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Identification Of Ground Water Potential Zones In Tamil Nadu By Remote Sensing And GIS Technique

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ABSTRACT
A case study was conducted to find out the groundwater potential zones in Salem, Erode and Namakkal districts, Tamil Nadu, India with an aerial extent of 360.60 km^2. The thematic maps such as geology, geomorphology, soil hydrological group, land use / land cover and drainage map were prepared for the study area. The Digital Elevation Model (DEM) has been generated from the 10 m interval contour lines (which is derived from SOI, Toposheet 1:25000 scale) and obtained the slope (%) of the study area. The groundwater potential zones were obtained by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in Arc GIS 9.3. During weighted overlay analysis, the ranking has been given for each individual parameter of each thematic map and weights were assigned according to the influence such as soil −25%, geomorphology − 25%, land use/land cover −25%, slope − 15%, lineament − 5% and drainage / streams − 5% and find out the potential zones in terms of good, moderate and poor zones with the area of 49.70 km^2, 261.61 km^2 and 46.04 km^2 respectively. The potential zone wise study area was overlaid with village boundary map and the village wise groundwater potential zones with three categories such as good, moderate and poor zones were obtained. This GIS based output result was validated by conducting field survey by randomly selecting wells in different villages using GPS instruments. The coordinates of each well location were obtained by GPS and plotted in the GIS platform and it was clearly shown that the well coordinates were exactly seated with the classified zones.
Keywords: Identification, Ground Water, Potential Zones, Tamil Nadu, Remote Sensing, GIS

I INTRODUCTION

1.1 ROLE OF REMOTE SENSING

Remote Sensing is an art of obtaining information about an object, without being in contact with the object under consideration. Remote Sensing has emerged as a powerful tool in planning. An ability of space technology for obtaining systematic, synoptic, rapid and repetitive coverage in different windows of electromagnetic spectrum and over large area form its vantage point in this space has made this technology unique and thus widened the spectrum of remote sensing applications in natural resource management. Remote sensing has its application in various fields like geology and mineral exploration, geomorphology and modern geomorphic process modeling, nature mitigation studies, hazard zone mapping, eco system study in hills, plains, riverine, coastal, marine and volcanic landforms, forest and biomass inventory, fishery management and ocean applications, natural resources survey and management. In these studies, remote sensing images have been analyzed by the visual interpretation technique, as this technique is economical, easy to learn and requires simple equipment 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 form for use in a Geographic Information System (GIS). Integrated approach using Geographic Information System provide cost effective support in resources inventory including land use mapping, comprehensive database for resources, analytical tools for decision making and impact analysis for plan evaluation. GIS accept large volumes of spatial data derived from a variety of sources and effectively store, retrieve, manipulate. Analyze and display all forms of geographically referenced information. Maps and statistical data can be obtained from the spatial integration and analysis of an area using GIS software's. IRS 1D LISS III imagery in hard copy has been used for the interpretation of Geology, Geomorphology, land use / land cover and lineaments on IRS 1D satellite data has clearly shown the presence of geomorphologic and landform characteristics of the study area.

1.2 CREDIBILITY OF REMOTE SENSING

Remote sensing is the process of sensing and measuring objects from distance, without directly coming into contact with them. Remote sensing is largely concerned with the measurement of electro-magnetic energy from the sun which is reflected, scattered or emitted by the objects on the surface of the earth. Different surface objects return different amount of energy in different wavelengths of the electro-magnetic spectrum. Detection and measurements of these spectral signatures enables identification of surface objects both from the ground, airborne and space-borne platforms.

This technology, integrated with traditional techniques is emerging as an efficient, time effective, cost effective and important tool for any developmental efforts.

Study of land use / land cover or land form from the air has been a focus of interest since the early days of aerial photography and has been gaining momentum again with the availability of new remote sensing techniques using aircraft and spacecraft as platforms with a capacity for operating outside the visible part of the electro-magnetic spectrum using microwaves (radar) and thermal radiation.

These remotely sensed data have relevance in major sections of the economy such as agriculture, forestry, irrigation, human settlements, geology, ecology, and oceans through ensuring the optional use of land, water, mineral resources etc.

These data we can use for either visual interpretation of digital image processing (analysis) this data can be collected by the remote sensing devices including passive and active systems and employ different bands in the visible, near infrared, middle infrared and far infrared as well as microwave regions. In the passive remote sensing, the reflected or emitted electromagnetic energy is measured by sensors operating in different selected spectral bands where the original source is sun but in active remote sensing method the earth surface is illuminated by an artificial source of energy. The emitted and reflected energy detected by the sensors on board platforms are transmitted to the earth station. The data then processed after various corrections and are made ready for the users.

1.3 TYPES OF DATA PRODUCT

The Remotely sensed data products are available to the users in the form of (a) photographic products such as proper prints, film negatives, dia-positives of black and white and false color composite in a variety of scales and (b) digital form as computer compatible tape (CCT), CD etc, after necessary corrections.

