Original Article

Mapping Of Geomorphology For The Exploration Of Landforms In Ananthapur District, Andhra Pradesh Using Remote Sensing And GIS

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Abstract

Geomorphological map is an essential tool for various types of planning and developmental activities in an area such as land use planning, agriculture, forestry, civil-engineering, exploration and utilization of mineral resources,groundwater development,terrain evaluation etc. The geogmorphological mapping for Ananthapur district area was carried out with the help of SENTINEL - 2A satellite(June 23rd 2018) Spatial Resolution 10m, Multispectral, Digital data imagery on 1:50,000 scale by visual interpretation techniques. Remote Sensing(RS) and Geographical Information Systems(GIS) play a basic employment in creating topical maps and incorporating examination for mapping, overseeing and observing the regular assets. RS and GIS innovations have propelled another period in the field of connected topography and geomorphology. Geomorphology is the exploration of landforms present on the Earth's surface and their deliberate examination is vital and special,keeping in mind the end goal to decipher them as marks of the past and continuous topographical procedures. The present examination intends to outline geomorphological highlights in the location of Ananthapur district in perspective of visual picture interpretation system. The examination territory principally contains Moderately Weathered Pediplain(39%) trailed by Shallow Weathered Pediplain(21%) and Structural Hill(16%).These maps would be helpful in further investigation for common earth assets arranging, administration and basic leadership. Topical maps of geomorphology have been produced on satellite information. Standard visual clarification strategies as per the norms given by NRSC have been pursued and depicted on-screen digitations of highlights.

Keywords: Geomorphology, Natural Resource Planning, Remote Sensing (RS),Geographical Information Systems (GIS) and GPS

I. INTRODUCTION

Remote sensing data is an important and effective tool to evaluate the hydrogeomorphological and hydro geological zones,which will be highly depending up on the physical, geological, hydrogeological and geomorphological characteristics[1]. Therefore, studies have been carried out using remote sensing & GIS techniques for hydrogeomorphological investigation. Besides these, many other studies in India and abroad have been carried out for the hydrogeomorphological evaluations using remote sensing data. Hence, through survey of literature proved that, the remote sensing is a quick and efficient method for demarcating and evaluating the zones of ground water. In the study area, the remote sensing has been effectively used as an important tool to delineate hydrogeomorphological features using standard remote sensing techniques.

II. STUDY AREA

The area under the investigation lies between 76'-50'' to 78'-30'' Eastern Longitude and 13'-40''to 15'-15'' Northern Latitude. The area is located in Ananthapur District of Andhra Pradesh. District forms the important part of Rayalaseema region. Its northern and central regions are a high plateau, generally undulating, with large granite rocks or low hill ranges rising occasionally. In the southern parts, surface is more hilly. Six rivers flowing within the Ananthapur district. Penna,Chitravathi,Vedavathi,Papagni, warnamukhi and Thadakaleru. District has 949 villages. The study area Ananthapur District was taken consisting of 3 revenue divisions covering a total area of around 19130 km^2. The economy of the district is predominantly agrarian with very few industries with a very scanty rainfall of 563 mm,district is one of the most backward province of the Andhra Pradesh state. Prominent crops are groundnut, rice, sunflower, chilly, bengalgram, orghum and cotton.

Silk trade, limestone quarrying iron and diamond mining constitute the few industries are here. Temple town of Lepakshi with famous Veerabhadra a wonderful example of Vijayanagara architectural style and art is located in Ananthapur.

Ananthapur district is part of Deccan Plateau and is an extension of Karnataka Plateau. It is bounded by Tumkur and Bellary district of Karnataka on the west, Cuddapah district of Andhra Pradesh on the east Chittoor district of Andhra Pradesh and Kolar district Karnataka on the southeast and by Kurnool district of Andhra Pradesh on the north. The district is divided into 3 revenue divisions and has a total area of 19,130 km^2.

