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Water Table Characteristics and Mapping of Gulbarga Taluk, Gulbarga District, Karnataka using Arc scene software

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Abstract

Gulbarga Taluk is located in semi-arid region of Karnataka. It receives less rainfall in every year. Crop yield is also very less due to excess of heat and low rainfall. In this regard, water table analysis is very important in study the crop relations and elevation strategy. Basically water table data is collected from central ground water board, Bangalore. The data is processed using ArcGIS and Arc scene software. Rainfall data is collected from Indian meteorological department. Cartosat DEM data is downloaded from Bhuvan website and processed using ArcGIS hydrological tools. Cartosat-DEM data, Rainfall data, water table data and drainage networks were overlaid on the Arc scene viewer and correlated with the characteristics. Water level in an area varies from 13 meters below ground level to 125 meters below ground level. Lithology comprises of Basalt, Limestone, Pink granite, Shale. The fracture zone varies from 14 meters below ground level to 229 meters below ground level. The 3 dimensional projection of water table, cartosat DEM, Fracture zones, Rainfall are trying to shown on the Arcscene viewer. The result shows the variation of water table in various Lithological conditions with respect to the parameters elevation, rainfall and fracture zones. It clearly shows that the water table in an area is highly depending on Geological structures and Lithological diversity. There is a great scope for the study and can be further useful for carry out the subsurface mapping and Aquifer mapping in an area.

Keywords: Water table, Cartosat DEM, Drainage, Fracture zones, Arc scence, 3d modeling and mapping, Correlation.

1. Introduction

Water resource is the non renewable energy resource and necessity material for survival of living beings next to air. Today, the water resource is completely exploited by exploration of ground water, water pollution and lack of maintenance. Rainwater is the major source for ground water recharge. The recharge process is constant from the older days, but the exploitation process increasing from day to day. To protect our water resource sustainably we have to achieve the sustainable development of water resource by introducing the rain water harvesting structures and modern agricultural techniques. Geoinformatic information system is an emerging tool in hydrological studies and serves as an efficient and powerful tool in recent decades.

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2. Study Area

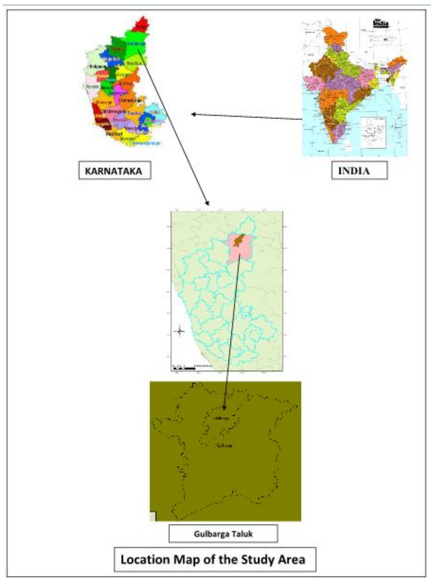

Fig. 1: Location map of the study area.

The study area Gulbarga taluk belongs to semi arid climatic conditions. The south western monsoon rainfall occurs mainly in the month of June to September. The rainfall is bulk and constitutes over 75% of the total rainfall. Normal rainfall of the Gulbarga district is 777 mm and actual rainfall is 881.10 mm. December is the coldest month. And in summer temperature raises up to 45 degree celcius. Relative humidity varies from 26% in summer and 62% in winter. As a result the relation between the water table, elevation of terrain and rainfall amount is necessary to study is important.

3. Methodology

The water table data is collected from the central ground water board in the form of litholog data. The data related to fracture zones, water table depth and lithological parameters. The data were processed on the ArcGIS by using the tool add XY data. The data is projected and update the fields of water table, fracture zones and lithologic parameters. 3d modeling and mapping is done by using Arcscence software. 3d modeling is done by using the base height operation tool. Vertical exhagaration must be calculated from extent.

Table 1: Table showing the values of different variables.

x cordinate	y cordinate	Water_level	Fracture 1	Lithology	Fracture 2
76.85	17.15	-14.00	-173.00	limestone or pink granite	-175.00
76.82	17.28	-126.40	-18.00	basalt or limestone	-48.00
76.96	17.30	-1.60	-218.00	basalt or limestone	-219.00
76.73	17.30	-13.20	-16.00	basalt or limestone	-21.00
76.80	17.40	-55.00	-114.00	basalt or limestone	-130.00
76.90	17.41	-43.00	-61.00	basalt or limestone	-63.00
77.02	17.48	-26.00	-42.00	bsalt or limestone	-43.00
77.06	17.63	-100.00	-126.00	basalt or limestone	-127.00

Arcscene software is well suitable for the projection of water table, fracture zones and DEM of terrain and drainage themes.

Using Inverse Distance Weightage tool of ArcGIS we can create the water level map and Fracture zone maps. IDW is an interpolation technique in which it can interpolate the surface based on Z value of the points.

4. Results and Discussions

By performing the water table, Fracture zones and DEM analysis we came to know that there is perfect correlation between all the parameters.

