Creation of physical characteristics information for Natural Resources Management Using Remote sensing and GIS : A Model study

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ABSTRACT
Natural resources are required for agriculture, forestry, rangeland, urbanization and many other developmental activities satisfying human needs. creation of these resources information system with the help of Remote sensing and Geographic Information System (GIS) tools could be helpful in getting the precise and valuable spatial information in understanding the present scenario contemplating with the past data and predicting the future trends. The main objective of the study is to evaluate and map the physical characteristics in the study area and to develop methods for its efficient utilization of natural resources for sustainable management useing remote sensing and GIS. The thematic layers are derived from IRS-P6, LISS-IV, MX satellite imagery(Fig.4) and Survey of India (SOI)(Fig.5) topomaps using visual interpretation technique. These maps are converted to digital format and further integrated in ARCGIS software for the generation of final outputs. This study recommends effective soil and water conservation measures to increase the subsurface aquifer capacity and identifies suitable cropping patterns, which help in reduced soil erosion, increased moisture conservation and improved productivity of the soil. The physical characterization of an area is also useful to plan the basic minimum needs of farmers, thereby improving their socio-economic conditions and helps in evolving a broad national policy which can be applied by decision makers for sustainable development of any given area.

Keywords: Physical characterization, Natural resources management, Remote sensing, Geographical Information System, Sustainable development.

1. INTRODUCTION
Natural resources are very much value for supporting agriculture, forestry, mining and human settlement. these are also have social, ecological and cultural uses and values. As with most environmental concepts, natural resourcees cannot be considered in isolation from other components of the environment. Comprehensive information about the status of the natural resources and their utilization is essential for any area treatment and management (Veerlapati Govardhan 1993). Among others, status of water resources, land evaluation for irrigation, cropping pattern and land use are the important factors that influence soil and water use efficiency, not only for optimizing agricultural production but also for control of the twin problems of soil and water which are usually associated with overuse and mismanagement in a study area (Isobel1998). Periodic mapping and monitoring of Natural resources and their utilization status is therefore important for formulation of appropriate strategies for planning and implementation of ameliorative and development measures. This can be achieved by conventional ground surveys or by application of modern technology of remote sensing with limited ground studies.The conflicting demand of human activities and the pressure of increasing population have made it essential to plan the use of land in an optimal manner, so as to reap maximum benefits for the millions of human beings (Arakeri 1984). The constant pressure of growing population, increased demand for food, fodder and fuel wood combined with intensive industrial activity have led to large-scale environment degradation and ecological imbalance. Hence in order to use natural resources optimally, it is necessary to have first hand information about the existing land and then assess the location in the study area. Remote sensing, because of its advantage like synoptic view, repetitive coverage and multi spectral and multi sensor data availability, have been universally accepted as a powerful technology for resources survey mapping and regular monitoring (Prithvish Nag 1992). Remote sensing data with rapid in-time availability, high resolution and low cost product is an important tool for planning activities and can be used to study the physical characteristics of terrain depicting various Natural resources (Agarwal and Garg). These maps as a reliable input can be put to a Geographic Information System (GIS) to describe natural resources both renewable and non-renewable as well as cultural and human resource (Anji Reddy 2003)

2. OBJECTIVES
- To create the physical characteristics information of the study area for effective management and future development.
- To create spatial digital database consisting of land use/land cover, drainage, physiography, soil and slope maps using IRS P6 satellite data, SOI toposheets and ground data on ARCGIS platform
- To generate attribute data base consisting of statistical details of each of the above thematic layers
- To suggest suitable conservation and land use management practices

3. DESCRIPTION OF STUDY AREA

The study area is part of Prakasam District of Andhra Pradesh in India Prakasam is an administrative district in the state of Andhra Pradesh with the district headquarters located at Ongole. There are a total of 56 mandals in this district occupying an area of 17,626 km² with a population of 3,054,941 (as of 2001census). Some of the main towns in Prakasam district are Markapur, Chirala, Addanki, Kandukur, Giddalur, Podili, Dornala, Cumbum, Kanigiri and Chimakurthi. Prakasam district occupies an area of 17626 $SqKm^2$ with various agricultural, mining and quarrying, manufacturing and other household industries. However, the study area Vetapalem mandal of prakasam district is located at Longitude of 80^0 .15’ 29’’ to 80^0. 24’ 30’’ and Latitude of 15^0 42’53’’ to 15^0 49’ 53’’.Vetapalem mandal has five Revenue villages and belong to Chirala constituency. (KothaPeta, NayaniPalli, PandillaPalle, PullariPalem and Vetapalem).

