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Geomorphological mapping through Remote Sensing and GIS Techniques for Janjhavathi River basin, Odisha and Andhra Pradesh.

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Abstract

Remote Sensing and Geographical Information Systems (RS and GIS) technology play a major role in thematic map generation and integrated analysis for mapping, managing and monitoring the natural resources. RS and GIS technology have opened a new era in the field of applied geology. A remote sensing observation from space provides a synoptic view of terrain, thus provide ability in detecting lithology, land form and lineaments on the imagery. Remotely sensed satellite data have a benefit that is, the image data can be enhanced/manipulated for improving image interpretability with better accuracy. GIS has capability to visualize, enhance, manipulate, generate, store, integrate and analyse the thematic data. This study aims to map the geomorphological features in the Janjhavathi river basin based on visual image interpretation techniques. These maps would be useful for further analysis for natural resource planning, management and decision making.

Keywords:

Remote sensing;
Geographic Information;
Geomorphology;
Thematic map;
Visual interpretation.

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1. Introduction

. Remote Sensing and Geographical Information System (RS and GIS) technology has opened new vistas for mapping, arranging, administration, and checking of normal assets like land, water, soil, backwoods, mineral, and so on. Both elevated photos and satellite information based investigations have demonstrated their capacities in different fields like geographical, geomorphological and auxiliary mapping, ground water study, woods and soil mapping, arrive utilize arranging, catastrophe, water system and water asset administration (e.g., Krishnamurthy and Srinivas, 1995; Dar et al., 2010; Sivakumar et al., 2013; Sivakumar, 2013; Sivakumar, 2014; Bhowmick and Sivakumar, 2015). Point by point data can be extricated precisely from high-determination satellite information and expansive scale aerial photos. Additionally point by point data can be produced or spoken to utilizing the above information in a GIS. The interpretation of aerial

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photographs and satellite data for various resources applications has been successfully carried out in the country and it has proved its utility with respect to time and space (e.g., Drury and Drury, 2001; Sivakumar, 2012). Geomorphology gives the essential learning of event and assessment of various landforms. The succinct view gave by satellite symbolism encourages better valuation for landforms and help in the mapping of various geomorphic units. In this examination, remote detecting pictures have been broke down by the visual elucidation system, as this procedure is temperate, simple to learn when contrasted with the advanced investigation strategy. Visual understanding of remotely detected information is a basic advance to take in the system for different applications, and consequent to change over the deciphered maps into computerized frame for use in a GIS. Landsat 5 symbolism has been utilized for elucidation of geomorphological highlights.

1.1 Study Area:

Janjhavathi River is a tributary of Nagavali River having a catchment area of 813.91 sq.km and is an interstate river taking its origin from the hilly regions of Narayanpatna tehsil Orissa State, and enters in Andhra Pradesh near Banjakuppa village of Komarada mandal and joins Nagavali River10.00 km upstream of Thotapalli regulator near Gumpa village of Komarada mandal in Vizianagaram district. Most of its catchment laying is in Odisha state.

The study area falls in the Narayanpatna, Bandhugam, Lakshmipur, Rayagada tehsils of Orissa and Komarada mandal of Vizianagaram district in Andhrapradesh. Most of the river basin is covered in the Orissa state. The study area lies between 83^0 to 83^0 29" E longitudes and $18^0$45" to 18^0 61" 30' North Latitudes. The area is covered in the Survey of India toposheets 65M/4, 65M/8, 65N/1 and 65N/5 of 1:50000 scale and are used for delineation and digitization of the drainage basin boundary. Only small part comes on the 65M/4 area topomap and 20% comes on the 65M/8 topomap and the remaining area in the two topomaps of 65N/1 and 65N/5. The Jhanjavati is a small river. It originates from the hilly regions of Narayanpatana tehsil. Covering a winding path of nearly 60 kms within the koraput district of Odisha state, it meets the need of water in that region. A small river, the Jhanjavati and numerous streams enrich the valleys and land of the districts with green vegetation.

