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Spatial Mapping and Analysis of Ground Water Pollution in Pallavaram Municipality

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Abstract

The usage of groundwater has gradually increased because of the increase in water demand and the shortage of surface water. Pallavaram is one such sector in Chennai Municipal Corporation using groundwater as the predominant water source. Ground water samples in and around the industries and the dumpsite in Pallavaram were studied to assess the impact of pollution on ground water resources in the particular area. Groundwater samples were collected during post-monsoon season from 12 sampling points, representing different point sources of water supply such as open and dug wells along with the lake water. The water samples were characterized and analyzed for various chemical parameters such as pH, electrical conductivity, chlorides, calcium, dissolved oxygen and total dissolved solids. The mobility, concentration, and geo-accumulation of certain trace elements such as nickel, chromium, lead, zinc and iron are also analyzed to quantify the levels of pollution. Chromium, lead, calcium and chlorine content for all the sample points were exceeding the permissible limits and the higher values were from points that were near the dump site. Spatial mapping of parameters was generated using ArcGIS and the spatial distribution of these parameters indicates the pathways of the hydrological system during the collection period. Results indicate that the analyzed water samples were highly polluted in comparison with the drinking water standards.

Keywords: *Groundwater, GIS, spatial mapping, chemical parameters, quality, pollutants, ArcGIS*

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INTRODUCTION

Ground water reserves are increasingly being subjected to pollution from various sources. The major classifications of sources of water pollution are point sources, which include landfills, leaking gasoline storage tanks, leaking septic tanks, accidental spills, municipal landfills and industrial waste disposal sites, etc., and non-point sources which include infiltration from farm land treated with pesticides and fertilizers, etc. Presence of trace elements even at low concentration may prove to be toxic in drinking water [1]. WHO has published standards for chemical parameters in drinking water under Drinking Water Specification IS 10500: 1991, which includes both trace elements as well as normal parameters [2].

Chennai is an area where industrialization and urbanization are at their peak growth in recent times. The study area, Pallavaram, is one of the most polluted sectors of Chennai with regard to ground water. Pallavaram hosts numerous manufacturing industries alongside water bodies which deal with use of chemicals for their production [3, 4]. The release of such chemicals proves to be highly toxic in nature if disposed of untreated. Also, the release of leachate from the dump yard present in Pallavaram poses a serious threat to quality of water. The map showing the municipal boundary of Pallavaram is in Figure 1.

