Resincap Journal of Science and Engineering
Volume 3, Issue 8 August 2019
ISSN: 2456-9976

Assessment of Groundwater Quality Due to Dumping of Municipal Solid Waste in Nashik.

Mr.Rajput Bhagatsingh E
PG Student,
Department of Civil Engineering,
YTCEM, Raigad, Maharashtra
bhagatsinghrajput007@gmail.com

Prof.Gaikwad Shailesh J
Assistant Professor,
Department of Civil Engineering,
YTCEM, Raigad, Maharashtra
shreeshailgaikwad23@gmail.com

Prof. Salunke Padmakar J
Assistant Professor,
Department of Civil Engineering,
MGMCE&T, Navi Mumbai,
pjsalunke11@gmail.com

ABSTRACT

In developing countries, open dumpsites are common, due to the low budget for waste disposal and non-availability of trained manpower. Open dumping of MSW is a common practice in many countries and it poses serious threat to groundwater resources. Increased environmental pollution from industrial, agricultural and municipal sources has deteriorated the groundwater quality over the past years. On the other hand, availability of energy is insufficient and poses a serious threat to the economic and social development. By considering the need for sustainable practices in disposing the solid waste, this scientific study was initiated in terms of research for the Assessment of groundwater quality due to dumping of MSW and its remediation through energy recovery in Nashik, Maharashtra, India. The main objectives of this research are to assess the suitability of groundwater for domestic and irrigation purposes. Groundwater samples from six wells from Gaulane Ghat Prakalp were collected for a period of four months December to March of 2018-2019 and analysed for thirteen selected water quality parameters Potenz Hydrogen ion concentration, Electrical conductivity , Total hardness, Total dissolved solids, Calcium, Magnesium, Sodium, Potassium, Chloride, Bicarbonate, Sulphate, Nitrate and Fluoride. Sampling methods and water analysis were carried out as per the standard procedure of American Public Health Association and Trivedy and Goel. The hydrochemistry and assessment of groundwater for irrigation were discussed for the period of 2018-2019.

Keywords

Potenz Hydrogen ion concentration, Electrical conductivity , Total hardness, Total dissolved solids, Nitrate, Fluoride.

1. INTRODUCTION

Solid waste is inevitable because by nature and every human activity generates a certain amount of solid waste. The rate of solid waste generated tends to increase with increase in population. Numerous debates are still going on about population growth in urban areas in developing countries. A large number of researchers (3&6) agreed that the major factor that leads to an increased number of people in the cities is, seeking a better life, among others. Rapid development of cities has come with various environmental challenges concerning solid waste management in developing countries. Solid waste arising from domestic, social and industrial activities is increasing in quantity and variety as a result of growing population, rising standards of living in most African countries and the development of technology (2& 4). SWM is a well-known term that includes a wide range of activities and practices that depict unwanted residues of any given society. All forms of human activities result in the generation of waste which leads to an assortment of changes in the environment and harm to animals, plants and ecosystems. Therefore, proper implementation of a careful SWM will limit the harm done to the environment and conserve scarce resources.

1.1 Municipal Solid Waste in Nashik

According to the Census of India, 2011 Nashik had a population of 1,486,973 and present population is estimated to be 2,000,006 (projected in year 2018) with a total area of 259 km² which makes it the fourth largest urban area in Maharashtra in terms of population. Nashik is the third most industrialized city in Maharashtra after Mumbai and Pune. Nashik has been on the tourist map of India, especially Hindu religious tourism, because of the legend that Lord Rama lived here during his exile.

The Nashik Municipal Corporation is collecting 300-350 Tons MSW per day. According to DPR for SWM, 2007 the average waste generation is only 218 gm/capita per day. This situation is either due to collection inefficiencies or due to high proportion of agriculture/horticulture farming, which helps in utilization of green waste for in-situ composting. With better collection and transportation measures, the collection efficiency should increase.

The city is registering almost 20% extra growth rate compared to similar other cities in India. This is leading to rapid development of real estates, housing, complexes, shopping malls etc. Consequently the per capita MSW quantity has been estimated to reach 400 gm/day by 2011 as per DPR (2007). The population growth rate of the city during the last decade has been 63.98%. This type of growth rate may be witnessed in the current decade also. Keeping above factors in view the projected quantity of MSW is 750 TPD by the year 2015 and 1628 TPD by the year 2031.

Analysis of city waste carried out recently, reveals 37.8% easily compostable (short-term biodegradable) materials, 19.50% hard lignite’s and long term biodegradables and 16.20% textiles, plastic, rubber etc. These last two components having 35.70% content in the MSW have become a major cause of concern. These materials are a negative contributor to the processing plant efficiency and rapidly exhaust available land for land filling.