4.1 Water table

Water table is an upper part of the saturated zone which is bounded by free water within the pores and voids under earth surface. The pressure in water table is equal to the atmospheric pressure. Ground water always occurs between the fractures zones within the earth's surface. Fractures, joints and faults are the major pathways for the ground water movement and storage.

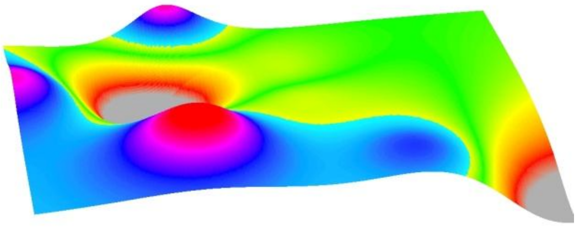

Fig. 2: Water table map of the study area.

4.2 Cartosat DEM

The data used for the 3d analysis of terrain is cartosat 1. Cartosat 1 is a product derived from the bhuvan website. The resolution of cartosat 1 DEM is 30meters. The data is extracted to our study area by using extract by mask tool in ArcGIS. The data is then processed using Arcsence software to project 3D view to correlate with the water table and terrain parameters.

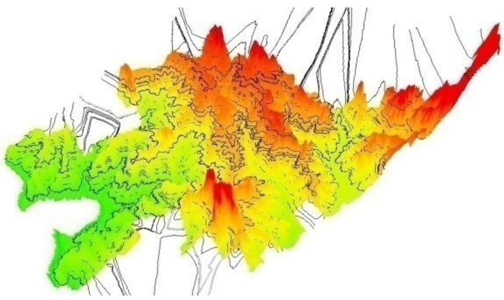

Fig. 3: Cartosat 1 DEM of the study area.

4.3 Drainage network

The drainage network is effectively derived from processing of cartosat 1 DEM. Hydrology tools were used in ArcGIS software to derive the drainage networks. The elevation value of the DEM data is extracted to drainage networks and projected in 3D viewer in Arcscene.

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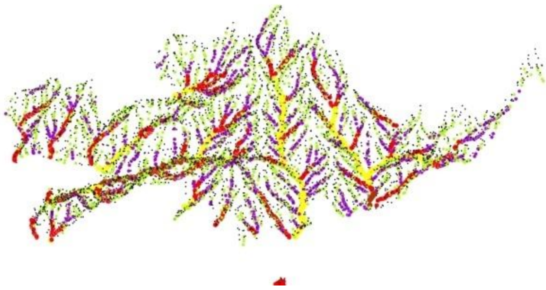

Fig. 4: Drainage network map of the study area

4.4 Fracture zones

The litholog data collected from central ground water board, Bangalore contains the fracture zone information of Gulbarga taluk. The fracture zone data is processed using the ArcGIS software and later projected in the Arcscene interphase.

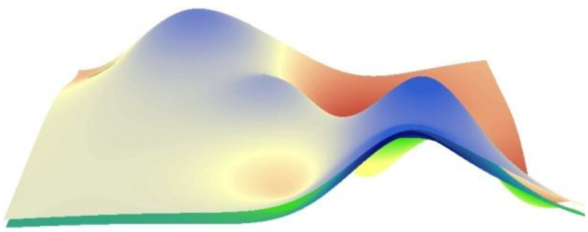

Fig. 5: Fracture zone map of the study area.

The results shown from the projection of water table, DEM, drainage network clearly shows the perfect correlation between the relative thematic layers.

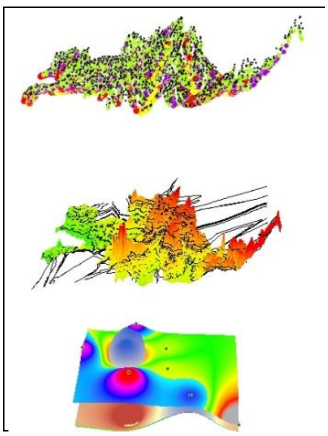

Fig. 6: Integrated Maps.

4.5 Correlation

In any statistical analysis correlation is the relation between dependence of one variable with respect to another variable. The correlation value ranges from +1 to -1. +1 indicates high positive correlation and -1 indicates low negative correlation. 0 indicates the no correlation between the parameters. The study indicates the correlation between various thematic layers.

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4.6 Correlation between the fracture zones

Correlation coefficient obtained by the analysis shows that there is a perfect positive correlation (0.99) between fracture zone 1 and fracture zone 2.It indicates that the upper fracture zones and lower fracture zones are highly dependent on one other.

Table 2: Table showing the values of Fracture zones.

