GEOLOGICAL, GEOMORPHOLOGICAL AND LINEAMENT MAPPING USING REMOTE SENSING AND GIS - A TOOL FOR LAND USE PLANNING IN TIRUCHCHIRAPPALLI DISTRICTS OF TAMIL NADU

Dr. A. Balukkarasu, Associate Professor, Centre for Remote Sensing, Bharathidasan University, Trichy, India. 1;
B. Santhosh Kumar, Research Scholar, Centre for Remote Sensing, Bharathidasan University, Trichy, India. 2

Abstract

Land use planning is mandate for developing countries like India. This study aims to map the distribution of rock units, geomorphological landforms and lineaments Patten across a Tiruchchirappalli district for land use planning. Geological map is a graphical presentation of geological observations and interpretations on a horizontal plane. The geological survey of India map has been used for Geological map creation and Landsat OLI satellite data for geomorphological landforms mapping in 1:50000 scale. The lineament map was created using Shuttle Radar Topography Mission (SRTM) satellite data. Granite gneiss and Charnockite were majorly covered in the study area. In the geomorphological landforms alluvial plain, pediment, pediplain were highly observed in the mapping. From the interpretation of lineaments NE-SW, NW-SE trends were vastly mapped. It can be used effectively in different urban Land use planning practices and geomorphological hazard mapping.

Keywords: Remote Sensing, Geomorphology, SRTM, Landsat OLI.

Introduction

The Natural hazards, historically, have been understood as haphazard acts of natural history, symbolised by extremes in physical processes. Disaster is an extensive agent that can include rapid onset natural hazards including cyclones and earthquakes, or slower 'creeping crisis' such as drought, famine, or disease (De Paratesi, 1989). It is difficult to define a disaster because they have varying magnitude, temporal and spatial dimensions and varying social and economic effects. The developing world will continue to be hardest hit by the cascading effects of human–driven climate change, environmental degradation, and population pressures.

Geology is purely science, world geology was coined by a Bishop in the fifteenth century. Geology, geo means earth, logy means science, which deals with the earth as a whole. Landforms on the earth surface are cost effect to map and monitor. Remote Sensing potential application for observations from space platforms provides a synoptic view of terrain on images. Multi-spectral satellite data provide an advantage to map the geomorphological landforms and time series analysis.

Any historical change has been identified through the times series studies and find out the problems. A map is a visual representation of an area - a symbolic depiction highlighting the relationships between elements of that space such as objects, regions and themes. A map showing the distribution of rock units and structures across a region, usually on a plane surface, is thus a geological map. Mineral resource mapping is an important type of geologic mapping activity and usually covers a great part of varied studies, focused on spectral analysis (e.g. Longhi et al., 2001), geological mapping (e.g. Harris, 1991), structural mapping (e.g. Liu et al., 2000), identification of hydrothermal alteration zones (e.g. Podwysocki et al., 1983), mineral alteration mapping (e.g. Tangestani and Moore, 2002), ferric oxide and oxyhydroxide mineral mapping (e.g. Farrand, 1997), gold exploration (e.g. Spatz,1997), hyperspectral imagery (e.g. Neville et al., 2003), integration with geographic information systems (GIS) (e.g. Akhavi et al., 2001) etc. Geomorphology is the systematic study of landscape. A few scientist of each generation chose the systematic description and analysis of landscape and the processes that change them as specialised area (S.M. Hamid Rizvi). It is science developed much later than geology although several aspects of geomorphology are embedded in geological processes. Geomorphology deals with the genesis of relief forms of the surface of the earth's crust.

Certain natural processes are responsible for the forms of the surface of the earth. The potentiality for groundwater occurrence in hard rock areas is influenced by the presence of lineaments. Presence of lineaments may act as a conduit for groundwater movement which results in increased secondary porosity and therefore, can serve as groundwater potential zone. Lineament analysis has been used extensively for geologic interpretation, particularly since the 1930s with the advent of photogeology, besides satellite data provides quick and useful baseline information on the parameters controlling the occurrence and movement of groundwater like geology, lithology/structural, geomorphology and lineaments.

