Ground Water Quality Evaluation in Raghunathapalli Watershed, Jangaon District,Telangana State, India

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***Abstract*- Over 60% of the global population thrives solely by relying on groundwater reserves. Groundwater quality needs attention as it is the major source for drinking purposes. Raghunathapalli watershed is located in North-Western part of Jangaon District, Telangana state. The watershed is a tributary of AleruVagu (Musi Sub-basin) of Krishna Basin. There are about 271 different sources like Hand Pumps & Deep Bore wells which are essentially being used for drinking purpose. The chemical elements (9 nos) examined are pH, Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Fluoride (F), Chloride (Cl), Iron (Fe), Nitrate (NO3) and Sulfate (SO4) with respect to its contamination spread as per ISO 10500: 2012 during pre and post-monsoon seasons. The spatial distribution and concentration of chemical elements is carried out by using spatial interpolation technique namely Inverse Distance Weightage (IDW) method from the point source data. Out of 9 elements; it is revealed that pH, Chloride (Cl), Iron (Fe) and Sulfate (SO4) distribution is within the permissible limits. The major problematic contaminant is Fluoride which is marginally affected (1.50-3.00 ppm) for about 18% sources. Total Hardness (14% sources), TDS (2%), Nitrate (2%) and Total Alkalinity (2%) are out of range marginally for a few sources.**

***Index Terms*- Chemical element, Watershed, Groundwater, Drinking, Quality, Source, Hand Pump, Interpolation.**

I. INTRODUCTION

In India, there used to be 5,000 cubic meters of available water per person 50 years ago. Population growth and increased water consumption have reduced it to 1,500 cubic metres. Due to its geographical diversity and climate change, India faces additional challenges relating to water-stress. Water quality is an important aspect of humans as it is directly related to their health. The project area is a problematic one in terms of Groundwater extraction as per previous Groundwater Estimation Committee (GEC) reports showing gap between recharge and drawl.

II. LOCATION

The study area (Raghunathapalle watershed) falls between the geographic co-ordinates of Longitudes (Cartesian X)79°7'12"E - 79°16'58"E; and Latitudes of 17°43'20"N - 17°52'22"N (Cartesian Y). The Raghunathapalle watershed falls in Jangaon District of Telangana state. A map of the location is shown in Fig. 1. The basin covers an area of 126 Square Kilometers. The project area covers part of Survey of India (SoI) Toposheet nos. on 1:25,000 scale - 56O1/SE, 56O1/SW, 56O/2NE, 56O/5SW, 56O/6NW.

