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Vulnerability Assessment of River (Vasista Nadhi, Tamilnadu) Water Using GIS & GPS

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ABSTRACT - Groundwater always contains some amount of chemical substances, and their concentration is a function of the initial composition, rainfall, land use, type of surrounding rocks, and the recharge processes. Vasita Nadhi is one of the important tributaries of Vellar River which originates in the Kalvaraayan Hills, Tamil Nadu, India. The basin lies between 11°22'0"N and 11°53'0"N latitudes and 78°29'0" E and 79°0'0" E longitudes. The aerial extent of the basin is about 1478 km². As groundwater is the major source for drinking and irrigation in the Vasita Nadhi River Basin, and the water available in the river and surface water bodies are not sufficient to meet out the demand for drinking and irrigation, it is essential for an integrated study of groundwater flow and quality. The effluents of Sago and hybrid-seed industries are directly disposed on land and surface water bodies without proper treatment. Thus, a detailed study has been carried out in Vasita Nadhi River Basin to understand the quality of surface and subsurface water. Various thematic maps pertaining to the water quality study were prepared using Geographical Information System. Thirty three groundwater samples and twenty five surface water samples were tested during March -2017 for pH, temperature, electrical conductivity, total dissolved solids, salinity and dissolved oxygen using portable water quality kit. Tested water quality parameters were compared with the BIS and WHO standards to understand the suitability of water for drinking and irrigation. Spatial variation of groundwater quality parameters were plotted using GIS. Groundwater flow patterns were also plotted using GIS from the measured groundwater head with respect to GPS datum. It is observed from the results that groundwater is highly affected in 1/3 of the basin area leading unsuitability of water for drinking and irrigation. Most of the surface water bodies and river channels were also affected by the effluent of Sago industries.

KEYWORDS: Central Ground Water Board (CGWB), Digital Elevation Model (DEM), Geographic Information System (GIS), World Health Organization (WHO), Bureau of Indian Standards (BIS), Public Works Department (PWD), Geological Survey of India (GSI).

I. INTRODUCTION

Requirement of water increases day by day to meet the needs of growing population and modern developments in various sectors. The erratic nature of precipitation cause highly uneven distribution of available water both in space and time which leads to floods and droughts affecting vast areas of our country (india). hence it is essential to manage the available water resources. management of water resources includes the management of ground water resources also. ground water is commonly referred as the water, which lies below the surface of the earth occupying the interstices and voids in various formations (todd, 1980).it is the major readily available fresh water in our earth (ragunath, 1987). nowadays ground water resource is being continuously exploited from the aquifers to meet the demand for industrial, agricultural and domestic needs. groundwater is always under movement and the flow takes place from the higher potentiometric surface to the lower potenetiometric surface.it is a known fact that gis has lots many multiple faces and its uses in the field of civil engineering are enormous. sreedevi et al. (2001) have used the remote sensing and gis techniques to understand the occurrence of groundwater in various geomorphological units of vasista NADHI RIVER BASIN, SALEM DISTRICT, TAMIL NADU, INDIA.

SALAMA ET AL. (1994) Have Studied The Basin geomorphological controls to understand the mechanism of recharge and discharge in the wheat belt of western australia. they have prepare various thematic maps from the satellite images and aerial photographs for identifying recharge and discharge areas in the salt river system of western australia. hydrochemistry is more important to assess the quality of groundwater for understanding its suitability for various needs. this will be helpful in managing the available ground water resources effectively. groundwater chemistry depends mainly on the geological formations through which it fluctuates. offiong and edet (1997) have considered the

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physiochemical and biological parameters to assess the water quality in akpabuyo, cross river basin, south eastern nigeria.

1.2 TOPOLOGICAL OVERLAY

If individual layers have planer enforcement, when two layers are combined, the result must have planer enforcement. In this case new intersection must be calculated whenever two lines cross and a line across an area object will create two new area objects. Such an overlay followed by planer enforcement is called topological overlay.

1.3 NEED FOR THE PRESENT WORK

GIS is a multi-faced software technique through which lot of difficult tasks can be answered in easy way, lot important decisions of national importance can be done with more perfection, can show improved system of data storage and retrieval. In this project GIS techniques are applied for ground water development studies.

Water resources play a vital role in the growth and development of human civilization on the surface of the earth and holding a key role on economy of any country. Ground water resources in Vasita nadhi Minor basin, Tamil Nadu, India are being continuously exploited to meet the demand for the water supply and irrigation because the water available in ground water and surface water bodies such as wells, tanks and reservoirs are not sufficient, and thus resulting rapid decline in the ground water head in many parts. Groundwater quality is also affected in many places of the basin due to anthropogenic activities. However, no systematic work has been carried out in this basin to understand the ground water regime. Thus, it is essential to assess the ground water quality for extraction and management of the water resources, which is emerging as a great public concern in this region.

