THE REPERCUSSION OF LEACHATE FROM INDUSTRIES ON WATER QUALITY IN JEEDIMETLA VILLAGE AND ITS SURROUNDINGS, MEDCHAL-MALKAJGIRI DISTRICT, TELANGANA

By

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ABSTRACT

Industries are the main resources for sustainable growth of the economy, but to allow waste water from industries create a lot of pollution in ground water and surface water. In this regard Jeedimetla industries association is one of the sources for the release of leachate. About 23 leachate samples are collected; they are filtered in canals, open ground, and lakes. By using UV spectrophotometer estimated the Arsenic, Nickel, Mercury and Nitrite, Nitrate mg/l. The toxic chemical percentage is very heavy, so most of the soil, water, and air is polluted. Thematic maps of toxic elements and physical parameters mainly concentrated in west side and Northeastern side of Jeedimetla village and its surroundings. The villages with good water quality resources available are Ramireddy Nagar, Maisammagudem and Bahadurpally, the main reason is industries far away from these areas. The villages with poor water quality are Dhulapally, Kaziguda, Jeedimetla, Chintal, Suraram and Apurupa colony. The water in the areas standard fall down due to industries drain on the surface. Arsenic values are high in Jeedimetla and Apurupa colony, it is very harmful to health. The government will take serious action immediately to stop drains of toxic element water or has to implement strict rules on the purification of water. Statistical analysis of the correlation matrix shows the relation between parameters EC, DO, Alkalinity, Fluoride, Nitrite, and Nitrate have positive relationships and remaining are negative. Positive relation is week 0.3 to <0.6 and strong relation is 0.6>.

Keywords: Quantum GIS, Correlation Matrix, Arsenic, Fluoride and Nickel.

INTRODUCTION

The study area has covered by different villages such as Jeedimetla, Dhulapally, Suraram, Shapur and Chintal villages are in the western part of the Hyderabad. These villages have good educational institutes of Engineering Colleges, Pharmaceutical College, Information Technology Colleges, Management Colleges, Secondary and Primary Education Schools. The temperature is between 26°C to 41°C in summer season. Average temperatures of January is 26°C, February is 32°C, March is 36°C, April is 38°C, May is 39°C. The forest land also well developed in this region, cultivation land is very less, because the land cost is heavier. Most of the people built buildings for industries, education, and villas purposes. More peoples are concentrated in this region.

They are related to industrial workers, employers and different sector employable persons. For hospitalities they are depended on different sectors such as hospitals, markets, shopping malls, schools, and other institutions. While the increase of population and infrastructure development releases the pollution in all geological aspects. In this regard, is it important for the living organism to determine the water quality. From Dhulapally village to Jeedimetla village a path of industrial belt contains small scale and large scale industries; it is located from 22 km west of Hyderabad. The industries are heavy engineering, paints, chemical, and paper factories, etc., All factories and domestics are generated approximately 8 million liters

of effluent water per day, effluent plants filtered a lot of polluted water, meanwhile some of the companies illegally drain the polluted water and air (AIC 1989, NEERI 1989).

1. Literature Review

An assessment of toxic element concentration in water is important to adopt sustainable safe use of water; in that water quality index method help to determine the good location (Pawar & Nikhumbh, 1999; Pearson, 1895). Developing countries produces the industrial wastewater, sewage sludge, and solid waste materials and discharged into the environment indiscriminately. These toxic elements pollute drastically, while entering into the surface water and subsurface aquifers and soil (Schwedt, 1997). The effluents concentrate depending on the accumulation factors of the individual metals, thus constitute a potential source of direct intake to man (Srikanth, Rao, Kumar, & Khanum, 1993; Kataria, 1994; Loranger & Zayed, 1995).

Fox Sagar lake is situated at Jeedimetla region in olden days, which is useful for Agriculture and for fishing to a nearby locality but now it is polluted. Fox sagar is the fifth largest lake in Hyderabad, before industrialization, the area had a high potential for freshwater recharge throughout the year and supported agriculture. The quality water has deteriorated over the period and the level of pollution has increased continuously and consistently (Chapman, 1992).

