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Research Paper

HYDROCHEMISTRY AND GROUND WATER QUALITY WITH SPECIAL REFERENCE TO NITRATE: A CASE STUDY FROM IPPATLA, KADAPA DISTRICT, ANDHRA PRADESH

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ABSTRACT

In order to understand the nitrate contamination in ground waters of Ippatla village, Kadapa (Dist), 20 ground water samples were collected and analyzed for different parameters like, pH, electrical conductivity (EC), total dissolved solids (TDS), hardness, K, Ca, Na, Mg, Cl and NO3.The main objective of this study is to know about the ground water quality especially nitrate in the study area. In the study area the pH of water varies from 6.7 to 8.4 indicating alkaline in nature. The electrical conductivity ranging from 450 to 4500 micromhos/cm, total hardness varies from 150 to 780 mg/l, TDS varies from 220 to 1200 mg/l, calcium values ranges from 45 to 280 mg/l, magnesium ranges from 32 to210 mg/l, sodium ranges from 32 to 210 mg/l and potassium ranges from 0.3 to 12 mg/l. In the study area, the analysis of ground water shows that the concentration of nitrate (as NO3) varies from 5 mg/l to 390 mg/l. The average nitrate concentration in ground water of the study area is 148.7 mg/l, which are significantly high as compared with guideline recommended by WHO. The concentration of nitrate is more than permissible limit (45 mg/l) in 15 water samples out of 20 samples in the study area. 60% of samples in the study area exceeded the upper limits 45 mg/l. Deeper wells have more NO3 concentration than shallow ones. Scatter plot shows the positive correlation between nitrate and chloride emphasizes that fertilizers are the probable source for the high values of nitrate and chloride. Nitrate and chloride concentrations in ground water were found to be lower in areas where the land had remained fallow for longer period. However, NO3 and Cl concentrations were found high in wells located in agricultural fields and where the land is in continual use. Thus, increased irrigation and fertilizer use caused increased nitrate and chloride concentrations in ground water of the study area. Hence there is a need to work out the optimum quantity of fertilizers that should be used for a particular crop in a particular area and to educate the farmers on this aspect

Keywords: Ground water, Ippatla village, Nitrate, Chloride, Fertilizer.

INTRODUCTION

Water is an essential constituent for all animal and vegetable matters. Ground water is one of the earth's most widely distributed and important renewable perennial resources occurring beneath the earth surface. There is increased pressure on ground water to meet various demands for sustenance of our society. This leads to interference with nature, threatening the resources in terms of quality. The quality of ground water is very important in evaluating its utility in various fields such as domestic, public water supply and agriculture. Water during the course of its flow, acquires the properties of its surrounding conditions and becomes a source of elements present in the areas through which it flows. The assessment of the dissolved constituents thus becomes very important for safe drinking water. Some ions dissolved in water and present in appropriate concentration are essential for human beings while higher concentration results toxicity. Ground water contamination has become a serious threat to mankind. . Up to an optimum level some of these may have beneficial effects but when the concentration reaches beyond a certain level it becomes hazardous for health. The quality of ground water has major impact on human health. High concentration of nitrate and other toxic entities pollute the ground water making it unsafe for drinking purpose (Kodate et al., 2007).

The occurrence of nitrogenous material in natural geologic systems is rare, but anomalously high concentration of nitrates in the groundwater indicates its contact with nitrogen rich soil zone. While nitrate is a common nitrogenous compound due to natural processes of the nitrogen cycle, anthropogenic sources have greatly increased the nitrate concentration, particularly in groundwater. The largest anthropogenic sources are septic tanks, application of nitrogen-rich fertilizers to turf grass, and agricultural processes. Technological advances in the field of agriculture and increased stress on the land to increase crop yield by irrational use of inorganic fertilizer has caused groundwater pollution. Nitrate contamination in ground waters is one of the worst environmental pollution problems and health hazards in many countries. Nitrate is one of the several inorganic pollutants contributed by human and animal wastes.

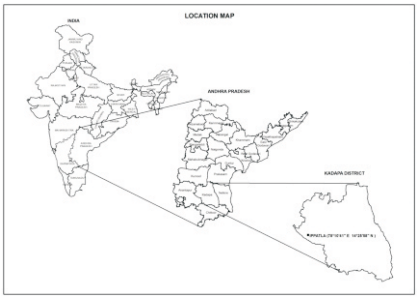
The maximum permissible limit for nitrates in drinking water is 45 mg/L (BIS, 2003; WHO, 1984). The consumption of water with high nitrate decreases the oxygen carrying capacity of the blood by oxidizing the normal haemoglobin to methaemoglobin, which restricts oxygen supply to the tissues. High nitrate concentration in drinking water is more dangerous to infants. Incidences of nitrate contamination in groundwater have been reported by several workers (Uma, 1993; Pawar and Shaikh, 1995; Gonnade et al., 2004; Bhartariya and Agrawal, 2004.

