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Groundwater Level and Quality Data Interpretation using QGIS and DEM in Rajanukunte Gram Panchayat, Karnataka, India

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Abstract

This study on groundwater status in Rajanukunte Gram Panchayat, Bangalore geologically lies at 13°09'58.7"N and 77°33'57.8"E. GIS and Remote sensing database was used to interpret watershed boundaries and direction flow map in order to estimate the groundwater quality. Altogether the thematic layers were overlaid, oriented, interpreted and examined using QGIS software. Groundwater samples were collected and determined fourteen physicochemical parameters like pH, total dissolved solids, electric conductivity, nitrate, total alkalinity, sulphate, fluoride, magnesium, chloride, total hardness, iron, sodium, phosphate, and calcium. As a part of this study, the groundwater level in the study area was monitored on monthly basis. Non-spatial data such as groundwater Quality, groundwater Level and rainfall data was graphically represented, these data were interpreted on maps using QGIS attribute tables. QGIS software was also used to generate base map, contour, hill-shades, elevation, DEM, streams, flow direction, drainage and delineation of watershed boundaries. Further, this study contributes in creation of GIS database for integration of geospatial and socio- economic data.

Keywords: *GIS, Remote Sensing, Groundwater Quality, DEM Generation, Watershed Boundaries*

1.0 Introduction

Groundwater is all the water that occurs in the drenched zone under the earth's surface. Sub surface water is a vital source of freshwater for mankind. Groundwater management is one of the most pressing issues of our time. Groundwater is subsidising around 34% of the annual water stock and is a vital and dynamic natural fresh water resource backup bio-physical, ecological and human wellbeing environment[1,2]. Groundwater is mostly utilized for the farming exercises in this review region. India will become a water- stress zone by 2025 and then India will become a water scarce region by 2050 unless rigorous steps are taken[3,4]. The amount of groundwater in a space principally relies upon topography, geomorphology, structures, vegetation and soil characteristics.

Remote sensing plays a crucial role in obtaining surface feature information for various applications, including groundwater studies. It provides valuable data on land uses, land forms, and drainage density, which are essential inputs for groundwater zone identification using GIS[5,6]. In the current circumstance with expanding populace groundwater is exceptionally critical. Overall, remote sensing is a valuable complement to conventional methods in groundwater exploration and management, offering efficiency, cost-effectiveness, and the ability to monitor changes over time. Integrating remote sensing with ground-based data collection techniques

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can lead to a more comprehensive understanding of groundwater resources in an area[7,8]. Remote sensing and GIS possess new possibilities for hydrogeological studies[9-10].

Indeed, remote sensing and Geographic Information System (GIS) have become powerful tools in recent years for assessing and managing groundwater resources. Their integration allows for the synthesis and analysis of diverse hydro-geological data, which helps in accurately delineating potential groundwater occurrence zones[11,12]. In this study groundwater level, rainfall data, ground water quality of the study area were assessed and delineate the watershed boundary using Remote sensing data and GIS[13].

2.0 Study Area and Description

The study area, Rajanukunte located in the southern suburban region of Bangalore city of Karnataka State in India. This area geologically lies between 13°09'58.7"N and 77°33'57.8"E. The temperature of the study area ranges between 22°C to 32°C with relative humidity 45%-79% and an average annual rainfall of 751mm. The elevation is 3000ft above mean sea level and clayey type of soil is mostly found here. The study area spreads across 333 hectares.

This region has developed with high density population. The drinking water is a primary concern in the study area is supplied on alternate days or once in 3 days and even the quantity of water supplied is meagre and is insufficient for daily domestic uses. The majority of people in this area depend on ground water for drinking and other domestic requirement.

3.0 Methodology

The various types of spatial data and non-spatial data are collected for monitoring the ground water level. Watershed delineation is the initial phase in this study, using GIS and Digital Elevation Models (DEM). The non-spatial data such as groundwater level data and Rain fall data were collected from Central Ground Water Board (CGWB) and Karnataka State Natural Disaster Monitoring Centre (KSNDMC) respectively. Through these data, digital GIS database was created. Flow direction map derived from DEM was correlated to the ground water level data to

