

# Ground Water Quality Analysis at Uruli Devachi - Using Geographic Information System Approach

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**Abstract-** Ground water quality at Uruli Devachi of Pune have been studied using geographic information system (G.I.S.) and remote sensing (R.S.). Uruli Devachi landfill is located near Uruli Devachi village which pollutes the ground water in the nearby areas. Overall 10 samples of ground water were collected from Uruli Devachi and were analyzed for the physico-chemical parameters like pH, turbidity, colour, odour, total hardness, alkalinity, total dissolved solids, chlorides, sulphates and MPN. Leachate samples were also the landfill and were analyzed for the waste water parameters like BOD, COD, oil and grease, heavy metals like lead, etc. Results showed that the values of all these parameters were very high and so the leachate and ground water was highly polluted. Then the Spatial variation of each of the ground water parameter throughout Uruli Devachi was plotted using the IDW interpolation technique in the ARC GIS. Overall water quality map was prepared for the study area using the Water Quality Index (WQI) to find the residential areas where the ground water is highly polluted.

**Keywords-** GIS, Ground Water Pollution, Landfill, Spatial Maps, WQI..

## I. INTRODUCTION

Ground water is one of the most important and purest natural resources of water known to humans since ages. Most of the rural population depend on it for drinking, domestic use and for irrigation. So the ground water quality is a matter of great concern especially in the industrial areas or in the areas where solid waste is disposed.

Uruli Devachi Landfill has 34600 square metre area where all the industrial and domestic waste is dumped from nearby areas by PMC. This process is ongoing since 1983 and people knew that there is some problem related to ground water and they wanted some solution. But to find the solution, the exact ground water quality with all the important parameters should be known. So the water quality near the Uruli Devachi Landfill is found out with respect to various parameters like pH, turbidity, colour, odour, total hardness, alkalinity, total dissolved solids, chlorides, sulphates and MPN. 10 locations were selected for the sample collection. Then

spatial variation maps were plotted followed by integrated water quality map to find the overall water quality of the area. Surface water quality was also analyzed from the leachate samples collected from the stream which is passing through the Uruli Devachi landfill.

OBJECTIVES – Following are the objectives of the study:

1. To take samples from various sampling stations and find their water quality with respect to various water quality parameters.
2. To map the spatial variability of water quality parameters using GIS approach.
3. Find the water quality using integrated water quality map.

## II. STUDY AREA

Pune Municipal corporation disposes its whole waste at the Uruli Devachi Landfill which is at 20km away from the city which is the reason for ground water pollution in the nearby area. Study area is 30 km<sup>2</sup> area and lies between 73°54'57.6"E to 73°58'44.4"E and 18°27'3.6"N to 18°29'6"N. Uruli Devachi landfill is the 34600 square metre area in which 1175 metric tonnes of garbage is dumped daily. It contains industrial, medical and domestic wastes.

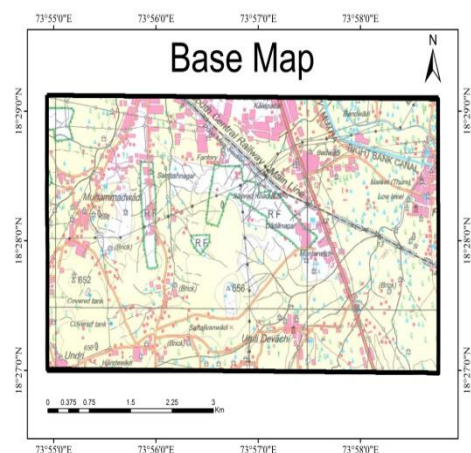


Fig. (1) - Base Map of the Study Area

Residential area Map- Prepared by overlapping 5 Google map images on ward map, geo-referencing them and then digitizing all the layers precisely.

