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Satellite Image Analysis using GIS Application in Studying the Musi-Krishna Region, Telangana, India.

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Abstract: *An over all synoptic view of the Musi-Krishna region in Telangana State, India, is provided by the IRS P6-LISS IV satellite image. Which are in Peninsular India's Eastern Dharwar Craton (EDC). The study area covers an area of 820 sq.km corresponding to the region (latitudes 16° 39' to 16° 57'N and longitudes 79° 31' to 79° 45'E) in parts of Nalgonda and Suryapeta Districts in Telangana State. The approach combined remote sensing data and various analytical techniques, including the examination of structural and field data. The first step in the procedure was digitally processing IRS P6-LISS IV satellite pictures using spatial filtering techniques to identify lineaments that are geologically relevant. Other techniques included lithology, drainage, geomorphology, and land use/cover to further decipher the terrain study. The drainage system exhibits a dendritic to sub-dendritic pattern. The landscape encompasses a variety of land use categories, including forests,uncultivated land (referred to as barren land), land cover types classified as built-up land, cultivated land, forested land,agricultural areas, water bodies in the study areas. The observed lineaments have been classified into faults, fractures/joints, and lineaments. The direction of lineaments varying from N-S, E-W, NW-SE and WSW-ENE trends. The different geomorphological aspects were evaluated and analyzed using satellite images, topographic maps, and field observations. IRS P6-LISS IV, satellite image made optimum utilization for the interpretation of terrain analysis. In summary, this study employed a holistic approach, incorporating remote sensing, GIS, terrain, and structural analysis in the Musi-Krishna region of Telangana State, India.*

Key Word: *Lineaments, Drainage, Geomorphology, GIS, Remote sensing.*

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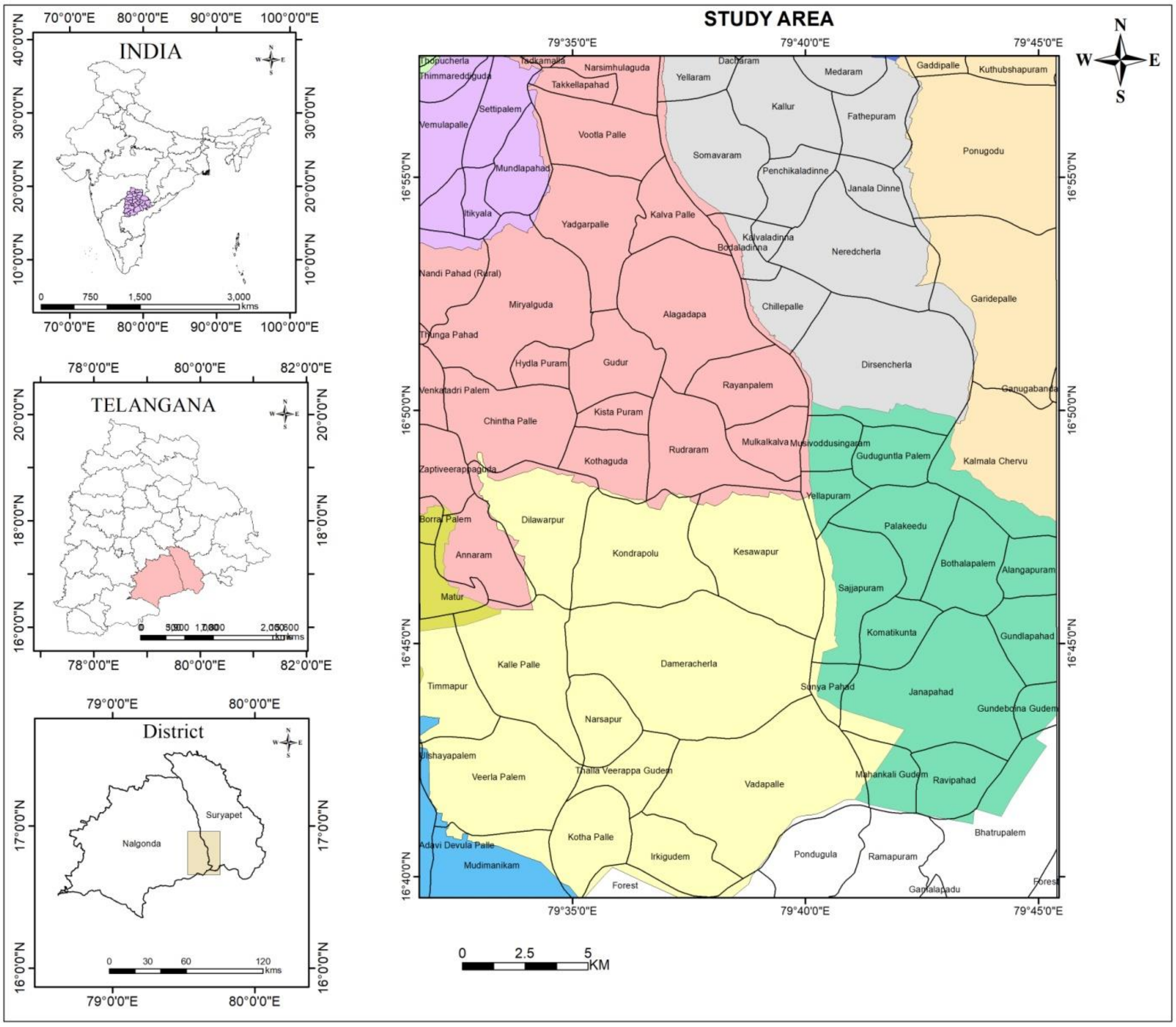
I. Introduction