Several organizations (Pollution Control Board, State Water Board for example) and several workers have been researched on the increased contaminants of BOD, COD, TDS, carbonates, bicarbonates, and sulfates in industrial effluents and surface and subsurface waters (Ninfa & Ballou, 2009). However, Pollution with toxic elements are a serious problem, and long-lasting nature will never disintegrate. The toxic elements of anthropogenic origin cause a health threat, in recent years industrial pollutants containing these toxic metals have posed a serious concern for health threat on a regional scale (Singare, Jagtap, & Lokhande, 2011; Hundal, Kumar, Singh, & Singh, 2007).

2. Methodology

Total 23 samples of water extracted from Jeedimetla and its surrounding areas, eventhough a maximum number of samples are collected near to the industrial areas. The external surface water bodies', water is extracted in high-density polyethylene bottles and marked with information like source and place of collection in the code format. The bottles were cleaned with water, which was collecting from the same location water for that, the sample is to avoid cross-contamination. After collecting the water samples on the first day, they had tested the DO on immediate next day because oxygen present in the sample may get mixed with the atmosphere. We prepared reagents as per IS standards instructions before 24 hours. The water samples analyzed for various physiochemical parameters like pH, Dissolved Oxygen (DO), Alkalinity, Electrical Conductivity (EC), Nitrites, Nitrates, Fluorides, Iron, Mercury, Arsenic, and Nickel using standards methods (Trivedi & Goel, 1986). Nitrate, Nitrites, Mercury, Arsenic, and Nickel has measured by UV-visible spectrophotometer. All the parameters are expressed in mg/l except for pH and EC. EC is expressed in micro Siemens/cm.

2.1 Inverse Distance Weighting (IDW)

IDW is a method used for the scattering of known location points upto the mark or boundary. Water quality values of particular sample location and neighbor location of water quality values spreading based on the average of weighing values, here the average of unknown location points are converted into known points.

Weighing function: The simplest weighing function is inverse power

$$w(d) = 1/dp$$

Where, $p > 0$.

The reading of p is indicated by the instructor. The feasible point is $p = 2$. For $p = 1$, modified to preserve the continuity of the boundary of two neighborhoods.

In QGIS software interpolation tool have an IDW function. This tool runs by Shepard's method (1968), two distinct weighting values using two individual neighborhoods, the support of 2 in the inner neighborhood and an exponent of 4 in the outer neighborhoods (Pejman, Bidhendi, Karbassi, Mehrdadi, & Bidhendi, 2009). IDW uses the measured values surrounding the prediction location. IDW points have an influence based on the distance. The results have more

strength to the center of the location; the points spread particular weight upto the mark or boundary is inverse distance weight.

2.2 Re-classify Method

This method is applied to change the alternate values to the existing value, all the reclassification method formed after IDW process and each cell of the alternate value is converted to the original cell zone. In this paper, we applied grouping values together to simplify the information in a raster.

$$r = \frac{N\sum xy - (\sum x)\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2)]}}$$

where,

N = number of pairs of scores

xy = sum of the products of paired scores

x = sum of x scores

y = sum of y scores

x2 = sum of squared x scores

y2 = sum of squared y scores

2.2.1 Pearson Correlation Coefficient Formula

Pearson correlation equation in an Excel Microsoft generates all the water quality parameters and builds them in the systematic statistical approach to understand strong, week, positive and negative correlation. This type of analysis is demarcated a strong relationship between elements (Pearson, 1895).

3. Objectives

- To understand the spatial distribution of toxic element concentration of water related to suitable for domestic, drinking and agriculture use.
- To understand correlation between elements by using change matrix method.
- Determine the highly polluted regions due to industrial effluent.

4. Results

Collected 23 water samples in 5 villages and analyzed for the parameters like pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Total Alkalinity, Iron, Nitrites, Nitrates, Fluoride, Mercury, Nickel, and Arsenic. Each parameter is compared with Indian standard water analysis data IS (Indian standard) 10500: 1991.

4.1 pH

The pH (potential of hydrogen) of water samples ranged from 6.35 to 9.5 in the study area (Figure 5). According to WHO (World Health Organization, 2004), the permissible limit for drinking water quality pH is 6.5 to 8.5. pH 9.5 (Table 1) found in the Jeedimetla region. The pH level is above 8.25 represented in Suraram colony, and Janapriya. On the other side Dhulapally village, Jaibery colony, Rami Reddy Nagar and Kaziguda represented the pH levels below 8.2.