1.4 REMOTE SENSING APPLICATIONS

1. Geology and geomorphology mapping: geology has a long history of Remote sensing application and its useful in
1. Preparation of large-scale reconnaissance maps of unmapped, inaccessible areas
2. Updating the existing geological maps
3. Rapid preparation of lineament and tectonic maps.
4. Identifying features favorable for mineral localization etc.

II CREDIBILITY OF GIS

Geographic Information System is defined as an organized collection of computer hardware, software, geographic data, and trained personnel designed to efficiently capture, store, update, manipulate, analyze and retrieve all forms of geographically referenced information.

Two very important aspect which characterize GIS are (Burrough, 1982)

1. Defining the absolute location of earth feature over a coordinate system like latitude/longitude and
2. Ability to relate the geographic information (like X, Y & Z coordinates) information that describe a feature.

General:

- Geo: Refers to the earth and
- Graphy: Indicates a process of writing so Geography means writing about earth.

Information:

- Refers well arranged data of particular object for decision making.

Systems:

- Refers to set of interrelated components may be physical or virtual (logical) performs to reach a particular task.
- Creation of Information System on various Natural, Physical, and human resources with reference to a geographic location.

In view of increasing demand of water for various purposes like agricultural, domestic, industrial etc., A greater emphasis is being laid for a planned and optimal utilization of water resources. Due to uneven distribution of rainfall both in time and space, the surface water resources are unevenly distributed. Also, increasing intensities of irrigation from surface water alone may result in alarming rise of water table creating problems of water logging and salinization, affecting crop growth adversely and rendering large areas unproductive.

This has resulted in increased emphasis on development of ground water resources. The simultaneous development of ground water especially through dug wells and shallow tube wells will lower water table, provide vertical drainage and thus can prevent water logging and salinization. Areas which are already waterlogged can also be reclaimed. On the other hand continuous increased withdrawals from a ground water reservoir in excess of replenish able recharge may result in regular lowering of water table. In such a situation, a serious problem is created resulting in drying of shallow wells and increase in pumping head for deeper wells and tube wells. This has led to emphasis on planned and optimal development of water resources.

An Appropriate strategy will be to develop water resources with planning based on conjunctive use of surface water and ground water. For this the first task would be to make a realistic assessment of the surface water and ground water resources and then plan their use in such a way that full crop water requirements are met and there is neither water logging nor excessive lowering of ground water table. It is necessary to maintain the ground water reservoir in a state of dynamic equilibrium over a period of time and the water level fluctuations have to be kept within a particular range over the monsoon and non-monsoon seasons.

Water balance techniques have been extensively used to make quantitative estimates of water resources and the impact of man's activities on the hydrologic cycle. The study of water balance is defined as the systematic presentation of data on the supply and use of water within a geographic region for a specified period. With water balance approach, it is possible to evaluate quantitatively individual contribution of sources of water in the system, over different time periods, and to establish the degree of variation in water regime due to changes in components of the system.

The basic concept of water balance

Input to the system - outflow from the system = change in storage of the system (over a period of time)

The general methods of computations of water balance include:

(i) Identification of significant components,

(ii) Evaluating and quantifying individual components, and

(iii) Presentation in the form of water balance equation.

2.1 GROUND WATER BALANCE EQUATION

Considering the various inflow and outflow components, the terms of the ground water balance equation can be written as:

$$Ri + Rc + Rr + Rt + Si + Ig = Et + Tp + Se + Og + \Delta S$$

where,

Ri = Recharge from rainfall;
Rc = Recharge from canal seepage;
Rr = Recharge from field irrigation;
Rt = Recharge from tanks;
Si = Influent seepage from rivers;
Ig = Inflow from other basins;
Et = Evapotranspiration;
Tp = Draft from ground water;
Se = Effluent seepage to rivers;
Og = Outflow to other basins; and
ΔS = Change in ground water storage.

This equation considers only one aquifer system and thus does not account for the interflows between the aquifers in a multi-aquifer system. However, if sufficient data related to water table and piezometric head fluctuations and conductivity of intervening layers are available, the additional terms for these interflows can be included in the governing equation. All elements of the water balance equation are computed using independent methods wherever possible. Computations of water balance elements always involve errors, due to shortcomings in the techniques used. The water balance equation therefore usually does not balance, even if all its components are computed by independent methods. The discrepancy of water balance is given as a residual term of the water balance equation and includes the errors in the determination of the components and the values of components which are not taken into account. The water balance may be computed for any time interval. The complexity of the computation of the water balance tends to increase with increase in area. This is due to a related increase in the technical difficulty of accurately computing the numerous important water balance components.

2.1.1 STUDY AREA

A basin wise approach yields the best results where the ground water basin can be characterized by prominent drainages. A thorough study of the topography, geology and aquifer conditions should be taken up. The limit of the ground water basin is controlled not only by topography but also by the disposition, structure and permeability of rocks and the configuration of the water table. Generally, in igneous and metamorphic rocks, the surface water basin and ground water basin are coincident for all practical purposes, but marked differences may be encountered in stratified sedimentary formations. Therefore, the study area for ground water balance study is preferably taken as a doab which is bounded on two sides by two streams and on the other two sides by other aquifers or extension of the same aquifer.

