Research Article

Quality Characterization of Groundwater at Amroha (Uttar Pradesh)

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ABSTRACT
Groundwater is a natural resource for drinking water. Like other natural resources, it should be assessed regularly and people should be made aware of the quality of drinking water. The present study is aimed at assessing the water quality for the groundwater of Amroha district. This has been determined by collecting twelve groundwater samples from public places of Amroha district and subjecting the samples to different physico-chemical analysis. It may be concluded that underground water at Amroha is highly alkaline, very hard, highly polluted with organic and also highly polluted with reference to all physico-chemical parameters studied. The water sources of the area are not suitable for drinking, domestic and industrial as well as irrigation purposes with respect to the physico-chemical parameters. The present study suggested that ground water quality management is urgently needed for the study area.

Keywords: Physico-chemical, ground water, iron, chemical oxygen demand.

INTRODUCTION

The quality of water is vital concern for mankind since it is directly linked with human health. Groundwater is highly valued because it constitutes the major drinking and irrigation water source in most of the parts of India. In recent decades, exploitation of groundwater has increased greatly, particularly for agricultural purpose, because large parts of the country have little access to rainfall due to frequent failures of monsoon[1,3]. Presently, 85% of the water requirement for domestic use in rural areas, 55% for irrigation and over 50% for industrial and urban uses is met from groundwater. Groundwater irrigation started with only 6.5 Mha in 1950-515, which was increased to 46.5 Mha in 2000- 200117 meeting about 70% of the irrigation water requirements of the country. This clearly indicates the growing pressure on groundwater resources. There is growing concern on the deterioration of groundwater quality due to geogenic and anthropogenic activities. The quality of groundwater in a region is a function of physical, chemical and biological parameters[9,10]. Groundwater quality is as important as the quantity. Poor quality of water adversely affects the plant growth and human health. It decreases agricultural production; reduce agrarian economy, retards improvement in the living conditions of rural people. Potable water is the water that is free from disease producing chemical substances and microorganisms that are dangerous to health, majority of the rural people do not have accesses to potable water for domestic use. Several regions in India have encountered degradation in groundwater quality too, due to increase of population growth and rapid urbanization[4-6]. The present study carried out with the aim of understanding the groundwater quality and its suitability for domestic and irrigation purpose. Groundwater is usually as direct use in rural water supply without proper treatment and for agricultural practice most of the year. Groundwater may also contaminated due weathering of rock and agrochemicals used for irrigation in this area. However, no studies have been carried out in the with respect to drinking and irrigation purpose so far in the rural area of Periyakulam taluk. India is endowed with a rich and vast diversity of natural resources, water being one of them. Water is nature's most wonderful, abundant and useful compound[22,23]. Of the many essential elements for the existence of human beings, animals and plants, water is rated to be of the greatest importance. Without food, human can survive for a number of days, but water is such an essential that without it one cannot survive[12,13].

Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries. Groundwater is an

important source of water supply throughout the world. The quantity and the suitability of groundwater for human consumption and for irrigation are determined by its physical, chemical and bacteriological properties. Its development and management plays a vital role in agriculture production, for poverty reduction, environmental sustenance and sustainable economic development. In some areas of the world, people face serious water shortage because groundwater is used faster than it is naturally replenished[14,15]. Human development and population growth exert many and diverse pressures on the quality and the quantity of water resources and on the access to them. Water quality monitoring and assessment is the foundation of water quality management; thus, there has been an increasing demand for monitoring water quality of many rivers and ground water by regular measurements of various water quality variables. The physico-chemical study could help in understanding the structure and function of particular water body monitoring of ground water regime is an effort to obtain information on ground water levels and chemical quality through representative sampling. Due to inadequate supply of surface waters, most of the people in India are depending mainly on groundwater resources for drinking and domestic, industrial, and irrigation uses[20,21].

