A

Dissertation Report on

Aquifer Mapping To Help Ground Water Recharge In Shirala Tal.

Submitted

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in

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by

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CERTIFICATE

This is to certify that, Ms. Dhanashree Bajirao Shinde Student Name (Roll No-1827018) has successfully completed the dissertation work and submitted dissertation report on "Aquifer Mapping To Help Ground Water Recharge In Shirala Tal." for the partial fulfillment of the requirement for the degree of Master of Technology in Civil Construction Management from the Department of Civil Engineering., as per the rules and regulations of Rajarambapu Institute of Technology, Rajaramnagar, Dist: Sangli.

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DECLARATION

I declare that this report reflects my thoughts about the subject in my own words. I have sufficiently cited and referenced the original sources, referred or considered in this work. I have not misrepresented or fabricated or falsified any idea/data/fact/source in this my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute.

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ABSTRACT

Groundwater is the water found underground in the cracks and spaces in soil, sand, rock etc. It is stored in and moves slowly through aquifers. Groundwater can be extracted using bore well or water well. Aquifer mapping is a combination of geologic , geophysical , hydrological and chemical an laboratory analysis are applied to find quantity, quality, and sustainability of groundwater in aquifer.

This dissertation work is an effort to suggest water management plan. For aquifer mapping five villages are selected in Shirala Tal. The selected villages are "Ghagarewadi", "Girajavade", "Dhamavade", "Kondaivadi", "Wakurdebudruk (Bk).

The field visit is conducted for understanding layout, geology and other aspects of the area. Two visits are necessary to complete geological mapping. Based on the water table contour maps we identified the direction of the groundwater flow and located the probable recharge-discharge areas. Drainage analysis generally involved to evaluate the drainage parameters for a single watershed. These are measured through certain parameters called morphometric drainage parameters.To understand the fundamental hydro-chemical characteristics of ground water, in situ water quality analysis was done using tracer. The tracer gives information about PH, conductivity, total dissolved solids and salinity. Pumping test done to find aquifer parameter which is transmissivity and storativity.

The major activities involved in the dissertation work include compilation of existing data, identification of data gaps, generation of data for filling data gaps and preparation of aquifer maps. As per the study we have demarcated the recharge and discharge areas and gave recommendation.

Keywords: Ground water, Aquifer, Hydrogeology, Aquifer system.

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Chapter 1

INTRODUCTION AND RELEVANCE

1.1 General

Water on the earth is in motion through the hydrological cycle. The world oceans cover about three fourth of earth's surface. The total amount of water on the earth is about 1400 million cubic kilometres which is enough to cover the earth with a layer 300 meters depth. However no all of this water is usable. About 2.7% of this total water available on the earth is fresh water of which about 75.2% is ice in the Polar Regions and remaining 22.6% is groundwater. The remaining 2.2% is available in the form of lakes, river, atmosphere moisture, soil and vegetation. Thus, a large chunk of water available for consumption comes from the groundwater [1].

Groundwater is recharge naturally by rain and snow melt and to smaller extent by surface water like river and lake. Groundwater is the water beneath earth's surface in soil pore spaces and present in the form of fractures of rock formation. Groundwater is invisible, non-stationary transitory escape resource which does not follow any boundaries set by land-holdings. To understand the essential characteristics of groundwater in any region, we need to know the physical framework within which groundwater occurs, i.e. the aquifers. Aquifer is a void /hollow spaces available deep underground which is a main source for groundwater. An Aquifer is an underground layer of water-bearing permeable rock unconsolidated materials like sand silt and gravel etc. Groundwater can be extracted by tube well or dug well. The study of water in the aquifers and to characterize aquifers is called hydrogeology [2].

1.2 Closure

In first chapter introduction and general information about aquifer mapping can be defined as a scientific process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analysis applied to characterize the quantity, quality and movement of water in aquifer. If aquifers are mapped and recharging methods to suit the topography are used, we will be sure and will be able to quantify the output of efforts taken and even can pan for water management. This chapter describes the aquifers are underground rock formations or sedimentary deposits porous enough to hold water. Most aquifers are naturally recharged by rainfall or other surface water that infiltrates into ground.

Chapter 2

LITERATURE REVIEW

2.1 General

In this section, the present theories and practices related to aquifer mapping and need of ground water due to extraction through bore well and dug well by referring to published literature in various journals, book and conferences.

2.2 Literature reviewed

2.2.1 O.A. Adeyeye, E.A.Ikpokonte, S.A.Arabi (2017): "GIS-based groundwater Potential mapping within Dengi area, North Central

In this paper, describes the need of exploration of water is unquestionable .RS digital elevation model of data was used for formation of thematic maps of soil, drainage density and drainage proximity. Field mapping and ground truthing was used to rise thematic maps of geology and groundwater potential modeling are divided in three zones low, medium and high groundwater potential zone. The map concurs with field condition. RS and GIS help to increase accuracy of results in groundwater investigation. Groundwater potential model was generated by using raster calculator feature on arc map. For groundwater recharging, type of soil plays an important role. Geology discovers aquifers in which groundwater flows. There are many methods to evaluate aquifer parameters but this paper pumping test recommended and these test perform on wells.

2.2.2 Kanak Moharir, Chaitanya Pande, Sanay Patil (2017): "Inverse modeling of aquifer parameters in basaltic rock with the help of pumping test method using MODFLOW software"

A precise study for understanding groundwater related issues hydrological system. Water exploration can provide useful information related to subsurface geology of area. The present study of evaluation of aquifer parameter such as transmissivity (T) and storability (S) are for the exploration of groundwater resources. Hydrograph analysis and pumping test are methods to calculate aquifer factor. Pumping test is a modest procedure and in this test groundwater level is calculated. A case study shows, a pumping test is used for getting fast speedy and accuracy results. Groundwater levels plays important role in an aquifer factors characteristics. From aquifer pumping test, the field data was collected. MODFLOW is computer code to solve groundwater flow equation. Groundwater is second alternative source of water which is used in agriculture sector. This study can be used aquifer mapping and also for systematic planning of groundwater management because of rising demand of water for irrigation and many sectors is likely to continue.

2.2.3 Varalakshmi, B.VenkateswaraRao (2017): "Groundwater Flow of a Hard Rock Aquifer: Case Study"

The study area is divided into granites, basalts and laterites in a few quantities. Groundwater flows unconfined to semi confined conditions in generation of weathered and fractured. In this case using MODFLOW software, groundwater flow modeling is achieved in a steady and transient state condition with finite method. This finite-difference, block-centered, 3D modeling can simulate transient groundwater flows for different hydrological systems. In the present study, pre-monsoon and post monsoon groundwater levels and they are reduced to mean sea level and the differences between pre-monsoon and post monsoon levels are contoured by Arc GIS software. The groundwater draft has been allocated by a well package. The study area is based on groundwater to fulfill agricultural demand. In this paper draft has been measure by unit draft.

2.2.4 Rafael Goncalves Santos, Mara Lucia Marques: "GIS Applied to the Mapping of LU, LC and Vulnerability of the Guarani Aquifer System"

This case study is an occurring in the surface an underground for analysis of aquifer. The result shows large presence of areas with high vulnerability corresponding to 60.3% of the city. Land use land cover through DIP for aquifer vulnerability assessment, the drastic is a best reliable model which developed by USEPA 1985.

Drastic index=DrDw+RrRw+ArAw+SrSw+TrTw+IrIw+CrCw

This study adopted drastic pesticide methodology. Drastic pesticide parameter of study area is depth to water, recharge aquifer media, soil media topography. According to drastic index 26 and 226 represents low and high vulnerability index.

2.2.5 Declan Page, Elise Bekele (2017): "Managed Aquifer Recharge (MAR) in Sustainable Urban Water Management"

This study focuses on need to diversify future sources of supply and storage. To fulfill urban water requirement, there is a need to support sustainable urban water management. This study based on recent scientific knowledge of aquifer process in MAR. This paper shows information about types of MAR, potential water quantity. Evaporation and land saving is best benefits to store water below ground in a urban water. MAR is suitable aquifer in which water is stored from various sources including urban storm water, treated sewage, rainwater or even rural runoff. Hydrological knowledge is used to identify aquifers and suitability of MAR. Confined aquifer systems are protected from pollution but there is necessary to require wells for access.

2.2.6 Da Ha, Gang Zheng(2019) "Estimation of hydraulic parameters from pumping tests in a multiaquifer system."

This paper shows accurate estimates of aquifer parameters through pumping tests are essential in geotechnical engineering practice. In this study, the applicability of different models for estimating hydraulic parameters in a multi aquifer system is analyzed.

2.3 Gap analysis

The above researches show need of groundwater management plan. Rainfall is a major source of groundwater recharge. Nowadays groundwater extraction is more in quantity through dug well and bore well. Therefore, there is a need to prepare guideline for aquifer mapping, the aquifer units are defined by data availability and data gaps with respect to parameters,

- Exploration
- Hydrogeology
- Water level monitoring
- Water quality
- Hydrology

From rainfall data in shirala Tal. Sangali Dist. has maximum rainfall in shirala Tal five villages are selected .The villages are “Ghagarewadi”, “Girajavae”, “Dhamavade”, “Kondaivadi”, “Wakurde budruk(Bk). But water level drops-downs in summer due to extraction of water through bore wells and dug wells. There is need to recharge groundwater source by aquifer mapping. And develop systematic water management plan.

2.4 Objectives

From gap analysis, there is need of groundwater recharge. Therefore objectives are as follows.

1. To develop geological maps of study area using GIS.
2. To analyze influence of geology on the groundwater accumulation and movement in the area through surfer software.
3. To map aquifer by plotting groundwater movement on the study area.
4. To suggest water management plan for study area based on transmissivity and storativity.

2.5 Closure

In this chapter we discussed the research paper, review paper and project on the aquifer mapping. From which we got to know about the methods which are used to find aquifers.

Above literature reviewed, describes the need of water exploration is undeniable. Groundwater is an essential resource for farmers especially in arid to semi-arid regions rapidly. There are many methods to calculate aquifer parameters but many papers show pumping test is used for accuracy results. Groundwater levels plays important role in aquifer characteristics.

Chapter 3

RESEARCH METHODLOGY

3.1 General

This chapter shows need of ground water management plan. The objective is derived from the research gap and problem statement. The methodology chart has been prepared by research gap

3.2 Problem statement

For the purpose of study, five villages are selected for aquifer mapping in Shirala Taluka. The selected villages are "Ghagarewadi", "Girajavae", "Dhamavade", "Kondaivadi", "Wakurde budruk(Bk). The villages have more scope in groundwater recharge because there is more ground water extraction through dug well and bore well. Therefore there is need to recharge ground water source by systematic aquifer mapping and also develop water management plan.

3.3 Present methodology

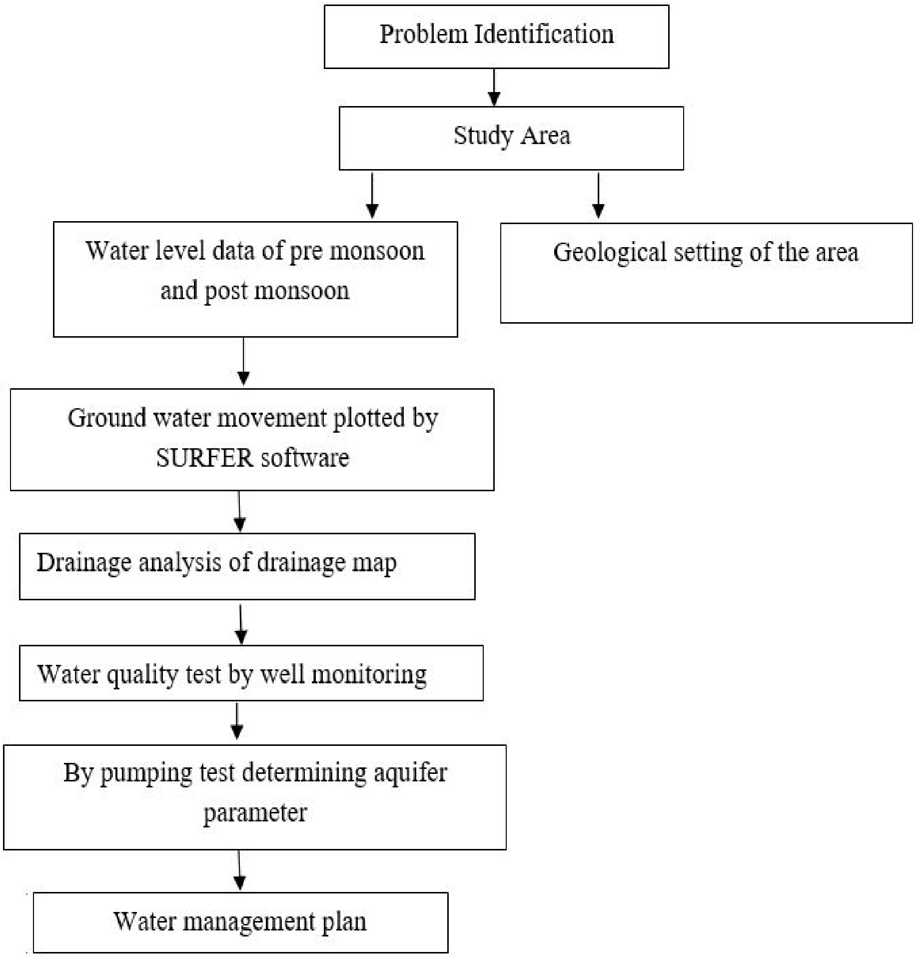

Figure 3.1: Methodology adopted in project work

3.3.1 Study area

The study area belongs to the Toposheet number 43E/04. The toposheet is a part of Maharashtra state and covers part of area of Sangli district. For aquifer mapping five villages are selected in Shirala Tal. The selected villages are "Ghagarewadi", "Girajavade", "Dhamavade", "Kondaivadi", "Wakurdebudruk (Bk).