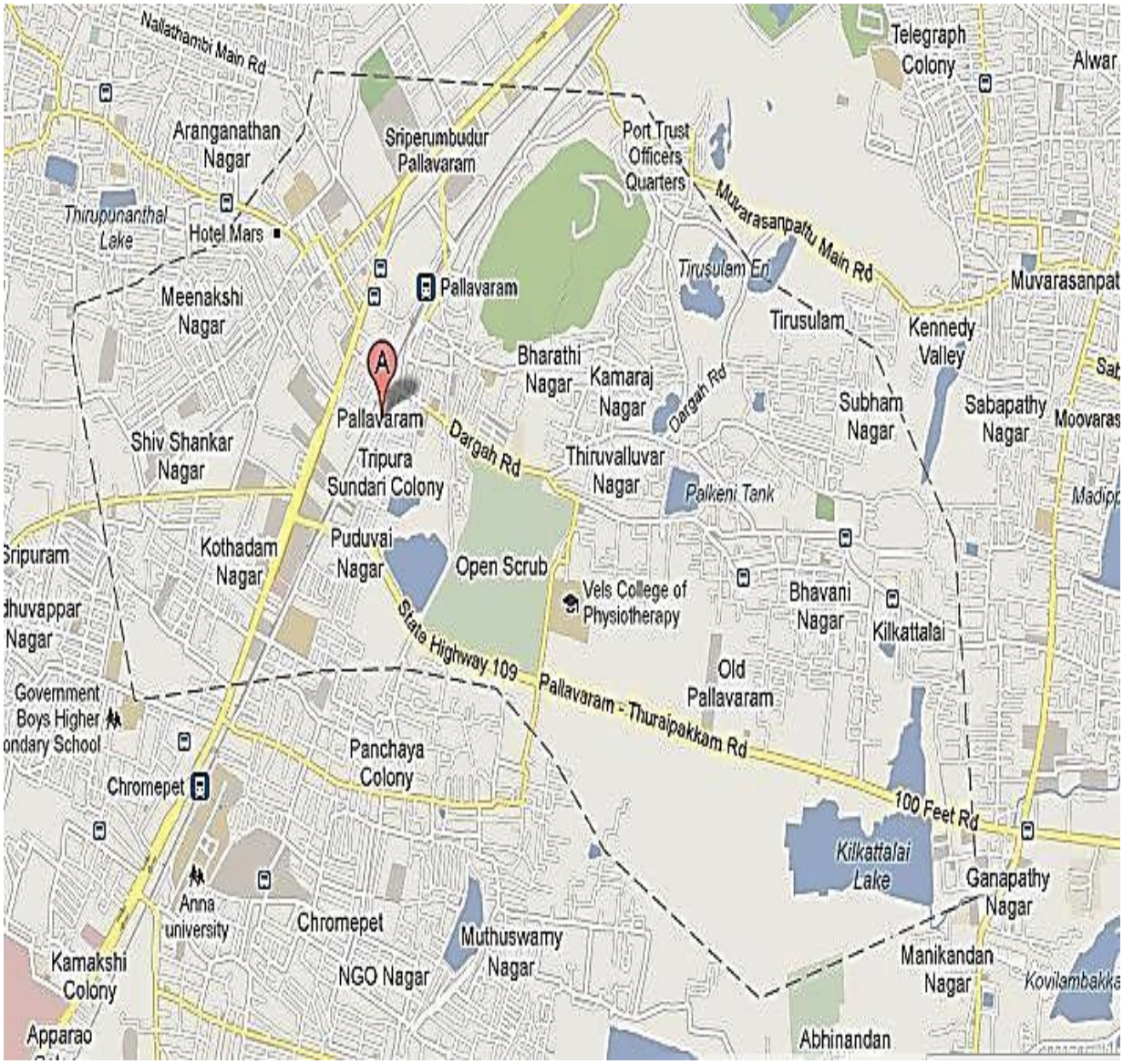

Fig. 1: *Pallavaram Municipality (Source: Pallavaram Municipality Office).*

EXPERIMENT

Representative ground water samples were collected from 12 sampling points, in the month of January, covering the major parts of Pallavaram Municipality. Table 1 shows the location of the sampling points along with their latitude, longitude and street names. Also, Figure 3 shows the location of sampling points using ArcGIS. Also, Figure 2 presents the flowchart explaining the procedure followed. The collected water samples were being characterized and analyzed for parameters such as pH, electrical conductivity, chlorides, dissolved oxygen (DO), total dissolved solids (TDS) and also for trace elements such as cadmium, chromium, lead, zinc and iron[2, 3, 5].

