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Study on the status of ground water quality across Vadodara city.

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Abstract: The present study was carried out to examine the ground water quality across the Vadodara city and to identify the areas which are most affected. Due to rapid urbanization, industrial growth nearby the Vadodara city may leads to increase in the ground water pollution level. Due to uncontrolled chemical wastes dumping nearby the industries, industrial effluent mixed with sewage and runoff water has arguably turned the local river Vishwamitri into big sewer, which ultimately leads to contaminate the ground water after leaching. To determine the ground water contamination level 8 sampling locations were selected for the collection of samples and various physico chemical parameters like pH, Conductivity, TDS, Total hardness, T. Alkalinity, Chlorides, Sulphates, Nitrate, Potassium, Chemical Oxygen Demand (COD), Phosphates , Heavy Metals were analyzed .Analysis of these different parameters shows that ground water quality in few areas of Vadodara city is not very good as the analysis is showing high values of certain parameters that can create health problem.

Key Words: Ground water quality, Industrial effluent, Contamination.

Introduction:

Water is very precious for our life and due to our negligence in the uses; we are playing with our life unconsciously. With the advent of industrialization and urbanization, ground water pollution has become a major problem of environment due to unsafe waste water management and it has further added the unsuitability in water consumption. The discharges of untreated wastes from industries in the forms of solids and effluents, illegal dumping sites, agricultural runoff, urbanization and increases in the use of synthetic organic substances may leads to ground water contaminations. Every year a large numbers of people die due to water contaminations and water born diseases in India. Now, it's present time demand to reduce the wastes of waters and save our water resources. The present paper aims to investigate the ground water quality across the city and identify the areas which are most affected due to the ground water contamination.

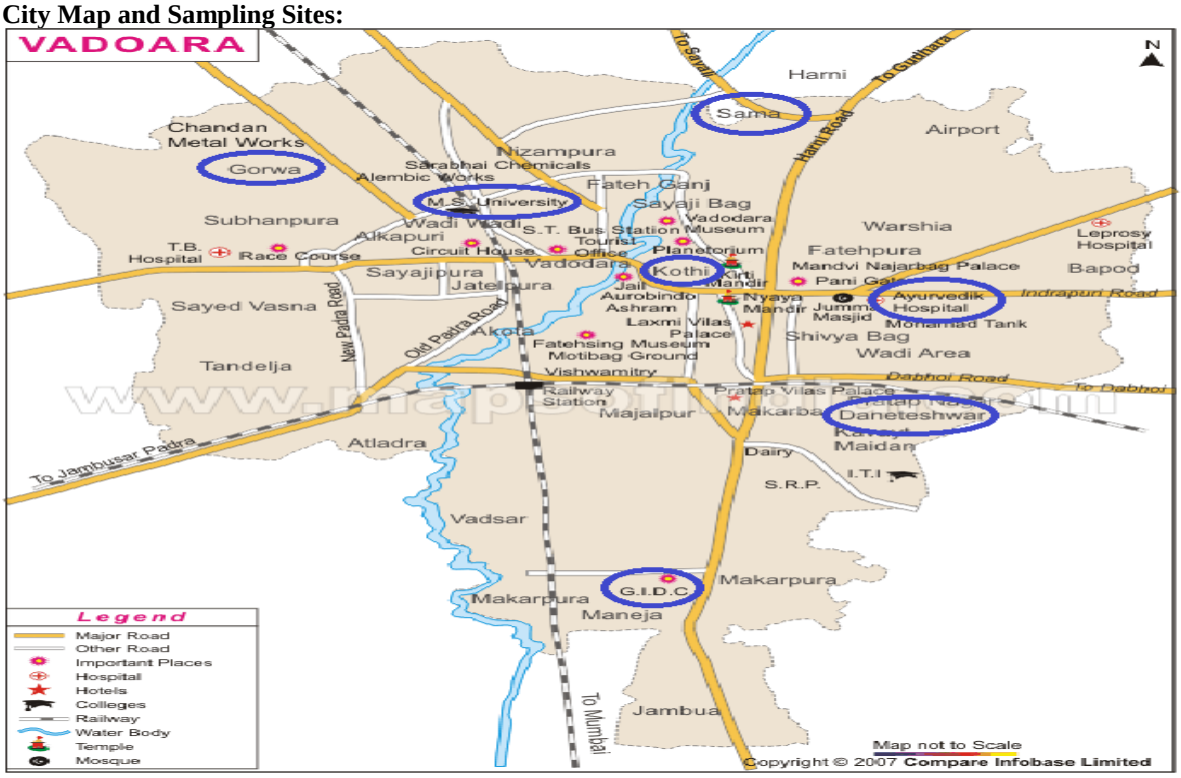
Study Area: Vadodara is located at latitude: 22°17'59 north latitude 73°15'18 east in western India at an elevation of 39 meters. The 18th largest city of India with an area of 148.95km2 and 1.6 million population according to 2001 census. The city developed on the banks of Vishwamitri River and located on the fertile plain between the Mahi and Narmada rivers. The principal industrial areas within the Vadodara urban are at Makarpura, Gorwa and Nandesari. The total registered industries are about 750, out of which 6000 are functioning. The Gujarat state Fertilizers & Chemicals, Indian oil Corporation Limited, Gujarat Refinery, Gujarat Alkali and Chemicals, Heavy Water Project and Gujarat Industries Power Company Limited are the large scale industries. In addition to these some public sector enterprises, medium scale and small scale industries are located in the vicinity of the residential areas