3.1 Village’s spatial extent:

KOTHAPETA:	Longitude	:	80^0 .20’ 18’’ to 80^0. 24’ 30’’
	Latitude	:	15^0 45’51’’ to 15^0 49’ 53’’.
NAYANIPALLI:	Longitude	:	80^0 .18’ 12’’ to 80^0. 21’ 57’’
	Latitude	:	15^0 44’20’’ to 15^0 48’ 1.53’’.
PANDILLAPALLE:	Longitude	:	80^0 .15’ 29’’ to 80^0. 17’ 35’’
	Latitude	:	15^0 44’20’’ to 15^0 46’ 53’’
PULLARIPALEM:	Longitude	:	80^0 .16’ 51’’ to 80^0. 20’ 7.42’’
	Latitude	:	15^0. 42’53’’ to 15^0. 46’9.93’’
VETAPALEM:	Longitude	:	80^0 .16’ 39’’ to 80^0. 19’ 51’’
	Latitude	:	15^0. 45’ 37’’ to 15^0. 48’40’’

The area of vetapalem mandal is 95.24 sq.kms .it has a total population of 67990 as per 2001 census, of which 28063 comprises rural and 39927 urban population. The mandal decadal growth rate is 7.40 in between1991-2001

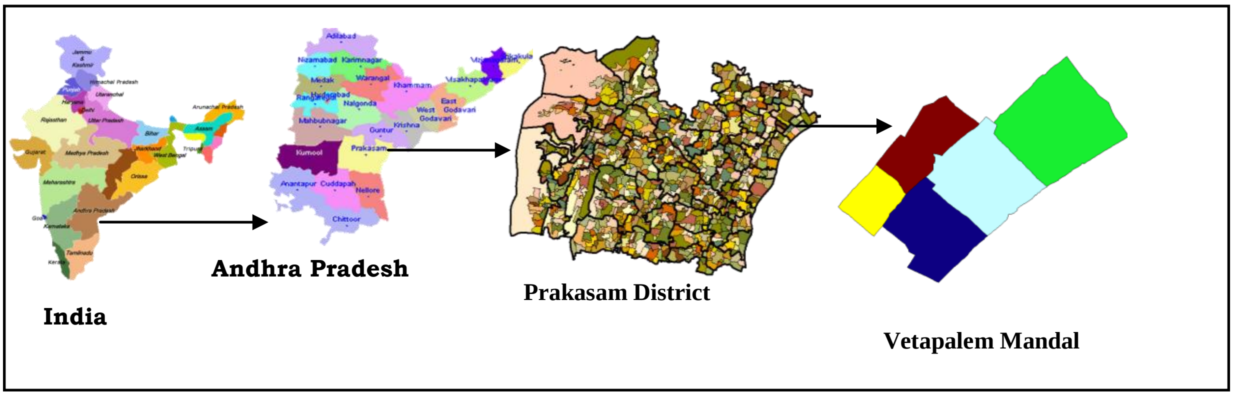

Fig.1: Location map of the study area

s.no	village name	village area in ha.	village area in sq.kms.
1	Pandillapalli	873	8.73
2	Pullaripalem	1348	13.48
3	Kothapeta	3031	30.31
4	Nayanipalli	2188	21.88
5	Vetapalem	2084	20.84

Tab.1: Village wise area in ha & Sq.Km.

4. METHODOLOGY

4.1 Data Collection

Different data products required for the study include SOI toposheets bearing the number 66A06NW,66A06SE,66A06SW on 1:25,000 scale, data of IRS-P6, LISS-IV, MX satellite imagery obtained from National Remote Sensing Agency (NRSA) and collateral data collected from related Government organizations and demographic data.

4.2Data Input and Conversion

IRS-P6 satellite imageries collected from NRSA are geo-referenced using the ground control points with SOI toposheets as a reference output in ERDAS Image processing software. The study area is then delineated and subsetted from the data based on the latitude and longitude values and a final hard copy output is prepared for further interpretation.