The first step in the procedure was digitally processing IRS P6-LISS IV satellite pictures using spatial filtering techniques to identify lineaments that are geologically relevant. Other techniques included lithology, drainage, geomorphology, and land use/cover to further decipher the terrain study. The data collected will enable us to ascertain the composition and characteristics of the Earth's surface and atmosphere across various scales, ranging from local to global. This analysis involves the examination of images captured at different points in time, allowing us to monitor and detect changes over time. Remote sensing has wide applications in geology for lithologic and structural mapping. The primary benefits of remote sensing observations conducted via satellites, which offer information about the Earth and its natural resources in a spatial format, include a synoptic perspective and comprehensive coverage of large geographic areas (as mentioned by Kasturirangan et al., 1996). The application of multispectral remote sensing data in various branches of geology, including lithology, land use land cover, geomorphology, and geo-environmental investigations shown significant potential. "According to Miller and Pearson., 1971; Goetz., 1975; Singer., 1980; Chavez et al., 1982; Pandey., 1987; Lillesand and Kiefer., 1993; Abdelhamid and Rabba., 1994; Price., 1995; Subhash Babu et al., 2014 were explained in detailed the digital image processing techniques in geology". Remote sensing technique has been used since the last century in earth science and land use/land cover studies (El Khidir and Babikir, 2013). Understanding land use and land cover changes is of paramount importance for comprehending the utilization, conservation, and management of natural resources (Nagamani and Ramachandram, 2003; Alekya et. al, 2017; Linga Swamy et al., 2022; Ramesh et al., 2022). Environmental elements include soil properties, climate, topography, and vegetation limit how land can be used. Additionally, it acknowledges that land is a vital and limited resource for the majority of human developmental endeavors, including forestry, industry, agriculture, energy generation, settlement, recreation, and water catchment and storage (Uma Maheshwari et.al., 2015; Udaya Laxmi et.al., 2016; Blessy et al., 2018). The present study emphasizes on the Satellite Imagery of the IRS P6-LISS IV analyses and interpretation of Musi-Krishna region in Telangana state (Figure 1), to assess terrain elements such as geomorphology, drainage, mapping of the inferred lithology/ geology, lineaments, and land use/ land cover.

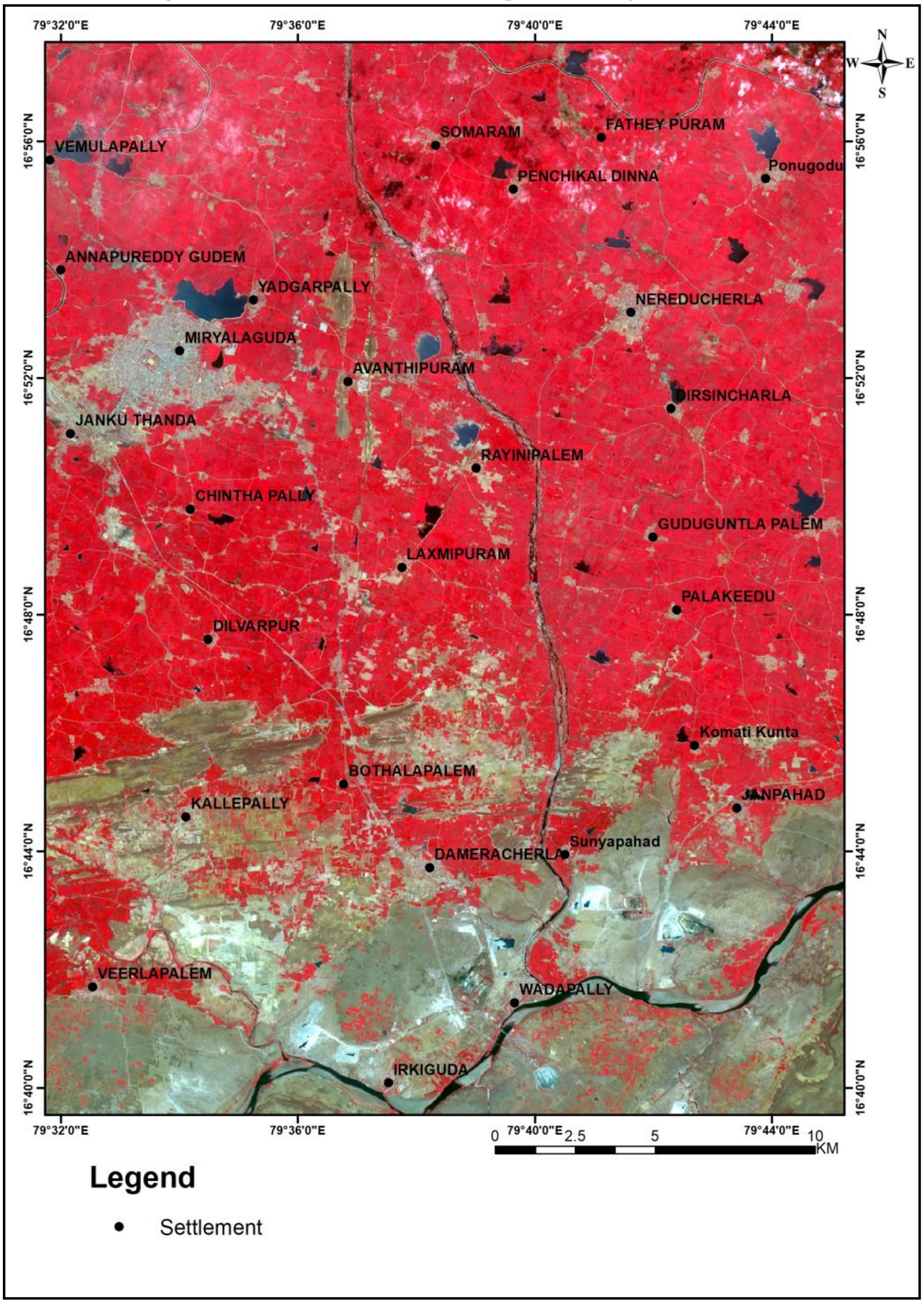
FIG.1. Location map of the study area.



