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Authored by

Sudhakar Shende

From

Late N.P. Waghaye Arts, Commerce and Science College, Lakhni-441804

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Studies on Major Ion Chemistry of Groundwater in Lakhandur City (M.H.) India

[1]*Sudhirkumar Maskey, [2]Sunil Barsagade, [3]Sudhakar Shende, [4]Nitin Vilayatkar, [5]Kishor Itankar

[1,2&5]Yashwantrao Chawhan Arts, Commerce and Science College, Lakhandur-441803

[3]Late N.P. Waghaye Arts, Commerce and Science College, Lakhni-441804

[4]S.S.Jaiswal College, Arjuni/Morgoan- 441701

Abstract:

Currently, study on major ion chemistry of groundwater this is very essential to improve the groundwater quality. Good groundwater quality is very necessary to human health, plant growth, microbial growth and industrial sector. Present research work understanding the quality of ground water and to evaluate major ion chemistry and for promoting sustainable development and effective management of ground water. A total of 14 water samples were collected from selected parts of the area of Lakhandur city in Bhandara district of Maharashtra, India during pre monsoon season for the period of two years from 2018. For this water sample, water chemistry of various anion and cation viz. F^-, NO_3^-, SO_4^{2-} HCO_3^-, CO_3^{2-},Cl^-, Na^+, K^+, Mg^{2+} and CO_3^{2-} are carried out. The nitrate ion appeared as a major problem of safe drinking water in this region. We recorded highest nitrate concentration, i.e., 255 mg/L in Eight groundwater sample. A comparison of groundwater quality in relation to drinking water quality standards revealed that about major nitrate and fluoride are ten groundwater locations are not suitable for drinking. The finding of the present study will be helpful to improve management plans for Groundwater quantity, control authority of the city.

Keywords: Groundwater quality, Sustainable development, Anion and cation chemistry, Drinking water, Lakhandur city, Control authority.

I. INTRODUCTION

In recent years observed that increase in population, industrialization, urbanization, deforestation and improving living standards. Then use of water has increased significantly which increase stress to supplying water from surface water resources such as lakes, rivers, streams and pounds therefore need to ground water[1]. It normally accumulate there when surface water, rain water and melting ice water seeps into the ground and moves downward due to gravity through the tiny pore between practical soil and rock. Ground water accounts nearly 95% of national fresh water resources. About 50 % of our drinking, municipal, domestic and agricultural water supply by ground water[2]. The use of groundwater has increased significantly in the last decades due to its widespread occurrence and overall good quality. Ground water is believed to be comparatively much hygienic than the surface water. Now this observed multifunctional activity of human ground water get pullulated drastically in many ways. As it soaks through soil, the water can dissolve hazardous materials that are present on or in the ground, becoming polluted. Some pollutants are naturally occurring that include contaminants such as bacteria, radon, arsenic, uranium and other minerals. Other pollutants find their way onto the land from Industrial and commercial activities, improper waste disposal, road salting and fuel spills can introduce hazardous substance to the ground. However, even typical residential activities, such as the use of fertilizers and pesticides, fueling of lawn equipment and disposal of household chemicals, can pollute the ground water when done improperly[3]. The quality of drinking water is the fundamental eminent of the health. Quality ground water is useful in deciding water use strategist for varies purposes. Limpid and immaculate dirking water is the basic necessity and hence, an internationally accepted human right and reducing the number of people without access to sustainable safe drinking water supply has been enlisted as one of the ten targets of the millennium development goals (MDGs) [4].

The present paper is evaluated that the cation, and anion other parameters for drinking water quality of the area of Lakhandur in Bhandara district of Maharashtra, India during pre monsoon season for the period of two years from 2018. Lakhandur is located at 20°.74" North and 79°.88" East with adjoining small village including Chicholi, Antargaon, Kinada, Madeghat and Asola. Main old city of lakhandur are crowded which are located on bank of chulband river. All border of lakhandur covered with agricultural land which have rice is main crop. About 85 % people of lakhandur economically depend upon agriculture and related job. Lakhandur has tropical wet and dry climate. The finding of the present study will be helpful to improve management plans for Groundwater quality, control authority lakhandur nagarpanchayet of the city.