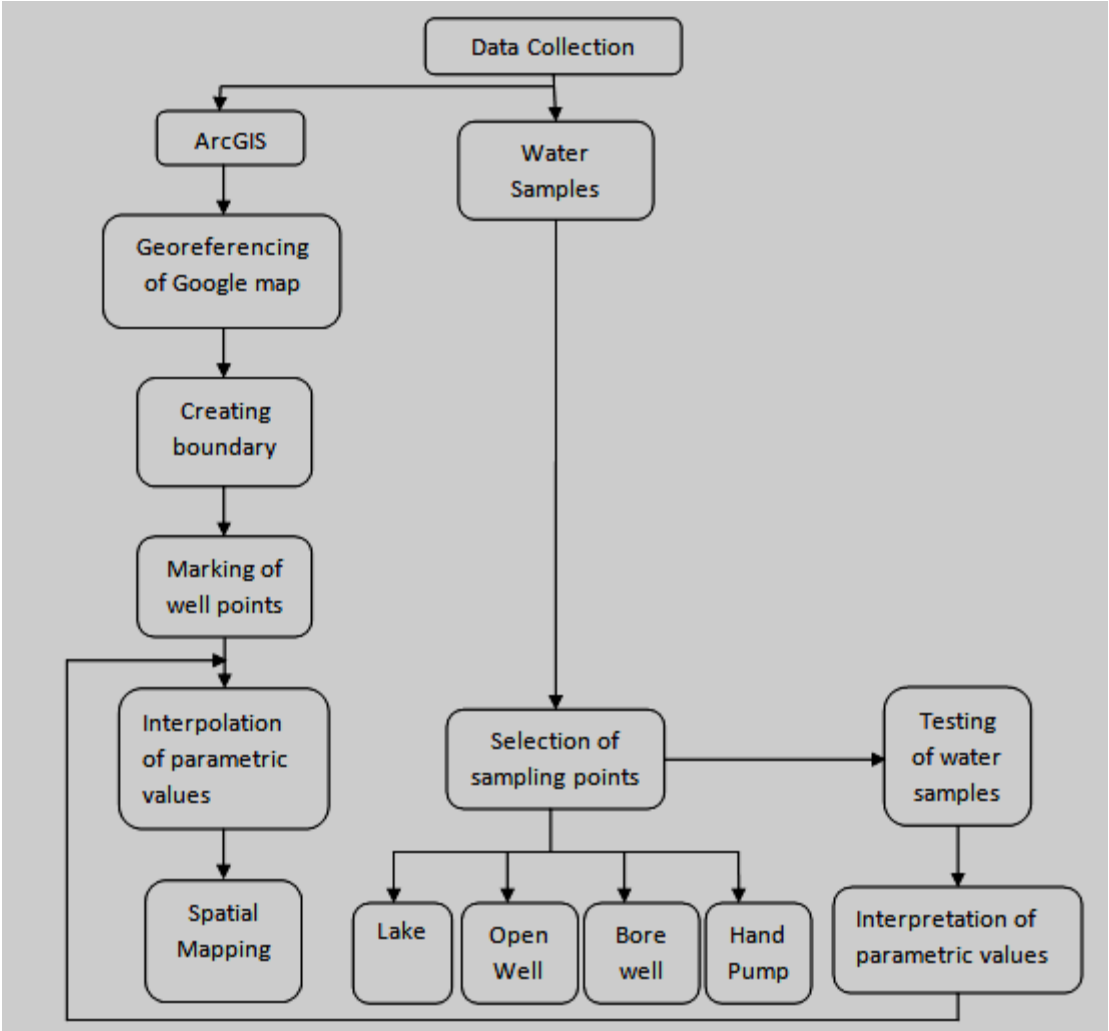

Fig. 2: *Methodology Flowchart.*

Table 1: *Location of Sampling Points.*

Well point	Latitude	Longitude	Street name
1	12.95740	80.152867	Periya Eri lake
2	12.954233	80.150617	Eri Karai
3	12.950367	80.158600	Ramamurthy Street
4	12.95910	80.149267	Sanjay Gandhi Street
5	12.959333	80.142333	Godhanda Nagar
6	12.963683	80.137633	Nagal Keni Street
7	12.973750	80.133600	Sendhalammam Koil Street
8	12.967567	80.148950	Bazar Road
9	12.959883	80.161317	Malliga Nagar
10	12.963950	80.156633	Malaganandha Street
11	12.954633	80.176650	Veluchamy Street
12	12.963142	80.176472	Church Street

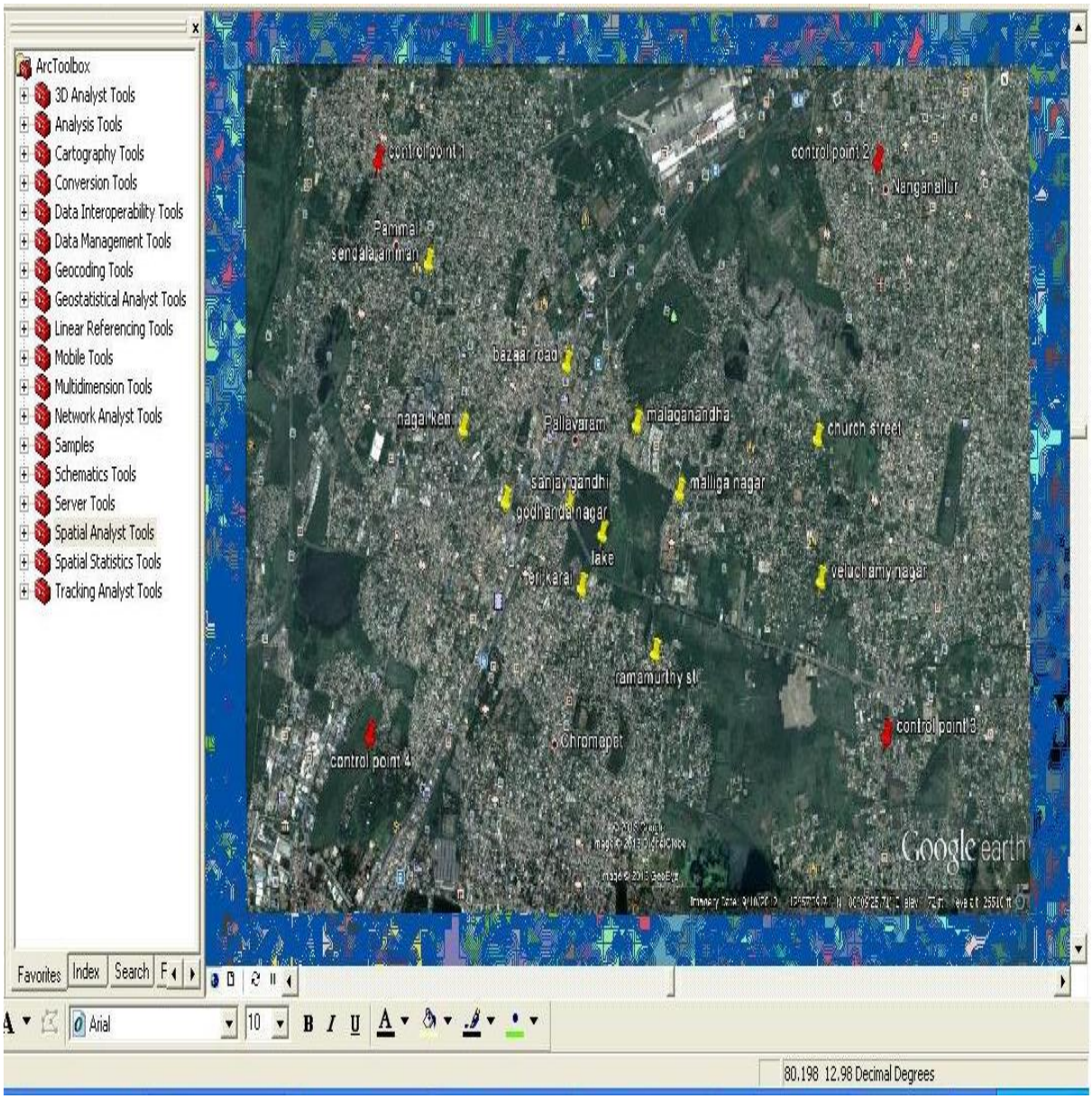

Fig. 3: *Location of Sampling Points (Source: Google Earth).*

Analyses of pH for all the water samples were carried out using the pH meter, while electrical conductivity was carried out using conductivity electrodes. The existence of dissolved oxygen was confirmed by Winkler's method. Total dissolved solids were also quantified. The quantity of calcium was determined by EDTA titrimetric method.

Chloride content of the samples was determined using Argentometric method of titration. The presence of trace elements was determined and quantified using Atomic Absorption Spectrometer (AAS) [2]. After the analysis, using ArcGIS 9.3, spatial mapping of the above parameter was done to study the distribution of the pollutants in Pallavaram for effective management of water quality [6, 7].

