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Impact of Industrial Development on Groundwater Quality- A Case Study of Impact of Effluent From Vishwakarma Industrial Area, Jaipur On Ground Water

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ABSTRACT
In this investigation we have compared the ground water parameter of industrial area with the prescribed BIS:IS: 10500,2003 standards to study the impact of Vishwakarma Industrial Area on ground water. We found that so far the parameters are well within the standard desirable limit except for the fluoride and TDS. Thus, from the present study it is concluded that as of now effluent water discharge from industrial area has been affected the ground water and is indicating that the quality of groundwater is worsening with the ever increasing threat of industrialization. If further effluent treatment systems will be in place for all the industries, groundwater will not be prone to further pollution. The positive correlations within the variables reveal their common source in groundwater especially from industrial activities in the study area. On the other hand negative correlation is found between Cu vs Fe (-0.160) and F vs Fe (-0.041) in groundwater indicates the anthropogenic and geogenic sources of these variables in the study area.
Keywords: *Physio chemical characteristics, Effluent, Metallurgy industries, effluent treatment systems*

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INTRODUCTION

Water has played a vital role in the evolution of human civilizations. Human social cultural evolution started in those areas, where adequate quantity and quality of freshwater was available Freshwater is a limited resource, which is essential not only for survival of living organisms but also for human activities such as agriculture, industry and domestic needs [1].

Due to recent industrialization and ever increasing urbanization, the quality of groundwater has become a matter of major concern because of heavy metal contamination. Contamination of water by trace metals is a serious health issue. Studies have shown that heavy metal toxicity leads to cardiovascular, neurological and renal problems [2]. The main health hazards caused by chemical pollution of water are due to presence of nitrates fluorides, arsenic, cadmium, lead and other toxic metals [2].

According to Hart and Stander [3] the population explosion, increased industrialization, agricultural development and recreational activities, all lead to corresponding increase in volume of effluents and diversity of pollutants, discharged into natural environment. It is pertinent to know that the harmful chemicals released from the industries as waste products enter the life chain by polluting the different components of environment which are common natural resources of mankind [2].

In the last two decades, the rapid growth industrialization and urbanization has created unconstructive impact on the environment. Due to industrial, municipal and agricultural waste containing pesticides, insecticides, fertilizer residues and heavy metals with water groundwater has been polluted by leaching process. These pollutants are being added to the groundwater and soil system through various human activities and rapid growth of industrialization which influence the human health directly or indirectly.

Pollution of groundwater due to industrial effluents and municipal waste in water bodies is another major concern in many cities and industrial clusters in India. A 1995 survey undertaken by Central Pollution Control Board identified 22 sites in 16 states of India as critical for groundwater pollution, the primary cause being industrial effluents [3-6].

The Vishwakarma Industrial Area of Jaipur district was chosen as target area to assess the effects of industrial pollution on groundwater quality as this area has come up with planned industrial

development comprises of big manufacturing groups in the last few decades. With the planned development it is anticipated that, this will help in proper management of water resources and further help to curtail deterioration of water quality in the study area. The study area is dominated by metal finishing industries. Wastewater from metal finishing industries contains contaminants such as heavy metals, organic substances, cyanides, and suspended solids, at levels which are hazardous to the environment and pose potential health risks to the public. Heavy metals, in particular, are of great concern because of their toxicity to human and other biological life. Heavy metals typically present in metal finishing wastewater are cadmium, chromium, copper, lead, nickel, silver, tin, and zinc [7]. The effluent discharged by this industry leads to serious pollution of groundwater and soils and ultimately affects the livelihood of the poor.