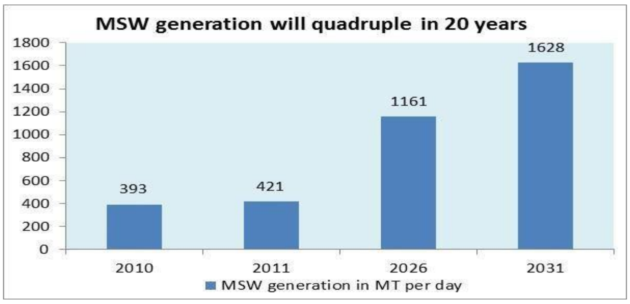

Chart -1: Projected Solid Waste Generation in Nashik

2. STUDY AREA

The domestic wastes are being brought to the Khat Prakalp dump yard by Ghantagadi, lorries & tractors and these wastes are then processed through various processing units of Khat Prakalp dump yard such as closure, composting yard, lagoons, landfill and segregation area. The new processing plant includes the Following a) pre- sorting unit with a capacity of 500 TPD b) aerobic composting unit c) Inert processing unit with capacity of 50 TPD d) Leachate treatment plant with a capacity of 0.4 mld leachate e) refuse derived fuel pant with capacity of 150 TPD f) Animal Carcass Incinerator with a capacity of 250 kg per hour g) Sanitary landfill in an area of 2 hector The map of Nashik City are shown below.

2.1 Description of Khat Prakalp Dumpyard

The domestic wastes are being brought to the Khat Prakalp dump yard by Ghantagadi, lorries & tractors and these wastes are then processed through various processing units of Khat Prakalp dump yard such as closure, composting yard, lagoons, landfill and segregation area. The new processing plant includes the Following a) pre- sorting unit with a capacity of 500 TPD b) aerobic composting unit c) Inert processing unit with capacity of 50 TPD d) Leachate treatment plant with a capacity of 0.4 mld leachate e) refuse derived fuel pant with capacity of 150 TPD f) Animal Carcass Incinerator with a capacity of 250 kg per hour g) Sanitary landfill in an area of 2 hector.

2.2 Location of Groundwater Sampling Stations

The groundwater sampling locations in and around Location of dump yard are designated as (W_1 to W_6) are presented in Table 1. The ground water samples were collected for a period of four months (December to March of 2018-2019).

Table No 1:Ground Water Sampling Stations In And Around Dumpyard.

Stations	Latitude	Longitude	Distance (m)	Use of water
W_1	$19^0$93.15N	$73^0$73.72E	600	Domestic
W_2	$19^0$93.05N	$73^0$73.71E	650	Domestic
W_3	$19^0$93.18N	$73^0$74.08E	136	Irrigation
W_4	$19^0$93.22N	$73^0$74.16E	265	Irrigation
W_5	$19^0$93.30N	$73^0$74.16E	148	Irrigation
W_6	$19^0$92.81N	$73^0$74.30E	125	Irrigation

Fig No 1: Locations of selected wells

3. MATERIALS AND METHODS

Groundwater Sampling can be collected by any of the following techniques such as Composite sampling which is a method of collection of numerous individual discrete samples taken at regular intervals over a period of time and Grab sampling which is a technique where samples are collected at one time at the point in time. For this study, groundwater samples were collected around MSW disposal site by Grab sampling method. Groundwater samples were collected from all the sampling points locations. Ground water samples were collected for a period of 4 months (December to March of 2018-2019), which includes winter and summer seasons of Nashik. Two litre plastic bottles were used to collect groundwater samples and before collecting the test samples, the containers were rinsed thoroughly with the water being sampled. After collection of samples, these bottles were instantly sealed and capped with wax and transported to environmental engineering laboratory of BVCOE & RI in Nashik for physico-chemical analysis. Ground water samples collection and preservation were done as per standard methods.

3.1 Assessment of Groundwater Quality For Drinking

The types of analysis could vary from simple field testing for a single analysis to laboratory based multi- component instrumental analysis. The measurement of water quality is a very exhaustive and time consuming process and a large number of quantitative analytical methods are used in this study. Sampling methods and water analysis were carried out as per the standard procedure of American Public Health Association (APHA 1995) and (11). All the instruments were calibrated appropriately for analysis according to thecalibration standards prior to the measurements. Various methods according to (1), ISI 1983, APHA 1985, WHO 1984, 1992, IS:10500-1991, 1993 & (8) adopted for the analysis are listed in Table 2. Water quality is examined through detailed chemical analysis of a wide range of parameters. Chemical analysis forms the basis of interpretation of quality of water in relation to source, geology, climate and use (10). The units of measurement are most important in chemical analysis of water quality.

