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Geological, Geomorphological and Lineament mapping through Remote Sensing and GIS Techniques, in parts of Madurai, Ramanathapuram and Tiruchirappalli districts of Tamil Nadu

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ABSTRACT

Remote Sensing and Geographical Information System (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 formand lineaments on the imagery. Remotely sensed (satellite) digital data have a benefit in that the image data can be enhanced/manipulated for improving image interpretability with better accuracy. Satellite data facilitate the preparation of geological, lineament and geomorphological maps, particularly at a regional and small scale according to the resolution of the images. GIS has capability to visualize, enhance, manipulate,generate, store, integrate and analyse the thematic data. This study aims to map the lithology, geomorphology and lineaments in parts of Madurai, Ramanathapuram and Tiruchirappalli districts of Tamil Nadu 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, Geographical Information System, Geology, Geomorphology and Lineament.

1. Introduction

Remote Sensing and Geographical Information System (RS and GIS)technology has opened new vistas for mapping, planning, management, and monitoring of natural resources like land, water, soil, forest, mineral, etc. Both aerial photographs and satellite data based studies have proved their capabilities in various fields like geological, geomorphological and structural mapping, ground water survey, forest and soil mapping, land use planning, disaster, irrigation and water resource management (e.g., Krishnamurthy and Srinivas, 1995; Dar et al., 2010; Sivakumar et al., 2013; Sivakumar, 2013; Sivakumar, 2014; Bhowmick and Sivakumar, 2015). Detailed information can be extracted accurately from high-resolution satellite data and large-scale aerial photographs. Further detailed information can be generated or represented using the above data in a GIS. The interpretation of aerial 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).

In this study, remote sensing images have been analysed by the visual interpretation technique, as this technique is economical, easy to learn as compared to the digital analysis technique. In addition, visual interpretation of remotely sensed data is an essential step to learn the technique for various applications, and subsequent to convert the interpreted maps into digital from for use in a GIS. IRS LISS III False Colour Composite (FCC) imagery has been used for interpretation of geology, geomorphology and lineaments.

1.2. Aims and objectives

The aim of the study is to prepare different thematic maps on 1: 50,000 scale for parts of Madurai, Tiruchirapalli and Ramanathapuram districts of Tamil Nadu using RS and GIS techniques. Objectives of the study are as follow:

1. Preparation of base map from the survey of India (SOI) toposheets on 1:50,000 scale
2. Preparation of geological map from Geological Survey of India (GSI) published map and update with satellite data.
3. Preparation of various thematic maps such as geology (GSI map is reference), geomorphology and lineament using satellite data.

2. Study area

The study area falls mid Tamil Nadu, which covers an area of 756 sq.km and the area falls in between north latitudes 10º 15' and 10º 30' and east longitudes 78º 15' and 78º 30'. The study area (topographic sheet no. 58J/7) comprises south-eastern part of the Kadavur basin and part of the Madurai, Tiruchirappalli and Ramanathapuram districts of Tamil Nadu (Figure.1).