Study area Description

Tiruchchirappalli district is located at the Central part of Tamil Nadu surrounded by Perambalur district in the north, Pudukottai district in the south, Karur and Dindigul districts in the west and Thanjavur district in the east. It lies between 10o10’ and 11o20’ of the Northern latitudes and 78o10’ and 79o 0' of Eastern latitudes in the centre part of the Tamil Nadu. The general slope of the district is towards east. It has a number of detached hills, among which Pachamalai Hill is an important one, which has a peak up to 1015m, located at Sengattupatti rain forest. There are reserve forests along the river Cauvery, located to the west/north-west of the city. Tiruchchirappalli district comprised of eight taluks viz. Thuraiyur, Lalgudi, Musri, Tiruchchirappalli, Thottiyam Manachanallur, Srirengam and Manapparai, which included 14 blocks, 408 Village Panchayats and 1590 Villages.

This district consists of four municipalities namely Ponmalai, Srirangam, Thuraiyur and Manapparai. Tiruchchirappalli is the only Municipal Corporation which is also the Head Quarters of the District. As per 2001 census the population of city was 746,137 and it is classified as a medium sized city. Figure 1 shows the location of the study area.

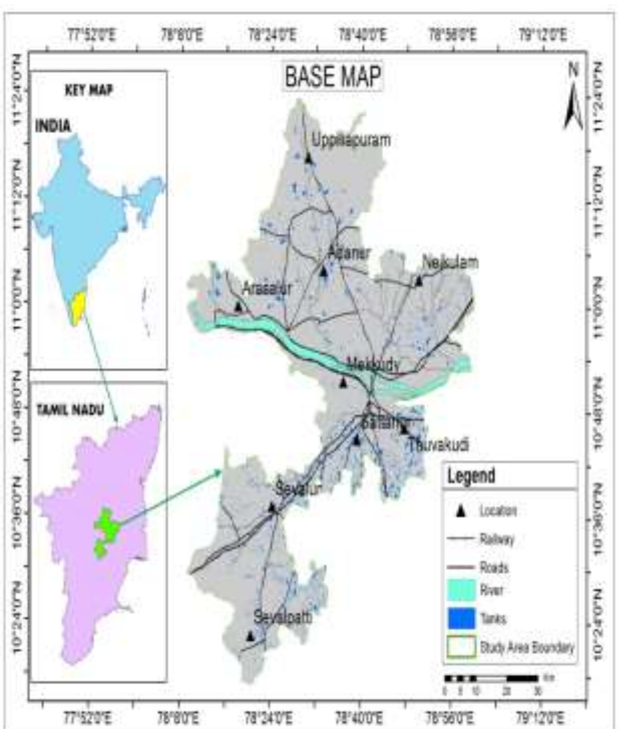

Figure 1, Study area Location Map

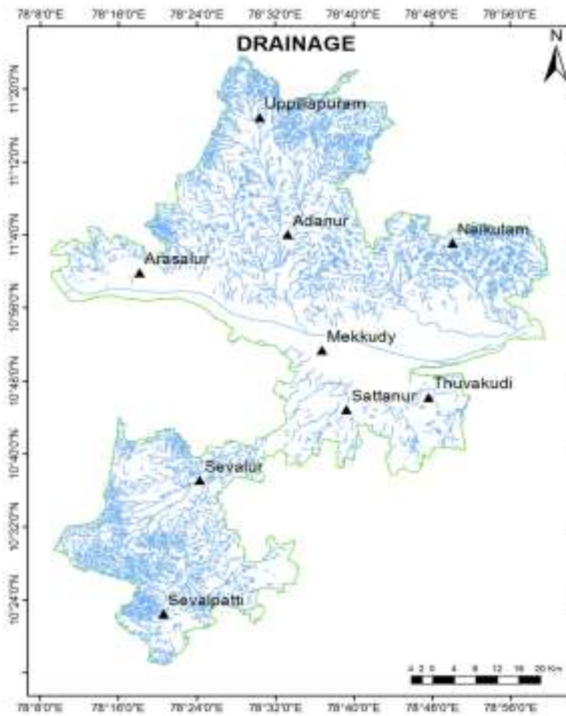

Figure 2, Drainage Map

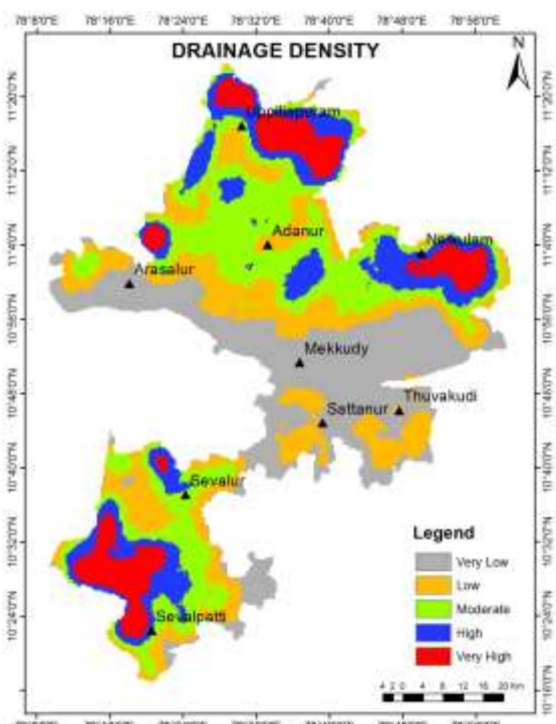

Figure 3, Drainage Density Map

Methodology

The methodology used was based on GIS approach. The toposheets, GSI map of geology were initially geo-referenced using geometric transformations. Each toposheet was corrected using a polynomial function with keyboard method and ground control points based on the topography map as geo-reference. From the Geological Survey of India map has been used for Geological map generations. The USGS satellite imagery of Landsat OLI (2017) and Geo eye was used for the geomorphological mapping. The Shuttle Radar Topography Mission (SRTM) has been used for lineament mapping. Figure 2 shows the methodology of the study.

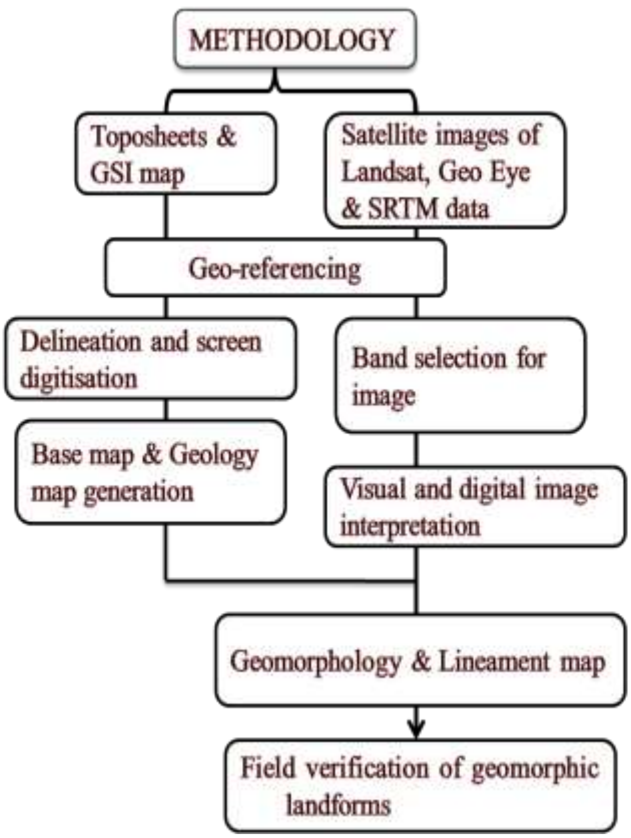

Figure 4, Methodology

Table 1: Information of the Used Data

Parameter	Data Source
Geology	Geological Survey Of India
Geomorphology	Landsat OLI (30m resolution)
Lineaments	SRTM Data (90 m Resolution)