II. METHODOLOGY

The study was conducted in Lakhandur city, Bhandara district, Maharashtra state, and belongs to survey of India topo sheet No. 55 P/13 and 55 P/14 and lies between 20°44'45" North latitude and 79°53'00" East longitude. A total number of 14 groundwater samples were collected from representative bore well/open well in Lakhandur city, Bhandara district, Maharashtra state, collected from Lakhandur area and send to analysis in divisional chemical laboratory of GSDA Nagpur MS and Department of Chemistry Yashwantrao Chawhan Arts, Commerce and Science College Lakhandur. Following parameters like pH, EC, TDS, TH and the major anion viz. (Mg^{2+}, Ca^{2+}, Na^{+}, K+) and cation viz. (Cl^-, CO_3^{2-}, HCO^{3-}, SO_4^{2-}, NO_3^-, F^-) were analyzed.

III. RESULTS AND DISCUSSION

The physicochemical parameters such as pH, EC, TDS, and major anions and major cations there minimum, maximum, and average concentrations are prescribed in table-1.The desirable and permissible limits given by WHO for drinking water purposes and the groundwater samples from the study area exist the desirable and permissible limit are shown in table-2[5,6].

Table .1. Chemical data of groundwater sampling silts

Sr. no.	pH	EC	TDS	TH	F^-	NO_3^-	SO_4^{2-}	HCO_3^-	Cl^-	Na^+	K^+	Mg^{2+}	Ca^{2+}
		µS/cm	Mg/l		Anions(mg/l)					Cations(mg/l)			
L-1	7.8	670	436	244	1.12	17	24	240	82	12	8	34	43
L-2	7.9	1230	800	392	1.31	33	58	440	114	31	5	44	86
L-3	8.3	1170	761	396	1.99	13	64	452	90	22	4	73	42
L-4	7.7	1330	865	480	1.17	52	58	380	170	75	11	67	117
L-5	7.8	2550	1657	552	1.88	38	72	536	292	24	5	118	32
L-6	7.7	840	546	392	1.19	10	32	432	38	16	15	50	77
L-7	7.8	1050	683	448	1.17	48	82	268	132	15	2	66	74
L-8	7.8	2400	1560	856	0.60	181	126	328	228	35	5	99	184
L-9	7.8	2040	1326	368	0.79	143	172	364	174	65	8	34	93
L-10	7.9	3180	2067	956	1.12	255	138	356	442	112	3	89	224
L-11	7.8	2130	1385	648	0.83	147	98	348	252	65	12	57	155
L-12	7.8	2430	1580	768	0.88	62	128	376	346	95	5	85	171
L-13	7.9	1510	982	560	0.75	113	84	328	210	65	7	60	128
L-14	7.9	730	475	268	0.41	17	38	256	38	12	8	21	58
Min	7.7	670	475	244	0.41	10	24	240	38	12	2	21	32
Max	8.3	3180	2067	956	1.99	255	172	536	442	112	15	118	224
Avg.	7.85	1661	1080	523	1.00	80.64	83.85	364.57	186.29	46	7	64.07	106

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Table 2. Groundwater samples of the study area exceeding the desirable and permissible limits prescribed by WHO for drinking purposes

Parameters	WHO 1997		No. of samples exceeding desirable limit	No. of samples exceeding Permiable limit
	Desirable limit	Permissible limit		
pH	6.5-8.5	9.2	-	-
EC (µS/cm)	750	1500	12	7
TDS (mg/L)	500	1500	12	4
Ca2+ (mg/L)	75	200	9	1
F^- (mg/L)	0.6-0.9	1.5	8	2
Mg2+ (mg/L)	30	150	13	-
SO_4^{2-} (mg/L)	200	600	-	-
NO_3^- (mg/L)	-	45	-	8
Cl^- (mg/L)	250	600	5	-
Na^+ (mg/L)	50	200	6	-
TH (mg/L)	100	500	14	6

3.1 PHYSICOCHEMICAL PARAMETERS

3.1.1. pH

In general, water with a pH less than 7 is considered acidic and with a pH greater than 7 is considered basic. The pH value range from 6 to 8.5 is normal range for pH in groundwater systems. In the present study, pH value ranges are found from 7.7 to 8.3 (average 7.85, Table-1), The maximum groundwater sample indicating an alkaline nature. All collected sample show the value of pH are well within the safe limit as prescribed by[7]. Human health doesn't have any direct effect because of pH, But it react with other chemical constituent of water.

3.1.2. Electrical conductivity (EC)

Electrical conductivity is an important indicator for water quality assessment. Since the composition of mineral salts **affects the electrical conductivity of groundwater, it is important to understand the relationships between mineral** salt composition and electrical conductivity. EC is measured in units called Seimens per unit area (e.g. mS/cm, or miliSeimens per centimeter) [7]. In the present study, the values of EC shows 670 to 3180 µS/cm. (avg1661).