4.3 Database Creation and Analysis

Creating a GIS spatial database is a complex operation, which involves data capture, verification and structuring processes. Raw geographical data are available in many different analogue and digital forms such as toposheets, aerial photographs, satellite imageries and tables. Out of all these sources, the source of toposheet is of much concern to natural resource scientist and an environmentalist (John R.Jensen 2003). In the present study, different thematic layers viz., base, drainage, slope, physiography, land use/ land cover and geomorphology are generated from toposheet and satellite data using visual interpretation technique.

The paper-based maps are converted to digital mode using scanning and automated digitization process. These maps are prepared to a certain scale and show the attributes of entities by different symbols or coloring. The location of entities on the earth's surface is then specified by means of an agreed co-ordinate system. It is mandatory that all spatial data in a GIS are located with respect to a frame of reference. For most GIS, the common frame of reference co-ordinate system is that of plane, Orthogonal Cartesian co-ordinates oriented conventionally North-South and East-West . This entire process is called geo-referencing. The same procedure is also applied on remote sensing data before it is used to prepare thematic maps from satellite data. This digitized data is then exported to ARC/INFO and further processed in ArcView GIS software to create digital database for subsequent data analysis.

5. RESULTS AND DISCUSSION

5.1 Base map

A topographic map is a representation of the shape, size, position and relation of the physical features of an area. The base map is prepared using SOI toposheet on 1:25,000 scale and updated with the help of satellite imagery. It consists of various features like the road network, settlements, water bodies Ramperu River, canals, The South central railway line passes through the study area and vegetation etc. delineated from the toposheet. The map thus drawn is scanned and digitized to get a digital output. The information content of this map is used as a baseline data to finalize the physical features of other thematic maps. Since the topo sheets are very old all the features like roads, railways, settlements etc are updated with the help of rectified and scaled satellite imageries of the area. The major settlements in the present study area are etc

5.2 Transport map

In the study area all the settlements are connected either by Metalled road or Un-Metalled road. Railway network (south central railway) passes through vetapalem village. The **image** shows the transport network map (Fig.7) of the Vetapalem Mandal.

5.3 Drainage Map

The drainage map (Fig.6) prepared from the toposheet forms the base map for the preparation of thematic maps related to surface and groundwater. All the rivers, tributaries and small stream channels shown on the toposheet are extracted to prepare the drainage map. Care is taken that the boundaries of rivers/ water bodies appearing on land use /land cover map or base map are perfectly matched with those on the toposheet. All the drainage lines are examined very closely and final drainage map is prepared. The study area is a first , second order streams and Ramperu River, canals are present. The present study area dendrite and prellal drainage are present. The flowing of water is tamed through construction of number of tanks and channels.

5.4 Watershed Map

Watersheds are hydrological units that are considered to be efficient and appropriate for assessment of available resources and subsequent planning and implementation of various development programmes. The watershed map (Fig.11) is prepared in accordance with the National Watershed Atlas and River Basin Atlas of India, 1985. According to this, India is divided into 6 regions (River Basin Atlas of India, 1985). The present study area comes under Region-4 and part of basin C, catchment 4, sub- catchment D, The study area is covered (4C4D1, 4C4D2) watersheds partially. In the 4C4D1 watershed Three sub watersheds is coming that is 4C4D1c,4C4D1d,4c4D1g,In the 4C4D2 One sub watershed is coming that is 4C4D2a.

5.5 Slope map

Slope has been categorized into different classes following a guidelines of all India Soil and Land Use Survey (ALS & LUS). To prepare the slope map on 1:25,000 scale survey of India topo sheets with 10m contour intervals have been used.

Slope classes 1, and 2 are observed in the study area . Most of the study area is covered by nearly level slope class (86% of the study area). Small part of the study area comes under very gently sloping (14%) .

5.6 Physiography
The purpose of Physiography layer is to understand disposition and distribution of barriers of winds. The Physiography is prepared using the contours derived from Survey of India topo sheets. Their physiography categories are demarcated in the map as Plains, Undulating land and Hills. The high slope areas not only pose physical constrains for developmental activities but also act as barriers for dispersion of air polluting emissions. The plains occupy the total study area, which indicates nearly level, gently sloping and very gently sloping terrain.

