

Trace Analysis of Heavy Metals in Ground Waters of Vijayawada Industrial Area

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ABSTRACT

In recent years, the new environmental problem are arising due to industrial hazard wastage, global climate change, ground water contamination and etc.,,, gives an attention to protect environment. one of the major source of contamination of ground water is improper discharge of industrial effluents these effluents contains so many heavy metals which are cause more effects the human life. The present study about contamination of ground water due to trace metals in and around the Vijayawada. 60 samples are collected industrial area around the Vijayawada. The study area divided into five zones depending on the nature of industries are present in the study area .The following trace metals are analyzed Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, and Zn were analyzed in all the sample. In some ground water sample are found to be more concentration of metals are exceeds maximum limits values of WHO, ISI standards. The result gives important information of ground water quality.

KEYWORDS

Trace analysis, heavy metals, Vijayawada, ground water, industrial

ARTICLE HISTORY

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Introduction

Water is the important resource which influences the human life. Generally water obtained from two types of natural sources surface water (lakes, ponds, rivers, streams etc.) and ground water (bore holes and well water). Water plays an important role domestic, industrial supply, irrigation in all over the world. But increase of population, industrialization and urbanization are causes contamination of ground water. The contamination ground water is not easy to restore. Hence it is necessary to protect quality of ground water. According to WHO 80% of diseases are arises due to contamination ground water¹.

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As the ground water flows from recharge area to discharge area the ground water quality will decrease due to chemical reactions. Heavy metals are important environmental pollutants which increased by human activities like mining, discharging industrial effluents containing metals without giving any treatment from industries like steel plants, battery, thermal power plants and over usage of fertilizers containing heavy metals in agriculture are the main reason to contaminate the ground water². In the world industrial, agriculture, and municipal activities are results ground water contamination. Specially the trace metal contamination in ground water shows serious health issues³. Generally metals such as copper, iron, manganese, zinc and cobalt are essential but increasing concentrations causes the severe health problems. The traces of metal ions play an important role in human life some these are very toxic such as Fe, Ni, Pb which affects the central nervous system. Furthermore various methods are used to compare the result after the analysis carried out on the concentration metals data. Variogram is used to separation of data depend upon the concentration of heavy metal to the geology and land use area⁴ the disparity of concentration of heavy metals⁵ gives in order direction on ecosystem evaluation. the objective of this study is 1) to evaluate the dissolved heavy metals in the ground water⁶ 2) to give significant relationships between trace metals. 3) to provide proper guidance to control pollution.

Study Area

Vijayawada is the one of the major city in Andhra Pradesh. The city located at 16.52° North Latitude 80.62° East Longitude. And it is present at 39 feet above the sea level. The city contains with an area of 261.88 km². The city municipal limits have a population of 1,048,240 (2011 Census), while the population of the metropolitan area is 1,491,202. The topography is most important to the geography of the Vijayawada. The study area marked with small and medium sized hill rocks with plain land between them Krishna river is the dominant part of the study area and also it contains the constitution of eastern ghats chain, these ghats are have low elevation as compared with rest of the ghats. The Krishna river runs throughout the city. Vijayawada is famous for agro industries, automobile building units, hardware, textile, chemical and power plants are the major industries. The city has two well equipped industrial estates auto nagar and Ibrahim patnam. The waste materials which are coming from these industries are major source of contamination of the ground water⁷ in Vijayawada city.

The recharging of ground water in study area is due to Krishna river and eluru canal. The Krishna river passing from the south side and eluru canal passing from the north east of the study area. The study area locate at north east side (auto nagar) south west (morampudi, pedavadlapudi and atmakuru) and north west side (Ibrahim patnam) Vijayawada city.

Materials and Methods

The ground water samples are collected from the bore wells in the study area the sampling location are given in table 1. The samples are collected in HDPE bottles. The bottles are pre washed with laboratory detergent and rinsed with de ionized water. Two samples are collected in each location. The samples are treated with 1.5 ml of nitric acid. The samples are stored at 4°C until analysis is done. The total metal concentration of aluminum, cadmium, copper, chromium, iron,

lead, manganese, mercury, lead, nickel, selenium, silver and zinc in the filtered and digestive samples⁸ are determined in ppm by using Atomic Absorption Spectrophotometer (AAS, Shimadzu AA-6300). Analysis was carried out in triplicate and average values are reported. The AAS was calibrated with relevant Shimadzu AAS spectroscopic grade standards. Flame atomic absorption spectrophotometer (Shimadzu double beam Atomic Absorption Spectrophotometer) (Direct determination - Flame: Pb, 0.1ppm; Furnace: Pb, 0.3 ppb).

