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Hydrogeochemical Investigation and Groundwater Quality Assessment in Patancheru area Medak District, South India

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Abstract
The current research was conducted to assess the groundwater quality in the Patancheruvu area of Medak District, South India. For this study, 60 well water data were collected at different locations for analysing physicochemical parameters of groundwater for the pre and post-monsoon seasons of 2020. The chemical analysis results show that the ground water nature in the study area is alkaline to basic and is classified very hard water. The TDS analysis shown that groundwater samples were found to be fresh water in nature. TDS is primarily caused by the ions Na, Cl, SO4, and HCO3. The presence of high TDS concentrations is due to various industries and anthropogenic activities around the study area. In both seasons, the order of major cations and major anions is in the following order: Na > Mg > Ca > K and Cl > SO4 > HCO3 > NO3 > F respectively. The majority of the EC, TDS, Na, TH, Mg, Ca, Cl, HCO3, and SO4 samples exceeded the desirable limit, and some samples also exceeding the permissible limit. In both seasons, the dominant hydro chemical facies identified by the Chadha diagram were Na- K-HCO3 and Ca-Mg-HCO3. From the WQI analysis, most of the data in both seasons fell into the Poor to Very Poor water category. The high concentration of TDS, Cl, and HCO3 in the region may be contributing to the high concentration of WQI. From the research it is observed that the groundwater quality in this area is poor, which may be attributed to both anthropogenic factors and geogenic processes.

1. Introduction

Water is a significant element and most important source for our life and it is most important resources on earth. It is an essential natural element for development of human life and activities. But the availability of fresh water on earth constitutes only 2 percent, even it plays a very important role. It is also one of the fastest decreasing resource in earth and without water not only the human but also a huge number of creatures could not sustain. To maintain a significant role in natural heritage, lake and river also water plays a major role. Human beings depend on water for variety of purposes like agriculture use, industrial use and for domestic purposes. In the past few decades ground water and lakes have been polluted owing to disposal of waste without treatment and overexploitation. But the availability of good quality water resource is limited (Booth et al., 2007). With the rapid development of social economy, the problem of surface water and groundwater is getting more and serious pollution. Groundwater quality issues are much more severe in densely populated, heavily industrialised areas, excessive use of pesticides and fertilisers in rural areas, and shallow ground water tablets.

Anthropogenic activities such as discharge of domestic, industrial and other major activates has caused major pollution problems to water quality. The use of pesticides is increasing which contaminates the groundwater, and these should also be analysed continuously. Good water quality carries organisms and nutrients to many areas. Fresh water helps in provide habitats for many species of plants and animals. Once, taking about water quality, groundwater quality also plays an important role on human lives (Puri et al.,2011). There is no substitute for the drinking water sources therefore, it is highly recommended to have a disciplined management if available water and timely monitoring of ground water quality is also required. In India, the availability of surface water resources is insufficient which ultimately results in the dependency of most of the urban and semi urban people on the ground water resources.

The assessment of the quality of water can be understood by evaluation of its chemical, physical and biological in relation to its natural quality. In nature, water quality affects the condition of ecosystems and altering the existence of living beings. All management of water resources involves the control and quality of water (Kumar and Dua, 2009). The determination of water quality is in the form of set of physical characteristics, chemical and biological factors that make water suitable for a specific use determined (Veettil at al., 2009). As a consequence of the economic and social development of the territories, the water quality receives negative impacts. For example, the use of chemicals in agriculture, the misuse of soils and the dumping of polluting chemicals into rivers and streams**.** Currently, surface water bodies and aquifers that store groundwater are changing greatly in terms of their quality. This is happening due to domestic, agricultural and industrial activities on surface and on atmospheric. These actions are changing water quality and directly impacting adjacent human health and socioeconomic aspects. In order to scientifically develop and manage water resources, it is necessary to evaluate and predict surface and groundwater quality. Anthropogenic activities change groundwater levels and flow conditions through pumping, which promotes the interaction between groundwater and aquifer rocks, while industrial drainage is discharged into surface water systems, thereby affecting the hydrogeochemical processes of the entire water system change.

Obi (2017) carried out a comparative analysis on surface and groundwater quality research in Nigeria. This study was very significant because disease vector was prevalent and thrive well in water. So, analysis has been performed for quality status of Otamiri River and water boreholes located in Owerri west, Nigeria. Bacteriological, physical and chemical analyses were carried out. The results showed the surface water was heavily polluted and unsafe for drinking. Spatial and statistical studies have been more effective in understanding the assessment of groundwater and lake water analysis.

Application of correlation coefficients and regression analysis were implemented for better understanding of relationship between parameters (Rehman et al. 2018). Statistical analysis such as discriminant analysis (DA) and principal component analysis (PCA) are widely used in the qualitative and statistical analysis and evaluation of environmental data sets, especially where flux data are absent (Shamsuddin et al. 2015). The groundwater impact on surface water quality can be explored through spatial variability and statistical analysis (Liang Yu et al. 2018). Nnadi and Fulkerson (2002) have carried out the assessment of groundwater under direct influence of surface water. The study explored the risk of groundwater contamination due to the geology and land use. Through Microscopic Particulate Analysis, the risk of groundwater contamination to surface water is assessed. The results showed majority of high-risk index of wells near the geologic formations. Andrew et al. (2014) performed a multivariate study of the hydro chemical properties of groundwater, in particular nitrate pollution. The study has shown that statistical analysis can be used to interpret the complex physicochemical characteristics of groundwater. Required tools and techniques should be developed for an effective environmental decision. Research on water quality on groundwater and surface water has been widely recognized method.