3.3.2 Water level data pre monsoon and post monsoon

The water level data of 31 well was collected twice. Using these data water table contour map was plotted using surfer. Based on water table contour map, we can identify the direction of brown water flow and locate the probable recharge-discharge areas.

3.3.3 Geological analysis

The geological mapping mainly included the marking of the flow units with the help of red layer and marking out of major zones of seepage. The field visit is conducted for understanding layout, geology and other aspects of the area. Two visits are necessary to complete geological mapping.

3.3.4 Groundwater movement

Based on the water table contour maps we can identify the direction of the groundwater flow and locate the probable recharge-discharge areas

3.3.5 Drainage analysis

Drainage analysis generally involves evaluating the drainage parameters for a single watershed. These are measured through certain parameters called morphometric drainage parameters.

3.3.6 water quality test

To understand the fundamental hydro-chemical characteristics of ground water, in situ water quality analysis was done using tracer. The tracer gives information about PH, conductivity, total dissolved solids and salinity.

3.3.7 Pumping test

There are many methods to evaluate aquifer parameters but so many papers pumping test is recommended and theses tests perform on wells.
Pumping test help us to find aquifer parameter which is transmissivity and storativity

3.3.8 Water management plan

As per the study we have demarcated the recharge areas and give recommendation.

3.4 Closure

The major activities involved in this process include compilation of existing data, identification of data gaps, generation of data for filling data gaps and preparation of aquifer maps.

Chapter 4

DATA COLLECTION

4.1 General

The study area belongs to the Toposheet number 43E/04. The toposheet is a part of Maharashtra state and covers part of area of Sangli district. The survey of India prepares the toposheet. The scale of the toposheet is 1:50000.

4.2 Location of the study area

The study area belongs to the Toposheet number 43E/04. The toposheet is a part of Maharashtra state and covers part of area of Sangli district. The survey of India prepares the toposheet. The scale of the toposheet is 1:50000.

4.3 Area information

The Maharashtra state is divided into two parts, the upland part is called as plateau region and the western coastal region is known as Konkan belt. The study area is part of the Shirala Tehsil of Sangali district of Maharashtra. For aquifer mapping five villages are selected in Shirala Tal. The selected villages are “Ghagarewadi”, “Girajavae”, “Dhamavade”, “Kondaivadi”, “Wakurde budruk (Bk).

From (1996-2018) rainfall data, In Shirala Tal. of Sangli Dist. has maximum (1038mm) rainfall. The rainfall obviously high but the steep slopes of the Ghats means that the runoff is equally high. The study area lies between latitudes 17^o 3’ to 17^o 6’ and longitudes 74^o 2’to 74^o 6’. The area is covers 39km2. The Morana river is the main river in the area and it flows north to south. The study area is a part of Morana river basin. The study area is divided into two parts of watershed area. The selected villages are "Dhamavade", "Kondaivadi", "Wakurde budruk (Bk) in a first part and "Ghagarewadi", "Girajavae" in second part.

Most of the people in study area depend on agriculture the seasonal crops taken by this people include rice and groundnut. Depending on the availability of water, vegetables are also cultivated in part of the basin. The villages have more scope I groundwater recharge because they are depending on dug well and bore well. Therefore, groundwater extraction is more in quantity in study area. Rainfall is maximum but due to groundwater extraction water level drops-down in summer.

Table 4.1: Well inventory

Village name	**Latitude**	**longitude**	**Altitude**	**Water level**	**Additional data**
Wakurde Budruk	17°03'04"N	74° 02' 43"E	-	1 m	Compact Basalt
Dhamavade	17°04'48"N	74° 03' 2"E	680.5 m	Near to the surface	Vesicular Basalt
Kondaiwadi	17°04'57"N	74° 02' 21"E	716 m	0.2 m	Compact Basalt
Ghagrewadi	17°05'19"N	74° 05' 16"E	704 m	Near to the surface	-
Girajvade	17°05'18"N	74° 03' 43"E	752 m	2.5	Well constructed C.B seen

4.4 Toposheet

A topographic map is detailed and accurate two-dimensional representation of natural and human made features on the earth's surface. These maps are used for several applications, from camping hunting, fishing, and hiking to urban planning, resources management and surveying.

Toposheet is a map which provides information all main topographical features with specified legend and symbology. The study area belongs to the number 43/E4. The toposheet is useful in understanding the geomorphological feature of the area. The toposheet along with the Google Earth images have been used to identify features like drainage pattern, lineaments in the area including dykes, fractures and so on.

4.5 Topographic analysis

A toposheet shortened name for topographic sheet. It essentially contents information about a study area. According to their usage, they may be available at a different scale search as 1:25000, 1:5000 etc. Topography of an area along with the geological structures and lithology play an important role for water management plan.
With the help of topographical sheet of a particular region following features are achieved:

1. Drainage pattern of basin
2. Delineation of watershed boundary

4.6 Data description

Table 4.2: Data description

Data	**Description**
Rainfall data	The data (1 Jan 1998 to 3 Dec 2017) comes from rainfall observation which get from maharani. Gov. in website.
Toposheet	Toposheet of western Maharashtra (43/E4)

4.7 Field work

The field area was visited to get an understanding of layout, geology and other aspect of the area. The geological mapping of the area was completed in couple of visits. The geological mapping mainly included marking of the flow units with help of the red layer and marking out of the major zones of seepage. Rock samples were collected for petrographic analysis. In the fourth field visit the hydrological study was carried out, which included monitoring of selected dug-wells i.e. water level and in-situ water quality analysis.

4.8 Tools used for data interpretation and analysis

The various maps viz, geological map, drainage map and hydrological map of the area were completed based on collected data. A lithological section of the area has also been created. The water quality analysis of the area was done through water quality testing. The basin wise drainage analysis of the area was also carried out. The water table contour maps were prepared with the help of surfer for the three sets of data to help with the demarcation of the groundwater flow in the watershed.

4.9 Boundary marking

Initial process starts with making the boundary of study area. Hence for these purpose topographical sheets are required. The initial phase of project starts with scanning of topographical sheets at 300dpi for better resolution. By geo-referencing the topographical sheets in GIS environment, Drainage of basin and making boundary is carried out.

4.10 Software used

4.10.1 Arc GIS

Arc GIS is a geographic information system (GIS) for working with maps and geographic information maintained by the Environmental Systems Research Institute (Esri). It is used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database.

- Arc Map, for viewing and editing spatial data in two dimensions and creating two-dimensional maps;
- Arc Scene, for viewing and editing three-dimensional spatial data in a local projected view;
- Arc Globe, for displaying large, global 3D datasets;
- Arc Catalog, for GIS data management and manipulation tasks.

This software was used to get the contours of the study area. They were extracted from the Digital elevation model (DEM) and then used for our work in the area. Drainage of the study area was digitized from the toposheet and used. The topography and drainage was overlain to understand the data collected and plotted here in 2D. Geological maps were created along with the location maps. This software was mainly used for the preparation of maps such as

- Drainage map
- Location map
- Geological map
- Watershed map

4.10.2 Google earth

Google earth pro is an open source software which has a data in the form of images which can be used for various purposes. We used the images to mark and understand the topography of the study area in 3 dimensions. The location and watershed were marked in this software and used the figures for our study. Google earth images can be used to see the historical landforms of the area of our interest which is a very useful tool to understand the history and the current situation.

4.10.3 Surfer software

Surer is software which helps us develop the water table contour maps from the collected water level data of the area. With its help we can find the recharge areas and discharge areas of the study area.
To convert the data into the contours the software needs at least 3 points to generate them. Sufer gives us various options to furbish the plotted data and the contours generated from the data. To generate the contours the data required is the Latitude, Longitude, Reduced water level (elevation- static water level) and the codes for the data points. This helps us to put up the codes so then we can exactly work around the desired data points using the plot. The software also allows us to fill those contours to get a better understanding of the plotted water table contours.
When the contours are generated, and the flow directions are plotted we can find the recharge area. When the flow directions move outward from a same point then that area falls in the recharge area. And the flow direction that converges or come together at a certain point then the area is discharge area.

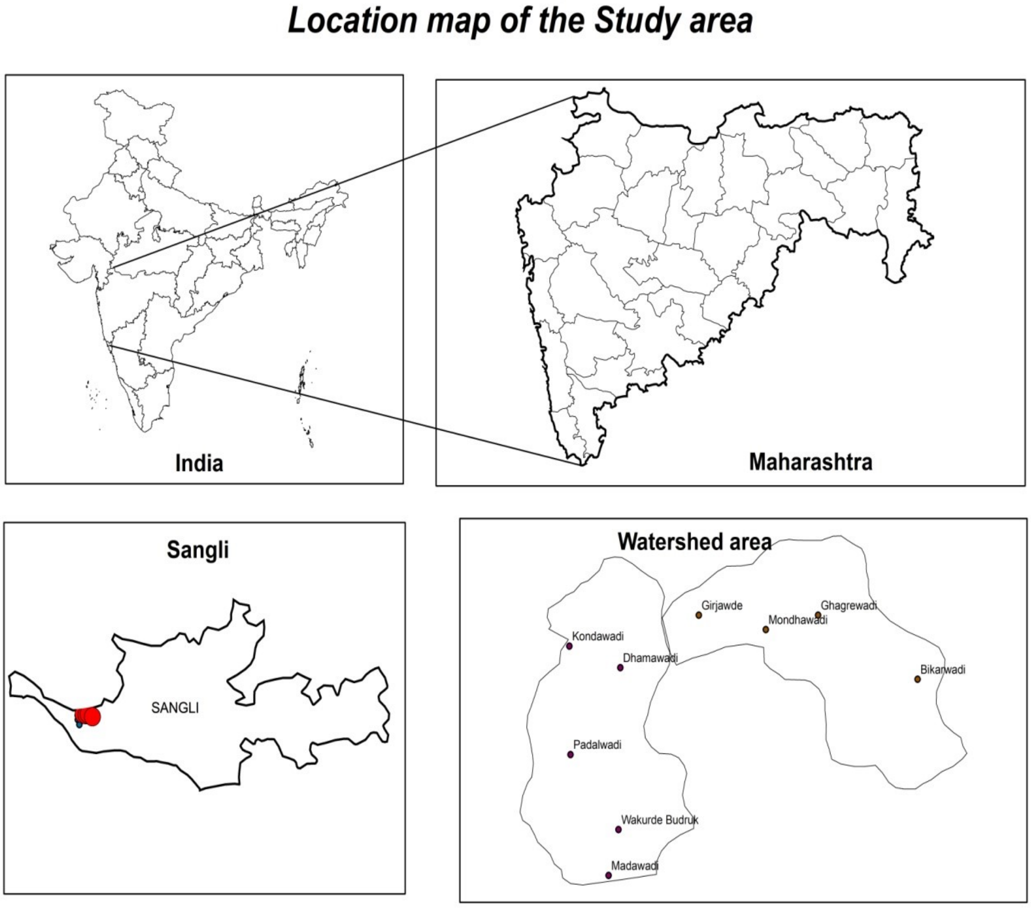

Figure 4.1: Location map

4.11 Closure

The various maps viz, geological map, drainage map and hydrological map of the area were completed based on collected data. A lithological section of the area has also been created. The water table contour maps were prepared with the help of surfer for the three sets of data to help with the demarcation of the groundwater flow in the watershed.

Chapter 5

DATA ANALYSIS

5.1 General

The study area is occupied by the Deccan Basalt. There are two types of basalt flows in the study area. The vesicular basalt is weathered- and each vesicular amygdaloidal basalt units is underlain by denser, compact basalt that is commonly sub-vertically jointed in the upper portion. the vesicular amygdaloidal basalt shows horizontal sheet joints structure through which the water comes out to the surface. The compact basalt in the area is dense and massive, the vertical joints seen in the wells of Ghaharewadi and Kondaiwadi villages.

5.2 Geology of the area

The study area is occupied by the Deccan Basalt. There are two types of basalt flows in the study area. The vesicular basalt is weathered- and each vesicular amygdaloidal basalt units is underlain by denser, compact basalt that is commonly sub-vertically jointed in the upper portion. the vesicular amygdaloidal basalt shows horizontal sheet joints structure through which the water comes out to the surface. The compact basalt in the area is dense and massive, the vertical joints seen in the wells of Ghaharewadi and Kondaiwadi villages.
The regional trend of the fractures is NE-SW. The study area divided into two water sheds namely Ghagarewadi and Dhamwade.
The field visit is conducted for understanding layout, geology and other aspects of the area. Two visits are necessary to complete geological mapping. The geological mapping mainly included the marking of the flow units with the help of red layer

and marking out of major zones of seepage.

