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Impact of Solid Waste Disposal on Quality of Ground Water Around Different Landfill Sites of Nizamabad City, Telangana State

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***Abstract*:- One of the worldwide biggest challenges is solid waste management. Land filling is the simple and common method of disposing solid waste ever observed in developing countries. The landfill leachates loaded with pollutants percolates in to water bodies present around the landfill sites results in pollution of ground water. An attempt is made to study the impact of landfills on ground water quality present around the landfills of nizamabad city and for proper interpretation the results also compared with the results of assessment of water samples from Alwal landfill located in Greater Hyderabad where an integrated solid waste management is undertaken. The water samples collected from various radial distances from the landfill site. Results of the study clearly indicate that the ground water quality is deteriorated badly and regular monitoring of ground water quality is needed. It also recommends need of Site-specific policies on ground water pollution control for Nizamabad landfill sites.**

Key words: Landfills, Solid waste, Pollution, Leachate, Ground water and WQI (water quality index).

INTRODUCTION

Disposing of solid waste at open low lying areas in unscientific manner leads to pollution of air, water and soil and also results in adverse affects on public health living nearby areas (7-9). Deterioration of ground water quality due to percolation of leachate generated from landfill sites is predominantly observed in many developing countries like in India (10-13). It is reported that most of the landfills are unlined and without leachate collection system. The rate of deterioration of quality of ground water resources near the landfill sites is need of urgent regular monitoring measures in many cities and towns of the country (14). The susceptibility of an aquifer to pollution from landfill leachate is highly dependent on number of factors like location of dumping site, composition of waste dumped, toxicity of leachate, depth and flow of water table and type of landfill (15, 16). Ground water is the most common source of water supply in both urban and rural regions of developing countries and pollution of ground water is potential threat to environment and public health (14, 17).

The impact of leachate on ground water has been reported in many studies (18-20) with a common conclusion of presence of high level of organic and inorganic pollution due to percolation of leachate. A study conducted [15] reported high values of pH, nitrate and BOD in ground water sample collected from the vicinity area of Malang landfill. A research (21) conducted in metropolitan city of Delhi, reported high levels of trace elements like K^+, Cl^- and $NH^{4+.}$ Studies (22, 23) have investigated the leachate composition generated from dumping sites and related it with ground water quality of nearby areas. An improper solid waste management system and absence of properly designed solid waste disposal mechanisms, landfills with growing urbanization, industrialization and population explosion has led to environmental pollution. The contamination of ground water is a potential environmental problem and needs to be addressed. Hence, an efficient method has been carried out to monitor the ground water quality index around municipal solid waste landfill sites of Nizamabad city. The quality of the ground water has been studied.

The waste generated in Nizamabad is dumped in open dumping sites. Residential and agricultural land is located in the vicinity of the dumping sites of three selected regions of city with seasonal rivulets flowing nearby the dump sites. Although the Municipal Corporations of the city are providing water supply but around 30% residents are still using ground water supplies like bore wells for daily needs. Percolation of leachate from these open dumping sites poses threat to ground water sources so a study was planned to evaluate the effect of dumping sites on the ground water resources in the vicinity areas of dumping sites of Dharmaram, Nagaram, Nehru Nagar respectively. The study also reported the WQI, calculated over a period of two seasons (Dry & Wet) from all the three regions of study sites of Nizamabad city to cover major city topographically, for determining the impact of leachate percolation on the groundwater quality.

MATERIALS AND METHODS

Study area

Nizamabad city is the headquarters of the nizamabad district, Telangana State. It is located at the intersection of longitude of 18.672° N 78.094° E and spread over an area of about 40 Sq Km. To determine the possible ground water contamination due to percolation of leachate from selected solid waste land fill sites, the ground water samples were collected from the nearby selected land fill sites i.e Dharmaram, Nagara, Nehru nagar of Nizamabad city during dry and wet seasons of the monitoring campaign. The ground water samples were collected from the bore well and other nearby submersibles close to the solid waste dumping sites at 5 different downstream locations (1Km, 2Km, 3Km, 4Km and 5Km) from the MSW dumping sites. Figure 3 (a), (b) (c) and (d) shows the aerial view of the studied areas with ground water sampling points. A total of 30 samples (n=5 for each site) were collected for the study purpose during entire two sampling periods (dry & wet) from three study sites of Nizamabad and 10 samples were used from alwal region of Hyderabad during entire two seasonal campaign. Separate analysis was carried out for the samples collected from different distances of study locations. The analysis of ground water samples were carried out as per the standard procedures.

