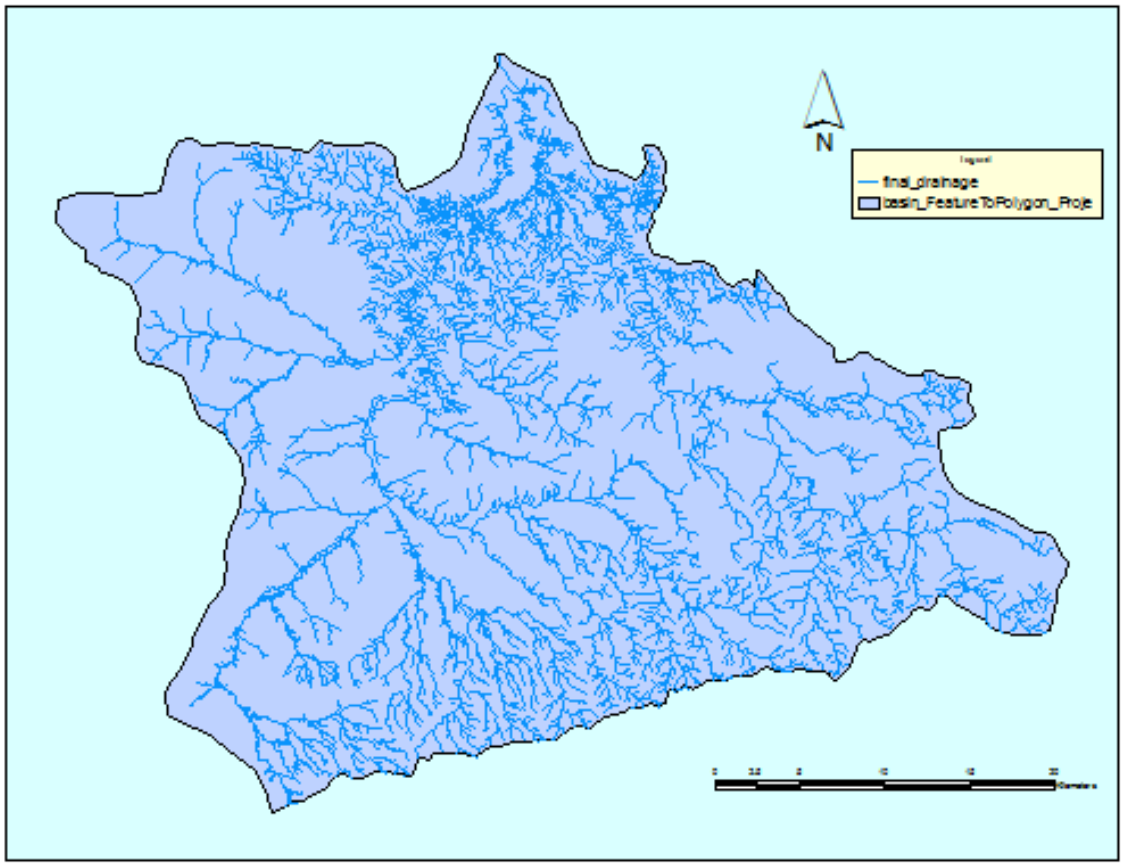

Figure 2: Drainage Map of the Study Region

Relief and Geomorphology

It is apparent from the generalized geomorphic map (figure 3), Naina- Gorma basin is characterized by mainly five basic geomorphic units viz. Plain, Vindhyan Upland, Rewa Plataeu, Rewa Escarpment Zone, and Kaimur Range. The Naina-Gorma basin occupying a synclinal trough probably of Upper

Vindhyanagejagged between Mirzapur hills in the North and Kaimur hills in the south, parallel to Son river. The general relief records varying in altitude in different part of the basin viz.,<140 m in Northern part, 140- 300 m in Central part, 300-360 m in Western part, 360-400 min Eastern part and 400- 480 m in the southern part of the basin. The general topography of the region being hilly and plain is very complex. The Naina basin is marked by narrow and broad valley after its confluence with Oddariver. The region is highly dissected by various streams.