STUDY AREA

The study area is Vishwakarma Industrial Area. The VKIA is situated in Jaipur district was set up RIICO in 1970. The area is well developed with quality infrastructural facilities like good road network of National Highway, State Highway and district roads(NH No.11), PHED & RIICO water supply, electricity by JVVNL, streetlights, etc. 20 renowned industries operating in the industrial areas are: Bharat Pottery, Clay Craft, ManglaSariya, Poddar Rubber Industries, Bairathi Rubber Indusjtries, Agarwal Marbles, Ultra Tech, Rajasthan transformers, Bajrang Wire, Gem Electro, Rajasthan Cylinder, Roachees Watches, Tijaria Pipes, Annapoorna Cold Storage, SR Marble, Techno Hind Marble, Autopal, International Furniture, Bajrang Wire, etc. RIICO has acquired and developed 1399.34 acres of land in the area. 1300 plots have been planned by RIICO in the area. Skilled manpower and labour power is available as per requirement in the industrial area. Public infrastructural facilities like two post offices at road No. 5 and Road No. 9F2, 5 number of banks, namely ICICI, State Bank of Bikaner & Jaipur, State Bank of India, Bank of Baroda and Punjab National Bank with 6 Nos. ATMs at road No. 4 are available in the industrial area. ESI Hospital at road No. 9 and Jyoti Nursing Home at Road No. 4 are providing medical facilities to the area. Police station at road No. 5 is providing police assistance to the area. The Industrial Area is easily accessible through all modes of transport: nearest railway station Dheharka Balaji is at a distance of 07 Kms. by road, nearest bus stand Sindhi Camp at a distance of 12 Kms. and nearest airport Sanganer is located at a distance of about 30 Kms. by road from the area. Nearest city Jaipur is at a distance of 10 Kms. from the area by road. Concerned administrative headquarter is at a distance of 8 Kms. from the area.

VKIA Industrial area is dominated by metal finishing industries. In the metal finishing industries products like ingot, billets, TMT saria, auto parts and other steel items are being manufactured.

HYDROGEOLOGY

Groundwater in the district occurs both in unconsolidated Quaternary formations and consolidated formations of Bhilwara & Delhi Super Groups and also Post Delhi Granites. In greater part of the district, alluvial deposits mainly fine sand & silt serve as potential aquifers in addition to gravel zones as encountered at Sanganer, Ambabari, Bajaj Nagar (Jaipur city) and Shahpura, Dhanauta, Nayan, Kalyanpur, Mohana and Chandalai. Shallow depth to groundwater occurs under water table condition and under semi-confined conditions at depth. Talus and scree deposits at foothills form potential aquifer at places including Banskho in Bassi block and parts of Amber, Jamuwa Ramgarh and Govindgarh blocks. Yield of wells in these formations ranges from 100 to 500 m^3 /day. Hard rock's of Bhilwara Super Group form main aquifers in Southern and south western parts of the district in Dudu, Phagi and Chaksu blocks comprising of granulitic gneisses, quartz mica schist, phyllite along with granite & pegmatite intrusives. Similarly, quartzite, schist & phyllite of Delhi Super Group form aquifers in Jamwa Ramgarh, Bairath, Kotputli, Shahpura, Amer and Bassi blocks. Movement of groundwater in these hard rock's is controlled by size, continuity and interconnectivity of weathered and fractured parts and due to other secondary porosities [2].

MATERIALS AND METHODS

Twenty six samples were collected from different locations and sources like hand pumps, tube wells and dug wells in the study area. Good quality standard sampling bottles were used for collecting the water samples. Parameters like pH and TDS were determined in the field itself at time of sample collection using the portable water and soil analysis kit. While, the metals (Fe, Cu) were immediately determined in the laboratory following the standard procedures (APHA, 1995). The results obtained were compared with the Bureau of Indian Standards (BIS: IS: 10500, 2003) guidelines for drinking water suitability in relation to possible health hazards.

RESULTS AND DISCUSSION

Twenty six samples from different locations and sources of groundwater were analyzed physico chemical parameters including heavy metals. The tabulated form of results for physicochemical analysis and critical water quality parameters along with their permissible limits (BIS: IS: 10500, 2003) are given in Table.