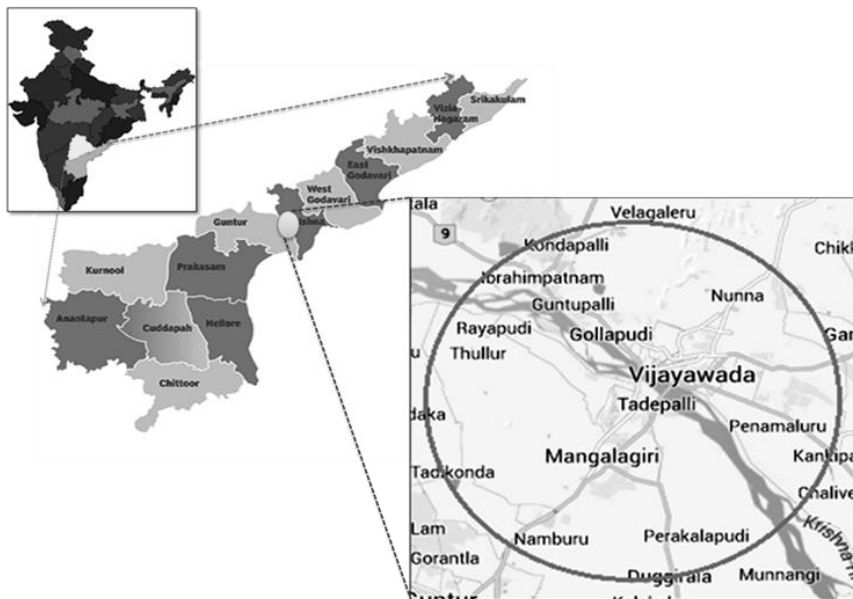


Figure 1. Study Area

Table 1. Samples from different zones of study Area

Zone No.	Industry type	No. of Samples	Area/ Sample location
1	Beverage/Diary	13	Ibrahimpatnam, Vijayawada
2	Power plants	06	Moramputi, Vijayawada
3	Chemical	20	Autonagar, Vijayawada
4	Electroplating Alloys	04	Kondapally, Vijayawada
5	Automobiles and Mechanical works	17	Autonagar, Vijayawada

Results and Discussions

All 60 samples are labeled properly and analyzed the metal content. The sample are analyzed 5 times and their sum, maximum, minimum, mean, standard deviation, % RSD, average deviations were obtained. The results are presented in the Table 2.



Table 2. The metal content

ZONE: 1

Sample Code	Industry Area	Place	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Zn
1	CONTINENTAL COFEE	Morampudi	0.01	0.001	0.09	0.02	0.05	0.4	0.14	0.05	0.001	0.02	0.001	0.06
2	CONTINENTAL COFEE	Tummadi	0.01	0.001	0.083	0.02	0.046	0.367	0.04	0.046	0.001	0.02	0.001	0.03
3	COCACOLA IND PVT LTD	Pedavadlapudi	0.01	0.001	0.08	0.02	0.042	0.355	0.039	0.044	0.001	0.02	0.001	0.028
4	COCACOLA IND PVT LTD	Athmakuru	0.01	0.001	0.124	0.02	0.047	0.392	0.035	0.041	0.001	0.02	0.001	0.03
5	COCACOLA IND PVT LTD	Managalagiri	0.01	0.001	0.114	0.02	0.98	0.13	0.04	0.001	0.001	0.02	0.001	0.09
6	VIAVA MILK DIARY	Chittinagar	0.01	0.001	0.092	0.02	0.01	0.92	0.09	0.04	0.001	0.02	0.001	0.08
7	VIAVA MILK DIARY	Chittinagar	0.01	0.001	0.095	0.02	0.011	1.017	0.1	0.044	0.001	0.02	0.001	0.24

ZONE:2

Sample Code	Industry Area	Place	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Zn
8	LANCO INDUSTRY	Guntupally	0.01	0.001	0.11	0.02	0.012	1.125	0.11	0.049	0.001	0.02	0.001	0.265
9	VTPS INDUSTRIES	Gollapudi	0.01	0.001	0.11	0.02	0.011	1.4	0.1	0.042	0.001	0.02	0.001	0.011
10	VTPS INDUSTRIES	LANCO, Vijayawada	0.01	0.001	0.106	0.02	0.011	1.354	0.097	0.041	0.001	0.019	0.001	0.011
11	NTPS	Kondapalli	0.01	0.001	0.103	0.02	0.02	1.309	0.107	0.039	0.001	0.019	0.001	0.02