The study area is divided into two watersheds. Both the watersheds Figure 5.1 and 5.2 shows the thirteen units of lava flows. These flows are found between elevation of 600m to 820m above msl, these flows grouped into 'compact basalt flows (CB)' and 'vesicular amygdaloidal basalt flow' (VAB). The seven flows are compact basalt flows, while six flows are vesicular amygdaloidal flows. Each lava flow unit varied in thickness. The minimum thickness of flow is 4m which is demarcated in simple flows, and maximum thickness flow is 13m which is demarcated in the compact basalt flow. There were three vesicular basalt flows are identified by the red tuffaceous layers, also the two compact basalt flows have demarcated by the red tuffaceous layers, while others have demarcated on the basis of change in lithology, or change in lithology type.

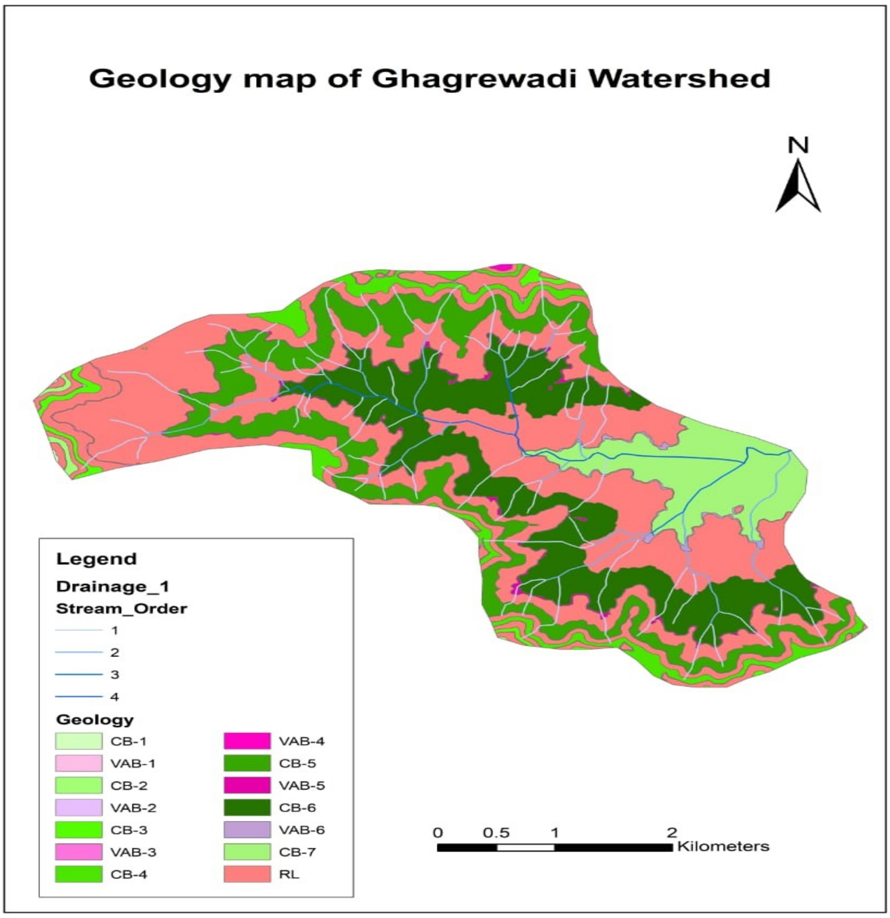

Figure 5.1: Geological map of Ghagrewadie watershed

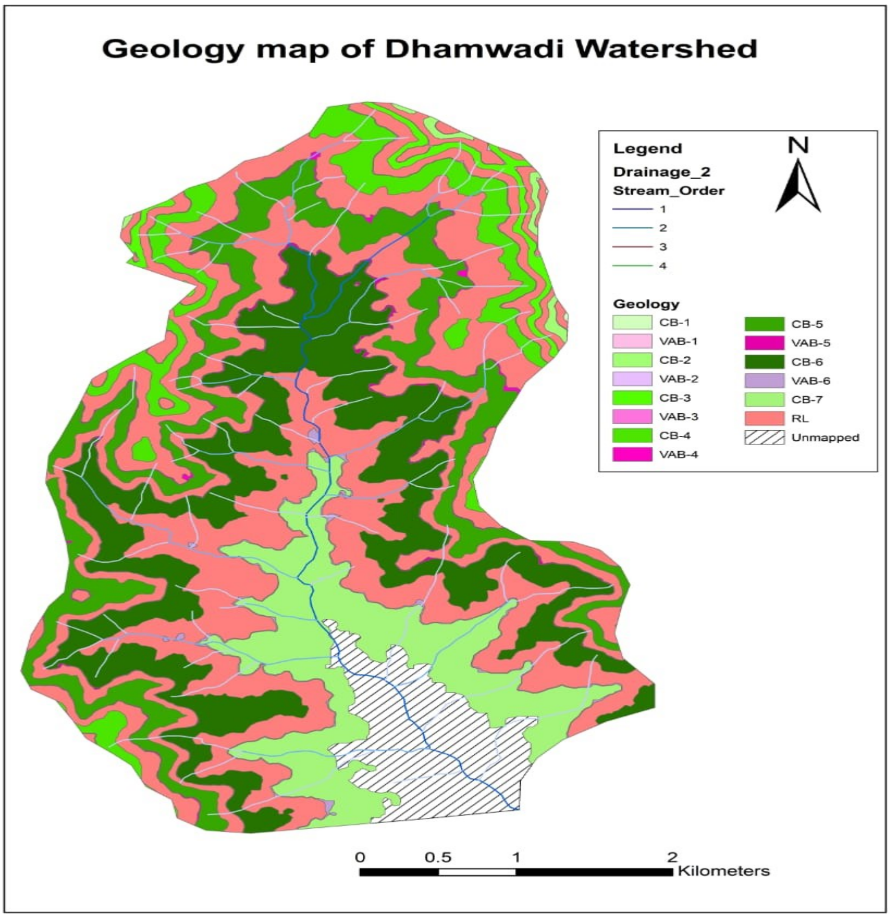

Figure 5.2: Geological map of Dhamwadi watershed

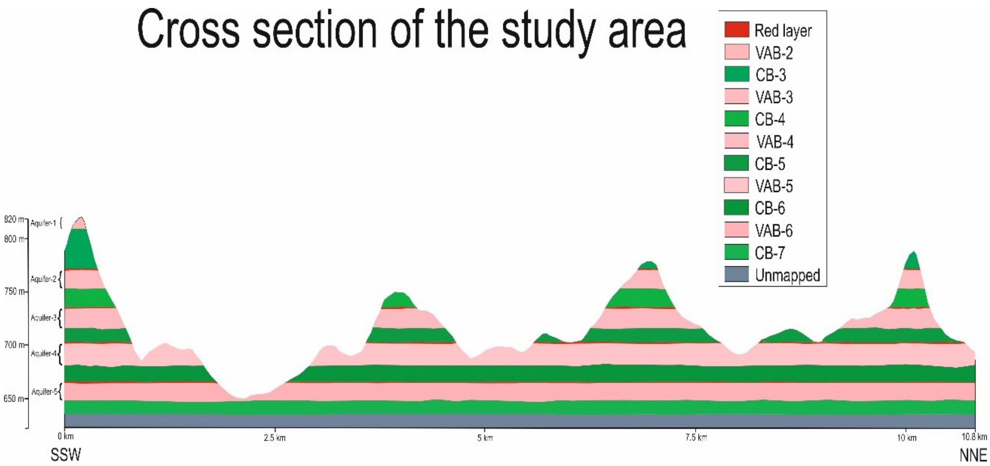

Figure 5.3: Cross section of the whole area along with the aquifer demarcation

The geological cross section of the area in the SSW-NNE direction shows that the slopes are higher in the SW direction grading down towards NE. Above Figure 5.3 shows the cross section is from Kondaiwadi to Girajwade.

5.3 Aquifers

There are six different aquifers present in the study area which mostly are unconfined aquifers.
The areas of the Aquifers in the study area are as in Table 5.1

Table 5.1: Aquifer and their area

Aquifer	**Area (Sq.km)**	**Thickness (m)**
Aquifer 1	0.005216	13
Aquifer 2	0.02205	9
Aquifer 3	0.083483	10
Aquifer 4	0.199778	15
Aquifer 5	0.332756	19
Aquifer 6	0.228984	18

To calculate the Aquifer storage, we need to have the information of the Aquifer thickness, Aquifer area and the specific yield.

$$\text{Aquifer storage} = \text{aquifer area} \times \text{Thickness} \times \text{Specific yield}$$

5.4 Hydrogeology

Hydrogeology is the study of groundwater – it is sometimes referred to as geohydrology or groundwater hydrology. Hydrogeology deals with how water gets into the ground (recharge), how it flows in the subsurface through aquifers and how groundwater interacts with the surrounding soil and rock.

5.5 Well inventory

Well inventory is necessary for many reasons- The geology, Water level, Groundwater extraction through the well by taking narratives. All this information then can be used to map aquifers and also is useful in drafting a management plan.

5.5.1 Selection of the wells

The selection of the monitoring wells was done in order to cover all the area and get the required information. The wells were selected on the basis of the aquifers

to get the water levels and get a clear understanding of the aquifer. Five villages were included in study area. 10 dug wells were selected for monitoring based on lithology exposed in the wells. 1-2 wells were monitored in each village. These wells will be numbered by the village name code and marked on the hydrogeological map. Some wells are along the Morna River.
The well monitoring included following aspects-

- Measurement of water level in the well
- The major lithology tapped by well
- In-situ water quality analysis test

Majority of the wells are found to be tapping the aquifers in compound flow one and two. The aquifer in compound flow to tapped by 22 dug wells, while the aquifer in compound flow one is tapped by five dug wells. Four wells are tapping the aquifer in simple flow unit. No wells are seen above the elevation 740m -800m. five dug wells are found in between elevations 700m-740m. While remaining four wells tapping the aquifers in simple flows occurs in between 800-880m out of the four wells in simple flows, three wells tapped aquifers in compact basalt, while one well tapes the aquifer in vesicular amygdaloidal basalt. The water quality analysis of dash wells was carried out [3].

5.5.2 Water level data

The water level data of 31 well was collected twice. The first time in September and second time in February. The static water level was taken with the help of normal tape with a plumb bob attached at lower end. The elevations of the wells were obtained with AGPs. The reduced water level (R.W.L) was calculated by subtracting the elevation of well from mean sea level from the static water level. Using these data water table contour map was plotted using surfer.
Based on water table contour map, we can identify the direction of brown water flow and locate the probable recharge-discharge areas. The recharge areas in the cluster can be observed towards the south. Among the studied wells, the well in DH is situated in recharge area, which is to the south east of the cluster since the water table contour have been plotted based on pumped water level, the discharge area cannot be demarcated directly. However, as a ground water flows towards

Morana river, it can be inferred that Morana river is influent in these areas that is ground water from these cluster feeds Morana river by way of base flows.
For greater accuracy the well monitoring needs to be carried out over a longer period. In addition, the noted water levels have to be static water level for demarcating the exact recharge –discharge area as in Table 5.2.
The Deccan basalt posses low to moderate storability and transmissivity.

Table 5.2: Water level data

Well no.	**Latitude**	**Longitude**	**Water level CB (in meters)**	**Additional data**
Wk 1	17° 03' 8"N	74° 03' 020"E	1.72	Regolith seen
Wk 2	17° 03' 386"N	74° 03' 541"E	4	Compact basalt
Wk 3	17° 03' 450N	74° 03' 615"E	5.4	Fractured CB
Wk 4	17° 03' 349"N	74° 03' 699"E	3.3	CB seen
Wk 5	17° 03' 252"N	74° 03' 565"E	1.5	-
Wk 6	17° 03' 207"N	74° 03' 474"E	3	-
Wk 7	17° 03' 262"N	74° 03' 437"E	o.5	Vesicular basalt
Knw 1	17° 05' 498"N	74° 02' 399"E	0.1	CB seen
Knw 2	17° 05' 226"N	74° 02' 395"E	2.2	-
Knb 3	17° 05' 013"N	74° 02' 332"E	100 ft water level	Fractured CB
Knw 4	17° 05' 897"N	74° 02' 439"E	0.3	CB seen
Knw 5	17° 05' "793N	74° 02' 439"E	0.4	-
Knw 6	17° 05' 770"N	74° 02' 455"E	1.8	-
Knw 7	17° 05' 850"N	74° 02' 619"E	0.2	CB SEEN
Dhw 1	17° 04'761 "N	74° 03' 123"E	2	Vesicular Basalt
Dhw 2	17° 05' 215"N	74° 02' 745"E	1	Vesicular Basalt
Dhw 3	17° 05' 117"N	74° 02' 968"E	2	Compact basalt
Dhw 4	17° 05' 056"N	74° 02' 972"E	0.6	Vesicular Basalt
Giw 1	17° 05' 401"N	74° 03' 907"E	1.3	CB seen
Giw 2	17° 05' 427"N	74° 04' 026"E	8.3	Vesicular basalt
Giw 3	17° 05' 104"N	74° 03' 837"E	1.72	CB seen
Ghw 1	17° 05'417 "N	74° 04' 701"E	1.65	-

Well no.	Latitude	Longitude	Water level CB (in meters)	Additional data
Ghw 2	17° 05' 372"N	74° 04' 898"E	0.57	-
Ghw 3	17° 05' 348"N	74° 04' 899"E	0.6	CB seen
Ghw 4	17° 05' 026"N	74° 05' 410"E	0.1	-

5.5.3 Waypoint of well inventory

GPS Essential application is used for creating wayponits of selected wells and also helps to take latitude, longitudinal and altitude. After collecting all reading in GPS Essiential, export to reading and we get the following Figure 5.4.