The methods of groundwater quality evaluation include single factor evaluation methods, and comprehensive pollution index methods (Singh et al.,2009). The singlefactor evaluation method and the comprehensive pollution index method are simple to calculate and easy to use, but the evaluation results are different from the real water quality status (Dahiya et al., 2007) . The commonly used methods for water quality prediction mainly include: numerical model prediction method, grey prediction method, artificial neural network prediction method and exponential smoothing method Veettil at al., (2011). There are many parameters to be considered in the establishment of a numerical model, and the adjustment of parameters is cumbersome; the accuracy of the grey prediction method depends on the characteristics of the monitoring data, and the prediction results are poor when the water quality index fluctuates greatly in a certain period (Yogendra and Puttaiah, 2008). The screening of factors expands and complicates the prediction process; the exponential smoothing method is simple to calculate, requires fewer observations, and has strong adaptability, and is widely

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used in hydrology, environmental science and other fields (Parmar, 2010). In this paper the study of water quality is done for Patancheruvu block, Telangana, India. The main objective of this paper is to study the variation of different water quality parameters with the changing land cover. The main objective of this research is to find out the effect of different land use on water and protect it from contamination without hampering the environmental balance.

2. Study Area

The study area is Patancheruvu having 186.67 km2 which is located at the north western end of Hyderabad. Its latitude is 17.53°N and its longitude is 78.27°E. It is an industrial zone on the HyderabadSolapur highway, about 32 km from the city centre and 18 km from HITEC City in the Sanga Reddy district of Hyderabad in the Indian state of Telangana. Patancheruvu is Telangana's main industrial hub. Ankit Packaging, Agarwal Rubber Limited, Aurobindo Pharma, Biological.E, Finecab, Sandvik Asia, Pennar, Paragon Polymer Products Pvt Ltd, and Rotec. It grew a lot when Indira Gandhi set up the Patancheruvu Industrial Park and other things. Water and air have become dirty because of these industries. which is affected by the health of people, animals, and plants. In 2009, it was found that the water in Patancheruvu had the most drugs in it. Researchers found large amounts of 21 different synthetic medicines in the water. Over 90 local drug factories dump their waste water into the ponds, which makes them dirty. Patancheruvu is divided into 25 villages; the population in 2022 was 2,03,764. According to the 2011 census of India, a total of 1,591 people is living in Patancheruvu Mandal, of which 81,734 are male and 77,457 are female. Patancheruvu is regarded a migratory hub for all of India due to its abundance of professional options. As a result, the population density had increased, making it one of the governorates with the highest population density. In addition to recreational activities, the Telangana governorate is home to numerous government services, including industrial, medical, educational, commercial, and governmental entities. Furthermore, the topography and climate of Patancheruvu exacerbate the pollution. The city is located in a valley surrounded by hills that absorb the air and water pollution. Fig.1. displays the region of study area. Figure.1. Study area of Patancheruvu Mandal, Sangareddy District, Telangana, India.

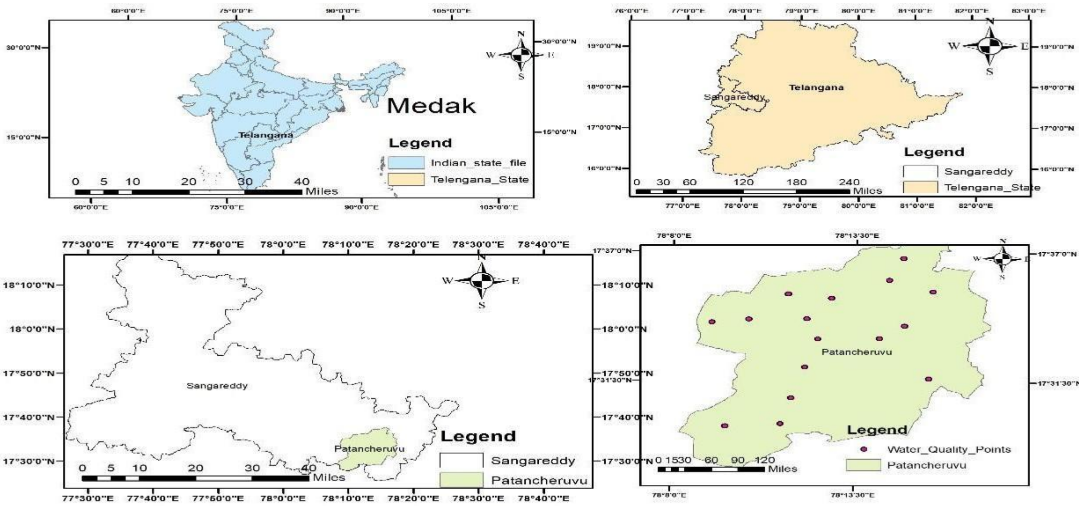


Figure.1. Study Area with water quality sample points

Materials and Methodology

The research was done by collecting available physicochemical information from various public and private institutions located in the study area. Subsequently, the quality of the data was verified considering: i) reasonable reported chemical and physicochemical values,
ii) transcription errors and, iii) analytical errors in the ionic balance less than or equal to 10% . To determine the water quality and chemical composition of groundwater graphic, descriptive and multivariate statistical methods are used. This method is combined and correlated with the geological

and hydrogeological knowledge of the study area.

In the current study, 60 well water data were collected for the months of May, 2020 and November, 2020 year. Here, May and November are considered as Pre-monsoon season and Post monsoon season respectively and analysed physicochemical parameters of groundwater using the APHA (2005) procedures.

Groundwater samples were collected in 1000-ml polyethylene bottles, after flushing the well assembly with water for 5-10 minutes to remove stagnant water. Before collecting the water form well, the bottles were cleaned with distilled water. The electronic OTT dip metre was used to measure the water level. At the time of the field visit, pH and conductivity metres were calibrated with standard buffers of the respective parameters for determining, Total Dissolved Solids (TDS), electrical conductivity (EC) and pH. To remove solid sediments, the samples were filtered in a vacuum filtration unit using 0.45-m Millipore filter paper. The Global Positioning System was used to determine the locations points of sampling well. For collected water data physicochemical parameters analysis was done for the both periods of 2020. Standard analytical method is used to calculate the total hardness (TH), magnesium (Mg), calcium (Ca), sodium (Na), bicarbonate (HCO3), potassium (K) carbonate (CO3), sulphate (SO4), chloride (Cl), and fluoride (F) (APHA 2005). The volumetric technique was used to determine the concentrations of Total hardness, HCO3, Mg, Ca, and Cl. Titrimetric ally standard EDTA titration is used to determined Ca and Mg concentrations. Titration of HCO3 to a methyl in the presence of phenolphthalein and methyl orange indicators. Titration with AgNO3 solution was used to determine chloride. Flame emission photometry was used to determine Na and K. SO4, NO3, and F were measured using a spectrometer and various buffer solutions. The data were statistically analysed, and mean, standard deviation calculated by excel 10. These parameters provide useful information about the processes that control groundwater in the study area. In the present study, it was considered that the data have quality assurance and control at the time of sample collection and analysis. However, the data was examined to verify that the compiled characterisations had the relevant quality for the development of this investigation. During this data review, errors such as: samples with uncertain locations or with inverted coordinates, no recording of depths, inconsistent units of measure (all concentration values were converted to mg/L format).