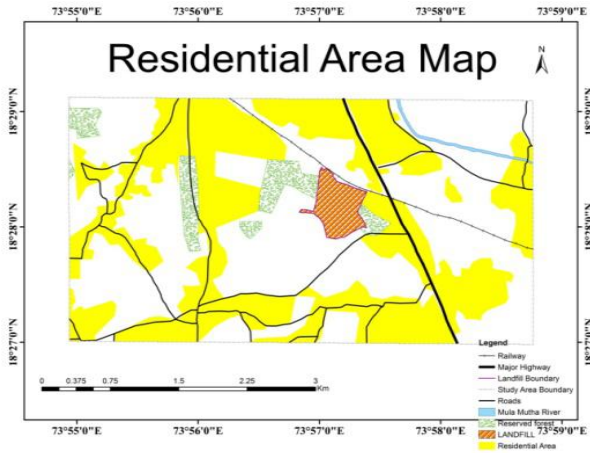


Fig. (2) - Residential Area Map

III. METHODOLOGY

1. LOCATIONS FOR SAMPLE COLLECTION

1.1 SURFACE WATER (STREAM) – 6 leachate samples were collected from the stream which has passed through the landfill area. Drainage map was prepared by tracing on streams from the toposheet.

Table (1) – Details of Leachate Samples Collected

Sr.No.	Lattitude	Longitude	Date
1	18°28'22.8"N	73°57'3.6"E	07-12-2016
2	18°28'26.4"N	73°56'56.4"E	07-12-2016
3	18°28'22.8"N	73°57'3.6"E	06-01-2017
4	18°28'26.4"N	73°56'56.4"E	06-01-2017
5	18°28'22.8"N	73°57'3.6"E	15-02-2017
6	18°28'26.4"N	73°56'56.4"E	15-02-2017

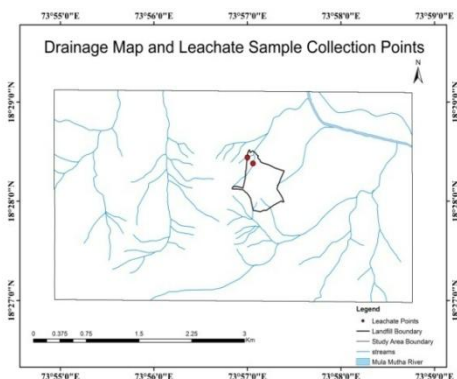


Fig.(4) Ground Water sample locations

Table (2) – Details of the Ground water Samples Collected

Sr.No.	Lattitude	Longitude	Description
1	73.96331	18.4662	O.W.
2	73.971	18.4551	O.W.
3	73.96281	18.47298	O.W.
4	73.94513	18.4511	O.W.
5	73.96213	18.4693	O.W.
6	73.928	18.4852	B.W.
7	73.954	18.483	B.W.
8	73.916	18.462	B.W.
9	73.979	18.482	B.W.
10	73.941	18.469	B.W.

(O.W.-Open Well, B.W.- Bore Well)

2. TESTING OF THE WATER SAMPLES – Heavy metals and the oil and grease test was done in Hydrotech lab, Pune while all the water samples were in the COEP Environmental Laboratory. All the standard methods adopted for the testing are given in Appendix 1.

2.1 LEACHATE SAMPLES -

Table (3) – Chemical Biological Parameters.

Sr.NO.	pH	BOD	COD	TDS
	5.5-9	30	250	2100
		(mg/l)	(mg/l)	(mg/l)
1	9.3	760	2300	20800
2	9.1	660	1900	17500
3	9	840	2900	25200
4	8.9	730	2200	19400
5	9.2	1050	3300	28800
6	8.8	830	2700	21200

Table (4) – Heavy Metals.