5.7 Land Use/Land Cover
The LU/LC map (Fig.8) of the study area is prepared from satellite imagery using visual interpretation technique. This technique consists of a set of image elements, which help in the recognition or interpretation of various land use /land cover features systematically on the enhanced satellite imagery during the classification of features (Lillesand and Kiefer 1994). The land use/ Land cover classification system used in this study is the system, which is pioneered by United States Geological Survey (USGS) and is modified by National Remote Sensing Agency (NRSA) according to Indian conditions. A preliminary image classification key is prepared for the fused pictorial data and is used during interpretation process. The base map is overlaid on the satellite imagery. Then the features of LU/LC classes are extracted and transferred from the satellite pictorial data. The doubtful areas (due to similar spectral response and spectral signature) identified during the preliminary image classification are listed out before ground verification. The doubtful areas are physically verified by field observation, based on which, corrections and modifications of misclassified land use/land cover details are carried out for preparation of final maps so as to extract the entropy or information content in accordance with the above thematic maps.
Land use / land cover map showing the spatial distribution of various categories and their aerial extent is vital for the present study. The spatial distributions of various land uses are interpreted based on IRS-P6, LISS-IV, MX satellite data. The land use/land cover categories such as built-up land, agriculture, forest, water body and wastelands have been identified and mapped for the study area Major part of the study area is covered Single crope(18%),Wetkands(1%),Cashew Plantationa(6%), Casuarina plantations(3%),Doublecrop (20%),Dried fishponds(2%),Fish ponds(2%),Grass lands(5%),Land with Scrub(3%),Land without Scrub(9%),Plantations(8%),Reserved forest(6%),Residential Area(9%),River Drain(3%),Salt pans(1%),Raod(1%) has been observed on the study area.

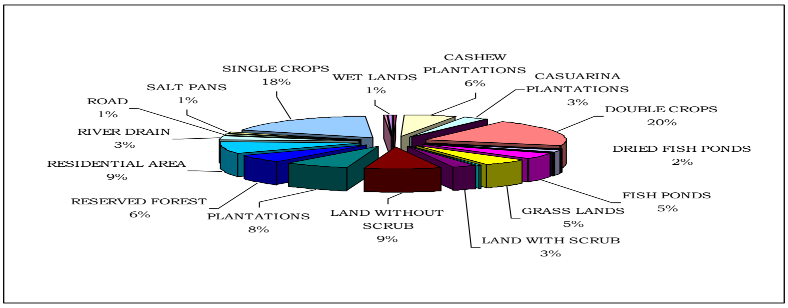

Fig.2: Pie Chart showing percentage distribution of Land use/ Land cover in the study area

5.7.1Crops Cultivated in the study area:

Food Crops	:	Paddy
Food grains	:	Ground nuts, Cashwenuts.
Cereals	:	Rice
Millets	:	Jowar, Bajra, Maize and Ragi
Pulses	:	Redgram and Green gram
Condiments and Spices	:	Onions, Chillies and Tamarind
Non-food crops	:	Cotton,Tobacco,Casuraina
Oil seeds	:	Groundnut, Sunflower

5.8 Geomorphology
Information on landforms is an important input for land management, soil mapping and identification of potential zones of groundwater occurrence. The aspects of morphography, morphogenesis, morphochronolgy and morphometry are vital inputs in preparation of geomorphologic maps (Fig.9). The geomorphological processes, which result from manifold effects of geological and climatological changes, leave their distinctive imprint upon landforms and each geomorphological process develops its own particular assemblage of landforms. Different landforms are identified through interpretation of satellite imagery together with ground truth data to enable the evaluation of groundwater potential of the study area The geomorphological classes observed in the study area are Alluvial plain, Coastal plain with deep weathering (CPD), Coastal plain with moderate weathering (CPM), Coastal plain with Shallow weathering (CPS), Tanks, Settlements, River.

Map Unit	Geomorphic Unit Description	Hydro Geology & Structure	Description	Ground Water Prospects
CPD CPM CPS Alluvial plain	Coastal plain shallow, moderate, deep weathering	Unconsolidated to semi consolidated Sand, Silt & Clay.	Gently sloping plain along the coast formed by marine action with Coastal Plain Moderate to Deep, Salt Flat, Mud flat and Beach.	Fresh water occurs as a thin layer over brackish water in the beach ridges and elevated tracts occupied by wind blown sand.