II. Data base and methodology

The database is made possible by a variety of publicly available sources that are accessible on blogs across the internet. The base map and border map of the study region were created using the fundamental data obtained from Survey of India (SOI) topographic maps at a scale of 1:50,000 (toposheet 56P/09 (E44T09), 56P/10 (E44T10)). The IRS P6-LISS IV multispectral satellite imagery, with a resolution of 5.8 m (Figure 2), was obtained from public domains in the research region and contains three spectral bands (B2: 0.52 -0.59; B3: 0.62-0.68; B4: 0.77-0.86 in μm) (http://glovis.usgs.gov.,.) and Google Earth (http://earth.google.com,). These maps offer supplementary information that aids in the interpretation of various land use categories. The satellite image was georeferenced and analysed using ERDAS 10.1 and ArcGIS 10.3 software. It provides data for 4096 contiguous pixels, covering a 23.9-kilometer swath. An optical arrangement with an isosceles prism splits the incoming beam into three imaging fields. The separation on the ground results in a 14.2-kilometer distance between B2 and B4 image lines. Band-3 captures nadir imagery, while Band-2 and Band-4 look ahead and behind in the velocity vector direction. (IRS-P6 Data User’s Manual, 2003). Standard interpretation methods were employed to classify terrain analysis (topography, land form, land use and land cover etc.), enhancement techniques (Image translation, Image enhancement, Image contrast, spectral and spatial filtering etc) as mentioned by Miller and Pearson, (1971); Goetz, (1975); Castleman, (1978); Hammond and McCullough, (1980); Singer (1980); Chavez et al., (1982); Short, (1982) and Price (1995). IRS-P6 data user’s manual, 2003 was applied for image information of the earth’s surface. When necessary, methods such as stratification, directed filtering, layered approach, composition, aggregation, and refinements were also applied to enhance the mapping quality.