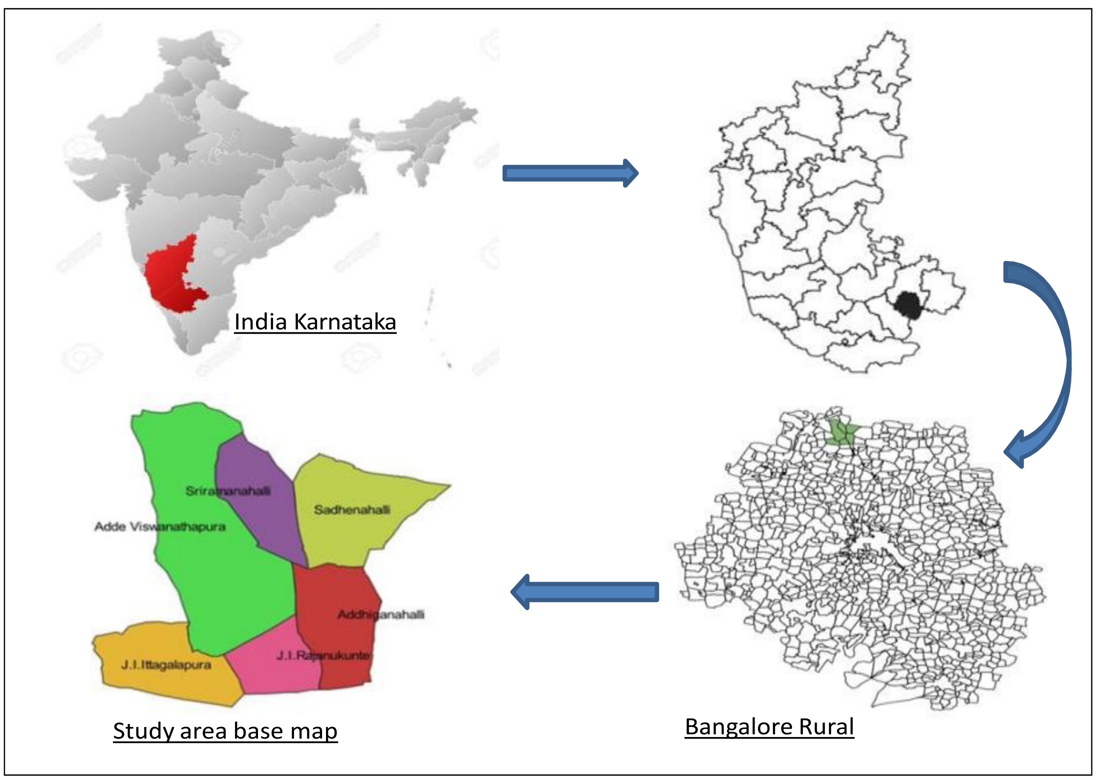


Figure 1. Study area map.

Table 1. Sampling locations with geo-coordinate, application and area under irrigation

Sl. No.	Type of Well	Depth (ft)	Elevation (m)	Location	Co-ordinates	Application	Area under Irrigation in Acres
1	Bore well	1200	809	Adde Vishwanathapura	13°10’29.8”N77°33’15.1”E	Agriculture and domestic purposes	5
2	Bore well	1150	790	Adde Vishwanathapura	13°10’54.9”N77°33’14.4”E		2
3	Bore well	950	740	Rajanukunte	13°10’19.4”N77°33’42.8”E	Water supply and domestic purposes	3
4	Bore well	850	829	Rajanukunte	13°09’58.7”N77°33’57.8”E	Agriculture	2
5	Bore well	700	820	Adiganahalli	13°09’58.7”N77°33’57.8”E		3
6	Bore well	1200	825	Adiganahalli	13°09’58.7”N77°33’57.8”E	Agriculture and domestic purposes	2
7	Bore well	1200	826	Sadenhalli	13°11’23.2”N77°34’15.9”E		2
8	Bore well	950	807	Sadenhalli	13°11’50.3”N77°34’12.5”E	Agriculture and brick manufacturing	3
9	Bore well	1200	830	Sriramanhalli	13°11’44.4”N77°33’39.6”E	Nursery plantation	4
10	Bore well	350	821	Sriramanhalli	13°11’31.0”N77°33’23.1”E	Agriculture	2
11	Open Well	1200	851	Itagalpura	13°10’08.4”N77°32’38.3”E		7

observe the spatial trend changes of the groundwater level and water quality information in the proposed regions.

3.1 Sample Collection and Monitoring

Ten numbers of bore well and one open well sampling stations were selected and located geologically using GPS. The relevant information on study area is gathered by communicating with the localities and agrarians. Groundwater level indicators work by using sensor probes to indicate water levels in a well. These probes send information back to the control panel to trigger an alarm or beep. Here water acts as a conductor, when the probe come in contact with water it completes the circuit and beep sound is observed. Rainfall data collection of the study area: Precipitation information of the review region was gathered from Karnataka State Natural Disaster Monitoring center, Attur Yelahanka. The data we gathered was from year 2015 to 2022 March. The information was then changed over into a structured presentation which was subsequently used to assess the precipitation in the review region

3.2 Groundwater Level Monitoring

The Groundwater level indicator instrument works by using sensor probes to indicate water levels in a well. These probes send information back to the control panel to trigger an alarm or beep. Here water acts as a conductor, when the probe come in contact with water it completes the circuit and beep sound is observed.