Table 2: *Experimental Methods* [2].

S.NO.	PARAMETER	NAME OF THE TEST	APPARATUS REQUIRED	REAGENTS REQUIRED	OTHER REQUIREMENTS
1.	Chloride	Argentometric method	1). Erlenmeyer flask 250ml 2). Buret 50ml	1). Potassium Chromate indicator solution 2). Std. silver nitrate titrant (0.0141N) 3). Std. Sodium Chloride (0.0141N)	Special reagents for removal of interference : 1). Aluminium hydroxide suspension 2). Phenolphthalein indicator solution 3). Sodium hydroxide, 1N 4). Sulfuric acid, 1N 5). Hydrogen peroxide, 30%
2.	pH	Winkler's method	pH meter		
3.	Electrical Conductivity		Electrodes		
4.	Total Dissolved Solids		12 China dish		
5.	Dissolved Oxygen		1). Burette 2). Burette stand 3). 300 ml glass stoppered BOD bottles 4). 500 ml conical flask 5). Pipettes with elongated tips 6). Pipette bulb 7). 250 ml graduated cylinders 8). Wash bottle	1). 2 ml Manganese Sulphate 2). 2 ml alkali-iodide-azide 3). 2 ml starch solution 4). Sodium thiosulphate	
6.	Calcium	EDTA Titrimetric Method		1). Sodium hydroxide, 1N 2). EBT indicator 3). Murexide (Ammonium purpurate indicator) 4). Std. EDTA titrant 5). Sodium Chloride	
7.	Chromium	Direct Air-Acetylene Flame method	Atomic absorption spectrometer and associated equipment's		
8.	Lead	Direct Air-Acetylene Flame method	Atomic absorption spectrometer and associated equipment's		
9.	Zinc	Direct Air-Acetylene Flame method	Atomic absorption spectrometer and associated equipment's		
10.	Copper	Direct Air-Acetylene Flame method	Atomic absorption spectrometer and associated equipment's		
11.	Nickel	Direct Air-Acetylene Flame method	Atomic absorption spectrometer and associated equipment's		

RESULTS AND DISCUSSION

The values of the parameters that were analyzed are tabulated in Tables 3 and 4. Also, the spatial mapping of these parameters in Pallavaram is presented in Figures 4–14.

Table 3: *Values of Parameters.*

Well points	pH	EC	DO	TDS (mg/L)	Chloride (mg/L)	Calcium (mg/L)
1	7.6	2.97	8799.77	22.5	1640	655
2	6.7	1.75	2101.85	2.50	760	580
3	7.0	2.61	2876.61	24.5	1240	680
4	7.2	4.05	7725.1	35.0	2240	590
5	7.0	3.66	3976.27	27.5	2240	725
6	6.8	2.39	2801.63	20.5	1200	630
7	7.0	2.20	2801.63	12.25	1240	700
8	7.6	0.86	1527.03	3.30	280	210
9	7.0	7.26	8299.93	35.0	5280	250
10	6.5	2.36	2326.78	8.0	1560	695
11	6.6	6.27	4083.8	9.75	2480	2500
12	7.9	0.87	602.31	2.80	280	240

Table 4: *Values of Parameters (Trace Elements).*

Well points	Copper	Chromium	Lead	Zinc	Nickel
1	0.1079	0.4204	0.0218	0.28545	0.06075
2	0.03145	0.05205	0.01435	0.09725	0.07025
3	0.0216	0.0168	0.01725	0.01505	0.0433
4	0.01565	0.058	0.01475	0.0408	0.02235
5	0.02305	0.01965	0.0184	0.0369	0.02
6	0.0111	0.01345	0.01565	0.01765	0.02715
7	0.00465	0.0084	0.01605	0.2213	0.01705
8	0.0034	0.0069	0	0.055	0.01635
9	0.0167	0.016	0	0.0114	0.01905
10	0.0277	0.01345	0.00845	0.2028	0.0385
11	0.0179	0.03	0.09575	0.09065	0.0126
12	0.0029	0.00545	0	0.00785	0.01495

The well points 1–4 are near the dump yard, 5–7 near industries and the rest are in residential areas (Source: Pallavaram Municipality). Table 3 indicates that the dissolved oxygen content of well point 1 (Periya Eri Lake) is the maximum (8799.77) mainly due to the flowing nature of water. Chloride is predominant in both industrial (2240 mg/L) as well as residential areas (5280 mg/L). Total dissolved solids are quite high in their presence near industrial zone (12.25 mg/L). Calcium, chloride, lead and chromium are present abundantly beyond permissible limits in almost all the sampling points while other parameters are within the desirable limits [2].

The post-monsoon presence of the above-mentioned chemical parameters is listed above. This shows that there is high concentration of parameters like chloride, calcium, lead and chromium in the study area. The reason for such high concentration is attributed mainly to the disposal of untreated industrial wastes. Improper storage and treatment, lack of public awareness have increased the seriousness of the issue.