1.4 AIMS AND OBJECTIVES

- ❖ To learn GIS software and water quality interpretation software.
- ❖ To generate three dimensional Digital Elevation Model of the basin.
- ❖ To learn satellite image interpretation techniques.
- ❖ To create ground water database of the basin.
- ❖ To asses the suitability of groundwater for drinking and irrigation.
- ❖ To plot the variation of hydro chemical parameters.
- ❖ To prepare statistical correlation matrices using software for quality parameters.

II. STUDY AREA

In Tamil Nadu, seventeen major river basins have been demarcated based on the drainage system (Figure 3.1) Vasita Nadhi river is one of the important tributary of Vellar river. Total length of the main stream is nearly 63 km. A detailed study has been carried out in Vasita Nadhi Minor River Basin to understand the nature of ground water using GIS. To understand the geological and hydro geological setting of the region, geological and hydro geological maps of Tamil Nadu were collected from Government departments.

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INDIA



TAMILNADU

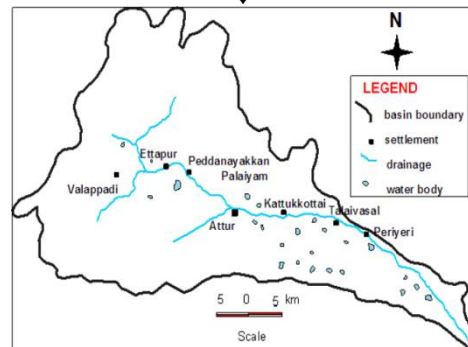


Figure 2.1 Location map of the study area

2.1 LOCATION STUDY AREA

Vasista Nadhi Minor River Basin is located in the state of Tamil Nadu, India. (Fig 3.4) between the latitudes 78.0.0 and 78.25.0 and longitudes 11.0.0 and 11.35.0 in the 58 I/5, 58 I/6, 58 I/7, 58 I/9, 58 I/10, 58 I/11 and 58 I/15 toposheet of 1:50000 & 1: 250000 scale, published by survey of India. The basin occupies an area of 1478 sq.km. It falls in Dharmapuri, salem, Namakkal, Perambalur and Villupuram Districts. The major settlements in the basin are Valappadi, Attur, Thalavasal and Tholuthur .

Five major soil types viz, red insitu, red colluvial, black soil, brown soil and mixed soil are noticed. In the total area of the basin, approximately about 300 sq.km comes under cultivated land, and the remaining areas fall under the category of barren and uncultivable lands. Tapiaco, Paddy, Cotton and sugarcane are the major crops in this region.

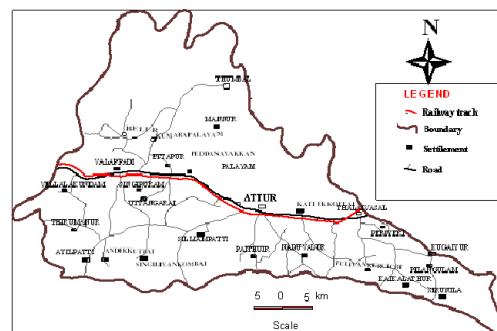


Figure 2.2 Study area map with major settlements

2.2 PHYSIOGRAPHY

Vasista nadhi river basin has four distinct different types of soils namely (i) black soil (ii) colluvial soil (iii) Red insitu soil (CGWB 1971). The black soil cover most of the Northern part of the basin and are considered as 'insitu' soil and occupy the upper or higher elevated portion of the basin. The top soil is dark grey to grayish brown in colour . The thickness of the soil layer ranges upto 1.25m.

2.3 HYDROGEOLOGY

The area is underlain by Gneiss and charnockite which are the predominant ones. Other rock types to be found are the granite, leptinite, dolerite and magnetite quartzite. Basic and ultra basic rocks and quartz are seen over the basin.(CGWB, 1971).

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2.4 CLIMATE AND RAINFALL

The observed data indicate, that the area is characterized by a sub-tropical climate with moderate humidity and temperature. The water is quite pleasant from November to February and becomes hot from March to June. The maximum temperature ranges from 24 °C to 40 °C and the minimum temperature from 13 °C to 28 °C. The average rainfall of this area is 979.65 mm from four different seasons viz. winter, hot weather period, summer south west monsoon, north east monsoon.

2.5 CROPPING PATTERN

The basin as a whole is deficient in rainfall and except for a small extent of area where Periyari irrigate. There is no assured surface water available for irrigation. The canal supply is also not assured and is available for 3-4 months only. Irrigation is mostly from wells and agriculture is the chief avocation for rural population. Both rain fed and irrigated crops are raised. Groundnut cultivation is mainly restricted to area of Periyari reservoir supply and mostly only one crop of tapioca is raised. Paddy, sugarcane, cotton and are the important crops raised.