The main objective of study is to know about groundwater quality (especially nitrate) in and around Ippatla village, Kadapa district, Andhra Pradesh. In the present work, hydrochemical studies of ground water are carried out in order to evaluate its suitability for drinking purposes.

AREA OF THE STUDY

The study area, Ippatla village is in Lingala Mandal

geologically comes under Cuddapah Basin and is located in Kadapa District, Andhra Pradesh, (Fig. 1) and lies between latitude 14o 25'58" N and longitude 78o 10' 41" E, and is included in the Survey of India toposheet No. 57 J/3. This study area forms part of the Lower Cuddapah super group comprising Papaghni and Chitravati Groups. This village is about 85 Kms from Kadapa town and 10 Kms from Pulivendla. Geologically, major part of the area is occupied by basalts, dolomites, limestones, dolomitic limestones, shales and sandstones. In this area, ground water occurs under phreatic and semi-confined conditions. The joints and fractures constitute the porosity and permeability of the rocks. In the study area, temperature varies from 20oC to 45o C. The average annual rainfall is 600 to 670 mm. Agriculture is the main occupation of the people of the area. The major landuse-landcover patterns are observed in the study area that includes agriculture and wasteland. The main crops of the area are jowar, ground nuts, sunflower, leman gardens, cotton and vegetables



METHODOLOGY

A total of 20 ground water samples from bore wells in and around Ippatla village of Kadapa district were collected during May 2006. The water samples collected are extensively used for drinking, irrigation and domestic purposes. The depth of bore wells varies from 25 to 66 m. water samples were collected in precleaned polyethylene containers of one liter capacity. These samples were analyzed as per procedure laid down in APHA (1985, 1992). The water samples were analyzed for the parameters like, pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), K, Ca, Na, Mg, Cl and NO3. Data on land use, type of crops and nature of fertilizer used, source of irrigation etc., were collected during the field surveys.

RESULTS AND DISCUSSIONS

The hydrochemical analysis data is shown in Table 1. In the study area the pH of water varies from 6.7 to 8.4 averaging 7.35 indicating alkaline in nature. The electrical conductivity ranging from 450 to 4500 micromhos/cm and the mean value 2352 micromhos/cm. The total hardness varies from 150 to 780 mg/l and the mean value 430 mg/l. The water is moderately (75 -150 mg/l) to very hard (>300 mg/l) categories (Sawyer and McCarty, 1967). TDS varies from 220 to 1200 mg/l and the mean value is 711 mg/l. The calcium values ranges from 45 to 280 mg/l averaging 147.2 mg/l, magnesium ranges from 32 to210 mg/l averaging 107.9 mg/l, sodium ranges from 32 to 210 mg/l averaging 99.6 mg/l, and potassium ranges from ranges from 0.3 to 12 mg/l averaging 3.93 mg/l. Nitrate-nitrogen concentration exceeds 45 mg/l in 60% wells. High values of nitrate in general are characterized by high concentration of chloride.

In the study area, the analysis of ground water shows that the concentration of nitrate (as NO3) varies from 5 mg/l to 390 mg/l. The average ground water nitrate concentration for the study area 148.7 mg/l, which are significantly high as compared with guideline recommended by WHO (1984) and ISI (1983), which shows that ground water is not suitable for drinking purposes and public health. The concentration of nitrate is more than permissible limit (45 mg/l) in 12 water samples out of 20 samples in the study area. 60% of samples in the study area exceeded the upper limits 45 mg/l (WHO 1984). Deeper wells have more concentration than shallow ones Scatter diagram between chloride and nitrate is used for ascertaining the correlation between the two parameters (Fig 2). The wells having more than 45 mg/l of No3 concentration in general show that the concentration of Cl and NO3 has similar pattern (Fig 2). The Cl concentration varies from 10 to 218 mg/l. High NO3 and high Cl values indicating fertilizer as one of the possible source. Fig.2 shows that the positive correlation between nitrate and chloride emphasizes that fertilizers are the probable source for the high values of the said parameters. The concentrations of nitrate and chloride are diagrammatically shown (Fig 3). The said parameters are carried to the ground water system by return seepage from irrigation. Higher concentration of NO3 in ground water is an anthropogenic pollutant contributed by nitrogenous fertilizers, human and animal wastes through biochemical activity of nitrifying bacteria. Nitrate has been linked to agricultural activities due to excessive use of nitrate fertilizers (Gonnade et al., 2004, Janardhana Raju et al., (2009). Nitrate and chloride concentrations in ground water were found to be lower in areas where the land had remained fallow for longer period. However, NO3 and Cl concentrations were found high in wells located in agricultural fields and where the land is in continued use. Hence there is a need to work out the optimum quantity of fertilizers that should be used for a particular crop in a particular area and to educate the farmers on this aspect. In the wells where the nitrate concentration is known to be in excess the public should be educated about the potential danger of using the water for feeding/drinking.