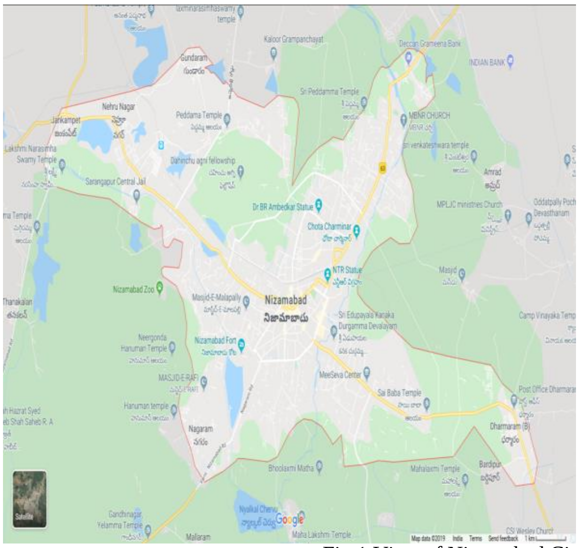

Fig 1 View of Nizamabad City

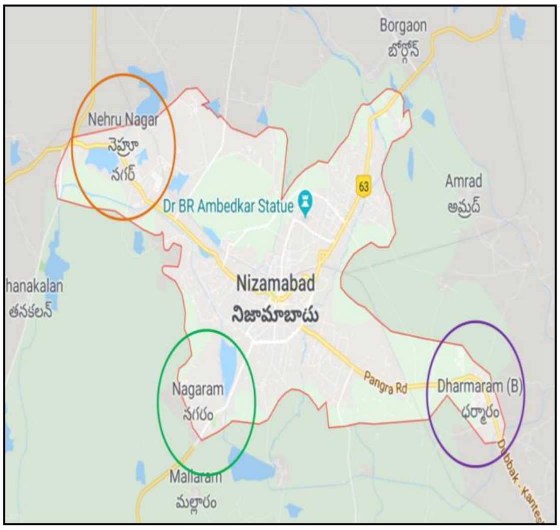

Fig 2 Showing study sites of Nizamabad city.