4.2 Electrical Conductivity (EC)

The EC values of water samples ranged from 817 to 1811 $\mu S\ cm^{-1}$ with a mean of 1335 $\mu S\ cm^{-1}$. The KCL solution prepared for the testing of conductivity is 1811 $\mu S\ cm^{-1}$. EC of sample values near Chintal, Jeedimetla and surrounding having a high concentration. Permissible limits of EC are 500 – 2000 $\mu S\ cm^{-1}$ (Figure 4).

4.3 Dissolved Oxygen (DO)

Dissolved Oxygen of all the water samples not acceptable limits of human consumption Chinthal, Suraram, Jeedimetla nearby factory drain surface water representing DO of 13.5 mg/l, which is considered as the sewage. Bahadhurpally, Dhualpally, Maisammagudem, and Rami Reddy Nagar are representing a maximum DO of 10.5 mg/l.

4.4 Nitrate

Nitrate values of water samples are ranges from 1-45 mg/l. According to WHO and IS standards, the acceptable range for drinking is up to 45mg/l only. All the water samples taken have Nitrate values within the Desirable limits of WHO and BIS. Nitrate concentration is ranging from 0-45 mg/l which

Water Quality Parameter	Requirement Acceptable Limit	Permissible Limit
pH	7.0	8.5
EC (μS/cm)	500	2000
Total 0.01 alkalinity mg/l	-	-
Fluoride mg/l	1	1.5
NO31- mg/l	0	1
NO −2mg/l	0	1
Fe mg/l	0.3	No relaxation
Arsenic mg/l	0.01	0.05
Hg mg/l	0.01	No relaxation
Ni mg/l	0.02	No relaxation

Table 1. Physical Parameters and Parameters Concerning Toxic Substances

	pH	EC	DO	Alkalinity	Iron	Fluoride	Nitrate	Nitrite	Nickel	Arsenic	Mercury
pH	1										
EC	-0.0680	1									
DO	0.0326	0.0629	1								
Alkalinity	-0.1940	0.4885	-0.3166	1							
Iron	0.1346	0.0256	-0.0010	0.1213	1						
Fluoride	-0.4533	0.0296	0.3712	-0.1358	-0.0610	1					
Nitrate	-0.1266	0.0665	-0.1447	0.1995	-0.0920	-0.3216	1				
Nitrite	-0.0820	0.3527	0.2713	0.0102	-0.0106	0.5992	-0.3648	1			
Nickel	-0.0234	0.6748	-0.1859	0.5758	0.0353	-0.2502	0.3339	-0.0081	1		
Arsenic	-0.3655	0.0363	0.5352	-0.1728	-0.1836	0.8199	-0.1911	0.5869	-0.1677	1	
Mercury	-0.2433	0.1164	-0.3443	0.3750	0.1322	-0.2109	0.1907	-0.0851	0.1392	-0.1615	1

Table 2. Correlation Matrix between Parameters for the Understanding Relationship