3.1.3. TDS

The salinity behaviors of groundwater indicated by TDS. It show the variation between 475 to 2067 mg/l average (1080 mg/l) [6]. According to WHO, the acceptable concentration of TDS from domestic purpose is 500mg/l, and excessive limit for permissible value is 1500 mg/l. The TDS values All groundwater samples are well within permissible limit of except four groundwater location (L-5,L-8,L-10,L-12). Classification of groundwater on the basis of TDS value, it is 500 mg/L (desirable for drinking); 500–1,000 mg/l (permissible for drinking) and 1,000 to 3,000 mg/L (useful for agricultural purposes). Depending on this classification, The observation of sample of the study area that, out of 14 samples collected, 2 samples (L-1 and L-14) are desirable for drinking, 6 sample (L-2,L-3,L-4,L-6,L-7,L-13) are permissible for drinking and 6 sample (L-5,L-8,L-9,L-10,L-11,L-12)are useful for agricultural purposes.

3.1.4. Hardness

For domestic application hardness is the very much useful property of water, boiler in industries, cause hard water problem. The acceptable limit for total hardness (as CaCO3) is 200 mg/L, which can be extended up to 600 mg/L in case of non-availability of any alternate water source[6]. In the study area total hardness (TH) as CaCO3 ranges from 244 to 956 mg/L with an average of 523 mg/l On the basis of TH classification, water as 0–60- soft; 61–120- moderately hard; 121–180- hard and >180 very hard water. In study area all samples are very hard type water.

3.2 ANION CHEMISTRY

The major anions are fluoride, nitrate, sulfates, bicarbonate and chloride and are analyzed. The Cl mainly derives from non-litho logical sources and contributed, mainly, from the surface sources through the domestic wastewaters, septic tanks, irrigation-return flows and chemical fertilizers.[7,8]

3.2.1. Fluoride (F^-)

The responsible constituent for increased floride, in groundwater of the study area is mainly apatite, biotite, clay and chemical fertilizer. Fluoride concentrations above 1.5 mg/l in drinking water cause dental fluorosis and much higher concentration skeletal fluorosis[9]. Low concentration (approximately 0.5 ppm) provides protection against dental caries. Or essential element for maintaining normal development of teeth and bones. [9]The concentration of F varies from 0.41 to 1.99 mg/L (average 1.00 mg/L) in the study area (Table- 1). Fluoride concentration found in two groundwater samples (L-3 and L-5) in study are they are above the permissible limits of 1.5 mg/L. and distribution of fluoride is shown in Fig-1.

3.2.2. Nitrate (NO^{3-})

The increasing use of artificial fertilizers, the disposal of wastes (particularly from animal farming) and changes in land use are the main factors responsible for the progressive increase in nitrate levels in groundwater[10]. Under natural conditions the concentration of $NO3^-$ does not exceed 10 mg/L in water. Nitrate concentration of - varies from 10 to 255 mg/L (average 80.64 mg/L) in the study area (Table 1). Nitrate levels above 10 ppm may present a serious health concern for infants and pregnant or nursing women anthropogenic contamination. Adults receive more nitrate exposure from food than from water. Excessive $NO3^-$ in drinking water can cause a number of disorders including metha emoglobinaemia in infants, gastric cancer, goiter, birth malformations and hypertensions.[11] The maximum acceptable limit of $NO3^-$ is 45 mg/L, only EIGHT groundwater locations (L-4,L-7,L-8,L-9,L-10,L-11,L-12,L-13) are exceeding prescribed limit (Table 2) and distribution of nitrate is shown in Fig-2.

3.2.3. Sulphate (SO_4^{2-})

Sulphate is a naturally occurring ion in almost all kinds of water bodies and is a major contributor to total hardness. Sulphate content more than 200 mg/L is objectionable for domestic purposes. Beyond this limit, Sulphate ion causes gastro-intestinal irritation particularly when Mg^{2+} and Na^+ are also present in groundwater[10]. It varies from 24 to 172mg/l (avg 83.85 mg/l) all the groundwater sample show so4 concentration below desirable limit of 200 mg/L (Table-2) and distribution of sulphate is shown in Fig-3.

3.2.4. Bicarbonate (HCO_3^-)

It is primary anion in groundwater derived from the carbon dioxide released by the organic decomposition in the soil. The dissolved bicarbonate in the groundwater originates mainly from the biologically active layers of the soil where carbon dioxide is generated by root respiration and decay of humus that in turn combines with rainwater to form bicarbonate[11]. The concentration of HCO_3^- are minimum 244 mg/l to maximum 536 mg/L as an average (364.57 mg/l) in study area.

