GIS-based study of groundwater monitoring of villages, Karhe Region, Maharashtra, India

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Abstracts: This paper examines that, in the current pilot study 10 groundwater samples from 2017 to 2019 from dug wells were collected by making waypoint location of each sample by using GPS-essential receiver. The hydrological data are collected for two seasons such as dry season and wet season this study called the Double Water Table Fluctuation method. The WTF method in the dry season gives the specific yield and wet season gives the rainfall recharge. In the study area, the water table level is near about below 8m from the ground surface. The Pre-monsoon water-table level is monitored during the month March and Post-monsoon level is monitored during the month of July, etc. Groundwater presence dependence upon characteristics of terrain along with structural Geology, Geomorphology and LU/LC of the area. This study is useful for water management to local authority and farmers for irrigation purpose. The Groundwater recharge in the study area is decreased due to declines in rainfall and return flow to Groundwater from Irrigation and less pressure of surface water body. The groundwater recharge is more during the dry seasons because of more backflow from Irrigation during the Pre-monsoon seasons. The Thematic map of the study area is prepared by using Arc GIS 10.4 software.

1. Introduction
Groundwater is widely distributed elements like other minerals resources. Every year due to rainfall there is a recovery of groundwater. Groundwater behaviors are depending on the Land use/Land cover, Geology, Structural Geology, Rainfall and Geomorphology of the area. The occurrence of Groundwater in joint, fracture and also in different structural Geology parts. Remote sensing Imagery data gives us spatial information and this information is effective for groundwater study. The requirement of ground water not only to household, Irrigation but also to protect the ecosystem of Environment. In the year 1992, Rio de Janeiro earth summit address the issue related to increasing usage of water and limited resource present of water. The recharge of aquifers, aquiclude, aquitard, aquifuge, and artificial well are depending on rainfall. India is the world largest user of groundwater. In the Village area, the main source of ground water is artificial well, bore well and hand pipe through the supply of water to Irrigation as well as Drinking. Nowadays Geographic information system is the effective tool for groundwater resource management and it helps for the preparation of Geo-database such as Land use/Land cover of the area, slope map, contour map, and soil map. In aquifer, groundwater plays the role of recharge. The dependency on Groundwater is more and its result day by day there is depletion of Groundwater resource, now it’s needed to develop sustainable groundwater resource management. Globally groundwater plays an important role in the rising need for urbanization, Industry, and agriculture more requirement of water. In Maharashtra, about 90% of the total geological area covered under Deccan basalt rock. In hard rock occurrence of groundwater is less and at higher depth, there is less presence of water. The Groundwater availability depends upon rainfall occurrence to that area, the rainfall occurs more, the maximum availability of surface water and the declines of groundwater in the study area need to understand the groundwater dynamics. The first study objective is to select the different well in the study area the collect water table depth in well and to analyse different groundwater of quality parameter.

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The second objective is the application of Geographic information system and Remote Sensing to draw the different thematic map such as well location map, land use/land cover map, soil map, contour map, slope map, and geological map. In Maharashtra groundwater mostly occur in the basalt rock. Total geographical area covered under the basalt rock is 65% to the. The thematic maps are prepared using GIS such as Geomorphology, Drainage, Geology, Soil map, Land use/Land cover, water level, Well recuperation map [1]. To get a soil index property map of soil GIS and GPS techniques were used [2]. The decreasing rainfall day by day and increasing need for groundwater drinking; Irrigation is continuously increasing its need to develop sustainable groundwater resource and management [3]. Water resource management requires information about surface water and groundwater to take a decision about sustainable resource development. The groundwater level is not regularly updated like rainfall data [4]. Today, in the world more than 2 billion people suffering from water crises [5] and [6]. Geographic Information System and remote sensing were used to find out the groundwater potential zone [7]. In the world, 2 billion people are using groundwater as a source of drinking water and it is the largest freshwater [8] and [9]. The different factors responsible for groundwater contamination are swift urbanization, Intensive use of fertilizer, human activity and Industrial area [10]. Geographic Information system along with hydrologic model used to practice groundwater recharge estimation [11]. The thematic maps are prepared using the Geographic Information System, it used to locate suitable sites for artificial groundwater recharge [12]. Using this spatial technique, the different thematic maps are prepared such as slope, Land use, Infiltration [13]. To locate artificial groundwater recharge site, Geographic Information system and Analytical hierarchy process were used. The hydrologic model used to develop how to crop type and drought-impacted on groundwater depletion, more water-intensive crop by decrease the groundwater storage and water-saving crop resource the groundwater storage [14]. A geographic Information system is used in conjunction with a finite-difference method to develop a numerical model to study the groundwater flow in well it gives stream-aquifer information to the water budget [15]. Water table and boundary elevation were used to formulate triangulated irregular network. The 22 wells location selected for groundwater monitoring [16]. The current use of groundwater for agriculture purpose is unsustainable. The groundwater sustainable management and Irrigated agriculture are interrelated [17]. To analyse groundwater quality applying physic-chemical examination and techniques used were GIS and Multi-tracer [18]. The water table is decline day by day by reason of rainfall and maximum use of groundwater for the different purpose its result quality of groundwater gets decrease to analyse this Geographical information system, Remote sensing and Global positioning system here used, using this initiating new structure for soil and water conservation.

