Assessment of Ground Water Quality in and around Pydibhimavaram Industrial Area, AP, India

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Abstract—**In recent days ground water quality is deteriorating at alarming rate due to increased industrial activities. This study assessed the water quality of 30 samples collected from 4 locations of Pydibhimavaram industrial area. An investigation was carried out by collecting a total of 30 ground water samples for three seasons in study area to assess the ground water quality for its suitability for agriculture and domestic purpose. This study focused on variation of water quality parameters with reference to water level fluctuations. The well reduced levels were determined with the help of total station and these levels are connected to the mean sea level. Ground water levels from the well top surface were measured using water level indicator. Water quality parameters such as pH, total hardness, chlorides (Cl), iron (Fe), electric conductivity (E.C), sulphates (SO_4^{2-}), nitrates (NO_3^-), cadmium (Cd), lead (Pb), nickel (Ni) and zinc (Zn) were analyzed. These parameters were estimated using standard procedures and the results were compared with environmental quality standards. The results indicated that the water quality of the study area exceed the permissible limits of standards. This showed that the ground water of the study area was contaminated due to the industrial effluents.**

Index Terms—**Water quality, assessment, heavy metals, industrial area, ground water levels.**

I. Introduction

Water is nature's most wonderful, abundant and useful compound. Clean safe and adequate fresh water is vital to the survival of all living organisms and the smooth functioning of ecosystems, communities and economies. Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries. The fresh water present on the earth is only2.8% out of all the waters on the earth and out of that 0.03% of fresh water is readily available for drinking and other purposes in the form surface water and ground water. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Ground water is the major source of drinking water in both urban and rural areas and it is also an important source for the industrial and agriculture sectors [1]. Water quality is of significant importance of water uses [2]. Ground water quality in a region is largely influenced by both natural processes and by manmade inputs. Ground water pollution with physical, chemical and biological contaminants by anthropogenic activities is of great environmental attention all over the world. The discharge of domestic waste, solid waste and industrial effluents causes the ground water pollution [3]. Due to these the water changes its properties. The monitoring of water quality is one of the major tools for sustainable development and provides important information for water management. Ground water pollution not only affects the water quality but also threats human health, economic development and social prosperity. The problem associated with the quality of water is a topic of prime importance in the world and getting popularity for research purposes. Therefore, it is necessary to examine the quality of ground water and knowledge of extent of pollution become essential in order to preserve the valuable sources of water for future generations. Thus, in this paper an attempt has been made to assess the physic-chemical properties of ground water of the Pydibhimavaram Industrial area.

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II. Study Area

The present study is conducted in Pydibhimavaram area, Ranasthalammandalam, Srikakulam District, Andhra Pradesh. It is situated between 18.145N 83.627E and 18.099N 83.674E Latitudes and Longitudes . The area is recognosed as aIndusrial area by the Government of India. Many Industries viz. Andhra Organics, Dr.Reddy's Laboratories, Aurobindo, United breweries are situated in the Pydibhimavaram. The area is cultivated in 20 Sq.km and solely dependent on the ground water. study area covers the villages like Pydhibeemavaram, Boyapalem, Akkayyapalem, Naruva and Mentada as shown in Fig.1. The chemical and pharmaceuticals industries located near this area and discharge their effluent on the low lying areas and in river water. Which is leads to the ground water pollution around the area. The present study is to assess the water quality by using the various physical, chemical, biological parameters in that industrial area. A large number of bore wells and open wells based spread over the area selected for the study and the water quality has been assessed for both dry and wet seasons over a period of 3 months. The assessment has been done with respect to common water quality parameters like chloride, hardness, ph, electrical conductivity, nitrites, sulphates, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand and heavy metals.

III. Methodology

A. Reconnaissance Survey of Study Area

First a preliminary visit was carried out to all those regions

around Pydibeemavaram industrial belt of Srikakulam district. Interaction with the local people of each area helped in finding out the regions which are much affected by ground water pollution. Based on these, our study area, Pydibeemavaram i.e. ranasthalammandalam of Srikakulam district was established as shown in Fig. 1.