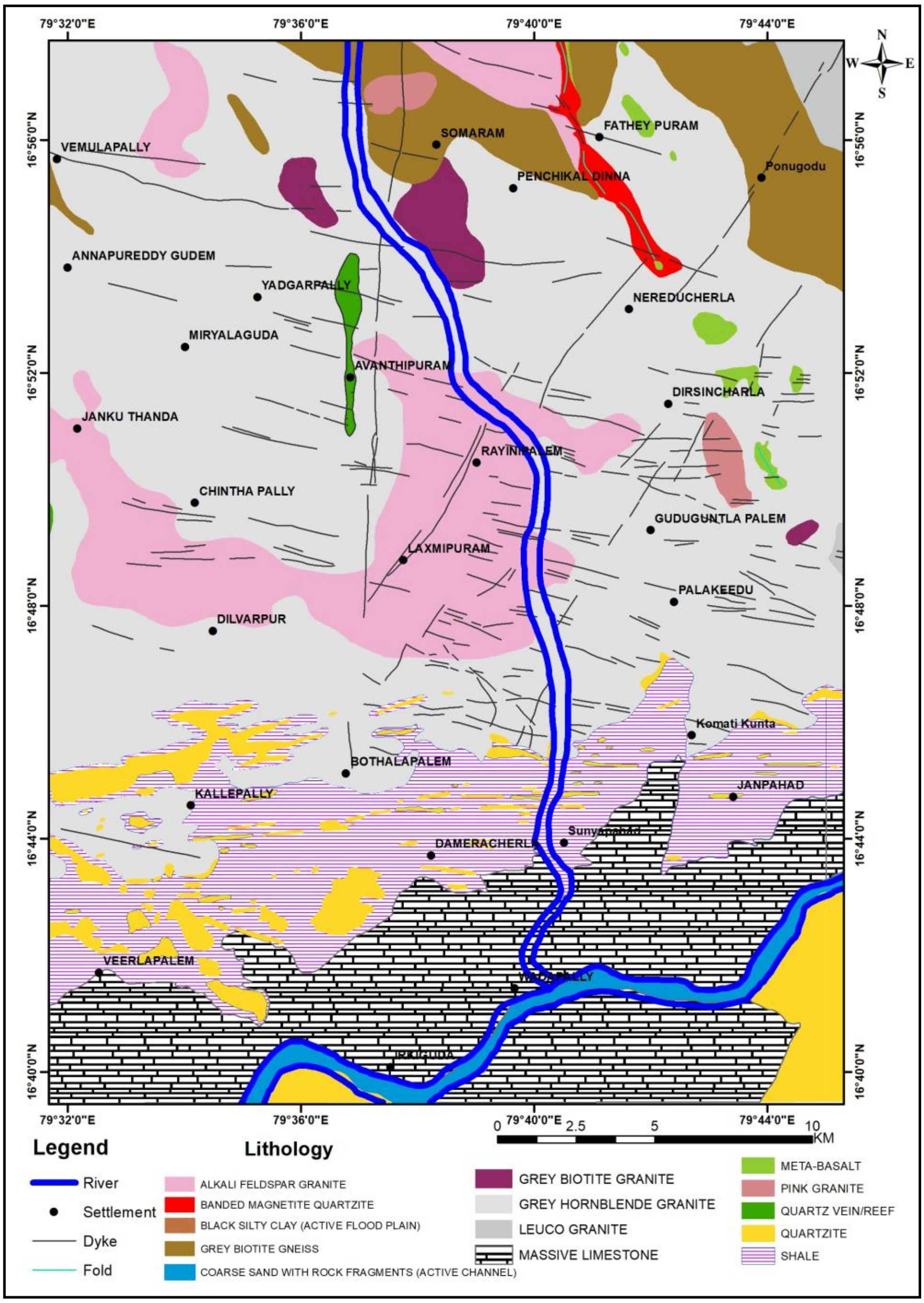
Fig. 2. IRS-P6 LISS-IV Satellite map of the study area.



III. Geology of the study area

The area forms a part of the Eastern Block of Dharwar Craton and is mainly occupied by older metamorphics, the Peninsular Gneissic Complex (PGC) and younger intrusives and The Kurnool group of sediments (Figure 3). The area comprises of older metamorphic rocks of Archaean age represented by banded magnetite quartzite occur as enclave within the PGC in northeastern part of Fatheypuram area.

Fig. 3. Geology map of the study area.



The Peninsular Gneissic Complex is made up of a diverse range of rocks within the gneiss-migmatite-granite suite. This complex exhibits significant variability in terms of mineral composition, appearance, geological structure, and ages. Granite and biotite -gneiss of alkali feldspar granite, grey biotite granite, grey hornblende granite, pink granite, leuco granite occupy a large part of the area and relatively younger coarse-grained grey biotite gneissic occurs in the northeastern part. A linear band of metabasalt is exposed continues through the valley east margin of Guduguntla palem to Fatheypuram, it is a continous band and associated with Banded Magnetite Quartzite. The quartz vein linear band is traversing north to south granitic rocks in central part of Avanthipuram. The Kurnool group of sediments belonging to Banganapalli Formation and Narji limestone are exposed in the mapped area. The Banganapalli formation consists of shale and quartzite. The south part of the area is a plain country and occupied by large spread of limestone which belongs to the Narji formation of Kurnool group, it extends from east to west. The limestone is having gradational contact with the underlying quartzites. The limestone is predominantly grey to black coloured, compact, and breaks with conchoidal fracture. The ratio of shale and quartzite decreases upwards and finally passes to shale limestone and massive limestone. The thickness of the limestone varies from 10 to 20m. The Banganapalli quartzite unconformably overlies the basement gneisses and older metamorphics. The quartzite forms, linear structural ridges in the kallepalli and large terraces in the south and middle part of the area. The shale is exposed in the low-lying areas and along the hill slopes below the quartzite at some places and shale is more predominant in the southern part. The dissected by several ENE–WSW, NE–SW, NW–SE and a few N–S trending lineaments represented by dolerite dykes. This dyke is linear, boulder discordant form, mainly medium to fine grained. A minor fold closure is noticed in the northeastern area in the Banded Magnetite Quartzite and meta basalt.

IV. Drainage pattern and Lineaments

The drainage map (Figure 4) was prepared with Survey of India Toposheet no. 56 P/9 and 56 P/10 as base using ArcGIS software and updated with the help of satellite imageries (LISS-IV, IRS P6). The classification of drainage pattern is important as it gives an idea of topographic and geologic controls on water flow and sediment accumulation. The drainage pattern is controlled either by the dominant formational trends or by cross-cutting fracture systems. The Krishna River flows from west to east in the direction of the south part of the area. Musi River is the main tributary flowing towards North to South direction in the area. The overall stream network has dissected the area resulting into a dendritic and sub-dendritic drainage pattern with moderate to high, average drainage density. Drainage density is major part of the comparatively, where granite and gneissic main litho-units. The drainage in the area is mainly controlled by lithology, geomorphology, NW-SE trending lineaments and other structural features such as folds and dykes. The master slope in the area is towards the south.

