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A study on physico-chemical analysis of ground water near industrial area, Warangal, Telangana, India

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Abstract
Groundwater is an essential and vital component of our life support system. The deterioration in the groundwater quality due to geogenic and anthropogenic activities has drawn great attention as it is the major alternate source of domestic and drinking water supply. The present study aims to identify the ground water contamination problem in areas located in the close vicinity of industrial area at Warangal (Telangana), India. Ground water samples were collected from different locations at the depth of 40- 120 feet from earth's surface layer. Analytical techniques as described in the standard Methods for examination of water and waste water were adopted for physico-chemical analysis of ground water samples and the results compared with the standards given by WHO and BIS guidelines for drinking water. The present investigation carried out analyzed for various parameters like PH, Electrical conductivity, Turbidity, Total dissolved solids, Total hardness, Sodium, Potassium, Flouride and Chloride. From the overall analysis, it was observed that there was a slight fluctuation in the physico-chemical parameters among the water samples studied. The water samples collected from the industrial area compared with other two locations and account for health hazards for human use.

Keywords: Ground water, electrical conductivity, turbidity, sodium

Introduction
Water is most essential for existence of Life on earth and is a major component for all forms of lives, from micro-organism to man. Various Physico- chemical parameters have a significant Role in determining the potability of water. As per World health organization, safe and wholesome drinking water is a basic need for human development, health and well-being, and it is an internationally accepted human right (WHO, 2001) [19]. India's environment is becoming fragile and environmental pollution is one of the undesirable side Effects of industrialization, urbanization, population growth and unconscious attitude towards the environment. At present, environmental protection is the main need of the society. In the last three decades, the rapid growth of Industrialization and urbanization has created negative Impacts on the environment due to industrial, municipal and agriculture wastes containing pesticides, Insecticides, fertilizers residues and heavy metals. Several Industries are being establishes day by day due to meet the complex the requirement of rapid growing Urbanization, consumerization and increase the demand Of product in the modern time (Sastry and Rathee, 1999) [15]. In modern industrialization period, the most of water resources have affected enormously by seepage, Leaching and mixing of industrial effluents in most of the Metropolitan cities and industrial townships. The study of underground contamination will be of immense help to researchers and environmental regulators working in the area to understand and evolve by initiating remedial measures. The detrimental alteration of the naturally occurring physical, thermal, chemical, or biological quality of groundwater is called ground water contamination. Ground water is considered as one of the purest forms of water available in nature and meets the overall demand of rural as well as urban population. With the growth of industry the ground water is made susceptible for contamination due to addition of waste materials. Waste materials from the factories percolate with rain water and reach aquifer resulting in erosion of ground water quality. Groundwater is used for domestic, industrial, water supply and irrigation all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population, unplanned urbanization, industrialization and too much use of fertilizers and pesticides in agriculture (Joarder *et al*., 2008) [8]. The industrial effluents contain toxic chemicals, Hazardous compounds, suspended solids and non biodegradable Materials. The major source of surface and Ground water pollution is injudicious discharge of untreated industrial effluents directly into the surface water bodies resulting in surface and

ground water Pollution (Nasrullah, *et al.,* 2006). The availability of ground water depends upon the rate at which it is recycled by hydrological cycle than on the amount that is available for use at any moment in time. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored back easily and to device ways and means to protect it (Maniyar, 1990).

The quality of water is of vital concern for the mankind since it is directly linked with human welfare. Therefore, monitoring the quality of water is one of the essential issues of drinking water management considering the above aspects of groundwater contamination. The present study was undertaken to investigate the impact of the groundwater quality water samples at industrial area Warangal district, Telangana, India.

Materials and Methods

The study site the research work was conducted in industrial area. There are different industries being located in the area such as chemical industries, hazardous waste reprocessing industry, re-cycling/ reprocessing used oil industry, lead acid storage batteries industry, animal feeds industries and some other agro based industries. With this regards present study is a taken assessment of groundwater quality in the region of industrial area, Warangal.