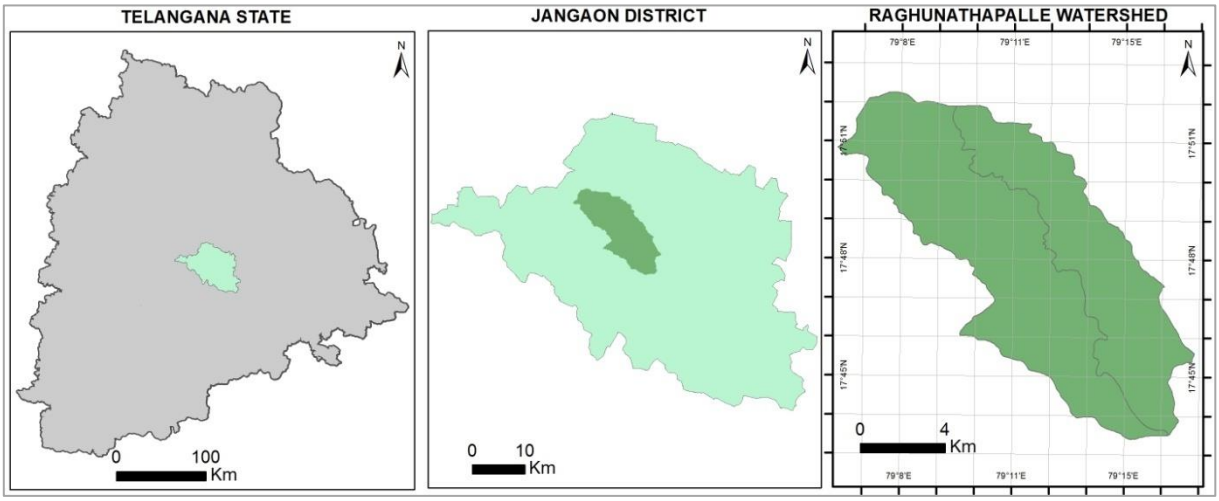

Fig. 1 - Location Map of the study area

III. GEOLOGY

The Geology or Lithology Map is shown in Fig. 2. The study area is underlain by rock formations essentially belonging to Archean group of rocks like Metamorphic rocks; Peninsular Gneissic Complex (PGC) groups of rocks like Leuco Granite and Grey Alkali Feldspar Granite, which are intruded by Pegmatite Veins and Dolerite dykes at several places. The majority of area is underlain by Grey Alkali Feldspar Granit and Leuco Granites. The primary porosity is limited to overlying weathered/semi weathered horizons only in unconfined aquifer. Whereas, the secondary porosity developed due to fractures, faults, joints and

shear zones developed deep inside during prolonged geological times provide the promising ground water potential with semi-confined to confined zones.

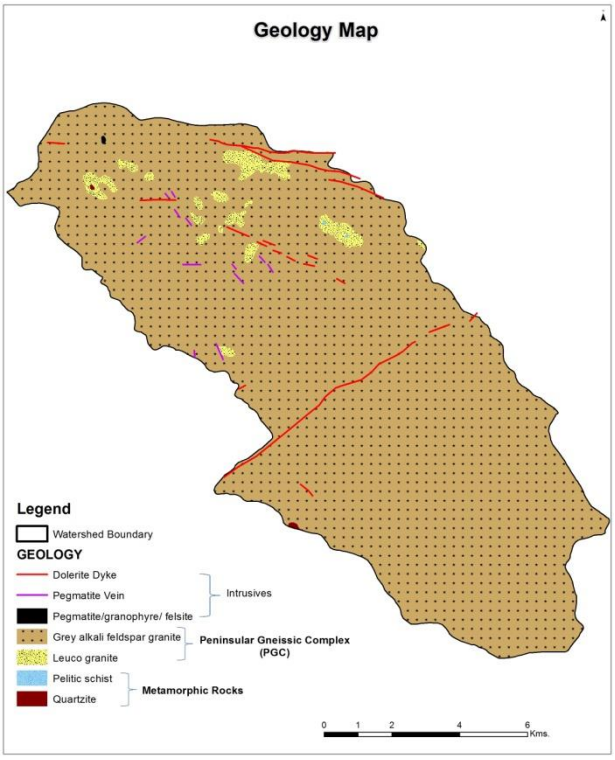

Fig. 2 - Map illustrating the geology of the study area

IV. GROUND WATER QUALITY MAPPING

Habitation wiselegacy ground water quality data for pH, Total Dissolved Solids (TDS), Total Hardness (TH), Alkalinity (A), Fluoride (F), Chloride (Cl), Iron (Fe), Nitrate (NO3) and Sulfate (SO4) elements (2012-14) are collected from Rural Water Supply & Sanitation (RWS&S) department. Data pertains primarily to drinking water sources like hand pumps / bore wells. The data is segregated in to pre (February to May) and post monsoon (September to December) seasons based on date of collection of samples. There are 271 different sources like Hand Pumps-187 nos& Source Bore wells-84 nos covered in 35 Habitations for which Groundwater quality data is available for pre as well as post monsoon seasons.

As there are many sources in a habitation, element wise average values are calculated for each habitation in point form. The spatial distribution of element wise ground water quality maps are prepared for pre and post monsoon seasons separately from this point data and interpolation is carried out by using Inverse Distance Weightage (IDW) method under Spatial Analyst tools of ESRI Arc GIS 10.3 software. Each element wise map is further re-classified in to 3 classes like Desirable (Potable); Permissible (Maximum allowable extent in absence of desirable water) and Non Potable following the guidelines given in Bureau of Indian standards (IS: 10500: 2012) as shown in Table 1.