Sr.NO.	Oil & Grease	Ar	Cd	Hg	Pb
	max 10	max 0.2	max 2	max 0.01	max 0.1
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1	7.8	0.8	0.65	0.2	0.18
2	6	0.56	0.4	0.14	0.12
3	11.3	0.92	0.78	0.31	0.16
4	7.9	0.41	0.47	0.15	0.11
5	9.1	0.97	0.69	0.22	0.19
6	6.3	0.61	0.34	0.11	0.12

2.2 GROUND WATER SAMPLES -

Table (5) – Physical Water Quality Parameters for Ground water

Sr.NO.	Physical Parameters	
	Colour	Odour
1	Pale Yellow	Agreeable
2	Pale Yellow	Agreeable
3	Pale Yellow	Agreeable
4	Pale Yellow	Agreeable
5	Pale Yellow	Agreeable
6	Colourless	Agreeable
7	Pale Yellow	Agreeable
8	Colourless	Agreeable
9	Colourless	Agreeable
10	Pale Yellow	Agreeable

Table (6) – Chemical and Biological Water Quality Parameters.

3. GENERATING THEMATIC MAPS– The variation of all

Sr. No.	Chemical Parameters						MPN
	Ph	TDS	Cl	TH as CaCO3	Alkalinity	Sulphate as SO4	
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
	6.5-8.5	500	Max 250	Max 200	Max 200	Max 400	
1	8.1	790	280	525	315	55	11
2	7.8	280	65	255	169	45	2
3	7.6	530	180	473	264	64	14
4	6.5	560	98	387	127	38	4
5	8.3	970	340	720	550	75	21
6	8.1	360	70	255	170	38	0
7	7.9	540	187	445	365	34	2
8	7.5	390	126	343	222	29	0
9	6.8	280	134	270	132	32	0
10	8.2	810	227	575	320	66	14

the water quality parameters in the ground water throughout the ward can be easily visualized from the Thematic Maps of all the parameters generated by using the Arc GIS 9.3. Input for generating these maps was the test results of 10 samples for all the parameters. For preparing the Thematic Maps using Spatial Analyst tool in the Arc GIS IDW method for interpolation was used as it best method suitable for water quality analysis.

Formula for IDW method of interpolation:

$$\lambda_i = \frac{D_i^{-\alpha}}{\sum_{i=1}^n D_i^{-\alpha}}$$

$\lambda_i$ : The weight of point,  $D_i$  = the distance between point  $i$  and the unknown point,  $\alpha$  = the power ten of weight.