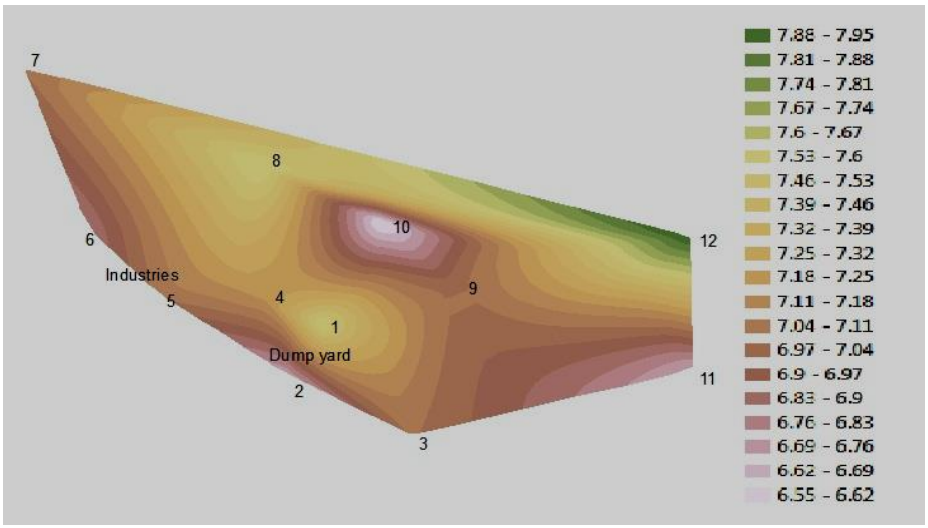

Fig. 4: *Spatial Mapping of pH (Source: ArcGIS 9.3).*

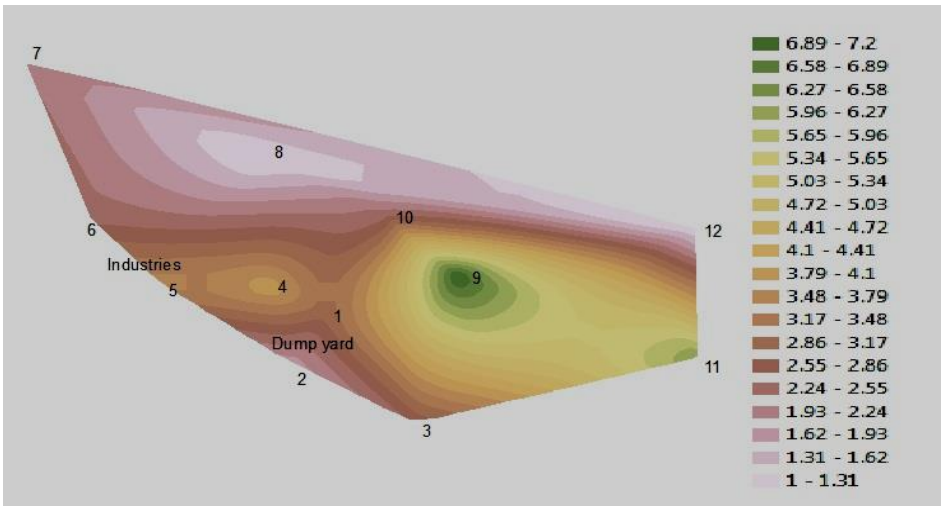

Fig. 5: *Spatial Mapping of Electrical Conductivity (Source: ArcGIS 9.3).*

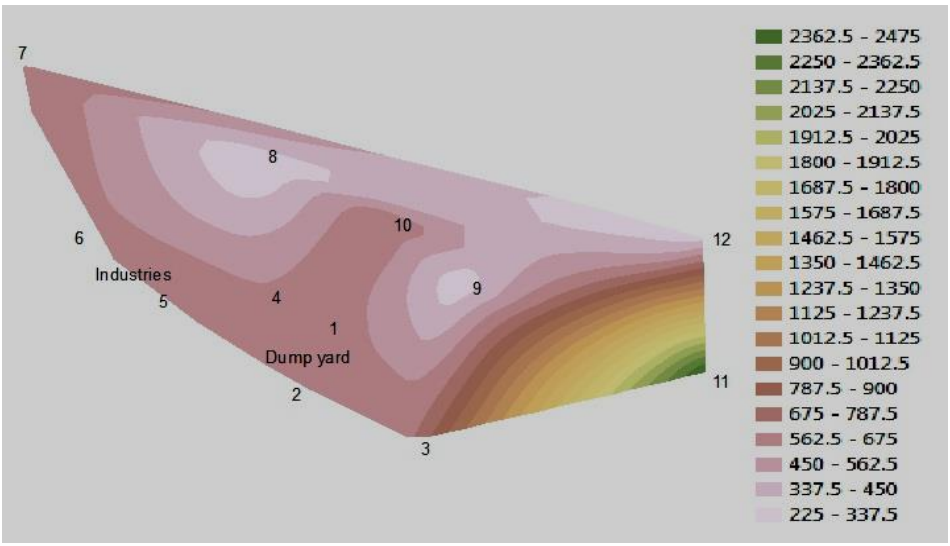

Fig. 6: *Spatial Mapping of Calcium (Source: ArcGIS 9.3).*

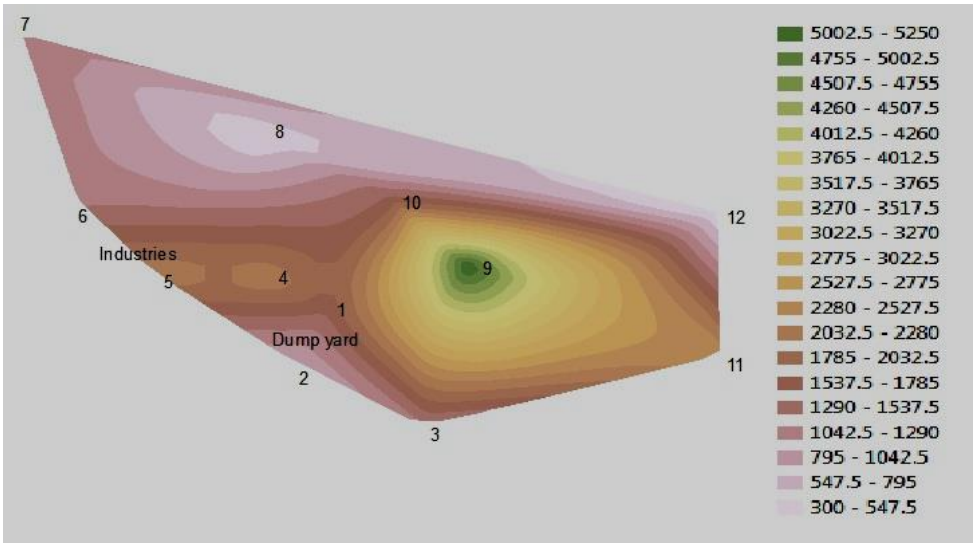

Fig. 7: *Spatial Mapping of Total Dissolved Solids (Source: ArcGIS 9.3).*

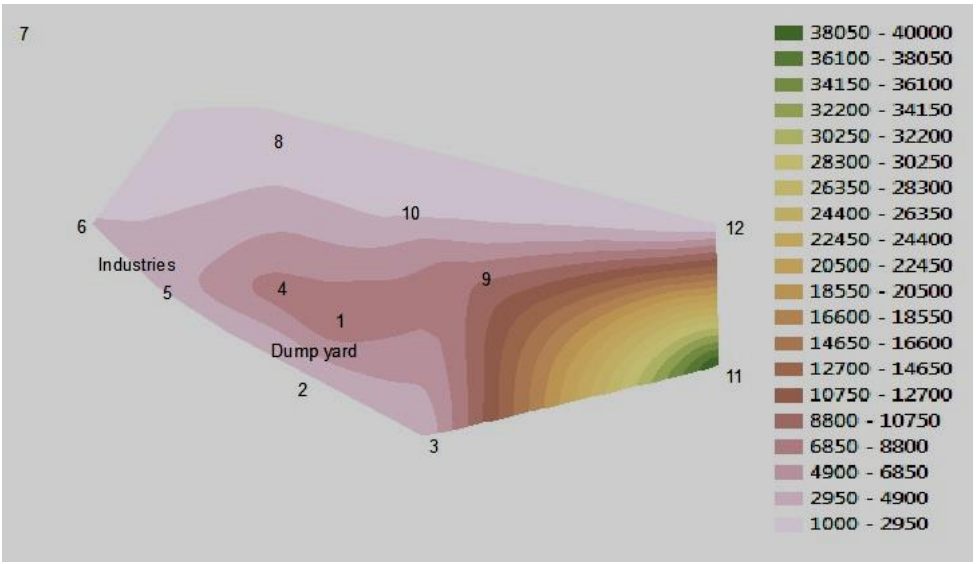

Fig. 8: *Spatial Mapping of Chloride (Source: ArcGIS 9.3).*

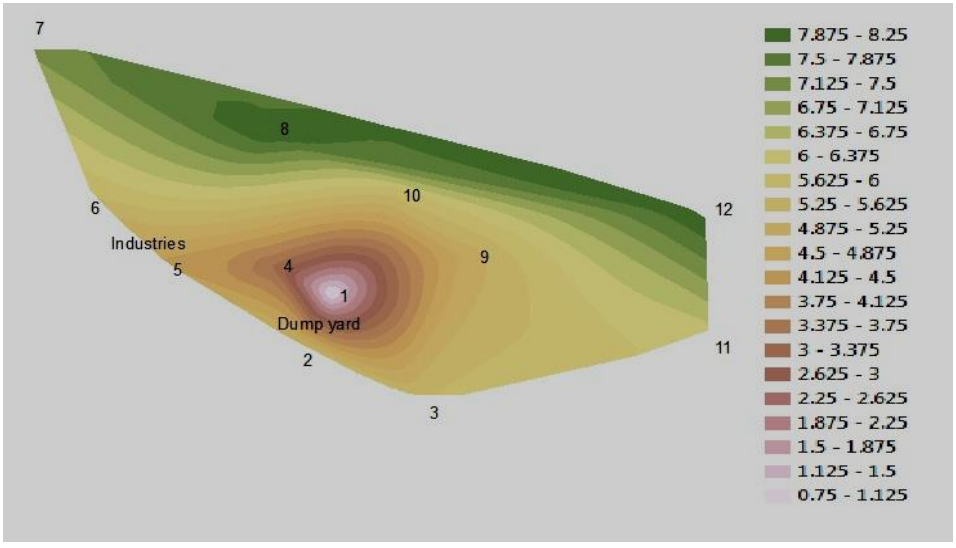

Fig. 9: *Spatial Mapping of Dissolved Oxygen (Source: ArcGIS 9.3).*

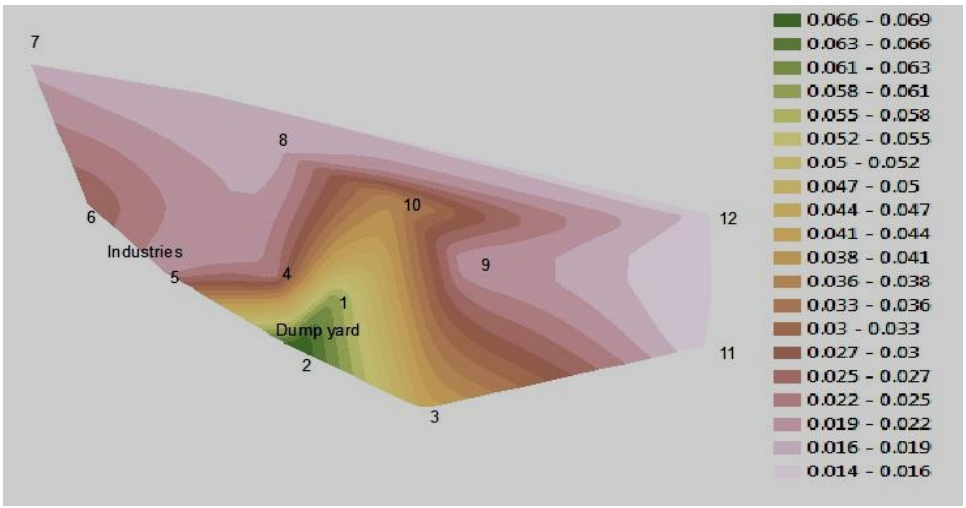