3.3 Graphical Applications

The MS excel and QGIS were used to plot water level and quality of different stations and base map and Digital Elevation Model (DEM) generation for the study area respectively.

3.4 DEM Generation

A DEM picture and a study area map are required to create a 3D model (Rolland Burgmann, 2017).

3.5 Graphical Application

Microsoft excel was used to analyse the rainfall data that was collected at KSNDMC, the daily rainfall was converted into monthly rainfall and then was made into a bar graph for easier understanding of the data. The groundwater level data and quality data were converted into graphs using Microsoft excel for better judgement. Google earth images were used for creating the base map.

4.0 Result and Discussion

4.1 Groundwater Level Monitoring

Groundwater level monitoring in the study area was done by using groundwater level indicator and results were compared and converted into a line graph (Figure 3).

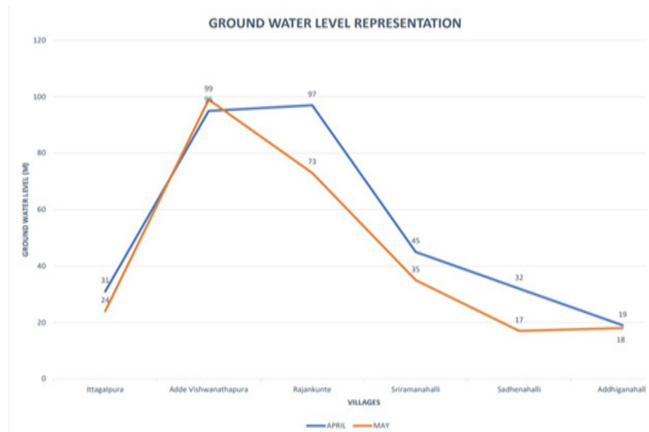


Figure 3. Line diagram on ground level.

4.2 Rainfall Data Collection

The rainfall we received from the KSNDMC was analyzed and was then changed over into a structured graph. The most noteworthy precipitation was in the year 2021 and the least in the year 2016 (Figure 4).

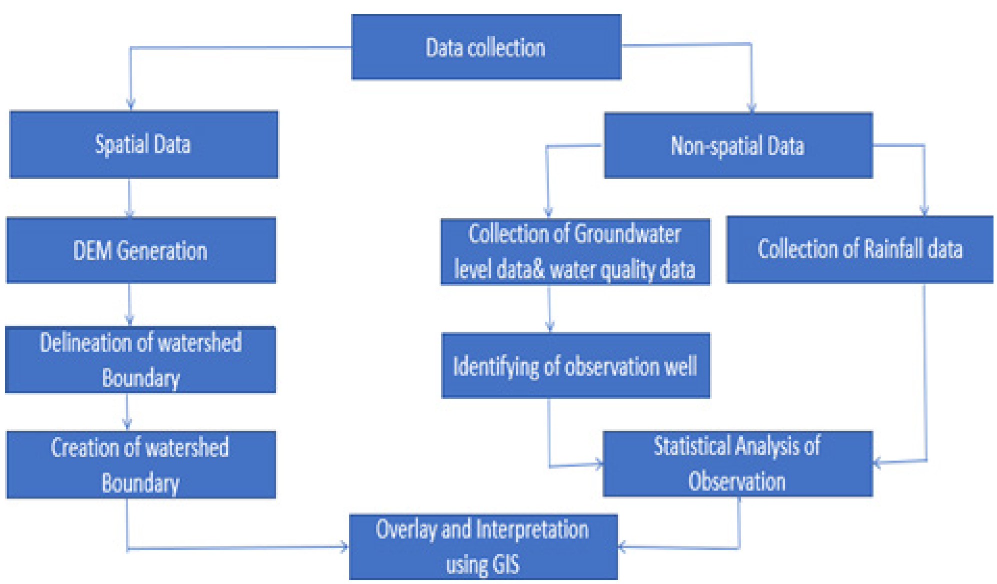


Figure 2. Flowchart of methodology.