Table-1: Classification of water quality based on elemental concentration limits
(Based on Indian Drinking Water Standards as per BIS Guideline-IS: 10500: 2012)

Sl. No	Element	Potable limits		Non-Potable
		Desirable	Permissible	
1.	pH	6.5 to 8.5	--	<6.5 to >8.5
2.	Total Hardness (as $CaCo_3$) mg/l	<200	200-600	> 600
3.	Iron (as Fe) mg/l	< 0.3	--	>0.3
4.	Chlorides (as Cl) mg/l	< 250	250-1000	> 1000
5.	Total Dissolved solids mg/l	< 500	500-2000	> 2000
6.	Nitrate (as NO_3) mg/l	< 45	--	>45
7.	Sulphate (as SO_4) mg/l	< 200	200-400	> 400
8.	Fluoride (as F) mg/l	< 1.0	1.0-1.5	> 1.5
9.	Total Alkalinity mg/l	< 200	200-600	> 600

V. METHODOLOGY

The spatial data base on ground water quality will be generated as part of the project. Basically, the legacy groundwater quality data in the form of a table of a source point is considered as origin and the contamination spread or distribution is mapped based on the interpolation technique using statistical method.

A schematic diagram with various components of the process in realizing ground water quality map is shown in Figure 3.

In the process, the raw-input data is segregated in to pre and post monsoon seasons based on date of collection of samples. From this database habitation wise average values of chemical elements and calculated. The raw data is conferred into GIS database in the form of a point called ground water sample layer after joining Habitation code with point shape file.

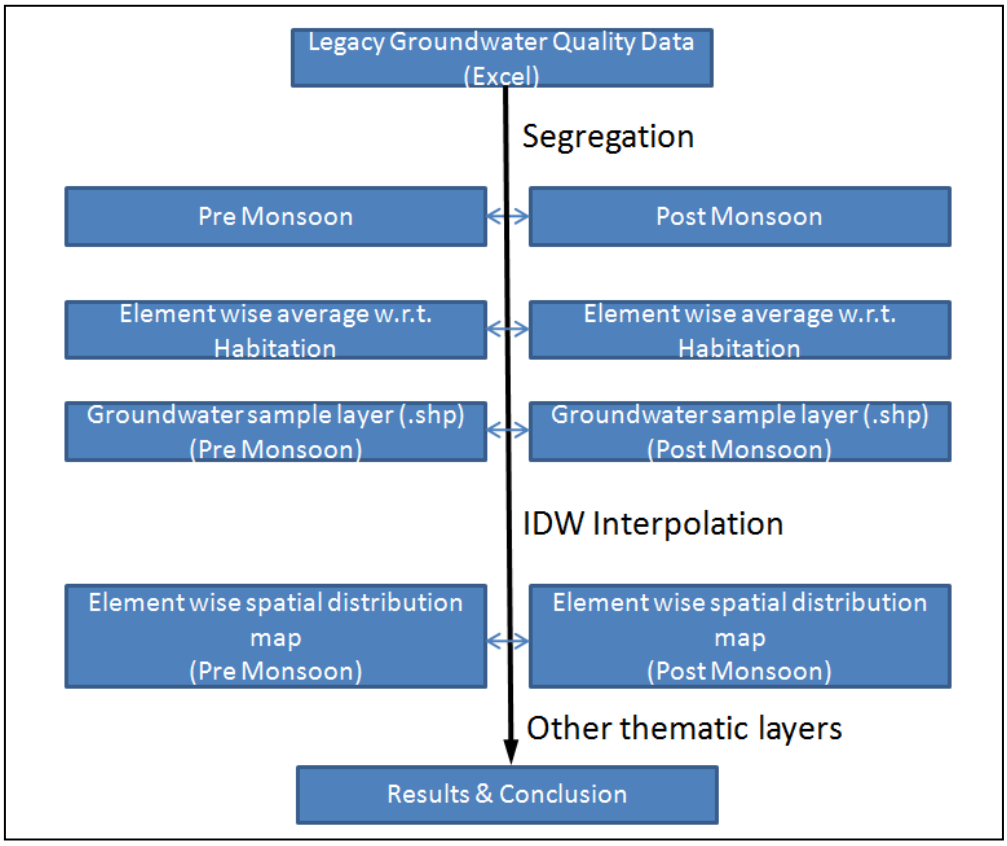

Figure 3: Methodology for Generating Groundwater Quality Map

Each element wise spatial distribution maps are prepared using IDW interpolation technique for pre and post monsoon seasons. The generated maps are studied with other thematic layers like Geology, Geomorphology, Rainfall, Lineaments etc. and remedial measures are proposed.