The current study's visual interpretation of lineaments utilizing IRS P6-LISS IV satellite pictures shows that these lineaments (Moore and Waltz., 1983; Drury., 1987; Ramadass et al., 2006; Veeraiah et al., 2006; Subhas Babu et al., 2014; Kazemi et al.,2009; Vani., 2012; Vani et al., 2013; Linga Swamy et al., 2022a). The lineament map (Figure 5) was generated using geological, remote sensing integrated together on scale 1:50,000. Subsequent classification of lineaments was based on tonal variation and pattern of dykes, quartz veins, fracture/joint and fault and are cross checked with ground truth. Broadly, all lineaments appear to be following the general trend of geology, which is in a major direction NW-SE and WSW-ENE. Some linear features follow a, E-W and N-S orientation. Faults, fractures/joints, and lineaments have been employed to classify the observed lineaments. The direction of lineaments varying from N-S, E-W, NW-SE and WSW-ENE trends

Fig. 4. Drainage map of the study area.

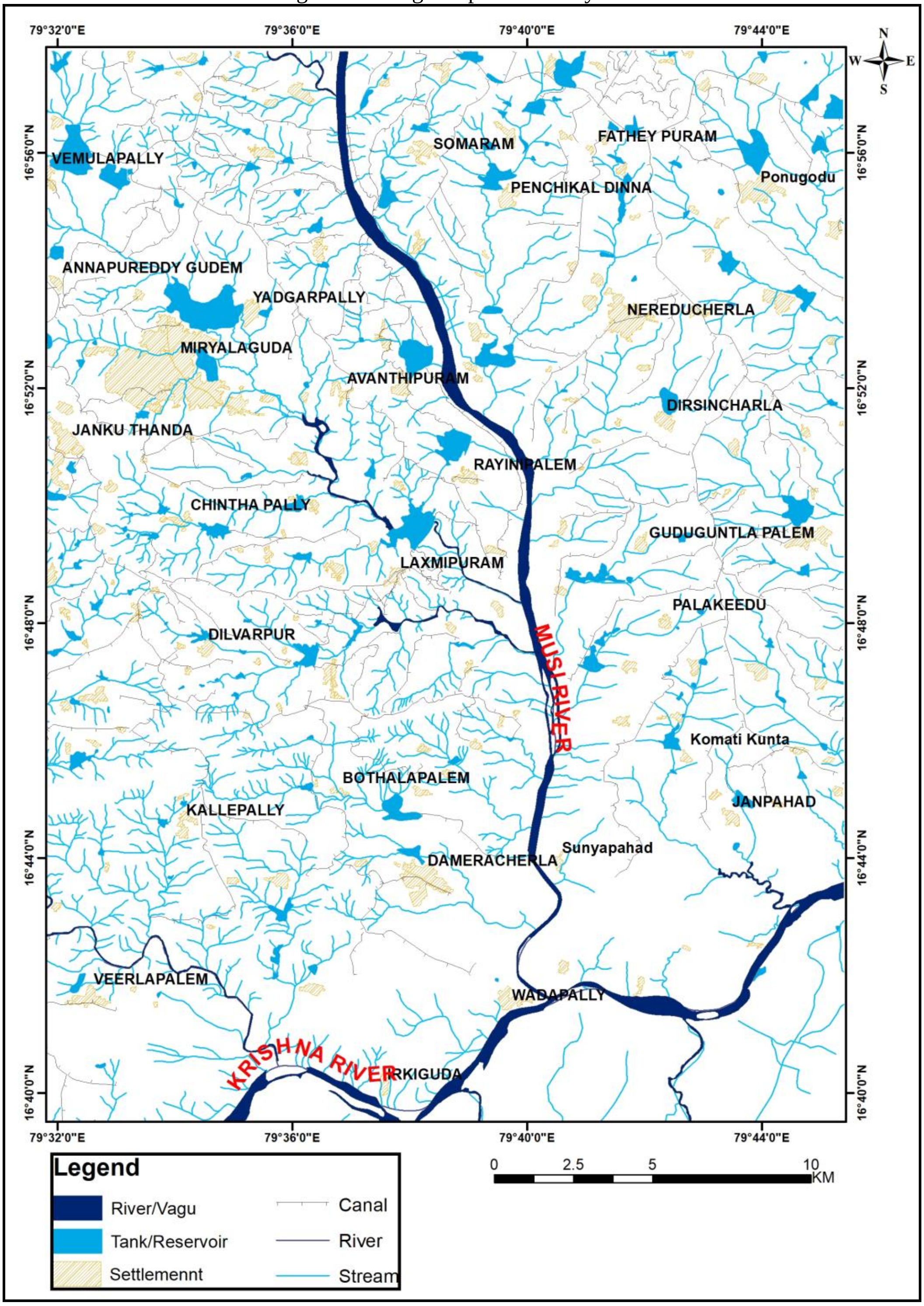
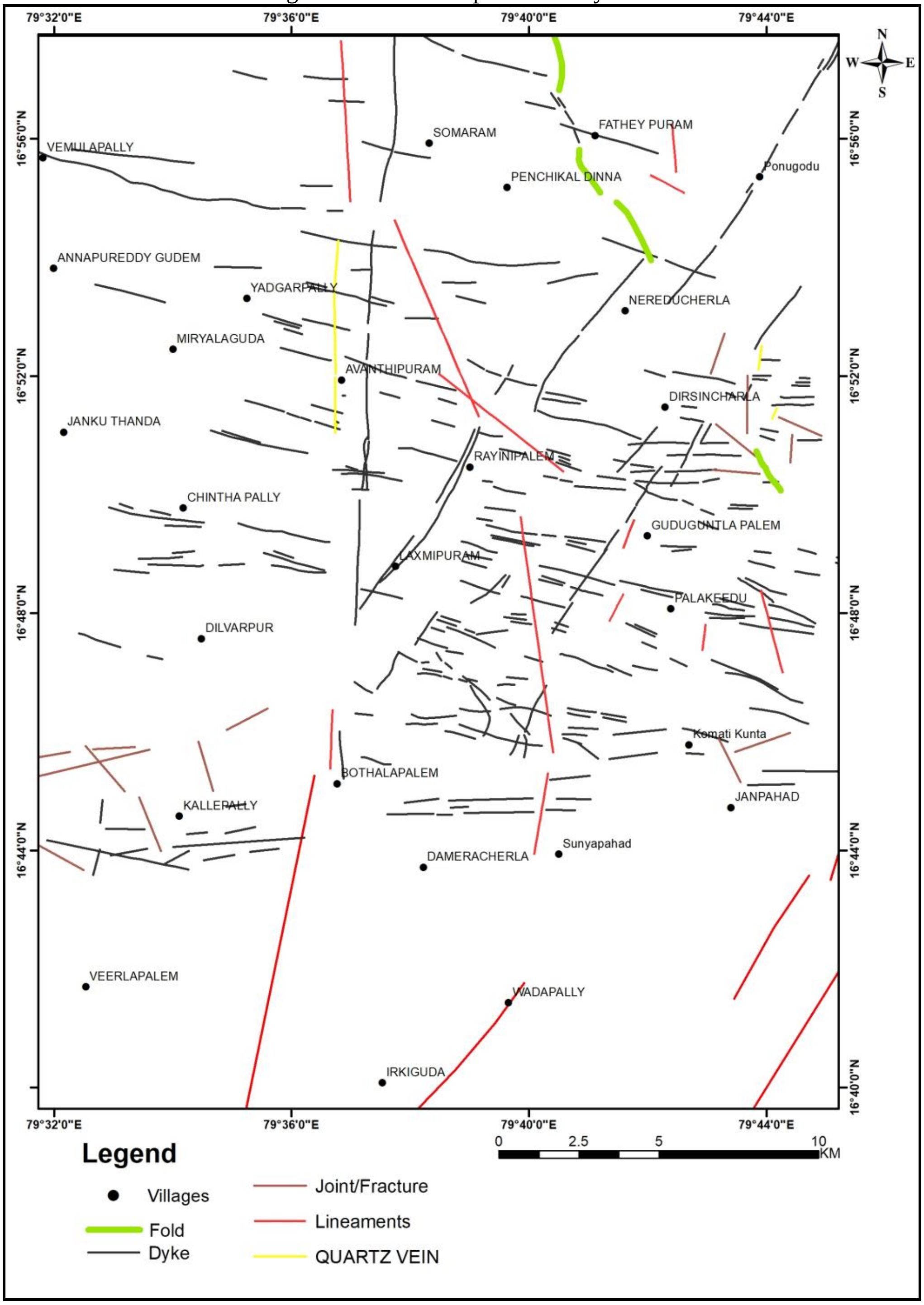