III. METHODOLOGY

3.1 GENERAL

Management of water resources in India is going to be crucially important to sustain the needs of one billion people of our country. The available groundwater resources can be optimally used and sustained only when the quantity & quality of the groundwater is assessed effectively. In this context, in our present study emphasis has been given on groundwater quality which includes water sample collection, groundwater sample analysis and its suitability for drinking and irrigation purposes. The analytical results obtained were used to determine the suitability of water for drinking and agricultural purposes.

To achieve the set of objectives, the work has been divided into five major parts. They are

1. Data collection from various departments
2. Field work
3. Analysis of water quality
4. GIS software's used in this project
5. Preparation of various basic thematic maps pertaining to the study
6. Data input to GIS by scanning and Digitizing maps
7. Integration of spatial and non-spatial information using GIS
8. Generation of 3-Dimensional Digital Elevation Model

3.2 DATA COLLECTION

Data is considered to be the major source for GIS Analysis and interpretation. The accuracy of the final result mainly depends upon the data collected (i.e data collected from the field). The following data were collected from Data Centre, SOI, PWD-Salem Circle and Central Groundwater Board, Tharamani.

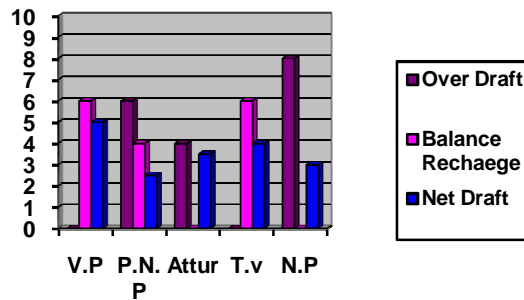
- Topo sheets (Fig)
- Groundwater Level data (Table)
- Groundwater Quality data (Table)
- Bore hole Lithology data (Table)
- Pump test sites data (Table)
- Rainfall data (Table)
- Utilisable ground water recharge and net draft in each block.

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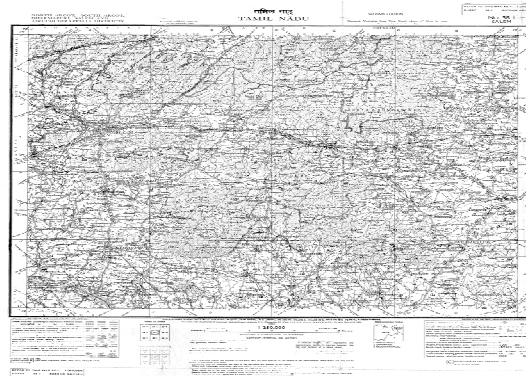
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V.P – Valapadi
P.N.P – Peddanayakanpalayam
T.V – Talaivasal
N.P – Namagiripettai

3.2.1 COLLECTION OF TOPO SHEETS

Toposheets (58 I/5, 58 I/6, 58 I/7, 58 I/9, 58 I/10, 58 I/11, 58 I/15) have been collected from Geospatial Data Centre, Survey of India. Our study area Vasita Nadhi Basin is located between the latitudes 7715 and 7748, and longitudes 1053 and 1155. The basin comes under parts of Attur taluk of Salem district in Tamil Nadu state, The major settlements in this basins are Valapadi, Attur, Thalaivasl, Aragalur and Tholuthur.



SOI Toposheet of 1:250,000 scale

3.3 FIELD WORK

3.3.1 RECOGNIZANCE SURVEY

In the initial stage of the project, the field is visited by the project mates with the help of Toposheets and Project guide. At the time of survey, we have find out that number of Industries are available (Sago & Hybrids industry), how the wastages are disposed? (with or without treatment). Nature of cultivation was also noticed (to check whether they are affected due to the wastages or not).

3.3.2 COLLECTION OF SAMPLES

Water samples were collected spread over the basin for the analysis during October 2012. Total number of samples is 58 (25 Surface & 33 Sub-surface samples). One liter, half liter and 100 ml sterilized plastic bottles were used to collect the samples (Fig). Before the collection of water samples, the bottle is thoroughly washed with distilled water. While collecting the sample, Nitric acid is mixed with half liter samples for the purpose of analyze the major ions in future If need. After collecting the samples, the water bottles were instantly sealed and capped with

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wax and then transported to the laboratory for chemical analysis.