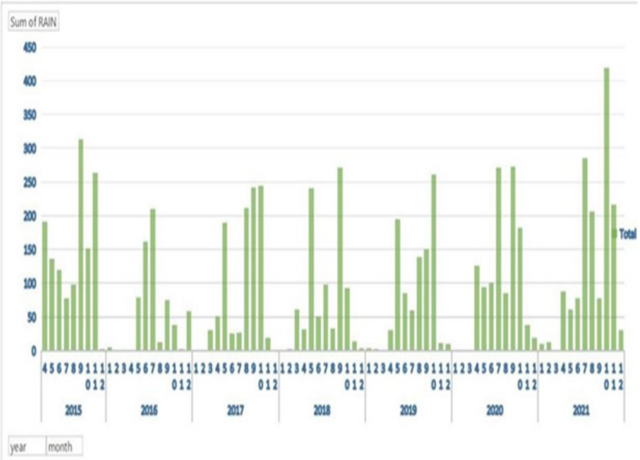


Figure 4. Rainfall data graphical representation.

4.3 Quality Analysis

All the collected samples were analysed for physico chemical parameters and compare with BIS standard limits (Table 2).

4.4 Base Map Generation

To audit the review region a base guide should be created for which QGIS programming is required. For this module speedy guide administrations should be introduced. The review region can be trimmed utilizing brief layer scratch choice. After the guide is separated the examining area sampling location details, the co-ordinates everything is added utilizing a legend and when tapped the whole data

Table 2. Groundwater quality results with standard limits

Quality Parameters	1	2	3	4	5	6	7	8	9	10	11	12	BIS Limits
pH. (Units)	6.9	6.6	7.2	6.3	6.5	7.2	6.55	6.55	6.6	6.8	7	6.7	6.5 – 8.5
Electric conductivity (Micromhos/cm)	110	980	151	980	900	102	111	111	106	280	142	119	2100
Total Hardness as $CaCO_3$, (mg/L)	361	310	495	279	239	306	334	334	306	902	494	353	600
Magnesium as Mg, (mg/L)	86	785		785	6	79	81.7	81.7	82	235			100
Total dissolved solids, (mg/L)	35	276	43	200	152	27	31.4	31.4	25	7.6	43	25	500
Chloride as Cl, (mg/L)	720	630	980	630	580	648	700	700	680	160	906	760	1000
Sulphate as SO_4, (mg/L)	78	734		783		83			69	146	83	64	200
Nitrate as NO_3, (mg/L)	34	296	40	383	212	27	35.2	35.2	26	5.8	20	33	45
Iron as Fe, (mg/L)	3.8	3.9	5	5.6	3.6	4.5	5	5	6	2.5	5.6	6.2	1.0
Fluoride as F, (mg/L)	0.2	0.16	0.2	0.2	0.18	0.2	0.21	0.21	0.2	0.12	0.2	0.2	1.5
Phosphate as PO_4, (mg/L)	0.4	0.4	0.4	0.5	0.4	0.4	0.43	0.43	0.4	0.2	0.4	0.4	1
Sodium as Na (mg/L)	305	269	360	234	226	261	206	206	364	123	305	329	100
Potassium as K (mg/L)	20	180	32	190	150	19	20	20	18	5	33	24	10

about the area can be gotten. Each village is shown in a different colour.

4.5 Base Map Preparation

The base map prepared using google earth and QGIS is shown in Figure 5. Here each village is shown as polygon feature. Bore wells locations is shown as point feature followed by legend that is specific names of the villages (Figure 5).

4.6 Overlay and Orientation of Base Map

Overlaying map is a map showing a number of geographic features as layers on a base map and maps are usually