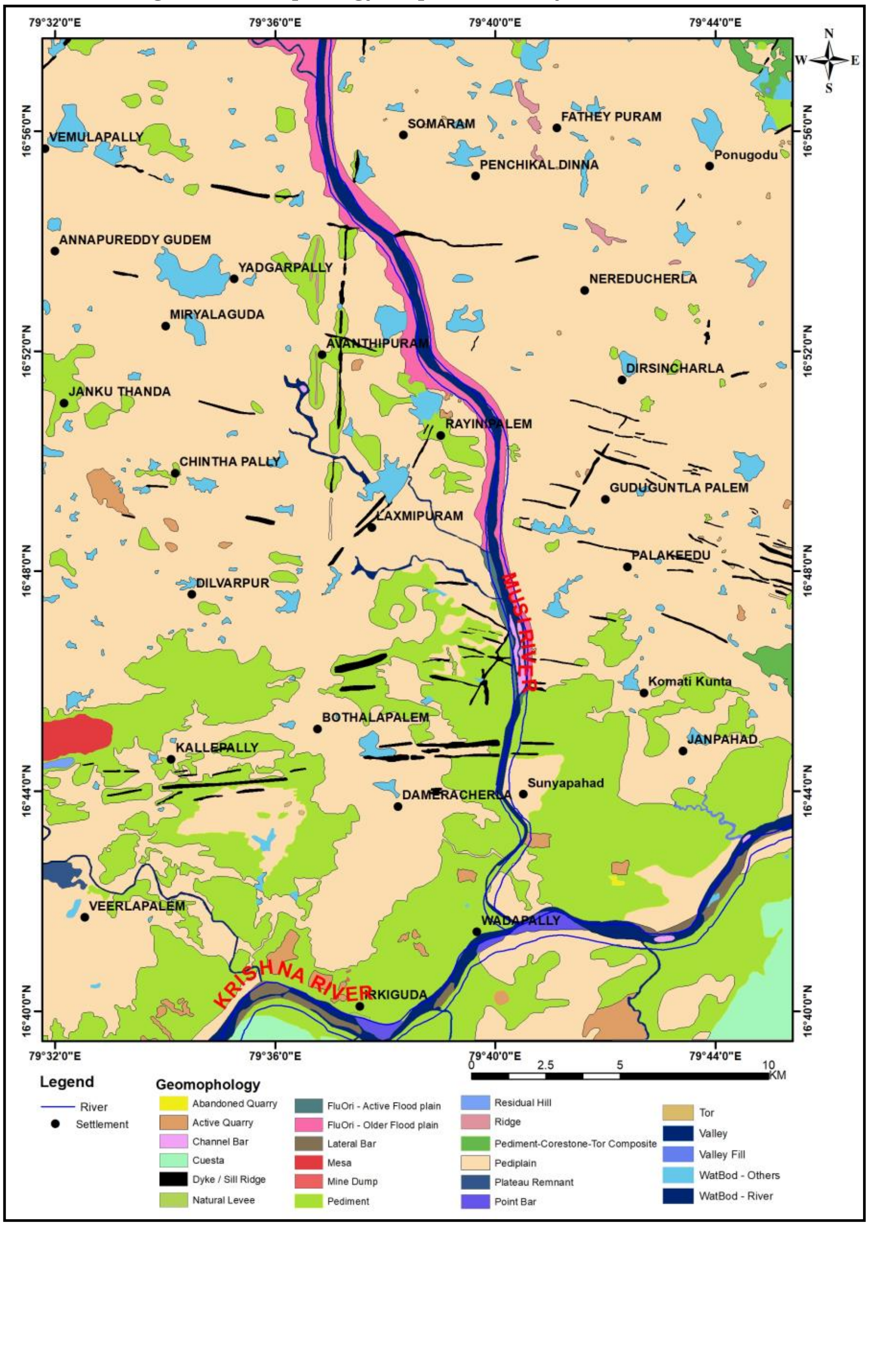
Fig. 5. Lineament map of the study area.



