GEOSPATIAL ASSESSMENT AND EVALUATION OF GROUNDWATER QUALITY DUE TO LANDFILL LEACHATE -A CASE STUDY

[1]Dr.C.S.V. Subrahmanya Kumar [2*]S.Ramesh Kumar, [3] Shivani Rathod, [4]Naveen Kumar, [5]Shakeer Hussain, [6]Ayyappa,
[1]Professor, [2*]Associate Professor , [3,4,5,6]Graduate students
[1,2*,3,4,5,6]Department of Civil Engineering, MVSR Engineering College, Hyderabad, Telangana, India

Abstract : Groundwater is considered as an important water source owing to its relatively low susceptibility to pollution and large storage capacity. One of the major problems associated with dumping of municipal solid waste landfill is the release of leachate and its impact on groundwater. In the present study an attempt is made to measure the impact of municipal solid waste landfill on groundwater quality around Nagole, a solid waste dumping site in Hyderabad, Telangana State, India. Groundwater samples were collected from wells, 2km radius around the solid waste dumping site. The various parameters analyzed are acidity, alkalinity, chlorides, hardness, pH, DO, BOD electrical conductivity, and total dissolved solids. Statistical analysis was carried out by determining maximum, minimum, average and standard deviation of all variables. The groundwater quality index was determined. The GIS software, ARC GIS 10 was used to prepare spatial distribution maps of different chemical parameters and groundwater quality index in the study area to assess the overall quality of groundwater. The study revealed that that the groundwater contained pollutants at a level beyond the permissible limit set by Bureau of Indian standards.

IndexTerms - Ground water quality, Ground water quality index, GIS.

I. INTRODUCTION: Water is a precious source and needs to be conserved. It is well known that 20% of fresh water present on the earth surface is in the form of ground water (Jat, 2009). The ground water is over utilized due to rapid urbanization, industrialization and increase in population. The ground water is to be protected from being polluted due to various sources like disposal of waste water from various sources, leachate from MSW etc. Indian cities are now generating 8 times more municipal solid waste than they did in 1947. Presently, about 90 million tons of solid waste is generated annually as byproducts of municipal, agricultural, and other activities. The per capita generation of MSW increased at a rate of 1-1.33% annually. It is estimated that nearly 3000 metric tons of municipal solid waste is generated in twin cities of Hyderabad and Secundrabad. Due to decomposition of municipal solid waste leachate is generated which is stronger than the domestic sewage, which percolates into the soil and pollutes ground water. Subramanya Kumar CSV et al., (2018), Aderemi Adeolu O et al., (2011), Jaseela Chonattu et al., (2016), Raman et al., (2011) and many others carried out studies on assessment of ground water quality around landfills.

II. AREA OF STUDY : Hyderabad, The capital city of Telangana, is one of the most populated city in India. Municipal solid waste generated in the city is around 3000 metric tonnes per day. The solid waste generated from twin cities, Hyderabad and Secunderabad is partly disposed at Nagole landfill. The location of landfill site is, Latitude 17˚22'23.4" and Longitude 78˚33'33.5".

In the present study, an attempt is made to study Ground Water Quality at Nagole. The objective of the study is to assess the ground water quality around municipal solid waste landfill using groundwater quality index method and prepare spatial distribution maps of different chemical parameters and groundwater quality index in the study area to assess the overall quality of groundwater.

III. CLIMATIC CONDITIONS:

Type of climate in Hyderabad is semi-arid. Hydro-geological features of the area: pink and granite of Archaeans age, intruded at places by dolerite dykes, pegmatite and quartz veins.

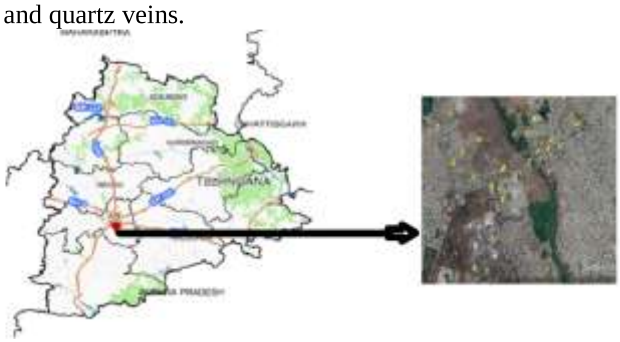

Fig 1 Location of Water samples collected from the bore well.