Out of the total geographical area of 19,130 km^2, forests cover 10% of the area. Similarly, barren and uncultivable land is 9% and land put to non-agricultural use is 8%. The total net area sown is 824955 ha. The important crops harvested in the district are paddy,jowar,ragi,chillis,sugarcane,onions and groundnut. Paddy and groundnut are the most important crops accounting for gross hectarage of 65,550 and 36,500 respectively. The average annual rainfall of the district is 563 mm, which ranges from nil rainfall in February and March to 129 mm in September. September and October are the wettest months of the year. The mean seasonal rainfall distribution is 316 mm during southwest monsoon (June-September) 146 mm during northeast monsoon (Oct-Dec), 1 mm rainfall during winter (Jan-Feb) and 72 mm during summer (March-May). The percentage distribution of rainfall season wise is 58.7% in southwest monsoon,27.6% in northeast monsoon,0.21 percentages in winter and 13.5% in summer(As per statistical hand book of Ananthapur 2018).

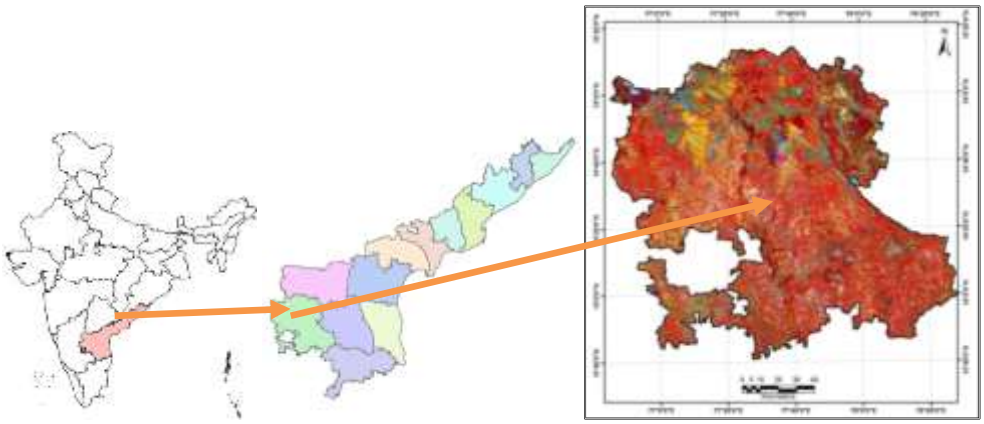

Fig.1 Location map of the study area as viewed on – SENTINEL - 2A satellite (June 23rd 2018) Spatial Resolution 10m, Multispectral, Digital data

RELATED WORK

M. Sunandana Reddy and L. Harish Kumar: In their investigation built a land evaluation strategy based on land information system for a region that will contribute to the National Land Information System. They additionally guaranteed that the outcomes will advance great administration and offer certainty based data to the decision makers [2]. Tulli ChandrasekharaRao, G. Jaisankar, AdityaAllamraju and E. Amminedu: In their study meant to delineate the geomorphological features in the Janjhavathi river basin based on visual image interpretation techniques which would be further valuable for essential analysis of important natural resource planning [3]. Suraj Kumar Singh, Vikash Kumar, Shruti Kanga: In their study analysed the Land use/land cover change dynamic and water quality assessment using geospatial techniques for Harmu river. It was observed that the river/drainage channels were primarily infringed by built-up land and few of the drainage channels were extinct due to urban activities [4]. V. Sivakumar: In his investigation has demonstrated that the satellite information is extremely valuable in different aspects of land, geomorphological and lineament mapping studies and it furnishes quick and exact information with minor subtle elements[5]. TriptiJayal: In her study of geomorphology and drainage basin characteristics found out that the drainage features are interlinked with geology, geomorphology, topography and climate [6]. Tanzeer Hasan studied the Geobotanical and geomorphological approach to map the surface lithology using remote sensor data to assess the capability of ASTER imagery for lithologic mapping in the intensely vegetated zones using digital image processing [7].