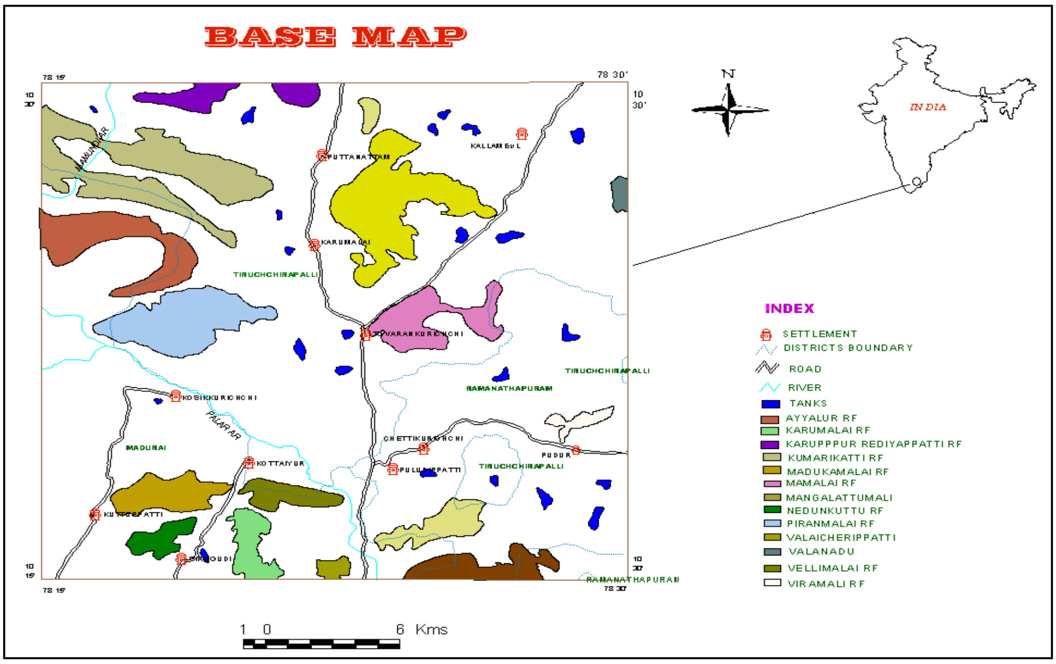

Figure 1: Study area map

3. Materials and methods

The data products used for the study comprised both satellite data and other conventional data. The Survey of India Toposheet, IRS1D LISS–III satellite image, published geological maps were used for the present study. The present work consists of investigation of Madurai, Ramanathapuram, Tiruchirappalli areas using satellite data interpretation. The study included preparation of base map followed by geological, geomorphological and lineaments mapping on 1:50000 Scale by visual interpretation of IRS LISS III FCC of bands R-2, G-3, B-4. ARC GIS, software was used for the study.

4. Results and discussion

4.1. Geological mapping

The area of study belongs to the Precambrian group of metamorphites and classified as Archeans super group and comprises quartzite, charnockites, hornblende biotite gneiss. Pink migmatites, pyroxene granulite and garnet-sillimanite graphite gneiss. The basic terminologies, which have been kept by the geological survey of India, have been retained as such for the present study. An independent lithological interpretation has been done using IRS LISS III imagery on the basis of their tonal, textural, structural, drainage, vegetation, biomass package, land use and land cover and other signatures. Such interpreted lithologies were matched with the original GSI map and appropriate modifications were done on original GSI maps and such modified map was taken for the present study (Figure. 2).