Plain countries has range below <140 m, suitable for agricultural purpose, **Vindhyan Upland** belongs to range between 140 – 300 m, contains major forest area, including open mixed forest, dense scrub and open scrub. **Rewa Plateau** having range between 300 – 360 m, having settlement, major water bodies and **Kaimur Range** having range between >360 m, most of the source streams of the basin originated from this range. This part is composed of Quarzitic sandstone, greenish flagstones, shale and sandy siltstone.

The present relief features of the entire basin consist of different type of landforms ranging from south to north. Almost flat and rolling surface of the basin area having broad and flat river valleys, abrupt decent of river courses along the foreland of Rewa plateau **i.e. Rewa Escarpment** making waterfalls of the varying dimensions, ranging from a few meters to 148 m., Rewa deep and narrow gorges. RewaEscarpment having free face element of sandstone, shales and siltstones, highly gullied foothill zone farming badlands, isolated flat top hills resembling mesas and butts.

Morphometric parameters are key features in watershed analysis and terrain evaluation of river basin. I have been analyzed the morphometric parameters in the published paper entitled "Linear Aspects of Naina – GormaRiver Basin Morphometry, Rewa district, M. P., India" (Vimla*et al.*, 2013), in International Journal Geomatics and Geosciences. Linear aspect morphometry includes stream order, stream length, bifurcation ratio, mean-bifurcation ratio etc. these all morphometric parameters of river basin calculated and described in the paper. So here this study is carried out for the study of land use features and geomorphic unit of the region.

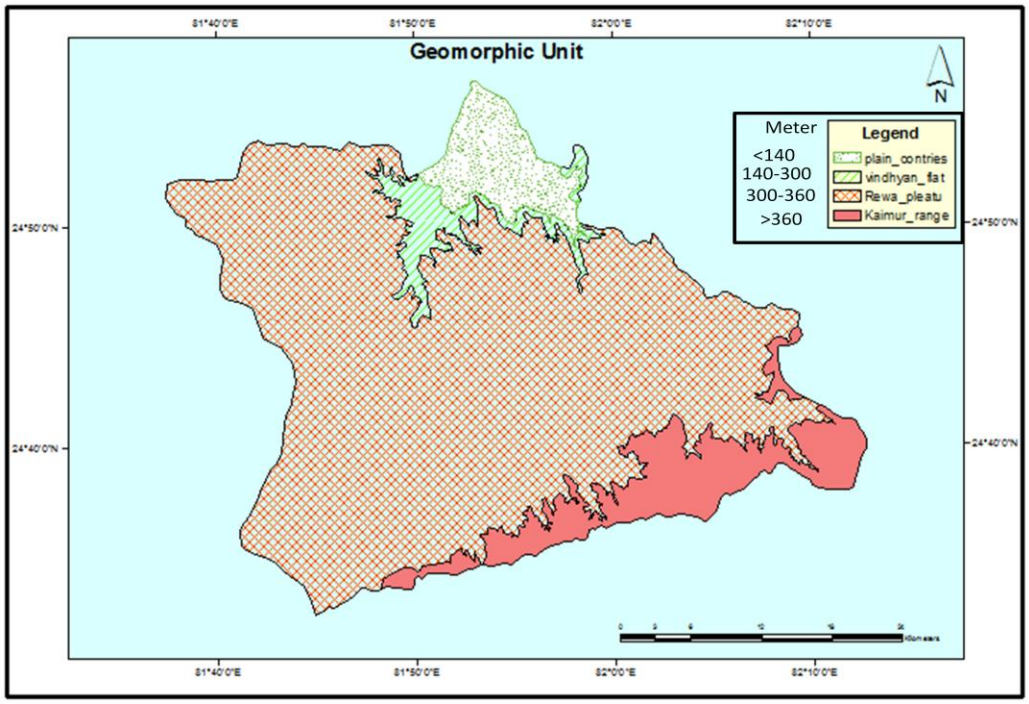

Figure 3: Geomorphic Map of the Study Area

DEM

A Digital Terrain Model (DEM) is a model providing a representation of a terrain relief on the basis of a finite set of sampled data,DEM, a raster data set containing elevation information. Terrain data refers to