ZONE 3

Sample Code	Industry Area	Place	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Zn
12	ZENITH POLYMERS	Ibrahimpatnam	0.01	0.001	0.134	0.02	0.02	0.65	0.1	0.04	0.001	0.04	0.001	0.14
15	IDA MAIN ROAD	IDA Ibrahimpatnam	0.01	0.001	0.104	0.02	0.018	1.952	0.1	0.025	0.001	0.017	0.001	0.087
16	IDA MAIN ROAD	IDA Ibrahimpatnam	0.01	0.001	0.096	0.019	0.016	1.791	0.1	0.023	0.001	0.015	0.001	0.08
17	R.K INDUSTRIES	IDA Ibrahimpatnam	0.01	0.001	0.09	0.07	0.05	1.2	0.1	0.05	0.001	0.02	0.001	0.005
18	ALEKHYA CHEMICALS	IDA Ibrahimpatnam	0.01	0.001	0.09	0.05	0.03	0.56	0.1	0.03	0.001	0.02	0.001	0.33
19	SANDEEP CHEMICALS	IDA Ibrahimpatnam	0.01	0.001	0.083	0.046	0.028	0.514	0.1	0.028	0.001	0.02	0.001	0.303
20	GODREJ AGRO LTD	IDA Ibrahimpatnam	0.01	0.001	0.076	0.042	0.025	0.497	0.1	0.025	0.001	0.02	0.001	0.278
21	POST OFFICE	IDA Ibrahimpatnam	0.01	0.001	0.073	0.047	0.028	0.481	0.1	0.024	0.001	0.02	0.001	0.307
22	SIRIS CHEMICAL INDUSTRIES	Vijayawada	0.01	0.001	0.071	0.043	0.031	0.465	0.1	0.022	0.001	0.02	0.001	0.34
23	M.S INDUSTRIES	Auto Nagar	0.01	0.001	0.069	0.041	0.028	0.449	0.1	0.022	0.001	0.02	0.001	0.311
35	SREE SAI DURGA RUBBER WORKS	Auto Nagar	0.01	0.001	0.071	0.02	0.018	0.453	0.1	0.018	0.001	0.02	0.001	0.018
36	ASIAN BIO CHEMICAL INDUSTRIES	Auto Nagar	0.01	0.001	0.065	0.02	0.016	0.415	0.1	0.016	0.001	0.02	0.001	0.016
37	VISAK INDUSTRIES	Auto Nagar	0.01	0.001	0.086	0.02	0.03	0.95	0.1	0.06	0.001	0.02	0.001	0.025
38	VINAY PLASTICS	Auto Nagar	0.01	0.001	0.083	0.02	0.029	0.919	0.1	0.058	0.001	0.02	0.001	0.024
42	AMBICA CHEMICALS	Auto Nagar	0.01	0.001	0.087	0.33	0.04	4	0.1	0.27	0.001	0.02	0.001	0.11
54	SRI RAMA INDUSTRIES	Auto Nagar	0.01	0.001	0.079	0.018	0.03	0.861	0.1	0.02	0.001	0.02	0.001	0.03