The accuracy of the data determined by using Ionic balance error.

$$\text{Error of Ion balance} = \frac{\sum \text{Cations} - \sum \text{Anions}}{\sum \text{Caions} + \sum \text{Anions}} * 100$$

For accuracy of the results it should be ±10

The ionic balance error is within ±10, excluding few samples which are above ±10 in both the seasons.

3.1 Water Quality Index (WQI)

Globally Water Quality Index (WQI) method is used to assess the appropriateness of water quality for domestic purposes. Water quality for drinking purposes around the study are is calculated with the help of WQI method and compare the WQI values with the BIS (2012) standards. WQI is calculated by using 9 parameters. Three steps were used to compute WQI. In the first step weight (wi) assign to the nine parameters (Hardness, pH, Cl, TDS, SO4, Ca, F, Mg and NO3) (Table 1). In the next step equation 1 is used to estimate the relative weight (Wi).

Table 1. Relative weight of chemical parameters

Chemical parameters	**Bureau of Indian Standards (BIS, 2012)**	**Weight (wi)**	**Relative Weight** $Wi = wi/\sum_{i=1}^{n} wi$

TDS	500	4	0.13333
pH	6.5-8.5	4	0.13333
Hardness	300	2	0.06667
Ca	75	2	0.06667
Mg	30	2	0.06667
Cl	250	3	0.1
SO4	200	4	0.13333
NO3	45	5	0.16667
F	1	4	0.13333
		∑wi =36	∑Wi=1

In the second steps, following equation was used to calculate the relative weight (Wi).

$$W_i = \frac{w_i}{\sum_{n} w_i}$$

wi = Weight of the respective parameter; n =Number of parameters.

Final step is assigning quality (qi) of respective parameter which was calculated by equation 2.

$$q_i = \frac{(C_i - C_{i0})}{(S_i - S_{i0})} \times 100$$

Where,

Ci = Measures value of respective parameter,

Si = Normal allowable value as given in BIS, 2012 for respective chemical parameter in mg/l and Ci0 is the ideal value.

WQI is calculated with the sub index (SIi) equation 3

$$SI_i = W_i \times q_i$$

Final WQI is computed by sum of SIi of each groundwater samples data as follows

$$WQI = \sum SI_i$$

3. Results and Discussions

Specific parameters were analysed spatially and statistically for collected groundwater samples of Patancheruvu. The various parameters determined were pH, TDS, electrical conductivity, chlorides, calcium, sodium, potassium, magnesium, alkalinity, nitrates, sulphates, fluorides, and total hardness. Tables 2 shows the Average, Maximum (Max), Minimum (Min), and standard deviation (St.D) values of physicochemical indicators for May and November 2020. The maximum and minimum values of the cations and anions reflect the degree of chemical heterogeneity of the groundwater as a result of the different geochemical processes present in the study area.

For the month of May pH ranges from 7.1 to 8.4, while for the month of November pH ranges from 8 to 9.5. In the May and November months, the normal pH is 8.8 and 8.6, respectively. It tells that the pH nature of the water in study area slightly having alkaline side. All collected data were found that within the adequate range as mentioned in BIS, 2012. In the month of May, the electrical conductivity (EC) range from 485 to 5408 S/cm and while in the month of November it is ranged from 385 to 5308 S/cm. These ranges are happening with and average value of 1715 S/cm and 1615 S/cm for the month of May and November respectively. The EC values show that the concentration of EC decreases from May to November, which could be due to dilution during the month of November. The presence of salts such as Na, Cl, and HCO3 in groundwater may explain the high EC value.

Table 1 Physico-chemical statistical analysis of various parameters for May and November 2020

Physicochemical Indicators	**Bureau Indian Standard (BIS, 2012)**		**May**				**Nov**			
	Desirable Limit	Allowable Limit	Mini	Max	Average	St.D	Min	Max	Average	St.D
pH	6.5	8.5	7.1	8.4	7.8	0.4	7.0	8.5	7.6	0.4
EC	-	-	485	5408	1715	1239	385	5308	1615	1239
TDS	500	2000	320	3569	1132	818	220	3469	1032	818
TH	300	600	236	1638	667	363	156	1558	644	389
Ca	75	200	45	360	105	68	33	348	102	72
Mg	30	100	30	214	98	50	18	214	95	55
Na	-	-	25	545	213	154	54	489	179	140
K	-	-	5	259	49	46	13	247	40	45
Cl	250	1000	175	850	299	201	265	811	255	192
SO4	200	400	125	1145	230	228	211	1130	224	9
HCO3	200	600	92	620	227	126	199	600	221	123
NO3	45	No relaxation	23	1050	202	241	20	989	198	7.6
F	1	1.5	0.25	2.50	0.96	0.56	0.10	2.35	0.81	0.56

The major cations and anions are added together to form total dissolved solids (TDS). In this study, TDS ranges from 320 to 3569 mg/l for May month with a mean value of 1132 mg/l and for November month it is range from 220 to 3469 mg/l with a mean value of 1032 mg/l. According to BIS, 2012 permissible limit and desirable limit of TDS are 2000 mg/l and 500 mg/l respectively. From the results, it is observed that the average TDS value is above the desirable limit. Approximately 70% and 60% of samples data are exceed the desirable limit in the month of May and November respectively. Aside from the desirable limit, 39% and 35% of the samples data exceeded the permissible limit. High concentration of TDS in the region may be due the presence of various industries and anthropogenic activities are major concern. The quality of groundwater in the region based on TDS and Total hardness (TH) for both the months are shown in following Figures. From the Figure 2, it is noted that majority of the samples was fresh water in nature. High TDS in the region may be due the presence of salts like Na, Cl, SO4 and HCO3.