The mineral concentrations in water are referred as TDS. The common measured unit of this is in parts per million (ppm) or mg/l. The dissolved concentration of inorganic salts was also present; hence the term “salinity” is mentioned in SI system. The mass concentration of dissolved solids in any liquid is given in terms of kilograms per cubic meter (kg/m^3). The “mg/l” is the common unit used to represent mostly because it is more accurate and numerically equal to the “ppm” units for high quality fresh water. For most of the practical purposes, water with less than 10,000 mg/l TDS and at temperature below 212^0F (100^0C) can be considered to have a density sufficiently close to 1 kg/l, so that 1 mg/l would be equal to 1ppm (5).

Table No 2: Methods adopted for analyzing parameters of groundwater.

Parameters	Units	Methods used
Hydrogen ion concentration	-	pH analyzer
Electrical Conductivity	(µmohs/cm)	EC analyzer

Total Hardness	(mg/l)	EDTA titration
Total Dissolved Solids	(mg/l)	TDS analyzer
Calcium	(mg/l)	Titration
Magnesium	(mg/l)	Titration
Sodium	(mg/l)	Flame photometer
Potassium	(mg/l)	Flame photometer
Chloride	(mg/l)	AgNO3 titration
Bicarbonate	(mg/l)	Acid titration
Sulphate	(mg/l)	Spectrophotometer
Nitrate	(mg/l)	Colorimeter
Fluoride	(mg/l)	Spectrophotometer

3.2 Water Quality Index

Water quality index is an important parameter for the assessment and management of groundwater. WQI indicates a single number (like a grade) that expresses the overall water quality at a certain location and time, based on several water quality parameters. WQI is an indicator, which reflects the composite influence of a number of water quality parameters which are significant for a specific beneficial use. WQI was carried out through Horton"s method. A set of constituents that collectively represent water quality was chosen and they were combined in several ways to give real index value**.** Different ranges of WQI and their status of water quality on the basis of increasing scale indices are given in Table 3.

Table No 3 Water quality index values and water quality

Sr. No.	Range	Water class
1	< 25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very Poor
5	>100	Unsuitable

3.3 Assessment of Groundwater Quality For Irrigation

Groundwater plays an important role in agriculture, for both watering of crops and for irrigation of dry season crops. The quality of ground water varies from place to place along with the depth of water table. It also varies with seasonal changes and is primarily governed by the extent and composition of dissolved solids present in it. Irrigation water quality refers to its suitability for agricultural use. The concentration and composition of dissolved constituents in water determine its quality for irrigation use. Quality of water is an important consideration in any appraisal of salinity or alkali conditions in an irrigated area. Good quality water has the potential to cause maximum yield under good soil and water management practices. The most important characteristics of water which determine the suitability of groundwater for irrigation purpose are Salinity Hazard, Sodium Adsorption Ratio, Percentage Sodium, Residual Sodium Carbonate, Kelley"s Ratio, and United States of Salinity Laboratory classification.

Table No 4 Groundwater quality based on salinity hazard

Symbol	EC range (µmohs/cm)	Water class
C1	< 250	Low
C2	251 – 750	Medium
C3	751 – 2250	Medium-High
C4	2250 – 3000	High
C5	> 3000	Very High

Table No 5: Classification of water based on Sodium Adsorption Ratio

Range	Type of water
Below 10	Low Sodium water
10-18	Medium Sodium water
18-26	High Sodium water
Above 26	Very High Sodium water

Table No 6: Groundwater quality based on Sodium Percentage

Sodium percentage	Water class
Below 20	Excellent
21-40	Good
41-60	Permissible
61-80	Doubtful
Above 81	Unsuitable

Table No7 Classification of water based on Residual Sodium Carbonate

Range	Water class
Below 1.25	Excellent
1.25-2.50	Good
Above 2.50	Unsuitable

Table No 8 Groundwater quality based on Kelley's Ratio

Range	Water class
Below 1	Suitable
Above 1	Unsuitable

Table No 9 Groundwater quality according to United States Salinity Laboratory Classification

USSL Classification	Water class
C1 – S1 (Low Salinity – Low Sodium) C2 – S1 (Medium Salinity – Low Sodium) C3 – S1 (High Salinity- Low Sodium) C4 – S1(Very High Salinity- Low Sodium)	Good
C1 – S2 (Low Salinity – Medium Sodium) C2 – S2 (Medium Salinity-Medium Sodium) C3 – S2 (High Salinity – Medium Sodium) C4 – S2 (Very High Salinity – Medium Sodium)	Moderate

C1 – S3 (Low Salinity – High Sodium) C2 – S3 (Medium Salinity – High Sodium) C3 – S3 (High Salinity – High Sodium) C4 – S3 (Very high Salinity – High Sodium)	Poor
C1 – S4 (Low Salinity – Very High Sodium) C2 – S4 (Medium Salinity – Very High Sodium) C3 – S4 (High Salinity – Very High Sodium) C4 – S4 (Very High Salinity – Very High Sodium)	Very poor