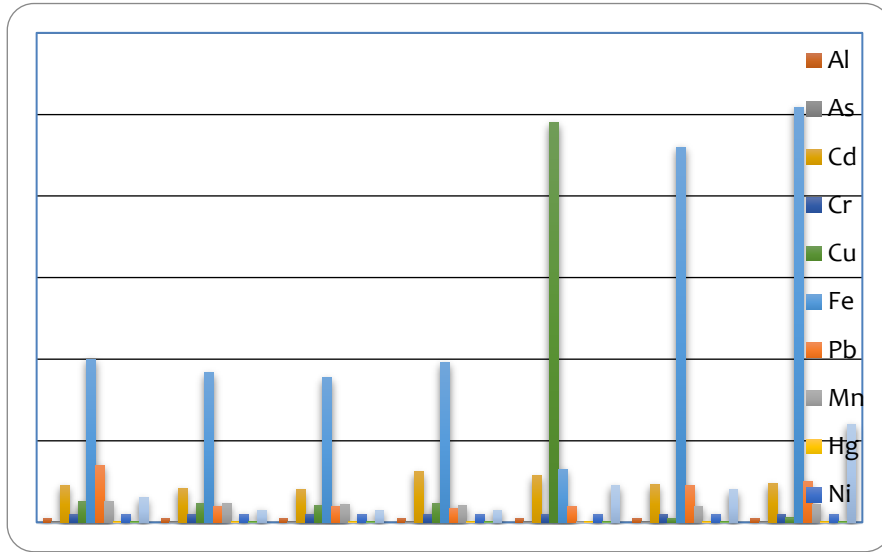


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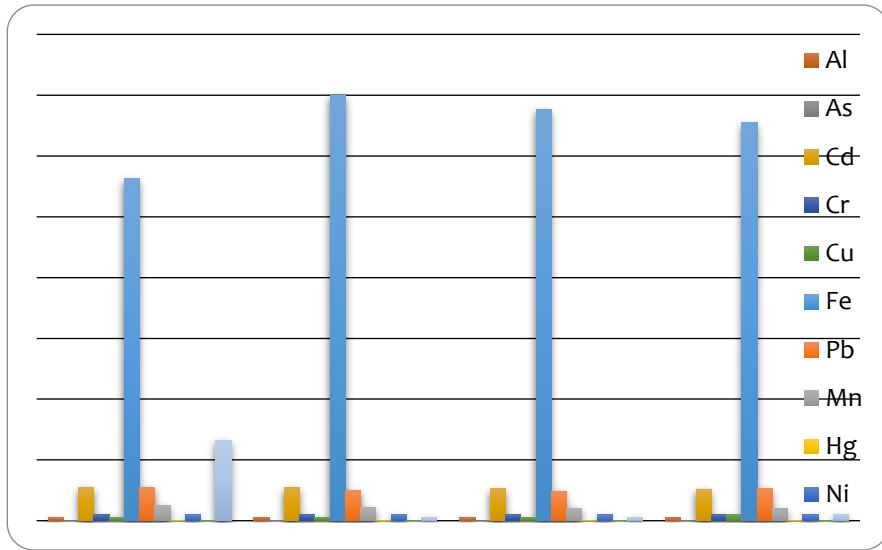
Sample Code	Industry Area	Place	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Zn
13	LAKSHMI ELECTRODES	IDA Ibrahimpatnam	0.01	0.001	0.124	0.02	0.02	2.2	0.1	0.03	0.001	0.02	0.001	0.02
14	LAKSHMI SYNTHONS	IDA Ibrahimpatnam	0.01	0.001	0.114	0.018	0.018	2.018	0.1	0.028	0.001	0.018	0.001	0.09
25	S. LAKSHMI PRSANNA PAPER MILL	Auto Nagar	0.01	0.001	0.058	0.035	0.025	0.378	0.1	0.018	0.001	0.02	0.001	0.276
26	LAKSHMI CHAITHANYA ALLOYS	Auto Nagar	0.01	0.001	0.09	0.04	0.04	0.27	0.1	0.03	0.001	0.02	0.001	0.13
27	AGNI COALS	Auto Nagar	0.01	0.001	0.124	2.245	0.02	0.944	0.1	0.02	0.001	0.01	0.001	0.04
28	SRI SAI ELECTRODES	Auto Nagar	0.01	0.001	0.131	1.599	0.98	1.72	0.112	0.02	0.001	0.18	0.001	0.79
29	VARDAM ELECTRODES	Auto Nagar	0.01	0.001	0.127	0.01	0.948	1.663	0.108	0.02	0.001	0.02	0.001	0.764
30	Opp PLOT NO 113	Auto Nagar	0.01	0.001	0.123	0.01	0.917	1.609	0.105	0.02	0.001	0.02	0.001	0.739
31	RATNA ELECTRICAL WORKS	Auto Nagar	0.01	0.001	0.181	0.18	1.34	1.76	0.089	0.02	0.001	0.11	0.001	0.95
32	PLOT NO 140	Auto Nagar	0.01	0.001	0.175	0.174	1.296	1.702	0.086	0.019	0.001	0.106	0.001	0.919
50	LAKSHI TIMBER DEPOT	Auto Nagar	0.01	0.001	0.072	0.008	0.035	0.497	0.1	0.02	0.001	0.02	0.001	0.319
55	SREE UMA MAHESWARA MECH	Auto Nagar	0.01	0.001	0.009	0.04	0.03	0.62	0.1	0.02	0.001	0.02	0.001	0.23
57	KRISHAN MOULDS	Auto Nagar	0.01	0.001	0.008	0.037	0.03	0.58	0.1	0.019	0.001	0.019	0.001	0.03
58	SIVA SANKAR CASTING WORKS	Auto Nagar	0.01	0.001	0.12	0.036	0.095	1.95	0.015	0.106	0.001	0.13	0.001	0.77
59	SAI DURGA TURNING WORKS	Auto Nagar	0.01	0.001	0.158	0.04	0.045	1.511	0.1	0.133	0.001	0.133	0.001	0.045
60	ROCK WELL INDUSTRIES	Auto Nagar	0.01	0.001	0.094	0.05	0.03	0.49	0.1	0.01	0.001	0.02	0.001	0.07