Sampling Locations: The locations were decided on the basis of different zones-east, west, north and south of the city and total 8 locations selected for the collection of samples. Most of the samples were collected from hand pumps.

Sampling Location	Category	Sample taken	Depth(Feet)	Water Uses
1-Kothi Char Rashta	Residential/Commercial	Bore Well	80	Domestic & Drinking
2-Shanti Niketan Socity near Ayurvedic hospital, Waghodia road	Residential	Bore Well	30	Domestic & Drinking
3-Maruti dham society 159,Danteshwar	Residential	Hand Pump	40	Domestic & Drinking
4-Vadsar road opp. Bank of Baroda, GIDC, Makarpura	Residential/Commercial/industrial	Hand Pump	42	Domestic & Drinking

5-M.S.U at Faculty of Art	Institutional	Bore Well	50	Drinking
6-Kenya nagar at Shiva temple, Sama	Residential/Commercial	Hand Pump	50	Domestic & Drinking
7-Ambica Dalitwadi, Karodia road, opp. Navrang society Gorwa	Residential	Hand Pump	50	Domestic & Drinking
8-Shri Gulabi Saibaba temple behind Gotri water tank	Residential/Commercial	Bore Well	85	Drinking

City Map and Sampling Sites:



Materials and Methodology:

In order to characterize the ground water quality in the Vadodara city four monthly surveys of piezometric level and physico-chemical analysis were performed from March 2014 to June 2014.The ground water samples for the different parameters were collected using Grab sampling. Three samples from each location were collected from Bore well and hand pump using a two liter plastic carboys for general parameters, one liter plastic carboys preserved with sulphuric acid for COD analysis and one liter plastic carboys preserved with nitric acid for heavy metal analysis.pH, Temperature and Conductivity were measured in the field using thermometer and Eutech make pH & Conductivity meter.

Afterward the analysis was done in the laboratory for the chemical constituents such as TDS, Alkalinity,Hardness,Ca^{+2},Mg^{+2},Cl^{-}, Na^{+}& K^{+} etc by using gravimetric, titrimetric and Flame Photometeric methods. The heavy metal samples were digested in HNO_3 and analysed by Atomic Absorption spectrophotometer of GBC Avanta make.

Table: 1: The physico-chemical parameters and heavy metals of ground water samples in Vadodara

Parameter	Average	Minimum	Maximum	Standard Deviation	Median
pH	7.42	7.07	7.77	0.2678	7.38
EC(µS/cm)	1137	794	1480	211.624	1036
Cl^-(mg/L)	112	42	182	42.994	89.95
SO_4^{-2}(mg/L)	106.9	33.8	180	45.903	61.1
TDS(mg/L)	846.5	390	1303	271.18	604.5
Na^+(mg/L)	68.5	39.5	97.5	19.375	58
K^+(mg/L)	28.65	1.6	55.7	19.0129	1.9
CaH (mg/L)	322.05	71.7	572.4	158.793	214.5
MgH (mg/L)	146.55	6.1	287	96.669	70.7
Cu(mg/L)	0.00515	0.0003	0.010	0.004612	0.005
Cd(mg/L)	0.0235	0.001	0.046	0.01539	0.003
Zn(mg/L)	0.5408	0.1889	0.8927	0.26899	0.3479