S. No.	Village Name	Sample Code	Long	Lat	pH	EC	DO	Alkalinity	Fe	F-	NO_3^{1-}	NO_2^-	Nickel	Ar	Hg
1	Apurupacolony	AP	17.551	78.469	6.89	1523	9.1	45.2	0.01	1.85	25	0	1142	0	0.001
2	Apurupacolony	APC	17.526	78.450	6.95	1308	9.8	16.8	0.02	1.45	35	0	981	0	0.0066
3	Apurupacolony	APC2	17.528	78.449	7.01	1644	10.5	31.4	0.48	2	10	0.2	1233	0	0.003
4	Bahadurpally	BA1	17.559	78.443	8.28	1333	10.8	24.2	0.52	1.2	25	0	1000	0	0.0001
5	Bahadurpally	BA2	17.558	78.443	8.28	817	8.8	26	0.03	1.5	30	0	613	0	0.002
6	Chintal	CH1	17.526	78.450	9.01	1390	8.7	25	0.36	1.05	35	0.1	1043	0	0.0075
7	Chintal	CH2	17.522	78.455	6.86	1811	9.2	44.3	0.46	1	45	0.5	1358	0	0.037
8	Dhulapally	D1	17.551	78.457	6.93	1027	8.7	26.8	0.5	1.24	15	0.5	770	0	0.35
9	Dhulapally	D2	17.552	78.462	8.38	1372	8.9	25.2	0.02	1.25	6	0.2	1029	0	0.0015
10	Jabeiry colony	JBC	17.544	78.466	7.11	1069	9.2	22.1	0.13	1.35	10	0.3	802	0	0.0025
11	Janapriya	JP	17.526	78.413	9.01	1241	12.6	23.4	0.346	1.15	24	0	931	0	0.01
12	Jeedimetla	CDW1	18.429	78.159	6.35	1120	13.5	26.2	0.03	2	25	0.5	840	0.94	0.001
13	Jeedimetla	CDW2	18.429	78.160	7.26	1743	11.8	30.6	0.29	3	2	44.39	980	0.94	0.0001
14	Jeedimetla	J1	17.522	78.457	9.5	1050	9.81	31.4	0.51	1.75	30	0.3	788	0.1	0.0021
15	Jeedimetla	J2	17.552	78.461	7.8	1000	11.5	31	0.7	2	21	0.4	850	0.17	0.0014
16	Jeedimetla	J3	17.520	78.462	7.44	1705	12.2	25.2	0.3	2	10	5	529	0.22	0.0354
17	Kaziguda	KZG	17.546	78.443	7.24	949	8.8	33.2	0.31	1.75	1	0	712	0.12	0.002
18	Misammagudeam	M	17.548	78.463	7.26	1163	11.8	20	0.3	1.5	25	0	872	0	0.001
19	Rami reddy nagar	RRC	17.539	78.467	6.89	1740	8.8	50	0.2	1.25	40	0.5	1305	0	0.375
20	Suraram	PCL	17.519	78.449	6.82	1271	11.5	21.4	0.07	3	24	5	953	1	0.001
21	Suraram	SRC1	17.544	78.443	8.67	1345	12.2	32.2	0.01	1	20	3	1009	0	0.005
22	Suraram	SRC2	17.539	78.434	8.6	1585	10.36	36.1	0.48	1	6	1	1189	0	0.0042
23	Suraram	SRC3	17.542145	78.436	6.95	1454	10.4	30.6	0.02	1.25	30	2	1091	0	0.0075

Table 3. Village Wise Water Quality Parameters in Jeedimetla Regions and its Surroundings

were taken for the lab test.

4.5 Nitrite

Nitrite values of water samples are ranging from 0-5.39 mg/l. According to WHO standards, the acceptable limit of nitrite for drinking water is 0-1 mg/l (Rajappa, Manjappa, & Puttaiah, 2010). Jeedimetla and Suraram colony are have nitrite concentrations above 2 mg/l respectively, which are not accepted as drinking or potable water shown in Table 3.

4.6 Fluoride

Fluoride levels of water samples are ranging from 1.25-3 mg/l shown in Figure 1. Acceptable limits of fluoride in drinking water is 1-1.5mg/l. Dhulapally, Misammagudeam, Jabeiry colony, Rami Reddy Nagar, Apparel park road are have zero concentrations of Fluoride. Chinthal, Jeedimetla, and Suraram colony villages have fluoride values ranging from 1-1.5mg/l within the permissible limits. On the other hand some of the samples, which are collected factory drained surface water in Jeedimetla and Chinthal having the fluoride concentration about 2mg/l. Fluoride concentration near Dhulapally, Kaziguda is having less concentration and near Jeedimetla, Apurpa colony having a high concentration.

4.7 Iron

Iron levels of water samples ranging are from 0-3mg/l (Figure 3), acceptable limits of iron in drinking water is 0.3-1mg/l. Dhulapally, Misammagudeam, Jabeiry colony, Rami Reddy Nagar, Chinthal, and Jeedimetla have zero concentration of iron.

4.8 Mercury

Mercury levels in water samples ranging are from 0.001 to 0.35 mg/l. The acceptable limit of mercury in water is <0.001mg/l (Ayyadurai, Kamalam, & Rajagopal, 1983).