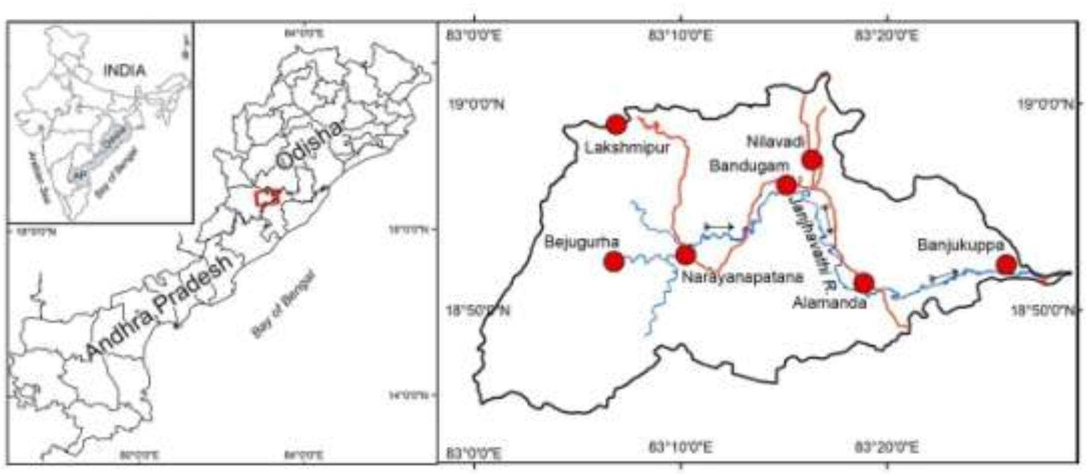

Figure1. Location Map of the Study area

2. Research Method

The investigation zone covers 4 numbers (65M/4, 65M/8, 65N/1 and 65N/5) of Survey of India (SOI) toposheets on 1: 50000 scale. These toposheets are geo-rectified and projected to polyconic projection (the Metric system units – meters are used as in the present study). The Janjhavathi river watershed boundary map has been scanned and saved in .jpg format and then it is imported into image format (.img) and referenced to polyconic projection using ERDAS IMAGINE 9.1 software. The study area boundary is digitized and overlaid on Mosaic toposheet and demarked the study area boundary on 1:50000 toposheet and verified by ground truthing, necessary corrections were made and checked in the field with the help of GPS. Image processing was carried out for Landsat 5 (Subset of the study area shown in Figure 1). After applying necessary image enhancement techniques (to improve the distinction between the features in the imagery shown in Figure 2), the landforms are delineated from geocoded Landsat 5imagery along with the available geological and geomorphology details. The ground truth verification was done in needy and problematic areas. The geomorphic units are delineated based on the image feature like shape, size, texture, color, structure, pattern, tone and association etc. Based on this, the identified geomorphologic features are structural hills, denudational hills, alluvial plains, pediment pediplain complex, pediment complex, pediment slope, valley fills, flood plain and water bodies shown in figure 3.