ZONE 5

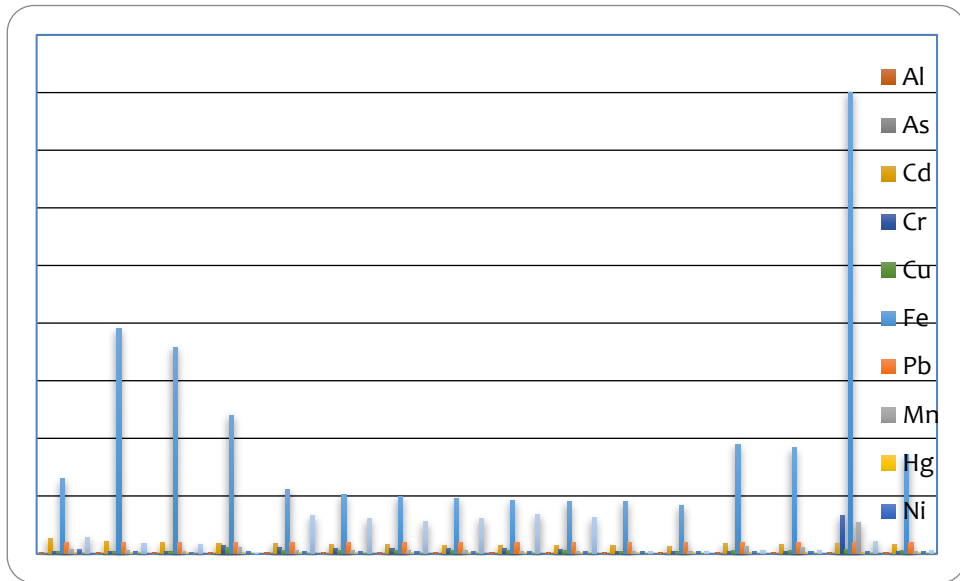
Sample Code	Industry Area	Place	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Zn
33	SREE SAI OIL WORKS	Auto Nagar	0.01	0.001	0.08	0.02	0.02	0.51	0.1	0.02	0.001	0.02	0.001	0.02
34	SAHANI AUTO MOBILE WORKS	Auto Nagar	0.01	0.001	0.073	0.02	0.018	0.468	0.1	0.018	0.001	0.02	0.001	0.018
39	G.V.K DIESEL WORKS	Auto Nagar	0.01	0.001	0.085	0.02	0.01	0.23	0.1	0.01	0.001	0.02	0.001	0.03
40	AZAHAR RADIATORS	Auto Nagar	0.01	0.001	0.09	0.02	0.05	0.55	0.1	0.06	0.001	0.02	0.001	0.28
41	SAI SAGAR INDUSTRIES	Auto Nagar	0.01	0.001	0.087	0.019	0.048	0.532	0.1	0.058	0.001	0.02	0.001	0.271
42	AMBICA CHEMICALS-a	Auto Nagar	0.01	0.001	0.087	0.33	0.04	4	0.1	0.27	0.001	0.02	0.001	0.11
43	AMBICA CHEMICALS-b	Auto Nagar	0.01	0.001	0.084	0.319	0.039	3.868	0.1	0.261	0.001	0.02	0.001	0.106
44	AMBICA CHEMICALS-c	Auto Nagar	0.01	0.001	0.081	0.309	0.037	3.741	0.1	0.253	0.001	0.02	0.001	0.103
45	SREE KANAKA DURGA WORKS	Auto Nagar	0.01	0.001	0.087	0.01	0.05	0.63	0.1	0.02	0.001	0.02	0.001	0.05
46	SREE LAKSHMI INDUSTRIES	Auto Nagar	0.01	0.001	0.084	0.01	0.048	0.609	0.1	0.02	0.001	0.02	0.001	0.048
47	SRI GAYATRI INDUSTRIES	Auto Nagar	0.01	0.001	0.081	0.009	0.047	0.589	0.1	0.02	0.001	0.02	0.001	0.047
48	AUTO MOBILE WORKS	Auto Nagar	0.01	0.001	0.086	0.01	0.04	0.59	0.1	0.02	0.001	0.02	0.001	0.36
48	AUTO MOBILE WORKS	Auto Nagar	0.01	0.001	0.086	0.01	0.04	0.59	0.1	0.02	0.001	0.02	0.001	0.36
49	SWATHI GASES	Auto Nagar	0.01	0.001	0.079	0.009	0.037	0.541	0.1	0.02	0.001	0.02	0.001	0.33
51	SYSHAME ENTERPRISES	Auto Nagar	0.01	0.001	0.07	0.02	0.03	0.48	0.1	0.02	0.001	0.02	0.001	0.03
52	VIJAYA LAKSHMI DIESEL AGENCY	Auto Nagar	0.01	0.001	0.089	0.02	0.03	0.97	0.1	0.02	0.001	0.02	0.001	0.08
53	SIRY AUTO MOBILES	Auto Nagar	0.01	0.001	0.082	0.018	0.03	0.89	0.1	0.02	0.001	0.02	0.001	0.03
56	AUTO MOBILE COMPACTS	Auto Nagar	0.01	0.001	0.009	0.039	0.03	0.6	0.1	0.019	0.001	0.019	0.001	0.03