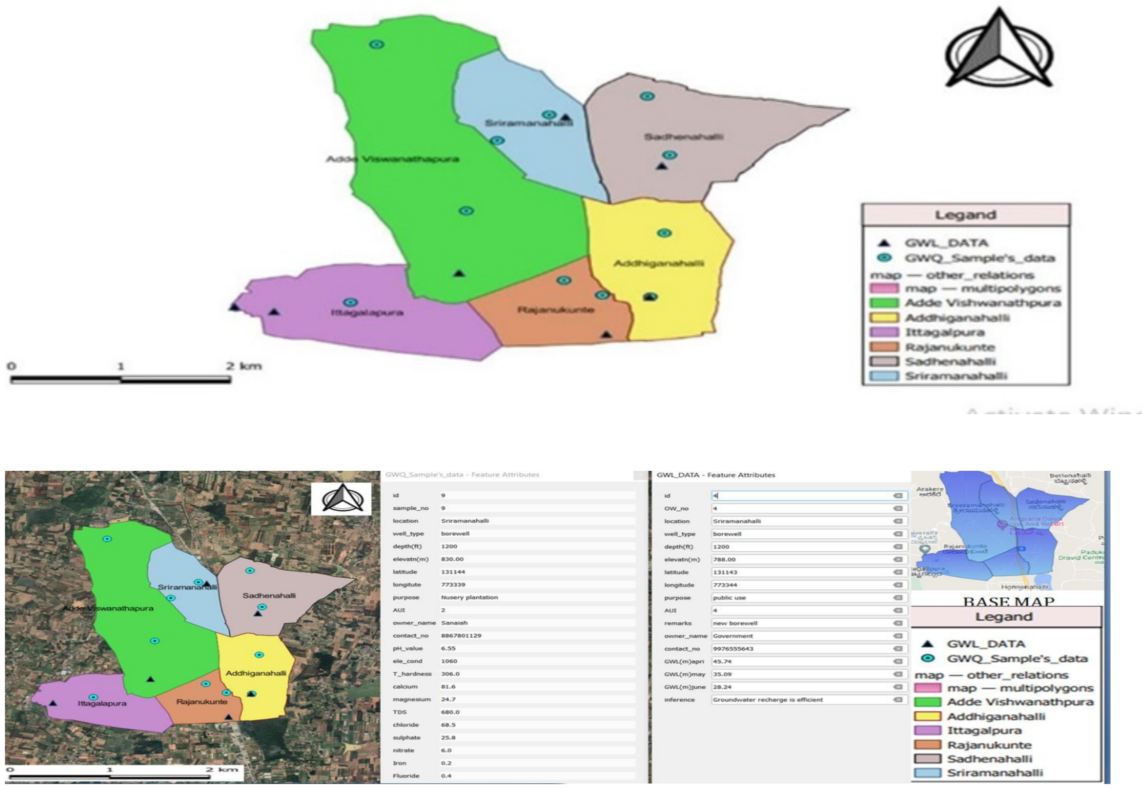


Figure 5. Base map preparation.

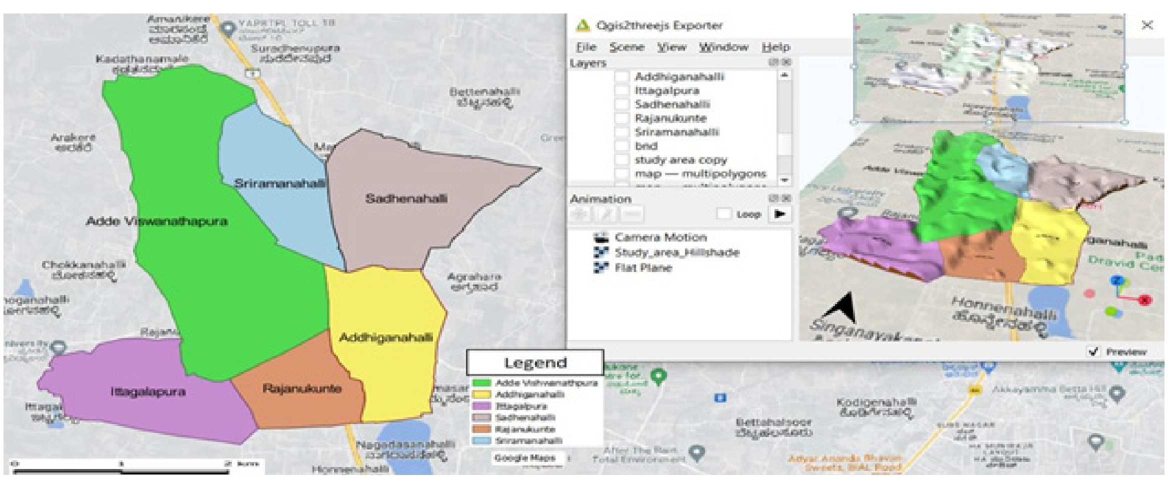


Figure 6. Overlay and orientation of base map.

created from the perspective of a particular direction (Figure 6). The directionality of a map is known as its orientation.

4.7 Interpretation Groundwater Level and Quality

The location of the bore wells by which water samples were collected for groundwater quality test are shown as nodes and location of the bore well by which groundwater monitoring was done is shown as triangles. These nodes and triangles are point features which contains attribute table. Interpretation of data was done using these attribute tables (Figure 6).

4.8 DEM Generation

DEM picture and a study area map are required to create a 3D model. Clip the study area by giving specific value 0 and by clip raster by mask layer and input layer.