May month TH variety from 236 to 1637 mg/l with a mean value of 667 mg/l, whereas for the month of November TH varies from 156 to 1558 mg/l with a mean value of 644 mg/l. From the TH results, it is identified that a greater number of water samples date range from hard to very hard type. It is also observed that average hardness value exceeds the desirable limit.

Calcium (Ca) concentrations varies from 45 to 360 mg/l in the month of May, and in the month of November it varies from 33 to 348 mg/l. The mean Ca value in the May month is 105 mg/l and in November it is 102 mg/l. Ca concentrations decrease from May to November, possibly due to dilution in rain season happen before November. In terms of drinking purposes, the average value of Ca is above the desirable limit (i.e. 75mg/l). Furthermore, approximately 75% and 69% of water samples data in May and November month exceeded the allowable BIS requirements of 200 mg/l. A high Ca concentration in water may have a negative effect on heart diseases.

The concentrations of Magnesium (Mg) varies from 30 to 214 mg/l and 18 to 214 mg/l in the month of May and November respectively. The average rate of Mg concentrations is 98 and 95 mg/l in the month of May and November respectively. It is observed that the average Mg value is above the desired limit. Approximately 87% of samples in the May and 73% of samples in November month exceeded the desirable limit of BIS standards. A high Mg intake may led to Kidney failure.

The concentrations of Sodium (Na) varies from 25 to 545 mg/l in the month of May, with an average rate of 213 mg/l. In the month of November Na range from 18 to 214 mg/l, with a normal rate of 95 mg/l. Concentrations of Potassium (K) in May month range from 5 to 259 mg/l (mean 49 mg/l) and in November month it varies from 13 to 247 mg/l (mean 40 mg/l). The concentrations of large quantity of K in groundwater could be formed due to irrigation activities. There is no prescribed limits of Na and K, but having high quantity of NA in water is a source to be salty water.

In the month May chloride (Cl) concentrations varies from 175 to 850 mg/l, and in the month of November the concentrations vary from 265 to 811 mg/l. The mean value of Cl in May and November months are shown as 299 and 255 mg/l respectively. The average concentration of CI is beyond the desirable value of 250 mg/l. It is observed that collected data are under the allowable limit of 1000 mg/l (BIS, 2012). High chloride concentrations may result from sewerage waste pollution and ion leaching from landfill sides (Singh Abhay et al., 2007).

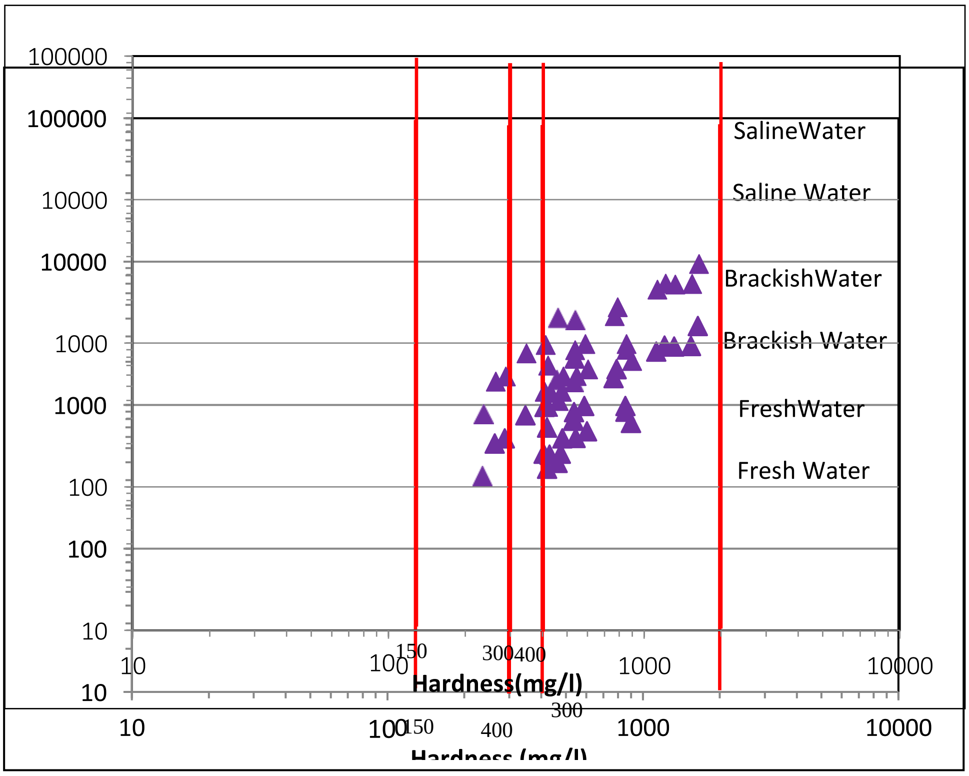


Figure .2 Classification of groundwater base on TDS and Total hardness (TH) in pre-monsoon

Concentrations of bicarbonate (HCO3) varies from 92 to 620 mg/l, and 199 to 600 mg/l in the month of May and November respectively. The average HCO3 concentration is given as 227 mg/l and 221 mg/l for two seasons respectively. Desirable limit of HCO3 is given as 200 mg/l (BIS, 2012). The results shown that, the average concentration of HCO3 is higher than the desirable limit.