measures of elevation at a set of points of the domain plus possibly a set of non-crossing line segments with endpoints. Elevation data or z data is treated as a cell value or a point data attribute ratherthan as a coordinate. Minimum elevation of the study area is northern and centralpart (i.e 28 m value shows infigure 4), medium elevation part of the study area is North eastern, western and southern western part (value ranging between 28-409m) and maximum elevation area of the study is the eastern region(value is 409m), (Figure 4).

In this study, 1/50,000scaled topographic maps containing water accumulation basin were used. Satellite remote sensing data can provide operationally digital elevation models (DEM) through radar interferometer or stereoscopic optical images and then further it analyzed through Geographical Information System (GIS) techniques. Digital elevation models (DEM) are efficient and effective methods used to determine the features of drainage networks and like size, length, and slope of drainage network and to determine characteristics of basin and sub-basin (Garbrecht and Martz, 1999). Elevation information of each contour was defined in geographic information system and according to these values, DEMs can be generated from contour lines, from Space Shuttle Radar Topography Mapping mission(SRTM), or from stereo satellite data, from Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER).

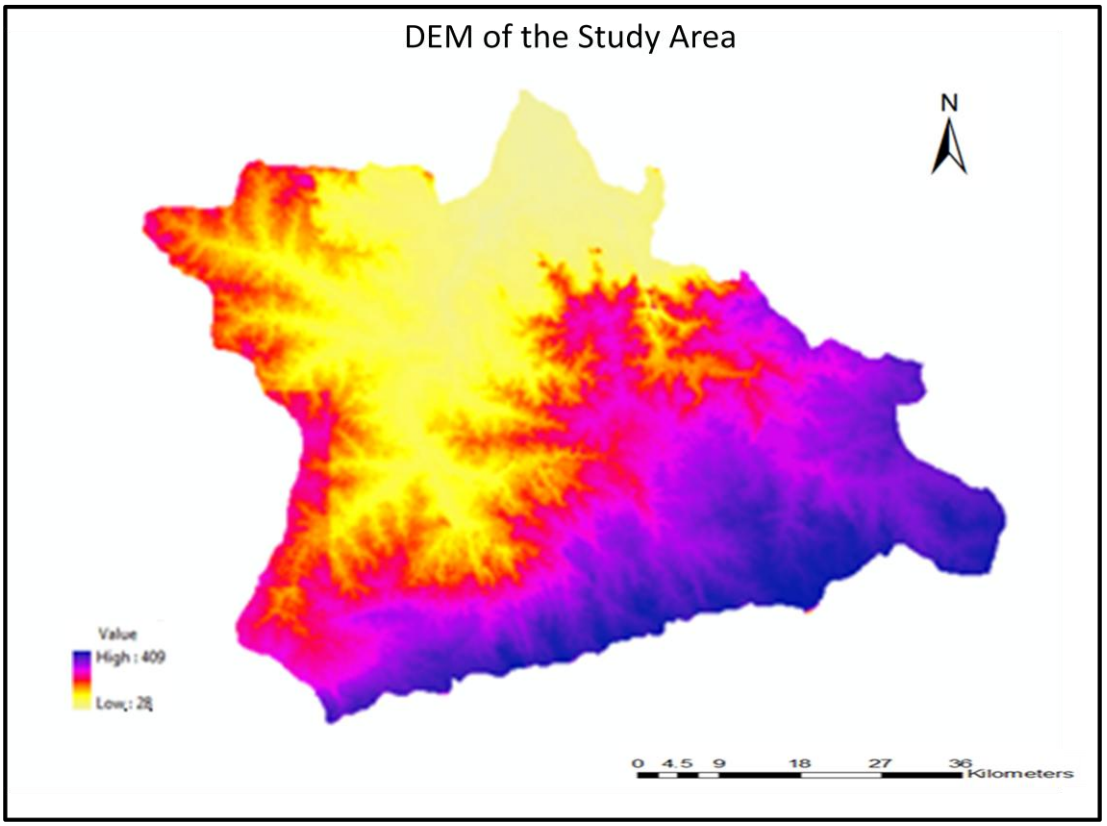

Figure 4: Digital Elevation Model (DEM) of the Study Area

Land Use Pattern

Besides the delineation of geomorphic features the remote sensing studies have been extended to demarcate the land use pattern of the study area. Standard remote sensing methods were adopted to demarcate various zones of natural and manmade patterns. For this purpose the terminology used is as per the remote sensing norms. In the study area, the northern part is full of fluvial land forms, and southern partis full of rocky landforms. Totally the landforms of the study area having undulating topography.

In study region infrastructural facilities are less developed. For irrigation of crops peoples are depended on river and ponds, there is no more tube wells, handpumps, in some part these facilities available but due to intense hot summer, the water level of the area becomes too below, so these tube wells, handpump, ponds becomes dry or not working and year by year populations were increased.So recently theagriculture fields are slowly in decreasing stage, and agriculture lands are transformed to built-up lands. Water scarcity is the main problem in the area, mainly in summer season for drinking and irrigation purpose. There are only 2.82% river bodies and 0.63% other water bodies like lake, and ponds are presents, of the total study area. The pie chart (figure 5) is drawn by supervised classification level-IIby using IRS LISS III satellite imagery of the study area, shows the distribution of land use in study area.The total build up area according to land use /land cover classification level - II of the study area, is 21.10% of the total study area.