SAMPLE COLLECTION

SURFACE WATER



SURFACE WATER



EFFLUENT



SOIL



Figure 3.2 Collection of samples

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3.3.3 LOCATION OF SAMPLES POSITIONS USING GPS

Magellan Triton 2000 series GPS has been used for locating the positions of samples. There are several different methods for obtaining positions using GPS. The method used depends on the accuracy required by the user and the type of GPS receiver available. We have adopted autonomous navigation methods in which single hand held receiver is used.



Figure 3.3 Location using Magellan Triton 2000 GPS

Table 3.1 Location details of Samples

Sl. NO	SAMPLE NO	VILLAGE	LATTU DE	LONGIT UDE
1	Ww1	Valapadi.	11°38'57"	78°22'□□"
2	Ww2	Singipuram.	11°25'02"	78°23'16"
3	Ww3	Singipuram.	11°34'53"	78°23'19"
4	Ww4	Mangalapuram.	11°34'10"	78°22'37"
5	Ww5	Mangalapuram.	11°34'05"	78°22'24"
6	Ww6	Oilpatty.	11°32'32"	78°20'57"
7	Ww7	Thinmanayakkanpatty.	11°34'22"	78°25'38"
8	Ww8	Echampatty.	11°34'35"	78°30'41'
9	Ww9	Thandavarayapuram.	11°35'29"	78°32'53"
10	Ww10	Thandavarayapuram.	11°35'37"	78°33'24"
11	Ww11	Thandavarayapuram.	11°34'55"	78°33'46"
12	Ww12	Narasingapuram.	11°35'52"	78°33'53"
13	Ww13	Attur. Paithur road.	11°34'42"	78°35'49'
14	Ww14	Attur. Paithur road.	11°34'58"	78°35'52'
15	Ww15	Attur. Paithur road.	11°35'12"	78°36'11"

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16	Ww16	Mulvaadi.	11°35'52"	78°37'02"
17	Ww17	Ammampalaiyam.	11°35'58"	78°38'22"
18	Ww18	Ammampalaiyam.	11°36'03"	78°39'35'
19	Ww19	Ayarpadi.	11°36'06"	78°39'28"
20	Ww20	Kattukkottai.	11°36'01"	78°40'15"
21	Ww21	Mettuppatty.	11°40'00"	78°18'39"
22	Ww22	Mettuppatty.	11°40'02"	78°19'27'
23	Ww23	Valapadi.	11°39'11"	78°21'39'
24	Ww24	periyakrishnavaram(lake) Thottam.	11°39'41"	78°25'51"
25	Ww25	Ettapur.	11°39'51"	78°28'41"
26	Ww26	kottampadi colony.	11°37'47"	78°32'19"
27	Ww27	Raasi seed, thalaiwasal.	11°35'32"	78°37'52"
28	Ww28	Attur.	11°35'33"	78°39'40"
29	Ww29	Attur.	11°35'16"	78°41'05'
30	Ww30	Attur.	11°35'19"	78°41'06"
31	Ww31	Kattukkottai.	11°35'16"	78°41'39"
32	Ww32	Opp Bharath SF.	11°35'05"	78°41'42'
33	Ww33	Manivizhundhan pond.	11°35'08"	78°42'16"

S.No	SAMPLE NO	VILLAGE	LATITUDE	LONGITUDE
1	SW1	Valapadi.	11°35'02"	78°23'15"
2	SW3	Singipuram.	11°32'14"	78°21'08"
3	SW4	Singipuram.	11°35'25"	78°32'58"
4	SW5	Mangalapuram.	11°35'34"	78°33'24"
5	SW6	Mangalapuram.	11°34'54"	78°33'43"
6	SW7	Oilpatty.	11°35'51"	78°33'53"
7	SW8	Thinmanayakkanpatty.	11°34'41"	78°35'52"
8	SW9	Echampatty.	11°35'50"	78°37'06"
9	SW10	Thandavarayapuram.	11°36'04"	78°37'12"
10	SW11	Thandavarayapuram.	11°36'23"	78°37'34"

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11	SW12	Thandavarayapuram.	11°36'13"	78°39'06"
12	SW13	Narasingapuram.	11°36'06"	78°39'32"
13	SW14	Attur. Paithur road.	11°35'58"	78°40'37"
14	SW15	Attur. Paithur road.	11°40'18"	78°26'38"
15	SW16	Attur. Paithur road.	11°39'37"	78°28'41"
16	SW17	Mulvaadi.	11°35'37"	78°36'54"
17	SW18	Ammampalaiyam.	11°35'33"	78°37'28"
18	SW19	Ammampalaiyam.	11°35'38"	78°37'30"
19	SW20	Ayarpadi.	11°35'32"	78°31'53"
20	SW21	Kattukkottai.	11°35'12"	78°41'37"
21	SW22	Mettuppatty.	11°35'03"	78°41'39"
22	SW23	Mettuppatty.	11°35'07"	78°42'30"
23	SW24	Valapadi.	11°35'08"	78°45'06"
24	SW25	periyakrishnavaram(lake) thottam.	11°35'15"	78°45'33"

3.4 ANALYSIS OF WATER QUALITY

The water samples were analyzed by Portable Digital Meter. From the analysis, we got six water quality parameters such as pH, Temperature, Electrical conductivity, TDS, Salinity and Dissolved Oxygen.