2.1.2 STUDY PERIOD

In areas where most of the rainfall occurs in a part of year, it is desirable to conduct water balance study on part year basis, that is, for monsoon period and non-monsoon period. Generally, the periods for study in such situations will be from the time of maximum water table elevation to the time of minimum water table elevation as the non-monsoon period and from the time of minimum water table to the time of maximum water table elevation as monsoon period. For northern India, the water year can be taken as November 1 to October 31 next year. The monsoon and non-monsoon periods can be taken as June to October and November to May next year respectively. It is desirable to use the data of a number of years preferably covering one cycle of a dry and a wet year.

2.1.3 DATA REQUIREMENT

The data required for carrying out the ground water balance study can be enumerated as follows:

1. **Rainfall data:**
   - Monthly rainfall data of sufficient number of stations lying within or around the study area should be available.
   - The location of rain gauges should be marked on a map.
2. **Land use data and cropping patterns** :
   - Land use data are required for estimating the Evapo-transpiration losses from the water table through forested area.
   - Crop data are necessary for estimating the spatial and temporal distributions of the ground water withdrawals and canal releases, if required.
   - Evapo-transpiration data and monthly pan evaporation rates should also be available at few locations for estimation of consumptive use requirements of different crops.
3. **River data:**
   - River data are required for estimating the interflows between the aquifer and hydraulically connected rivers.
   - The data required for these computations are the river gauge data, monthly flows and the river cross-sections at a few locations.
4. **Canal data:**
   - Month wise releases into the canal and its distributaries along with running days each month will be required.
   - To account for the seepage losses, the seepage loss test data will be required in different canal reaches and distributaries.
5. **Tank data** :
   - Monthly tank gauges and releases should be available.
   - In addition to this, depth vs area and depth vs capacity curves should also be available.
   - These will be required for computing the evaporation and the seepage losses from tanks.
   - Also field test data will be required for computing final infiltration capacity to be used to evaluate the recharge from depression storage.
6. **Aquifer parameters:**
   - The specific yield and transmissivity data should be available at sufficient number of points to account for the variation of these parameters within the area.

Water table data :

- Monthly water table data or at least pre-monsoon and post-monsoon data of sufficient number of wells should be available.
- The well locations should be marked on a map.
- The wells should be adequate in number and well distributed within the area, so as to permit reasonably accurate interpolation for contour plotting.
- The available data should comprise reduced level (R.L.) of water table and depth to water table.

Draft from wells:

- A complete inventory of the wells operating in the area, their running hours each month and discharge are required for estimating ground water withdrawals.
- If draft from wells is not known, this can be obtained by carrying out sample surveys.

III GIS SOFTWARE

The choice of software package selections generally based on the user requirement. There are standard commercial GIS packages now available in the markets (Arc GIS 9.3+). The criteria of GIS software are more-so-ever standardized. The details of criteria are as follows:

1. Data entry: digitizing, scanning, automated data capture, interface with existing digital formats, manual keyboard entry.
2. Analysis: map overlay analysis, proximity analysis, mathematical modeling, enclosure, buffer generation, measurements, attribute analysis and interpolation.
3. Surface modeling: 3-D surfaces, slope analysis and draping.

3.1 ADVANTAGES OF GIS:

1. All data can be stored in digital formats
2. It occupies less space in contrast to very larger maps and data sheets
3. Data/maps don't get shrink or damaged
4. Data searching and retrieval is easy
5. Preferential filtering of selective data is possible
6. Manipulation of data possible, time series analysis is possible

3.2 APPLICATION OF GIS:

1. Groundwater Resources Management
2. Oceanographic Studies
3. Oil and Natural Gas Exploration studies
4. Environmental Assessment
5. Urban and Town Planning
6. Wasteland development
7. Land Information Systems
8. Forestry and Wild Life Management

9. Archaeological Applications
10. Telecommunications

IV BASIC STUDIES ON A LOCATION

ABOUT STUDY AREA:

Salem District is a district of Tamil Nadu state in southern India. The city of Salem is the district headquarters. Other major towns in the district are Mettur, Omalur and Attur. The district is well connected by rail and road networks.

Salem district is known for its mangoes, steel and for the Mettur dam, which is a major source of irrigation and drinking water for the state of Tamil Nadu.

4.1 HISTORY

The culture of the region including Salem district dates back to the ancient Kongu Nadu. Salem was the largest district in Tamil Nadu before it was divided into two districts: Salem and Dharmapuri. Later, Salem district was again divided with the formation of the Namakkal district. The first cinema theater named Modern Theaters was in Salem. Salem city, the seat of the district, is the fourth most urbanized city in Tamil Nadu (following Chennai, Coimbatore, and Madurai).

Located approximately midway between Mysore and Madurai, Salem district is surrounded by hills. Yercaud, a mild-weather hill station, is an important tourism destination in the district.