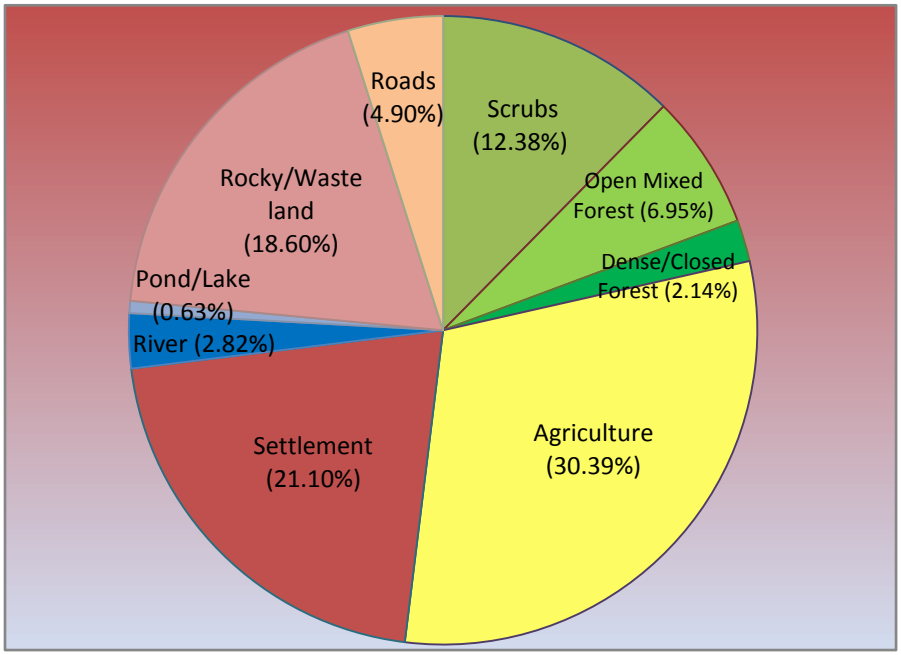

Figure 5: Land distribution of the study area

Conclusion

This study is carried out with the help of GIS and Remote Sensing, which play vital role in terrain analysis and provides a synoptic view of the whole study area. Various studies have been reported across the world, illustrating the application of GIS in the evaluation and management of landform, soil, and water resources. There is a continuous changes in the environmental and climatic conditions due to the urbanization and industrialization these changes affect the river area and the surrounding ecosystem including flora & fauna. Terrain analysis is a fundamental process in providing predictive information about the terrain and environment. With the help of above study we can evaluate and monitor the suitability and condition of soil and terrain characteristics for the agriculture purpose. The study area is has very dissected topography, northern part of the study area is suitable for agriculture crop and productivity is good due to flat terrain and availability of maximum water resources for irrigation purpose. Most part of the study area having sandy, rocky and bare soil, to be better for settlement not for agriculture purpose. With the help of aforestation and social forestry, the barren land can be converted in to fertile land. In the study area drainage shows dendritic type trend pattern and has been controlled by both structure and lithology. The river basin exhibits different pattern geomorphologic, hydrological and physical setup of geomorphic terrain, the river provides evidences of parallel transverse faults. The geotectonic movement controls the drainage pattern, topography and ground water.

ACKNOWLEDGEMENT
The author is extremely grateful to UGC for providing the Fellowship.

REFERENCES
Burrough P.A. (1986). Principles of Geographical Information Systems for Land Resources Assessment.Oup 147-166.
Gupta HariShanker (2001). Terrain Evaluation For Eco-Restoration Using Remote Sensing And GIS, Review Article, Department of Geography, University College, M.D. University, Rohtak.