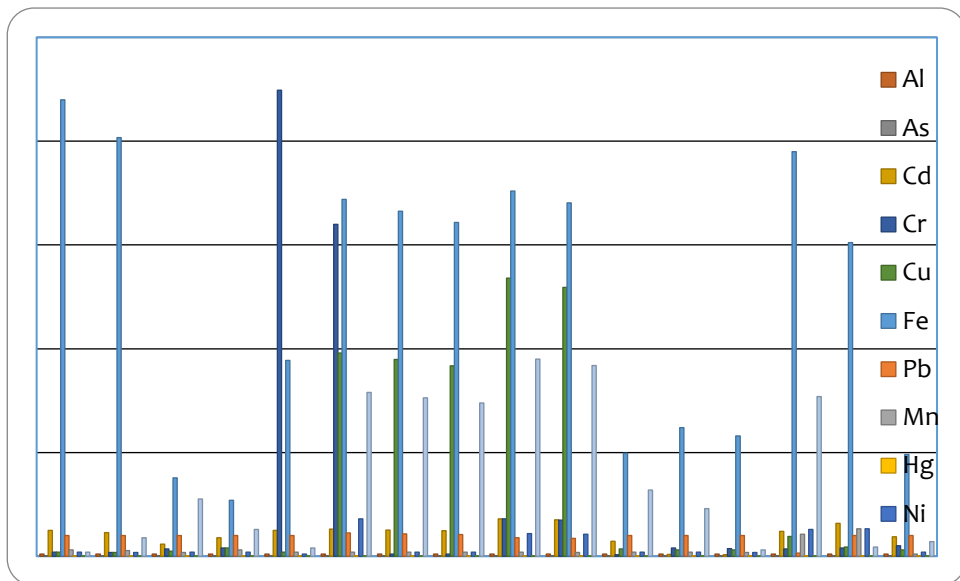
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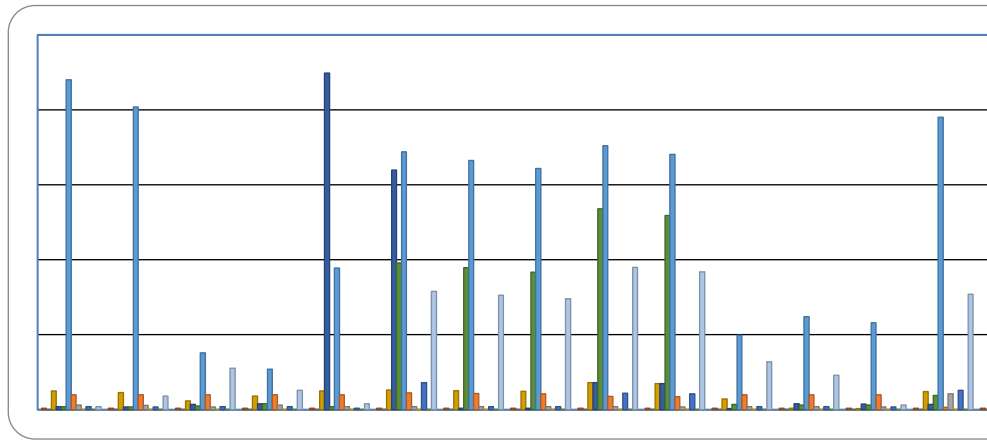
Zone 2



Zone 3



Zone 4



Zone 5

Figure 2. Please add the figure legend

Aluminum

Aluminum is the third most abundant element in the earth crust. Aluminum is the most abundant metal and the third most abundant element in the earth's crust, it present 8.8% by weight. It is found in Free State. It enters into environment from the rocks and minerals, waste water effluents and solid waste of industries and human activities⁹. We are not found any exceed level of aluminum in our samples according to WHO and ISO standards.