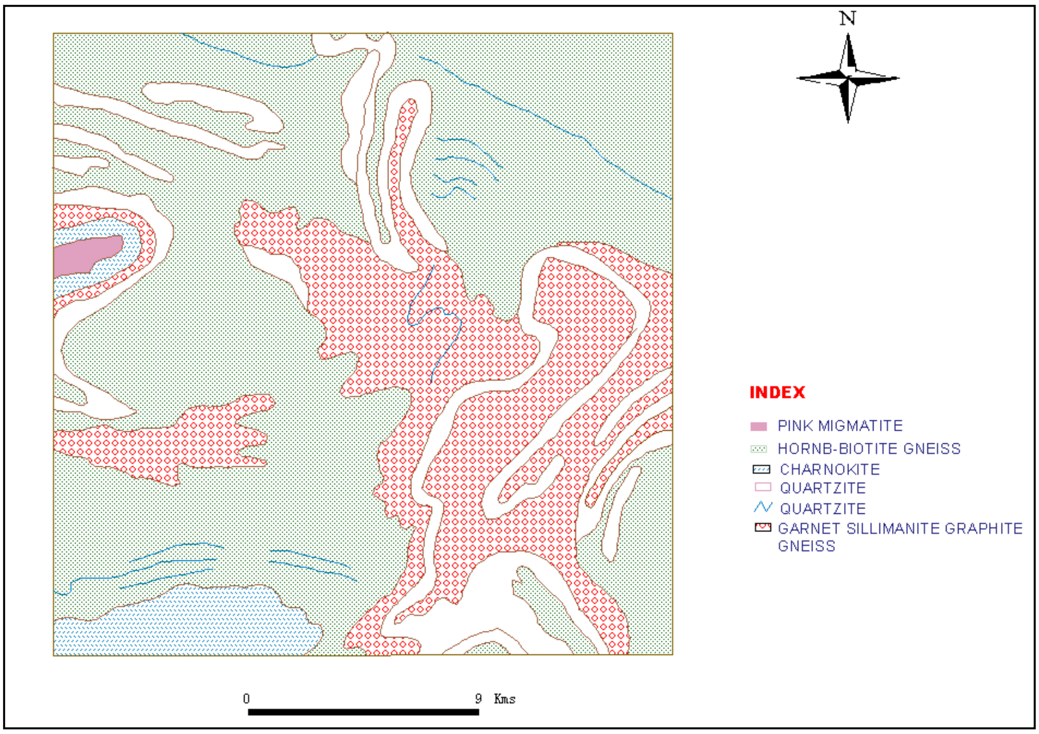

Figure 2: Geology map

4.2. Lineament mapping

The remotely sensed photographs give best enhancement in interpreting fracture systems and the lineaments. These fracture systems represents deep seated faults, master fractures and joint sets through which magmatic and metalliferous fluids are brought to the surface, groundwater movement takes place along them, act as zones of erosion, house geothermal springs and also act as neotectonic windows through which earthquakes and seismicity take place. Hence, the remote sensing has really opened up new chapters in lineament mapping (e.g., Ramasamy, 1996; Neelakantan, et al., 2005). The geoscientists can also evolve genetical classification of these lineaments such as extension, shear and release failures and based on which more precise proximation can be done for locating the metals and minerals. These lineaments also act as master conduits through which pollutants migrate aggressively (e.g., Ramasamy and Balaji, 1993). Hence, based on such lineament studies, these areas may not be considered for disposing of factory effluents.

Ramasamy and Balaji (1993) have analyzed the lineaments of Tamil Nadu and classified the lineament into three major azimuthal groups such as ENE- WSW trending a tensional fractures, NE-SW dextral & WNW-ESE trending sinistrtal failures and NNE_SSE aligned release lineaments. Ramasamy and Balaji (1993) have brought out one more set of lineament with NNE-SSW to N-S orientation. The present study has once again substantiated the earlier findings. Ramasamy and Balaji (1993) have also demonstrated that amongst the above 4 set of lineaments are younger in age and also seismically active as express striking coincidences with earthquake epicenters and also the drainages show frequent anomalies along them.

Lineaments are the linear, rectilinear and curvilinear features of tectonic origin observed on satellite image. These lineaments normally show tonal, textural, soil tonal, relief, drainage and vegetation linearity's and curvilinerities on satellite data. All these linear features were interpreted from the satellite data and lineament map was prepared for the study (Figure. 3).

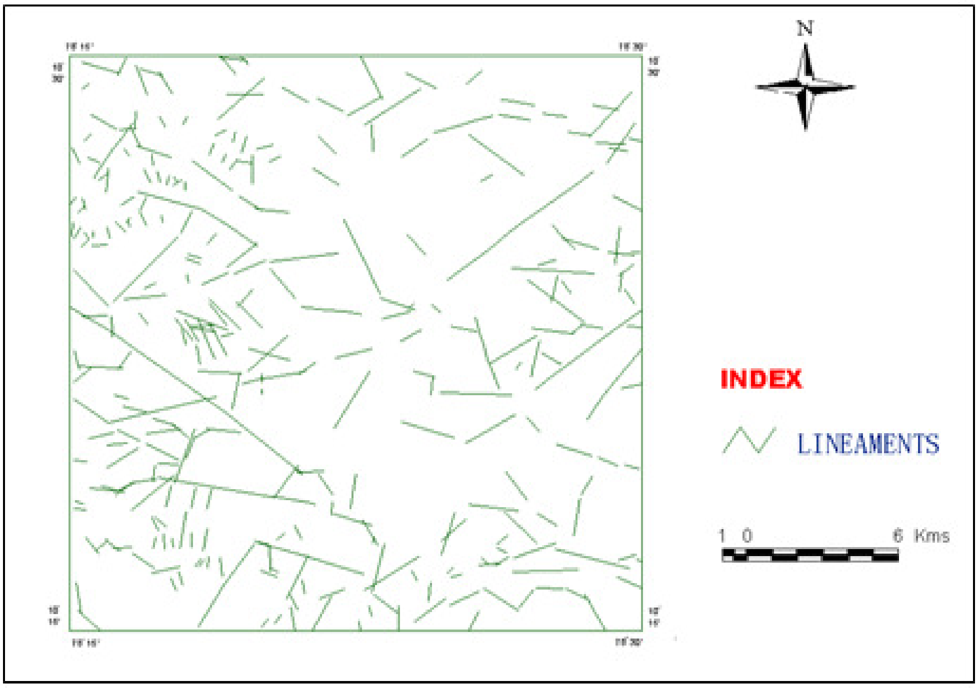

Figure 3: Lineament map

4.3 Geomorphology mapping

The geomorphological map has been prepared on 1:50000 scale based on visual interpretation. Different landforms units were identified such as pediments, piedmont zone, alluvial fill, colluvial fill, valley fill etc., (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.

4.4 Structural hill

These are the hills formed due to the regional tectonics showing structural trends of the region. The hill ranges in general have shown anticlinal hills, synclinal valleys and ring shaped hills, which are easily delineated using satellite data. The structure of Madurai, Ramanathapuram, Tiruchirappalli areas have shown complex folding and high degree of fracturing.

4.5 Piedmont zone

Piedmont, as the term suggests, is a feature usually formed at the foot of a mountain. Piedmont normally is a zone of coalescing fans, which occupies a long and narrow to moderately wide apron at the foot slopes of a high relief. Identified by its pale greenish tone, texture and radial pattern of drainages.