4. HYDROCHEMISTRY OF GROUNDWATER

This chapter presents quantitative findings with regards to water quality parameters in terms of water quality index for human consumption and Total Dissolved Solids, Total Hardness, Electrical conductivity, Sodium Adsorption Ratio , Residual Sodium Carbonate, Kelley‟s Ratio, Percentage Sodium and United States Salinity Laboratory diagram for irrigation purposes in the sampled wells. The selected parameters for analysis were Potenz Hydrogen ion concentration, Electrical conductivity, Total hardness , Total Dissolved Solids, Calcium, Magnesium, Sodium, Potassium, Chloride, Bicarbonate, Sulphate, Nitrate and Fluoride. The findings are compared with World Health Organization drinking water standards and Bureau of Indian standards (IS 10500-1991). The drinking water specifications are tabulated in Table 10 given by BIS (1991) and WHO (1993).

Table No 10 Drinking water specifications given by IS 10500 (1991) and WHO (1993)

Water Quality Param-eters	Bureau of Indian Standards (1991)		WHO (1993)	
	Highest Desirable	Maximum Permissib-le	Highest Desirable	Maximum Permissib-le
pH	6.5-8.5	No Relaxation	7-8.5	6.5-9.5
EC	-		-	-
TH	300	-	100	500
TDS	500	2000	500	1500
Ca2+	75	200	75	200
Mg	30	100	50	150
Na	-	-	-	200
K	-	-	-	12
Cl^-	250	1000	200	600
HCO_3^-	-	300	-	-
SO_4	200	400	200	400
NO_3	45	100	45	-
F-	1	1.5	-	1.5

The hydro-chemical assessment was carried out to determine the use of groundwater suitability based on different chemical indices. Groundwater samples collected from six locations in Gaulane were analysed for its Physico-chemical characteristics during December to March 2018-2019 are presented in Table 8 respectively. Further the hydrochemistry and assessment of groundwater for various uses are discussed for the periods February and March of 2019.

Table No 11: Physico-chemical parameters of groundwater samples at Gaulane during December - March of 2018 – 2019.

Water Quality Parameters	Units	December			January			February			March		
		Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
pH		7.68	8.15	7.92	7.78	8.2	7.97	7.6	8.1	7.91	7.45	7.9	7.69
EC	µ$/cm	176	340	255.7	184	370	275.8	201	376	282.7	204	364	272.3
TDS	(mg/l)	858	1100	952.2	886	1135	970.5	794	862	831	658	852	763.5
TH	(mg/l)	250	308	277.3	262	322	285.7	248	308	280.3	252	287	270.3
Ca	(mg/l)	10	20	15.4	14.8	25	18.8	9	19	14.83	9	18	13.5
Mg	(mg/l)	16.67	26.72	22.17	19.7	29.5	25.17	15.3	25.7	20.57	9.1	23	17.37
Na	(mg/l)	17.9	19.9	18.7	17.1	19	18.08	16.8	17.9	17.3	16.1	17	16.75
K	(mg/l)	11	17	14.33	10	14	11.33	9	11	9.83	9	10	9.33
Cl	(mg/l)	235	285	258.2	238	288	259.3	238	281	252.6	210	257	231.2
HCO_3	(mg/l)	135	425	248.3	145	455	266.7	131	409	241	115	395	216.7
SO_4	(mg/l)	128.9	178.3	165.3	138	179	165.7	126	175	161.4	110	172.2	152.9
NO_3	(mg/l)	19	22.1	20.76	18	22	19.92	15	20	17.58	14	19	16.67
F	(mg/l)	0.55	0.82	0.71	0.45	0.79	0.64	0.25	0.59	0.41	0.1	0.29	0.18

4.1 Potenz Hydrogen Ion Concentration

The pH value of water is very important indicator of its quality. It is controlled by the amount of dissolved carbon dioxide, carbonate and bicarbonates stated that the addition of salts to water may cause reduction in its pH value depending on added salts. It was observed that in and around Gaulane disposal site, the pH concentration ranged from 7.6 to 8.1 with a mean value of 7.91 during February and during March it varied from 7.45 to 7.9 with a mean value of 7.69 which indicated the normal groundwater was present as shown in table 11.It was observed that 100 % of samples are within the desirable limit during February and March of 2019 respectively in and around Gaulane disposal site. From the study around locations it is proven that the pH value of groundwater is found normal and all of the samples are within the desirable limit.