Results and Discussion

Geology

Principally there are various reasons why geological field mapping is carried out all of which involve collecting variable amounts of field data. These reasons can, however be summarized into three broad objectives which may sometimes be organized; natural resources, government importance and academic needs. Natural resources are naturally occurring materials that exist within the earth's crust and are extracted mostly for economic purposes. Government importance are, In order to better understand an unknown area, for planning purposes in development projects, prevention of adverse destruction during natural disasters such as earthquakes (hazard preparedness) impact assessment studies. Academic Processes, in the subsurface are not fully understood and the in mapping geological features on the surface we get some insight into the more complex system (Eppler, 1997). The study area belongs to the Pleistocene, Precambrian, Upper Cretaceous and comprises Alluvium, Charnockites, Dharwar Sysytem, Granite Gneiss (Peninsular Gneiss), (Pink Granite, Uttatur, Trichinopoly, Ariyalur and Niniyur Stages). The basic terminologies, which have been kept by the geological survey of India, have been retained as such for the present study.

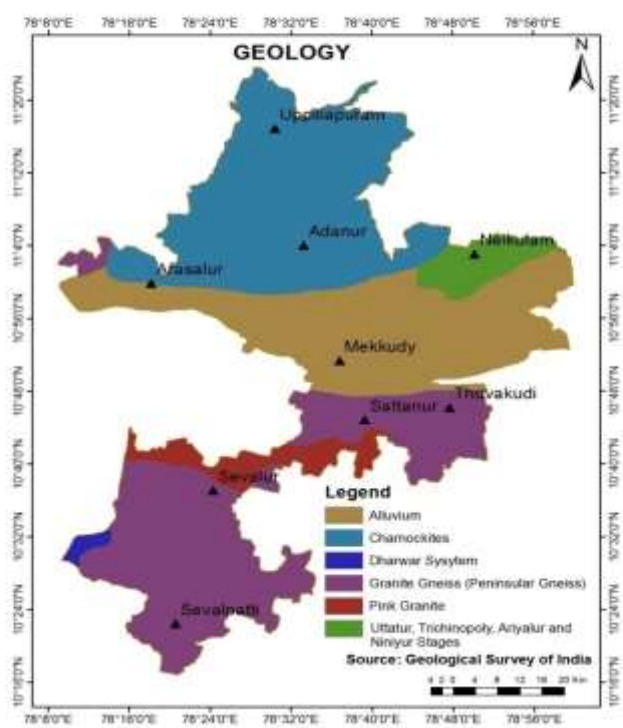

Figure 5, Geology map

Geomorphology

The geomorphological map has been prepared on 1:50000 scale based on visual interpretation. Different landforms units were identified such as Alluvial Plain, Denudational Hills, Flood Plain, Inselberg, Linear Ridge, Buried pediment, Pediment, Weathered Pediplain, Piedmont Zone, Residual Hill, Shallow Flood Plain, Structural Hills (Figure.4) and these geomorphic units are grouped based on their origin (e.g., William D. Thornbury,1995). The details are discussed in the following sections.

Alluvial Plain

The alluvial plain is formed by extensive deposition of alluvium consisting of gravels, sand, silt and clay by major river systems. This unit is normally flat to gently undulating and usually adjacent to a river that periodically overflows its banks. Alluvial plain aquifer is important component for Groundwater balance. It is deposited along the river. It occurs in the North eastern part of the study area. They are identified by its bright tone.

Denudational Hills

It is formed due to differential erosion and weathering or epiorogenic so that a more resistant function or intrusion has developed a character of hill/mountain. It has located in the southwestern part of the thiruchchirappalli district.

Flood Plain

Floodplains are land areas adjacent to rivers and streams, it is unique ecosystems because of their linear form, the sometimes extreme dynamism of their geomorphology and because they process large fluxes of energy and materials from upstream areas.

Inselberg

Inselbergs are isolated rises above a plain which consist of hard bedrock. If they have a soil cover, then this is very sparse. They vary in height depending on their development, and they take on different forms, as far as both ground plan and cross section are concerned, according to their genesis and lithology. It occurs in the upper part of the study area.

Linear Ridge

The ridges arranged in a line or lines and show linear, narrow, low lying relief, which is generally barren. These ridges are sometimes strike controlled. It has majority present in the upper part of the study area.

Pediment

Pediments, gently sloping erosional surfaces of low relief developed on bedrock, occur in a wide variety of lithologic, and climatic settings. It has present highly on the nearby river course. It shows medium grey tone and medium texture in the satellite FCC composite.