4.2 ARTS AND CULTURE:

Modern Theatres was started by T R Sundaram in 1937, soon after the era of silent films ended in the South Indian film industry. It was built on nearly nine acres of land at the foot of the picturesque Yercaud hills. Sundaram was able to access verdant and beautiful shooting sites for his films, all within a 50 km radius of his studios. He was also able to hire cheap and efficient labour in lightboys and cameramen to assist in the production of his films. He produced nearly 117 films in Tamil, Hindi, Kannada, Telugu, Sinhalese and other languages. Most of them were box office hits and he is credited with bringing to stardom writer M Karunanidhi and actors such as M G Ramachandran, M N Nambiar and Jayashankar to films.

Education

Salem educational institutions include government schools, arts and science colleges, engineering colleges like the Government College of Engineering, Sona College of Technology and Thiagarajar polytechnic college. Salem has two universities - Periyar University and Vinayaka Missions University. There are several medical schools (including dental, homeopathy, Siddha, yogic and aturopathy colleges). There are CBSE schools and international schools in Salem. Some of the schools in Salem are St.joseph's, Vedha Viyas, Vedha Vikas, Holy Cross, Holy Angels and Cluny.

Industries

Salem is famous for its SAIL (Steel Authority of India Limited) steel company near Salem, MALCO (Madras Aluminum Company Limited), Chemplast Sanmar Limited (a chemicals manufacturer) at Mettur Dam and JSW Steel company at Potaneri near Mettur Dam. Rowsons power and distribution transformers are playing a prominent role on development of these industries. Mangoes are cultivated, especially the Malgova variety. Mettur dam Thermal Power station is located about 50 km from Salem.

Demographics

According to the 2011 census Salem district has a population of 3,480,008, roughly equal to the nation of Panama or the US state of Connecticut. This gives it a ranking of 89th in India (out of a total of 640). The district has a population density of 663 inhabitants per square kilometre (1,720 /sq mi). Its population growth rate over the decade 2001-2011 was 15.37%. Salem has a sex ratio of 954 females for every 1000 males, and a literacy rate of 73.23%.

It had a population of 3,480,008 as of the census of 2011. It is 46.09% urbanised. The district has a literacy rate of 73.23%

4.3 ERODE DISTRICT

Erode District (previously known as **Periyar District**) is one of the industrialized districts located in the western part (Kongu Nadu) of the state of Tamil Nadu, India. The headquarters of the district is Erode and it is divided into two revenue divisions namely Erode and Gobichettipalayam. Periyar district was a part of Coimbatore District before its bifurcation on September 17, 1979 and was renamed as Erode District in 1996. Mathematician Srinivasa Ramanujan and social reformer Periyar were from here.

1. History

The area belonging to the district was ruled successively by several dynasties of South India. It was under the rule of Cheras and Cholas during the early years. The district was occupied by Tipu Sultan in 18th century from the Madurai rulers and after the Mysore wars in 1799, the district was occupied by the British until the Indian independence in 1947. It was a part of the Coimbatore district until its bifurcation in 1979.

2. Demographics

Erode district had a population of 22,59,608 as of 2011. It is 46.25% urbanised as per Census 2001. The district has a literacy rate of 72.96% and is on the rise. Erode is the largest city in the district followed by Gobichettipalayam which is another major center.

3. Geography

The district is bounded by Chamarajanagar district of Karnataka to the north, and by Kaveri River to the east. Across the Kaveri lies Salem, Namakkal and Karur districts. Tirupur District lies immediately to the south, and Coimbatore and the Nilgiris district lies to the west. Erode District is landlocked and is situated at between 10 36" and 11 58" north latitude and between 76 49" and 77 58" east longitude. Western Ghats traverses across the district giving rise to small hill locks. Western Ghats as seen from Gobichettipalayam

I. Bhavani River

Bhavani rises in the Western Ghats of Silent Valley National Park in Palakkad District of Kerala. It receives the Siruvani River which has the second tastiest water in the world, a perennial stream of Coimbatore District, and gets reinforced by the Kundah river before entering Erode District in Sathyamangalam. Bhavani is more or less a perennial river fed mostly by the southwest monsoon.

II. Kaveri River

Kaveri rises in the Western Ghats of Kodagu (Coorg) District, in Karnataka, and is joined by many small tributaries. It runs eastward through Karnataka, and at Hogenakal fall takes a sharp turn, east to south. Before reaching this point, it is joined by its main tributary, the Kabini River. From here it runs towards the southeast, forming the boundary between Bhavani Taluk of Erode District and Tiruchengode Taluk of the neighbouring Namakkal District. The Bhavani River joins the Kaveri at the town of Bhavani.

4.4 NAMAKKAL DISTRICT:

Namakkal District is an administrative district in the state of Tamil Nadu, India. The district was bifurcated from Salem District with Namakkal town as Head Quarters on 25-07-1996 and started to function independently from 01-01-1997. The district has 4 taluks (subdivisions); Tiruchengode, Namakkal, Rasipuram and Velur (in descending order of population) and has two Revenue Divisions; Namakkal and Tiruchengode. It was ranked second in a comprehensive Economic Environment index ranking of districts in Tamil Nadu not including Chennai prepared by Institute for Financial Management and Research in August 2009. It was major source of Tamil Nadu Economy.