S.N. Mohapatra, PadminiPani and Monika Sharma examined the implications on the rapid urban expansion and its suggestions on Geomorphology with the help of Remote Sensing and GIS [8]. AungLwina and Myint Myint Khaing dealt with Geomorphology identification and its Environmental Impacts Analysis by Optical and Radar Sensing techniques for their identification and management. They conveyed an investigation for the effect of land use/ land cover (LULC) changes on stream flow patterns. They construed that the hydrologic response to intense, surge delivering precipitation occasions bears the signatures of the geomorphic structure of the channel network and of the characteristic slope lengths defining the drainage

density of the basin [9]. C. Siart, O. Bubenzer and B. Eitel examines the application and quality of SRTM and ASTER DEMs, high resolution Quickbird satellite imagery and GIS techniques for the detection and mapping of karst morphology [10]. G.Brierley, in his examination considered geomorphic perspectives on ecosystem approaches to river management [11]. S. J. Walsh, D. R. Butler and G. P. Malanson performed the satellite image processing and change-detection analysis.

III. METHODOLOGY

The investigation zone covers 2 sequences of the Survey of India(SOI) toposheets, they are 57 G/10,57 G/6,57 G/2,57 C/14,57 K/5,57 K/1,57 G/13,57 G/9,57 G/5,57 G/1,57 C/13 57 J/8,57 J/4,57 F/16,57 F/12,57 F/8,57 F/4,57 B/16,57 J/7,57 J/3,57 F/15,57 F/11,57 F/7,57 F/3,57 B/15,57 J/2,57 F/14,57 F/10,57 F/6,57 F/2,57 B/14,57 J/1,57 F/13,57 F/9,57 F/5,57 F/1,57 B/13,57 I/4,57 E/16,57 E/12,57 E/8,57 E/4,57 A/6 scale 1:50,000. These toposheets are geo-rectified and projected to polyconic projection (the Metric system units – meters are used as in the present study). The ANANTHAPUR toposheet map has been scanned and saved in .jpg format and then it is imported into image format which is then referenced to polyconic projection using ArcGIS software.

The study area boundary is digitized and overlaid on Mosaic; demarked the study area boundary on 1:50000 toposheet and later verified by ground truthing. Necessary corrections were made and checked in the field with the help of GPS. Image processing was carried out for SENTINEL - 2A SATELLITE (JUNE 23RD 2018) SPATIAL RESOLUTION 10M, MULTISPECTRAL, DIGITAL DATA IMAGERY ON 1:50,000 SCALE BY VISUAL INTERPRETATION TECHNIQUES. After applying necessary image enhancement, the landforms are delineated from geo-coded satellite imagery along with the available geological and geomorphology details. The geomorphic units are delineated based on the Standard visual interpretation techniques as per the norms given by NRS and represented on screen digitations of features. In these terrain elements, nearly 21geomorphic erosional and fluvial classes have been delineated. The major features of the area are pediplain shallow, pediplain moderate etc. as shown in figure 2. The run-off features of hills are exposed prominently in the northern part of the area.

IV. RESULTS AND DISCUSSION

Geomorphological features in hilly terrain

The entire study area has been interpreted using satellite data of SENTINEL - 2A satellite (June 23rd 2015) Spatial Resolution 10m, Multispectral, Digital data both digital and FCC imagery has been used. In the existing lithological groups various geomorphic units have been interpreted from satellite data and hydrogeomorphological map was prepared by incorporating the geological, structural, groundwater data. The major geomorphological units identified in the study area described below and methodology followed has been described in methodology. Geomorphologically, Anantapur district forms the northern extension of Mysore Plateau. The district has been classified into four major units based on relief, slope factor and soil i.e., (i) Denudation hills (ii) Dissected pediments (iii) Pediplains and (iv) Valley fills such as colluviums and alluvium.