Figure 3.4 Portable Water Quality Kit (Merck)

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3.5 GIS SOFTWARES USED IN THIS PROJECT

3.5.1 SURFER

Surfer-8.0 is a contouring and 3-D surface mapping program that runs under Microsoft windows. It quickly and easily converts our data into outstanding contour, surface, wireframe, vector, image, shaded relief and post maps. Virtually all aspects of our maps can be customized to produce exactly the presentation we wish to be.

3.5.2 GEOMEDIA PROFESSIONAL

Geomedia's smart maps presentations tools for the web have improved with rich text, multi color symbols and raster transparency. Geomedia 6.0 also adds image transparency, supports the ECW (ER mapper compressed images) format and enables bulk insertion of raster files.

The Geomedia 6.0 products provides a boost to user productivity with improvements including more CAD – like data capture and edit commands, expanded export option to popular GIS or CAD formats for performing local analysis are distribution and enhanced application generation tools for the web.

3.6 PREPARATION OF VARIOUS THEMATIC MAPS

The map which is prepared for a particular theme is called thematic maps. Various thematic maps of the study area pertaining to ground water studies namely, Study area map, drainage map, soil map, geology map, geomorphology map, lineaments map and sample location map were prepared from the Survey of India toposheets of 1:250000 scale. The prepared maps were scanned and digitized using surfer software. Database of the study area was created after superimposing various spatial and non-spatial data. Various thematic maps related to groundwater quality were also prepared using software.

3.6.1 DRAINAGE MAP

The Dentrictic type of drainage patter is noticed in this region. Fine patterns are observed in the northern part, and the coarse pattern are observed in the southern pattern part. This show that rainfall runoff is comparatively high in the northern part of the basin. Coarse pattern are indicative of high infiltration. Parallel drainage pattern is also available seen in some places for example near southern part of Thalaivasal. There are 22 number of water bodies are available spread over the basin.

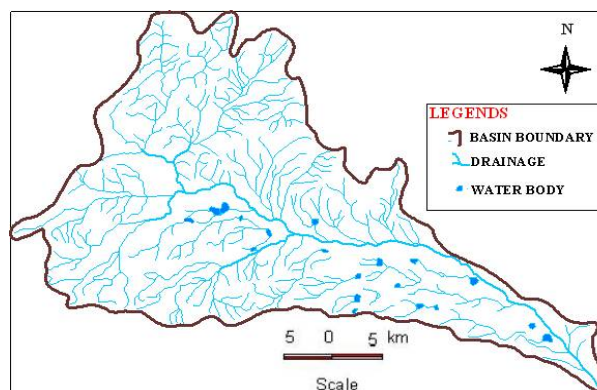


Figure 3.5 Drainage Map

3.6.2 SOIL MAP

A soil characteristic of a terrain is an important aspect since they meet the basic needs of all agricultural

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production. Variety of soils that occur are derived from a wide ranges of geological materials, knowledge about the types of soil, its extent and occurrence are of primary importance for agricultural planning to maximize production.

Five major soil types viz, red insitu, red alluvial, black soil, brown soil and mixed soil are noticed.

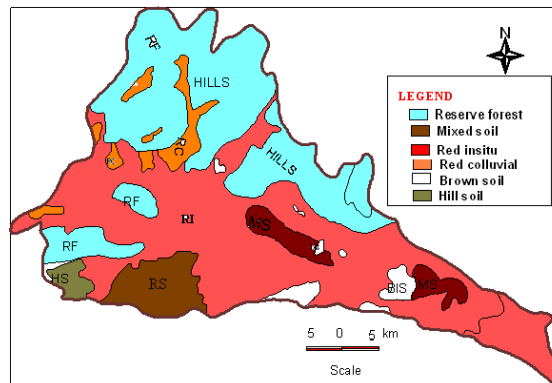


Figure 3.6 Soil Map

3.6.3 GEOLOGY MAP

The study area is underlain by leptinite, charnockite, ultrabasic with magnetite and gneisses rocks. The geology of the study area is very complicated owing to recurring tectonic, and magmatic activities in the pre-cambrian period.

