Int. J. Adv. Res. Sci. Technol. Volume 4, Issue 4, 2015, pp.421-425.

IJARST

International Journal of Advanced Research in Science and Technology

journal homepage: www.ijarst.com

ISSN 2319 – 1783 (Print)

ISSN 2320 – 1126 (Online)

Hydrogeochemistry of Osmansagar Lake Ecosystem Of Hyderabad City, Telangana.

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ARTICLEINFO

Article history:

Received 12 May 2015
Accepted 04 Jun. 2015
Available online 12 Jun. 2015

Keywords:

Osmansagar Lake,
Piper Trilinear Diagram,
SAR,
WHO (2006),
Permeability Index (PI).

PAPER-QR CODE

IJARST
Volume-4, Issue-4

ABSTRACT

The aim of the present study is to evaluate the quality of Osmansagar lake waters and ground waters with respect to different physico-chemical parameters (pH, EC, TDS, TH, CO_3, HCO_3, Ca, Mg, K, Cl, Na, SO_4, F, NO_3) in December 2014. Both the waters have been compared to World Health Organization, WHO (2006) standards in order to evaluate its suitability for drinking purpose. The important constituents that evaluate the waters for its suitability for agriculture and irrigation such as Sodium Adsorption Ratio (SAR), USSL, RSC, Na% and PI were also calculated.

Citation: *Laith Hemed. et. al. Hydrogeochemistry of Osmansagar Lake Ecosystem Of Hyderabad City, Telangana., Int. J. Adv. Res. Sci. Technol. Volume 4, Issue 4, 2015, pp.421-425.*

Introduction:

Water is one of the most important components of the ecosystem. Especially, lakes and surface water reservoirs are the planet's most important freshwater resources and provide innumerable benefits. Fresh water habitats occupy a relatively small portion of the earth surface as compared to marine and terrestrial habitats, but their importance to man is far greater than their areas. Fresh waters are the most suitable and cheapest source for domestic and industrial needs and they provide convenient waste disposal systems. Most of the Fresh water bodies all over the world are getting polluted, thus decreasing the potability of the waters (Gupta et.al., 2005). Due to increased human population, Industrialization, use of fertilizers in agriculture and many man-made activities, the lakes are being deteriorated. Lakes and their surroundings are unique assets and valuable ecosystems of society and nature; these are of social, cultural and aesthetic value. India being essentially a rural and agrarian country, needs assured supply of water for a larger population and even a larger agricultural area demanding assured input of water.(Mukherjee et.al., 1993).

Importantly, ground water can also be contaminated by naturally occurring sources. Pollution caused by fertilizers and pesticides used in agriculture, often disperse over large areas and is a great threat to ground water ecosystems. The pollutants leach through the soil and geologic formations and finally reach the water table thus contaminating the ground waters. These impurities may give waters bad taste, color, odour, turbidity and cause hardness, corrosiveness, staining or frothing (Muller et.al., 2001). In India, where ground water is used extensively for irrigation and industrial purposes, a variety of land and water based human activities are causing pollution of this precious resource.(De, A.K,2002). Therefore essentiality of regular monitoring of the surface and ground water quality may prevent contaminated water supply, proper suggestion of treatment techniques, suitable planning and management strategies and policies execution.(V.Hema Sailaja et.al.,2013).

Study Area:

Osmansagar popularly known as Gandipet, is a reservoir in the Indian city of Hyderabad. The lake is around 46km2 and the reservoir is around 29km2. It lies between 17°23′N 78°18′E. The city of Hyderabad lies in the Deccan region which receives seasonal rainfall during the monsoon months which extends from June to September. This lake had served drinking water for Hyderabad city but, due to increase in population, it is

not sufficient for water supply to Hyderabad city so now it is being used for public recreation (Fig:1).

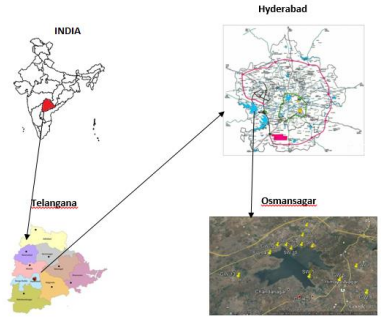

Fig. 1: Location Map of the Study Area

Materials and Methods:

Seven surface waters(7) and seven ground water samples(7) have been collected in Pre cleaned high density polyethylene bottles(HDPE) with dil HNO_3 in and around Osmansagar lake and numbered (Table:1). The bottles were rinsed with the same water which is to be taken as the sample so as to avoid cross contamination. The water samples were then analyzed for major ion chemistry using standards methods (APHA, 1995). The results were evaluated in accordance to the drinking water standards WHO: 2006).