4.2 Electrical Conductivity

The total soluble salt content of irrigation is generally measured by determining EC. EC is the most important parameter to distinguish salinity hazard and suitability of groundwater for irrigation purpose. In and around Gaulane disposal site the EC values ranged from 201 to 376 µmohs/cm and 204 to 364 µmohs/cm with a mean value of 282.67 and 272.33 during February and March respectively as presented in Table 11. The classification of ground water on the basis of irrigation around was observed that 50% of the samples in around Gaulane disposal site fell in Excellent and 50 % of the samples fell in good category during February & March respectively.

4.3 Total Hardness

Hardness is the result of the dissolution of limestone which produce calcium trioxocarbonate (CaCO3) and the excess concentration of calcium makes water hard. Chemical softening, reverse osmosis, electro dialysis, or ion exchange reduces the hardness to acceptable limits. Around Gaulane disposal site, TH concentration of groundwater samples ranged between 248 mg/l to 308 mg/l with a mean value of 280.33 mg/l, it varied from 252 mg/l to 287 mg/l with a mean value of 270.33 mg/l during February & March respectively and it is given in Table 11. From the study, it was observed that 100% of samples around Gaulane disposal sites were hard during February & March respectively

4.4 Total Dissolved Solids

Total dissolved solids is generally considered as a primary pollutant, but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants. TDS concentration of groundwater samples around Gaulane disposal site, ranged from 794 mg/l to 862 mg/l , 658 mg/l to 852 mg/l with a mean value of 831 mg/l, 763.5 mg/l during February & March respectively and it is given in Table 8.

It shows that in Gaulane, 100 % of samples were within permissible limit were fit for drinking during February & March respectively. From this result it was observed that most of samples around location were found within the permissible limit. TDS is the main factor which determines the use of groundwater for any purpose. All of the samples showed values greater than the desired limit of 500 mg/L.

4.5 Calcium

Calcium is the most abundant among the alkaline earth minerals. The concentration up to 100 mg/l of calcium is capable of forming scales in pipes and boiler and fortunately it has no adverse physiological manifestation on human system (7). Ca is necessary for proper mineralization of bones and bone strength. Deficiency in intake of calcium leads to eventual demineralization of bones for complementing the inadequate amounts of Ca in the body. From the study Ca concentration of groundwater samples around Gaulane disposal site were ranged between 9 mg/l to 19 mg/l with a mean value of 13.5 mg/l and 9 mg/l to 18 mg/l with a mean value of 14.83 mg/l during February & March respectively as given in Table 11.It shows the percentage of calcium in the samples that fell within Permissible limit and highest desirable limits from the study areas. It was observed that 100% of the samples fell within the Highest desirable limit during February and March respectively in and around Gaulane disposal sites.

4.6 Magnesium

Magnesium is one of the most common elements in the earth's crust which is present in all natural water and it is an important contributor to water hardness and source of this ion is dolomites and mafic minerals amphibole present in the rocks. Mg ion concentration in the groundwater samples around Gaulane disposal site varied from 15.3 mg/l to 25.7 mg/l with a mean value of 20.56 mg/l during February and it ranged from 9.1 mg/l to 23 mg/l with a mean value of 17.36 mg/l which is given in Table 11. It was also observed that 100% samples were within the permissible limit during February & March around Gaulane disposal sites

4.7 Sodium

Sodium is an important ion used for classification of irrigation water due to its reaction with soil and because leachates reduces its permeability. Na is an essential nutrient and Na salts are soluble and will not precipitate unless high concentrations are reached. Clay minerals may release large quantities of exchangeable sodium. Ancient brines, seawater, industrial waters and untreated sewage may add some Na to groundwater. The maximum permissible limit of sodium is 200 mg/l and most of the samples fell above the limit. Around Gaulane disposal site Na ranged from 16.8 mg/l to 17.9 mg/l with a mean value of 17.3 mg/l during February and during March, it was 16.1 mg/l to 17 mg/l with a mean value of 16.75 mg/l as given in Table 11.It was observed that 100% of samples around Gaulane were within the highest desirable limit during February and March.

4.8 Potassium

Potassium enters the structure of certain clay minerals and to higher resistance to weathering of K minerals. Around Gaulane disposal site, the amount of K varied from 9 mg/l to 11 mg/l with a mean value of 9.83 mg/l during February and in March it ranged from 9 to 10 mg/l with a mean value of 9.33 mg/l, was given in Table 8. It was observed that K in all the samples of disposal sites was within the desirable limit. It shows the percentage of potassium around location. From the study it was observed that 100% of samples were within permissible limit in February and March in Gaulane disposal site.