History

After the struggle between the Cheras, Cholas and Pandyas, the Hoysalas rose to power and had the control till the 14th century followed by Vijayanagara Empire till 1565 AD. Then the Madurai Nayakas came to power in 1623 AD. Two of the Poligans of Tirumalai Nayak namely, Ramachandra Nayaka and Gatti Mudaliars ruled the Salem area. The Namakkal fort is reported to have been built by Ramchandra Nayaka. After about 1635 AD, the area came successively under the rule of Muslim Sultans of Bijapur and Golkonda, Mysore kings and then the Marattas, when about the year 1750 AD Hyder Ali came to power. During this period, it was a history of power struggle between Hyder Ali and later Tippu Sultan, with the British.

Geography

Namakkal district is bounded by Salem district on the north; on the east by Attur taluk of Salem district, Perambalur and Tiruchirapalli District's; by Karur district on the south and on the west by Erode district.

Industry

The main occupation in the district is agriculture. The cultivation generally depends on monsoon rains, wells and tanks. Nearly 90 percent of the cultivated area is under food crops. The principal cereal crops of this district are paddy, cholam, cumbu and ragi. Panivaragu, Kuthianally, Samai Varagu and Thinai are some of the millets cultivated. Among pulses, the major crops are redgram, blackgram, greengram and horsegram. Among oil seeds groundnut, castor and gingelly (sesame) occupy important places. Of the commercial crops, sugarcane, cotton and tapioca are some of the important crops. Tapioca is used for the manufacture of sago.

4.5 TIRUCHENGODE:

Tiruchengode is 35 km from Namakkal. It is one of the seven Sivasthalams in Kongunadu. The Arthanareeswarar Temple is located on a hill. The presiding deity is depicted as half-male and half-female, vertically to represent Shiva and Parvati worshipped as one form. It is considered one of the oldest temples in this region. Tiruchegode is the olden Poondurainadu in Kongunadu. Tiruchengode olden name is Thirukodimadachengondurur. Borewells and Textile are the main business in Tiruchengode. Lorry body building is famous in this place.

V IMAGE ELEMENTS USED IN INTERPRETATION

Tone or Color:

- It represents the radiation that has been reflected by the object.

Texture:

- It is defined as a repetition of a basic pattern. It creates a visual impression of surface roughness of objects.

Pattern:

- It refers to the spatial arrangements of surface features.

Shape:

- It represents the general form, configuration or outline of the objects.

Place:

- Objects position in relation to others.

Shadows:

- They are cast due to sun's illumination angle, size and shape of the object of sensor viewing angle, shadows of object also in identifications.

Size:

- It refers to the spatial dimension of the object on ground to the scale in case of aerial photographs, size and shape are interrelated.

5.1 GROUNDWATER

Water is a renewable resource occurs in three forms viz., liquid, solid, vapour (gaseous), all these three forms of water are extremely useful to man. No life can exist without water. Since, water is an essential for life as like that of air, it has been estimated that in the human body two-third portion is constituted by water. The water is not only essential for survival of human beings, but also for animals, plants and other living beings.

The area chosen for the study comprise of parts of Salem, Namakkal and Erode districts of Tamil Nadu. The study area covers approximately 1458 sq.km.

Location:

The study area is a part of Salem, Namakkal and Erode districts, which is bounded by Dharmapuri district in the North, Karur District in the South, Coimbatore district in the West and Cuddalore district in the East.

Accessibility:

The study area is well connected with a network of roads with other parts of the state.

Rainfall:

The distribution of rainfall in the study area is only due the north east monsoon and minimum during winter.

Temperature:

The mean temperature ranging from 38.2˚C to 40.4˚C during March to September and the area experience cool climate during December to February.

Physiography and Drainage:

The area is composed both of hilly as well as plain terrain. Denudation hills can be seen in the North-Western part and some minor amounts of residual hills were seen distributed along the area. The drainage pattern is finer along the hills and lesser along the plains.

Cauvery is the major river flowing N – S along the area. Bhavani is the other River which comes from Western side, flowing towards East and finally joined with Cauvery River.

VI METHODOLOGY

6.1 INTRODUCTION

Using SOI Toposheet 58E / 10,11,14,15 the Base map, drainage map, Slope map were prepared. From the Satellite Imagery (IRS 1D LISS – III, Path – 101, Row – 65) the Lineament map, Geomorphology map, and Land Use and Land Cover map were prepared. Lithology map of the study area is prepared by using Geological survey of India District Resource map. Soil map of the study area is prepared from SOI TamilNadu soil map. Based on the character, the features in different thematic layers were assigned with different weight age values according to the potential for groundwater. After the layers were integrated using GIS and then the area can be classified as high, moderate and low groundwater potential zones.