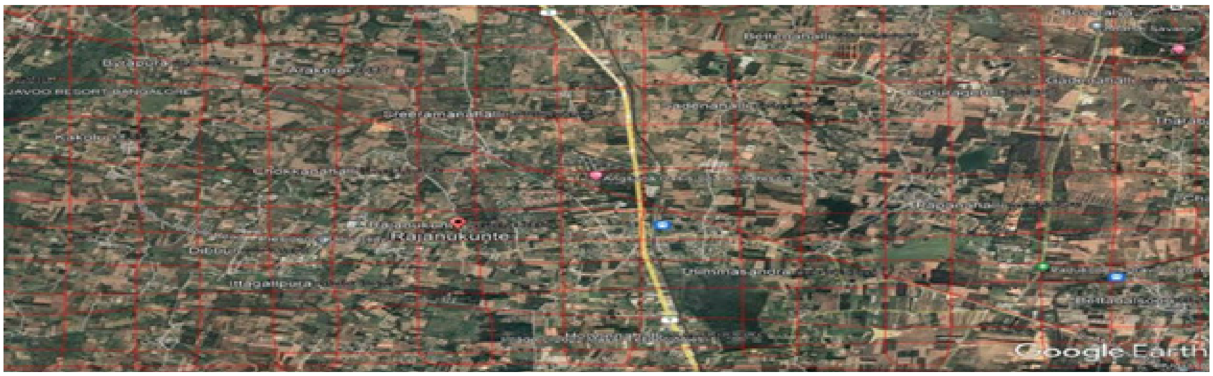
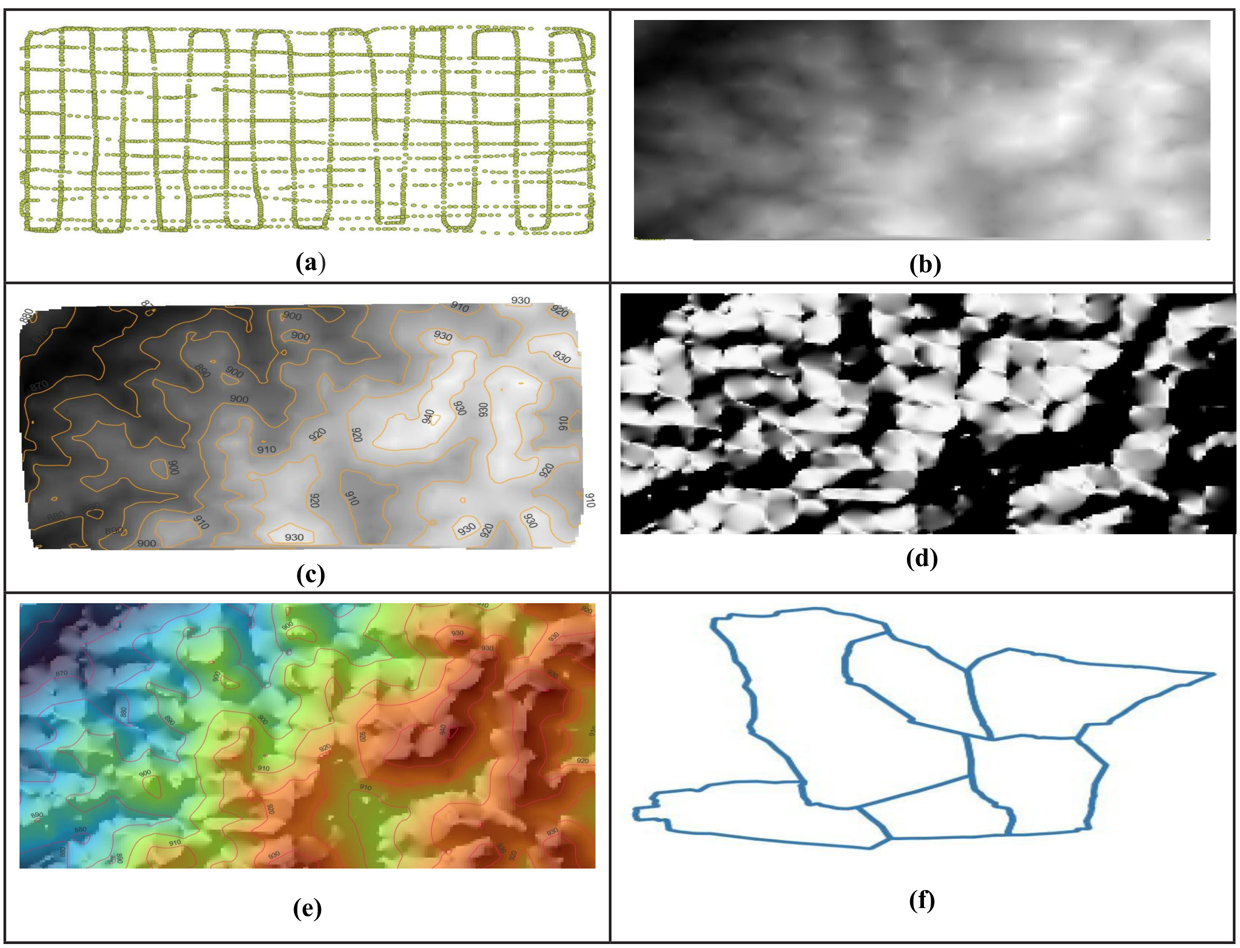


Figure 7. Creation of path in Google Earth pro.