Innumerable large towns and many cities in India derive water supply from groundwater for different uses through municipality network and also from large number of private boreholes. About one billion people are directly dependent upon groundwater resources in Asia alone, and In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and created health problems. In recent years, because of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposals, the rate of discharge of the pollutants into the environment is far higher than the rates of their purification. The dependence on groundwater has increased tremendously in recent years in many parts of India. Hence, physico-chemical analysis of water is important to assess the quality of groundwater in any basin and/or urban area that influences the suitability of water for domestic, irrigation, and industrial needs. Because of the importance of groundwater in drinking and in other uses, its environmental aspects such as contamination transport have been significantly studied[16,17]. Many researchers have focused on hydro chemical characteristics and contamination of groundwater in different basins as well as in urban areas that resulted due to anthropogenic intervention mainly by agricultural activities and industrial and domestic wastewater. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. The availability of good quality drinking water is extremely important for prevention of diseases and for improving the quality of life for humans. Pure water does not exist in nature[18,24]. Water in its natural form contains living / non-living, soluble / insoluble, organic / inorganic components and its quality keeps on changing from time to time and place to place. The contamination of water is directly linked to the contamination of our environment. Potable water is derived either from surface water (rivers, lakes, streams, ponds etc.) or ground water (aquifers, ranney wells etc.) However, water from either source is rarely fit for drinking[19,20].

Amroha is a ‘C’ class city of western Uttar Pradesh having a population more than 19 lakh as per the census of 2011. District Amroha lies in the west of Moradabad District adjoining Meerut, Hapur, Sambhal & Buland Shahar. The district consists of 1133 villages, 3 Tehsils, 6 Blocks & 11 Police Stations. Its geographical area is 2470 Sq. Km. Extending from Latitute 28° 54’ North to 39° 6’ North and Longitude 78° 28’ East to 78° 39’ East. The maximum & minimum height from sea level are 240ft. and 177ft. respectively. In the north of the district lies district Bijnore, tehsil Sambhal of Moradabad is in the south, tehsil Sadar of Moradabad is in the east and in the west are situated districts Meerut, Ghaziabad & Buland Shahar. Ganga river separates it from district Ghaziabad, Meerut & Buland Shahar. Amroha has gone through rapid industrialization and population growth during last few decades. Some industries are causing underground water pollution in the area of our study and therefore, an attention is urgently needed.

MATERIAL AND METHODS

India Mark II (IM2) hand pump water at ten different sites at Amroha district was collected. Standard methods and procedures were followed for quantitative estimation of water quality physico-chemical parameters. All the

chemicals of Analytical Reagent (AR) grade were used, unless otherwise stated for analytical purposes[2,8,11]. 1.5 liter polypropylene bottles were used for water sample collection. Prior to sample collection, all bottles were washed with dilute acid followed by distilled water and were dried in an oven. Before taking final water samples, the bottles were rinsed three times with the water to be collected. The sample bottles were labeled with date and sampling source. Three samples of each site were collected, analyzed and arithmetic mean of three values is reported here. A blank was also run for all volumetric titrations[25,26]. The specifications of used instruments are Century CP 901 pH meter, RI Conductivity meter and Hach 2010(version 6.4) spectrophotometer. The estimated parameters are Temperature, pH, Conductivity, Total Solids, Total Dissolved Solids, Total Suspended Solids, Turbidity, Total Hardness, Calcium, Magnesium, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Chloride, Alkalinity, Phosphate and Sulphate[7]. A brief description of sampling sites is given in Table 1.

RESULT AND DISCUSSION

Site-wise estimated values of seventeen physico-chemical parameters with their prescribed W.H.O. standards are presented in Table 2 (W.H.O. 1984). A critical analysis of the data revealed following facts regarding ground water quality at Amroha.

The temperature was in the range of 21.2^{0}C to 25.4^{0}C in the ground water sample. pH reveals if a solution is acidic or alkaline. pH of water beyond permissible range can affect mucous membrane of cells and cause corrosiveness in water supply system. pH value determined for all the water samples collected from selected sites was found in the range of 7.33 to 8.01. All water samples were found to have high value of pH from the limit of WHO i.e. 6.5 to 8.5. EC is the most important parameter to demarcate salinity hazard and suitability of water for irrigation purpose. It signifies the amount of total dissolved solid. The Turbidity of any water sample is the reduction of transparency due to the presence of particulate matter such as lay or slit, finely divided organic matter, plankton and other microscopic organisms. In the present study, the range of turbidity in the study area is 2.13 to 5.40. EC values were in the range of 0.430 to 1.010 µS/cm. The high value of conductivity in all of the samples is likely due to prolonged and intensive agricultural practices and geological conditions acquiring high concentrations of the dissolved minerals.