Table: 2: Methods Adopted

Parameter	Methods	References	Instrument/Apparatus Used
Temperature	Manual	Strickland and Parsons (1965).	Digital Thermometer
pH	Potentiometric Method	APHA (1998)	Digital pH/ Conductivity Meter (Eutech-merck).
Conductivity	Conductometric	APHA (1998)	Digital pH/ Conductivity Meter (Eutech-merck).
TDS	Filtration/Dried at 180°C	APHA (1998)	Hot Air Oven
T. Alkalinity	Acid titration	APHA (1998)	--
T. Hardness	EDTA- titration	APHA (1998)	--
Calcium	EDTA- titration	APHA (1998)	--
Magnesium	EDTA- titration	APHA(1998)	Calculation method
Chloride	Argentometric	APHA (1998)	--
Sulphate	Turbidity Method	APHA (1998)	Spectrophotometer(UV-Visible-2300)
Nitrate	Chromotropic Acid Method	ASTM (1987)	Spectrophotometer(UV-Visible-2300)
Phosphate	Stannous Chloride Method	APHA (1998)	Spectrophotometer(UV-Visible-2300)
Nitrite	Sulphanilamide-NEDA Method	APHA (1998)	Spectrophotometer(UV-Visible-2300)
Ammonical Nitrogen	Nessler's Method	APHA (1995)	Spectrophotometer(UV-Visible-2300)
C.O.D.	Open Reflux Method	APHA (1998)	Digestion and Titration
Sodium & potassium	Flame Emission	APHA (1998)	Flame Photometer (Systronics)
Heavy Metals	Digestion/AAS Method	APHA (1998)	Atomic Absorption Spectrophotometer(GBC-Avanata)

Table: 3: Results

Physico-chemical:

Location	Parameters								
	pH	**Cond.**	**TDS**	**COD**	**T.Hard**	**CaH**	**MgH**	**F^-**	**Cl^-**
Kothi Char Rashta	7.62	1005	605	22.4	138	73.0	65.2	0.86	76.9
Shanti Niketan Socity near Ayurvedic hospital, Waghodia road	7.77	794	390	25.4	77.8	71.7	6.1	0.56	93.8
Maruti dham society 159,Danteshwar	7.07	1236	664	19.2	302.4	216.0	86.4	0.33	86.9
Vadsar road opp. Bank of Baroda, GIDC, Makarpura	7.13	1480	1303	41.6	859.6	572.4	287.2	0.18	182
M.S.U at Faculty of Art	7.70	1067	604	32.0	427.7	213	214.7	0.15	114
Kenya nagar at Shiva temple, Sama	7.19	990	579	19.2	311.0	282.1	28.9	0.49	52
Ambica Dalitwadi, Karodia road, opp. Navrang society Gorwa	7.37	920	533	25.6	246.2	170	76.2	BDL	42
Shri Gulabi Saibaba temple behind Gotri water tank	7.39	1169	662	36.8	346.0	284.7	61.7	BDL	93

Location	Parameters							
	NH_3-N	**NO_2-N**	**NO_3-N**	**T.Alk**	**PO_4-P**	**SO_4^{-2}**	**Na^+**	**K^+**
Kothi Char rashta	0.09	0.0006	6.59	188	0.15	64.4	97.5	55.7
Shanti Niketan Society near Ayurvedic hospital, Waghodia road	0.01	0.0017	0.15	175	0.03	33.8	76.1	2.4
Maruti dham society 159,Danteshwar	0.07	0.0072	2.69	254	0.04	43.5	65.8	1.8
Vadsar road opp. Bank of Baroda, GIDC, Makarpura	1.72	0.28	22.54	265	0.009	181.41	70.6	1.6
M.S.U at Faculty of Art	0.12	0.0048	BDL	193	0.01	57.41	50.2	2.2
Kenya nagar at Shiva temple, Sama	0.62	0.04	6.91	181	0.02	57.8	44.8	1.7
Ambica Dalitwadi, Karodia road, opp. Navrang society Gorwa	0.17	0.01	5.70	200	0.17	66.3	39.5	1.8
Shri Gulabi Saibaba temple behind Gotri water tank	0.07	0.0084	8.48	214	0.04	70.3	50.2	2.0

Note: Except pH & Cond., all other results expressed in mg/L. The Conductivity is expressed in mS/cm.