Concentrations of Sulphate (SO4) varies from 125 to 1145 mg/l and 211 to 1130 mg/l in the month of May and November respectively. Average Sulphate (SO4) is 230 mg/l and 224 mg/l for two seasons, respectively. The average SO4 concentration is exceeds the desirable limit of 200 mg/l. Aside from the desirable limit, approximately 45% and 38% of samples higher than the allowable range of 400 mg/l. High SO4 concentrations caused due to breakdown of organic materials in weathered soils, as well as anthropogenic and agricultural activities (Craig and Anderson 2017). Due to high magnesium in drinking water, laxative effect happens and led to unstable of water and harm to human system.

The concentration of Nitrate (NO3) around the study area ranged from 23 to 1050 mg/l, with a normal value of 202 mg/l. Concentrations of NO3 varied from 20 to 989 mg/l during November month, with an average of 198 mg/l. The average NO3 concentration exceeds than the allowable value of 45 mg/l. In terms of nitrate contamination, the majority of the data is higher than the allowable limit (BIS, 2012). The concentration of NO3 is high in the study area could be led to a faulty sewage system and poor waste disposal management.

Fluoride (F) concentrations varies from 0.25 to 2.5 mg/l and 1.10 to 3.35 mg/l, with a mean value of 0.96 mg/l and 0.81 mg/l in the month of May and November respectively. Approximately 47% and 39% of the water data were found beyond the allowable value of 1.5 mg/l.

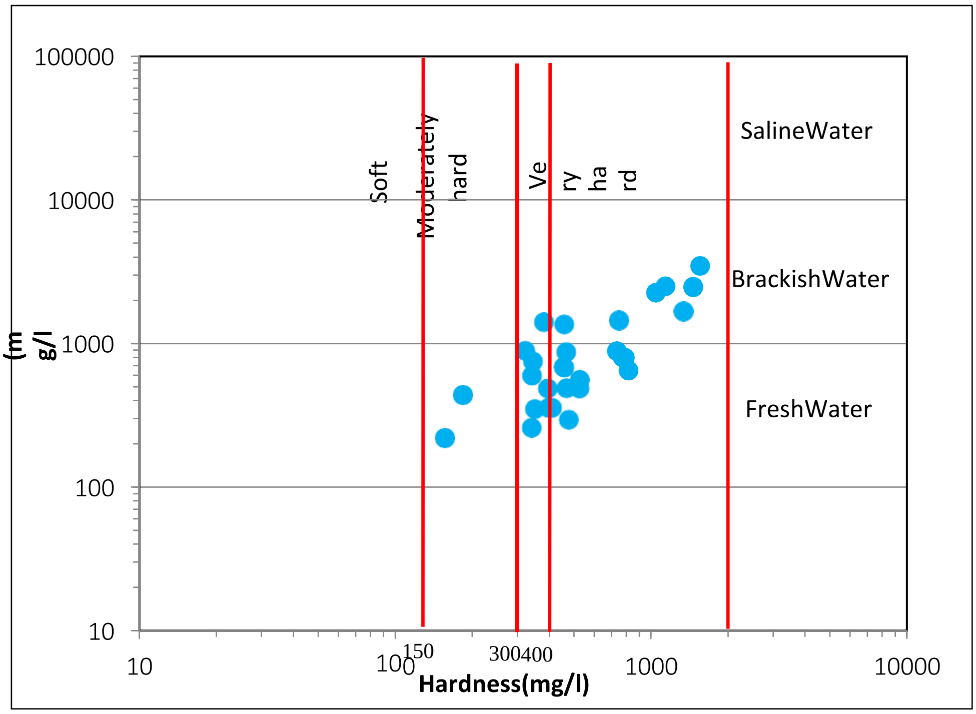


Figure .3 Classification of groundwater base on TDS and Total hardness (TH) in post-monsoon

Total Cations and total Anions

A plot was made between the total cations and total anions in milliequivalent for the May and November month to check the accuracy of the results. The majority of sample points fall along an equiline, indicating that the total cations and anions are balanced (Figure 4, 5). This graph depicts the precision of the chemical analysis data. This result was also supported by the ionic balance ratio.