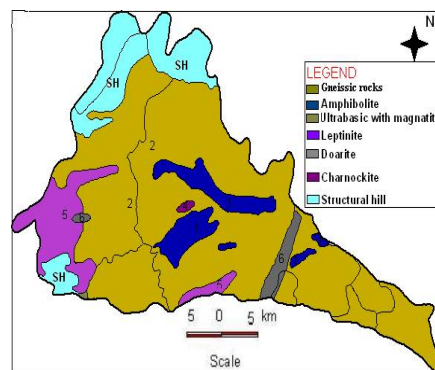


Figure 3.7 Geology Map

3.6.4 GEOMORPHOLOGY

Geomorphology maps helps to identify the various geomorphic units and groundwater occurrence in each unit. Selected and limited field checks are carried out in the field to verify the different geomorphic units.

Structural Hill and plateau constitute the pediment zone in this structural Hills slope wash materials, valley fills are occurring on both sides of river.

Eventhough the geomorphic potential zones are demarcated based on remote sensing techniques and the subsequent field check, the present extraction of groundwater has to be taken into consideration before implementing further groundwater schemes.

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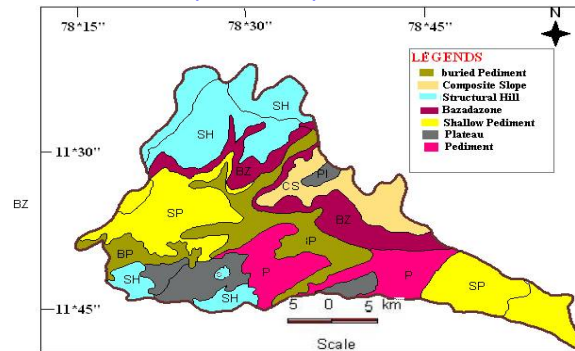


Figure 3.8 Hydrogeomorphological Map

Table 3.5 Geomorphic units and availability of ground water

Geomorphic Unit	Characteristics	Hydrogeology	Ground water Potential
Plateau (P1) Composite plain (CS) Bazada Plain (BZ)	This unit is the Coalition of alluvial cones and fans, formed after composite slopes boundary	Poor More infiltration recharge zone comprised of colluviofluvial materials	Very Good
Pediment (P)	It forms outcrop with or without soil cover.	Run off zone	Poor
Shallow Pediment (SP)	Intermediate zone between pediment and buried pediments weathering thickness is appreciable	Moderate infiltration. Recharge is influenced by Hydrological features.	Moderate
Burried Pediment (BP)	It is a shallow depressed low relief area with good drainage networks.	Infiltration moderate to good recharge by hydrological feature storage complemented by secondary features.	Good

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Structural Hill (SH)	Composed of Composite ridges and valley traversed by structural features	Run off zone little infiltration along secondary fractures	Poor
Residual Hill (RH)	„	„	„

Source: Remote Sensing Unit, Taramani.

3.6.5 LINEAMENT MAP

Generally, lineaments are weaker zones which have been formed due to crystal movements of earth. Lineaments occur as linear lines and are identified in satellite imageries for aquifers of small scale lineament map for regional study. Lineament may be in the form of fault or Geological contact or Shear major joints. Lineaments are the proven secondary aquifers in hard rocks.

Groundwater occurrence is confined to fractured aquifers and is stored in the deeper zones. after exploiting the shallow aquifers for agricultural and domestic purpose targeting of groundwater is concentrated towards the investigation of heterogenitic hydrofracture zones. Lineament map of our study area has been prepared from landsat and IRS FCC imageries of scale 1:250000 by visual interpretation.

Intersection of Lineaments are proven potential zones of ground water. A detailed investigation can be formulated to undertake detailed hydrofracture study in these zones. Almost the entire shallow aquifer zone is tapped for agriculture development in hard rock areas. Hence to meet the future demand for ground water a detailed investigation is warranted in the fractured aquifers for modeling the fracture density and development of secondary aquifers. At the same time, the open fractures can be utilized for artificial recharge and for storing ground water in the underground reservoir.

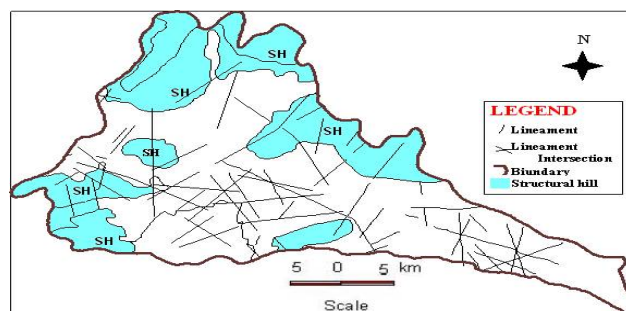


Figure 3.9 Lineament Map

IV. VULNERABILITY ASSESSMENT OF GROUND WATER USING GIS

The quality of water plays a prominent role in promoting both the standard of agricultural production and human health. If deterioration starts in water quality it will naturally affect the soil-crop-water system and human health conditions (Srinivasa Rao.Y et al). In the initial period of water quality deterioration, the damage may be low but if it is not controlled at the right time, this water will not be suitable for any purpose. Water quality may vary depending upon variation in geological formations. Human activity such as industrialization, mining and urbanization may also to determine its quality and classify the quality of water used for different purposes.