Study area

Sample collection and Analysis

Main objective of the research work is to study the impact of industries on groundwater quality. The groundwater pollution might occur due to intrusion of effluents discharges from the industries, rock deformations, agricultural returns and application of fertilizers during farming. The site selection was divided into 2 zones namely at the industrial area and domestic borewells. The ground water samples were collected from different areas of near to industrial area, such as (S-1)- Domestic areas, (S-2)- Domestic Area, (S-3). The water sample were collected in monthly intervals of 3 trials in sterilized polyethylene cans (2-l capacity) and was transported to the laboratory for chemical analysis. The samples were analyzed as per the procedure laid down in APHA (1998) [3]. The results are given in Table 2, 3 and 4.

Table 1: Standard Methods used for Physico-Chemical Analysis

Sl. No.	Parameters	Methodology	References
1	pH	Electrometric method Digital pH meter (Hanna make of model PHEP)	APHA (1998) [3]
2	Electrical Conductivity (µmhos/cm)	Electrometric method Conductivity meter (Hanna make with model number DiST-4)	APHA (1998) [3]
3	Turbidity	Nephelometer	
4	Total Alkalinity (mg/L)	Volumetric analysis, Titrimetric	Grasshoff (1999) [3]
5	Totlal Dissolved Solids (mg/L)	Electrometric, (Hanna make with model number DiST-4)	APHA (1998) [3]
6	Calcium Hardness (mg/L)	Titrimetric method	APHA (1998) [3]
7	Magnesium Hardness (mg/L)	Titrimetric method	APHA (1998) [3]
8	Total Hardness (mg/L)	Titrimetric method	APHA (1998) [3]
9	Sodium (Na^+) (mg/L)	Flame Photometer (ELICO make)	APHA (1998) [3]
10	Potassium (K^+) (mg/L)	Flame Photometer (ELICO make)	APHA (1998) [3]
11	Fluorides (mg/L)	SPADNS Method, Colorimeter (ELICO make)	APHA (1998) [3]
12	Chlorides (mg/L)	Argentometric, Titration	APHA (1998) [3]

The average concentration of physicochemical parameters of GW samples and its percentage compliance with drinking water quality standards BIS (10500, 1991).

Parameter	Indian Standards (Desirable Limits)
PH	6.5-8.5
Turbidity	5
Ec	
Total Dissoloved Solids	500
Total Hardness	300
Sodium	200
Potassium	2-4
Ca++	75
Mg++	35
Cl	250
flouride	1.5
Total Alkalinity	100-200

All units except pH, Turbidity and EC are in mg/L, Turbidity in NTU, EC in umohs/cm

Results and Discussion

PH: PH is measure of intensity of acidity or alkalinity of water. All chemical and biological reactions are directly dependent upon the PH of water system. In the collected samples the values of PH were in the permissible limits prescribed by WHO 1993, FAO, 1985; Minhas *et al*., 1992) [19, 20].

Electroconductivity: Electrical conductivity is used to indicate the total ionized constituent of water. It is directly related to sum of the cations and anions (Maruthi and Rao, 2004). The sample No 1 shows the values ranges from 1150-1630, 1950-2300 (sample -2) and Sample -3 shows 18450-19320 mmhos/cm. In all the collected samples EC values were present in permissible limits Except Sample No 3.

Turbidity: Generally water turbidity is due to colloidal and extremely fine dispersions. In the present study the turbidity values varied between 0.3-0.4 NTU, and the values were in permissible range in pre monsoon and post monsoon.

Total alkalinity: Alkalinity of water is the measure of its capacity to neutralize acids. This is due to the salts of weak acids or strong bases. Carbonates and bi carbonates represent the measure of alkalinity Bicarbonates are formed in considerable amount from the action of carbon dioxide upon basic materials fin soil and other salts of weak acids (APHA, 1998, Ansa- Asare *et al*., 2000) [3, 2]. In all sample sites values were within permissible limits, S-1 (328-400), S-2 (384-408) And S-3 (252-300). The values of total alkalinity were comparatively moderate. The water for domestic use having alkalinity less than 100 mg/l is safe. The high content of alkalinity is shown in the Table 2, 3 & 4.

Total Dissolved Solids: This is the important parameter for the use of water. The water with high TDS value indicates that water is highly mineralized. Desirable limit for TDS is 500 mg/L and maximum limit is 2000 mg/L prescribed for drinking purpose. High levels of TDS may aesthetically be unsatisfactory for bathing and washing. The concentration of TDS in the present study is observed in the range of 759-1076 mg/L it was observed in sample No 1. In the sample No 2 concentration of TDS values 1200-1452, where as in the sample No 3 the values are very high (12408-12738). It is indicating that this water is unsuitable for drinking purpose. Drinking Water with high total dissolved solids generally showed Inferior potable quality and induced an unfavourable Physiological reaction in the transient consumer and gastrointestinal infections.