B. Identification of Wells

Some of the wells in each area were identified with the help of the local people. An approximate of 50 wells was chosen in each region (village) of the study area. All the wells which are chosen for the study purpose are identified and labelled with appropriate numbers. At each of the identified wells, the latitude and longitude of the location is found out by using a GPS instrument of that particular well where the sample is collected and wells in the study area as shown in Fig.1.

C. Determination of Elevations of the Study Area

Survey was conducted for knowing the elevation of each and every study well by using Total station survey procedure.

D. Collection of Water Samples

Thirty ground water samples were collected randomly selected from study area in the months of November, December& January (winter) with all precautions and preserved .For sampling, bore wells, pumps were permitted to flow for more than 10 min and required quantity of water was collected in pre-cleaned polythene containers. After identification and demarcation of each study well, every sample was marked with appropriate number to tally with location of sample where it has been collected.

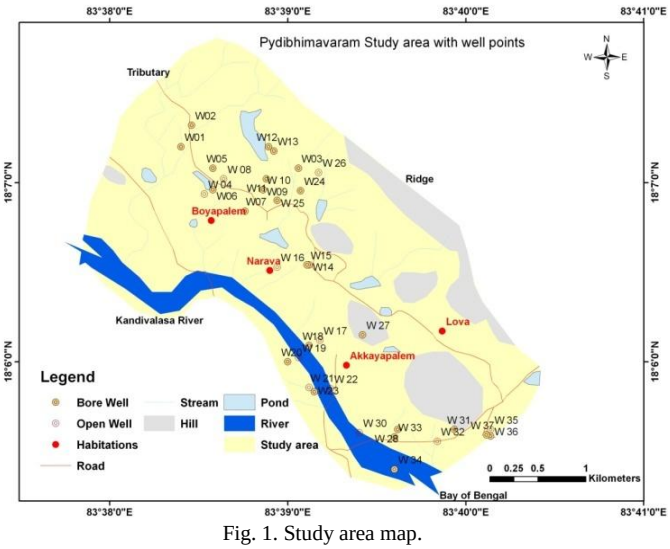

Fig. 1. Study area map.

E. Determination of the Water Level of the Wells

The water level of each and every well was determined using water level indicator.

F. Sampling and Analysis of Water Samples

Water samples were collected using spot sampling procedure [4] in previously washed and dried polythene containers from in and around areas of Pydibhimavaram. The samples were put to examination in the laboratory to analyze some physical and chemical parameters. These include colour, odour, temperature, pH, electrical conductivity, chloride, hardness, nitrites, sulphates, heavy metals viz., Cd, Zn, Fe. The analysis of water samples was done using standard procedure [5] and all analysis was done in triplicate.

IV. Results and Discussion

A. Water Levels Flucuations in Bore Wells and Open Wells

Samples are collected from bore wells and open wells at different water levels in three months i.e. in November, December and January (winter).These water samples are tested for physic- chemical parameters. The water level fluctuations in winter season were tabulated in Table I. These Figures indicated that the depths of water in the open wells and bore wells decreased with time that is from November to January. The water levels decreased slightly high in open wells compared to bore wells. This decrease in water level may be due to extraction of water from bore wells and due to exposure to atmosphere in open wells along with water extraction. The results revealed that the water level changes in wells are high in Boyapalem (W01, W02, W03, W05, W06, W07, W09, W11, W12,W13, W24, W25) than compared to Akkayyapalem (W18, W20, W21, W22, W23, W27, W28) and Mentada (W35, W36, W37, W38) of study area and water level fluctuations are low with time at Naruva (W14, W15) in the study area.

B. Water Quality Parameters

The discussion of variation of water quality parameters during November, December and January months is given in the following paragraphs.

Water pH is one of the most important aspects of water quality. Chemical and biological reactions are directly dependent upon the pH of water system. The pH of ground water obtained in range from 7.01 to 8.12. The acceptable limit for the drinking water standard is 6.5 – 8.5 as prescribed by 'WHO', 1996 [6]. The results showed that all the samples are within permissible limits. The pH of water samples in bore wells is higher in November month compared to December and January where as the pH of some open wells are higher in December and January than that of the November month

Electrical conductivity is a measure of water capability to transmit electric current and also it is a tool to assess the purity of water. The electrical conductivity in the water samples as an indication of dissolved ions. In the present work conductivity of ground water samples are in the range from 521.00 to 2589.00 mhos/cm, all the water samples are found to be well above the permissible limit (300 mhos/cm) as per WHO. The higher values of EC indicate the sample contains higher levels of dissolved ions [7].