4.9 Chloride

Chloride is naturally occurring anion found almost in all types of water. Cl is the major constituent of earth‟s crust but a major dissolved constituent of most natural waters. The presence of Cl in large amounts may be due to natural processes or it may be an indication of pollution from seawater or industrial or domestic waters. Cl is a good indicator of sewage and manure inputs and has been extensively used to identify sources of contamination from anthrophogenic activities (7). Sodium Cl may impart a salty taste at 250 mg/L and the amount of chloride ranged from 238.1 mg/l to 280.8 mg/l with a mean value of 252.62 mg/l around Gaulane disposal site. 33.33% of the samples were within the desirable limit and 66.67 % samples were within the permissible limit during February. During March it ranged from 210 mg/l to 257 mg/l with a mean value of 231.16 mg/l and 83.33 % of the samples were within the desirable limit and 16.67 % of the samples were within the permissible limit, as given in Table 8. From this study it was observed that the presence of Cl around disposal sites were within the permissible limit.

4.10 Bicarbonates

Bicarbonates derive from carbon-dioxide in the atmosphere, soil and solution of carbonate rocks. Presence of carbonic acid is indicated when pH is less than 4.5. Carbonate and bicarbonates contents contribute to total alkalinity and it imparts bitter taste to water. Concentration of HCO_3 in and around Gaulane ranged between 131 mg/l to 409 mg/l with a mean value of 241 mg/l during February and it varied from 115 mg/l to 395 mg/l with a mean value of 216.67 mg/l during March as given in Table 11.Around Gaulane 100 % of the samples were within the desirable limit during March & 83.34% were within the desirable limit and 16.66% were within the permissible limit February. Bicarbonates in all the samples around the disposal sites were found within the desirable limit.

4.11 Sulphate

Sulphate can be found in almost all the natural waters and most of the sulphate compounds originate from the oxidation of sulphite ores, the presence of shales or from the industrial wastes. Sulphate is one of the major dissolved components of rain. High concentrations of SO_4 in the water can have a

Volume 3, Issue 8 August 2019
ISSN: 2456-9976

laxative effect when combined with ca and mg, the two most common constituents of hardness. SO_4 produce bitter taste at high concentrations. Around Gaulane disposal site, the SO_4 concentration varied from 125.6 mg/l to 175.3 mg/l with a mean value of 161.42 mg/l during February and 110.1 mg/l to 172.18 mg/l with a mean value of 152.91 mg/l during March as given in Table 11. 100% of the samples were within the highest desirable limit during February and March around Gaulane disposal site. Concentration of SO_4 were found that disposal sites were within desirable limit.

4.12 Nitrate

Nitrates is an essential macro-nutrient in aquatic environments and most common groundwater contaminant. It is harmful to humans because our intestines can break nitrates down into NO_3 which affect the ability of red blood cells to carry oxygen. The excess levels can cause methaemoglobinaemia or "blue baby" disease. Although NO_3 levels that affect infants do not pose a direct threat to older children and adults, they do indicate a possible presence of other more serious residential or agricultural contaminants, such as bacteria or pesticides. High levels of NO_3 were the indicative of high pollution load due to intrusion of sewage and industrial effluents into natural water. The permissible limit for the nitrate is 45 mg/l. Around Gaulane disposal site the presence of NO_3 concentration ranged from 15 mg/l to 20 mg/l with a mean value of 17.58 mg/l during February and 14 mg/l to 19 mg/l with a mean value of 16.67 mg/l during March as given in Table 8**.**

4.13 Fluoride

The F concentration around Gaulane disposal site samples ranged from 0.25 mg/l to 0.59 mg/l with a mean value of 0.41 mg/l during February and 0.1 mg/l to 0.29 mg/l with a mean value of 0.18 mg/l in March as given in Table 11**.** 100 % of samples were within the desirable limit limit during February & March around Gaulane disposal site.

4.14 Water Quality Index

Table No 12 Summary of Water Quality Index in Gaulane during January to March

Sample Id	Months				Mean
	Dec	Jan	Feb	Mar	
W1	46.81	48.03	44.57	40.56	44.99
W2	50.71	52.55	46.99	45.12	48.84
W3	48.88	49.76	45.64	41.76	46.51
W4	52.99	53.55	49.77	45.16	50.37
W5	55.22	56.18	49.47	46.41	51.82
W6	47.27	48.21	49.29	43.91	47.17

The status of water quality in the study areas were compared with the WQI range by taking the mean values of WQI calculated during December, January, February and March. In Gaulane, WQI analysis showed that 66.67 % of samples fall under good and 33.33 % under poor category. The percentage of suitability of water quality changes in different areas, are due to characteristics of solid waste seasonal effects and diluted waste. The overall quality of the groundwater within the study areas was fit for domestic purposes and agricultural purposes.