4.9 Arsenic

Arsenic levels in water samples ranging are from 0 to 0.22

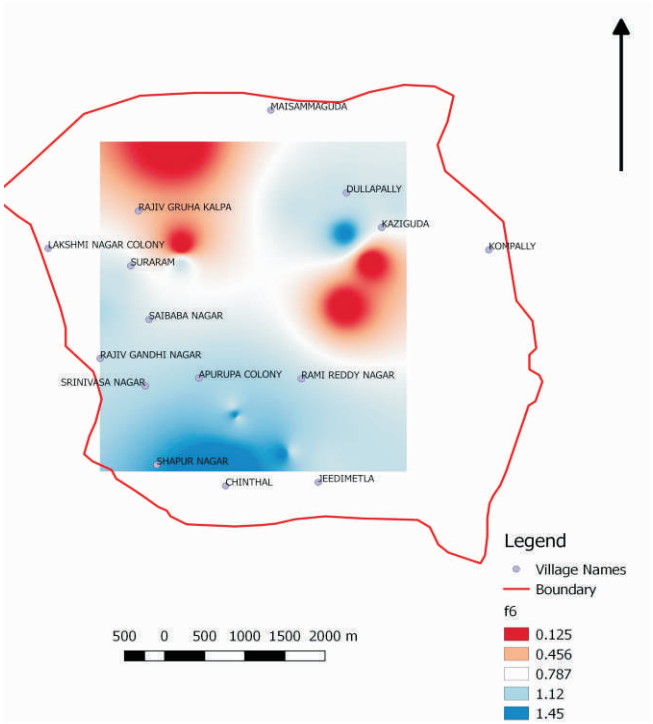

Figure 1. Fluoride Values Distribution in the Study Area

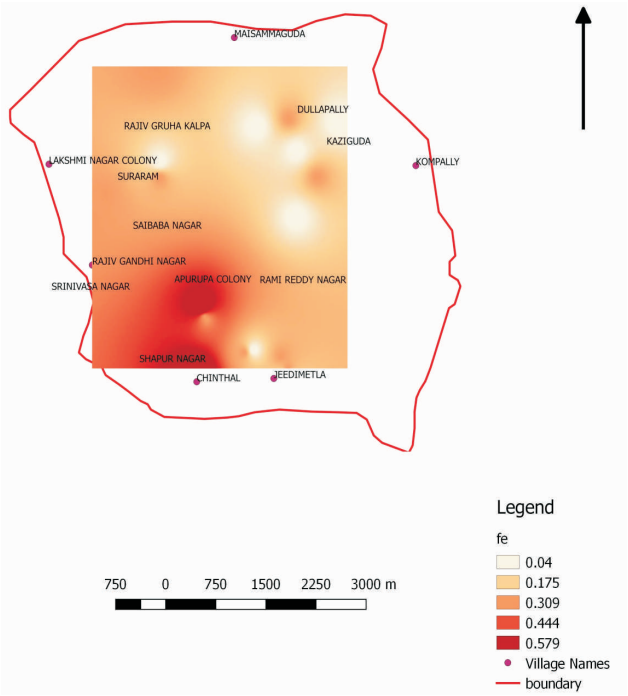

Figure 3. Fe Values Distribution in the Study Area

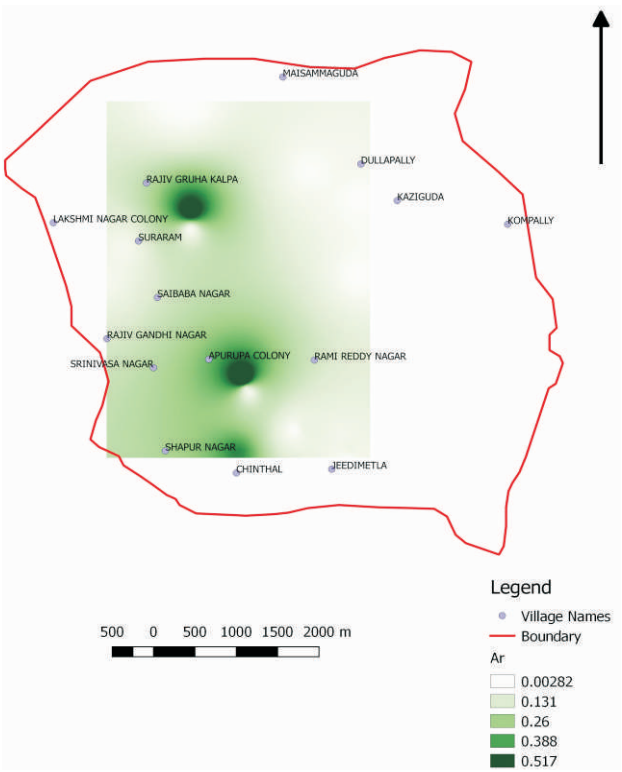

Figure 2. Arsenic Values Distribution in the Study Area