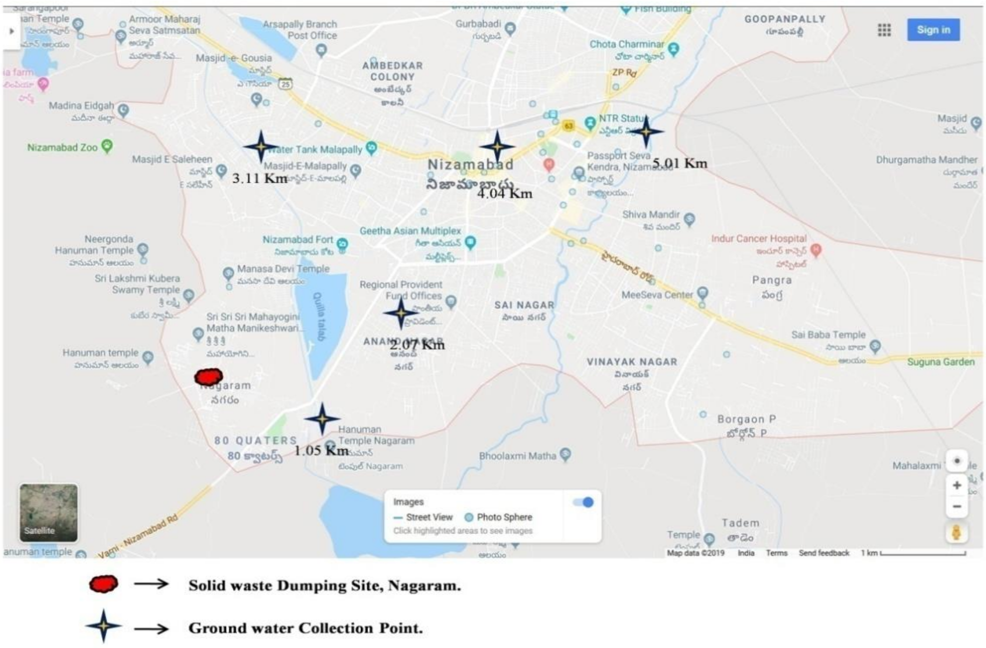

Fig 3 (a) Aerial View of the Nagaram study area with ground water sampling points

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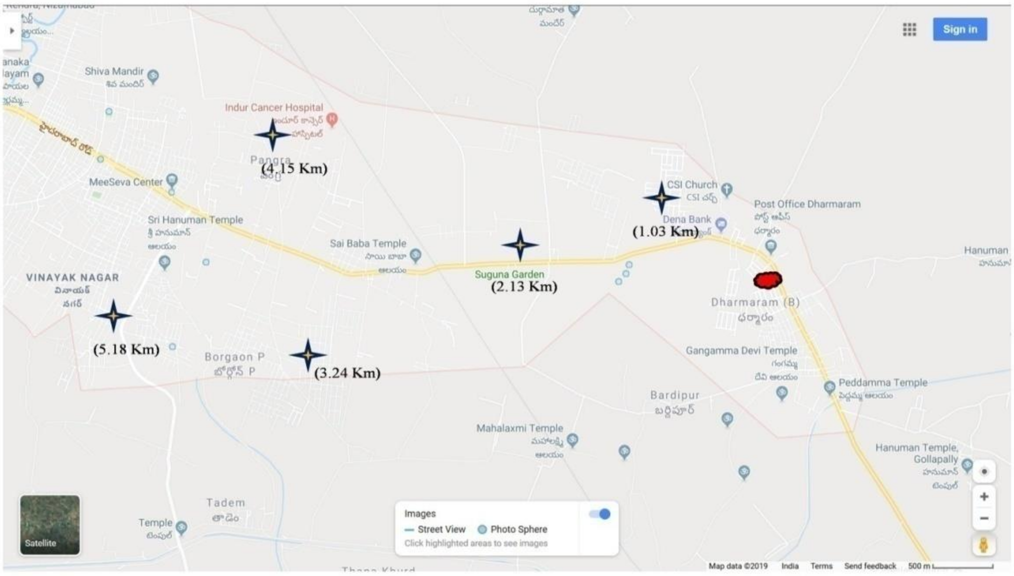
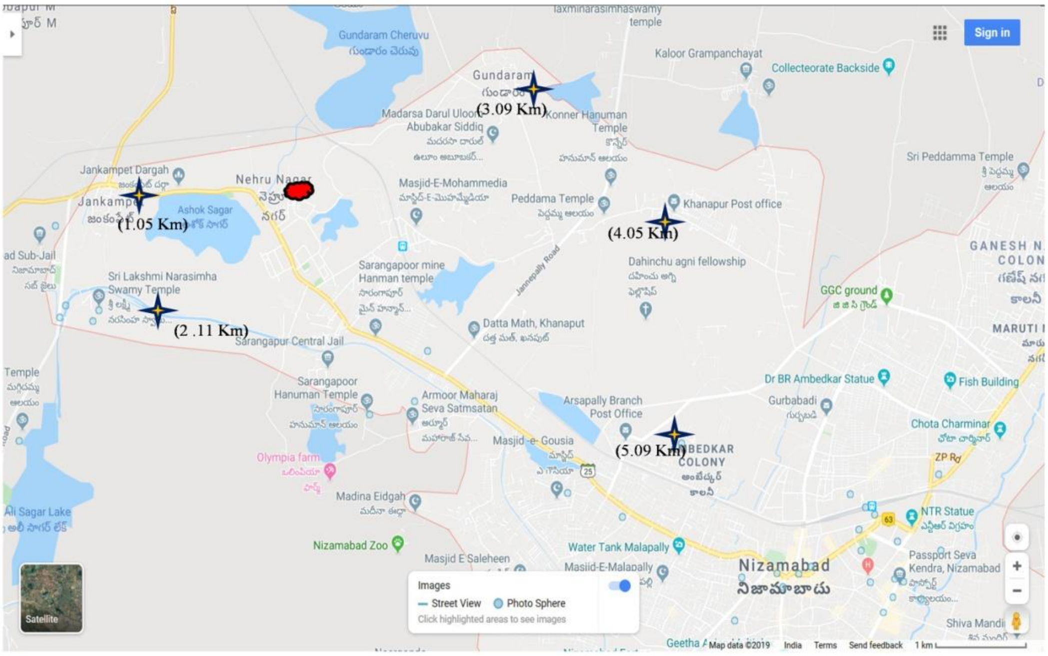