V. Geomorphology

Geomorphology is essential in a variety of geological studies for designing exploration and exploitation tactics in mineral exploration. The significance of structure in lowering the resistance of rock, which presents itself in many geomorphic forms, is critical. In the present study, the different geomorphological aspects (Figures 6) were evaluated and analyzed using satellite images, topographic maps, and field observations. Geomorphological characteristics like residual hills, linear ridges, pediments, pedplains, highly plateaus, shallow valley fill, and dyke ridges were all depicted in the image (Figure 6). These characteristics can be observed along the foothills, creating an outer margin for the hills. There are substantial pediments located to the south, along with isolated patches in the western part of the region. The pediplain predominantly extends from the northern and central areas, progressing towards the southern portion of the region. Ridges are discordant bodies found as basic intrusions and are of dolerite dykes. These dykes are extending northeast and south part of the area, the intersection zones of dyke ridges considered as weak zones. The small patch of mesa covered in west part of Kallepalli area.

Fig. 6. Geomorphology map of the Study area.



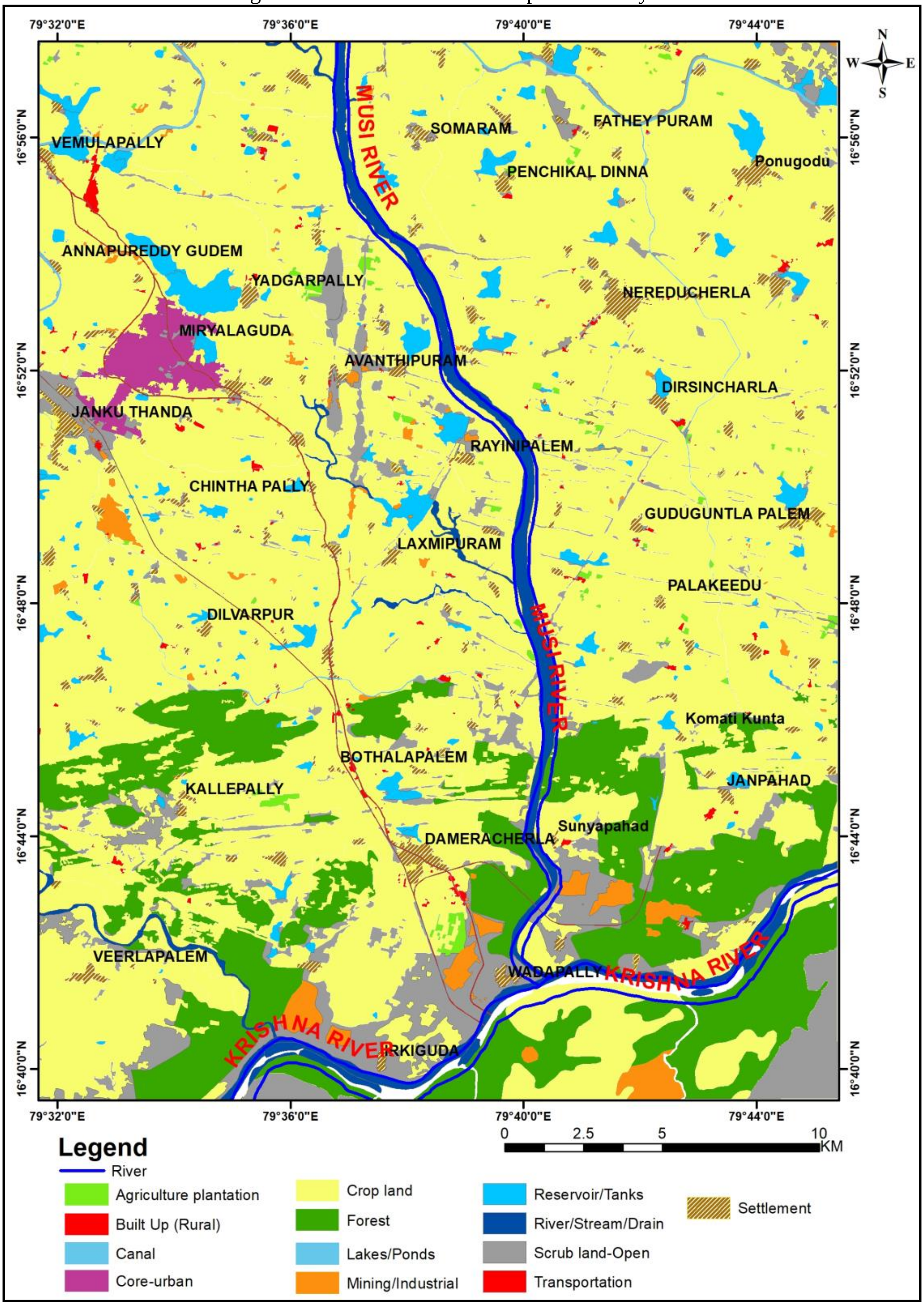
VI. Land use and Land cover

The land use map has been generated using remote sensing satellite imagery, depicting the spatial distribution of various land uses along with their respective percentile quantities and divisions. This information is visually presented in (Figure 7) and further detailed in Table 1, which has been compiled based on ground truth data. The study area's diverse land use patterns are illustrated by visually interpreting satellite imagery from IRS P6 LISS-IV. Comprehending the patterns of land use and land cover, as well as their spatial distribution, is imperative for formulating effective strategies needed to ensure the orderly development and management of a specific region (Ramadass et al., 2016; Blessy et al., 2018; Linga Swamy et al., 2022). The area shows various geomorphic landforms, manifesting predominantly lithological control in their evolution under semi-arid climatic conditions. The land use and land cover have been categorized into eleven conventional divisions in the current study, as outlined in Table 1. These divisions were defined and demarcated using visual interpretation techniques, which entailed the analysis of satellite imagery characteristics like color, tone, texture, pattern, size, and shape. A major part of the area is used as agricultural land (69%). The Banganapalli Quartzite and Narji Limestone which is extensively exposed in the study area form stony-lands and are covered by Scrub land-Open (7%). Around 11% of the total area is land covered by reserved forest in the south part of the area and the Reserved Forest are open mixed jungles with stony land.

Table 1: Spatial distribution of land use-land cover.

Land use -Land cover	**Area_in_Sqkm**	**Area_in_%**
Agriculture plantation	3.51	0.43%
Built Up (Rural)	22.31	2.73%
Canal	2.83	0.35%
Built Up (Urban)	7.25	0.89%
Agriculture Crop land	564.99	69.23%
Forest	92.12	11.29%
Mining/Industrial	11.7	1.43%
Reservoir/Tanks/Lakes/Ponds	23.17	2.84%
River/Stream/Drain	22.24	2.73%
Scrub land-Open	63.94	7.83%
Transportation	2.06	0.25%
Grand Total	**816.14**	**100.00%**

Fig. 7. Land Use Land Cover map of the study area



VII. Conclusions

In the current study, we employed satellite imagery from IRS-P6 LISS-IV, boasting a spatial resolution of 5.8 meters. We harnessed the power of image processing and Geographical Information System (GIS) techniques to delineate and explain various geographical features. These features include lithological characteristics, drainage patterns, geomorphological attributes, lineaments, and land use land cover units. To identify land use categories such as Agriculture plantation, Barren rocky areas, Built-up regions (both rural and urban), Forest Plantations, Reservoirs/Tanks, and different types of Scrub. Also incorporated pre-existing topographic sheets from the Survey of India for enhanced accuracy in assessing changes in land use and land cover over time. Providing valuable insights for both macro and micro-level planning. Additionally, topographic maps were used to refine the demarcation of distinct geomorphic units, ensuring a comprehensive understanding of the study area.

We observed drainage pattern is dendritic to sub-dendritic and most of the lineament's trends towards N to S direction which is flow to Musi and Krishna River.

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