VI. RESULTS AND DISCUSSIONS

It has been observed that for the elements pH, Chloride (Cl), Iron (Fe) and Sulfate (SO4), the qualityis within permissible limits and the distribution for other parameters is as given hereunder.

Fluoride

The habitation wise average values of fluoride in the study area varies from 0.45-1.63 mg/L (Pre Monsoon) and 0.14-2.08 mg/L (Post Monsoon). The marginal higher values (>1.50 mg/L) are found atisolated places. The spatial distribution of fluoride map is shown in Figure 4. The spatial distribution of fluoride concentration is less during pre monsoon season as compared to post monsoon season. There are about 16% sources were quality affected with fluoride element during pre monsoon season whereas it is only 18% during post monsoon season. The fluoride concentration is out of range (>1.50 mg/L) mainly in western parts of watershed (Ramachandrapuram and Ibrahimpur); Central part (Ramarayani Bangla).The sources for which the fluoride is out of range are found essentially in rock types belonging to Peninsular Gneissic Complex (Alkali Feldspar Granite).

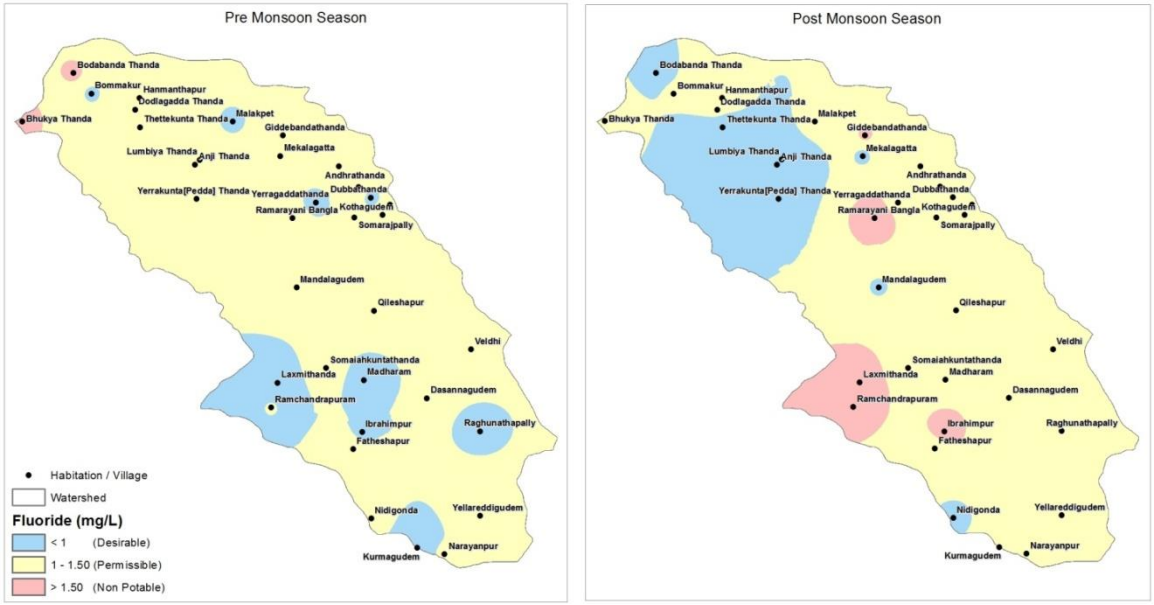

Fig. 4 Spatial Distribution of Fluoride

Total Dissolved Solids (TDS)

A map of the spatial distribution of TDS is shown in Figure 5. The habitation wise average values of Total Dissolved Solids are ranging from 534-1,465 mg/L (Pre Monsoon) and 482-957 mg/L (Post Monsoon). There are about 2% sources were quality affected with TDS during pre-monsoon season whereas about 1% sources were out of range during post monsoon season in the state. Thus it is indicating that the dilution of water during post monsoon season and improvement in quality.