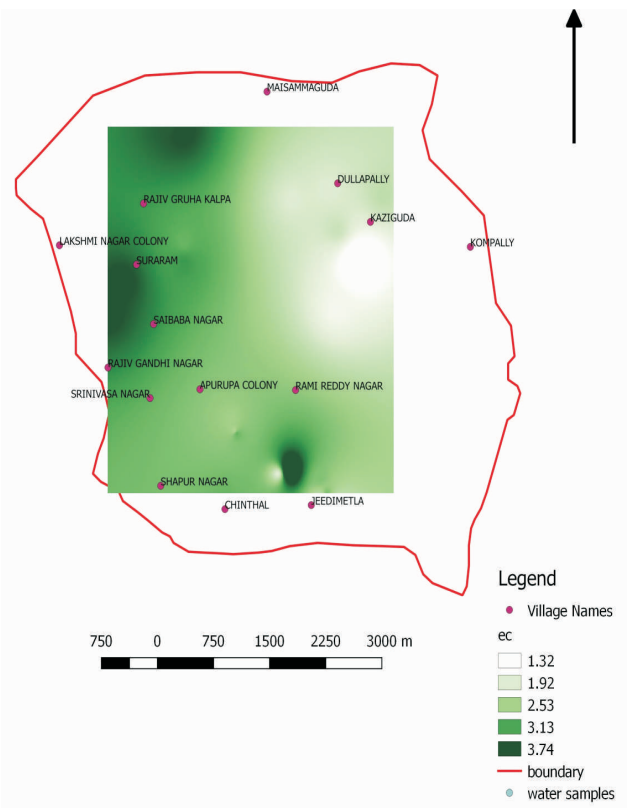

Figure 4. EC Values Distribution in the Study Area

mg/l. Acceptable limits in drinking water are < 0.01mg/l shown in Figure 2. Dhulapally, Jabeiry colony, Chinthal, Apurupa colony have about zero concentration of arsenic.

On the other hand, some of the water samples which are collected factory drained surface water in Jeedimetla and