3.2.5. Chloride(Cl^-)

Content of chloride varied from 38 to 442 mg/L,(186.29mg/l) it indicate that the groundwater of study area caused by chemical fertilizer and influences of irrigation return- flows. Intensive and long-term the agricultural activity shows the truths of ground are not other sources. However, none of the groundwater locations are exceeding maximum permissible limit of 600 mg/L (Table 2) and Distribution map of chloride is shown in Fig-4.

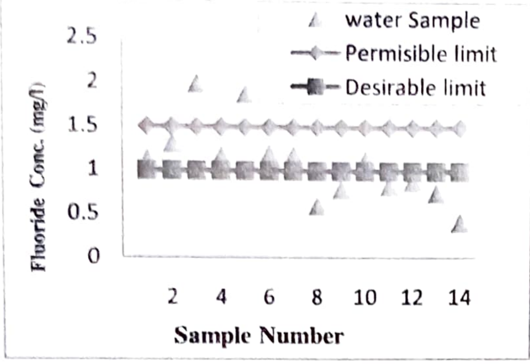

Fig. 1. Fluoride Distribution

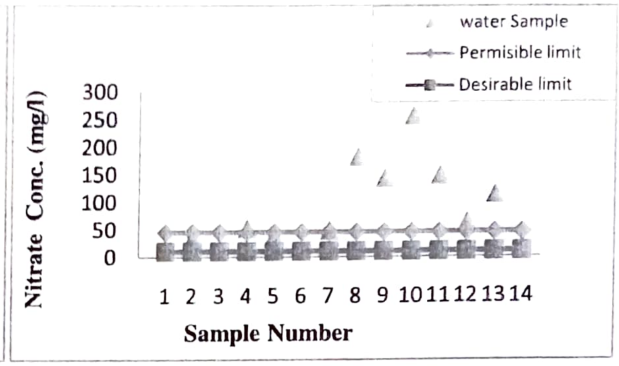

Fig. 2. Nitrate Distribution

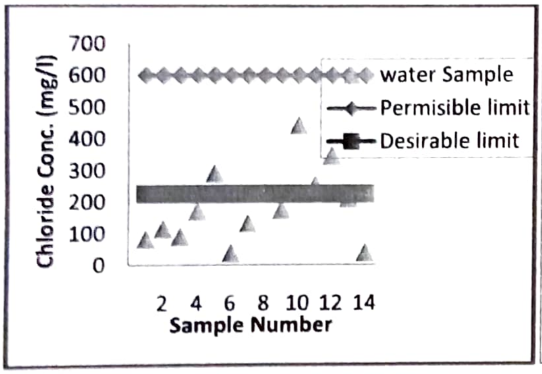

Fig.3. Sulphate Distribution

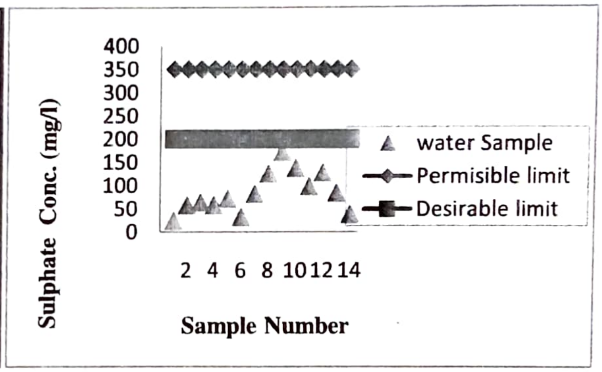

Fig. 4. Chloride Distribution

3.3 CATION CHEMISTRY

3.3.1 Sodium ion (Na^+)

Concentration are depending on the weathering of rock forming minerals like sodium plagioclase, halite and other silicate mineral. It is also depend upon anthropogenic sources just like domestic and animal waste. High doses of sodium chloride (about 1,570 mg sodium/kg body weight) have been observed to cause reproductive effects in various strains of pregnant rats. Effects on the dams have included decreases in pregnancy rates and maternal body weight gain. Developmental effects have included increased blood pressure and high mortality.[13] In the study area the Na concentration ranges from 12 to 112 mg/l(avg 46 mg/l) Table-1 the desirable limit of Na are 50 mg/l and permissible limit 200 mg/l (WHO 1997) [6]. There are non of the groundwater sample show above permissible limit Table-I, The distribution map of sodium is shown in Fig-5.