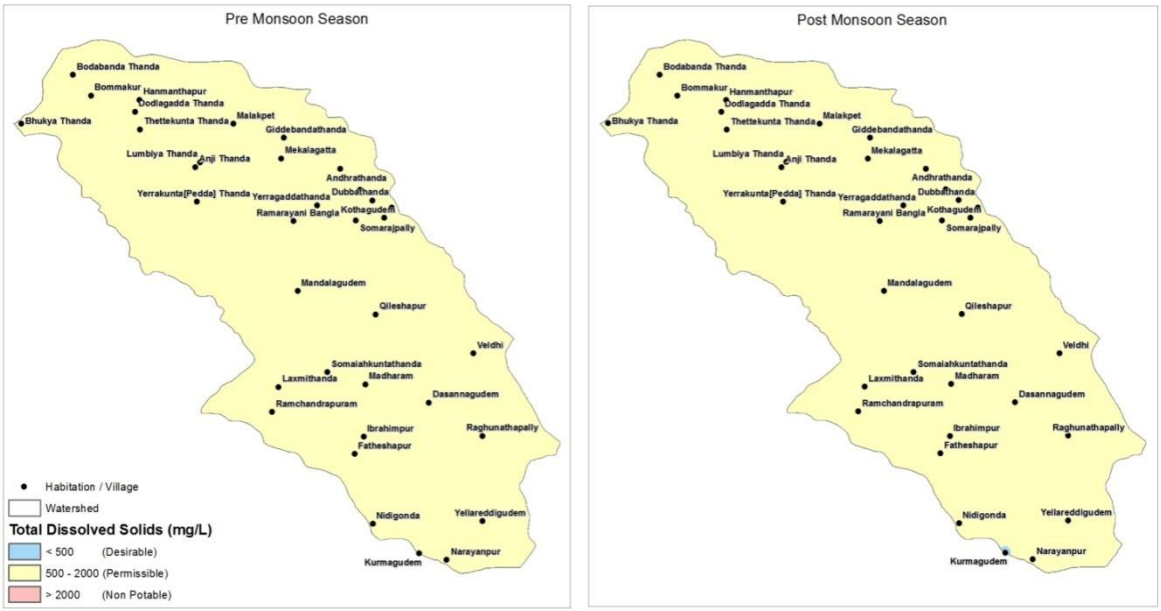

Fig. 5 Spatial Distribution of Total Dissolved Solids

Total Hardness (TH)

The habitation wise average values of Total Hardness are rainging from 149 - 784 mg/L (Pre Monsoon) and 234 - 578 mg/L (Post Monsoon). There are about 12% & 14% sources were quality affected with Total Hardness during pre and post monsoon seasons respectively. The spatial distribution of Total Hardness is shown in Figure 6. It is revealed that there is an improvement in the quality of groundwater during post monsoon season.