Arsenic

Arsenic is naturally occurring element. It is odorless and tasteless. It is available in inorganic form in in the environment. It enters into ground water through underground rocks, soil and industrial human activities. Increase concentration of arsenic can cause problems to the skin, circulatory and nervous system. If the arsenic stocks in human body causes the cancer, neural disorders. Daily consumption of water with greater than 0.01 mg/l of arsenic, less than 0.2 % of the fatal dose, can on long term lead to problems with the skin as well as circulatory and nervous systems. If arsenic builds up in the human body, open lesions, organ¹⁰ The maximum acceptable concentration of arsenic in drinking water recommended by the World Health Organization is 10µg/l In our study none of the sample are exceeds the WHO and ISO standards

Cadmium

Cadmium is the one most commonly found metal. It found with zinc, carbonate and sulfide ore. It is also found as a byproduct in the refining of other metals. it enter into ground water by different sources One source is ingestion of grown foodstuffs, especially grain and leafy vegetables, which readily absorb cadmium from the soil. The cadmium may occur in groundwater naturally or as a contaminant from sewage sludge, fertilizers, polluted groundwater or mining and industrial effluents¹¹ Increase of Cd may be changes the pH of the water. Cadmium can be present in groundwater from a wide variety of sources in the

environment and from industry. In our present study all samples are exceeding the WHO standards.

Chromium

Chromium is one of the heavy metal present in nature but it occurs in only in combined state. It exists as trivalent and hexavalent states. Trace amount of Chromium compound are present in water. It discharged into groundwater or surface water through metal refinery industries and alloy industries. Hexavalent chromium enters into water from industrial waste water which are mainly discharge form paints and tanning. Trivalent chromium is essential trace element for human. It plays important role removal of glucose from blood with help of insulin. Chromium trioxide dust in work place may causes cancer and damages the respirational system. Whereas hexa valent chromium¹² is highly toxic. It causes allergic and asthmatic reaction. It is more carcinogenic than trivalent chromium. In our present study 10% of the sample are exceed the maximum limits of WHO standards.

Copper

Copper is common heavy metal found in environment and spread through the natural phenomenon it is widely used in industries and agriculture. It enter into ground water due industrial wastage contain copper, agriculture pesticides and released into drinking water through corrosion of copper pipes. It is trace essential element for human health. But large concentration of copper can cause eminent health problem. High levels of copper in drinking water¹³ has had been found to cause kidney and liver damage in some people. Children under one year of age are more sensitive to copper because it is not easily removed from their system. People with liver damage or Wilson's disease are highly susceptible to copper toxicity.

Iron

Iron is naturally occurring metal in nature in the form of magnetite hematite etc. It enter into water in the extraction of metal from its ore. It also enter into the water aluminum waste products which are contains iron are discharged into water. Iron essential element for dietary requirement for most of organisms, and it is central atom in haemoglobin and helpful to transport the oxygen in to various organs through the blood. Iron¹⁴ content in the body exceed and stored in liver, pancreas, and heart, damage these organs. It defects leads anemia. In our present study all the samples are exceeds the max concentration according to WHO and ISI standards.

Lead

Lead is a toxic metal which occurs naturally in the environment. It is used in many products found in and around homes. But the concentration of lead may be increases due to human activities, it enter into environment through the exhaust of cars. It enters into water through the corrosion of pipes. Small amounts of lead it causes many health problems, especially in the case children below six-year-old are most risk. Lead¹⁵ can cause disruption of the biosynthesis of hemoglobin, rise in blood pressure kidney damage etc. In our present study all the samples are exceeds the max concentration according t WHO and ISI standards.