Denudational Hills

Denudational hills are the residual of the natural dynamic process of denudation and weathering. The geomorphic forms of denudational hills occur like as exfoliation domes, linear ridges, mesas, low mounds and tors with partial scree or debris covered at the foot slopes (Raju, 2012). The denudational hill is the major geomorphic class which occupies an area about 2269.37 KM^2 The Geomorphic form of denudation hills occur as exfoliation domes, inselbergs, linear ridges, mesas and tors with partial scree or debris covered at the foot slopes. Most of the denudation hills are strong and barren of vegetation and forms about 11.94% of the total geographical area of the district. Hill masses acts as run-off zones. Lithology and alignment of structural features like joints and fractures can control the geomorphic expression and shape of the denudational hills. The hills are run-off zones and material rolls down to the plains due to steep slopes. The Peddakedari hill range is fully occupied by different constructions. All along the foot hill, several urban dwellers constructed concrete structures. The Penukonda Range which starts in the South of Dharmavaram through Penukonda and Hindupur proceeds to Karnataka State.

Structural Hills (SH-K)

These structural hills are formed as linear to arcuate hills showing definite trend lines associated with following faulting. The rock types are mostly Khondalite, Leptynites and in few places Charnockite. These landforms occupied in north and southern side of Kambam Narasimha Swamy Hills and The Muchukota Hills about 35 KMs. in length, run from North of Gooty Town upto extreme Southern Corner of Tadipatri and Yadiki Mandals. Another line of Hills starts from West of Gooty Mandal and run 80 KMs. called by name Nagasamudram Hills. The Mallappakonda Range begins at Dharmavaram and runs into Karnataka State.

Inselbergs / Residual hills (RH, K, Lpt, Ch)

These are the resistant isolated, steep sided, usually smoothened and rounded hill or rock outcrops of circular denudation raising abruptly from and surrounded by and extensive and nearly level plains in tropical regions(Woodworth, J. B. 1912). In the study area outcrops with an elevation of 25 to 30 meters above MSL have been described as residual hills Inselbergs which are exhibiting conical to rounded forms with steep to very steep debris slopes. King(1989) called Inselbergs to those residual hills, which are resulting from scarp retreat and pediplanation. These types of geomorphological features are observed in the study area as well. This landform formed due to differential weathering and erosion. This unit consists of fractures, joints, and lineaments. These hills are low relief features and occupied in very limited area.

The rock types are Khondalite, Leptynites and Charnockite. It has its origin in the Nandi Hills of Karnataka State where it is called "UTTARA PINAKINI" and enters this District in the extreme South of Hindupur Mandal and flows through Parigi, Roddam, Ramagiri, Kambadur, Kalyandurg, Beluguppa, Uravakonda,Vajrakarur,Pamidi, Peddavadugur, Peddapappur and Tadipatri Mandals and finally enters Cuddapah District. In this groundwater prospects are poor to nil. Prominent, isolated, steep sided, usually smoothed and rounded, residual knob, hill or small mountain of circumdenudation rising abruptly from and surrounded by an extensive and nearly level, lowland erosion surface in a hot, dry region, generally bare and rocky although partly buried by the debris derived from and overlapping its slopes. Its characteristic of an arid or semiarid landscape in a late stage of the erosion cycle.

Pediment (P-K)

These are being constituted by erosional surface which extent downwards from hill to neighbouring basin consist of phylite, quartzite showing gentle slope sparse vegetation(Webb, R. W. 1946). Rock floor with a very thin or low soil cover has been identified on pediments the lineament intensity is low. Drainage density is moderate and it is characterized by very gentle slope vary from 5 to 10 degrees. Therefore these are poor potential units from the point of view of ground water occurrence from Muchukota Hills. The term pediment has been defined as an eroded rock surface of considerable extent at the foot of the mountain slope. Formed in arid to semi-arid climate. Granites and migmatites as seen in Gooty, Kalyandurg, Anantapur and Penukonda Mandals underlies the dissected pediment area.