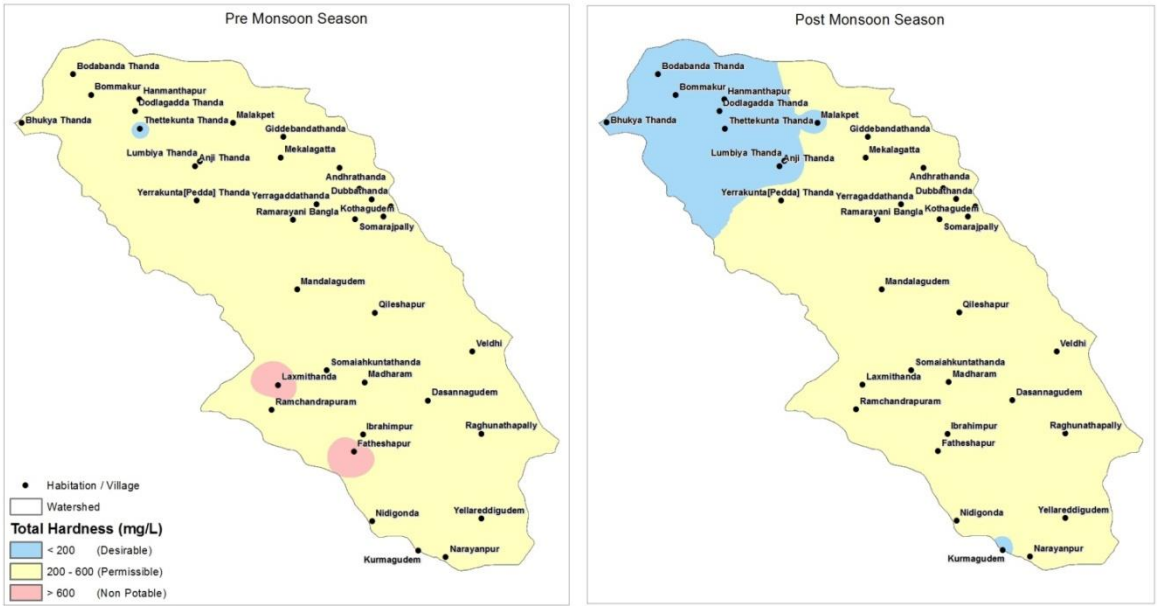

Fig. 6 Spatial Distribution of Total Hardness

Total Alkalinity (TA)

A map of the spatial distribution of TA can be found in Figure 7. The habitation wise average values of TA in the District vary from 112 - 500 mg/L (Pre Monsoon) and 96 - 292 mg/L (Post Monsoon). There are about 1% sources were quality affected with Total Alkalinity during pre monsoon season. Whereas there are no sources quality affected during post monsoon season. It is observed that the Total Hardness is out of range mostly in low lying areas where agriculture activity is more.

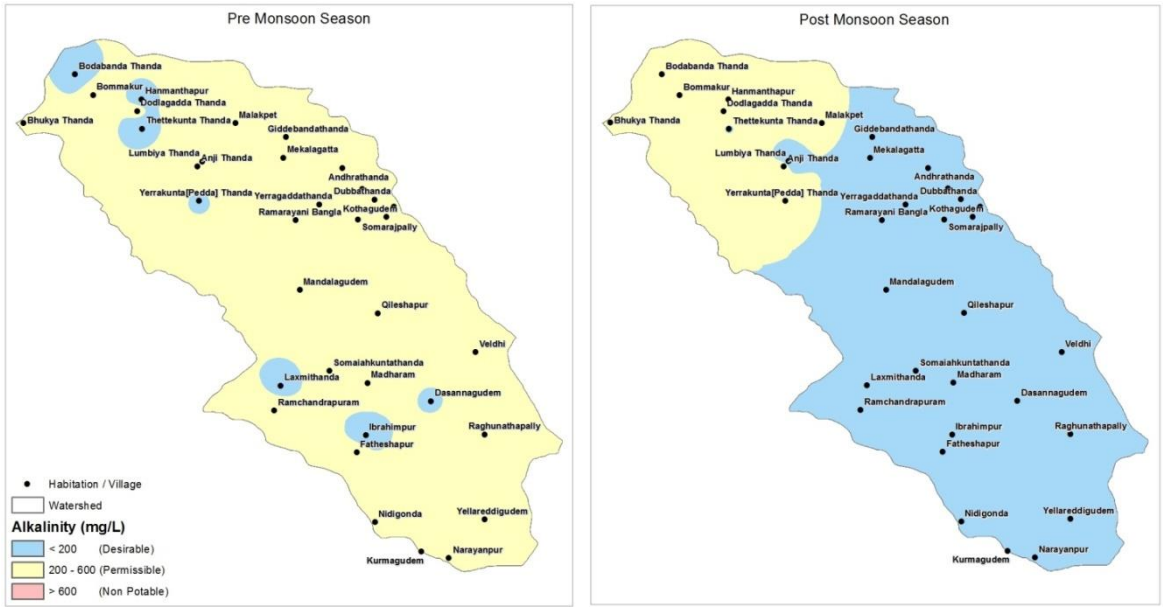

Fig. 7. Spatial distribution of Total Alkalinity

Nitrate

A map showing the spatial distribution of Nitrate can be found in Figure 8. The habitation wise average value of Nitrate in the area varies from 3.20-40.70 mg/L (Pre Monsoon) and 5.15-62.20 mg/L (Post Monsoon). There are about 2% sources were quality affected with Nitrate during post monsoon season whereas there are no sources quality affected during pre monsoon season. The concentration of Nitrate is out of range (>45 mg/L) at isolated places.