2. Study Area
Karhe Village belongs to Sangamner Taluka of Ahmednagar district of Maharashtra state in India. The study area is selected because of irregular rainfall, Drought, more scarcity of water and continuous degradation of the water table. Considering the current need for water and soil conservation different hydrological structure are constructed such as contour bund, Gabion Bandara, Vanrai Bandara, contour trenches, Compartment Bunding, Farm pond, Small Earthen bund, etc. It is enclosed hillock from west and south directions. The geographical area of the village 1527 ha. The total population of the village of 1560. There have three numbers of minor Irrigation project work are done and an average annual rainfall of village 360.3 mm. The source of drinking water is tanker water fed. The groundwater table in the month of May 15 m. The village area is a highly drought-prone area.
3. Materials and Methods

3.1 Well Location
The wells are located in the Karhe village of Sangamner. In the study area total ten wells have been identified for monitoring groundwater. The data was collected in the pre-monsoon season for the year 2017 to 2019. The latitude and the longitude of the well were taken in the android app called GPS Essential. The well location map is shown in Figure 2.

3.2 Geology of Study Area
The stratigraphic status of the area is the Deccan Trap. Geologically maximum part of area consists of basalt rock, it composes to hard rock formation the characteristic of basalt rocks is jointed, contact zone, weathered, and fractured [19]. According to the Geological Time scale age of the area is upper
cretaceous to Palaeogene. The soil cover of the area is black cotton and toward hill Gravelly loam. The black cotton soil is good for agriculture [7]. The different property of soil such as Moisture content, specific gravity, ground water level, the liquid limit is useful for soil Investigation [2]. The soil map and Geology map are shown in Figure 3 and Figure 4.

![Figure 3. Soil map.](image)

![Figure 4. Geology map.](image)

### 3.3 Land use/Land cover
Remote Sensing Imagery data of the study area were collected from USGS earth explorer, it used for the source of primary data. The Secondary data are using Arc-GIS-10.4 software, the projection system used to WGS 1984 UTM 43N. The total geographical area of Karhe Village 1527 hectares. Study area shape file from collected to Bhuvan India. The visual Identification purpose actual field visit and Google earth reference are taken, the training sample of respective classes were taken then maximum likelihood supervised image classification are done by ArcGIS 10.4 software.
Figure 5. Land use/land cover map.

3.4 Slope Map and Contour Map

The map showing different classes of slope and contour elevation was developed from the Digital Elevation Model; the prerequisite data of DEM is collected from portal Bhuvan India. The Contour Interval is the elevation difference between two adjoining Contour line. The degree of slope indicates that the steepness of Terrain, the flat slope lies between 0 to 5%, the shallow slope is between 8 to 15%, moderate slope lies between 15 to 25% and the steep slope is greater than 45%. This slope layer is helpful for to visualize the nature of ground it helpful to indicate the flow of groundwater. The contour map gives the idea of Terrain Nature. The slope map and contour map are useful to construct different soil and water conservation structure such as compound contour trenches, earthen Nala bund, percolation pond, compartment bunding, etc. Figure 6 and 7 shows the slope map and contour map.
4. Result and Discussion
The tables 1. mention shows the linear data which includes well number, depth of well, the water level in the well, latitude, and longitude of the well. The latitude and the longitude of the well were taken in the android app called GPS Essential. The mean annual rainfall occurs during the period of 2017 to 2019 is 360.3 mm. The water level in a well was taken during the month of March. In the year 2017, 2018 and 2019 the mean groundwater table are 5.54 m, 4.58 m and 3.375 m respectively. The local rainfall plays an important role to recharge the groundwater table. According to the value of the water table, it reduces from 2017 to 2019; it shows the decline in the water table. In dry season i.e. month of April, May the requirement of water be more, its result on pumping of well water. During the period of the dry season, the groundwater table is reduced, thus the seasonal variability also effects on water table depth. In the month of March, April and May more scarcity of water during these 3 months i.e. 90 days period and the atmospheric temperature do increase up to 42°C its result on evaporation of water. The study area consists of basalt rock, it permits less flow of water and the presence of water in basalt rock is also less. In basalt rock water present mostly in joints, Fracture, unconformity, etc. The study area consists of black cotton clayey soil, it’s good for Agriculture but it has swell and shrinkage property. Slope map indicates the direction of flow of groundwater based on the steepness of the terrain.
Table 1. Well water table depth data from subsurface level