6.2 DATA PRODUCTS USED:

The data products used for the study constitute both the satellite and other conventional data types. The following data were used for this study:

SOI Toposheet No	: 58E / 10,11,14,15
Scale	: 1:50,000
Year of Survey	: 1970 – 1971
Satellite Imagery	
Satellite	: IRS 1D.
Sensor	: LISS III.
Path and Row	: 101 and 065.
Date of Acquisition	: 16 May 2000.
Resolution	: 23.5 m
Scale	: 1:50,000
Product Type	: Geocoded
Repeativity	: 24 days (3 Days revisit)

6.3 INTERPRETATION:

Visual Interpretation:

The satellite data was interpreted by using different visual interpretation key and elements such as Tone, Texture, Pattern, Shape, Place, Shadows and Size.

Digital Interpretation:

Digital image interpretation has been carried by using Digital Image Processing software namely ENVI and the following processes have been done to improve the quality of the data as well as identify features.MNF, NDVI, PRINCIPAL COMPONENT ANALYSIS (PCA), HIGH PASS AND LOW PASS FILTERING.

6.4 LANDUSE AND LANDCOVER AREA CALCULATION

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements. It also has been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" (FAO, 1997a; FAO/UNEP, 1999). Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants and animals. Land use information can be used to develop solutions for natural resource management issues such as salinity and water quality. For instance, water bodies in a region that has been deforested or having erosion will have different water quality than those in areas that are forested. Forest gardening, a plant-based food production system, is believed to be the oldest form of land use in the world.

The major effect of land use on land cover since 1750 has been deforestation of temperate regions. More recent significant effects of land use include urban sprawl, soil erosion, soil degradation, salinization, and desertification. Land-use change, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide, a dominant greenhouse gas.

According to a report by the United Nations' Food and Agriculture Organization, land degradation has been exacerbated where there has been an absence of any land use planning, or of its orderly execution, or the existence of financial or legal incentives that have led to the wrong land use decisions, or one-sided central planning leading to over-utilization of the land resources - for instance for immediate production at all costs. As a consequence the result has often been misery for large segments of the local population and destruction of valuable ecosystems. Such narrow approaches should be replaced by a technique for the planning and management of land resources that is integrated and holistic and where land users are central. This will ensure the long-term quality of the land for human use, the prevention or resolution of social conflicts related to land use, and the conservation of ecosystems of high biodiversity value.

Figure. 6.1 Land covers MAP

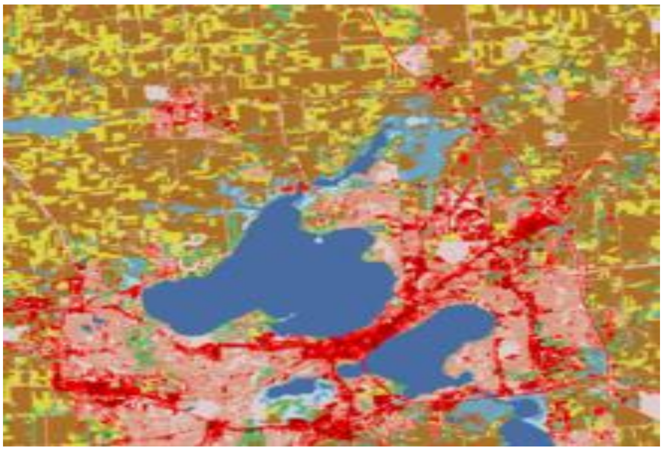

Figure.6.2 Land covers MAP 2

Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. There are two primary methods for capturing information on land cover: field survey and analysis of remotely sensed imagery.Land covers surrounding Madison, WI. Fields are colored yellow and brown, water is colored blue, and urban surfaces are colored red.(Figure 6.1 & 6.2)

6.4.1 GEOMORPHOLOGY AREA CALCULATION:

Geomorphology is the scientific study of landforms and the processes that shape them. Geomorphologists seek to understand why landscapes look the way they do, to understand landform history and dynamics and to predict changes through a combination of field observations, physical experiments and numerical modeling. Geomorphology is practiced within physical geography, geology, geodesy, engineering geology, archaeology and geotechnical engineering, this broad base of interest contributes to many research styles and interests within the field.

The broad-scale topographies of Earth illustrate this intersection of surface and subsurface action. Mountain belts are uplifted due to geologic processes. Denudation of these high uplifted regions produces sediment that is transported and deposited elsewhere within the landscape or off the coast.[1] On progressively smaller scales, similar ideas apply, where individual landforms evolve in response to the balance of additive processes (uplift and deposition) and subtractive processes (subsidence and erosion). Often, these processes directly affect each other: ice sheets, water, and sediment are all loads that change topography through flexural isostasy. Topography can modify the local climate, for example through orographic precipitation, which in turn modifies the topography by changing the hydrologic regime in which it evolves. Many Geomorphologists are particularly interested in the potential for feedbacks between climate and tectonics mediated by geomorphic processes. Practical applications of geomorphology include hazard assessment (such as landslide prediction and mitigation), river control and stream restoration, and coastal protection. Planetary geomorphology studies landforms on other terrestrial planets such as Mars. Indications of effects of wind, fluvial, glacial, mass wasting, meteor impact, tectonics and volcanic processes are studied. This effort not only helps better understand the geologic and atmospheric history of those planets but also extends Geomorphological study of Earth. Planetary Geomorphologists often use Earth analogues to aid in their study of surfaces of other planets.