Fig. 10: *Spatial Mapping of Nickel (Source: ArcGIS 9.3).*

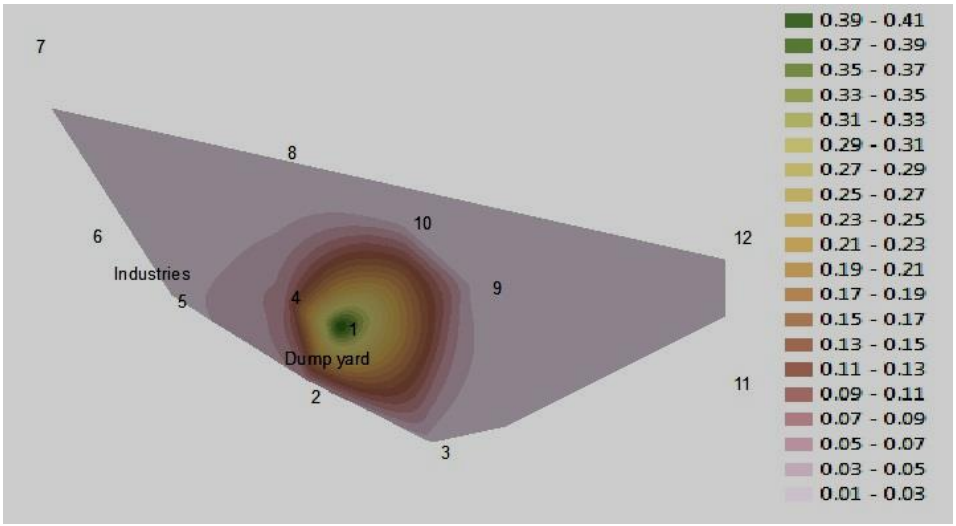

Fig. 11: *Spatial Mapping of Chromium (Source: ArcGIS 9.3).*

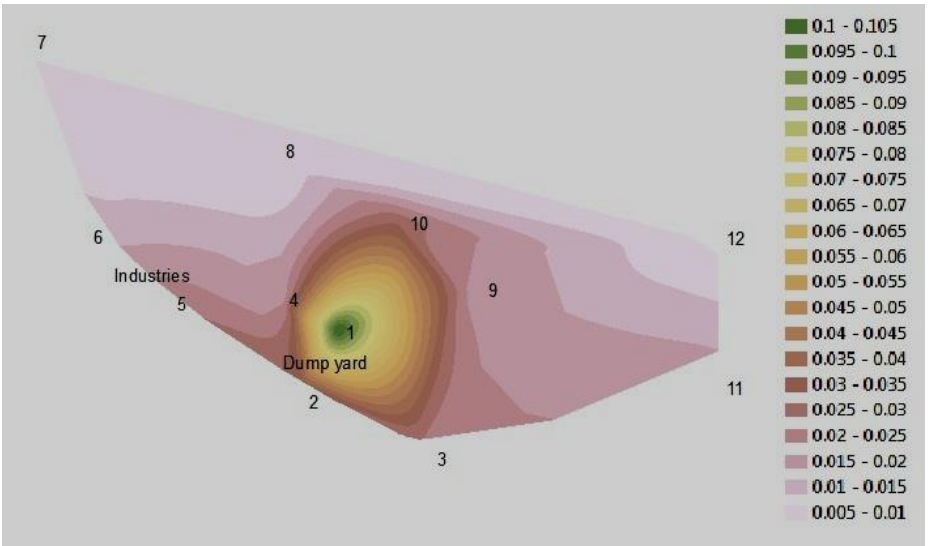

Fig. 12: *Spatial Mapping of Copper (Source: ArcGIS 9.3).*

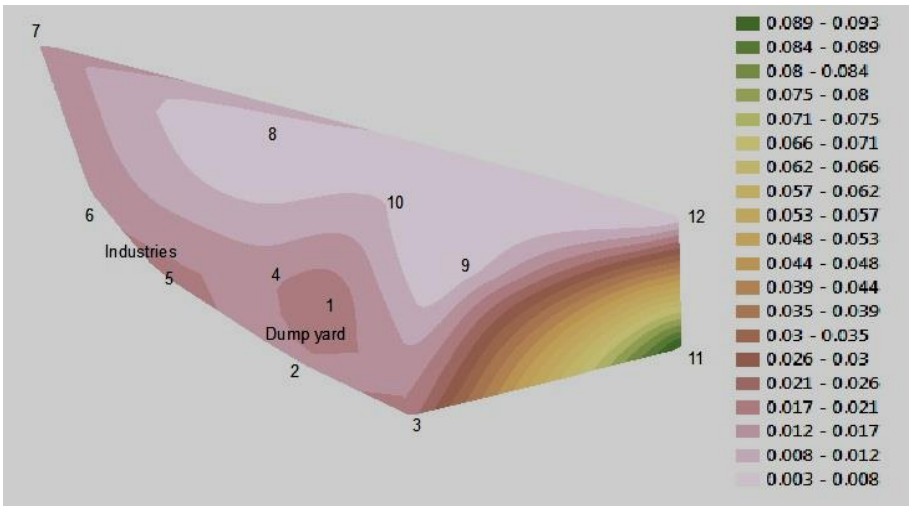

Fig. 13: *Spatial Mapping of Lead (Source: ArcGIS 9.3).*

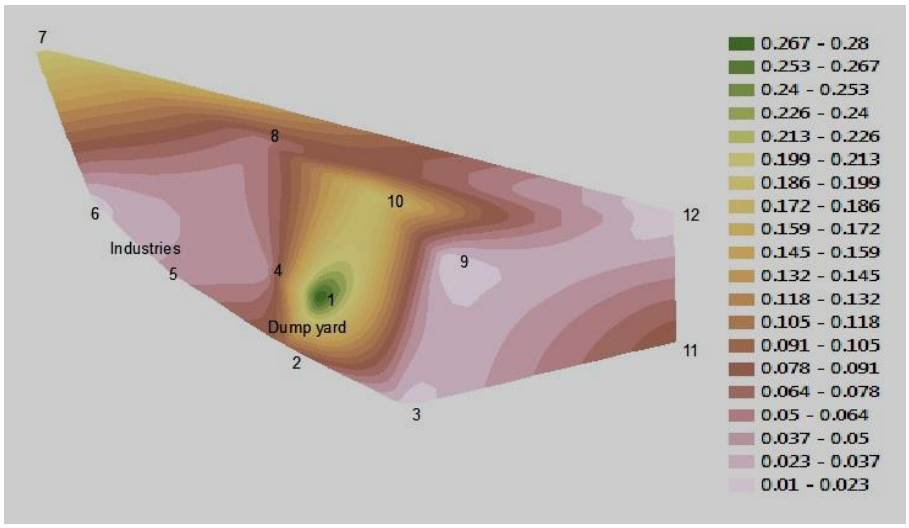

Fig. 14: *Spatial Mapping of Zinc (Source: ArcGIS 9.3).*

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REFERENCES

1. Ramesh R, Purvaja GR, Ika Raveendra V. The problem of groundwater pollution: a case study from Madras city, India. *Man's Influence on Freshwater Ecosystems and Water Use*. (Proceedings