REMOTE SENSING AND GIS APPLICATIONS FOR TERRAIN EVALUATION AND LAND RESOURCES ASSESSMENT IN YERALA RIVER BASIN, WESTERN MAHARASHTRA, INDIA

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ABSTRACT

The integration of remote sensing methodologies with GIS provides a powerful way of extracting land features inherent in satellite images. This paper focuses on the study of the terrain and major land features of upper Krishna Basin (Yeralu River) using remote sensing and Geographical Information System (GIS). Representation of the terrain is based on the digital elevation model (DEM). The Landsat 7 TM and ETM+ images of the study area were processed and interpreted to extract information about land-resources delineation (forest-vegetation cover, water resources, and agricultural and residential areas) in the region. The information provided in this study has many areas of application, including hydrological watershed analysis and modeling, environmental management and planning, landform and natural resource evaluations, geological and geo-structural study.


INTRODUCTION

Geographical Information System coupled with Remote Sensing has proved a powerful tool in the field of land evaluation and management. Various studies have been reported across the world, illustrating the application of GIS in the evaluation and management of landform, soil, and water resources. The spatial pattern of relief yields the topographic mosaic of a terrain and is normally extracted from the topographical maps which are available at various scales and are rarely good inputs for terrain analysis. Survey of India topographical maps, at a variety of map-scales are the most readily available data source for terrain analysis.

A DEM has been defined as a regular gridded matrix representation of the continuous variation of relief over space (Burrough, 1986). The attraction of a simple matrix of elevation values was one of the most important reasons for its uptake in the early 1970s as a model suitable for landscape analysis (Evans, 1972). As mathematical–statistical models can be easily built by well-defined algorithms, digital manipulation and visualization of database becomes easier. Thus, as a model of surface form, the steady and widespread use of DEM may be attributed to its easy integration within a GIS environment (Weibel and Heller, 1991). Remote sensing data, including those derived from aerial photographs, are used for
terrain evaluation and landform studies (Thomas, 1999). RS-images are used for the study of fluvial
landform, rock types, geological structures, water bodies and stream networks.

MATERIALS AND METHODS

Study Area

The study area comprises of an upland watershed and a major tributary of Krishna River in the upper
Krishna basin. The study area lies in west part of Maharashtra state bounded by Latitude 16° 55’ to 17°
28’ N and Longitude 74° 20’ to 74° 40’ E. falling in part survey of India topographical sheet no 47 K –
5, 6, 7, 8, 10, 11, 12, 47 L - 9 on the scale 1:50,000 (Fig. 1) it covers total area of 3035 km² includes two
districts (Satara and Sangli) in Maharashtra. These districts experiences a tropical wet-dry climate
characterized by alternating wet and dry spells. The study area receives rainfall during South-West
monsoon from June to September. The distribution of rainfall is not even all over the area. Western part
of the river basin, in Karad and Koregaon taluka area receives heavy rainfall (above 1200mm). While
eastern part of the basin comes under rain shadow zone. The average annual rainfall increases from 600
mm in the western side to 350 mm in the east side. The rainfall is scattered. The numbers of rainy days in
a season are less. It has been observed that about 20% rainfall is received during post-monsoon and by
thunder showers in the month of May. The temperature may rise up to 42°C in summer and may fall
down to 8°C during winter.

Fig. 1 : Location map of the study area
Geology

Geology of the area is dominantly covered by basaltic rock. The area has suffered a lot by tectonic movement in the past as evidenced by varying fold, fault and lineament association with hills located in the western side of study area. Area is covered by the basaltic flows related to Deccan Volcanic activity of Cretaceous to Eocene age. They generally exhibit step like topography and hence are known as Deccan Trap. These flows vary in thickness of individual flow from few meters to 40 meters. They extend for a considerable distance. The basaltic lava flows are almost uniform in mineralogical and chemical composition (Fig. 2).