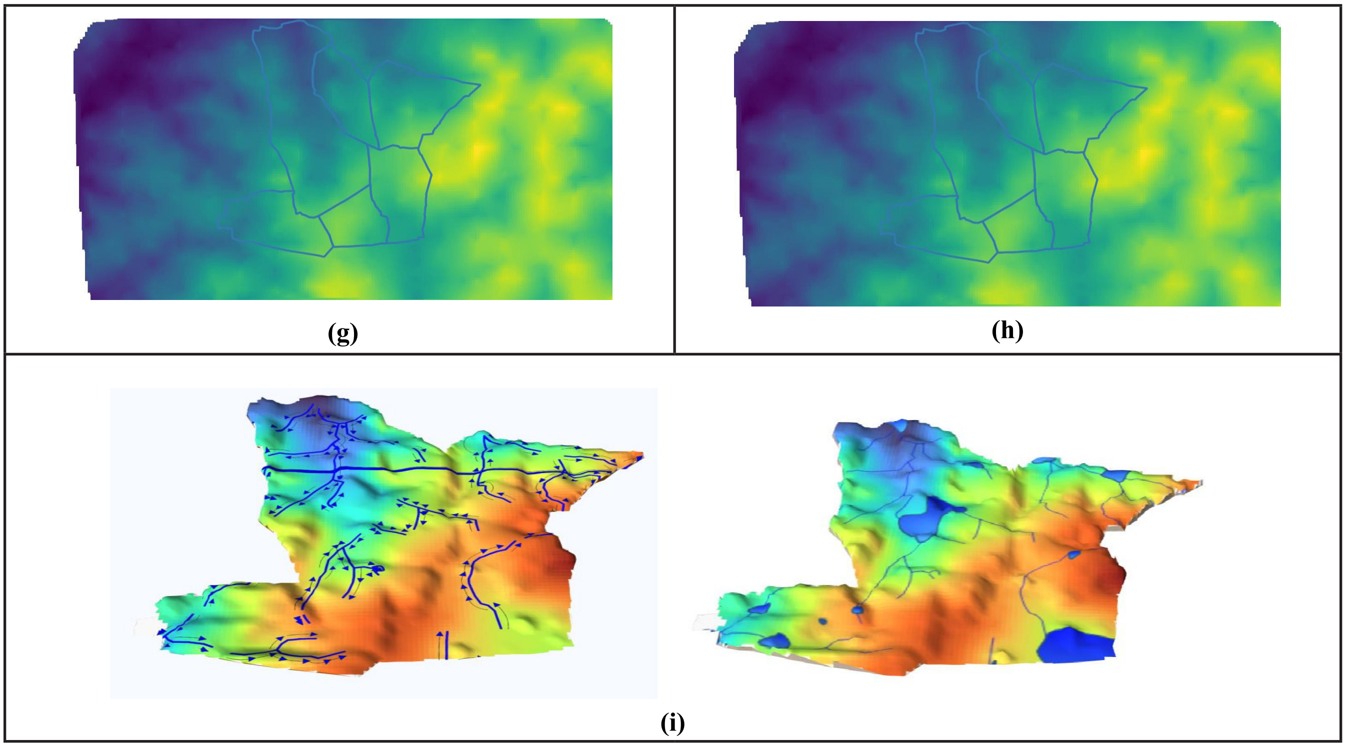


Figure 8. (a): Target grid, (b): DEM dipped target grid. (c): DEM dipped contour. (d): Hill shades. (e): Hill shades elevation. (f): Study area. (g): Study area DEM. (h): Study area DEM extraction. (i): Flow direction and drainage.