4.6 Valley fills

Valley fills were found along narrow synclinal depression or along fracture valleys that trap sediments that are removed from the hill summits, slopes and as a result cobbles, pebbles and unconsolidated sediments were deposited in the valley. In the imagery valley fills were identified by its dark red tone (with vegetation), light gray tone (without vegetation), shape and associated with the hill ranges are important elements to recognize these landforms.

4.7 Colluvial fill

These are formed due to the fluvial activity mainly along the lower order stream as well as by gravitational action and deposition of the unconsolidated material in the down catchment and within the areas between the hills and the catchment. It is well observed in satellite data by its red tone, irregular shape. Colluvial fills are found all along the hill ranges.

4.8 Pediment

The pediment is developed by a combination of processes including stream erosion, weathering, sheet wash, etc, Much of the area forming the pediment consist large area as a result of continuous process of pedimentation, It is normally termed as a pediplain. These pediments have been divided into 3 categories based on the thickness of weathering mantle, climate etc. i. Pediments at shallow depth which, show medium grey tone and medium texture in the satellite FCC composite, ii. Pediments at medium depth that show greenish red tone and irregular/regular texture in the satellite imagery and iii. Pediments at deep depth, which show dark red to dark green tone and smooth texture in the satellite data.

4.9 Residual hill

Residual hill are the end products of the process of pediplanation which reduces the scattered knobs standing on the pediplains (William, 1990). The residual hills are identified by its dark reddish tone in the imagery.

4.10 Alluvial fills

Alluvial fills are deposited along the river / stream courses due to repeated flooding. Alluvial fills occur in the eastern region of the study area. They are identified by its bright tone.

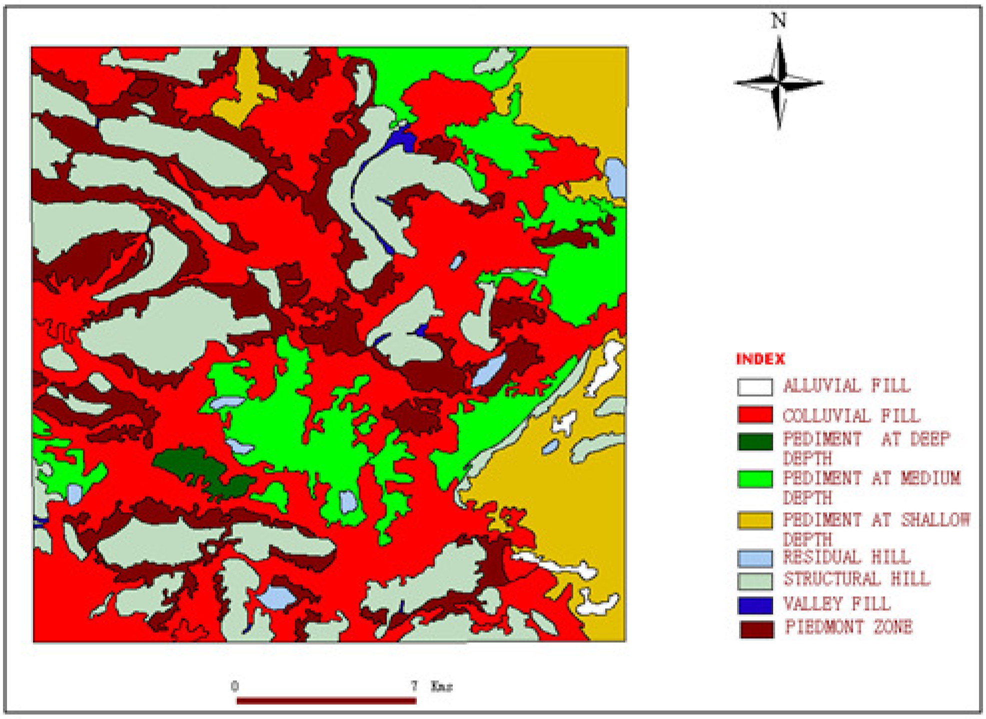

Figure 4: Geomorphology map

5. Conclusion

1. The present study has shown that the satellite data is very useful in various aspects of geological, geomorphological and lineament mapping studies.It provides quick and accurate data with minor details.
2. Archeans super group rock type such as quartzite, charnockites, hornblende biotite gneiss are mapped.
3. Geomorphologically,the area is classified as structural hills, pediments, valley fills, piedmont zone and colluvial fills.
4. Major and minor lineaments are mapped in these areas.

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