***BDL**-Below detectable limit.

Heavy Metals:

Location	Parameters				
	Cu	**Fe**	**Cd**	**Zn**	**Ni**
Kothi Char Rashta	0.010	ND	ND	0.4167	ND
Shanti Niketan Society near Ayurvedic hospital, Waghodia road	ND	ND	0.001	0.1889	ND
Maruti dham society 159,Danteshwar	ND	ND	0.003	0.883	ND
Vadsar road opp. Bank of Baroda, GIDC, Makarpura	0.007	ND	0.001	0.5388	ND
M.S.U at Faculty of Art	0.003	ND	0.046	0.2508	ND
Kenya nagar at Shiva temple, Sama	ND	ND	0.003	0.2313	ND
Ambica Dalitwadi, Karodia road, opp. Navrang society Gorwa	0.010	ND	0.009	0.8927	ND
Shri Gulabi Saibaba temple behind Gotri water tank	0.009	ND	0.006	0.2791	ND

Note: All metals results expressed in mg/L. ***ND**-Not detected

Discussion:

The ground water samples of the study area have pH values ranging from 7.07 to 7.77 which show that the ground water is slightly alkaline in nature. The values of electrical conductivity ranges from 790 to 1480µS/cm , which is distinctive of mixed water(Ca-Mg-Cl-HCO3).It indicates that there are some lateral input of waste water which are having higher conductivity due to industrial discharges. Some of the samples are showing values of total hardness very high compared to given limits like that of GIDC-Makarpura (i.e. 860 mg/L) are showing high total hardness than given range which makes the ground water unsuitable for domestic, irrigational and industrial activities .According to the analysis done for the samples the Ca,Mg hardness and alkalinity in few areas is little higher than the prescribed limit, which can be due to general process like evaporate dissolution ,carbonate dissolution and silicate weathering.

The results of the analysis shows that the values Chlorides, Sulphates, and Nitrates are within the prescribed limit whish indicated that the ground water quality is safe for consumption. The higher values of SO_4^{-2}, Na^+ and K^+ can be due to salinity and soil strata which can leads to the deterioration of ground water quality. The higher values of phosphates and nitrates can be due to contamination of sewage into ground water which can result into the increase in nutrient load in ground water. The COD values are observed in higher site in some areas which shows there are some organic contaminants leached from industrial zone and sewage system. Illegal dumping of organic wastes may also a reason of COD contamination in ground water.

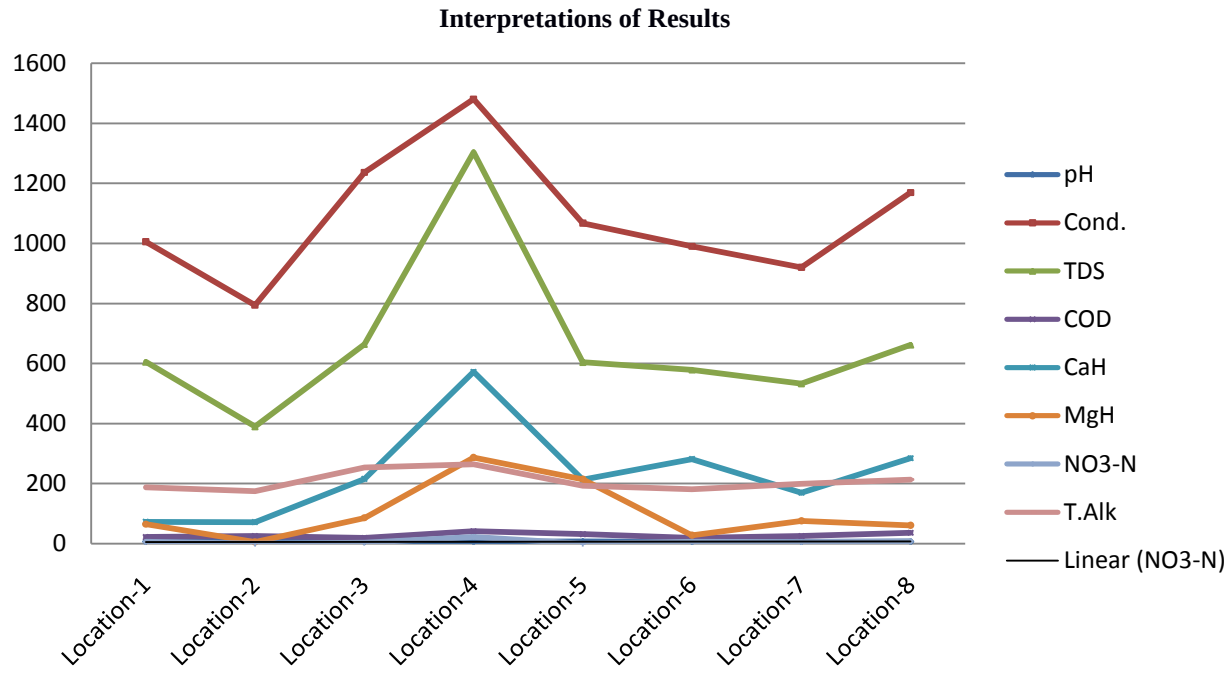
The heavy metals enter the environment by natural and man made sources such as natural weathering of earth crust, industrial discharge, sewage effluents etc. The analysis was carried out for Cu, Fe, Cd, Ni and Zn metals and results shows the samples containing higher Zn concentration and remaining metals are well within the prescribed norms.