The Water Hardness Classification, according to WHO, 2004 [8] follows this criteria; Soft (0-50mg CaCO3/L), Moderate Soft (50-100mg CaCO3/L, Slightly Hard (100-150mg CaCO3/L), Moderate Hard (150-200 mg CaCO3/L), Hard (200-300 mg CaCO3/L) and Very Hard (over 300mg CaCO3/L). Total hardness (TH) for the samples were found in the range of 139.3 to 1136.4mg/L. From the WHO 2004 classification, the groundwater samples analyzed were slightly hard to very hard. The results indicated that the

wells W13 ,W14 ,W15 ,W23 ,W28, W33 ,W16 ,W17 ,W26 ,W32 , and W34 which exceeds the permissible limits.

The concentration of chloride in the groundwater samples ranged from 40.89 to 690.45mg/L. The amount of chloride ions recommended being acceptable by WHO (1996) [6] is within 10 – 250 mg/L. The results indicated that very few samples (W28, W29 and W31) exceed the permissible limit. This may be due to groundwater contamination as a result of seepage from septic systems, landfill, fertilizers or animals [7]. Nitrite contents are found to be ranging from 0.0012 to 1.373 ppm. The desirable limit for nitrite is 0.02 mg/L. Nitrite concentrations over 1mg/l should not be used for infant feeding. Nearly 90% of the samples exceed the permissible limits. The nitrite concentration in bore wells is almost same in all the months, similar case in open wells except in some wells.

TABLE I: WATER LEVEL MEASUREMENT WITH REFERENCE TO MEAN SEA LEVEL

S.No	Map notation	Latitude	Longitude	Reduced Level (MSL)	Water level from MSL		
					Nov	Dec	Jan
Bore Wells							
1	W01	18.1200	83.6400	20.432	16.53	14.63	14.13
2	W02	18.1220	83.6410	18.330	14.61	12.03	11.91
3	W03	18.1180	83.651	19.887	16.30	13.48	13.35
4	W05	18.1180	83.6430	17.758	13.76	10.15	08.15
5	W06	18.1160	83.6430	15.874	11.87	08.45	06.77
6	W07	18.1140	83.6460	18.286	14.21	10.93	09.68
7	W09	18.1160	83.6477	18.888	15.93	12.68	10.68
8	W11	18.1170	83.6480	25.043	22.05	18.24	17.94
9	W12	18.1200	83.6482	14.860	11.80	07.30	07.14
10	W13	18.1196	83.6487	17.176	14.07	09.11	08.96
11	W14	18.1090	83.6520	18.755	15.50	10.40	10.10
12	W15	18.1090	83.6518	18.104	14.80	10.25	09.39
13	W18	18.1015	83.6520	09.879	05.97	03.01	02.67
14	W20	18.1000	83.6500	14.528	10.42	08.74	08.22
15	W23	18.0972	83.6525	16.317	13.11	12.73	12.53
16	W24	18.1159	83.6512	19.120	16.23	15.61	15.40
17	W 25	18.1150	83.6490	19.887	16.86	16.35	16.20
18	W 27	18.1025	83.6570	15.649	12.52	12.16	12.02
19	W 28	18.0937	83.6603	06.713	03.63	03.29	03.12
20	W 31	18.0937	83.6656	12.698	09.52	04.27	04.07
21	W 33	18.0930	83.6600	12.988	10.18	04.82	04.60
22	W 34	18.0900	83.6600	11.773	08.67	03.49	03.36
23	W 36	18.0931	83.6690	13.718	11.11	05.52	05.40
24	W 37	18.0932	83.6686	14.194	11.29	06.13	05.98
25	W 38	18.1063	83.6890	14.408	11.35	06.80	06.42
Open wells							
26	W 04	18.1156	83.6422	16.120	13.02	10.87	10.30
27	W 08	18.1170	83.6440	19.134	15.08	11.46	09.24
28	W 10	18.1160	83.6477	18.170	15.27	11.93	09.67
29	W 16	18.1088	83.6490	15.890	12.56	07.20	07.17
30	W 17	18.1020	83.6530	12.560	08.06	03.58	02.76
31	W 19	18.1004	83.6510	14.424	11.71	11.61	11.09
32	W 21	18.0976	83.6520	14.065	11.22	10.85	09.96
33	W 22	18.0975	83.6540	16.098	13.14	12.48	12.13
34	W 26	18.1176	83.6529	26.297	23.19	22.87	22.68
35	W 29	18.0926	83.6505	04.869	01.75	01.50	01.15
36	W 30	18.0934	83.6567	04.067	00.95	00.53	00.21
37	W 32	18.0926	83.6640	13.328	10.12	04.98	04.79
38	W 35	18.0937	83.6690	14.343	12.34	06.44	06.05