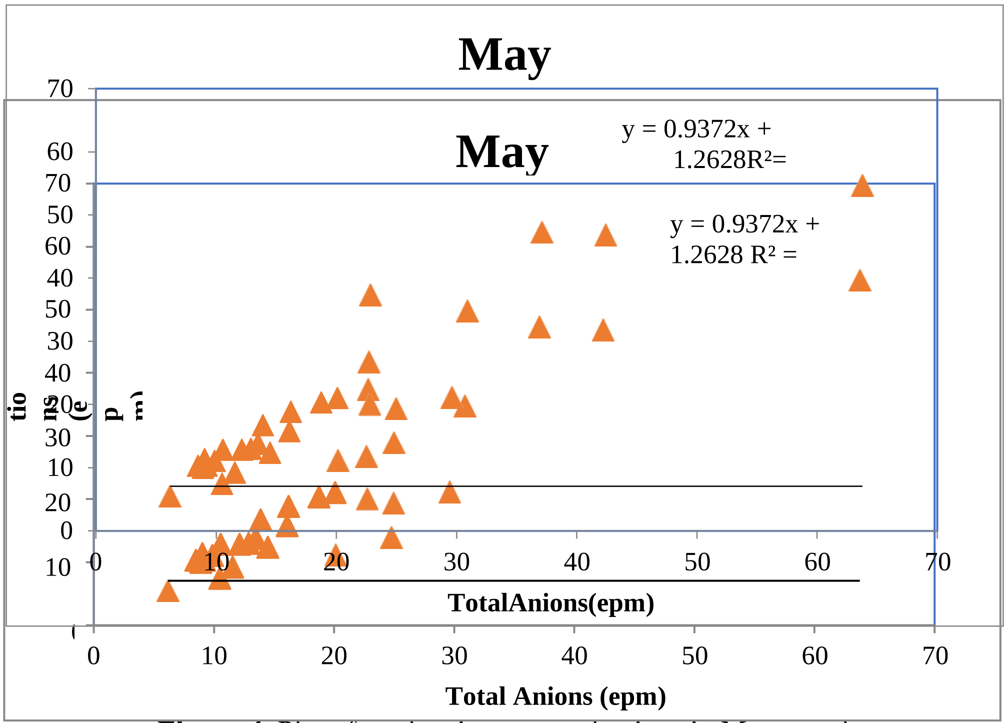


Figure 4. Plot of total cations vs total anions in May month

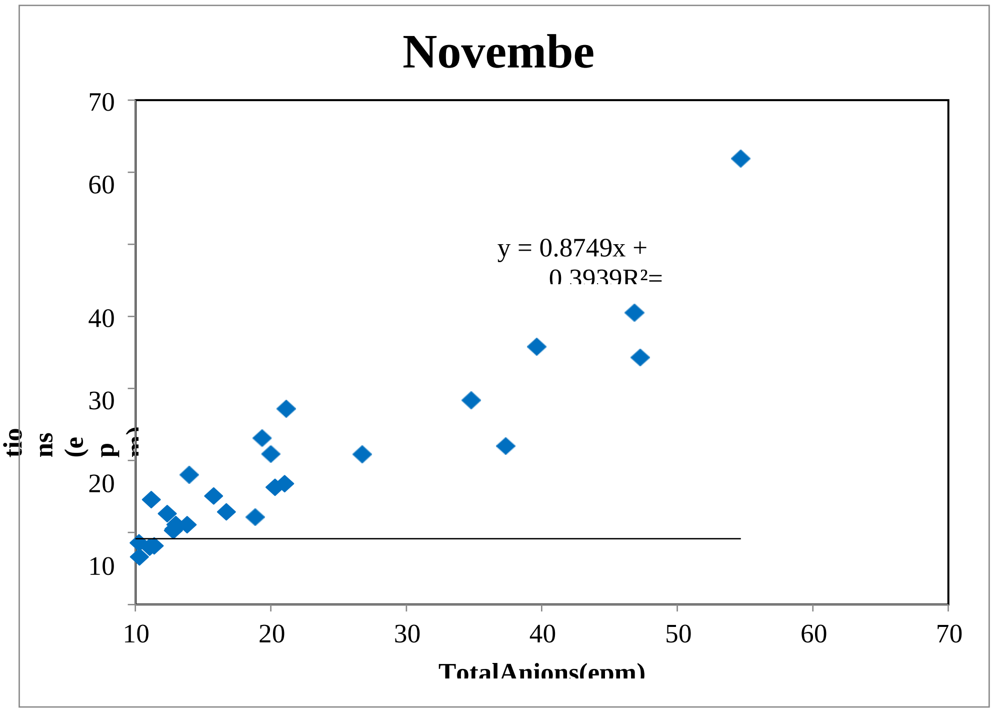


Figure 5. Plot of total cations vs total anions in November month

Hydro chemical facies of groundwater

Groundwater hydrogeochemical lithologic investigation is a useful method to defining the pattern of flow and chemical characteristics of origin in groundwater. For the month of May and November, chemical data in milliequivalent percentage was plotted in a Chaddah diagram (Chadha, 1999). The Chadha diagram, shown in figure 6.a, b, identified six facies. According to the graph, the most of the water data samples fall into classes 6 and 4. Class 6 and 4 have alkaline earths (Ca+Mg) that outnumber alkali metals (Na+Cl) and strong acidic anions (HCO3+CO3) that outnumber weak acidic anions (Cl+SO4), respectively. In both seasons, the dominant hydro chemical facies identified by the Chadha diagram were Ca-Mg-HCO3 and Na-K-HCO3.

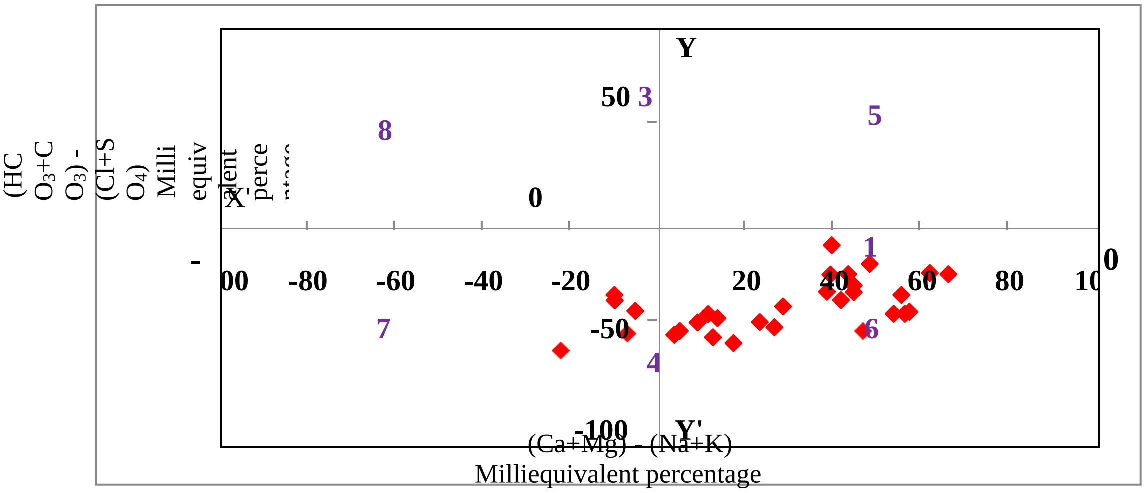


Figure 6(a)