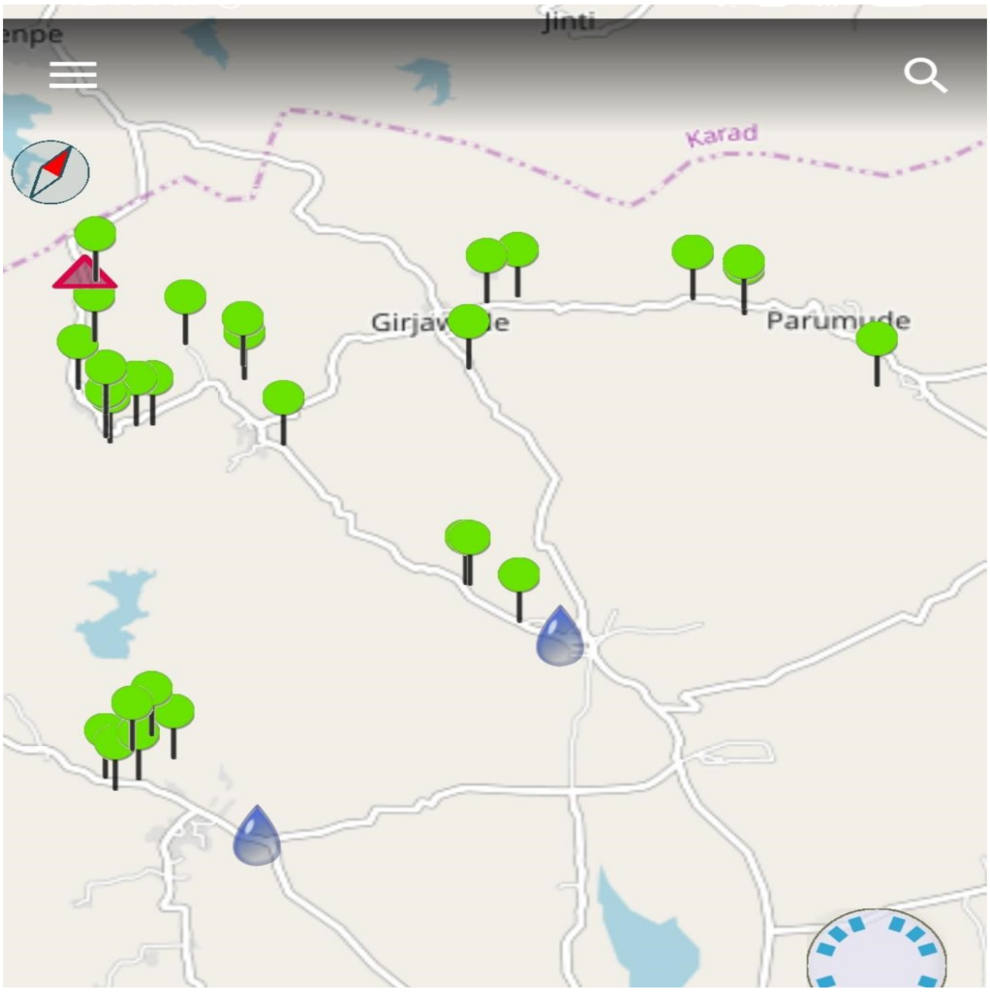

Figure 5.4: Waypoint of well inventory

5.6 Groundwater system

The Deccan basalt possesses low to moderate storativity and transmissivity. Two types of basaltic flows seen in the study areas is vesicular amygdaloidal flows and compact basalt flows. The simple flow in the study area consists of vesicular amygdaloidal flow and compact basalt. The compact basalt flow in the study area is mostly denser, compact and massive at the centre. The porosity of these flows is determined by the number of vesicles present in the flow. Its permeability is determined by the nature of inner connectivity of these vesicles and secondary opening like fractures.

Most of the wells in the study area are found in between contact of vesicular basalt and compact basalt. The compact basalt is fine grained, massive and denser. Is has vertical two sub-vertical joints up to certain depth. Due to these vertical sub vertical joints, ground water is not store or accumulated in large amounts. These flows hold ground water up to the depths of the joints and fractures. While the vesicular basalt has large number of openings. As mention earlier the porosity is dependent upon the presence of openings, hence the porosity of the compact basalt flow is lower than in vesicular basalt. The permeability depends upon inter-connection between vesicles or openings. These flows are compact and dense due to which the vesicles openings are miner in compact basalt. Hence permeability in the compact basalt is less, while the permeability in vesicular basalt is more.

31 wells are found in the compound basalt flows 1 and 2. These wells are found at various elevations in the flows. The demarcation of aquifer for compound flows is difficult, because the thickness of these flows is more than 30m. Hence the aquifers for these flows are delineated on the basis of thickness of flow and this are demarcated at the central part of compact flows.

The aquifer in compact flows form in the pockets. Due to this the water table in these flows is variable and the aquifers in the compound flow are the localized [4].

5.7 Water table contour map

Based on the water table contour maps Figure 5.5, we can identify the direction of the groundwater flow and locate the probable recharge-discharge areas the above contour map in Figure shows that groundwater flow is to be towards west. The recharge area in the study area can be observed towards east.

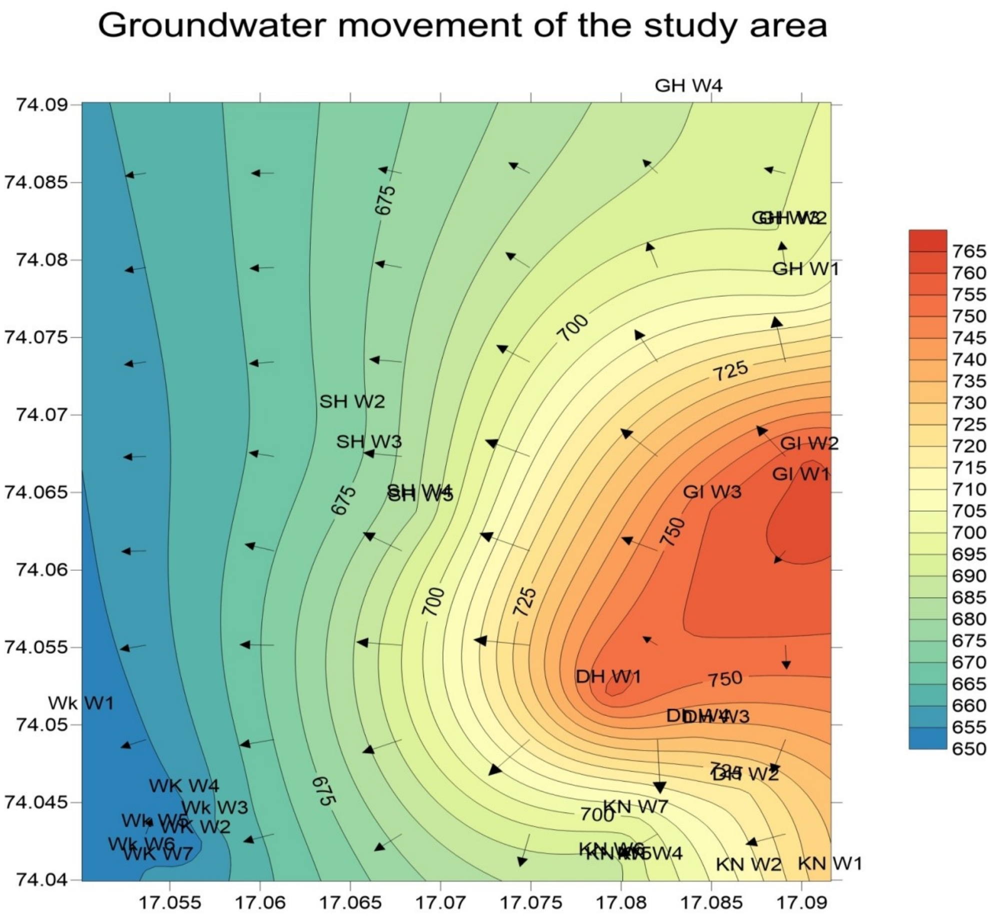

Figure 5.5: Water table contour map

5.8 Water quality

Water quality test introduced about hydro-chemical characteristics of ground water in the study area.The ground water in the study area is used for household purpose, agriculture, and livestock.

5.8.1 Water quality test

In the rainy season the rain water indicates with soil and the rocks through which it flows hence the groundwater is never pure but always has certain element depending upon the geology. The climate and lithology of the area decides water quality of area. To understand the fundamental hydro-chemical characteristics of ground water, in situ water quality analysis was done using tracer. The tracer gives information about PH, conductivity, total dissolved solids and salinity.

5.8.2 Permissible limit of water

In chemistry, pH is scale used to specify acidity or basicity of aqueous solution, lower pH value corresponds to solution which is more basic or alkaline. at room temperature, pure water is neutral and has Ph of 7. The PH ranges between 7.2 to 8.9 which are within expected limits for Deccan basalt among the 12 selected samples. Pure water is not good conductor of electricity. Because electrical current is transported by the ions in the solution, the conductivity increases as the concentration of the ions increases. From the Table 5.3 the electric conductivity of well L1 is slightly more than 500μS. and remaining wells of water have electric conductivity in desirable limit. Total dissolved solids TDS is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in molecular ionized, or micro granular suspended form. TDS concentrations are often reported in parts per million (ppm). Water TDS concentrations can be determined using a digital meter. TDS value of water in selected wells is within desirable limit Salinity affects farms. Salinity can decrease plant growth and water quality resulting in lower crop yields and degraded stock water supplies. When a source of drinking water becomes more saline, extensive and expensive treatment may be needed to keep salinity at levels suitable for human use. According to BIS, desirable limit of salinity of water is 0-500 ppm. The Table 5.4 shows the salinity of water in selected well is between 90-250 ppm.

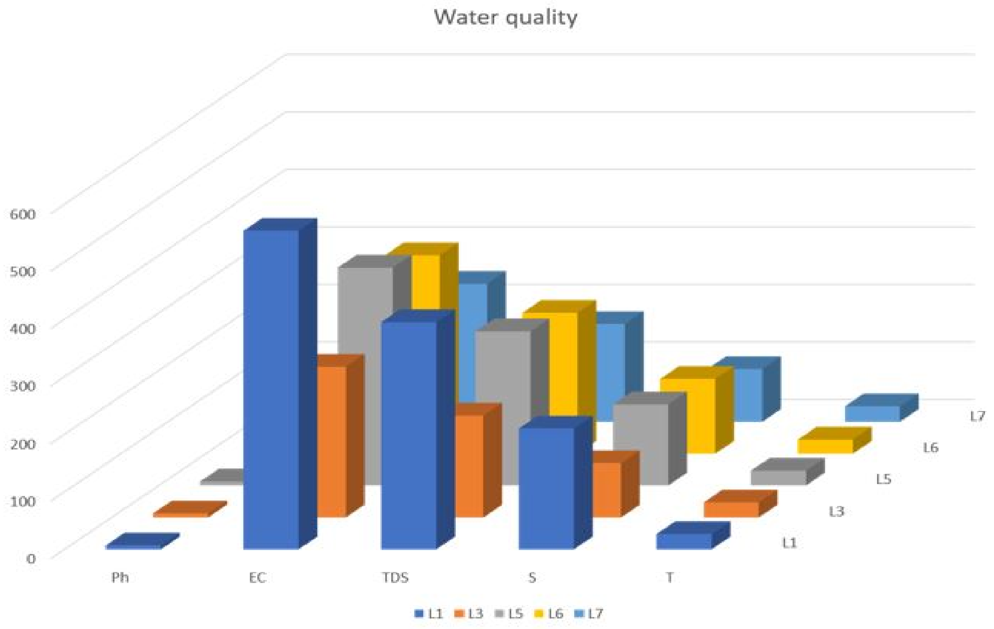

Figure 5.6: Water quality analysis done in the area

Table 5.3: Desirable limits by BIS (Bureau of Indian standards)

	Desirable limit	
Ph	6.5 - 8.5	
EC	0-500	μS
TDS	0-500	Ppm
S	0-500	Ppm

Table 5.4: Location of the wells from which the water quality is done

Latitude	**Longitude**	**Code**	**Ph**	**EC**	**TDS**	**S**	**T**
17.0838	74.0902	L1	6.89	554	395	210	26.7
17.0896	74.08163	L3	6.97	262	177	94.5	26.1
17.09	74.06511	L5	7.05	379	268	141	25.8
17.0843	74.04955	L6	7.2	345	245	130	24.6
17.0916	74.04	L7	7.38	240	170	91.6	26.9

5.9 Closure

This chapter gives the information about data collection which helps to understand geographical analysis, hydrological analysis and water quality analysis of the selected study area. The geological maps, hydrological map of the area were completed based on collected data. Based on the water table contour maps, we can identify the direction of the groundwater flow. The recharge area can be obeserved towards east. This chapter explain about parameter of water quality test. All values are in desirable limit.