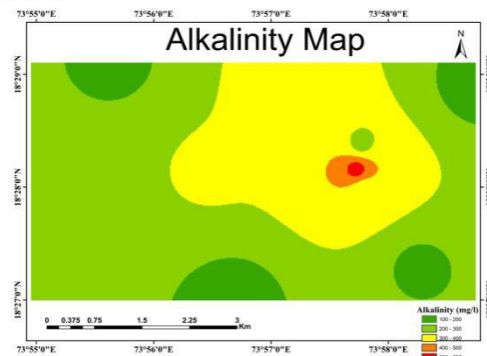


Fig.(5) Alkalinity Variation Map

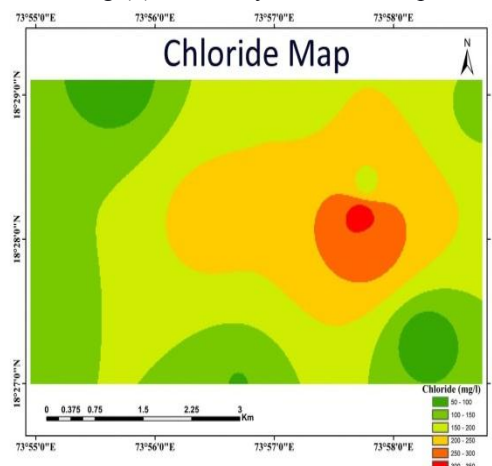


Fig.(6) Chloride Variation Map

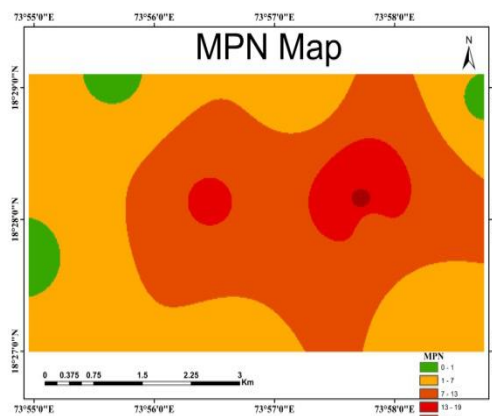


Fig.(7) MPN Variation Map

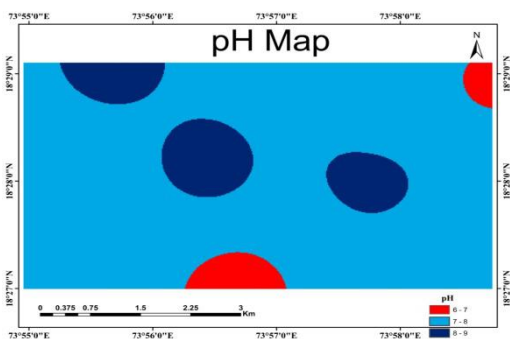


Fig.(8) pH Variation Map

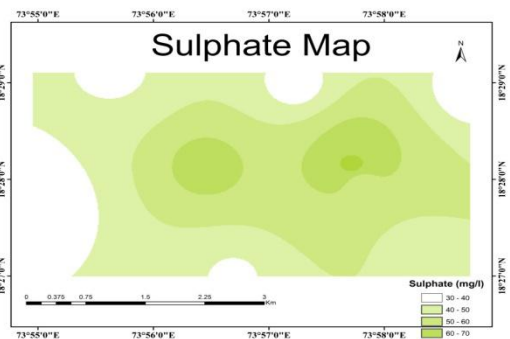


Fig.(9) Sulphate Variation Map

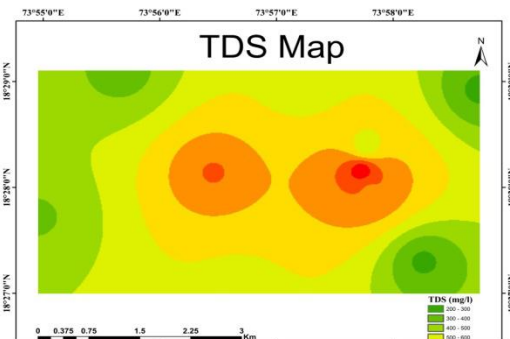


Fig.(10) Total Dissolved Solids Variation Map

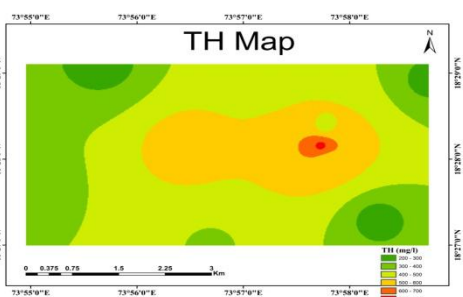


Fig.(11) Total Hardness Variation Map

4. CALCULATING WATER QUALITY INDEX (WQI) – A water quality index may be defined as “a rating reflecting the composite influence of number of water quality parameters overall of water” of water”.

$$WQI = \frac{\sum q_n W_n}{\sum W_n}$$

$$q_n = 100 \left[ \frac{V_n - V_{io}}{S_n - V_{io}} \right]$$

qn - Quality rating for nth water quality parameter, Vn –Value of nth parameter in the given sample, W–Unit weight for nth parameter, Sn – Permissible limit for the nth parameter, Vio – Ideal value of the parameter

Table (7) – Calculation of WQI for sample 1

Sr no	Parameter	Observed Values	Standard Values (Sn)		Unit Weight (Wn)	Quality Rating (Qn)	Wn*Qn
			Desirable	Permissible			
1	pH	8.3	6.5-8.5	6.5-8.5	20	86.667	1733.333
2	TDS (mg/l)	970	500	2000	10	48.5	485
3	Cl (mg/l)	340	250	1000	16.666	34	566.644
4	TH (as CaCO3) (mg/l)	720	200	600	10	120	1200
5	Alkalinity (mg/l)	550	200	600	10	91.667	916.67
6	Sulphate (as SO4) (mg/l)	75	200	400	13.334	18.75	250.0125
7	E coli (by MPN)	21	0	0	20	2100	42000
						100	47151.66
						WQI =	471.5166

Similarly WQI for all the samples was calculated.