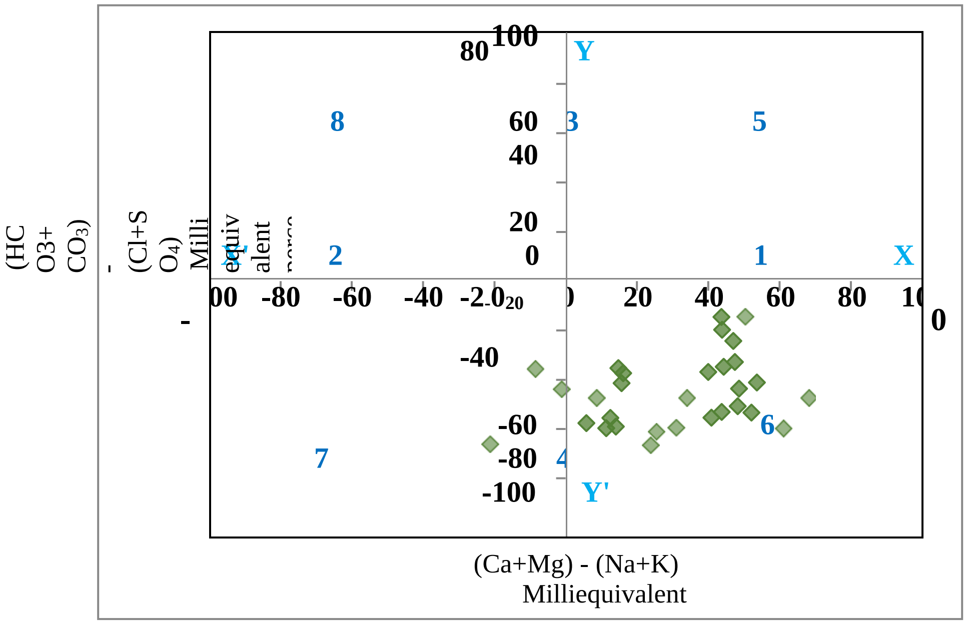


Figure 6(b)

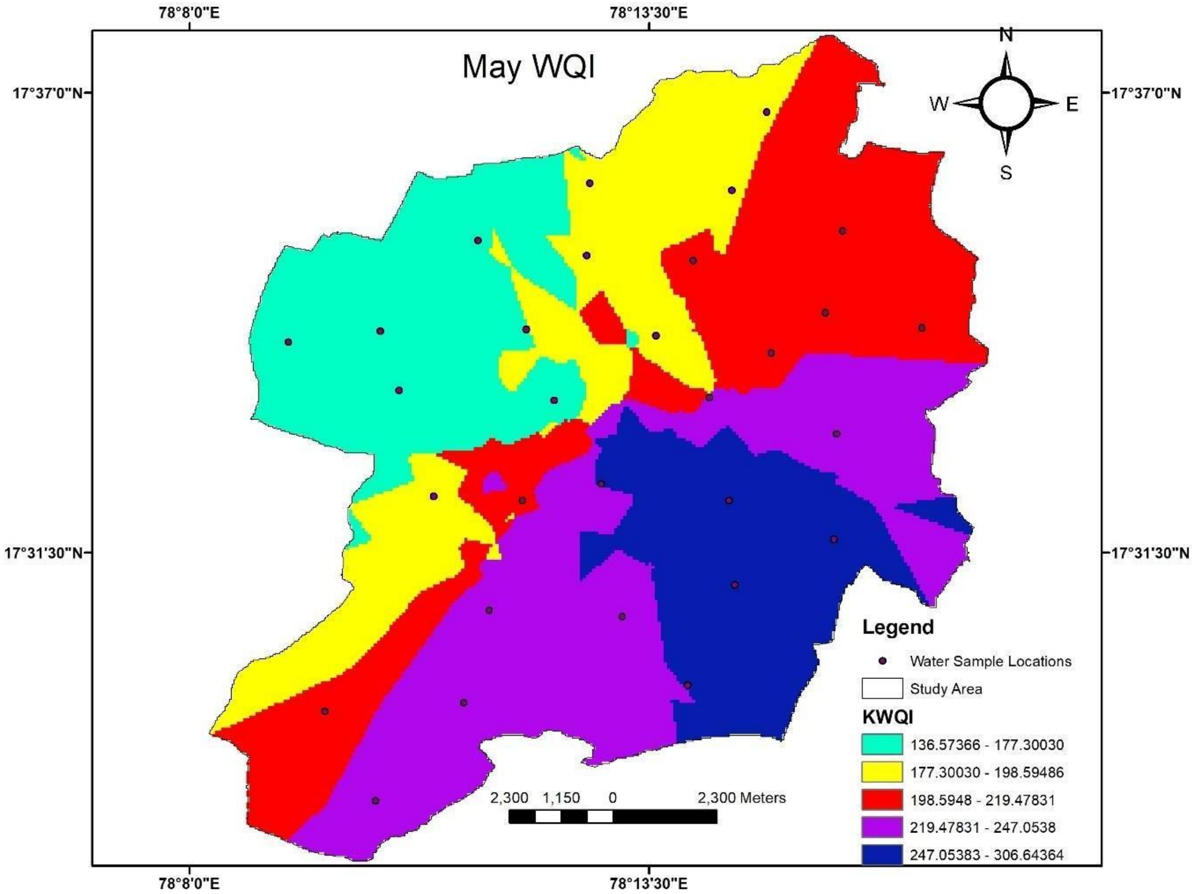
Figure 6. (a,b): Chadha diagram (a, May; b, November).

Kriging Water Quality Index (KWQI)