IV. EVALUATION METHODOLOGY:

1. The wells near the dumping site in a distance of 2 km radius were identified.
2. Ground water samples were collected from 20 wells.
3. The water samples were analyzed for the parameters like acidity, alkalinity, chlorides, hardness, pH, DO, BOD electrical conductivity, and total dissolved solids.
4. The overall quality of groundwater was found out by determining groundwater quality index.
5. Spatial distribution maps of different parameters and groundwater quality index in the study area are developed using ARC GIS Map (version 10).

V.GROUNDWATER QUALITY INDEX (GWQI): The groundwater quality index (GWQI) was calculated using Weighted Arithmetic Index Method and the quality rating/sub index (Q) corresponding to the parameter is a number reflecting the relative value of this parameter,
The Q_i is calculated by using following expression

$$Q_i = \{(M_i - I_i) / (S_i - I_i)\}*100 \qquad (1)$$

Where,

M_i= estimated values of the i^{th} parameter in the laboratory
I_i =ideal values of the i^{th} parameter
I_i =0 for all the parameters except for DO and P^H which are 14.6 & 7.0
S_i= Standard values of the i^{th} parameter.
The sign (-) indicates the numerical difference of the two values ignoring the algebraic sign. All the ideal values (I_i) are taken as zero except p^H = 7, DO = 14.6. In the present study, unit weight (W_i) value inversely proportional to the recommended standards(S_i) of the corresponding parameter.

$$W_i = K / S_i \qquad (2)$$

Where,

$$K = \frac{1}{(1/s_1) + (1/s_2) + (1/s_3) + \cdots + (1/s_i)}$$

s_1, s_2, s_3-----------s_i are standard values of various parameters from 1,2,3,------i.

The overall groundwater quality index (GWQI) was calculated by aggregating the quality rating (Q) with unit weight (W_i) linearly.

$$GWQI= \{\Sigma_{i=1}(Q_iW_i) / \Sigma_{i=1}(W_i)\} \qquad (3)$$

In this study, the GWQI for drinking purpose is considered and permissible GWQI for drinking water as 100, i.e., any value above 100 indicates groundwater contamination.

Table 1: Ground Water Quality Rating

WQI Level	Water Quality Rating	Grading
0 – 25	Excellent	A
26 – 50	Good	B
51 – 75	Poor	C
75 – 100	Very Poor	D
>100	Unfit for drinking purpose	E

VI.GEOGRAPHIC INFORMATION SYSTEM: The geographic information system software of the environmental systems research institute, (USA) Arcmap10.1 was used to prepare spatial distribution maps of different parameters and water quality index.

VII. RESULTS & DISCUSSIONS:

Table. 2 Statistical Analysis of Water Quality

S. No	Water Quality Parameter	Maximum	Minimum	Average	Standard Deviation
1	Alkalinity	500	200	391	92.30
2	Acidity	125	20	65.5	30.43
4	Electrical Conductivity	3.08	0.95	1.62	0.58
5	Total Dissolved Solids	943.2	136.1	620.19	249.63
6	Total hardness	270	112.5	221.05	44.20
7	Chlorides	556.3	139.95	257.51	97.04
8	Dissolved Oxygen	4.9	1.6	2.83	0.88
9	pH	7.89	7.2	7.47	0.22
10	Biological Oxygen Demand	4.2	1.4	2.33	0.86