Table (8) – WQI for all the Ground Water Samples

Sr. No.	WQI	Water Quality
1	259.12	Very Poor
2	61.72	Poor
3	308.07	Very Poor
4	87.6	Poor
5	471.52	Very Poor
6	25.98	Good
7	72.44	Poor
8	21.1	Good
9	8.73	Good
10	320.95	Very Poor

5. GENERATING THE INTEGRATED WATER QUALITY MAP – It is the Thematic Map of intergrated water quality genrerated from the WQI of all the 10 sample points.

APPENDIX

Appendix 1

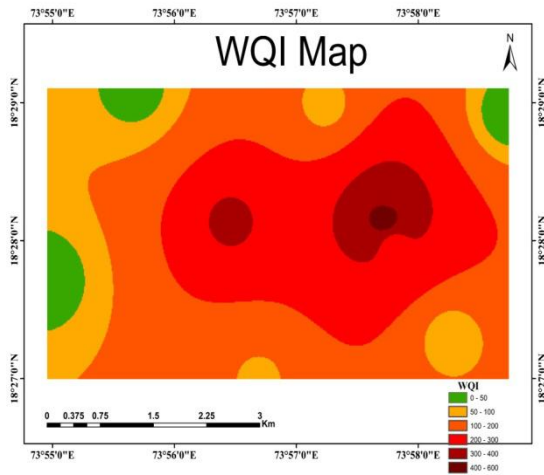


Fig (12) – WQI map for the Study area

III.CONCLUSION

1. The ground water quality was found to be very poor near the landfill area (Dadanagar , Mantrawadi , Uruli Devachi , Fursungi , Santoshnagar) and the presence of poisonous heavy metals in the stream water (leachate) passing through the landfill is a matter of great concern.
2. Ground water of some areas of Kalepadal and Bedwadi is also polluted because of landfill.
3. Stream water near the landfill is highly polluted and the presence of very poisonous heavy metals is the matter of concern
4. From the water quality maps of various parameters we can predict water quality at any point in Study area

CONCLUCING MAP – It is prepared by overlaying Residential layer (60% transparent) with the WQI map

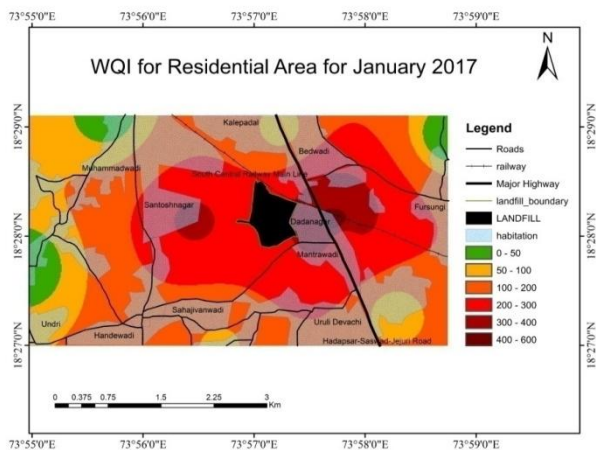


Fig (13) – Water Quality Map Showing the ground water polluted areas in Study area

TESTS	METHOD USED
pH	Digital pH Meter
Total Dissolved Solids	Gravimetric Method
Chloride	Standard Silver Nitrate Method
Total Hardness	Complexometric Titration using E.D.T.A
Alkalinity	Using Acidimetric Titration
Sulphate	Gravimetric Method
MPN	Multiple Fermentation Technique
BOD	Winkler’s Method with Azide Modification
COD	Winkler’s Method with Azide Modification
Oil and Grease	Partition Gravimetric Method
Mercury	Atomic Absorption Spectroscopy
Lead	Atomic Absorption Spectroscopy
Arsenic	Atomic Absorption Spectroscopy
Cadmium	Atomic Absorption Spectroscopy

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