→ Solid waste Dumping Site, Dharmaram

→ Ground water Collection Point.

Fig 3 (b) Aerial View of the Dharmaram study area with ground water sampling points.



→ Solid waste Dumping Site, Nehru Nagar.

→ Ground water Collection Point.

Fig 3 (c) Aerial View of the Nehru Nagar study area with ground water sampling points.

Fig 3 (d) Aerial View of Alwal, Hyd., study area with ground water sampling points.

ANALYTICAL METHODOLOGY

According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be re-established easily and to device ways and means to protect it. Groundwater Quality helps us understand the hydro geologic system, flow dynamics and groundwater contamination Ground water samples were determined for physico-chemical parameters according to the standards APHA and BIS methods (29, 30). All the samples in the experimental work were analyzed for physico-chemical parameters like pH, electrical conductivity (EC), total dissolved solids (TDS), chemical oxygen demand (COD), biological oxygen demand (BOD), total alkalinity (TA), total hardness (TH), chloride (Cl^-), sulphate (SO_4^{-2}), phosphate (PO_4^{-3}), calcium (Ca^{+2}), magnesium ($Mg^{+\ 2}$), ammonical nitrogen (NH_4^+-N), fluoride (F^-), nitrate (NO_3^-), sodium (Na^+) and potassium (K^+).

WATER QUALITY INDEX:

Water quality index (WQI) is a method of rating of existing water quality status in a single expression which is helpful for selection of treatment techniques (31). WQI provides information about the water quality in a single value. WQI utilizes the water quality data and helps in modification of the policies formulated by the environmental agencies (32). It represents the assessment of water quality through determination of physico-chemical and biological parameters of ground water (33). WQI was initially developed by Horton (34, 35) and after that concept has been modified by many scientists and researchers (34-37). A general approach for determination of WQI includes parameter selection wherein these parameters are selected based upon their impact on water quality. Once the parameters are fixed, determination of sub-indices of these parameters is quantified which are finally aggregated using an aggregate indexing method by means of different mathematical expressions (24, 37).

WATER QUALITY INDEX- BIS 10500:

Determination of WQI as based on the BIS 10500 standards was determined by assigning weights (wi) according to the relative importance of each chemical parameter for drinking purposes and has been summarized [12]. The parameters like chloride, nitrate, total solids, ammonical nitrogen, sulphate, fluorides and electrical conductivity has been assigned maximum Weightage of 5 because of their high significance in maintaining quality of ground water [61]. Other determined parameters like calcium, magnesium, total hardness and total alkalinity were assigned weight between 1 and 5 depending on their importance in water quality assessment. The relative weight (Wi) is computed using following equation:

$$W_i = w_i / \Sigma^n_{i=1} w_i$$

Where; W_i= relative weight
w_i = weight of each parameter,
n= number of parameters.