Tab.2: Description of Geomorphic Units

5.9 Structures

Structural features found in the study area are lineaments i.e., conformed lineament and inferred lineaments. The conformed lineaments are observed in the central portion of the study area towards west to east and major conformed lineaments are observed in SW corner of the study area. The inferred lineament is observed in NW, SW and SE corner of the study area.

5.10 Soil

The soil map (Fig.10) depicting different soil classes identified from the satellite imagery and their aerial extents are obtained through GIS analysis.Soil Sample strips were randomly selected for further field verification. Field visits were made to study soil profile characteristics and to correlate the interpretation units with the soils of the study area. Intensive profile examinations were carried out in the sample strips. Soil samples were collected from representative profiles for analysis in the laboratory. Random observations were however also made outside the sample strips in order to account for variation in soil therein. The soil profile data along with their taxonomic classification were incorporated into image interpretation units. Based on observations in the field, soil boundaries drawn during preliminary visual interpretation were modified and a legend showing soil series and associations was prepared. Subsequently the soil scape boundaries were transferred onto base maps prepared from Survey of India toposheet at 1:25,000 scale.In the study area Alluvial loamy soils(227),Clayey soils with crusting low (231), medium(232) Available Water Capacity (AWC),Red coastal clayey soils (241),Black cracking clay (246),Coastal clay soils(233) are observed.

6. CONCLUSION AND RECOMMENDATION

By studying the existing scenario of study area through the spatial analysis of agriculture activities, socio-economic and their impacts on the land and water resources using Remote Sensing and GIS tools, following conclusion s are drawn.

1. Through the analysis of physical characteristics attribute data,gives the information of affected by erosion. In future this may lead to consequential problems to the major water bodies. This could be best controlled by construction of gully control bunds and extensive reforestation / afforestation or through agricultural soil conservation and management practices.

2. As irrigation water requirement varies with different crops, cropping pattern in the study area is to be changed for optimum utilization of this resource. Crops like pulses, vegetables should be cultivated, which may result lower requirement of water, fertilizer and also pesticide load.

3. The three key activities that are essential for the management of Resources.

- Irrigation management
- Catchment management
- Drainage basin monitoring and management

To address these three activities planners need physical characteristic information on comprehensive lines. Hence, the present work, concentrated on the development of physical characteristics for study area**.**

4. This study has been concluded to above stated findings. But this study will be useful as input base line data for models like LWAT (Land and Water Assessment Tool) that give more precise and detailed long term predictions on Natural resources.