5. SUITABILITY OF GROUNDWATER FOR IRRIGATION

Suitability of groundwater for irrigational purpose depends upon the salinity, electrical conductivity and hardness of water. These parameters are on the increasing trend due to the poor sanitation, dumping of solid waste and release of sewage. In the recent years, the concern for groundwater quality in irrigation water supplies gained more importance and with that a need for sound planning to ensure that the quality of water available is put to the best use. Groundwater contains a varying amount of different kinds of ions such as carbonate, bicarbonate, calcium, magnesium, sulphate, hardness and so on. Among them, the major cations are Ca, Mg and Na that influence the suitability of groundwater for irrigation purpose. Some of these cations are beneficial to crop production at expected concentration which otherwise would cause toxicity to plant and affect the properties of soil. The suitability assessment of groundwater for irrigation in the study areas were determined using Salinity Hazard, Sodium Adsorption Ratio, Percentage Sodium, Residual Sodium Carbonate , Kelley's Ratio and United States Salinity Laboratory Classification

5.1 Salinity Hazard

The total soluble salt content of irrigation is usually measured by determining the EC. It is the most important parameter to distinguish salinity hazard and suitability of groundwater for irrigation purpose. Excess salinity reduces the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil. If the electrical conductivity is at higher order in the groundwater and even if the soil appears to be wet, the available water to the plants is less. Therefore, irrigation water with high EC reduces the yield potential. Groundwater quality based on salinity hazard is given in Table 4.18. In Gaulane the groundwater samples fell within excellent to permissible range for irrigation.

Table No 13 : Groundwater quality based on salinity hazard (Mean of February-March)

Range	Type of water	Classification	Percentage of Samples
< 250	Low Saline	Excellent	50
251 - 750	Medium Saline	Good	50
751 - 2250	Saline	Permissible	0
2250 - 3000	High Saline	Doubtful	0
> 3000	Very High Saline	Unsuitable	0

5.2 Sodium Adsorption Ratio

Irrigation water containing large amounts of sodium is special concern due to sodium's effect on the soil poses a sodium hazard. SAR quantifies the proportion of sodium to calcium and magnesium ions in a sample. Sodium concentration is important in classifying the water for irrigation purpose because sodium concentration can reduce the soil permeability and soil structure. According to this classification, it was observed that Sodium concentration is low in Gaulane. SAR and EC could be used reciprocally to evaluate irrigation water quality formulated by US Salinity Laboratory Staff (1954). Salinity and Alkalinity hazard based on US Salinity diagram for the mean of December to March in the study areas are illustrated in Figure 2 respectively. It was observed that 100% of sample in come under good category. The overall quality of groundwater in the study area was fit for irrigation**.**

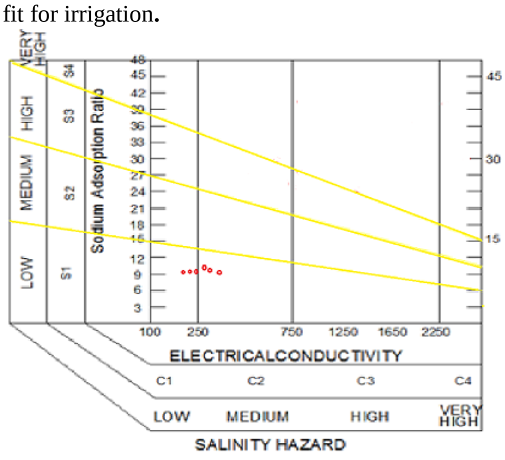

Fig No 2: Salinity and alkalinity hazard based on US Salinity diagram for Gaulane

5.3 Percentage of Sodium

Sodium in soil is considered vital for determining groundwater suitability for irrigation purpose because sodium reacts with soil to reduce its permeability and support little or no plant growth. Sodium is usually expressed in terms of sodium percentage. From Wilcox diagram, it was observed that in Gaulane 33.33% of samples fell within excellent to good to permissible, 66.67 % in the range of good to permissible. The overall quality of the groundwater in the Gaulane areas it was suitable for irrigation purpose. The Wilcox plot for the locations are presented in Figure 3 respectively.

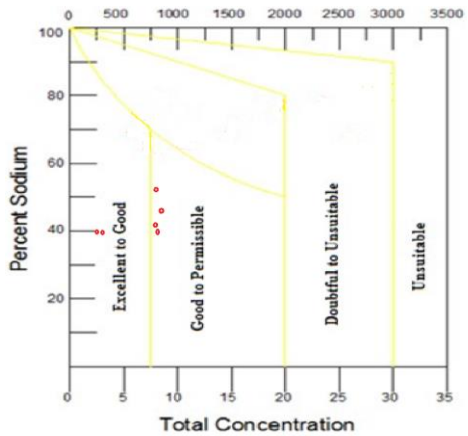

Fig No 3 Wilcox diagram for Gaulane

5.4 Residual Sodium Carbonate

A high salt concentration in water leads to formation of saline soil and alkaline earth metal cations expressed as RSC also influence the water quality for irrigation purpose. Based on RSC value, it was observed that 49.83% of groundwater samples were excellent and 25 % of geounwater sampkes were good in Gaulane. Nearly 29.17% of groundwater samples were unsuitable for irrigation in the study areas Gaulane.