Table 1. Hydrochemical Analysis of Ground Water Samples from Ippatla Village

Sample No	pH	Electrical Conductivity (EC) (Micromhos/cm)	TDS (mg/l)	Total Hardness(mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Cl (mg/l)	NO_3 (mg/l)
1	6.7	650	570	325	45	80	42	0.3	37	20
2	6.9	650	380	150	90	190	80	4.0	36	42
3	7.0	450	465	315	240	160	55	1.2	100	210
4	7.1	1050	735	540	92	83	136	0.4	120	219
5	6.7	2070	390	270	55	64	40	3.0	30	38
6	7.2	1290	680	400	250	132	165	6.0	130	190
7	8.0	3650	730	520	52	170	45	2.0	75	145
8	6.9	4155	600	332	200	55	35	1.5	10	5
9	7.3	4500	1200	780	195	80	140	8.0	25	41
10	7.0	3600	920	640	120	125	180	1.9	66	70
11	7.5	800	220	175	125	90	32	0.3	120	390
12	7.7	2900	545	460	260	150	90	12.0	90	88
13	6.8	3800	926	600	60	104	190	1.6	218	360
14	6.7	4200	725	465	135	120	50	8.0	150	340
15	7.4	850	1050	620	84	125	85	10.0	65	40
16	8.1	500	895	345	210	75	110	3.0	36	22
17	8.2	1900	990	520	280	115	43	0.8	115	280
18	7.5	2875	670	450	156	120	210	10.0	132	215
19	8.0	4000	1010	390	85	130	190	0.7	20	30
20	8.4	3100	520	305	210	70	74	4.0	110	166

CONCLUSIONS

The greatest contribution of nitrate in ground water is

decaying organic matter, sewage and fertilizer. The high value of nitrate in the study area might be excessive use of the fertilizer. Less content of NO3 in shallow wells is possibly due to denitrification in vadose zone of shallow ground water under phreatic conditions. Gillham and Cherry (1978) had stated that denitrification occurs when water table is less than 2 to 3 m and the process is insignificant of deeper levels. The conditions required for dentrification are presence of liable organic carbon, denitrifying bacteria and a reducing environment (Starr and Gillham 1993). Denitrification process may be ceased at greater depth due to longer residence time of infiltrating water in vadose zone and degradation of organic carbon during the longer course of percolation in case of deeper aquifers. Various workers have revealed that, nitrate in ground water from different sources viz., leakage of septic tank, leaching from animal waste and organic and inorganic fertilizers, (Pawar and Shaikh 1995). The high value of nitrate in the study area might be excessive use of the fertilizers. Thus we conclude that fertilizers are the probable source for the high values of nitrate in ground water of the study area. Nitrate and chloride concentrations in ground water were found to be lower in areas where the land had remained fallow for longer period. However, NO3 and Cl concentrations were found high in wells located in agricultural fields and where the land is in continuous use. Hence there is a need to work out the optimum quantity of fertilizers that should be used for a particular crop in a particular area and to educate the farmers on this aspect. In the areas where the nitrate concentration is known to be high the public should be educated about the potential danger of using the water for feeding/drinking.

REMEDIAL MEASURES

With regard to the nitrate problem in ground waters the best suggestion to avoid health risks is to have wells checked frequently and to reduce the fertilization of fields. The overload of nitrogenous fertilizers to the soils actually kills the biota that helps to provide nitrogen to the soil, which the crop plants can use. By using much lower amounts of fertilizers these crops may still be as productive as those produced under heavily fertilized soils, due to the healthier environment for the microbes. If the farmer adds large amounts of fertilizer in the beginning then he is forced to use more and more each year. Using only moderate to low amounts at the outset allows the farmer to avoid the entrapment into this vicious cycle. Hence, the most important step for farmers is to reduce the amount of nitrogen applied to the crops. Moreover, many of the aforementioned prevention methods can be incorporated to help reduce nitrate leaching from the soil into the groundwater. Slurry stores and concrete lagoon pits can significantly reduce the concentration of nitrate. By avoiding over-irrigation of a field both turf grass managers and farmers can help to control the leaching of nitrate to the groundwater.

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