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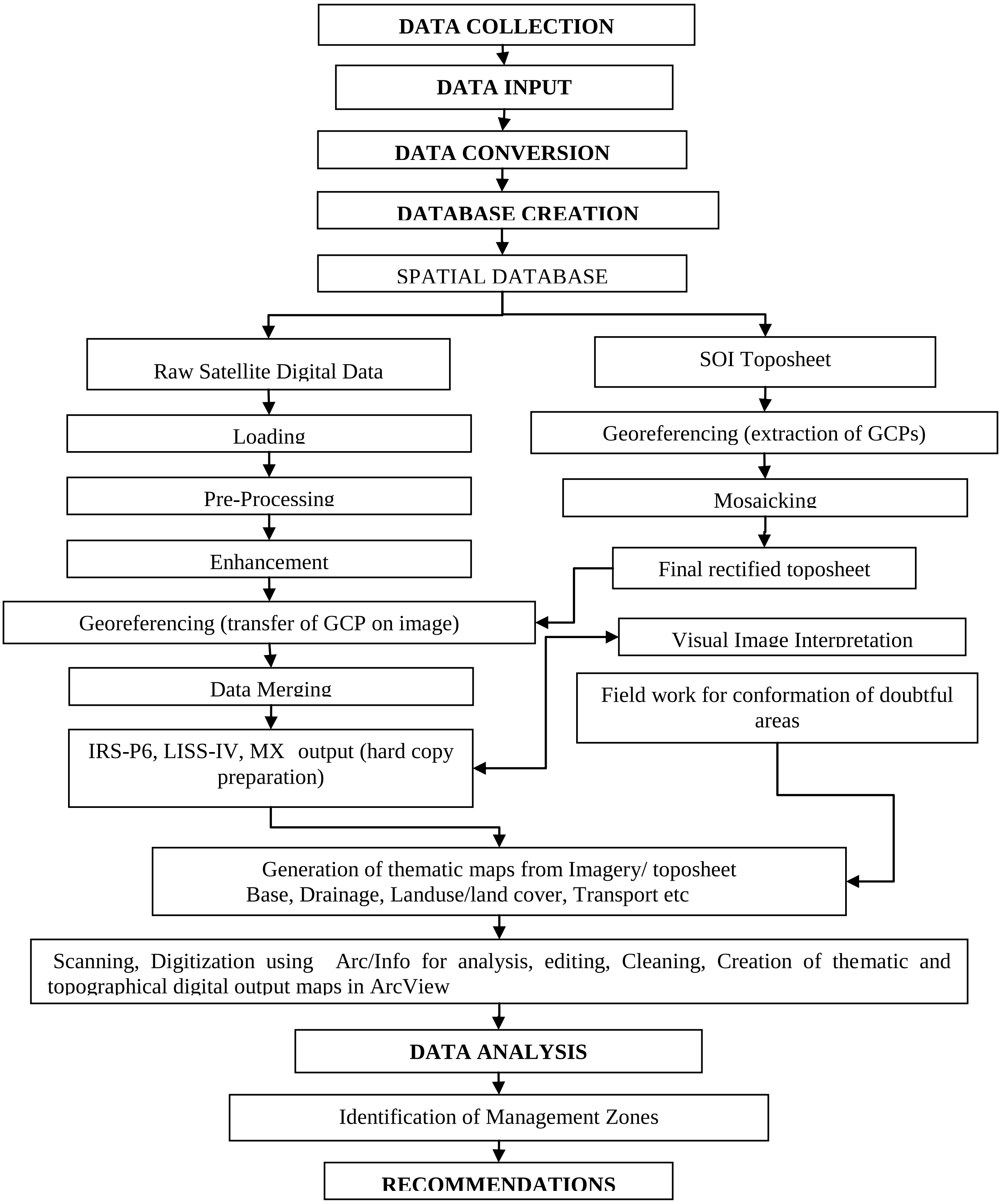