The value of total solid is 750 to 1000 mg/L in area of study. The high TS may be attributed to use of salts during dyeing process. Total Dissolved Solids of water refers to the inorganic salts and organic matter present in water which may be due to the presence of sodium, potassium, calcium, magnesium, carbonates, hydrogen carbonate and ions of chloride, sulfate and nitrate. Total Dissolved Solids content of the drinking water samples collected from various sites showed a range between 680 mg/L to 805 mg/L. However; all the water samples showed higher TDS value from WHO guidelines i.e. 500 mg/L. In the present study, the range of total suspended solid is 45 to 205 mg/L in ground water samples. Suspended solids containing much organic matter may cause putrefaction and consequently the stream may be devoid of dissolved oxygen.

Dissolved Oxygen is an important for many chemical and biological processes taking place in water. DO in water can decrease due to microbial activity, respiratory and organic decay. Dissolved Oxygen value is an indicative of pollution in water and depicts an inverse relationship with water temperature. The permissible limit for DO as per WHO is 5 mg/L. Drinking water samples collected from various sites were found to contain DO levels ranging from 2.0 mg/L to 4.5 mg/L. All drinking water samples had DO within WHO permissible limit. The amount of dissolved oxygen is irrelevant for ground water. However, water sample are found to be deficient of oxygen. The oxygen-demanding nature of biodegradable organics is of utmost importance in natural water systems. In the present study, the BOD values in ground water samples were 13 and 28 mg/L. The results showed that the BOD values were higher in almost all the sites in the study area. Chemical Oxygen Demand test is quite useful in finding out the pollution strength of industrial waste and sewage. Chemical oxygen demand as is the amount of oxygen required for a sample to oxidize at its organic and inorganic matter. In the present study, the range of COD is 20 to 50 mg/L. Higher values of chemical oxygen demand are noticed for all study area.

Table 1: Details of sampling sites

S.No.	Site No. & Name	Location of site	Apparent water quality	Usage
1	I, Amroha Block	3.0 km North-East from Railway Station	Pale yellow on standing, odourless	Drinking & Bathing
2	II, Tehsil Amroha	6.0 km West from Railway Station	Colourless, odourless	Drinking & Bathing
3	III, Shah Vilayat Dargah Square	1.5 km South to site no. II	Colourless, odourless	Drinking & Bathing
4	IV, Vashu Dev Tirth	2.5 km West to site no. III	Pale yellow on standing, foul smell	Drinking, Washing & Bathing
5	V, Railway Station	6.0 km East Tehsil	Pale yellow on standing, odourless	Drinking, Washing & Bathing
6	VI, Lakra Square	4.0 km West to site no.II	Pale yellow on standing, foul smell	Drinking & Bathing
7	VII, Hasanpur Bus Stop	6.0 km South to site no.II	Colourless, odourless	Drinking, Washing & Bathing
8	VIII, Dhanora Bus Stop	7.0 km South-West to site no.II	Colourless, odourless	Drinking, Washing & Bathing
9	IX, District Court	4.5km South-West from Railway Station	Colourless, odourless	Drinking & Bathing
10	X, Nagar Palika Parishad	5.0 km South to site no.II	Pale yellow on standing, odourless	Drinking & Bathing
11	XI, Collectrate Amroha	0.5 km South to site no.IX	Colourless, odourless	Drinking & Bathing
12	XII, Roadways	2.0 km South from Railway Station	Colourless, odourless	Drinking & Bathing

Table 2: Site-wise estimated values of different physico-chemical parameters with their WHO standards