Table 1: Summary statistics of Ground Water Quality of Vishwakarma (VKIA) Industrial Area

S.No.	VARIABLE	OBSERVATIONS	MINIMUM	MAXIMUM	MEAN	INDIAN STANDARD (BIS 10500)
1	pH	26	7.090	7.500	7.299	7.5
2	Fe (mg/l)	26	0.010	0.020	0.015	0.3
3	Cu (mg/l)	26	0.001	0.018	0.006	0.05
4	F (mg/l)	26	0.250	1.2	0.82	1
5	Dissolve solid (mg/l)	26	198.000	1486.000	607.615	500

pH: The pH in the samples studied ranged between 7.09 and 7.5. This shows the water is neutral and is well within the prescribed limits of 6.5 and 8.5.

Iron: The iron in sample ranges from 0.01 to 0.02 mg/l which is well within the prescribed limit of 0.3 mg/l. Iron in traces is essential for nutrition. However, while persistently consuming large amounts of iron can lead to a state known as iron overload; iron overload can lead to hemochromatosis, a severe disease that can damage the body's organs. Early symptoms include fatigue, weight loss and joint pain, but if hemochromatosis is not treated, it can lead to heart disease, liver problems and diabetes.

Copper: Water sample has shown the copper concentration well within the prescribed limit of 0.05 mg/l. The results ranges from 0.001 to 0.018 mg/l. High concentrations of copper in drinking water can cause liver damage, irritation of central nervous system and depression.

Flouride: The samples ranged from 0.250 to 1.2 mg/l, which is slightly above the prescribed limit of 1.0 mg/l. Ingestion of fluoride can produce gastrointestinal discomfort, affects dental health and persistent exposure to fluoride in large amounts impedes with bone formation. The most widespread examples of fluoride poisoning arise from consumption of ground water that is abnormally fluoride-rich.

Dissolved solids: The water sample has shows higher results than the prescribed limit of 500 mg/l. The result ranges from 198 to 1486 mg/l. The presence of dissolved solids in water may affect its taste. No latest data on health effects related with the ingestion of TDS in drinking-water appear to exist; however, associations between various health effects and hardness, rather than TDS content, have been investigated in many studies.

CORRELATION MATRIX (PEARSON) FOR VKIA:

Correlation matrix of heavy metals in groundwater of VKIA does not indicate any strong positive correlation between any two metals. The positive correlations within the variables reveal their common source in groundwater especially from industrial activities in the study area. On the other hand negative correlation is found between Cu vs Fe (-0.160) and F vs Fe (-0.041) in groundwater indicates the anthropogenic and geogenic sources of these variables in the study area. Flourine values are already high in groundwater in Rajasthan thus not showing any positive correlation with any parameter.

Table 2: Summary statistics of Ground Water Quality of Vishwakarma (VKIA) Industrial Area

Variables	pH	Fe	Cu	F	Dissolve solid
pH	**1**				
Fe	0.044	**1**			
Cu	-0.071	-0.160	**1**		
F	**0.642**	-0.041	0.108	**1**	
Dissolve solid	0.288	**-0.737**	0.160	0.263	**1**
Values in bold are different from 0 with a significance level alpha=0.05					

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that effluent water discharge from industrial area has affected the ground water and is indicating that the quality of groundwater is worsening with the ever increasing threat of

industrialization. If further effluent treatment systems will be in place for all the industries, groundwater will not be prone to further pollution.

Some treatment system for small scale industries growing in the region should be set up to avoid groundwater contamination of this region.

Following are some policy suggestions to achieve environmentally sustainable industrial development

• **Integrated Production Approach:** - In an integrated unit, the pollution abatement cost has become a part of its overall manufacturing cost and therefore the burden is less.

• **Strict Enforcement:** - The role of the Pollution Control Board is critical in pollution management and it should strictly enforce all the pollution control regulations. There should be proper regulations for the production and dumping of effluents produced as a result of industrial activities in the area.

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