5.5 Kelley's Ratio

A Kelley's Ratio of more than one indicates an excess level of sodium in waters. Hence, water with KR less than one are suitable for irrigation, while those with a ratio more than one are unsuitable for irrigation. According to KR, the ground waters in all the study areas are suitable for irrigation purposes.

6. CONCLUSIONS

6.1 Groundwater Quality

An investigation has been made to find the suitability of groundwater for drinking purpose in the study areas. Groundwater samples in the 6 selected locations around Gaulane were analyzed for their Physico-chemical characteristics such as hydrogen ion concentration, electrical conductivity, total dissolved solids, total hardness, bicarbonate, sulphate, chlorides, nitrates, sodium, calcium, magnesium, potassium and fluoride during December to March of 2018-2019.

6.2 Suitability of Groundwater For Drinking Purpose

Groundwater quality parameters were compared with World Health Organization (WHO 1993) drinking water standards and Indian drinking standards (BIS 10500-1991). From this study, it was observed that most of the physicochemical characteristics such as EC, Cl^-, TH, HCO_3 and Na in groundwater samples were at their maximum and higher than the highest desirable limit in all the locations. Based on TDS, 100% in Gaulane the groundwater samples were fit for drinking purpose. The mean value of WQI calculated for Gaulane exhibited good quality in greater percentage

6.3 Suitability of Groundwater For Irrigation Purpose

The suitability of groundwater for irrigation was assessed based on the total concentration of salts and relative proportion of sodium. Based on Wilcox diagram, it was observed that 33.33% of samples fell within excellent to good to permissible, 66.67 % in the range of good to permissible respectively in Gaulane area. The overall quality of the groundwater in Gaulane was fit for irrigation purpose. The USSL classification shows that 100% of the samples in Gaulane area came under good category. The study confirms that the overall quality of groundwater in the study areas are fit for irrigation. Groundwater quality in the study areas are slowly reaching an alarming stage. Hence, an immediate remedial measures and proper planning are essential in this venture to preserve the fragile ecosystem.

REFERENCES

[1] Aher, KR, Patil, SM & Mane, VP 2015, "Preliminary study in Irrigational quality of Groundwater sources in parts of Soygaon block, District Aurangabad, India", International

Research Journal of Earth Sciences, vol. 3, no. 2, pp. 7-12.

[2] Balasubramanian, M & Birundha, VD 2012, "An Economic Analysis of Solid Waste Management in Madurai District, Tamil Nadu", Applied Journal of Hygiene, vol. 1, no. 1, pp. 01-07.

[3] Cleland, J 1996, "Demographic data collection in less developed countries 1946–1996", Population Studies', vol. 50, no. 3, pp.433-450.

[4] Dickerson, G 1999, "Solid Waste Trash to Treasure in an Urban Environment", New Mexico Journal of Science, vol. 39, pp. 166-173.

[5] Freeze, RA & Cherry, JA 1989, "What has gone wrong? Ground Water", vol.27, no.4, pp.458-464.

[6] Kasala, SE 2014, "Critical Analysis of the Challenges of Solid Waste Management Initiatives in Keko Machungwa Informal Settlement Dares Salaam", Journal of Environmental Protection, vol. 5, no. 12, pp. 1064.

[7] Murali, K & Elangovan, R 2013, "Assessment of Groundwater Vulnerability in Coimbatore South Taluk, Tamilnadu, India Using Drastic Approach", International Journal of Scientific and Research Publications, vol. 3,no. 6, pp. 1-5.

[8] Oseji, JO 2012, "Hydrochemical Analysis of Ground Water Potential in Onicha - Ukwuani, Ndokwa Land Area of Delta State Nigeria", Advances in Applied Science Research, vol. 3 no. 3, pp. 1799-1808.

[9] Powell, J, Stolb, B, Peters, M, Tinch, R, Turner, K & White, O 2002, "The development of a sustainable and effective waste management policy for the UK (final report)", Centre for Social and Economic Research in Global Environment (CSERGE), University of East Anglia, Norwich, United Kingdom.

[10] Raghunath, H 1987, "Ground Water Hydrology, Ground Water Survey and Pumping, Tests, Rural Water Supply and Irrigation Systems", Wiley Eastern Ltd, Delhi India, vol. 563. ISBN-10: 0470273151, ISBN-13: 978-0470273159.

[11] Trivedy RK. and Goel PK 1984, "Chemical and biological methods for water pollution studies", Environmental Publication. Karadchi, India.