S.No.	Parameters	Site No.I	Site No.II	Site No.III	Site No.IV	Site No.V	Site No.VI	Site No.VII	Site No.VIII	Site No.IX	Site No.X	Site No.XI	Site No.XII	WHO Standards
1	Temperature(^{0}C)	24.8	23.1	25.4	25	22.8	21.2	22.7	25.2	24.4	25.2	25.1	24.9	-
2	pH	7.72	7.68	7.43	7.33	7.95	7.70	7.39	8.01	7.85	7.55	7.60	7.45	-
3	Turbidity (NTU)	2.72	3.21	2.54	2.13	5.40	3.01	2.55	5.10	4.75	3.15	2.95	3.41	5
4	Conductivity(µS/cm)	0.781	0.791	0.670	0.580	0.970	0.532	0.500	1.010	1.001	0.631	0.535	0.430	0.300
5	Dissolved Oxygen(mg/L)	4.12	3.52	2.5	3.06	3.7	4.4	4.5	2.0	2.43	3.8	2.8	3.2	5
6	Biological Oxygen Demand(mg/L)	22	16	25	15	25	15	14	25	28	17	14	13	6
7	Chemical Oxygen Demand(mg/L)	28	23	35	20	50	18	20	42	40	35	32	34	10
8	Total Hardness(mg/L)	350	380	285	270	550	320	335	450	535	340	355	320	100
9	Calcium(mg/L)	255	280	215	220	455	280	290	410	495	255	285	265	100
10	Magnesium(mg/L)	95	100	70	50	95	40	45	40	40	85	70	55	30
11	Total Solids(mg/L)	900	850	780	810	1000	750	860	950	980	780	810	805	500
12	Total Dissolved Solids(mg/L)	710	680	715	685	795	705	690	805	790	685	675	710	500
13	Total Suspended Solids(mg/L)	190	170	65	125	205	45	170	145	190	95	135	95	-
14	Chloride(mg/L)	61	81	56	65	165	80	69	150	170	72	85	67	200
15	Alkalinity((mg/L)	235	238	240	210	300	180	225	320	280	160	185	310	100
16	Iron (mg/L)	0.31	0.23	0.28	0.21	0.70	0.33	0.20	0.65	0.61	0.51	0.30	0.25	0.1
17	Fluoride (mg/L)	0.32	0.50	0.40	0.63	0.62	0.30	0.21	0.53	0.41	0.21	0.11	0.17	1.0

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 aluminium, barium, manganese, iron, zinc etc. The range of total hardness in all the drinking water samples was between 270 mg/L to 550 mg/L. However, all the water samples showed the range of hardness exceed permissible WHO limits. Calcium content is very common in groundwater, because they are available in most of the rocks, abundantly and directly related to hardness. Calcium concentration varies between 215 to 495 mg/L and found exceed permissible limit in many locations as per WHO. Magnesium usually occurs in lesser

concentration than calcium due to the fact that the dissolution of magnesium rich minerals is slow process. Magnesium concentration varies between 40 to 100 mg/L which were found most of samples exceed the prescribed limit (30 mg/L) as per WHO. The concentration of calcium and magnesium in drinking water is more than the permissible limit in area of study, it causes unpleasant taste to the water.

The chloride concentration due to domestic sewage, fertilizers applications and/or leaching from upper soil layers in semi arid climates. Small amounts of chlorides are required for normal cell functions in plant and animal life. Chloride concentration varies between 56 to 170 mg/L and found few samples exceed the prescribed limit. Alkalinity of the samples is in the range of 160-320 mg/L. The alkalinity levels of all the water samples are high thus, resisting acidification of the groundwater samples. Iron concentration in the groundwater samples are varies from 0.20 to 0.70 mg/L which exceeds the permissible limit of 0.1 mg/L as per WHO Standards.

The ground water samples exhibited high Iron contamination which is an indication of the presence ferrous salts that precipitate as insoluble ferric hydroxide and settles out as rusty silt. High concentration of iron is may contributed by industrial estate located at the sampling site, Iron is an essential element in human nutrition**.** Exposure to excess consumption of fluoride over some period may lead to increased chances of bone fractures, pain in bones and tenderness in adults. Young children exposed to excess amounts of fluoride have a chance of developing pits in tooth enamel. Fluoride levels ranging from 0.011 mg/L to 0.63 mg/L were detected in the drinking water samples. All drinking water samples had fluoride content within the range as suggested by WHO is 1.0 mg/L.

CONCLUSION

On the basis of discussion, Majority the sources had high Fe-content exceeding the WHO permissible limit in all the sites. Most of the parameters in the water sources of the study area were found high value from the WHO permissible limits. However, increasing urbanization, leaching from natural geological formations, domestic sewage and surface runoff from non-point agricultural sources have affected concentration levels of the studied constituents. A large portion of the contamination may be the outcome of growing human activities *i.e*., massive industrialization, construction activities, utilization of agricultural land and forest land for other developmental purposes in the catchment area. This also shows that the water sources of the area are not protected properly. The water sources of the area are not suitable for drinking, domestic and industrial as well as irrigation purposes with respect to the physico-chemical parameters. It may be concluded that underground water at Amroha is highly alkaline, very hard, highly polluted with organic and also highly polluted with reference to all physico-chemical parameters studied. At present that, Amroha city is losing its water quality day by day. From the above chemical analysis we saw that most of the water parameters have already existed there tolerates limits. Still it has the time to control the ground water pollution of the Amroha district.

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