3.3.2 Potassium (K^+)

Potassium is an essential element and is present in all animal and plant tissues, and also essential element for human nutrition. But it is in excess condition may behave as a laxative. In study area it varies from 2 to 15mg/l (avg 7mg/l) with significant fluctuation. Only one (L-6) groundwater location have K+ concentration above the recommended value of 12 mg/l [12]. The distribution map of potassium is shown in Fig-6.

3.3.3 Calcium and Magnesium (Ca^+& Mg^+)

These are essential nutrients for animals and plant, and these are responsible for bone, nervous system and cell development. Ca and Mg are the main agent to contributors of hardness. These are in water are beneficial of presence of Ca & Mg in water. There were no limits prescribed for protection of human and aquatic health. In drinking water addition of Ca & Mg nutritional benefits to the people. One may possible effect are ingesting high concentration of Ca2+ for long periods or it may be an increased risk of kidney stone[12]. In the present study area calcium ranges from 32 to 224mg/l (avg 106mg/l), and the value of Mg2+ is varied from 21 to 118 mg/l (avg. 64.07 mg/l) (table-1). WHO prescribed limit for Ca are 200 mg/l and Mg are 150 mg/l respectively. There are only one sample show the (L-10) Concentration of Ca above permissible limit and non of the sample show the Mg concentration above permissible limit. The distribution map of **Calcium and Magnesium** are shown in Fig-7 and Fig-8 respectively.

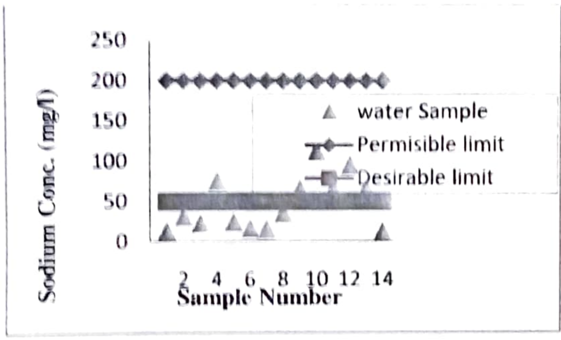

Fig. 5. Sodium Distribution

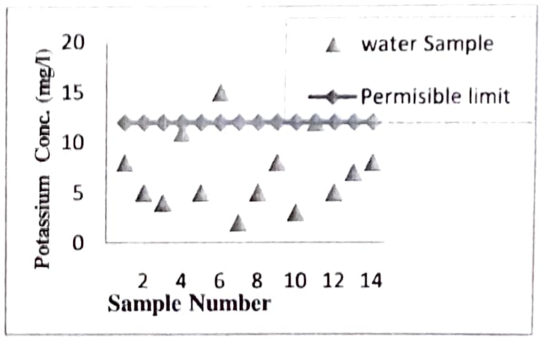

Fig. 6. Potassium Distribution

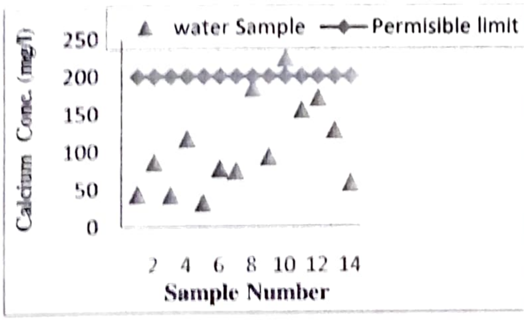

Fig. 7. Calcium Distribution

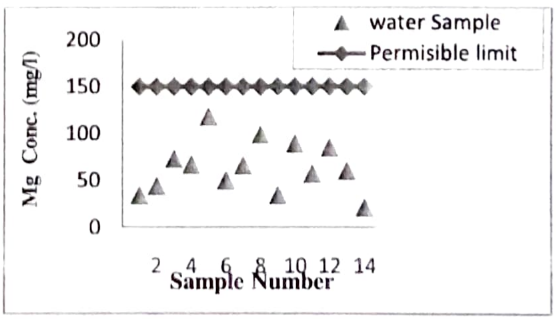

Fig. 8. Magnesium Distribution

IV. CONCLUSION

On the basis of results and discussion the major ion chemistry develop all the groundwater location from study area, are found very hard type. According to Davis and De Wiest classification, TWO sample are desirable for drinking. SIX sample are permissible for drinking and SIX sample are useful for agricultural purposes. Only EIGHT groundwater location have nitrate concentration above the permissible limit of 45 mg/l and not suitable for drinking. Elevated fluoride concentration TWO groundwater locations above permissible limit of 1.5 mg/L, which is not suitable for drinking.

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