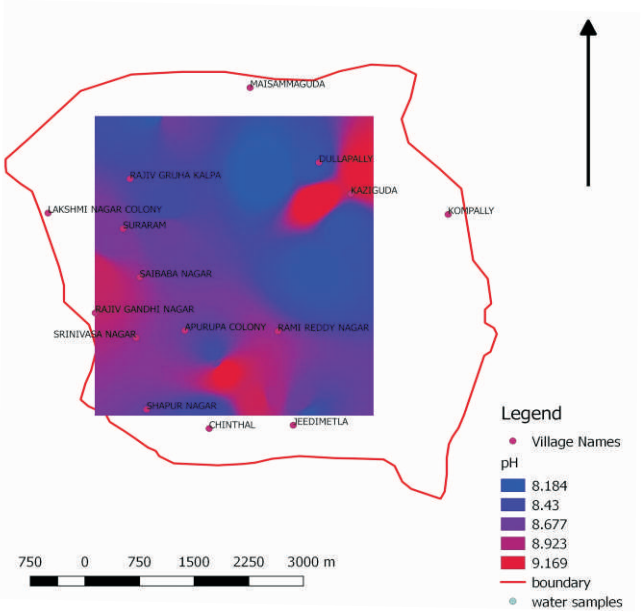

Figure 5. pH Values Distribution in the Study Area

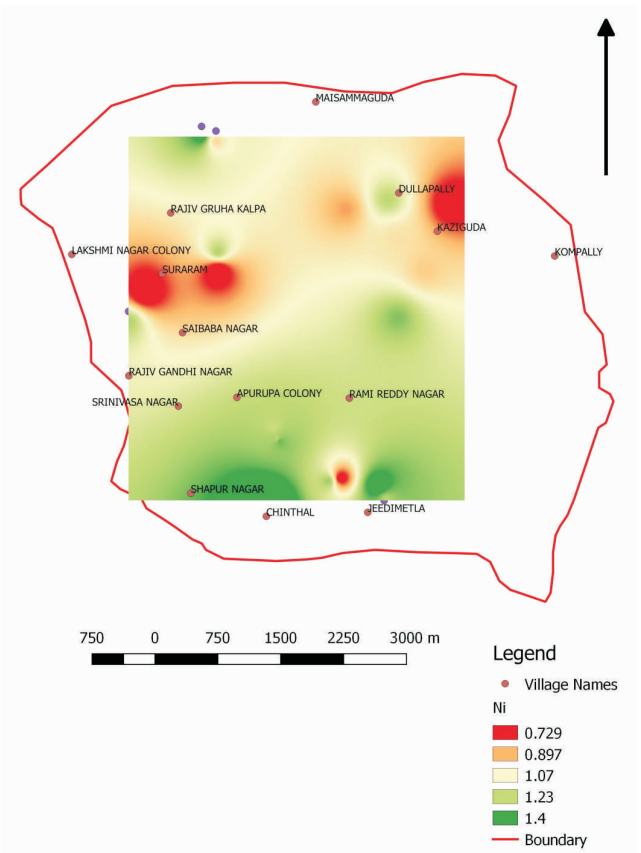

Figure 6. WQI Values Distribution in the Study Area

Suraram having the Arsenic concentration of about 0.2-0.15mg/l. This element causes a severe health problems, Arsenic values are in Apurupa colony, this value is higher than the permissible limit, which is unacceptable for human consumption.

Arsenic compounds are rarely used from the long period (Singare et al., 2011). The concentration of arsenic elements affects the physical properties of the metals and alloys. These trace elements spread due to the disintegration of rocks, soils, chemical fertilizers, cultivation and fossils fuels as well as disposal of industrial, municipal and animal waste. Arsenic is a constituent of many foods, such as fish, grains, and cereals. The toxicity, availability and environmental mobility of arsenic are very much independent of their chemical forms (Chakraborti et al., 2009).

4.10 Correlation Matrix

Pearson statistical work has been enhanced by applying microsoft excel formula to the physicochemical parameters for all the water samples. Pearson's correlation coefficients can calculated all the parameters and make them into tabulator form then we can analyze the positive and negative values, within the strong and weak correlation between two components in that matrix shows 11 columns have a positive bond and all remains, the negative bonds as shown in Table 2.

5. Recommendation

- Water standards of BIS (1991) and WHO (2004) values are no satisfactory data to recommend health-based value guidelines. Depends on environmental conditions, when setting national standards the volume of water consumed and the consumption of other sources should be considered.
- To maintain waste water treatment, plants are each individual industry to obstruct the leachate.
- Government has to take serious action on industries, that release leachate on the surface, canals, and underground areas.

6. Limitations

- Table 1 shows the Requirement acceptable limit and Permissible limit of variable parameters. The Arsenic concentration is 0.2-0.15mg/l, it is exceeding the permissible limit.
- Fluoride values are 1.5-3 mg/l exceeding the

permissible limit. Some pH value of water samples is above permissible limit.

- Jeedimetla and Suraram village samples are having nitrite concentration above 2 mg/l respectively, which are not acceptable for drinking water.

Conclusion

Water has polluted due to waste material dump leaving on the surface, drain water from factories. The results obtained from a study area, that shows the leachets drains impacts on the water quality. The water samples have arsenic concentration exceeding the permissible limits. It had assumed nickel element concentration high nearby National highway and industry results from anthropogenic input. Fluoride is present in water due to heavy metal in the parent rocks. Water quality index projected water resource in available villages are Ramireddy Nagar, Chintal, Suraram colony, Maisammaguda and Bahadurpally, the main reason is the industries are away from these areas. The poor water quality villages are Dhulapally, Kajiguda, Jeedimetla and Apurupa colony (Figure 6). These areas fall down the water standard due to steel and plastic industries to drain the polluted water on the surface. Arsenic values are very harmful to health in Jeedimetla and Apurupa colony.

Statistical analysis of the correlation matrix shows that, the relationship between parameters electrical conductivity, dissolved oxygen, alkalinity, fluoride, nitrite, and nitrate have positive relationships and remaining are negative. Positive relation is week 0.3 to <0.6 and strong relation is 0.6>, the matrix correlation electrical conductivity verses nickel; fluoride verses arsenic are a strong correlation. While electrical conductivity values increases, Nickel values increases and Fluoride increases arsenic values are also increases.