Figure 3: Flow chart showing the methodology adopted for the present study

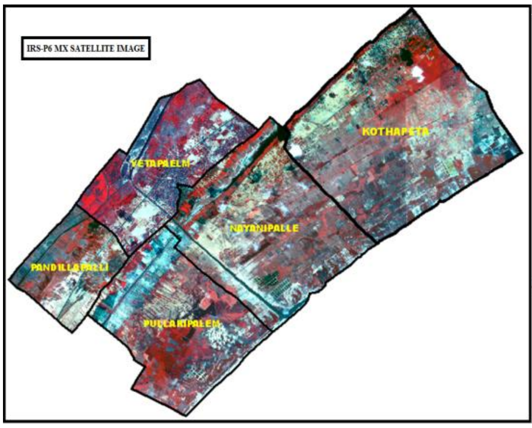

Fig.4: Satellite Image

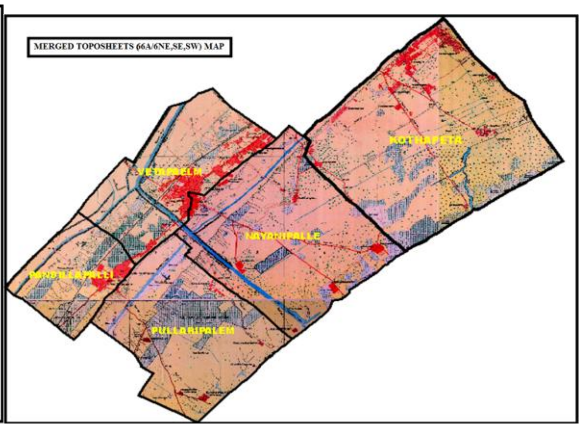

Fig.5: Merged Toposheet

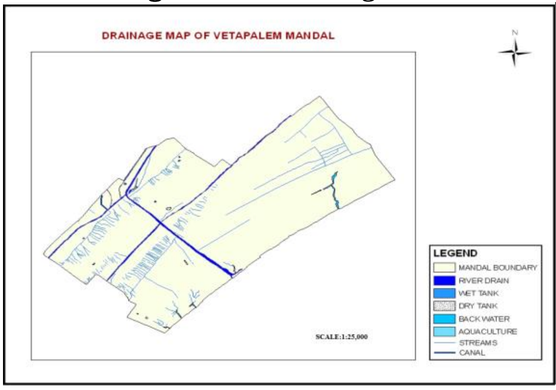

Fig.6: Drainage Map

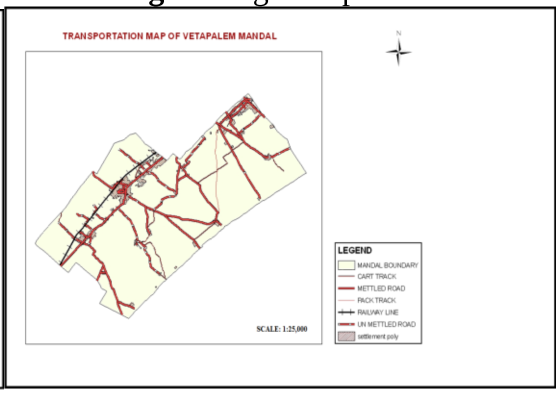

Fig.7: Transport network Map

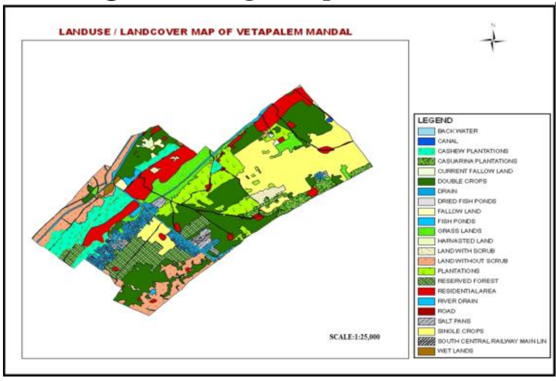

Fig.8: Landuse/Landcover Map

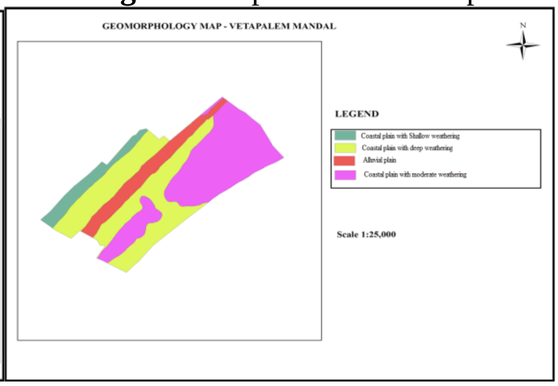

Fig.9: Geomorphology Map

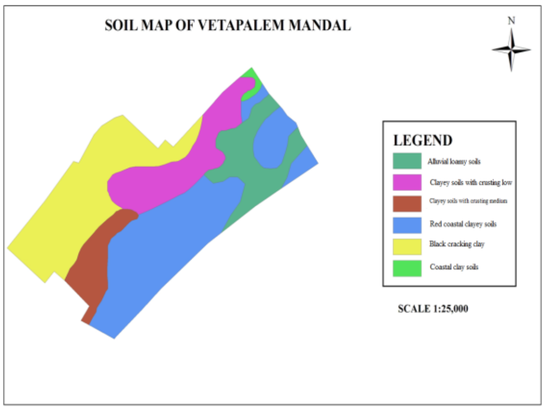

Fig.10: Soil Map

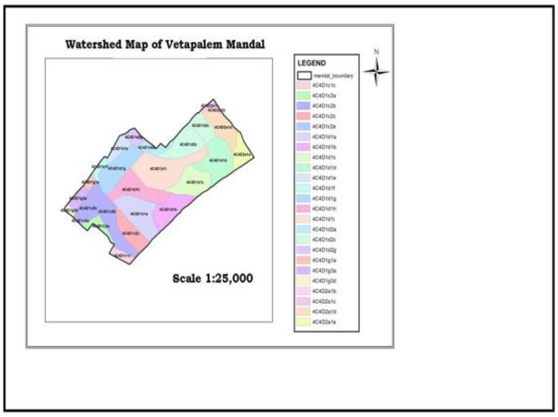

Fig.11: Watershed Map