Piedmont Zone

Alluvium deposited along foot hill zone due to sudden loss of gradient by river/streams. 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. It has identified by its pale greenish tone, texture and radial pattern of drainages.

Residual Hill

When the process of erosion takes place gigantic wave of water flows on the mountains and other high land areas this causes boulders, sediments and other solid materials are

washed away and when these rocks resituated in a large size on other parts of land then called residual hills. It present on the northern and southern part of the study area. It is identified by its dark reddish tone in the satellite imagery.

Structural Hills

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 of huge view. The northern and southern parts of Tiruchchirappalli have shown complex folding and high degree o fracturing.

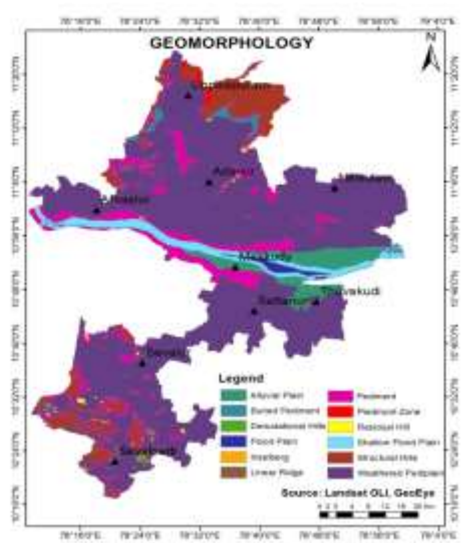

Figure 6, Geomorphology Map

Lineament

In flat-lying sedimentary sequences Lineaments are commonly surface expressions of tectonic fractures and faults in the bedrock, emphasized on the surface by topography, drainage, and vegetation - many can be identified by remotely sensed data. In many of the following investigations, comprising structural studies of landforms, the usage of the term lineament is defined and generally implies that landforms are related to features in the underlying bedrock (cf. El-Etr, 1974) in agreement with Hobbs definition from 1912. The Tamil Nadu has 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 from the literature survey. Lineaments are the linear, rectilinear and curvilinear features of tectonic origin observed on satellite image. All these linear features were interpreted from the satellite data and NE-SW, NW-SE trends were vastly mapped.