Calcium Hardness: Calcium content is very common in groundwater, because they are available in most of the rocks, abundantly and directly related to hardness. The concentration of calcium value present in the sample No 1(180-200) S-2 (150-200) and S-3 (1600-1640). The study revealed that in sample No 3 consist of higher amount of Ca levels. It is indicating that water is unsuitable for drinking. The high concentration of calcium levels may be due to discharge of various chemical hazardous substances from the industries percolated into the ground water. The results showed that in all locations the calcium values were not permissible limits.

Magnesium hardness: The presence of major ions such as Ca, Mg and HCO_3 in water causes hardness and makes it unsuitable for drinking purpose (Jain *et al*., 2005) [6]. According to the Indian standards the permissible limits of Mg is 30 mg/L, but in the present study, in all the ground water samples showed exceeding limits (180-200, 120-128 and 2300-2800) in S1, S2 and S3. In the S3 samples concentration of Mg ions were present in exceeding limits, it is due to the discharge of industrial effluents in to the ground water. This study revealed that ground water collected from the industrial area unsuitable for drinking purpose.

Total hardness: The major sources of hardness in water are dissolved calcium and magnesium ions from sedimentary rocks, whereas minor contribution to the hardness of water is made by ions of aluminum, barium, manganese, iron, zinc etc. The permissible limits prescribed by WHO is 300 mg/L. In the present study the ground water samples collected from the sample no 1 values ranges 360-400 both in pre and post monsoon. The values in S2 consist of 280, where as in the ground water collected from the S3 (3925-4400). The results showed that S1 has moderate value and S3 consist of exceeding limits and is not suitable for drinking purpose. The high degree of water hardness can definitely be Attributed to the disposal of untreated and improperly Treated sewage and industrial wastes (shanker, *et al.*, 2008) [16].

Sodium: Sodium concentration is important in water. Excess of Na in water is unsuitable for patients suffering from hypertension or congenital heart diseases and also from kidney problems (Rao *et al*., 2012) [14]. It is dangerous for human health, particularly for infants causing Methaemoglobinemia. As per WHO (1993) [19, 20] 200 mg/L sodium is the permissible limit. In the present study the concentration of Na inS1 (144-150), S2 (90-92) and S3 (360-370). Here in this study S1, S2 except S3 showed permissible limits.

Potassium: The main reason for the increase in the potassium concentration in ground water is due to agricultural activities. The excess amount of potassium present in the water sample may leads to nervous and digestive disorders (Tiwari, 2001) [17]. In the present study all the samples contain excess limits than the permissible limits (10-12, 9-10 and 20-22 in pre and post monsoon season). From this results indicating that all the ground water samples unsuitable for drinking purpose it causes neurological problems.

Flouride: According to BIS and WHO standards the limit of fluoride is 1.0 to 1.5 mg/L. The table 2, 3 & 4 showed that the concentration of fluoride lies between 0.5-1.5 mh/L. in pre and post monsoon seasons. From this study indicates that sample 3 only consist of slightly higher values than the sample 2 and 3. Fluoride concentration exceeds the level of 3 mg/L, it causes skeletal flourosis (Kalwale *et al*., 2012) [9].

Chloride: Chloride content in fresh water is generally influenced by evaporation and precipitation (Dhuley *et al*., 2000). Chloride in the form of Cl is one of the major inorganic anions in water. High concentration of Cl produces hypertension, Effect on metabolism of body and increase the electrical conductivity of water. High concentration of Cl indicates organic pollution in the water. (Tripati *et al*., 1989). According to BIS standards the limit of chloride is 250 mg/L. In the present study the concentration of Cl in the sample 1 (160-180), S2 (232-280) and S3 (5300-5700). The present study showed that sample 3 contain Cl concentration is exceed than the normal value. It indicates that he ground water sample collected from industrial area is highly contaminated and unsuitable for drinking. Excessive Chloride imparts bitter taste to water and corrode steel and may cause cardio-vascular problem.