All units are in ppm except pH

Table.3 Groundwater Quality Index & Status

Sample No.	GWQI	GWQ Status	Grade
1	79	Very Poor	D
2	72	Poor	C
3	77	Very Poor	D
4	83	Very Poor	D
5	77	Very Poor	D
6	86	Very Poor	D
7	88	Very Poor	D
8	101	Unsuitable	E
9	77	Very Poor	D
10	60	Poor	C
11	87	Very Poor	D
12	98	Very Poor	D
13	71	Poor	C
14	83	Very Poor	D
15	71	Poor	C
16	73	Poor	C
17	74	Poor	C
18	73	Poor	C
19	65	Poor	C
20	77	Very Poor	D

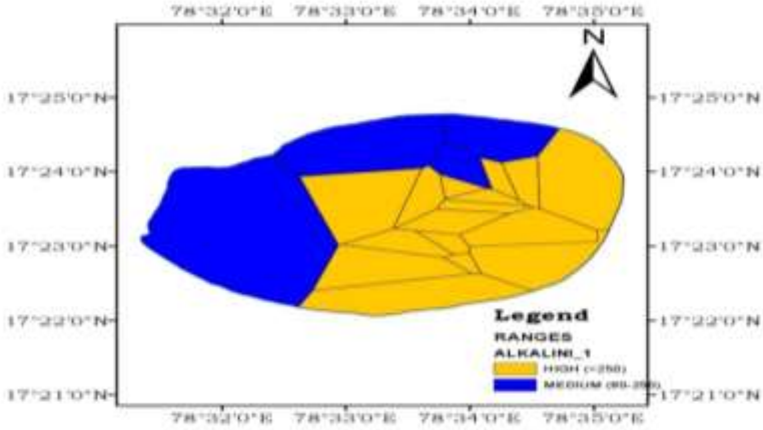

Fig.2 Spatial variation of Alkalinity

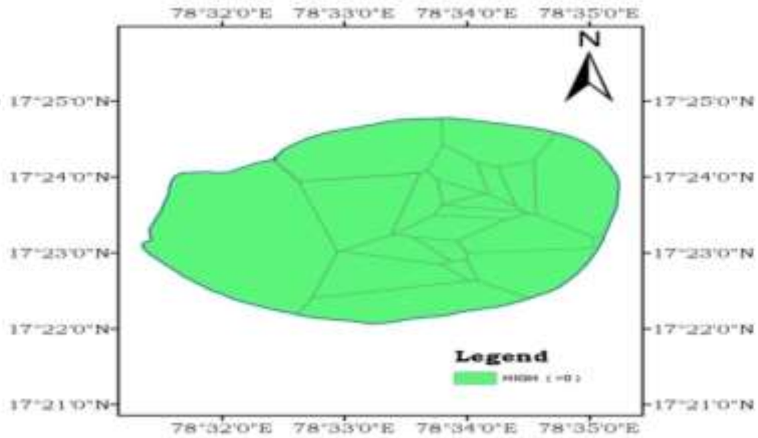

Fig.3 Spatial variation of Acidity

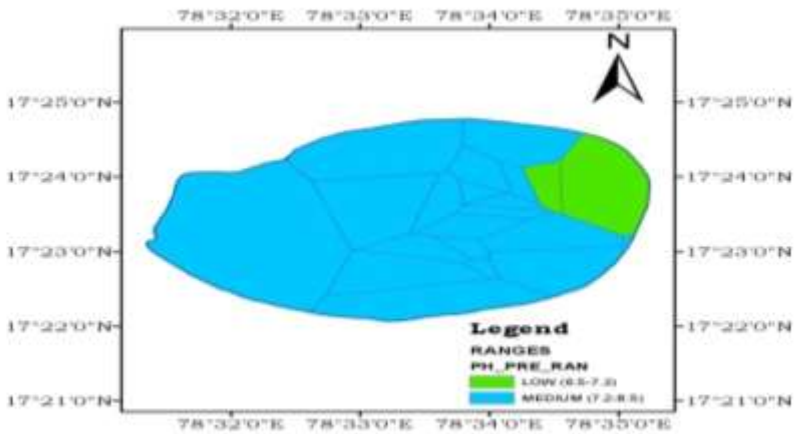

Fig.4 Spatial variation of pH

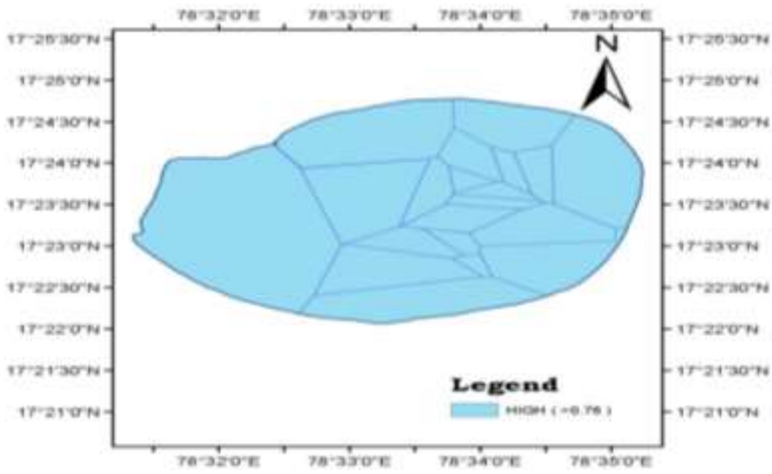

Fig.5 Spatial variation of Electrical Conductivity

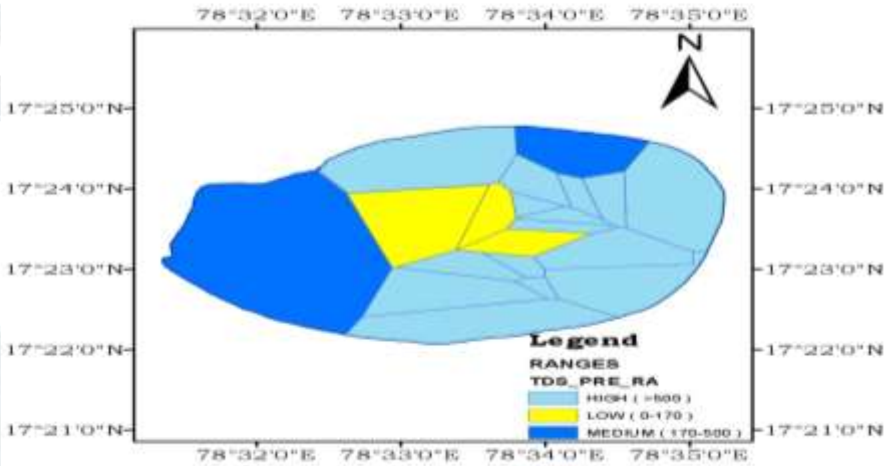

Fig.6 Spatial variation of TDS

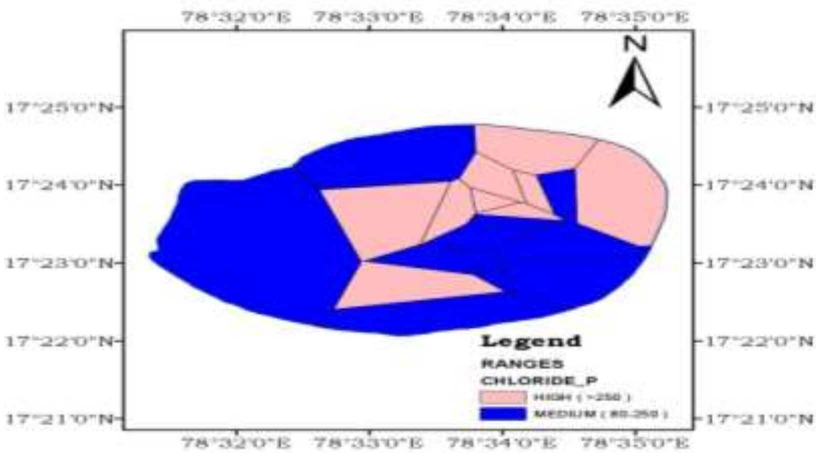

Fig 7 Spatial variation of Chlorides

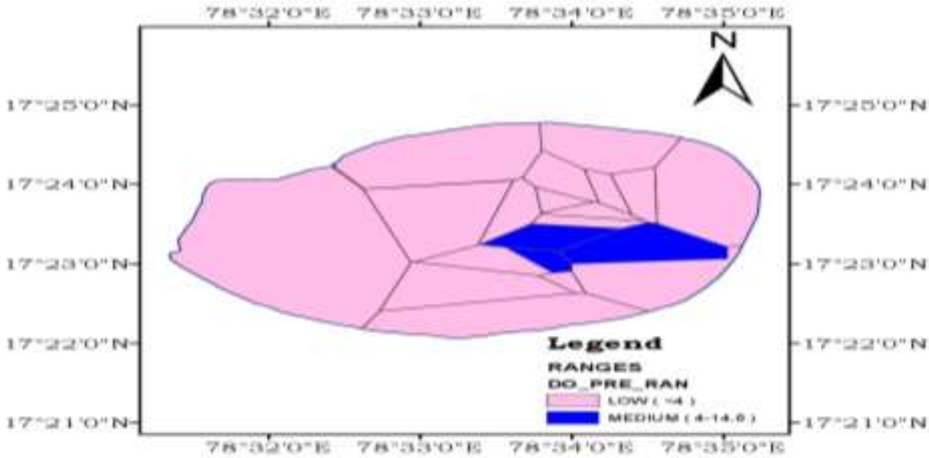

Fig.8 Spatial variation of Dissolved oxygen

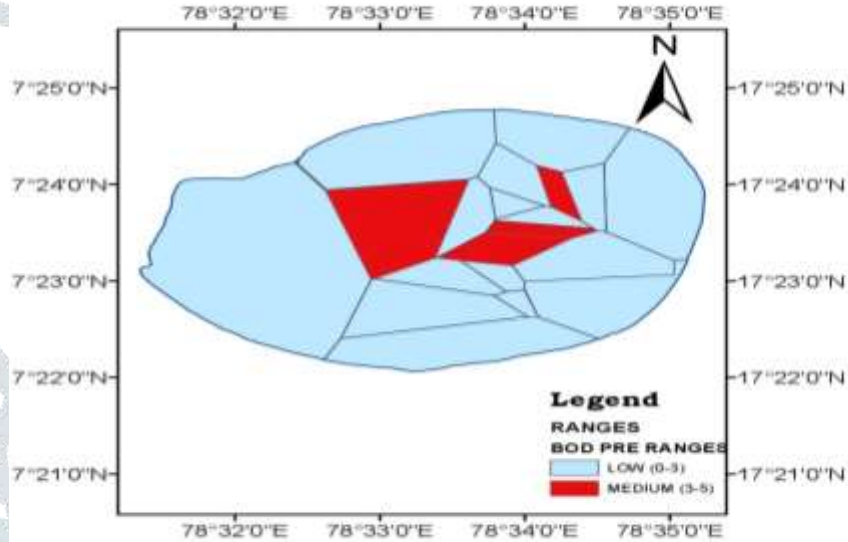

Fig.9 Spatial variation of BOD

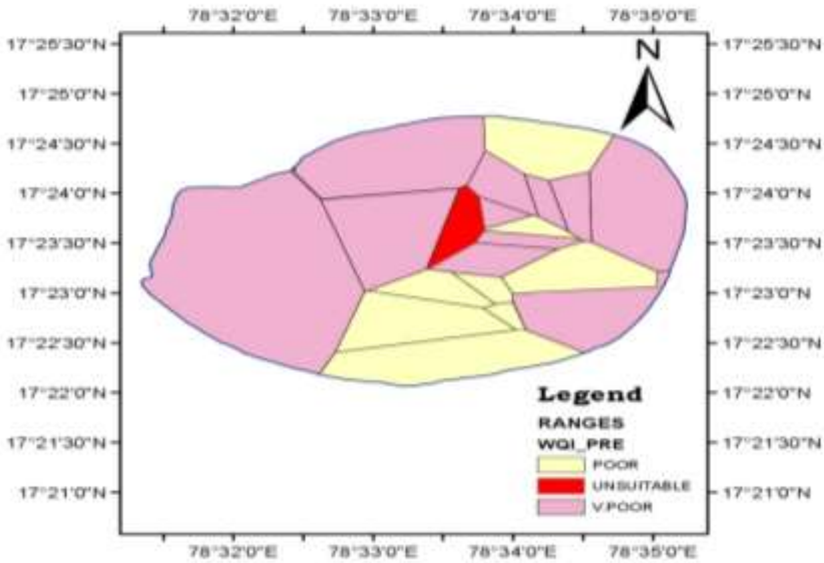

Fig.10 Spatial variation of Water Quality Index