of a Boulder Symposium, July 1995). Centre for Water Resources, Anna University, Chennai 600025. IAHS Publ. no. 230, 1995.
2. *Indian Standard Drinking Water – Specification* (First Revision) (Incorporating Amendment No. 1) UDC 628.1.033. IS 10500: 1991 Edition 2.1 (1993-01). Bureau of Indian Standards.
3. Raman N, Sathiyanarayanan D. Quality assessment of ground water in Pallavapuram municipal solid waste dumpsite area nearer to Pallavaram in Chennai, Tamilnadu. *Rasayan*. 2011; 4(2): 481-87p. ISSN: 0974-1496 CODEN: RJCABP. http://www.rasayanjournal.com.
4. Chennai Metropolitan Development Authority Website, Pallavaram Village No. 158, Tambaram Taluk, Kanchipuram District, Pallavaram Municipality.
5. Rajkumar N, Subramani T, Elango L. Groundwater contamination due to municipal solid waste disposal – A GIS based study in Erode City. *International Journal of Environmental Sciences*. 2010; 1(1).
6. Rimal Bhagawat. Application of Remote Sensing and GIS, land use/land cover change in Kathmandu Metropolitan city, Nepal. *Journal of Theoretical and Applied Information Technology*. 2005–2011. JATIT & LLS.
7. Srivastava VK, Giri Devendra Nath, Bharadwaj Pawan. Study and mapping of ground water prospect using remote sensing, GIS and geoelectrical resistivity techniques – A case study of Dhanbad district, Jharkhand, India. *J. Ind. Geophys. Union.* April 2012; 2012; 16(2): 55–63p.