A quality index (qi) based on the parameters were computed by dividing the concentration of each sample by its respective standard as assigned by BIS 10500 and multiplying the result by 100:

$$q_i = C_i/S_i \times 100$$

Where; q_i= quality rating based on concentration of the $_i$th parameter C_i = concentration of each parameter (mg/l), S_i= Indian drinking water standard for computing WQI, SI is first determined for each parameter:

$$SI = w_i \times q_i$$

Where; SI= sub-index of the $_i$th parameter WQI is then determined using following equation:

$$WQI = \Sigma\ SI$$

Table 1 Water quality rating as per BIS 10500

WQI	Value Rating of water quality
<50	Excellent water quality
50-100	Good water quality
100-200	Fair water quality
200-300	Poor water quality
>300	Very poor water quality

RESULTS AND DISCUSSIONS

The Physico-chemical characteristics of the groundwater samples collected from Dharmaram, Nagaram and Nehru Nagar of Nizamabad and alwal region of Hyderabad are described in Table 2. Obtained results were also compared to the WHO and BIS standards for drinking water .The results of all the parameters are symbolized as S1 and S2 for Dharmaram, Nagaram , Nehru Nagar and Alwal, Hyderabad for Dry and Wet seasons respectively.

PHYSICO-CHEMICAL PARAMETERS

Table 2 Physico-chemical Characteristics of ground water at different downstream distances for two seasonal campaigns for three regions of Nizamabad city and Alwal,Hyderabad.

Parameters	X-Dist. (Km)	Dharmaram		Nagaram		Nehru Nagar		Alwal. Hyd.		Standards	
		S1	S2	S1	S2	S1	S2	S1	S2	WHO	BIS
Temperature (°C)	1’	27.3	23.6	29.5	24.1	26.8	23.8	27.8	22.4	-	-
	2’	26.5	22.7	28.6	23.5	26.2	23.2	27.1	21.7		
	3’	24.8	21.5	28.1	22.7	25.4	22.6	26.5	21.1		
	4’	22.4	20.4	27.3	22.1	23.7	22.3	25.8	20.6		
	5’	21.7	20.1	26.9	21.3	22.8	21.7	25.1	20.3		
pH	1’	7.56	7.83	6.21	6.33	6.97	6.84	7.23	6.99	6.5-9.2	6.5-8.5
	2’	7.54	7.81	6.43	6.52	7.24	7.11	7.62	7.06		
	3’	7.43	7.76	6.49	6.67	7.28	7.29	7.53	7.23		
	4’	7.51	7.79	6.85	6.94	7.19	7.18	7.08	7.29		
	5’	7.36	7.78	7.22	7.14	7.23	7.33	7.52	7.34		
TDS (mg/L)	1’	752	875	1273	1391	879	913	736	779	500	500
	2’	724	865	1239	1374	851	898	721	752		
	3’	708	832	1144	1339	833	886	704	741		
	4’	645	809	1123	1283	817	851	683	723		
	5’	621	756	1101	1251	794	823	668	711		
Ammonical Nitrogen (NH3-N) (mg/l)	1’	1.4	1.8	1.8	1.7	1.6	1.8	1.2	1.4	-	0.5
	2’	0.8	1.3	1.1	1.3	1.2	1.4	0.5	0.7		
	3’	0.4	0.7	0.6	0.8	0.8	0.7	0.2	0.3		
	4’	0.1	0.3	0.3	0.4	0.4	0.6	0.09	0.04		
	5’	0.08	0.1	0.04	0.03	0.05	0.12	0.01	0.02		
Phosphate (mg/l)	1’	0.07	0.09	0.6	0.8	0.06	0.08	0.03	0.05	-	-
	2’	0.03	0.04	0.5	0.6	0.03	0.04	0.01	0.02		
	3’	0.02	0.03	0.3	0.4	0.01	0.02	0.0	0.0		
	4’	0.01	0.01	0.07	0.09	0.0	0.0	0.0	0.0		
	5’	0.0	0.0	0.04	0.06	0.0	0.0	0.0	0.0		
Turbidity (JTU)	1’	12	13	11	10	13	14	8	7	-	1
	2’	10	12	9	8	11	12	6	6		
	3’	8	10	7	9	9	10	5	6		
	4’	6	7	5	6	8	10	2	4		
	5’	5	6	4	5	6	7	2	3		
Biochemical Oxygen Demand (BOD) (mg/l)	1’	125	158	247	342	128	149	132	158	-	5
	2’	114	143	229	331	121	142	108	127		
	3’	107	133	211	312	115	134	93	113		
	4’	95	117	194	289	109	126	76	85		
	5’	92	107	183	281	94	114	64	72		
Sulphate (mg/l)	1’	125	158	78	92	127	158	169	189	200	200
	2’	121	153	73	94	118	154	164	172		
	3’	117	154	71	97	114	152	162	176		
	4’	116	156	74	88	113	161	152	169		
	5’	123	151	81	84	119	158	157	167		
Sodium (mg/l)	1’	89	72	124	114	116	108	158	189	-	-
	2’	73	54	117	103	104	92	149	204		
	3’	64	46	107	85	92	79	172	251		
	4’	53	41	85	71	83	64	186	214		