Chapter 6

DRAINAGE ANALYSIS

6.1 General

The study the geometry of drainage network of an area gives information about the relationship between the surface runoff, the infiltration of rain water and relative permeability of rocks exposed in watershed. Drainage analysis generally involves evaluating the drainage parameters for a single watershed.

6.2 Drainage analysis

These are measured through certain parameters called morphometric drainage parameters. These are as follows:

- Bifurcation Ratio
- Stream Frequency
- Constant of Channel Maintainance
- Drainage Density

6.2.1 Bifurcation ratio (Rb)

In a drainage basin, the number of streams of any order will be generally greater than the number of streams of the next higher order. The ratio of the number of streams of a given order to the number of streams of the next higher order is called Bifurcation ratio.

Bifurcation ratio values above five are said to indicate structural controls over the drainage. Values below five indicate little structural control and drainage is developed as per normal conditions of topography and gradient.

6.2.2 Stream frequency (F)

Stream frequency is the ratio of total number of streams of all orders within a given basin to the basin area. A higher stream frequency indicates steeper gradients and lower permeability of surface

6.2.3 Drainage density (Dd)

Drainage density is defined as the total stream length cumulated for all orders in a basin to the total area of basin. Drainage density can be said to measure the texture of the drainage basin. Higher drainage density values indicate greater relief and lower permeability o surface.

6.2.4 Constant of channel maintenance (C)

The constant of channel maintenance is the inverse of drainage density. The constant denotes the area require to support a unit length of stream.

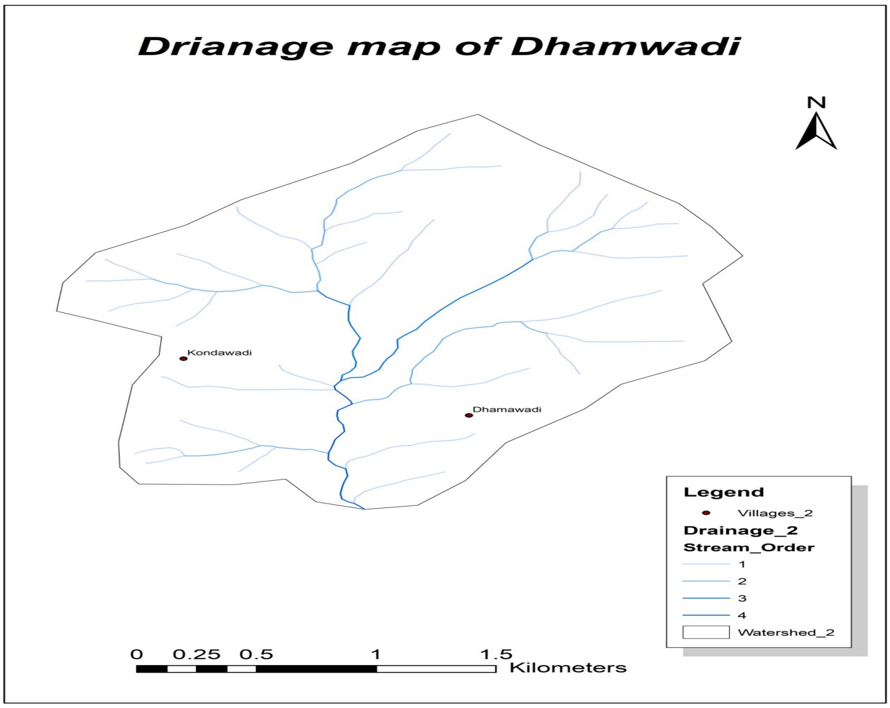

Figure 6.1: Drainage map of Dhamwadi

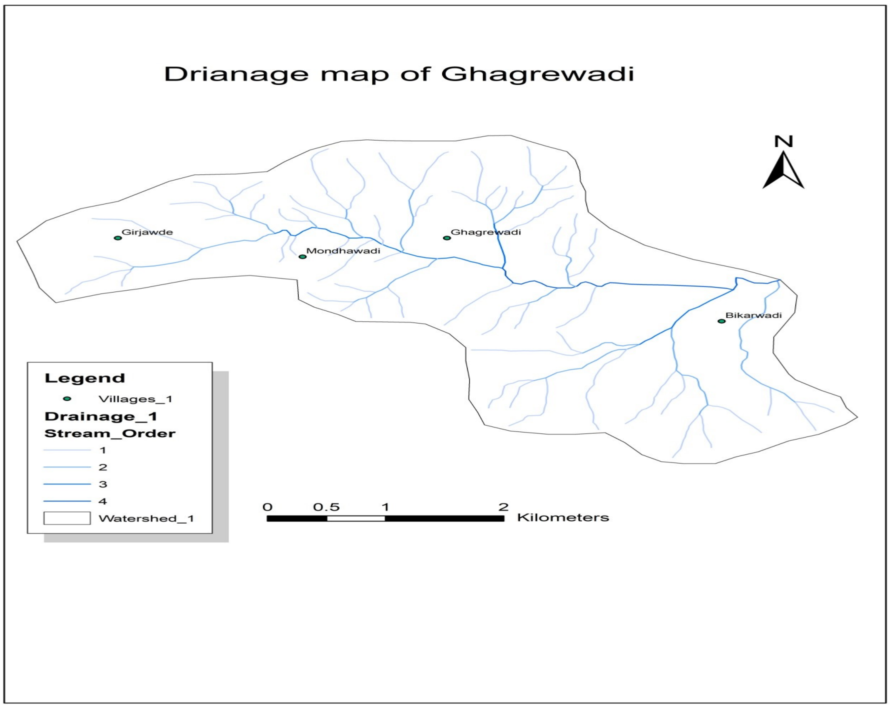

Figure 6.2: Drainage map of Ghagrewadi

Table 6.1: Drainage analysis of watershed area

Location	**Stream**	**No of order**	**Length of streams (km)**	**Basin area (sq.km)**	**Bifur cation ratio no of streams (n/n+1)**	**Stream frequency sum of no of streams /basin area /sq.km**
Shirala Dhamwadi	1 2 3 4	28 6 2 1	11.57 4.32 2.07 1.15	5.43	4.66 3 2 N.A	6.8
		Total	37	19.12		
Ghagrewadi	1 2 3 4	58 14 3 1	32.82 12.11 4.12 2.86	17.5	4.14 4.66 3 N.A	4.34
		Total	**76**	**51.93**		

6.3 Drainage analysis calculation

1. **Stream Order**

   It is a dimensionless number and Strahler's method (1952) is used for ordering the streams. In this method, two lower order streams join to form a higher order stream. The main stream into which all the lower order streams add their discharge, eventually becomes the higher order stream for that basin. A basin is denoted by the highest order of stream draining the basin.

2. **Bifurcation ratio**

   It is a ratio between number of streams of order 'n' and number of streams of order 'n+1'. It gives information about the factors controlling the drainage.
   a) If the bifurcation ratio falls between2–5 this generally implies that the drainage is slope controlled. A bifurcation ratio greater than 5 implies that there is some structural element such as a fracture, fault, dyke, etc. which is governing the drainage pattern.The both Figure 6.1 and 6.2 shows that both Ghargrewadi and Dhamwadi have mountainous terrains.

   Table 6.2: Bifurcation ratio interpretation

Bifurcation Ratio	**Interpretation**
less than or equal to 2	Flat terrain
2 to 5	Mountainous terrain
more than or equal to 5	Structurally controlled terrain

   b) Under normal conditions the bifurcation ratio should decrease as the stream order increases. However if it increases this suggests that there is some anomaly.
   Also the bifurcation ratio is very close to 5 hence the 1st order stream of Dhamwadi while 1st and 2nd order stream of Ghagrewadi are structurally controlled.

3. **Drainage Density**

   It is a ratio between the summations of length of all the streams to the area of the basin [5]. The drainage density gives an indication of the texture of the drainage and permeability of the underlying rock strata. It also tells the minimum length of stream required to drain a unit area of the watershed.
   The both watersheds show moderate drainage density.

4. **Stream Frequency**

   It is a ratio between the total number of streams of all orders to the area of the watershed [6]. It is a pure indictor of the permeability of the underlying rock strata.

Table 6.3: Drainage density interpretation

Drainage Density value	**Interpretation**
0-2	Low
2 to 4	Moderate
4 to 6	High
≤6	Very High

Table 6.4: Stream frequency interpretation

Stream Frequency value	**Interpretation**
0-2	Very Poor
2 to 4	Poor
4 to 6	Moderate
≤6	Very High

In Dhamwadi the stream frequency is very high which tells us that the rock strata is very poorly permeable. While in Ghagrewadi the stream frequency is Moderate which shows that the rock strata is less permeable.

6.4 Closure

This chapter shows drainage network of the selected study area. From drainage analysis we can find permeability, bifurcation ratio and drainage density. From bifurcation ratio ,both Ghagarewadi and Dhamavadi have mountainous terrains. Therefore these area has need of groundwater recharge. And stream frequency calculation tells us that the rock strata is poorly permeable in Dhamwadi and less permeable in Ghagarewadi.

Chapter 7

PUMPING TEST

7.1 General

A pumping test is a field experiment in which a well is pumped at a controlled rate and water level response is measured in observation well. From response data, we can estimate the hydraulic properties of aquifer.

7.2 Pumping test

Pumping tests were conducted to evaluate an aquifer by pumping a well that taps the aquifer and observing the drawdown in the well as well in other wells tapping the same aquifer referred to as observation wells. There are two types of pumping tests; Well test and Aquifer test. The pumping tests are also useful to find out the various aspects of the well and the aquifer that it taps. These aspects include transmissivity, storativity and specific capacity. Transmissivity means the rate at which water is transported through the aquifer and the value changes with the nature of aquifer. The storativity of aquifer implies the water present in the aquifer. Specific capacity of a well is the rate at which water recovers its original water level after the pumping of the well.

7.3 Experiment

Commonly an aquifer test is conducted by pumping water from one well at a steady rate. It often utilizes one or more observation well. An observation well is simply a well which is not being pumped, but it is used to monitor the hydraulic head in the aquifer. At the time of pumping test; carefully measurements of the water levels in the pumping well and the observation well are taken.

Essential equipment needed for conducting pumping test include bucket or drum of known volume, measuring tape, stop watch, and electric motor or diesel engine. A fixed point is chosen for taking all measurements referred to as the measuring point. This point is such that the readings will be most accurate i.e. there will be least curve and free from vegetation and other structural obstructions and in a convenient location such that multiple measurements can be taken comfortably. The measurements of some parameters are taken before the pumping test starts which include well diameter, well depth, and static water level. The decrease in the water level with the pumping of the well is measured in pre-decided time intervals. This decreased water level is called as pumped water level (P.W.L) for that time. The drawdown is measured from these values as (PWL-SWL). When the pumping is stopped the readings are taken with the same interval of time as taking for the pumped well, these readings are called as recovery (WL-SWL). The rate of discharge of water from the well is also measured with the help of bucket and a stop watch.

The values obtained from the pumping test data was used for calculating the values of transmissivity , storativity and specific capacity of the individual well. The formula used for the calculations of transmissivity and storativity is that given by Cooper and ACOB (1964). Slichter's method is used for the calculations of specific capacity. The formulas have been given below.

In Deccan basalts usually large diameter wells are found; due to the large diameter of the wells a sufficient amount of water is stored in the wells. Now the discharge of the well depends upon the water pumped from the well and the water derived from the aquifer. At the initial stage, only stored water in well is derived by the pumping. The aquifer discharge is increased with drawdown and time. Three pumping tests were conducted in the Shirala taluka. These wells lie in two different parts of the study area. But there are several problems in getting accurate or appropriate results from the pumping test.