Scales in geomorphology

Different geo-morphological processes dominate at different spatial and temporal scales. Moreover, scales on which processes occur may determine the reactivity or otherwise of landscapes to changes in driving forces such as climate or tectonics.[6] These ideas are key to the study of geomorphology today. To help categorize landscape scales some geo-morphologists might use the following taxonomy:

- 1st - Continent, ocean basin, climatic zone (~10,000,000 km^2)
- 2nd - Shield, e.g. Baltic Shield, or mountain range (~1,000,000 km^2)
- 3rd - Isolated sea, Sahel (~100,000 km^2)
- 4th - Massif, e.g. Massif Central or Group of related landforms, e.g., Weald (~10,000 km^2)
- 5th - River valley, Cots worlds (~1,000 km^2)
- 6th - Individual mountain or volcano, small valleys (~100 km^2)
- 7th - Hillslopes, stream channels, estuary (~10 km^2)
- 8th - gully, barchannel (~1 km^2)
- 9th - Meter-sized features

VII DATA INTEGRATION AND ANALYSIS

7.1 CONCEPT OF GROUNDWATER MAPPING

Almost all groundwater resources are vulnerable to various degrees. The accuracy of its assessment depends, above all, on the amount and quality of representative and reliable data available. The required data is often not available and thus the scale of mapping is often limited to broad scale maps.

The original concept of groundwater vulnerability was based on the assumption that the physical environment may provide some degree of protection referred to as the barrier zone with regard to contaminants (the threat) entering the sub-surface water (groundwater resource). The earth materials may act as natural filters to screen out some contaminants. Water infiltrating at the land surface may be contaminated but is naturally purified to some degree as it percolates through the soil and other fine grained materials in the unsaturated zone.

Here a groundwater potential map has been generated for the study area using Geographical Information System (GIS). In order to achieve this, a number of spatial attributes need to be mapped, such as geology, geomorphology, landuse / landcover etc. Then these are weighted and prioritized.

7.2 GROUNDWATER POTENTIAL ZONES:

Groundwater potential zones are demarcated by thematic layer Integration method. The integration method has been discussed as follows:
Preparation of Drainage Density and Lineament Density map using Kernel Density method in ARC GIS.
The density were classified as five types, such as

1. Very high
2. High
3. Moderate
4. Low
5. Very Low

Using this category, we entered into the integration method. The levels of integration are shown below,

1. Level I – Drainage Density + Lineament Density.
1. Level II – Level I + Geomorphology.
2. Level III – Level II + Land use and Land cover.
3. Level IV – Level III + Lithology.
4. Level V – Level IV + Slope

Level – I GIS Integration

With the help of drainage and lineament map, density map has been prepared by using Kernel density method in Arc Gis Software. Integration of these two density maps given the result of level I integration. The result shows five categories of Ground Water potential Zones as

1. Very High Potential Zone

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2. High Potential Zone
3. Moderate Potential Zone
4. Low Potential Zone
5. Very Low Potential Zone

Level – II GIS Integration

The level II integration has done by the integration of level I and Geomorphology layer. Integration has to be done on the basis of weight age values of different features in that layer. It consist of different type of combination.

Level – III GIS Integration

Similarly level III integration has to be done by integrating level II + Land use and Land cover layer on the basis of weight age values. Finally it consists of different combination of polygons.

Level – IV GIS Integration

Level IV integration has done by integrating level III + Lithology, based on weight age values. And it consists of different combination of polygons comparatively more than level III integration polygons.

Level –V GIS Integration (Final Integration)

Final integration has to be done by integrating level IV + Slope layer based on weight age values. This consists of numerous polygons, from this it is classified as 5 categories of Ground water Potential Zone.

OUTPUT

On the basis of weight ages assigned to each and every thematic layers unique polygons were identified having their own relative weight age combinations. Now, for each and every polygon combinations, all the weight ages were cumulated and these values are ranging from 6 to 30. Based on the range of cumulative values the area has been categorized into 5 priority zones. They are

< 10 →Very High Ground Water Potential Zone
10 –15 →High Ground Water Potential Zone
16 – 20 →Moderate Ground Water Potential Zone
21 – 25 → Low Ground Water Potential Zone
25 – 30 → Very Low Ground Water Potential Zone

VIII RESULT AND DISCUSSION

In order to learn the basic knowledge of visual interpretation and image processing, I have taken this area to identify the areas potential for the occurrence of groundwater, by using different thematic layers pertaining to geomorphology, and land use / Land cover, Lithology, Slope were assigned with weight age values according to their favor less for groundwater and integrated in GIS environment and classified into very low, low, moderate, high and very high groundwater potential zones. In this study, major part of the area have been classified as moderate potential zone, and some part have been classified as high potential zone, low and very low potential zones and only very few areas have been classified as very high Ground water potential zone because according to the Lithology as the area mainly composed of hard rock's the weight age values assigned to the features were very small so that major part of the area comes under low. Figure. 8.1 shows Administrative Boundary and Villages. Figure. 8.2 shows Roads and Railways. Figure. 8.3 shows Drainage Densities. Figure. 8.4 shows Soil Map. Here in this study concern, only five layers have been utilized for identifying the potential zones for groundwater this may be a meagre quantity. If it is necessary of accuracy for groundwater potential zones we can go for further more deeper in narrower classifications for weight age values and taking some more thematic layers into consideration.