	5’	42	32	81	62	71	53	179	247		
Potassium (mg/l)	1’	18	23	14	18	19	23	21	19	-	-
	2’	13	21	11	16	15	17	17	15		
	3’	11	18	8	13	12	16	13	13		
	4’	7	14	5	11	8	14	10	8		
	5’	6	12	4	9	4	15	7	5		
Total Hardness (TH) (mg/l)	1’	458	468	745	842	471	493	371	412	300	200
	2’	442	459	736	825	432	462	347	395		
	3’	428	442	711	764	402	438	312	364		
	4’	403	430	682	751	372	411	268	328		
	5’	376	412	654	724	339	385	232	302		
Calcium (Ca) (mg/l)	1’	36	45	28	39	42	51	53	68	100	75
	2’	42	53	31	47	48	63	57	73		
	3’	49	59	39	56	57	78	69	79		
	4’	52	62	51	62	53	81	73	83		
	5’	57	72	59	69	63	73	78	75		
Magnesium (Mg) (mg/l)	1’	23	37	24	54	38	42	21	32	150	30
	2’	28	45	36	63	32	53	26	36		
	3’	34	59	27	52	49	59	35	39		
	4’	27	48	21	61	58	55	42	29		
	5’	39	52	29	48	55	50	37	24		
Total Alkalinity (TA) (mg/l)	1’	469	489	751	826	462	487	382	427	-	200
	2’	438	462	742	801	438	462	352	402		
	3’	421	448	719	778	409	437	324	371		
	4’	401	417	672	762	387	407	284	346		
	5’	372	385	645	734	364	371	259	327		
Nitrates (mg/l)	1’	23.3	39.4	18.3	31.6	23.2	39.6	19.4	41.5	10	45
	2’	25.5	41.7	21.2.	34.8	25.3	42.4	21.3	38.9		
	3’	24.7	42.5	17.7	32.4	29.7	44.8	20.7	42.5		
	4’	21.6	40.3	23.4	33.6	27.4	47.9	18.4	43.6		
	5’	29.9	43.8	27.2	35.7	26.8	45.2	19.6	44.7		
Chlorides (mg/l)	1’	123	143	85	97	136	153	158	189	250	250
	2’	148	149	93	117	142	168	149	204		
	3’	162	139	97	123	138	189	172	251		
	4’	177	153	91	114	156	224	186	214		
	5’	165	158	105	129	169	217	179	247		
Fluorides (mg/l)	1’	4.6	3.7	5.3	4.8	4.5	3.8	3.6	1.8	1.5	1.0
	2’	4.1	3.2	5.1	4.2	4.1	3.1	3.1	1.7		
	3’	3.5	2.4	4.7	3.7	3.7	2.6	2.8	1.6		
	4’	3.2	2.1	3.9	3.3	3.3	2.2	2.4	1.9		
	5’	2.6	1.7	3.5	2.7	3.1	1.4	1.5	1.3		
EC (µS/cm)	1’	1293	1582	2345	2569	1389	1593	1058	1278	300	300
	2’	1285	1532	2189	2411	1271	1532	932	1185		
	3’	1241	1472	2004	2143	1195	1472	874	1123		
	4’	1196	1395	1872	2079	1172	1395	817	1102		
	5’	1125	1327	1749	1894	1087	1327	804	1058		

Water Quality Index (WQI): WQI is one of the most effective tools to provide feedback on the quality of water to the policy makers and environmentalists by giving a single value. In the present study WQI determined on the BIS 10500 standards and values for all the three study sites of Nizamabad respectively were calculated using equation for standards for drinking water purposes as recommended by BIS 10500.