Pediplains

Pediplains occupy maximum area of about 53.27% of the district is characterized by low line flat terrain with gentle slope of < 5°. The pediplains are covered by red brown and black clayey soils extending upto 2 m.

Landforms of fluvial origin

The word fluvial is used in Earth science to refer to processes and landforms produced by running water. As with other surficial processes, running water can either erode material from the earth's landscape, or deposit layers of sediment. The resulting landforms can thus be classified as either erosional landforms or depositional landforms. The incredible power of running water in carving various erosional and depositional landforms is well known. Although the quantity of water in stream is small at one time during the course of the year, very large volumes of water move through the channel and they form an important component in the hydrological cycle. The fluvial dissection of the landscape consists of valleys and their included channel ways organized into a system of connection known as a drainage network. Drainage networks display many types of quantitative regularity that are useful in analyzing both the fluvial systems and the terrains that they dissect.

Flood plain

The surface or strip of relatively smooth land adjacent to a river channel constructed (or in the process of being constructed) by the present river in its existing regime and covered with water when the river overflows its banks at times of high water. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. This feature is observed along the course of Pennar, Chitravati and Papagni rivers.

Valley Fills

It is the waste produced by mountain top removal mining, named because it is typically piled high in nearby valleys. River alluvium occurs along major river courses mostly derived from catchments, transported and deposited. Such alluvium is seen along the river Hageri, Chitravati, Pennar, Papagni and minor rivers and streams like Maddileru, Tadakaleru, Padameru, Kushavasti. Colluvium occurs in narrow valleys and minor nallas. The width is not much but more in shallow broad valleys. It is derived from the adjoining upland and deposited in the low lying shallow fluvial channels consisting of an admixture of unsorted material of various shapes and sizes.

Pediment slope

The angle of a pediment's slope is generally from 0.5° to 7°. Its form is slightly concave and it is typically found at the base of hills in arid regions where rainfall is spasmodic and intense for brief periods of time. There is frequently a sharp break of slope between the pediment and the steeper hillside above it. Water passes across the pediment by laminar sheet flow, but if this is disturbed, the flow becomes turbulent and gullies develop. The attribute table of geomorphology map is shown below in Table.1

Table.1: Attribute table of geomorphology map

S.No	Names	Area	%
1	Channel bar	1140.56	6.00
2	Curvilinear ridge	0.29	0.00
3	Denudational hill	2269.37	11.94
4	Dome structural	44.87	0.24
5	Flood plain	532.14	2.80
6	Hog-back	3.81	0.02
7	Inselberg	0.48	0.00
8	Intermontane valley	16.43	0.09
9	Linear ridge	170.05	0.89
10	Mesa	0.22	0.00
11	Oxbow lake	1.38	0.01
12	Pediment	3256.66	17.13
13	Pediplain	10126.53	53.27
14	Piedmont slope	28.63	0.15
15	Piedmont zone	8.43	0.04
16	Plateau	4.56	0.02
17	Point bar	1.74	0.01
18	Residual hill	189.18	1.00
19	Structural hill	980.54	5.16
20	Structural valley	166.35	0.88
21	Valley fill	68.33	0.36
		19130	100.00

The above table shows the Geomorphologic data of Ananthapur district. It consists of basalt with lava, denudation hills, flood plains, granite & gneiss, pediplains and sandstones & shales. When considered in percentages of above soils viz basalt with lava having 1.39%,denudation hills having 11.94%,flood plains having 2.80%,granite & gneiss having 35.71%,pediplains having 53.27% and sandstones & shales having 7.33 %. percentage as shown in Fig.2. The classified hydrogeomorphological map is as shown below in Fig.3.