According to Slichter' s formula,

$$\text{Specific capacity (C)} = 2.303\ (\times \frac{A}{t'} log \frac{S1}{S2})$$

Where,

C = specific capacity of well, in $\frac{m^3}{min}$

A = Cross sectional area of the well

T' = time, in minutes, since pumping stopped

S1 = total drawdown in m

S2 = residual drawdown in meters at time t'

$$T = 264 \times \frac{Q}{\triangle S}$$

Where,

Q = average discharge in m3 per min

$\triangle$S = S plotted on graph

$$S = 2.25 \times T \times \frac{t'}{R2}$$

Where,

T = transmissivity

R2 = distance between pumping well and observation well

Pumping Test 1

Well no.1 - Wakurde bk

Location No. 17 03' 450N

74° 03' 615"E

Pumping test data (Drawdown part)

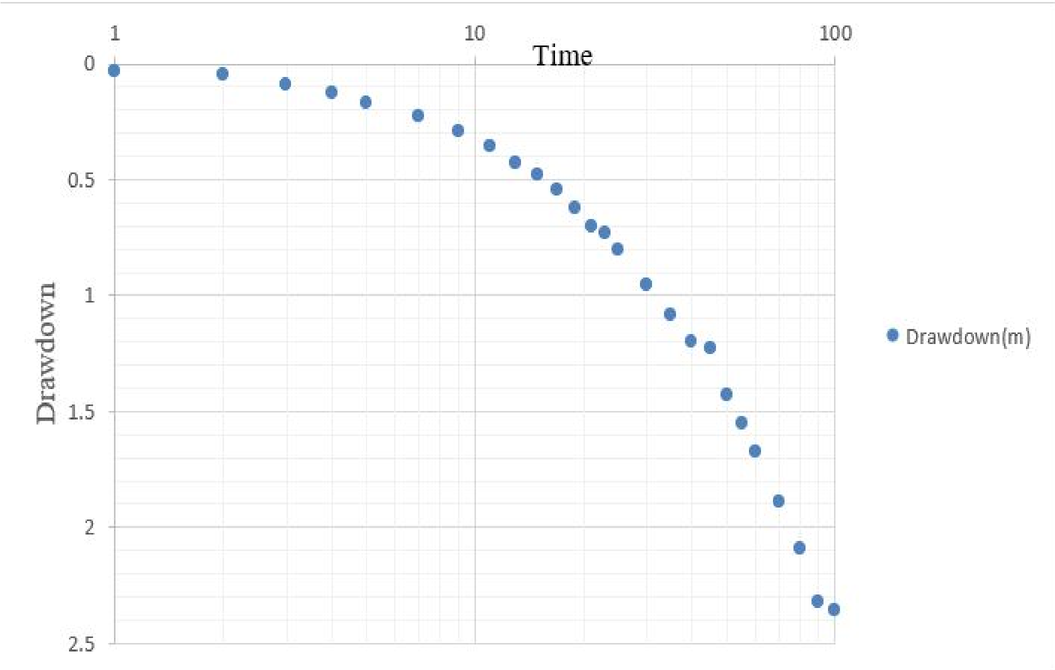

Figure 7.1: Pumping test 1 data graph

Table 7.1: Drawdown time of Wakurde Bk

Time	**Water level**	**Drawdown**
0	4.32	0
1	4.35	0.03
2	4.368	0.048
3	4.408	0.088
4	4.446	0.126
5	4.486	0.166
7	4.544	0.224
9	4.614	0.294
11	4.678	0.358
13	4.748	0.428
15	4.801	0.481
17	4.864	0.544
19	4.944	0.624
21	5.022	0.702
23	5.052	0.732
25	5.122	0.802
30	5.272	0.952
35	5.4	1.08
40	5.52	1.2
45	5.55	1.23
50	5.75	1.43
55	5.87	1.55
60	5.992	1.672
70	6.212	1.892
80	6.408	2.088
90	6.641	2.321
100	6.68	2.36

Pumping test data (Residual Drawdown part)

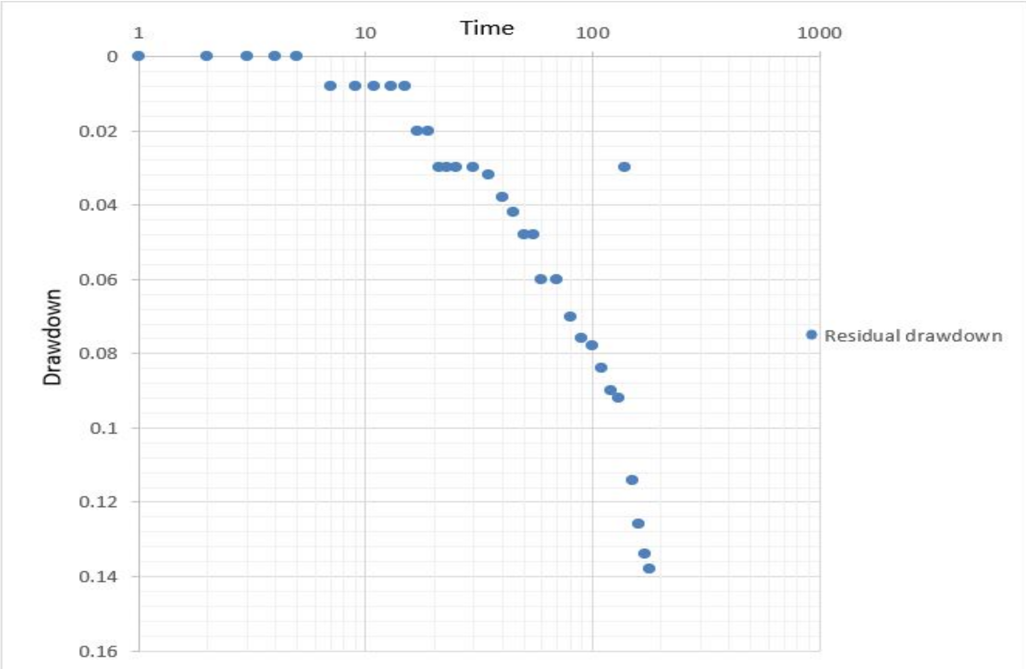

Figure 7.2: Pumping test 1residual data graph

$$T = 264 \times \frac{Q}{\triangle S}$$

Where,

Q = average discharge in m3 per min

Q= 0.1848

$\triangle$S = S plotted on graph = 0.9

$$S = 2.25 \times T \times \frac{t'}{R2}$$

Where,

t' = 21

$\triangle$s = 0.9

Discharge = 184.8 0.1848

T = 43.90848

S = 0.092208

The pumping test graph shows the drawdown from the pumping well. The X axis shows the time required for the drawdown and the Y axis shows the water levels below ground level. The graphs tells us the time required for the total drawdown which gives us the value for our transmission from the aquifer. The time required is calculated by using the slope of the drawdown and the intercept is used for the

Table 7.2: Residual Drawdown time of Wakurde Bk

Time	**Recovery**	**Residual drawdown**
0	6.68	0
1	6.68	0
2	6.68	0
3	6.68	0
4	6.68	0
5	6.68	0
7	6.672	0.008
9	6.672	0.008
11	6.672	0.008
13	6.672	0.008
15	6.672	0.008
17	6.66	0.02
19	6.66	0.02
21	6.65	0.03
23	6.65	0.03
25	6.65	0.03
30	6.65	0.03
35	6.648	0.032
40	6.642	0.038
45	6.638	0.042
50	6.632	0.048
55	6.632	0.048
60	6.62	0.06
70	6.62	0.06
80	6.61	0.07
90	6.604	0.076
100	6.602	0.078
110	6.596	0.084
120	6.59	0.09
130	6.588	0.092
140	6.65	0.03
150	6.566	0.114
160	6.554	0.126
170	6.546	0.134
180	6.542	0.138

further calculations of the Transmissivity from the aquifer.
The gentler the curve of the drawdown higher the Transmissivity and steeper the slope of the drawdown Less the transmissivity.

Pumping Test 2

Well no.2 - Girjavade

Location No. 17^o 05' 401"N

74^o 03' 907"E

Pumping test data (Drawdown part)

Table 7.3: Drawdown time of Girjavade

Time(Min)	**Water Level (m)**	**Drawdown(m)**
0	7.27	0
1	7.74	0.47
2	7.762	0.492
3	7.784	0.514
4	7.806	0.536
5	7.826	0.556
7	7.88	0.61
9	7.91	0.64
11	7.96	0.69
13	7.996	0.726
15	8.024	0.754
17	8.07	0.8
19	8.114	0.844
21	8.15	0.88
23	8.19	0.92
25	8.232	0.962
30	8.338	1.068
35	8.42	1.15
40	8.496	1.226
45	8.57	1.3
50	8.65	1.38
55	8.72	1.45
60	8.79	1.52
70	8.92	1.65
80	9.03	1.76
90	9.12	1.85
100	9.2	1.93
110	9.28	2.01

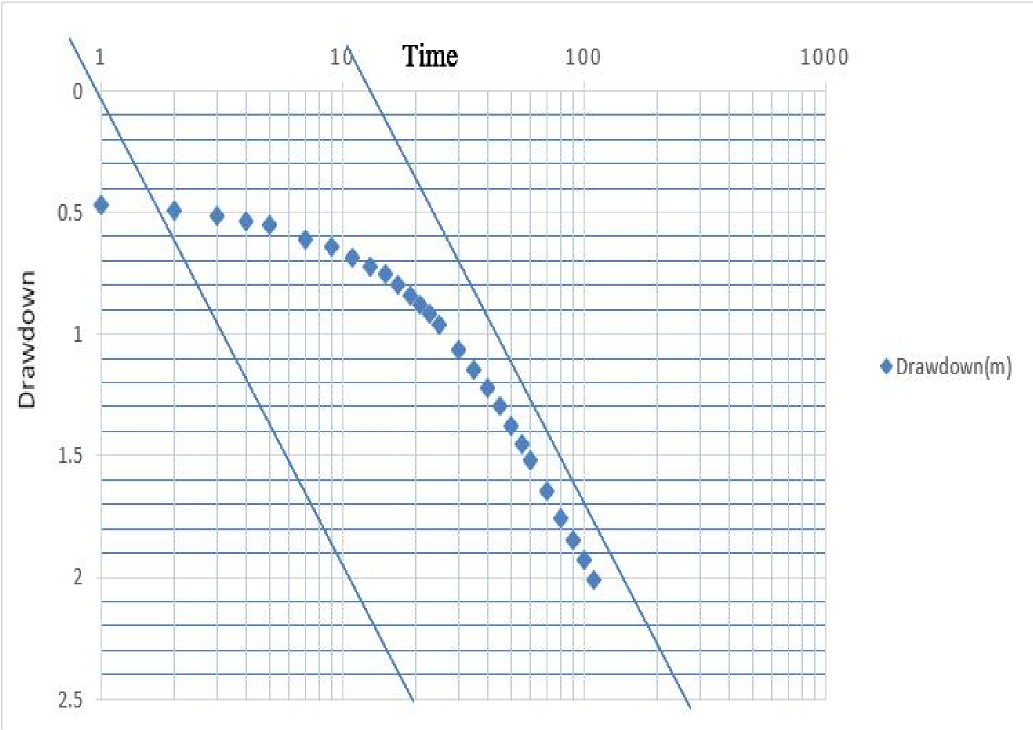

Figure 7.3: Pumping test data graph

$$T = 264 \times \frac{Q}{\triangle S}$$

Where,

Q = average discharge in m3 per min

Q= 0.100

△S = S plotted on graph = 0.5

$$S = 2.25 \times T \times \frac{t'}{R2}$$

Where,

Discharge = 15 liter in 8.97 second

100.3344 lpm

t' = 3.4

△s = 0.5

Discharge = 100.3344 0.100334

T = 13.24414

S = 0.041482

Table 7.4: Drawdown time of Girjavade

Time (Min)	**Recovery (m)**	**Residual drawdown**
0	9.28	0
1	9.28	0
2	9.274	0.006
3	9.27	0.01
4	9.264	0.016
5	9.26	0.02
7	9.258	0.022
9	9.256	0.024
11	9.252	0.028
13	9.24	0.04
15	9.234	0.046
17	9.23	0.05
19	9.224	0.056
21	9.218	0.062
23	9.21	0.07
25	9.2	0.08
30	9.193	0.087
35	9.19	0.09
40	9.18	0.1
45	9.172	0.108
50	9.16	0.12
55	9.154	0.126
60	9.132	0.148
70	9.106	0.174
80	9.09	0.19
90	9.068	0.212
100	9.05	0.23
110	9.034	0.246

Time (Min)	**Recovery (m)**	**Residual drawdown**
120	9.014	0.266
130	9	0.28
140	8.972	0.308
150	8.958	0.322
160	8.94	0.34
170	8.922	0.358

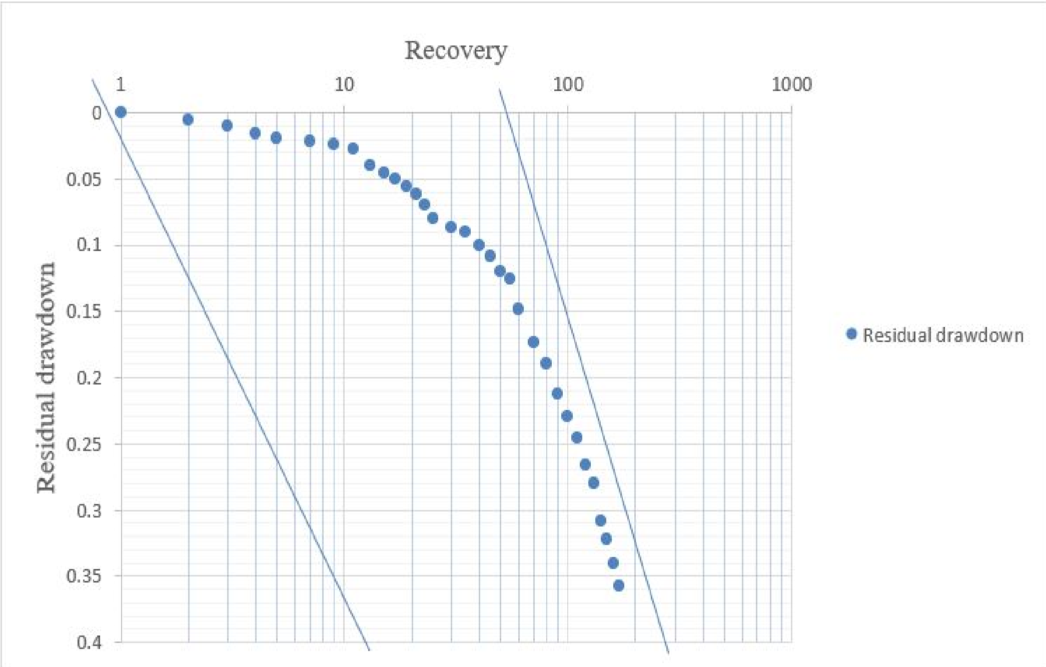

Figure 7.4: Pumping test residual data graph

7.4 Closure

The gentle the curve of the drawdown higher the Transmissivity and steeper the slope of the drawdown Less the transmissivity. The graph helps us find the time intercept value which is further used for the calculations to find the T. From pumping test, well no.1 and well no. 2, result shows the Deccan basalt posses low to moderate storativity and transmissivity.