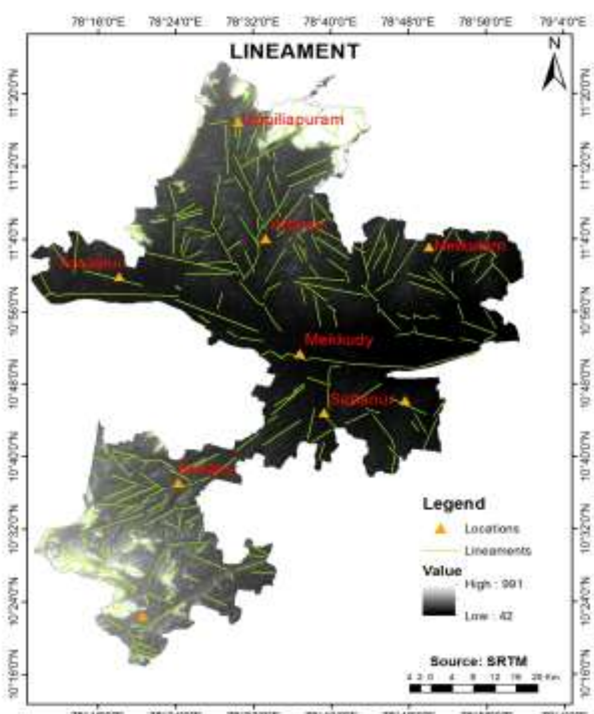

Figure 7, Lineament map

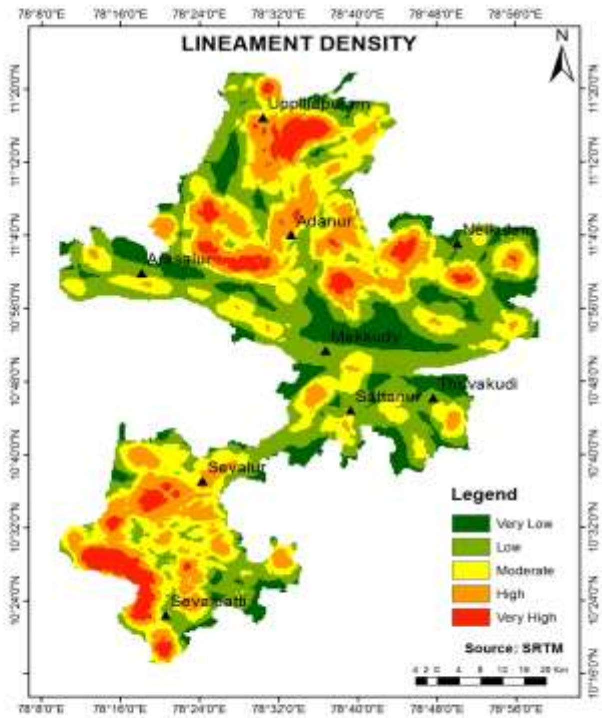

Figure 8, Lineament Density map

Conclusion

In this research, Geology, Geomorphological landforms, Lineamnets were mapped in detailed manner. The study area of Pleistocene, Precambrian, Upper Cretaceous and comprises Alluvium, Charnockites, Dharwar Sysytem, Granite Gneiss (Peninsular Gneiss), (Pink Granite, Uttatur, Trichinopoly, Ariyalur and Niniyur Stages) have been kept by the geological survey of India. The geomorphological landforms like Alluvial Plain, Denudational Hills, Flood Plain, Inselberg, Linear Ridge, Buried pediment, Pediment, Weathered Pediplain, Piedmont Zone, Residual Hill, Shallow Flood Plain, and Structural Hills could be easily identified and mapped through remote sensing and GIS techniques. The evaluation of lineaments detected can be easily performed in a GIS environment, showed extensive NE-SW, NW-SE trending lineament systems most of which were clustered in the northern part of the region. Land use planning and management is continuous process due to natural and anthropogenic causes. For future land use planning and management, it is mandatory to value the presented geomorphic units and extents. Based on the mapped geomorphic units local and government authority and academicians can make decision to more accurate land use planning for human activities and sustainable development.

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Biographies

Dr. A. Balukkarasu is at present working as Associate Professor in Centre for Remote Sensing, Bharathidasan University, Khajamalai Campus, Tiruchirappalli – 620 023, Tamil Nadu, India. He completed M. Sc, M. Phil and Ph.D from Annamalai University, Tamil Nadu. He was formerly working in Geological Survey of India and has twenty three years of experience in Lignite, Coal and Platinum Group of Elements. His explorations area comprises Tamil Nadu, Kerala and Andhra Pradesh. He has contributed to the lignite exploration work by adopting concept oriented studies coupled with integrated approach. He received the prestigious National Mineral Award in 2007 for the discovery of huge lignite deposit in Mannargudi and Ramnad Sub basins of Cauvery Basin. He has also carried out extensive laboratory studies with the help of scientific instruments such as Electron Probe Micro Analyzer (EPMA) and Scanning Electron Microscope (SEM-EDX) and generated valuable data in the mineral chemistry of Platinum Group of Mineral phases. He has also unraveled the Nature and Control of Platinum Group of Elements mineralization in Sittampundi Layered Ultramafic Complex and various places. Author may be reached at E-mail: gsibalu63@gmail.com.

Mr. B. Santhosh kumar, has received his M.Tech degree in Geo-Technology and Geo-Informatics from Centre for Remote Sensing, Bharathidasan University, Khajamalai Campus, Tiruchirappalli-23, Tamil Nadu, India. And currently pursuing Ph.D. at Centre for Remote Sensing, Bharathidasan University. His research interest includes Natural Resources Management, Climate Change, Sustainable Development, Environmental Impacts Assessment, Mineral potential Identification, Remote Sensing and GIS, Disaster Management and Hydrology. He completed off campus outreach program of Hyper spectral Remote Sensing and Geo-Web services-Technology & Application both were conducted by IIRS, ISRO, DOS, Government of India. Author may be reached at E-mail: Santhosh.geotech@gmail.com.