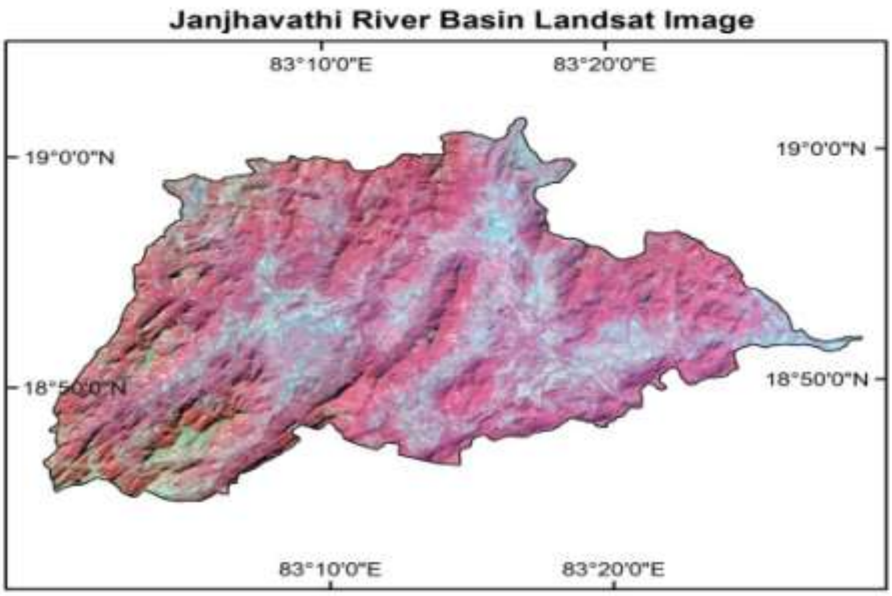

Figure2. Satellite imagery of the study area

3. Results and Analysis

The geomorphological map has been prepared on 1:50000 scale based on visual interpretation. Different landforms units were identified such as alluvial plains, denudational hill, flood plain, pediment complex, pediment slope, pediment-pediplain complex, structural hill, valley fill and water bodies (Figure.4) and these geomorphic units are grouped based on their origin (e.g., William D. Thornbury, 1995). The details are discussed in the subsequent sections.

3.1 Alluvial Plain

An alluvial plain is a largely flat landform created by the deposition of sediment over a long period of time by one or more rivers coming from highland regions from which alluvial soil forms. An alluvial plain is the larger area representing the region over which the floodplains have shifted over geological time.
As the highlands erode due to weathering and water flow, the sediment from the hills is transported to the lower plain. Various creeks will carry the water further to a river, lake, bay, or ocean.The study area is 7.807600 km^2 under the alluvial plains.

3.2 Denudational Hill

Denudational hills are formed due to differential erosion and weathering so that more resistant formations stand as mountain hills or they are relief hills which have undergone the process of denudation generally exposing themselves as barren rocky and steep sided. Their structure consists of fractures, points, lineaments etc. They are varying lithology and are mostly khondalite, charnockite,granite gnieses. The hills are relatively low relief features and of less aerial extension occurring on the plains detached from high mountain/hills. These land forms occur both on fluvial plain, pediment and pediplains. The denudation hills are formed due to brittle nature of material being eroded by circumdenudation .The high relief varying from 300 m to 900 m with gentle slopes forms the denudation hill above pediplain.
The denudational hills mainly consist of highly fractured rocks covered with pebbles and sparse vegetation occurring superficially due to the accumulation of moisture holding soils. This zone is generally potential for ground water because of occurrence of fractured rocks through which rain water percolates and ground water is recharged (Gangadhar Bhat, 1992).The study area is 0.915600 km^2 under the denudational hills.

3.3 Flood Plain

A flood plain is an area of land adjacent to a stream or river which stretches from the banks of its channel to the base of the enclosing valley walls and which experiences flooding during periods of high discharge. The soils usually consist of levees, silts, and sands deposited during floods. Floodplains are made by a meander eroding sideways as it travels downstream. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, the water drawn from them being pre-filtered compared to the water in the river. This is the basis of sustainable flood management, which is essential to our everyday lives. The study area is 1.961600 km^2 under the flood plains.

3.4 Pediment

A pediment is a very gently sloping (0.5°-7°) inclined bedrock surface. It typically slopes down from the base of a steeper retreating desert cliff, or escarpment, but may continue to exist after the mountain has eroded away. It is caused by erosion. It develops when sheets of running water (laminar sheet flows) wash over it in intense rainfall events. It may be thinly covered with fluvial gravel that has washed over it from the foot of mountains produced by cliff retreat erosion. It is typically a concave surface gently sloping away from mountainous desert areas. The study area is divided into Pediment complex (0.138680km^2) and Pediment Slope (5.220900km^2) and total geographic area under the pediment is 5.35958 km^2.

3.5 Pediplain
On the basis of genesis, the pediplans are large areas developed as result of continous process of pedimentation *(Thornbury, 1986).* On the basis of earth features, the pediplan can be defined as large areas with subdued topography rising in elevation from 100 m to 600 m towards the origin. The pediplans are characterized by gentle sloping smooth and erosional bed rock with or without this veneer or detritus. They are classified into rolling plain and undulating plains. The altitude variation is relatively high for rolling plain and is about 10m to 15 m occurring prominently at the peripheral areas of the foot hills, where as for undulating plain it is about 2 m to 10 m. The study area is divided into Pediment-pediplain complex covering 197.942100 km^2 of total geographic area.