Manganese

Manganese is one of the most abundant metals in earth crust it present in the form of oxides and hydroxides. It is one of the common essential trace element and toxic. It enter into atmosphere. Suspended particulates resulting from industrial emissions, soil erosion, volcanic emissions and the burning human activities are also responsible for much of the manganese contamination in water in some areas. Manganese¹⁶solids may form deposits within pipes and break off as black particles that give water an unpleasant appearance and taste. And it increases the growth of unwanted bacteria that form a slimy coating in water pipes .in our present study only two samples are exceed the WHO and ISI standards

Mercury

Mercury is the liquid metal. Mercury is a rare element in Earth crust. It is present in water and soil. It presents in several form they are elemental mercury inorganic mercury and organic mercury. It released into the environment by burning of coal in power plants, burning hazardous waste, producing chlorine, breaking mercury products, and spilling mercury improper treatment and disposal of products waste containing mercury. Ground water contamination with Hg from both inactive and active industrial sodium hydroxide using Hg-cell technology have shown to contribute Hg to surface water, soils and groundwater¹⁷. Increase concentration mercury may cause skin discoloration, swelling and desquamation profuse sweating, tachycar (faster-than-normal heart beat), increased salivation, and high blood pressure. In children it effects loss of hair teeth and nails transient, hypotonia and kidney etc. In our present study none of the sample are exceeds the WHO and ISI standard.

Nickel

Nickel is one of the essential heavy metal present in the earth crust. It is found in sand stone and slate, mainly present as pentlndate, element accumulates in sediments of biological cycles. It enters into water from power plants, waste incinerator and metal industries. It also enters through improper diffusion of nickel cadmium batteries Nickel compounds may also be found in sludge, and in slags and fly ashes from waste incinerators. Increased concentration of nickel in ground water¹⁸ nickel is a dietary element required for many organisms, but increase concentration leads many hazard effect like tertogenic and carcinogenic to mammals. In our present study none of the sample are exceeds WHO and ISI standard.

Selenium

Selenium is the trace metal. The major sources of selenium in drinking water are erosion of natural deposits; discharge from mines and discharge from petroleum and metal refineries; it is an essential nutrient food fish, birds and animals, and humans. One of the most important features of selenium is the very high amounts of selenium are found to cause toxicity in wildlife Increase the concentration selenium¹⁹can cause nausea vomiting, nail change, loss of energy. Hair loss, white horizontal streaking on fingernails, nail inflammation, fatigue, irritability, , garlic breath odor, etc. In our present study None of the sample exceeds the WHO and ISI standards.

Zinc

Zinc is an essential trace metal. It enters into water on locations where zinc ore are found. It is used treatment and prevention of zinc deficiency and its consequences, including stunted growth and acute diarrhea in children, and slow wound healing. Zinc boosting the immune system, treating the cold and recurrent infection in ear, and preventing lower respiratory infections. It also enters into from Industrial wastewaters galvanic industries, battery production, etc., zinc oxide is a constituent of salves, paints and catalysts, and Zinc leaks from zinc pipes and rain pipes, consequential to circulation of carbon rich water. Increase concentration zinc²⁰ may be causes the toxicity leading to stomach aches and vomiting colics, fevers and diarrhea. In our present study none of the sample are exceeds WHO and BSI standards

Conclusions

Ground water is the main source of drinking water in around the Vijayawada city. Its quality is getting destroyed due to discharge of industrial effluents without proper treatment. The urban population is also relying on wells, bore wells hand pumps for all their ground water requirements. The uncontrolled usage of pesticides fertilizers are the primary causes of ground water contamination. The results of this study consider the ground water in zone -1 contains high levels of Cd, Cu, Fe and Pb according to WHO and ISO standards. In Zone-2 it contains Cd, Fe and Pb are above the permissible levels set by WHO and ISO, in this zone the high concentration of these metals is due power plants. In zone -3 the water is more contaminated in this area Cd, Cr, Cu, Fe, Pb and Ni. In Zone-4 Cd, Cr, Cu, Fe, Pb and Mn are above the permissible levels given by WHO and ISO, the high concentration of these metal is due to electroplating and alloy industries. In zone-5 Cd, Cr, Cu, Fe, and Mn are present high concentration as per WHO and ISO standards. In this study the concentration of following metals are present as follows Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, and Zn are identified concentrations ,<0.01 ,<0.001, 0.065-0.125, 0.018-0.33, 0.018-1.34, 0.13-2.2, 0.035-0.112, 0.001-0.207,<0.001, 0.017-0.133, <0.001 and 0.011-0.77 mg/l respectively The analytical result of sample sites monitored in this study irrespective of pollution source and it signaling that the ground water from these sampling sites required treatment to reduce the level of trace metal concentration in drinking water before to supply to the consumer. From the present study we are getting clear information that; the metal concentration is not at the level which could be harmful¹³. But still the study suggest that the concentration of toxic metals is present in slight excess in some locations it indicates precautionary measure should be taken immediately to avoid the harmful effects due to high concentration of heavy metal.

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Disclosure statement

No potential conflict of interest was reported by the authors.



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