| Well No. | Latitude       | Longitude       | Depth of well (m) | Depth of Water in meter (2019) | Depth of Water in meter (2018) | Depth of Water in meter (2017) |
|----------|----------------|-----------------|------------------|------------------------------|-----------------------------|------------------------------|
| W1       | N19’ 41.082”   | E74’ 10.247”    | 13.6             | 0.8                          | 1                           | 3                           |
| W2       | N19’ 41.306”   | E74’ 10.335”    | 14.6             | 0.62                         | 1.5                         | 2.5                          |
| W3       | N19’ 41.306”   | E74’ 10.335”    | 23               | 1.5                          | 2.5                         | 3                            |
| W4       | N19’ 41.170”   | E74’ 10.027”    | 14               | 11.23                        | 12                          | 12.9                         |
| W5       | N19’ 42.427”   | E74’ 10.731”    | 15.2             | 4.2                          | 6                           | 7.25                         |
| W6       | N19’ 40.488”   | E74’ 9.867”     | 16.7             | 8.2                          | 12                          | 13.25                        |
| W7       | N19’40.396”    | E74’ 9.873”     | 11.7             | 2                            | 3                           | 3.5                          |
| W8       | N19’ 40.664”   | E74’ 10.184”    | 17.8             | 4                            | 6                           | 7.5                          |
| W9       | N19’40.664”    | E74’10.184”     | 13               | 0.5                          | 1                           | 1.5                          |
| W10      | N19’ 40.639”   | E74’ 10.250”    | 8                | 0.7                          | 0.8                         | 1                            |

Table 2. General parameter of groundwater quality sample

| Well No. | pH   | TDS (ppm) | Hardness (ppm) | Calcium (ppm) | Magnesium (ppm) |
|----------|------|-----------|----------------|---------------|-----------------|
| W1       | 7.99 | 302       | 84             | 19.2          | 15.55           |
| W2       | 8.1  | 322       | 82             | 17.2          | 14.55           |
| W3       | 8.3  | 440       | 88             | 18.4          | 16.70           |
| W4       | 8.2  | 280       | 80             | 22.4          | 13.82           |
| W5       | 7.84 | 1153      | 320            | 104           | 47.52           |
| W6       | 8.1  | 275       | 78             | 16.8          | 14.66           |
| W7       | 8.22 | 285       | 82             | 19.2          | 15.07           |
| W8       | 8.11 | 792       | 180            | 64            | 27.84           |
| W9       | 8.49 | 574       | 110            | 34.4          | 18.14           |
| W10      | 8.23 | 555       | 90             | 33.3          | 17.4            |

To examine groundwater of quality ten groundwater samples are collected from the study of the area well and the analysis of general parameters such as the pH TDS, Hardness, Calcium, and magnesium was done in the laboratory. Some samples of the range above the BIS standards. The quality of groundwater is degrading by the reasons of cropping pattern, over the use of fertilizer, animal excreta. The minerals are penetrating day by day by reason of Slope nature of Topography of the area.

5. Conclusion

Groundwater is the important natural source of drinking water in the village area as well as in the urban area. The study area preferred for study because of the decline of water table depth from 2017 to 2019. In the study area groundwater resource are under extensive stress because the current necessary of the area is optimum use of available groundwater; avoid deforestation in the area, soil and water conservation, and sustainable groundwater resource management. The measure for water conservation by constructing different groundwater recharge structure need to planned depending upon Land use/Land cover, soil map, Geology map, contour map, slope map, and other confined factors. The Remote sensing Imagery, Geographic Information system, and Global positioning system are the effective techniques for groundwater study. The slope and contour map analysis found that area consist of hill and Geology map examine that the area composed of basalt rock and is highly impermeable in nature. The higher concentration of pH, Hardness, TDS, Ca, Mg is constituted in groundwater which caused the contamination of groundwater. The possible cause of groundwater pollution is the use of fertilizer, animal excreta, and the presence of minerals in the water, the slope of the area and topography of the area. The groundwater is not safe for drinking purpose hence safeguard action is required to avoid contamination of groundwater.
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