3.6 Structural Hill

Under this category, land form units are shaped by a complex of erosional process predominately by sheet erosion, circumdenudation weathering mass wasting and erosion. In this the structure dip of strata controls the rate of denudational process. Structural hills are associated with folding and faulting. This zone has great potential for ground water because of geo-structural distortion.The hilly terrain is with less structural distortion and sparse occurrence of faults. Ground water prospecting is moderate but surface runoff is more. These land forms are formed as linear to accurate hills and they show indefinite trend lines associated with folding and faulting etc.The study area is divided into Structural Hill (Highly) 320.712100 km^2 and Structural Hill (Moderatly) 252.284100 km^2 with total geographic area of 572.9962 km^2 under structural hills.

3.7 Valley Fill

Valley fill deposits are colluvio-fluvial deposits derived from the weathering and wasting and get deposited by action of streams at the flow of the valleys. The valley fills are flat to gentle in profile raising in slope approximately 1 to 3 degrees and particularly slumping material pediments deposits. Ground water prospect in valley fill are good to excellent because of the topographical location at the bottom of the geological composition consisting of highly porous and hydrophilic materials of fluvial sediments. The rain water gets concentrated in the valley fill through surface flow from upper reaches. The valley fills also contain colluvio-alluvial deposits. Subsurface water potential is good to excellent at the valley fills as the deposits harbour dense vegetation and orbitration of insulation energy (Geological Survey of India 1994).This zone may have very good ground water prospects and is suitable for dug-cum-bore wells and shallow bore wells.The study area is 1.740100 km^2 under the valley fill.

3.8 Water bodies

A waterbody is any significant accumulation of water, generally on a planet's surface. The term most often refers to oceans, seas, and lakes, but it includes smaller pools of water such as ponds, wetlands, or more rarely, puddles. A body of water does not have to be still or contained; rivers, streams, canals, and other geographical features where water moves from one place to another are also considered bodies of water. Most are naturally occurring geographical features.The study area is 25.047800 km^2 under then Waterbodies.

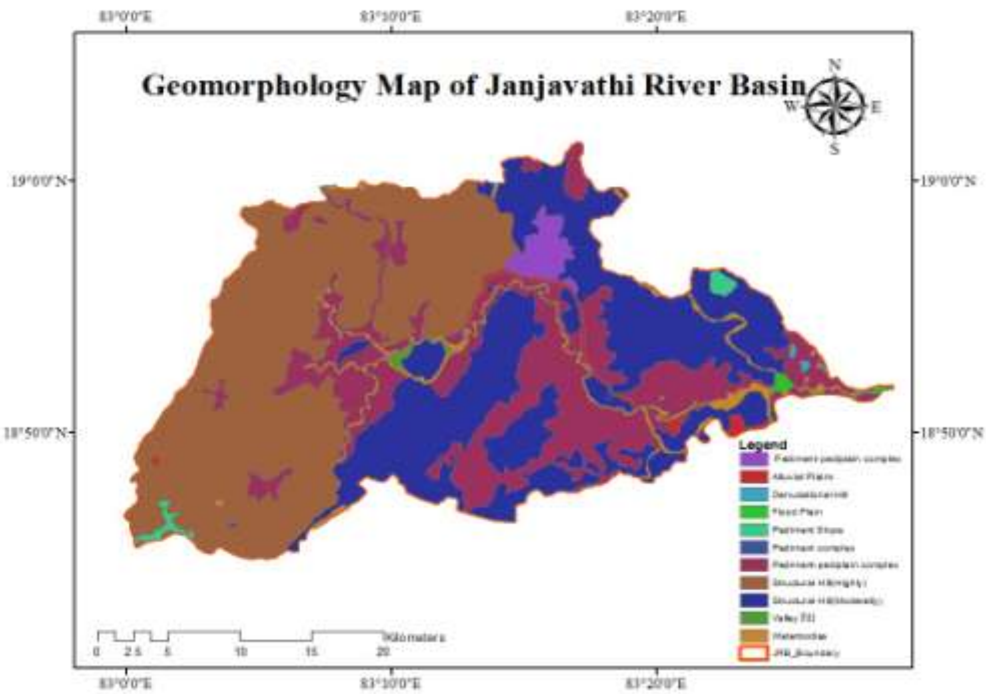

Figure3. Geomorphology Map of Janjhavathi river basin

Table1.Areal distribution of Geomorphological features of Janjhavathi river basin