Results

Table 2: Water quality during the south-west and north-east monsoon period at domestic area warangal district

Sampling month	pH	EC	Turbidity	Total Alkalinity	TDS	Ca Hard-Ness	MgHard-ness	Total Hard-ness	Sodium	Potassium	Fluorides	Chlorides	WHO prescribed standard
Jun 2015	7.3	1580	0.3	370	1050	200	190	400	144	10	0.9	175	
July 2015	7.31	1450	0.3	345	1007	200	200	400	148	12	1.3	180	
Augt 2015	7.30	1320	0.4	360	970	200	190	400	146	11	1.2	170	
Sept 2015	7.35	1630	0.4	400	1076	200	200	400	150	10	0.7	160	
Oct 2015	7.28	1150	0.3	328	759	200	200	400	149	10	1.3	180	
Nov 2015	7.28	1330	0.4	380	878	180	180	360	149	11	0.5	180	
SD	0.02582	179.444	0.05477	25.5376	119.099	8.16497	8.16497	16.3299	2.25093	0.8165	0.33714	8.01041	
Mean ±	7.30333	1410	0.35	363.833	956667	196.667	193.333	393.333	147.667	10.6667	0.98333	174.167	

Table 3: Water Quality during the South-West and North-East Monsoon period at DOMESTIC AREA-2

Sampling month	pH	EC	Turbidity	Total Alkalinity	TDS	Ca Hard-Ness	Mg Hard-ness	Total Hard-ness	Sodium	Potassium	Fluorides	Chlorides
Jun 2015	7.0	2100	03	395	1200	160	126	280	91	9	1.3	266
July 2015	7.1	2300	03	400	1417	150	125	280	92	10	1.3	240
Augt 2015	7.0	2100	04	390	1450	200	122	280	90	9	1.3	250
Sept 2015	7.1	2200	03	384	1452	170	122	280	91	10	1.3	260
Oct 2015	7.1	1970	04	408	1200	152	128	280	91	9	1.3	232
Nov 2015	7.0	1950	04	400	1287	160	120	280	90	9	1.3	280
Mean ±	7.05±	2103.33±	0.35	396.167	1334.33	165.333	123.833	280	90.8333	9.33333	1.3	254.667
SD	0.05477	133.666	0.05477	8.44788	120.324	18.4029	2.99444	0	0.75277	0.5164	0	17.603

Table 4: Water Quality during the South-West and North-East Monsoon period at INDUSTRIAL AREA, WARANGAL City

Sampling month	pH	EC	Turbidity	Total Alkalinity	TDS	Ca Hard-Ness	Mg Hard-ness	Total Hard-ness	Sodium	Potassium	Fluorides	Chlorides
Jun 2015	7.2	18580	0.3	290	12611	1610	2400	3930	360	22	1.4	5600
July 2015	7.4	18450	0.3	277	12645	1600	2400	3925	366	21	1.4	5600
Augt 2015	7.3	19320	0.4	270	12547	1620	2500	3930	370	20	1.3	5500
Sept 2015	7.4	19300	0.4	300	12738	1640	2300	3940	367	22	1.4	5600
Oct 2015	7.3	18800	0.3	252	12408	1600	2800	4400	365	21	1.3	5300
Nov 2015	7.6	18800	0.3	280	12408	1600	2800	4400	366	22	1.5	5700
Mean ±	7.38	18875	0.33333	278.1667	12559.5	1611.67	2533.33	4087.5	365.6667	21.33333	1.383333	5550
SD	0.148324	362.6431	0.05164	16.57005	132.5787	16.0208	216.025	242.11	3.265986	0.816497	0.075277	137.8405

Conclusion

From these results, it may be concluded that quality of ground water in pre and post monsoon varies from place to place. The ground water of industrial area region possessed higher values of all parameters compared with other sample sites. The overall observation of present study indicated deterioration trend of ground water quality in the available water table on sampling areas due to lack of Waste water treatment facilities in all industries these Industries have not fulfilled the norms of pollution. Controlling authorities such as central pollution control Board, New Delhi and State Pollution Control board. Such types of industrial water pollution problems mainly concerned by lack of environmental ethics, lack of financial resources and non-adoption of environmental laws at the corporate level. The ground water resources must be non-contaminated, purified and treated efficiently on sustainable basis at point and non point sources of pollution level. The drinking water quality should be properly maintained and be available for human society to get healthy longer life.

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