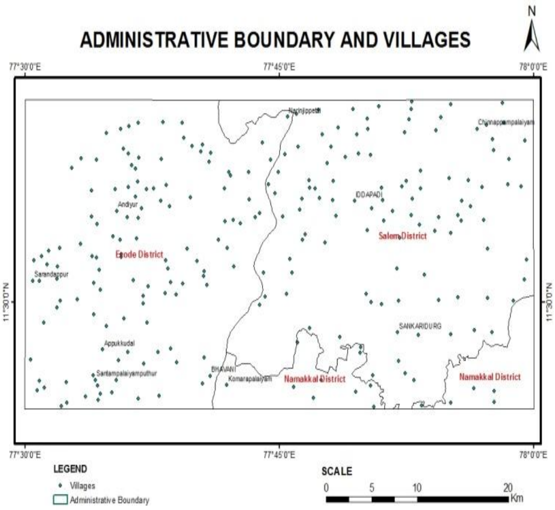

Figure. 8.1 Administrative Boundary and Villages

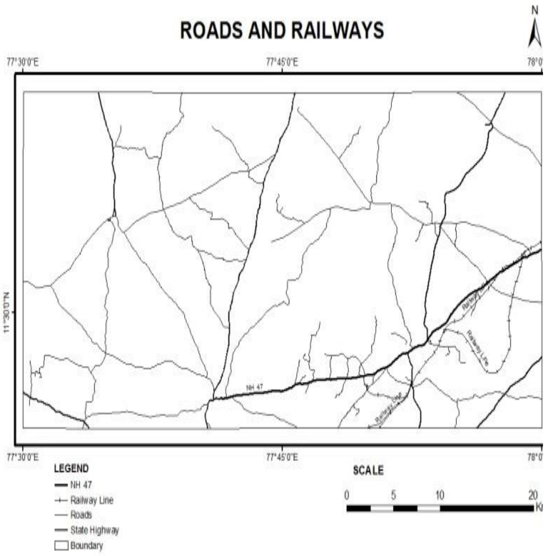

Figure. 8.2 Roads and Railways

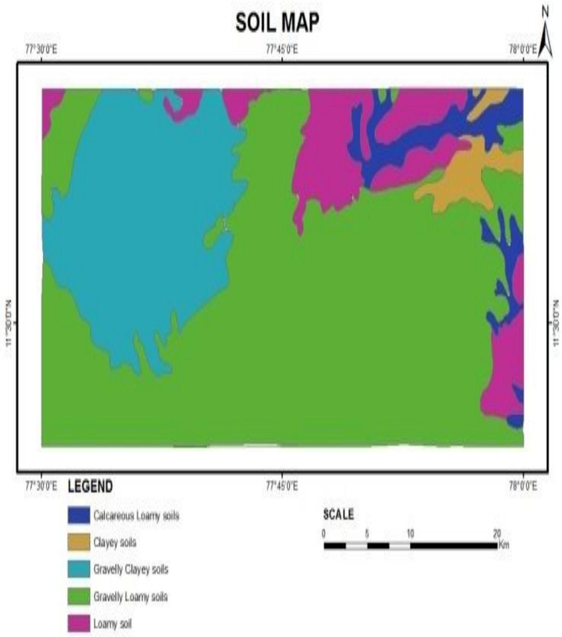

Figure. 8.4 Soil Map.

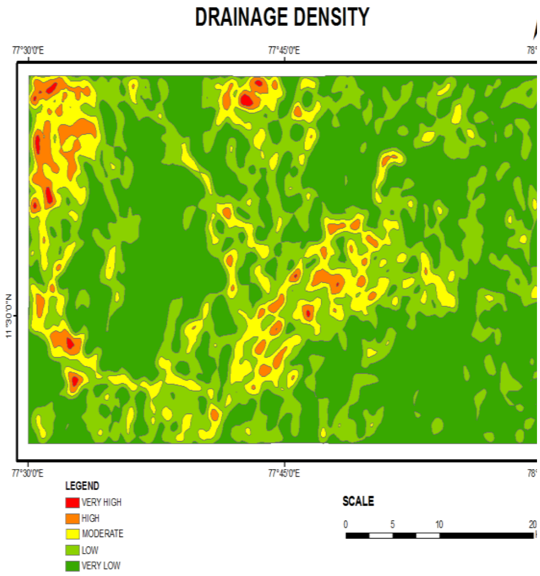

Figure. 8.3 Drainage Densities

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