VISIT PHOTOS

Figure 7.5: Red layer observed

Figure 7.6: Water level measurement

Figure 7.7: Discussion with farmer

Figure 7.8: Water level measurement in second visit

Figure 7.9: Discussion with well owner for pumping test in third visit

Figure 7.10: Ready for pumping test

Chapter 8

CONCLUSION

- These are the activities which can be undertaken for the effective recharge to the aquifer in the area.
- Geological maps are prepared in two visits. There are six different aquifers present in the study area which mostly are unconfined aquifers.
- All the five aquifers have been demarcated in Vesicular basalt
- Groundwater movement are identified by surfer software. Based on the water table contour maps, we can identify the direction of the groundwater flow is to be towards west and locate the probable recharge-discharge areas the above contour map shows that groundwater flow is to be towards west. The recharge area in the study area can be observed towards east.
- From drainage analysis bifurcation ratio shows that both Ghargrewadi and Dhamwadi have mountainous terrains.
- In Dhamwadi the stream frequency is very high which tells us that the rock strata is very poorly permeable. While in Ghagrewadi the stream frequency is Moderate which shows that the rock strata is less permeable.
- Water quality test is done to understand the fundamental hydro-chemical characteristics of ground water. The tracer gives information about PH, conductivity, total dissolved solids and salinity. All values are in desirable limit.
- Pumping test is used to evaluate storativity and transsmissivity. The gentler the curve of the drawdown higher the Transmissivity and steeper the slope

of the drawdown Less the transmissivity.

- The Deccan basalt posses low to moderate storativity and transmissivity.
- Recommendations:In these recharge areas we have some recommendations for recharge as follows,

1. Continues contour trenches
2. Staggered contour trenches
3. Recharge ponds

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LIST OF PUBLICATIONS ON PRESENT WORK

[1] Dhanshree B. Shinde, Prf. Dr. S. S. Kulkarni, "Mapping of Aquifer for Ground Water Recharge in Shirala Taluka", *International Research Journal of Engineering and Technology (IRJET)*, Vol. 07, Issue: 10, Oct 2020. (Published)

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Mapping of Aquifer For Ground Water Recharge In Shirala Taluka

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Abstract - *Aquifer mapping is defined as a scientific process of a combination of geologic, geophysical, hydrologic and chemical field and laboratory analysis are applied to find the quantity, quality and sustainability of ground water in aquifers. Groundwater is the water that occurs below the surface of earth, where it occupies all or part of the void spaces in soils or geologic strata. The recharge and discharge of groundwater are control by aquifer characteristics and other factors such as soils, climate, land use, cropping pattern. The Identification of clusters of aquifers will help for preparation of aquifer management plans for sustainable groundwater management. This will help achieving drinking water security, improved irrigation facility and sustainability in water resources development in a rural area. The identification and evaluation aquifer involves GIS applications for demarcation of aquifer boundaries and division into smaller units, various software's has been used for defining preliminary 3D disposition of aquifer systems.*

Key Words: *Aquifer, Groundwater, GIS, Hydrogeology*

1. INTRODUCTION

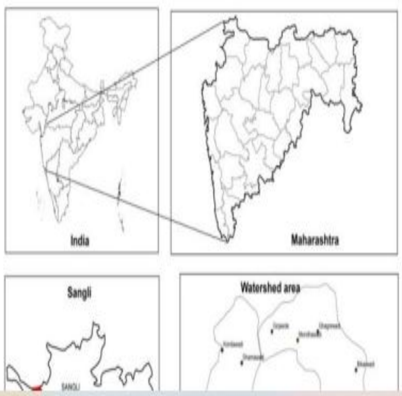
Water on the earth is in motion through the hydrological cycle. The world oceans cover about three fourth of earth's surface. The total amount of water on the earth is about 1400 million cubic kilometres which is enough to cover the earth with a layer 300 meters depth. However no all of this hollow spaces available deep underground which is a main source for groundwater.

An Aquifer is an underground layer of water-bearing permeable rock unconsolidated materials like sand silt and gravel etc. Groundwater can be extracted by tube well or dug well. The study of water in the aquifers and to characterize aquifers is called hydrogeology.

2. Case Study and Data Collection

For current study of aquifer mapping five villages has been selected from Shirala Tal. The selected villages are "Ghagarewadi", "Girajavade", "Dhamavade", "Kondaivadi", "Wakurdebudruk (Bk).The study area lies between latitudes 17º 3' to 17º 6' and longitudes 74º 2'to 74º 6' the area under study is covers about 39km.

Location map of the Study area

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Mapping of Aquifer for Ground Water Recharge in ShiralaTaluka

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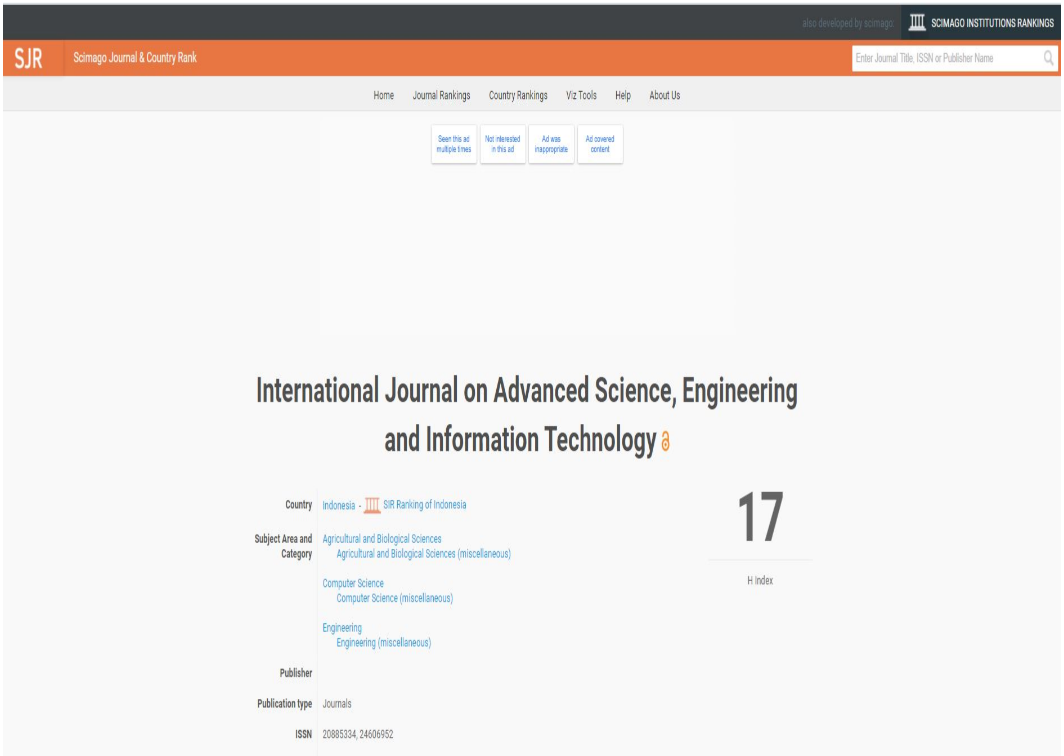
Abstract: -

Groundwater is the water that occurs below the surface of earth, where it occupies all or part of the void spaces in soils or geologic strata. Ground water is stored in aquifers and moves slowly through it. Ground water has been extracted by using bore well and water well. Most of the ground water originates from precipitation form of rain or snow and it is not reduce by evaporation, transpiration or runoff, water from these sources has been infiltrate into the ground.

Aquifer mapping is defined as a scientific process of a combination of geologic, geophysical, hydrologic and chemical field and laboratory analysis are applied to find the quantity, quality and sustainability of ground water in aquifers. The study of water flow in aquifers and the characterization of aquifers are called hydrogeology.

The recharge and discharge of groundwater are control by aquifer characteristics and other factors such as soils, climate, land use, cropping pattern. The Identification of clusters of aquifers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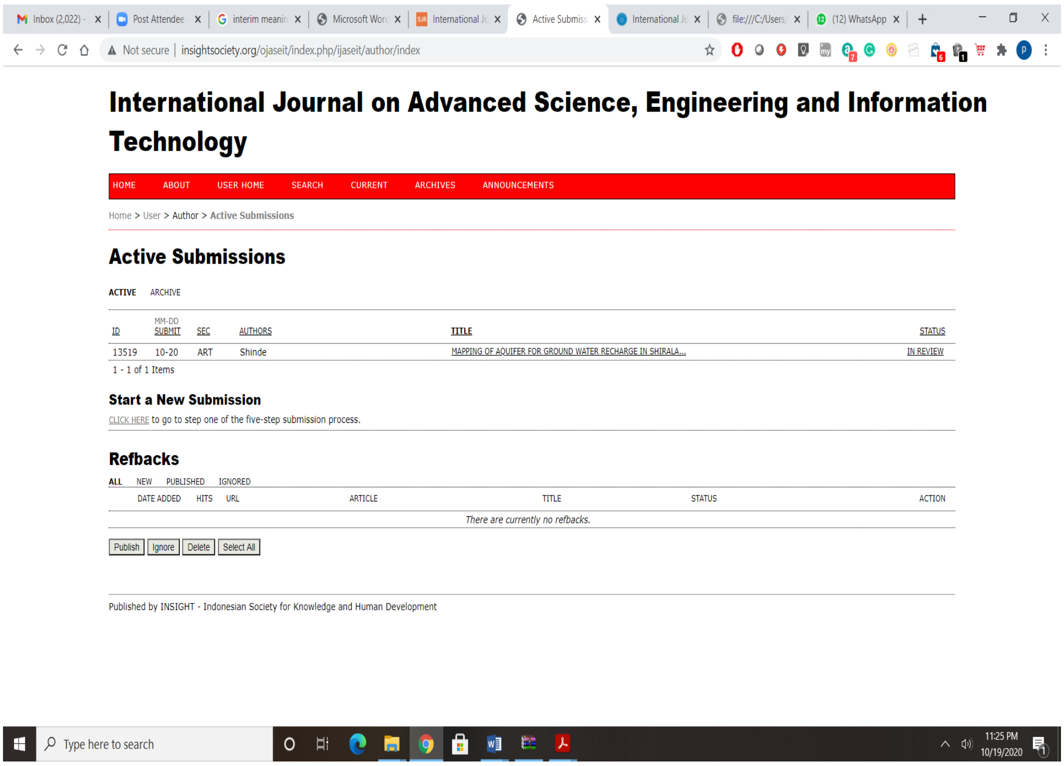
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SYNOPSIS OF M. TECH DISSERTATION

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2. Name of Student	: Dhanashree Bajirao Shinde
3. Date of Registration	: July 2019
4. Name of Guide	**: Mrs. Dr. S. S. Kulkarni**
5. Sponsors Details	: N.A
6. Proposed Title	: "Aquifer mapping to help ground water recharge in Shirala Taluka, District Sangali

7. Synopsis Dissertation work

7.1. Introduction& Relevance

Aquifer is void/hollow space available deep underground which is a main source for ground water. Water shed management has many methods which help ground water recharge of large area, depending on the topography, water harvesting structure and rainfall intensity the depth at which water will percolate and which aquifer will get recharged.

Aquifer mapping can be defined as a scientific process, wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analysis applied to characterize the quantity, quality and sustainability of ground water into aquifers. If Aquifers are mapped and recharging methods to suit the topography are used we will be sure and will be able to quantify the output of efforts taken and even can plan for water management.

This work requires use of GIS software and imagery from various sources. Once mapped this project will also try to analyze the requirement of the nearby area and develop a water management plan. The water table contour maps are prepared with the help of Surfer Software.

7.2 Present Theories and Practices

O.A Adeyeye, E.A.Ikpokonte, S.A.Arabi (2017): "GIS-based groundwater Potentialmapping within Dengi area, North Central

In this paper, Describes the need of exploration of water is unquestionable .RS digital Elevation Model of data was used for formation of thematic maps of soil, drainage density and drainage proximity. Field mapping and ground truthing was used to rise thematic maps of Geology .And groundwater potential modeling are divided in three zones low, medium and high groundwater potential zone. The map concurs with field condition. RS and GIS help to increase accuracy of results in groundwater investigation. Groundwater potential model was generated by using raster calculator feature on arc map. For groundwater recharging, type of soil plays an important role. Geology discovers aquifers in which groundwater flows. There are many methods to evaluate aquifer parameters but this paper pumping test recommended and these test perform on wells.

Kanak Moharir, Chaitanya Pande, Sanay Patil (2017): "Inverse modeling of aquifer parameters in basaltic rock with the help of pumping test method using MODFLOW software"

A precise study for understanding groundwater related issues hydrological system. Water exploration can provide useful information related to subsurface geology of area. The present study of evaluation of aquifer parameter such as transmissivity (T) and storativity (S) are for the exploration of groundwater resources. Hydrograph analysis and pumping test are methods to calculate aquifer factor. Pumping test is a modest procedure and in this test groundwater level is calculated .A case study shows, a pumping test is used for getting fast speedy and accuracy results. Groundwater levels plays important role in a aquifer factors characteristics. From aquifer pumping test, the field data was collected. MODFLOW is computer code to solve groundwater flow equation. Groundwater is second alternative source of water which is used in agriculture sector. This study can be used aquifer mapping and also for systematic planning of groundwater management because of rising demand of water for irrigation and many sectors is likely to continue.