NageswaraRao K, LathaP, Swarna Kumar P, Arun M and Hari Krishna (2010). Morphometric analysis of Gostani river basin in Andhra Pradesh State, IndiaUsing Spatial Information Technology.*International Journal of Geomatics and Geosciences***1**(2) 179-187.
Prakasam C and BiswasBiplab (2012). Evaluation of Geomorphic Resources Using GIS Technology: A Case Study of Selected Villages in Ausgram Block, Burdwan District, West Bengal, India.*International Journal of Geology, Earth and Environmental Sciences* 193-205.
Prasad Nageshwar and SarkarRumki (2011). Terrain Evaluation - A Review.*International Journal of Current Research***3**(7) 296-301.
Punithavathi J, Tamilenthi S and BaskaranR (2011). Geologic and Geomorphologic Investigation of Cauavery River Basin in Thanjavur District, Tamil Nadu, India Using Spatial Technology.*Archives of Applied Science Research* 358-366.
Semere Solomon(2003). Remote sensing and GIS: Applications for groundwater potential assessment in Eritrea, doctoral dissertation, environmental and natural resources information systems, royal institute of technology Stockholm, Sweden.
Singh Savindra (1991).*Geomorphology* (PrayagPustakBhavan) Allahabad.
Singh Vimla and DubeyAlok(2012). Land Use Mapping Using Remote Sensing & GISTechniques In Naina - Gorma Basin, Part Of Rewa District, M.P., India. *International Journal of Emerging Technology and Advanced Engineering* (Issn 2250-2459) **2**(11) 151-156.
Singh Vimla and DubeyAlok (2013). Linear Aspects of Naina-Gorma River BasinMorphometriy, Rewa District, Madhya Pradesh, India.*International Journal of Geomatics and Geosciences***3**(2) 364-368.
Tamilenthi S and Baskaran R (2012). Digital Elevation Model (Dem) For Cauavery River Basin in Salem District, Tamil Nadu, India Using Spatial Technology.*International Journal of Current Research* **4**(02) 008-011.
Zende M, Abhijit R, Nagarajan PK and Deshpande KR *et al.*, (2012).Remote Sensing and GIS Applications for Terrain Evaluation and Land Resources Assessment in Yerala River Basin, Western Maharashtra, India.*International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)* 17-24.