The values of WQI obtained using the methodology based on BIS 10500 have been summarized in Table 3 and the classification of water quality have been summarized in Table 4

Table 3 WQI for Three sites of Nizamabad and alwal, Hyderabad as per BIS 10500

Dist. / Monitoring	**Dharmaram (DRM)**		**Nagaram (NRM)**		**Nehru nagar (NN)**		**Alwal, Hyderabad**	
	S1	S2	S1	S2	S1	S2	S1	S2
1 km	117	132	123	136	121	128	97	102
2 Km	105	109	113	108	104	110	91	96
3 Km	85	89	92	96	82	86	69	72
4 Km	47	56	52	63	49	48	41	48
5 Km	43	44	43	49	41	43	38	43
Avg	79.4	86	84.6	90.4	79.4	83	67.2	72.2
Avg. of 2 seasons	82.7		87.2		81.2		69.7	

Table 4. Showing output result of Water quality index (WQI) at different distances of all the study regions.

Dist. / Monitoring	Dharmaram (DRM)		Nagaram (NRM)		Nehru nagar (NN)		Alwal, Hyderabad		Average			
	S1	S2	S1	S2	S1	S2	S1	S2	DRM	NRM	NN	Alwal
1 km	U.D	U.D	U.D	U.D	U.D	U.D	Very Poor	U.D	U.D	U.D	U.D	Very Poor
2 Km	Very Poor	Very Poor	Very Poor	Very Poor	Very Poor	Very Poor	Poor	Very Poor	Very Poor	Very Poor	Very Poor	Very Poor
3 Km	Poor	Poor	Poor	Very Poor	Poor	Very Poor	Poor	Poor	Poor	Very Poor	Very Poor	Poor
4 Km	Good	Poor	Poor	Poor	Good	Good	Good	Good	Poor	Poor	Good	Good
5 Km	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good

U.D: Unsuitable for drinking

COCLUSION AND DISCUSSION

It was observed from Table 4 that the ground water quality in almost all study sites of Nizamabad within a 2 km vicinity of the dumpsite experiences poor quality of ground water for drinking purpose, without any exception during entire seasonal monitoring campaign. Beyond 2km radius vicinity of any dumping site of Nizamabad that are located in Dharmaram, Nagaram and Nehru nagar experienced a good water quality value. The poor quality of groundwater in Dharmaram is primarily because having more dense small and medium scale industries. The primary reason behind poor water quality in Nagaram is might be due to high dense population and highest socio-economic status among all areas of Nizamabad city. That could be result in disposal of high amount solid waste into the environment. Lack of proper solid waste management systems could be considered as primary reasons for poor water quality on Nehru nagar. The cumulative average of all distance collection points of any of the study site lies under the category of good water quality, as shown in Table 3.

Seasonal variation showed that the overall dry seasonal water quality was superior to wet season due to increased chances of leachate percolation in to layers of soil associated with dumping sites which was resultant of high moisture content in the environment. So dry seasonal water quality index of all study sites including alwal region of Hyderabad was observed to be superior when compared to wet seasonal water quality index. One important note has been observed from the results that with increase in downstream distance, the quality of groundwater improved. Similarly, it was observed from that the overall quality of groundwater was classified as good for all study sites including the alwal region of Hyderabad. The WQI results revealed that the ground water samples from the nearby location to the dumping sites are affected due to leaching of ions from the leachate. We made an important observation from the results that relative water quality of alwal Hyderabad is good when compared to other threes study sites of Nizamabad. This observation could take a positive important note to understand implementation procedures towards sustainable development of various solid waste management practices for Nizamabad city.

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