The basaltic flow can be classified as Compact, fine-grained, massive basalt and vesicular, amygdaloidal basalt, the vesicles are filled with secondary minerals like Quartz, chalcedony and calcite etc. Comparatively soft, friable and break more easily. The boundaries of basalt flows have been identified on the basis of presence of red beds, change in jointing and weathering pattern, ropy surface etc. Another criteria which can be used for the identification of various basaltic flows is the development of flat surface at various altitudes. These flat surfaces may be taken as flow tops. Basaltic flows are often separated by red to brown colored clayey rock known as ‘red beds’. The thickness of red bed varies from few centimeters to more than 2 meters. It also gradational relationship with the top section of underlying flow. These rocks possess negligible primary porosity but are cause to be porous and permeable due to secondary porosity by fracturing and weathering.

In high rainfall are and under good drainage condition on weathering of basalt, laterite is formed. During weathering process silica, alkalies and alkaline earths have been leached away leaving behind alumina, iron, manganese and titanium. Laterite shows vermiculite or pisolitic structure. Alluviums deposited are more or less stratified deposits of gravel, sand, silt and clays deposited by streams and river. In these districts alluvial deposits are well developed along the bank of the main rivers. They vary in thickness from few meters along Warna, Morna, Yerala, Agrani, Man and Bor rivers to 10.00 to 30.00 meters along Krishna river. These deposits commonly show features like graded bedding, current bedding and cross bedding. At the base of these deposits fine graded sand and silt is present along with kankar nodules locally known as Mann.

GEOMORPHOLOGY

About 11% of the area in Yerala Basin is hilly & highly dissected, 56 % is moderately dissected & 33% is undissected & valley filled. There are 16 designated watersheds in Yerala River Basin but major sub-watershed are nine. Geomorphology is the study of forms and process of landforms, which are the products of various exogenetic and endogenetic forces. Landforms play a significant role in land resource mapping, watershed studies, terrain evaluation and soil classification (Fig. 3).
Objectives and Methodology

The study was carried out with the following objectives:

1. To extract information about land-resources delineation (forest-vegetation cover, water resources, and agricultural and residential areas) in the region

2. To suggest appropriate development measures for the area

The drainage map, boundary map and contour map of the sub Watershed area were scanned and then imported into Arc-GIS as image files and were digitized, geo-referenced and then overlaid with the imagery after selecting the co-ordinates of GCPs. To achieve the above objectives, the following methodology and procedure is adopted in the present study (Fig. 4).
RESULTS AND DISCUSSIONS

The terrain evaluation of the area has been carried out by various thematic maps (geology, geomorphology, drainage network, drainage density, slope, relative relief, land-use, soil thickness, and rainfall Fig. 8). It has been prepared on the basis of field information, interpretation of SOI topographic sheets and remote sensing data.

Area of the watershed area was calculated to be 3035 sq. km. The drainage pattern of study area is dendritic and it is a 7th order stream. It is fairly known that the stream head location and drainage density will change progressively over time. Valley gradient increases initially with increase in stream order and then decreases. Maximum grading is found in second to fifth order streams. Increase in slope length with stream order essentially is the reason for such relations to mean gradient and steam order. In the 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 a vital role in determining the shape of a surface.
Elevation Zone Map was derived from DEM. The altitude zones ranges from 500 meters to 1250 meters above sea level. The land-use/land-cover data show that about 47% area is under forest cover and non-agricultural, but the land capability analysis showed that 10,700 ha (71%) area is suitable for agriculture (Fig. 6 & 7). This indicates that more area can be brought under cultivation with improvement in soil conservation and management practices.
Fig. 6: Unsupervised classification of Landsat 7 Image

Fig. 7: Landuse/Landcover of Yerala river basin

Fig. 8: Slope map
CONCLUSIONS

Terrain analysis remains a fundamental process in providing predictive information about the terrain and environment. A large number of data was compiled and new layers and maps as well as a relational database were produced. A qualitative as well as the quantitative terrain analysis of the region was made based on above mentioned map. Decisions on land use have always been part of the evolution of human society. In the past, land use changes often came about by gradual evolution. A multidirectional approach need be adopted to effective use for watershed development. It can also be useful for water conservation by identifying and providing one or more of the schemes like tiny check dams, percolation tanks, subsurface dykes, contour canals, duly plugging/nala bunds etc. in streams and by vegetative support (afforestation), terracing, application of geotextiles etc. in soil cover, wherever suitable or necessary. In order to recommend the design and size of a particular type of intervention scheme, site-specific and detailed field studies are required.

REFERENCES