Fracture 1	Fracture 2
-16.00	-21.00
-114.00	-130.00
-18.00	-48.00
-173.00	-175.00
-61.00	-63.00
-218.00	-219.00
-42.00	-43.00
-126.00	-127.00

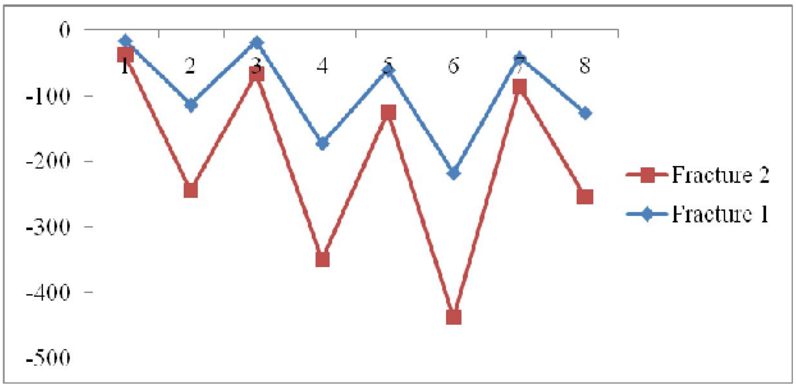

Fig. 7: Representation of fracture zones.

4.7. Correlation between Water level depth to Elivation of terrain

As the water table depends mostly on the amount of recharge from surface, it highly depends on the surface topography. Correlation coefficient obtained by the analysis of water level in wells and respected elevation shows positive correlation coefficient 0.375. it indicates the highly dependence variable of water table with the terrain elevation factors.

Table 3: Table showing the Representation of Elevation to water table depth.

Water_Level in Meters	Elevation in Meters
13.20	366
55.00	405
126.40	350
14.00	350
43.00	400
1.60	377
26.00	377
100.00	498

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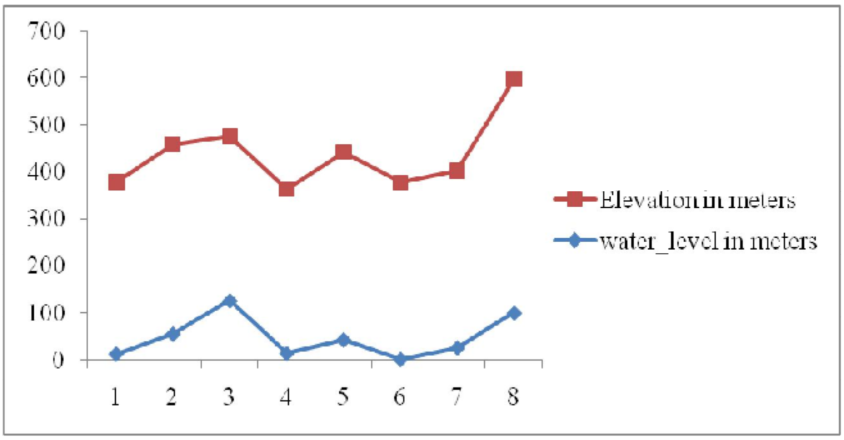

Fig. 8: Representation of Elevation and water level depths.

4.8. Correlation between Water level depths to Stream order.

The correlation coefficient between the water table and stream order influence is found to be 0.345. It shows a positive correlation between the drainage order and water table depth. Result obtained by the analysis indicates that the water table depth of study area is directly dependent on the area of influence of drainage catchment.

Table 4: Table showing the representation of stream order and water table depths.

Water Table	Stream Order
26.00	3.00
100.00	2.00
1.60	3.00
43.00	3.00
14.00	2.00
126.00	5.00
55.00	4.00
13.20	4.00

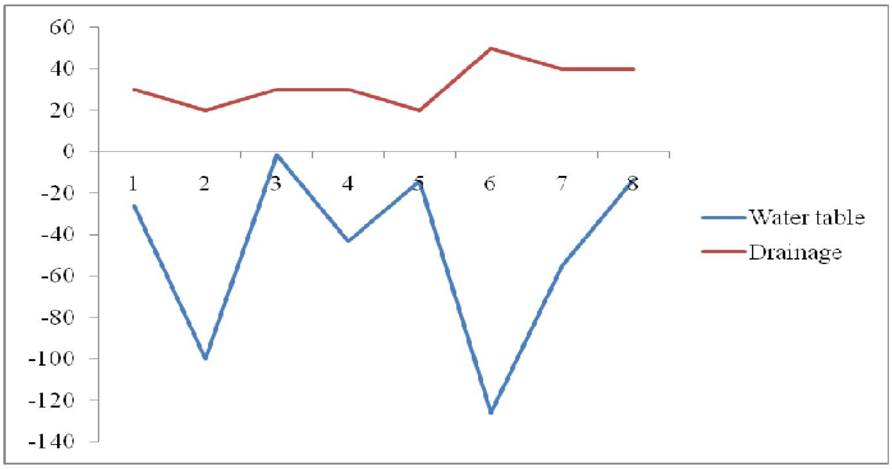

Fig. 9: Representation of water table and stream order.

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5. Conclusion

The movement of groundwater is controlled mainly by porosity and permeability of the surface and underlying Lithology. The same Lithology forming different geomorphic units will have variable porosity and permeability thereby causing changes in the potential of groundwater. This is also true for same geomorphic units with variable Lithology. The surface hydrological features like topography, geomorphology, drainage, surface water bodies, etc. play important role in groundwater replenishment. High relief and steep slopes impart higher runoff, while the topographical depressions help in an increased infiltration. An area of high drainage density also increases surface runoff compared to a low drainage density area. The study illustrates the necessity of ground water recharge and sustainable development of water resource.

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