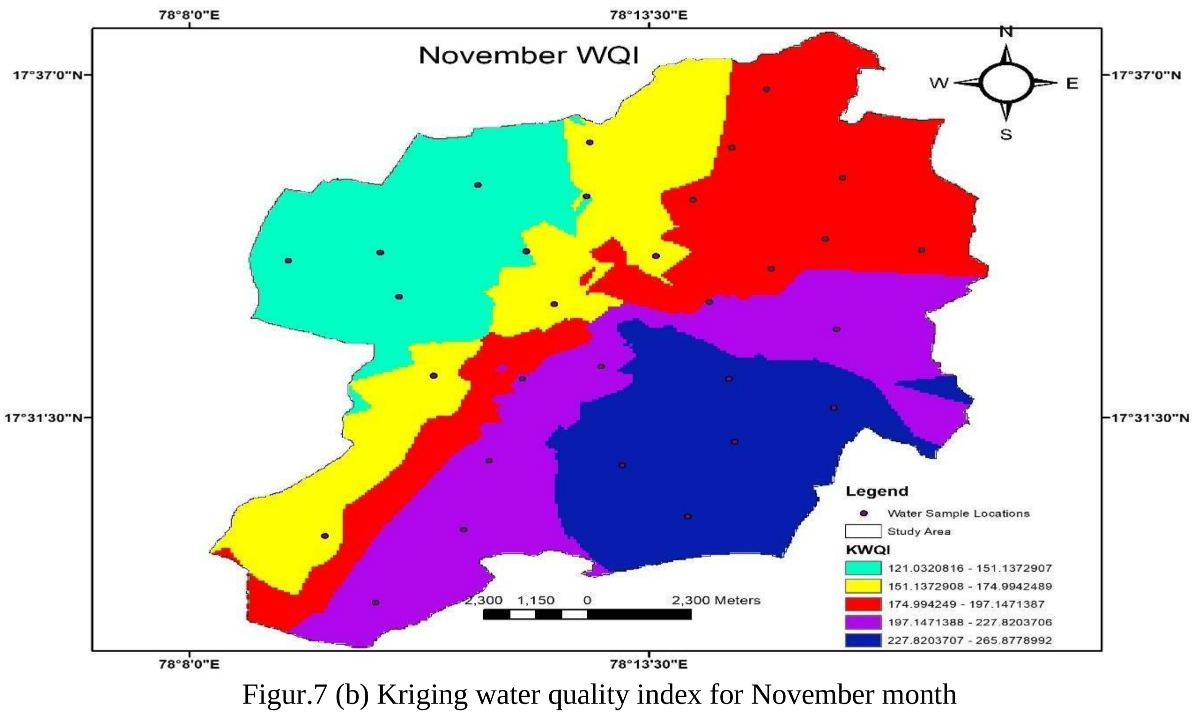
From the results it is observed that WQI ranged from 74 to 508 mg/l with a mean value of 201 in the Month of May 2020, and from 59 to 474 mg/l with a mean value of 184 mg/l in November month. Table 5 represents the water in the study area and its categorisation based on WQI values. According to the WQI classification, approximately 15% and 21% of samples in the May and November month respectively, belong to the very good water quality. From the WQI results it is observed that most of samples, approximately 40% and 45% are exhibit the Poor water type in the month of May and November respectively. Interestingly, it is observed that round 10% and 8% of the samples data are not acceptable for drinking purposes. Kriging interpolation is performed on the five buffer zones of the study area as shown in Figure 7 (a, b). From Figure 7 (a, b), we can clearly see the spatial distribution trend of water quality for May and November months. The Kriging Water Quality Index (KWQI) map shows depicts six classes of water quality, namely excellent: white colour (range <120), very good: Beryl green colour (121-150), good: yellow colour (range 151-174), poor: red colour (175-200), very poor: purple colour (range 201-250), and not acceptable for drinking: blue colour (range >251). The major part of the study area falls in the good category during two seasons and there are no major seasonal variations in the study area. Through semi-variance function and Kriging interpolation, it is found that the overall characteristics of each water quality index are telling that at south east side water is not acceptable for drinking purposes and in west north side water is very good condition. We can also see that in north east and south west side water is range from poor to good condition. From spatial analysis we can say that in south east side more significances precautions should be taken.

Table 5. Groundwater quality classification based on WQI

WQI (mg/l)	Water Quality	% of samples	
		May 2020	**November 2020**
<120	Excellent	-	-
121-150	Very Good	15	21
151-174	Good	40	45
175-200	Poor	30	20
201-250	Very Poor	5	6
>251	Not acceptable for drinking purposes	10	8



Figur.7 (a) Kriging water quality index for May month



Figur.7 (b) Kriging water quality index for November month

4. Conclusions

Present study was undertaken to measure the groundwater quality of Patancheruvu, one of the most polluted cities in Medak District, South India. The entire study area is characterised by high pollution load in terms of almost all the physiochemical as well as heavy metals. Most of the measured variables exhibited random distribution in the groundwater samples and the correlation study showed mutual associations among various parameters. The average TDS value exceeds the desirable limit of 500 mg/l (BIS, 2012). Approximately 39% and 35% of the samples exceeded the permissible limit of the BIS standard for drinking. The majority of the samples were discovered in nature as fresh water. The presence of salts such as Na, Cl, SO4 and HCO3 may contribute to the region's high TDS. The presence of various industries and anthropogenic activities may result in high TDS concentrations. The arrangement of major cations is in the following order: Na > Mg > Ca > K. In two months, the major anions are Cl > SO4 > HCO3 > NO3 > F. Most of the data exceeded the desirable limit for TDS, EC, TH, Na, Mg, SO4, CL, HCO3 and Ca. In both months, the dominant facies identified by the Chadha diagram are Ca-Mg-HCO3 and Na-K-HCO3. WQI ranged from 74 to 508 mg/l with a mean value of 201 in May 2020, and from 59 to 474 mg/l with a mean value of 184 in November. According to the WQI classification, the most of the data in both seasons fell into the Poor to Very Poor water category. The high concentration of TDS, Cl, and HCO+ in the region may be contributing to the high concentration of WQI. About 70% groundwater sample belonged to the hard water category. It is observed that groundwater quality in this area is poor, which may be attributed to both anthropogenic factors such as septic tank leakage, untreated domestic discharge, fertilisers from irrigation, and waste come from various industries. Overall, the water quality evaluation in the study area revealed that the aquifer is under significant anthropogenic stress. However, the extent of pollution/contamination is very severe, and if neglect means the environmental conditions may deteriorate if it remained unnoticed. Therefore, it is recommended to safeguard the aquifer by implementing the appropriate environmental management strategies thereby limiting the intrusion of the anthropogenic pollutants and reducing the point and non-point emission sources in the study area. Therefore, consistent efforts and planning should be taken place so that this groundwater quality can breathe easily. To sum up all results, it is conclusion that very necessary to carry out the research on the spatial distribution characteristics of ground water quality in the study area. The change of its characteristics on the spatial scale will be helpful for in-depth analysis of the characteristics of groundwater quality.

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