Varalakshmi, B.VenkateswaraRao (2017): "Groundwater Flow of a Hard Rock Aquifer: Case Study"

The study area is divided into granites, basalts and laterites in a few quantities. Groundwater flows unconfined to semi confined conditions in generation of weathered and fractured. In this case using MODFLOW software, groundwater flow modelling is achieved in a steady and transient state condition with finite method. This finite-difference, block-centered, 3D modeling can simulate transient groundwater flows for different hydrological systems. In the present study, pre-monsoon and post monsoon groundwater levels and they are reduced to mean sea level and the differences between pre-monsoon and post monsoon levels are contoured by Arc GIS software. The groundwater draft has been allocated by a well package. The study area is based on groundwater to fulfill agricultural demand. In this paper draft has been measure by unit draft.

Rafael Goncalves Santos, Mara Lucia Marques: "GIS Applied to the Mapping of LU, LC and Vulnerability of the Guarani Aquifer System"

This case study is an occurring in the surface an underground for analysis of aquifer. The result shows large presence of areas with high vulnerability corresponding to 60.3% of the city. Land use land cover through DIP for aquifer vulnerability assessment, the drastic is a best reliable model which developed by USEPA 1985.

Drastic index=DrDw+RrRw+ArAw+SrSw+TrTw+IrIw+CrCw

This study adopted drastic pesticide methodology. Drastic pesticide parameter of study area is depth to water, recharge aquifer media, soil media topography. According to drastic index 26 and 226 represents low and high vulnerability index.

Declan Page, ElliseBekele (2017): "Managed Aquifer Recharge (MAR) in Sustainable Urban Water Management"

This study focuses on need to diversify future sources of supply and storage. To fulfill urban water requirement, there is a need to support sustainable urban water management. This study based on recent scientific knowledge of aquifer process in MAR. This paper shows information about types of MAR, potential water quantity. Evaporation and land saving is best benefits to store water below ground in a urban water. MAR is suitable aquifer in which water is stored from various sources including urban storm water, treated sewage, rainwater or even rural runoff. Hydrological knowledge is used to identify aquifers and suitability of

MAR. Confined aquifer systems are protected from pollution but there is necessary to require wells for access.

Da Ha, Gang Zheng(2019) "Estimation of hydraulic parameters from pumping tests in a multiaquifer system."

This paper shows accurate estimates of aquifer parameters through pumping tests are essential in geotechnical engineering practice. In this study, the applicability of different models for estimating hydraulic parameters in a multi aquifer system is analyzed.

7.2 Research Gap

India is wide variation country in hydro geological, geological, topographical condition.From (1996-2018) rainfall data, In Shirala Tal. of Sangali Dist. has maximum (1038 mm) rainfall but due to maximum bore wells and dug wells water level drops-downs in summer. Therefore there is need to prepare guideline for aquifer mapping, the aquifer units are defined by data availability and data gaps with respect to parameter

- Exploration
- Hydrogeology
- Water level monitoring
- Water quality
- Hydrology

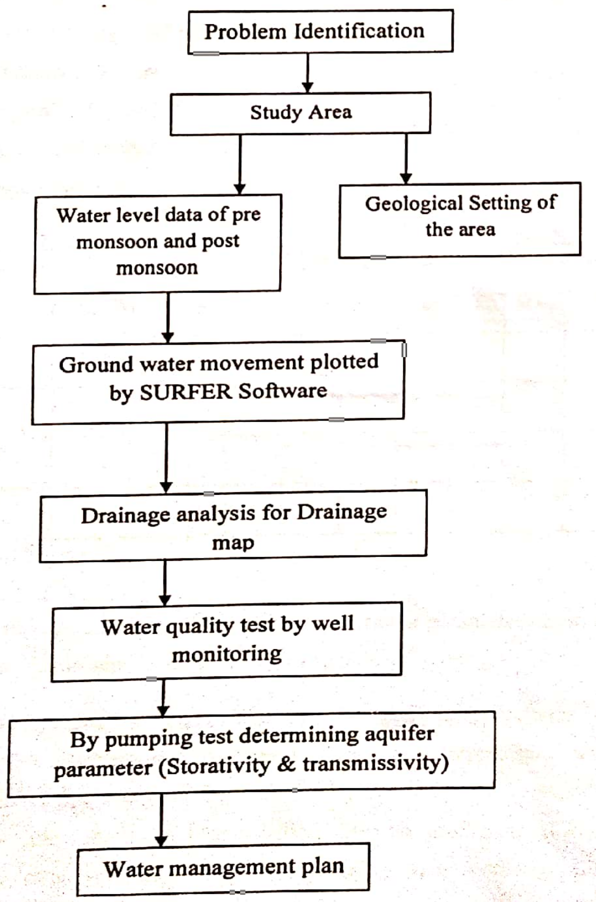
7.3 Problem Statement

For the purpose of study, five villages are selected for aquifer mapping in Shirala Taluka. The selected villages are "Ghagarewadi", "Girajavae", "Dhamavade", "Kondaivadi", "Wakurde budruk(Bk). The villages have more scope in groundwater recharge because there is more ground water extraction through dug well and bore well. Therefore there is need to recharge ground water source by systematic aquifer mapping and also develop water management plan.

7.4 Objectives

- To develop geological maps of study area using GIS
- To analyze influence of geology on the groundwater accumulation and movement in the area through software
- To map aquifer by plotting ground water movement on the study area.
- To develop water management plan for study area based on transmissivity and storativity.

7.5 Methodology to be use



7.6 Plan of Proposed Work

Phase I - (July - Aug 2019)

- Study of literature related to the aquifer mapping and ground water recharge.
- Selection of the study area.

Phase II - (Sept - Dec 2019)

- Collection of data related to the ground water levels of the selected area.
- Study the geological mapping and lava flow mapping of the area.

Phase III - (Jan – Feb 2019)

- Drainage analysis of the selected area and study the hydrology in basaltic terrain.
- Well inventory and pumping test analysis.
- Recommendations

Phase IV (March - May 2019)

- Result and conclusion
- Report writing

Activity	**Month (July 2019 to June 2020)**												
	JUL	**AUG**	**SEPT**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**
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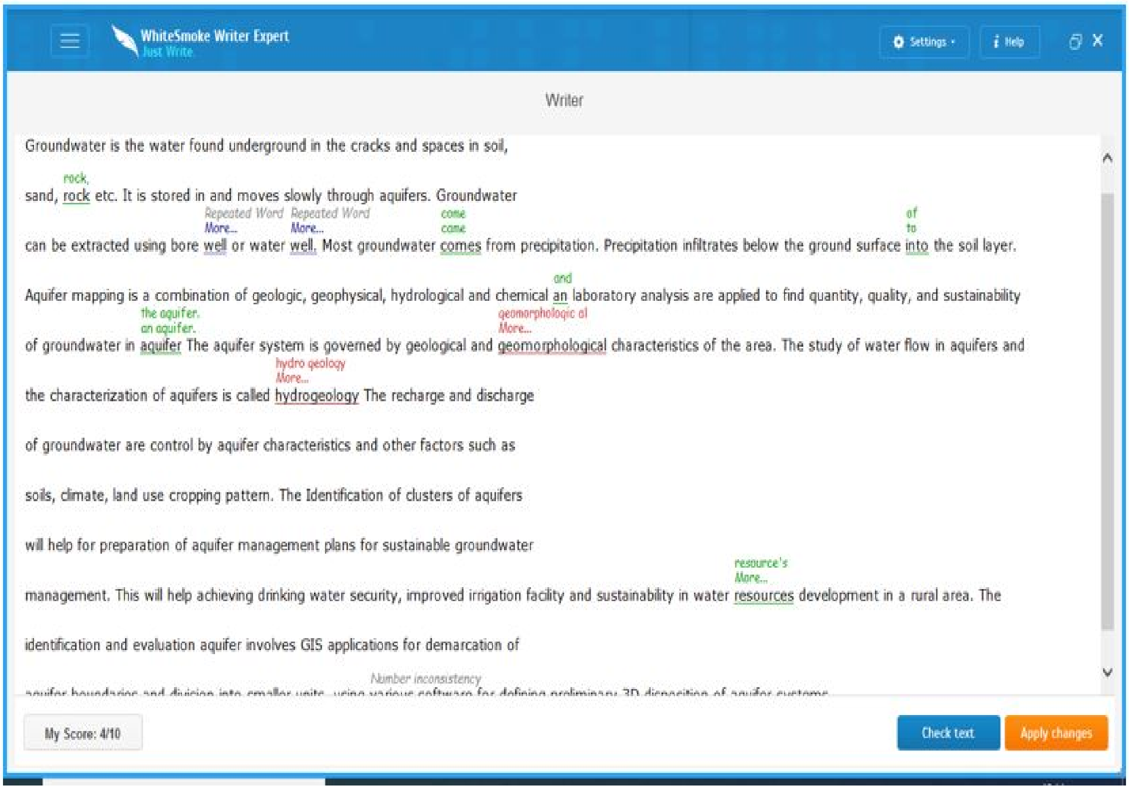
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Groundwater is the water found underground in the cracks and spaces in soil,
sand, rock etc. It is stored in and moves slowly through aquifers. Groundwater
can be extracted using bore well or water well. Most groundwater comes from precipitation. Precipitation infiltrates below the ground surface into the soil layer.
Aquifer mapping is a combination of geologic, geophysical, hydrological and chemical an laboratory analysis are applied to find quantity, quality, and sustainability
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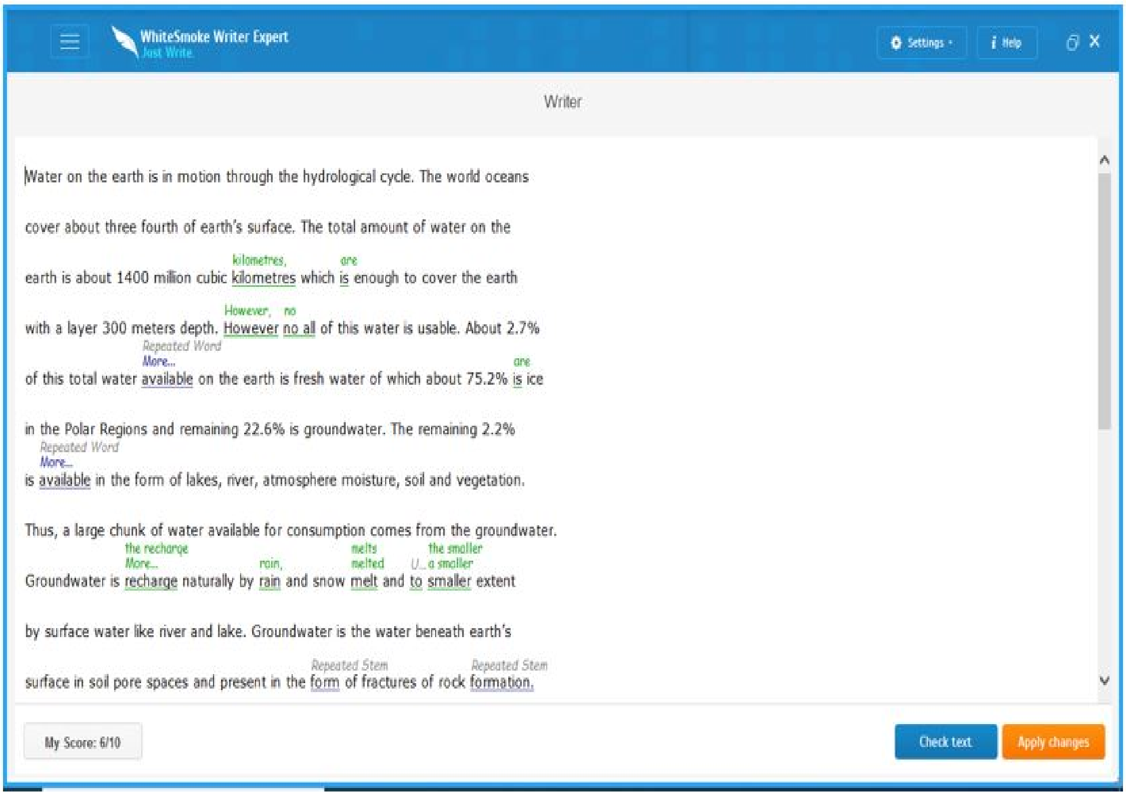
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Water on the earth is in motion through the hydrological cycle. The world oceans
cover about three fourth of earth's surface. The total amount of water on the
earth is about 1400 million cubic kilometres which is enough to cover the earth
with a layer 300 meters depth. However no all of this water is usable. About 2.7%
of this total water available on the earth is fresh water of which about 75.2% is ice
in the Polar Regions and remaining 22.6% is groundwater. The remaining 2.2%
is available in the form of lakes, river, atmosphere moisture, soil and vegetation.
Thus, a large chunk of water available for consumption comes from the groundwater.
Groundwater is recharge naturally by rain and snow melt and to smaller extent
by surface water like river and lake. Groundwater is the water beneath earth's
surface in soil pore spaces and present in the form of fractures of rock formation.
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