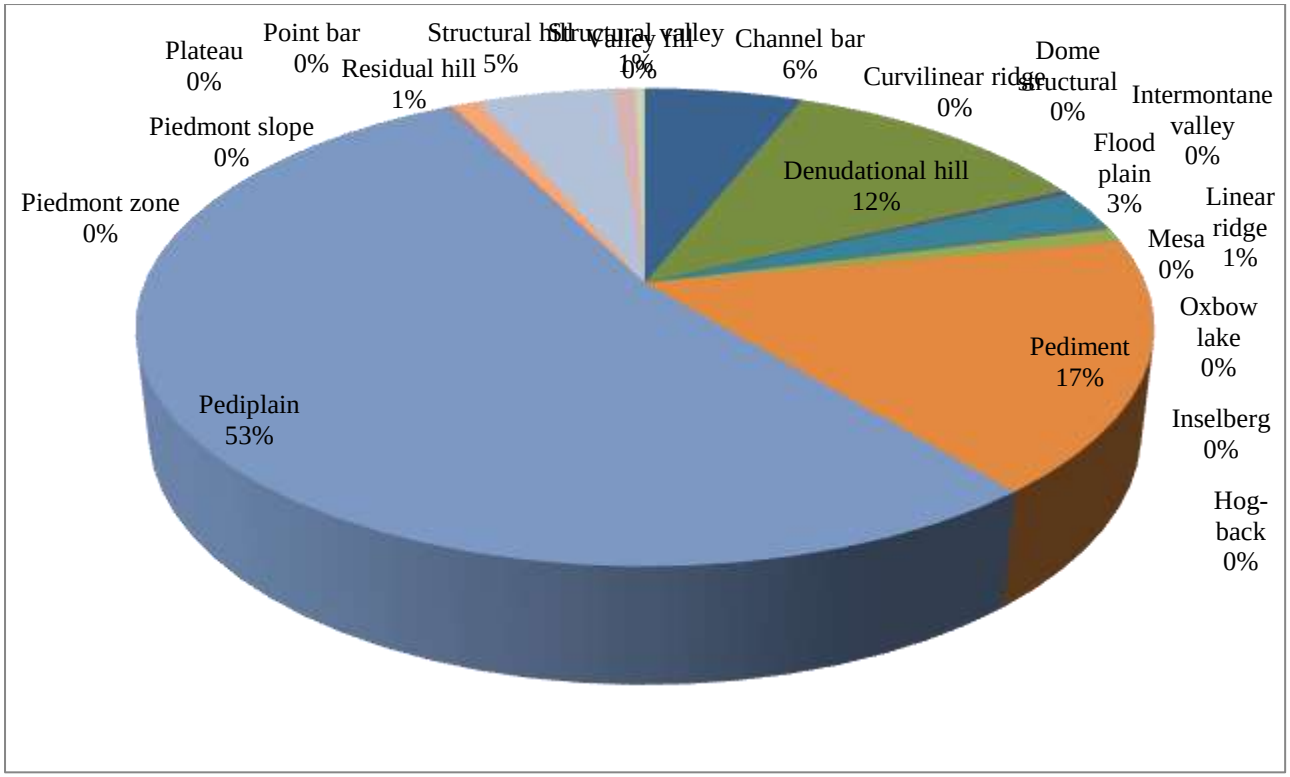

Fig.2: Geomorphology features percentage wise

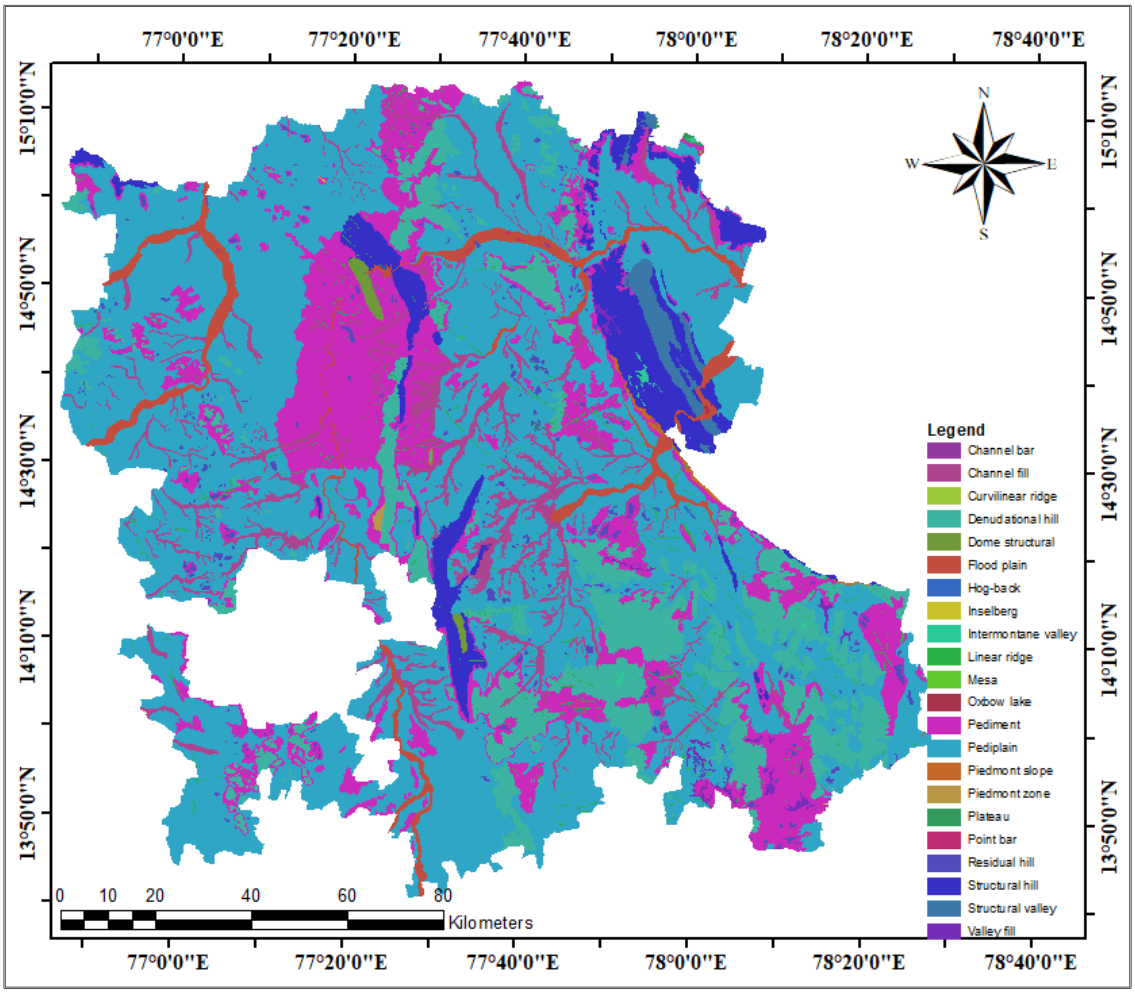

Fig.3: Geomorphology map

V. CONCLUSION

In this research, the area of investigation covers a total area of 19130 km^2 and almost 100% of the area is under Ananthapur district of Andhra Pradesh, India. The remote sensing data has been used to delineate geomorphological features using Sentinel-2A satellite imageries. In total, 21 landforms were delineated, out of which denudational hills, structural hills, inselbergs, residual hills and pediment inselberg complexes act as run-off zones. These categories (run-off zones) cover an area of 3673.77 km^2 and suitable areas for infiltration (recharge zones) cover about 10126.53 km^2. Moderately Weathered Pediplain is the major landform covering an area of 532.14 km^2 in the upstream of Pennar, Jayamangala, Chitravathi and Vedavathi river basin and The streams are mostly ephemeral in nature. The drainage pattern is dendritic, rectangular to sub-rectangular due to the influence of geological structures followed by structural hill which covers an area of 980.54 km^2; Shallow Weathered Pediplain covering an area of 10126.53 km^2.

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