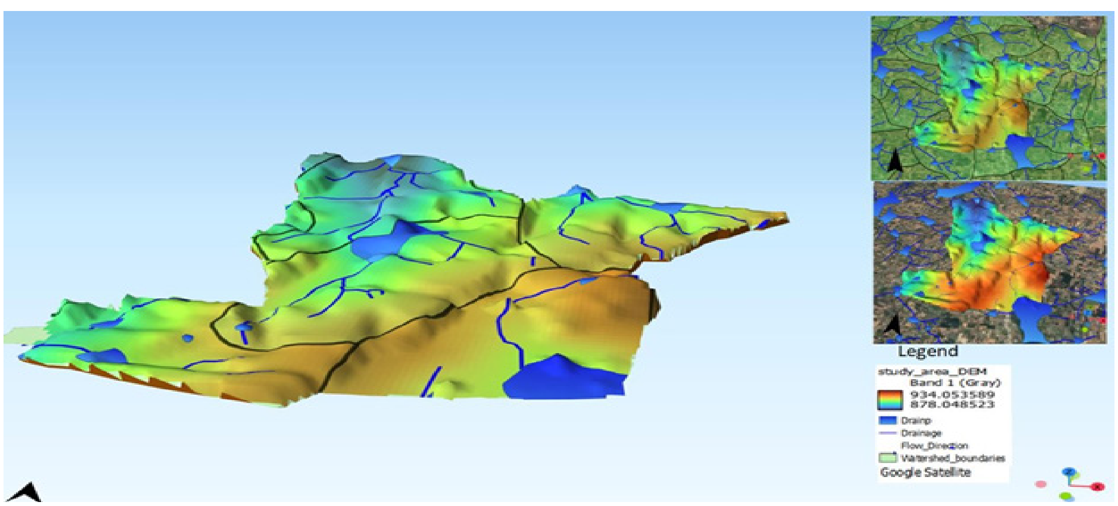


Figure 9. Orientation and delineation watershed boundary.

Manage and install plugins. Set the texture width, scene setting and vertical exaggeration, assign color gradients and then view as 3d map. DEM is a 3d model of the study area. The base map generated is then converted into a digital elevation model as below (Figures 7-10). Creation of the GIS database of Groundwater quality and Groundwater level of Rajanukunte region which will help for the development and utilization purpose. Integration of Geospatial and Socio-economic data for integrated Groundwater management was the major outcome in

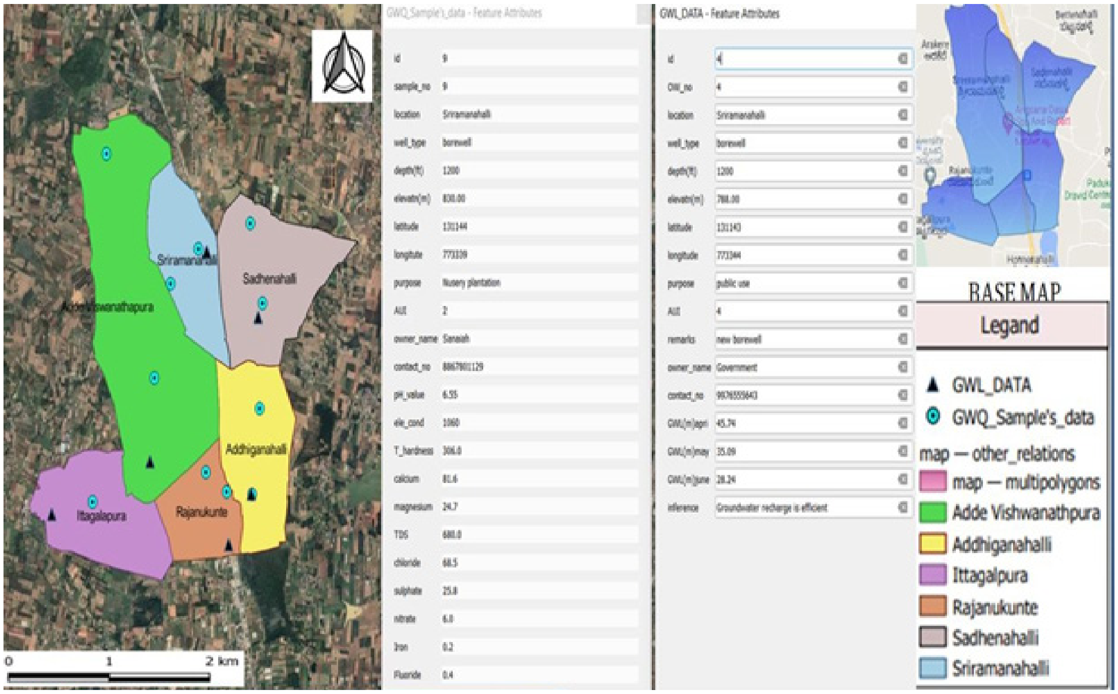


Figure 10. Interpretation groundwater level and quality.

the study. Developed Strategies as DEM generation could help groundwater management through Communication and Collaboration, to empower socio- economic status of Rajanukunte Gram Panchayat.

5.0 Conclusion

This study concludes that groundwater quality in the study area is still intact but deteriorating at considerable rate. The rainfall in this review region is moderate and groundwater is a crucial source for agriculture and domestic purposes. Hence more prominence must be given to avoid further worsening of groundwater quality through recharging and restoration measures. Technologically advanced approaches as DEM generation in this research could really benefit groundwater management through communication and association to authorize socio- economic eminence of the study area.

6.0 Acknowledgement

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