Keeping these points in mind, an attempt was made to study the qualitative analysis of groundwater and also to detect the suitability of water quality for drinking and irrigation, by collecting 33 ground water & 25 surface water samples in the Vasista Nadhi River Basin, Tamil Nadu, and India.

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4.1. SUITABILITY OF GROUNDWATER FOR DRINKING PURPOSES

The analytical results of physical and chemical parameters of groundwater were compared with the standard guideline values as recommended by the World Health Organization (WHO 1971, 1973) and BIS standards (IS 10500-1993) for drinking and public health purposes (Table). The table shows the most desirable limits and maximum allowable limits of various parameters. The spatial variation of pH and temperature are illustrated in the figure 4.1 and 4.2 respectively.

Table 4.1 Ground water samples of the study area exceeding the permissible prescribed by WHO for drinking purpose and the resulted undesirable effects on the human system

Parameter	WHO International Standard (1971,1983,1996)		Wells exceeding permissible limit		Undesirable Effects
	Most desirable limit	Max. allowable limit	Open wells	Surface water	
pH	7-8.5	9.2	-	-	Taste
TDS mg/l	500	1500	11	14	Gastrointestinal irritation

Table 4.2 Ground water samples of the study area exceeding the permissible prescribed by BIS for drinking purpose and the resulted undesirable effects on the human system

Parameter	BIS International Standard (1971,1983,1996)		Wells exceeding permissible limit		Undesirable Effects
	Most desirable limit	Maximum allowable limit	Open wells	Surface water	
pH	6.5-8.5	No relaxation	-	2	Taste
TDS (mg/l)	500	2000	12	9	Gastrointestinal irritation

4.2.3 TOTAL DISSOLVED SOLIDS

To ascertain the suitability of groundwater for any purposes, it is essential to classify the groundwater depending upon their hydro chemical properties based on their TDS value (catroll 1962: Freeze and Cherry 1979), which are presented in table. The groundwater of the area is equally distributes as fresh water and brackish water. Nearly 55% of the groundwater samples are within the maximum permissible limits for drinking as per the WHO International standard. The TDS zonation map was prepared for the obtained results. The map shows that 2/3 of the basin is 500-1000 mg/l of TDS, indicating low content of soluble salts in groundwater which can be used for drinking without any risk.

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Table 4.3 Nature of ground water based on TDS values

TDS(mg/l)	Nature of water	Total number of	
		Open wells	Surface water
<1000	Fresh water	8	9
1000-10000	Blackish water	25	15
10000-100000	Saline water	-	-
>100000	Brine water	-	-

4.3 SUITABILITY OF GROUNDWATER FOR IRRIGATION PURPOSES

Electrical conductivity is a good measure of salinity hazard to crops as it reflects the TDS in groundwater. 30 out of 60 samples exceed the permissible limits for irrigation (Ragunath 1987). Excess salinity reduces the osmotic activity of plant and thus interferes with the absorption of water and nutrients from the soil (saleh et al 1999).

Table 4.4 Quality of irrigation water based on electrical conductivity

EC (µS/cm)	Water Class	Total number of	
		Open wells	Surface water
<250	Excellent	-	-
250-750	Good	-	2
750-2000	Permissible	15	6
2000-3000	Doubtful	11	8
>3000	Unsuitable	7	9

1.4.1 CORRELATION OF GROUNDWATER QUALITY PARAMETERS

Table 4.5 Correlation matrix of Ground water samples

	Temp	pH	EC	TDS	Salinity	DO
Temp	1					
pH	-0.212	1				
EC	0.176	-0.168	1			
TDS	-0.012	-0.007	0.896	1		

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Salinity	-0.084	-0.088	0.827	0.931	1
DO	0.122	-0.013	0.017	0.0002	-0.037

Table 4.6 Correlation matrix of Surface water samples

	Temp	pH	EC	TDS	Salinity	DO
Temp	1					
pH	0.205	1				
EC	-0.174	-0.488	1			
TDS	-0.171	-0.485	0.999	1		
Salinity	-0.198	-0.489	0.985	0.983	1	
DO	0.229	0.715	-0.692	-0.688	-0.724	1