Conclusion:

From this study it can be concluded that the ground water quality in Vadodara city has occurred mainly in areas like Old city, waghodia, and sama. Other places like GIDC-Makarpura, M.S.U and Gotri are also showing high values of certain parameters that can create health problem. pH and alkalinity of all groundwater samples collected from different location from Vadodara city is within range of standards by BIS/ WHO. TDS and Total hardness of all groundwater samples collected from different location from Vadodara city is within range of standards by BIS/ WHO. Calcium hardness and magnesium hardness values in ground water sample from GIDC-Makarpura, Sama, M.S.U and Gotri are showing high values because of mainly geological inheritance salinity. Carbonates hardness in water leads to scaling in container in which it is stored hence water having high values of total hardness cannot be use either for house hold, irrigational and industrial purposes. Chlorides of all groundwater samples of collected from different location from Vadodara city are within range of standards by BIS/ WHO. The chloride is essential in the diet and passes through the digestive system unchanged to become one of the major components of raw sewage. Ground water can have high nitrate compared to surface water. The samples from different locations are showing very low nitrates presence. Potential sources of nitrate include septic systems, animal waste, commercial fertilizer, and decaying organic matter. Surface water which comes in contact with a source of nitrate and then moves downward through soil will carry nitrate to groundwater. Shallow wells are susceptible to nitrate contamination because there is less soil and rock to serve as a filter between the soil surface and the ground water supply. In groundwater sodium range is between 6 mg/L to 130 mg/L, it may exceed up to 300 mg/L depending on geological locations. Generally it present in form of chlorides or sulphates.but the groundwater samples of collected from different location from Vadodara city is within range of standards by BIS/ WHO. The eastern and northern zones are more polluted than other zones. The possible reasons for this are improper sewage and waste water disposal activities practice by Municipal Corporation authorities in this areas and lack of proper development of sewage lines in slums areas surrounding this areas.

Actions points for protection of groundwater:

- Mapping of vulnerable areas of groundwater depletion and pollution.
- Notification of critical areas of groundwater depletion and pollution.
- Notification for banning commercial selling of groundwater.
- Special studies on areas of high concentration carcinogenic element of groundwater.
- Directives of industries / mining / commercial establishments for regulation of over with-drawl of groundwater.
- Environmental impact study for groundwater in identifies areas.
- Campaigns to create public awareness for judicious use and conservation of groundwater.