S.No	Names	Area
1	Alluvial Plains	7.807600
2	Denudational Hill	0.915600
3	Flood Plain	1.961600
4	Pediment complex	0.138680
5	Pediment Slope	5.220900
6	Pediment-pediplain complex	197.942100
7	Structural Hill(Highly)	320.712100
8	Structural Hill(Moderatly)	252.284100
9	Valley Fill	1.740100
10	Waterbodies	25.047800

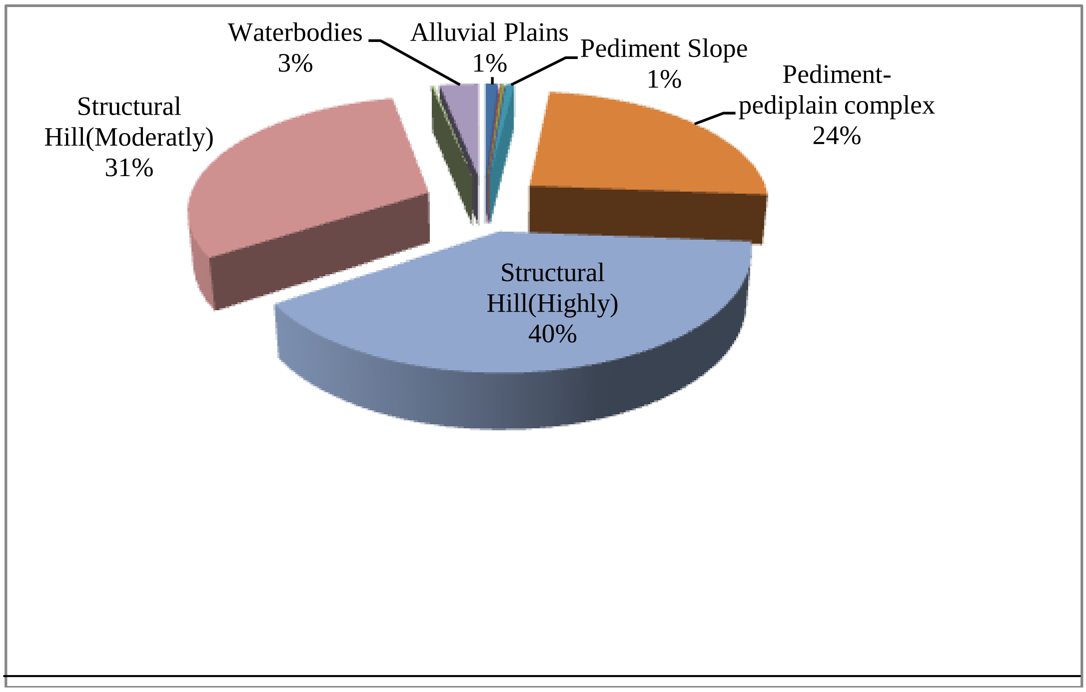

Figure 4: Areal percentage distribution of Geomorphological features of Janjhavathi river basin

4. Conclusion

In the study area of Jhanjhavathi river basin, the distribution of various mandals under observation covers an area of the Narayanapatna (46.24%), Bandhugam (37.76%) ,Lakshmipur (7.21%),Komarada (6.8%) and Rayagada (1.99%). Moreover, the major portion of Narayanpatna mandal consists of structural hills(highly) and structural hills (moderately), Pediment-pediplain complex. In Bandhugam structural hills (moderately)covers the major portion followed by Pediment-pediplain complex. Most of the Lakshmipur area is under Pediment-pediplain complex.The Komarada mandal mostly consists structural hills (moderately) followed by Pediment-pediplain complex, Denundation hills, Pediment slope, Alluvial Plains and Flood plains. Rayagada Mandal consists of structural hills (highly) as major geomorphic feature. Geomorphologically ,the area is classified as structural hills and Pediment-pediplain complex.

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