VIII. RESULTS & DISCUSSIONS:

1. Alkalinity values investigated for the study period indicates that the values lie between 200mg/l to 500 mg/l High level of alkalinity may be accompanied by objectionable taste, or precipitation of scale in pipes and containers. The major contaminant source of alkalinity includes landfills and other sites where alkaline or basic chemicals have been dumped.
2. Acidity values investigated for the study period indicates that the values lie between 20 mg/l to 125 mg/l High value of acidity is harmful to health and mild acidity can dissolve lead or copper that may be in plumbing pipes and fixtures.
3. From the results obtained it is observed that the p^H values lie between 7.2 to 7.89 indicating that the samples are in alkaline range.
4. Chloride concentration varied from 139.95 mg/l to 556.3 mg/l. High levels of chloride impart a salty taste and affect people with Hypertension and Cardiac problems.
5. Total hardness values lie between 112.5 mg/l to 270 mg/l. It is concluded that water is not hard in the study area.
6. EC values investigated for the study period indicates that the values lie between 0.95 µs/cm to 3.087 µs /cm. The high EC value in the groundwater near the landfill is an indication of its effect on groundwater.
7. DO values investigated indicate that the values lie between 1.6 mg/l to 4.9 mg/l.
8. TDS concentration was found to vary between 136.1 ppm to 943.2 ppm. The higher value may be due to proximity to the Musi stream carrying sewage. TDS affects palatability of food cooked and also causes gastro-intestinal irritation.
9. BOD values investigated indicates that the values lie between 1 ppm to 4 ppm.

IX. CONCLUSIONS:

1. The Ground Water Quality Index in the entire area is above 100 indicating that the water is unfit for drinking.
2. The results indicate that ground water is polluted near the landfill site and is unfit for drinking.
3. High values of TDS in drinking water are generally not harmful to human beings, but high concentration of these may affect persons suffering from kidney and heart problems.
4. Spatial variation of various chemical parameters is studied using ARC GIS.
5. Rain-water harvesting may be adopted to reduce water pollution.
6. The sanitary landfill site is to be used to dispose the municipal solid waste.
7. The municipal solid waste can be managed using composting, incineration and power generation techniques.

REFERENCES:

[1]. APHA., 2012 Standard methods for the examination of water and waste water, 22ndEdn, American Public Health Association, Washington.

[2] Aderemi Adeolu O, et al; (2011), "Assessment of Ground water contamination Leachate near a Municipal Solid Waste Landfill", African Journal of Environmental Science and Technology, Vol.5 (11),933-940.

[3].Jaseela Chonattu.et al; (2016). Geo Spatial and Statistical Assessment of Ground Water Contamination due to Landfill Leachate, Journal of Water Resource and Protection (2016), 112-134,121-134.

[4]. Raman, N. and Sathiyanarayanan, D., (2011). "Quality Assessment of Ground Water in Pallavapuram Municipal Solid Waste Dumpsite Area Nearer to Pallavaram in Chennai, Tamilnadu", Journal of Chemistry. 4 (2): 481-487.

[5]. Subrahmanya Kumar CSV et al., (2018) "Assessment and Evaluation of Groundwater Quality due to Landfill Leachate Using Fuzzy Logic", International Journal of Emerging Technology and Advanced Engineering, Volume 8, Special issue 5, 212-217.