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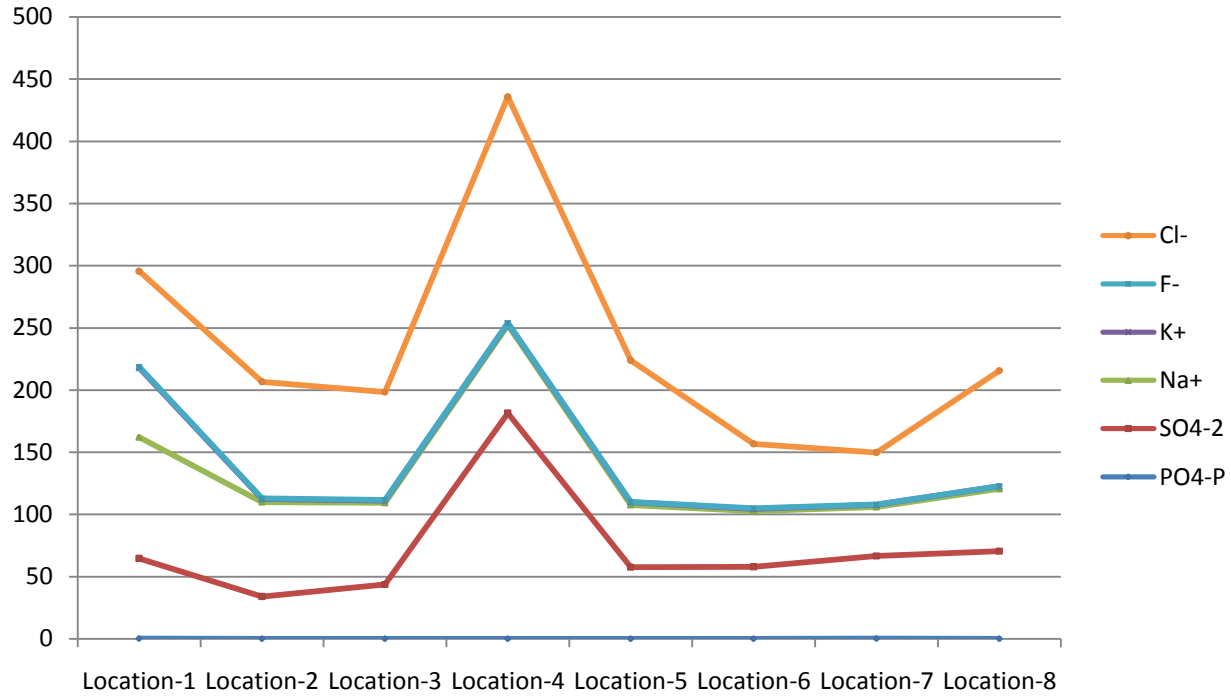

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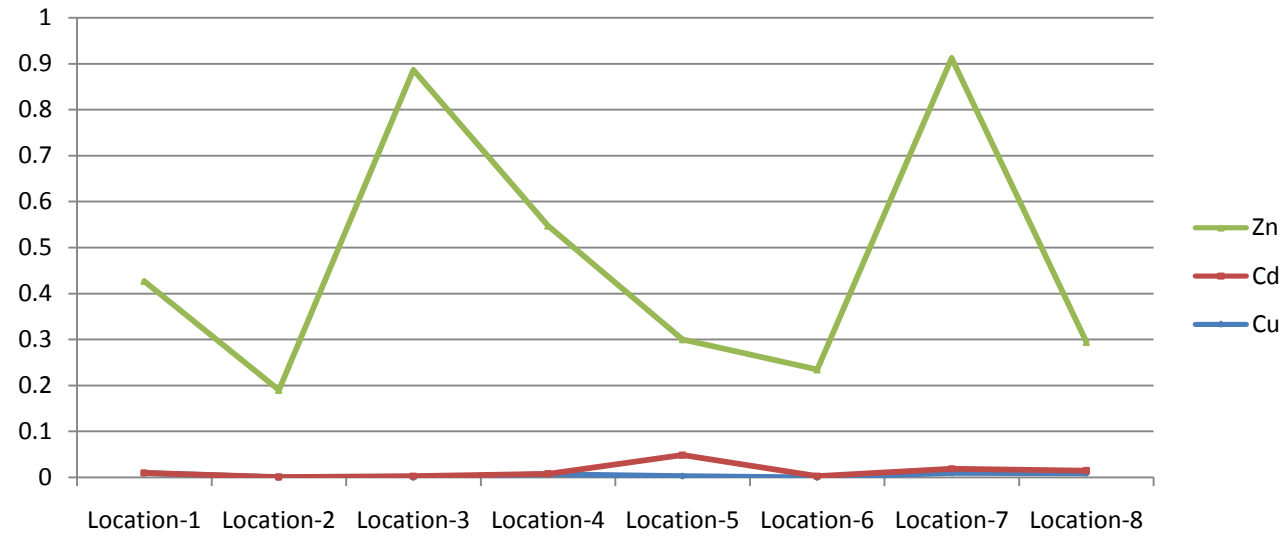

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