Fig. 8. Spatial distribution of Nitrate

Mapping different parameters like Geology, Geomorphology, Structures, Digital Elevation Model, Slope etc are discussed in another paper entitled "**Appraisal of Water Resources Development Action Plan for Groundwater Recharge in Raghunathapalli Watershed, Jangaon District, Telangana State, India** " and Crossref DOI can be found in the following link:https://doi.org/10.36948/ijfmr.2023.v05i05.6307

As per previous periodic assessment reports (2008, 2013 & 2020 years) of dynamic ground water resources of Telangana State Ground Water Department (SGWD) in collaboration with Central Ground Water Board (CGWB) clearly shows that the project area is a problematic one. The previous GEC reports status with respect to groundwater exploitation in terms of Safe (<= 70%), Semi-Critical (70-90 %), Critical (90-100%)and Over Exploited (> 100%) is shown in Fig. 9

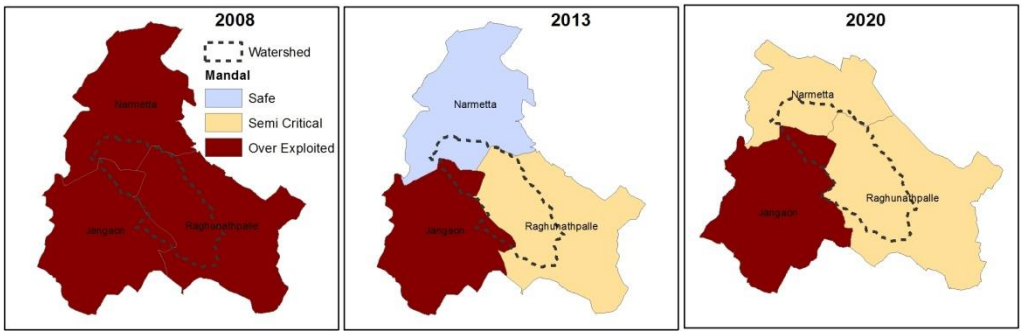

Fig. 9. Status of Groundwater Exploitation as per GEC report

The habitation–wise chemical analysis data is subjected to detailed analysis and the following observations are made. It is observed that the fluoride concentration is more in shallow and moderately weathered pediplains and valleys in granitic rocks like Alkali Feldspar Granite. Most of the quality affected sources are having marginally high concentration of fluoride (1.50-3.00 ppm) who is at risk for dental fluorosis.

The high concentration of fluoride rich ground water can be diluted with the augmented infiltration from a surface water body upstream of affected area. In view of this, different rainwater harvesting structures are suggested at suitable locations which improves dual benefits of both quality and quantity.

Most of the Indian states are facing acute shortage of water to cater domestic and irrigation sectors. This situation is much worse in the states lying on hard-rocks, where in, groundwater is the chief source of drinking and irrigation requirements. To cope up with the situation and practice water conservation strategies for sustainable development, scientific understanding of groundwater availability and movement in fractured geologic media is needed

VII. CONCLUSIONS

It is revealed that the utility of GIS technique helps in quality mapping spatially from known point data to unknown areas. Fluoride contamination is the major problematic element in the study area. Flurode is out of range marginally (1.50-3.00 mg/l) in Bodabanda Thanda & Bhukya Thanda during pre monsoon season whereas it is out of range in Ramarayani Bangla, Laxmi Thanda, Ibrahimpur, Giddebanda Thanda and Ramachandrapuram during post monsoon seasons. The marginal concentration of fluoride can pose health risks like dental fluorosis in long run. Water treatment processes like using alum powder or defluoridation technique may be employed to overcome the fluoride menace. Total Hardness is out of range in Laxmi Thanda and

Fateshapur villages during pre monsoon season whereas it is within the permissible limits during post monsoon season. Hardness in groundwater refers to concentration of calcium (Ca2+) and magnesium (Mg2+) ions (CaCO3) in the water. Hard water is not a health concern, but it can have several implications like scale buildup in plumbing and reduce the effectiveness of soaps and detergents. Nitrate is out of range in Anji Thanda during post monsoon season whereas it is within permissible limits during pre monsoon season. The most significant source for nitrate contamination is agricultural practices (applying synthetic fertilizers) and animal manure from livestock operations. Best agriculture practices needs to be taken up.

VIII. ACKNOWLEDGEMENTS

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