Sulfate can be found in almost all natural water. The samples contain the sulphate concentration in the range of 71.90 to 517.944 mg/L. The desirable limit for sulphate is 200 mg/L and the permissible limit in the absence of alternate source is 400 mg/L. The wells which exceed permissible limits are W23, W33, and W34. This may be due to groundwater contamination as a result of industrial wastes.

Rapid industrialization results more effluents discharged in various water resources. These effluents are usually treated by physicochemical treatment followed by biological treatment process. However, such treatment systems are not effective for removal of color, dissolved solids, trace metals, etc. The effluents containing trace metals, when discharged on agricultural land for irrigation, increase the metal content of the soils and availability of metals to plants. Trace metals are widely distributed in the environment with sources mainly from weathering of minerals and soils [9], [10] (Merian, 1991; O'Neil, 1993). However, inputs from anthropogenic activities have increased the levels in the environment tremendously [11], [12]. Some of the metals are of concern because of their toxicity to plant (Zn) while others (Cd, Pb, Ni, Fe) are hazardous to human health.

The concentration of Zn in the water samples ranged from 0.01 to 0.4 mg/l. The permissible limit of Zn concentration in drinking water is 5.0mg/l (WHO, 2004) [8]. It was observed from the data that all the samples were below the permissible limit of WHO. Beyond this limit it can cause astringent taste and opalescence in water.

Concentration of Ni varied between 0.01 and 0.07 mg/L from the analysis. The desirable limit for Ni is 0.02 mg/l for drinking water (WHO, 2004). The concentration of iron in the samples ranged from 0.01 to 0.2 ppm, except for bore well W 31 (0.8900 mg/lt) and open well W 32 (0.5790 mg/lt). This result indicated that bore well 31 and open well 32 were contaminated with Fe. The concentration of Pb inwater samples ranges from 0.04 to 0.119mg/l. Thepermissible limit of Pb concentration in drinking water is 0.01 mg/l (WHO, 2004).

The results revealed that most of the samples are above the permissible limit. High Pb concentration was observed in ground water samples collected from Pydibheemavaram industrial area. All the samples analyzed for Cd in water samples fell within the WHO (2004) recommended limits of 0.01mg/L for Cd in drinking water. The reason for elevated metal content in the samples was due to the increased human influence on ground water [13].

V. Conclusions

The ground water sample from Pydibhimavaram industrial area was assessed for their quality in terms of their potential for drinking and irrigation. The results revealed that the ground water in the study area was neutral. The results indicated that all the samples have high electrical conductivity. The results also showed that in some areas chlorides, hardness, sulfates and nitrites concentrations were above the permissible limits. Samples of the Pydibhimavaram Industrial area exceed the permissible limits of BIS. The elemental concentrations of Fe, Ni, Cd, and Pb were found to exceed the permissible limits of drinking water quality, whereas Zn concentrations are within the permissible limits. High trace metal concentrations were observed in ground water samples of Pydibhimavaram industrial area. This research may serve as a preliminary study to provide baseline information that may direct future water quality assessment studies in the study area.

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