As shown by our data, serious contaminations in the urban area originated from factories that produced serious pollution, although many of these plants have been closed or moved to other locations. However, the inventories of factories that moved from an urban area is incomplete, both in detail and extent. Improving urban soil quality requires, understanding and identifying the pollution source and integrating information processing. Complex co-contaminations of trace metals exist in many cities. The current and potential threats need to be understood, so that suitable technologies can be developed to repair contaminated soil.

References

[1]. Ayyadurai, K., Kamalam, N., & Rajagopal, C. K. (1983). Mercury pollution in water in Madras city. *Indian Journal of Environmental Health,* 25(1), 15-20.

[2]. Bureau of Indian Standard (BIS). IS 10500. (1991). *Drinking Water Specification* (6th reprint, 2004), New Delhi, 8.

[3]. Chakraborti, D., Das, B., Rahman, M. M., Chowdhury, U. K., Biswas, B., Goswami, A. B., ... & Hossain, A. (2009). Status of groundwater arsenic contamination in the state of West Bengal, India: A 20-years study report. *Molecular Nutrition and Food Research,* 53(5), 542-551. https://doi.org/10.1 002/mnfr.200700517

[4]. Chapman, D. (1992). *Water Quality Assessments,* Published on behalf of UNESCO/WHO/UNEP, Chapmen & Hall Ltd., London, 585.

[5]. Hundal, H. S., Kumar, R., Singh, K., & Singh, D. (2007). Occurrence and geochemistry of arsenic in groundwater of Punjab, Northwest India. *Communications in Soil Science and Plant Analysis,* 38(17-18), 2257-2277.

[6]. Kataria, H. C. (1994). Heavy metals contamination and pollution in Betwa River. *IJEP,* 15(1), 34-38.

[7]. Loranger, S., & Zayed, J. (1995). Environmental and occupational exposure to manganese. A multimedia assessment. *International Archives of Occupational and Environmental Health,* 67, 101-110.

[8]. Ninfa, A. J., & Ballou, D. P. (2009). *Fundamental Laboratory Approaches for Biochemistry and Biotechnology* (2nd Ed.). Wiley.

[9]. Pawar, N. J., & Nikumbh, J. D. (1999). Trace element geochemistry of groundwater from Behedi basin, Nasik district, Maharashtra. *Journal-Geological Society of India,* 54, 501-514.

[10]. Pearson, K. (1895). Notes on Regression and Inheritance in the Case of Two Parents Proceedings of the Royal Society of London, 58, 240-242.

[11]. **Pejman, A. H., Bidhendi, G. N., Karbassi, A. R., Mehrdadi, N., & Bidhendi, M. E. (2009).** Evaluation of spatial and seasonal variations in surface water quality using multivariate statistical techniques. *International Journal of Environmental Science & Technology,* 6(3), 467-476.

[12]. Rajappa, B., Manjappa, S., & Puttaiah, E. T. (2010). Monitoring of heavy metal concentration in groundwater of Hakinaka Taluk, India. *Contemporary Engineering Sciences,* 3(4), 183-190.

[13]. Schwedt, G. (1997). *The Essential Guide to Analytical Chemistry* (Brooks Haderlie, trans.). Chichester, NY: Wiley. 16-17.

[14]. Shepard, D. (1968, January). A two-dimensional interpolation function for irregularly-spaced data. In *Proceedings of the 1968 23rd ACM National Conference* (pp. 517-524). ACM.

[15]. Singare, P. U., Jagtap, A. G., & Lokhande, R. S. (2011). Water pollution by discharge effluents from Gove Industrial Area of Maharashtra, India: Dispersion of heavy metals and their Toxic effects. *International Journal of Global Environmental Issues,* 11(1), 28-36.

[16]. Srikanth, R. A., Rao, M., Kumar, C. H. S., & Khanum, A. (1993). Pb, Calcium, Ni and Zn contamination of groundwater around Hussein Sugar lake, Hyderabad. *Bulletin Environment Contamination Toxicology,* 50(1), 138-143.

[17]. Trivedy, R. K., & Goel, P. K. (1986). *Chemical and Biological Methods for Water Pollution Studies.* Environmental publications.

[18]. World Health Organization, (WHO) Geneva. (2004). *Guidelines for Drinking-water Quality.* Volume 1: Recommendations. Wayback Machine. 3rd ed.

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