Water quality parameters of Surface (River) water samples

Sl. NO	SAMPLE NO	PH	PH in 'mv'	EC In 'm.s/cm'	SAL	RES $\times 10^{-4}$ in (cm/m.s)	TEM in °C	DO in 'mg/l'	DO in %
1	SW1	7.61	-50	2310	1.1	4.329	30.6	5.58	77.4
2	SW2	7.38	-31	1293	0.5	7.73	30.5	5.74	79.5
3	SW3	7.69	-52	898	0.2	0.111	30.7	6.01	83.3
4	SW4	7.31	-30	4320	2.3	2.314	30.6	5.86	81.2
5	SW5	7.57	-43	3730	1.9	2.68	30.5	5.87	81.1
6	SW6	8.02	-70	1654	0.7	6.045	30.5	5.91	81.9
7	SW7	7.32	-30	1363	0.5	7.336	30.5	5.80	83.3
8	SW8	7.62	-47	2380	1.0	4.201	30.5	5.25	73.5
9	SW9	7.60	-47	3160	1.6	3.164	30.5	5.55	76.8
10	SW10	7.78	-56	2390	1.1	4.184	30.6	5.56	77.1
11	SW11	7.72	-50	1318	0.5	7.587	30.6	4.93	68.2
12	SW12	7.41	-37	2240	1.0	4.464	30.5	5.38	74.6

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13	SW13	7.5 6	-43	1776	0. 7	5.36	30. 5	4.4 0	58. 6
14	SW14	7.4 0	-33	1903	0. 8	5.25 4	30. 5	5.3 0	78. 4
15	SW15	7.6 6	-49	1078	0. 3	9.27 6	30. 5	5.0 7	69. 5
16	SW16	7.6 1	-47	3570	1. 8	2.80 1	30. 6	5.3 3	74. 0
17	SW17	7.8 5	-60	1665	0. 7	6.00 6	30. 5	5.8 0	80. 2
18	SW18	7.7 5	-54	3110	0. 5	3.21 5	30. 6	6.0 0	82. 5
19	SW19	8.0 0	-69	2270	1. 0	4.40 5	30. 6	5.8 3	83. 7
20	SW20	7.8 8	-61	2520	1. 2	3.96 8	30. 5	5.9 7	82. 7
21	SW21	7.6 3	-47	1501	0. 6	6.66 2	30. 5	4.9 8	68. 4
22	SW22	7.9 2	-64	837	0. 2	0.11 9	30. 4	5.7 0	78. 8
23	SW23	7.7 9	-57	1276	0. 4	7.83 6	30. 4	5.7 5	79. 3
24	SW24	7.9 4	-66	2730	1. 3	3.66 3	30. 4	5.5 9	77. 1
25	SW25	8.0 8	-74	2480	1. 2	4.03 2	30. 4	5.3 7	74. 4
26	SW26	7.6 5	-48	1094	0. 3	9.14	30. 5	5.3 8	74. 5
27	SW27	7.9 1	-64	3090	1. 5	3.23 6	30. 5	4.6 7	64. 5
28	SW28	7.9 8	-68	2480	1. 2	4.32	30. 4	5.6 0	77. 4
29	SW29	7.2 5	-24	1480	1. 2	6.75 6	30. 5	5.6 6	78. 6
30	SW30	7.6 7	-49	5010	2. 7	1.99 6	30. 4	5.3 0	73. 1
31	SW31	7.4 9	-38	1868	0. 8	5.35 3	30. 5	6.5 2	90. 2
32	SW32	7.7 2	-52	2130	0. 9	4.69 4	30. 5	5.4 5	75. 6
33	SW33	7.5 4	-45	2120	0. 9	4.71 6	30. 4	5.5 1	76. 3

V. SUMMARY AND CONCLUSION

5.1 CONCLUSION

- Sago and Hybrid Seed industries are common in this basin.
- The effluents of the industries are directly discharged into land and water bodies without proper treatment.
- Biogas is being produced in many sago industries.
- Ground water is highly affected in nearly 1/3 of the basin leading unsuitability of water for drinking and irrigation.
- Most of the surface water bodies and river channels were also affected by the effluent of Sago industries.

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- The regional groundwater flow in the basin is towards east.
- The second phase to be cleared about the sample water quality with GIS images.

5.2. SCOPE FOR FURURE STUDY

The wastage should be treated by using proper treatment system and do not directly dispose into the agricultural land & water bodies. Low cost treatment technologies have to be suggested to reduce the concentration of polluting parameters. Combined treatment system can also be introduced to the small Industries to avoid the direct disposal of wastage. We can suggest the type of fertilizer to improve the productivity of the crops. To know the importance of proper drainage system.

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