The pH was measured with Digital pH meter (Model 802 Systronics) and EC was measured with Conductivity meter (Model 304 Systronics). Total hardness as $CaCO_3$ and (Ca^{+2}) were analyzed titrimetrically using standard EDTA. (Mg^{+2}) was computed taking the reference between TH and (Ca^{+2}) values. Carbonate (CO_3^{-2}) and Bicarbonate (HCO_3^-) were estimated by titrating with standard H2SO4. Chloride (Cl^-) was estimated by standard $AgNO^3$. Sodium (Na^+) and Potassium (K^+) were measured by Flame Photometer (Model Systronics 130). Sulphates (SO_4^{-2}) and nitrates were measured with Spectronics 21(Model BAUSCH AND LOMB), and Fluoride (F-) was analyzed by Orion ion analyzer with Ion-Selective Electrode. Total Dissolved Solids (TDS) were calculated from Electrical Conductivity (EC). All the parameters are expressed in mg/l except for pH and EC. EC is expressed in micro Siemens /cm.

Results and Discussions:

Suitability for drinking purpose:

The quality of both surface and ground waters determine its suitability for different purposes depending on the specific standards. Fourteen water samples (ground & surface) after analyzing for physico chemical parameters have been compared to WHO: 2006 drinking water standards. According to WHO: 2006, pH values of all the water samples are found permissible ranging from 7.7 to 8.5 with an average of 8. EC of all the water samples fall within permissible levels except for 2 samples. EC values range from 500 to 1700µS/cm with an average of 1000. High EC values of two water samples may be due to anthropogenic activities. TDS values of all the water samples are permissible except for only one sample. Total Hardness (TH) as CaCO3 of all the water samples fall within permissible limits (WHO: 2006).

The chemical parameters analyzed were the major cations and anions. Major cations include Mg^{2+}, Ca^{2+}, K^+, Na^+. The major anions include SO_4^{2-}, NO_3^-, F^-, Cl^-, CO_3^{2-}, HCO_3-. Concentrations of calcium in the study area range from 12-68 mg/L with an average value of 30 mg/L. All the samples fall within permissible limits as per WHO: 2006. Concentrations of magnesium found in the water samples ranges from 11-39mg/L with an average of 19mg/L. which are within desirable limits of 50mg/L. K^+ values in waters ranges from 1-3mg/L with an average of 3mg/L. It is clearly evident that potassium distribution in the study area is within the desirable limits of 55mg/L as per (WHO:2006) Na+ concentrations in waters ranges from 14-107 mg/L with an average sodium concentration of 38mg/L which is also within permissible limits of 200 mg/L as per WHO:2006.

Chloride (Cl^-) in and around Osmansagar lake ranges from 43-348mg/L with an average of 117mg/L. Three (3) water samples exceeds permissible limits which may be due to pollution sources such as domestic effluents, fertilizers and septic tanks. Sulphate(SO_4^{-2}) concentrations ranges from 17-98mg/L with a mean of 38mg/L. All are within the permissible limit as prescribed by WHO: 2006. Nitrates (NO_3^-) concentration ranges from 3-233mg/L with an average mean value of 44mg/L. 4 out of 14 samples were found to have nitrate content above desired limit of 50mg/L set by WHO: 2006. High levels are observed as a result of leaching or runoff from agricultural lands or due to human and animal waste contributions. Fluoride (F^-) concentrations varied from 0.42-2.3mg/L with a mean average of 1mg/L where most of the samples fall within the permissible limit except for 2 samples. Fluoride (F^-) becomes toxic when it occurs in drinking water beyond the maximum permissible limit of 1.5 ppm. Chronic exposure to fluoridated ground or drinking water creates a health problem not only in human beings but also in diverse species of domestic animals in the form of osteo-dental fluorosis (A.S Datta et.al.2014). Bi Carbonate concentration in this area ranged from 122mg/L to highest of 409mg/L with an mean of 1000mg/L which is within the permissible limits.

The results are summarized in (Table: 2). as per the WHO: 2006. The surface and ground water samples of the study area are congenial for drinking purpose except for few samples which can be treated using standard methods.

Suitability for agriculture and irrigation purposes:

The surface waters of Osmansagar and surrounding ground waters have been assessed for its suitability for irrigation and agriculture purpose by employing standard methods like SAR, Na%, RSC, and PI.

Table: 1 Results of Physico-Chemical Parameters of Surface and Ground Waters of Osmansagar

Sample Id	pH	EC	TDS	NO_3	CO_3	HCO_3	Ca	Mg	TH	Na	K	SO4	F	Cl	SAR	Na%	RSC	PI
1(SW)	8.1	1100	704	4	18	293	26	11	110	23	2	31	0.7	57	0.96	32.3	3.2	100
2(SW)	7.8	1500	960	233	18	305	46	30	240	106	3	76	1.76	280	2.98	49.3	4.05	72
3(SW)	7.7	1700	1088	140	15	403	68	39	330	107	2	98	2.03	348	2.59	41.8	0.5	64
4(SW)	8.1	1100	704	4	15	177	16	16	105	15	3	32	0.46	53	0.68	27	1.3	85
5(SW)	8.5	500	320	4	15	140	12	13	85	16	3	21	0.44	50	0.76	31.4	1.2	90
6(GW)	8	700	448	8	18	390	26	19	145	16	2	19	2.3	78	0.58	20.5	4.2	89
7(GW)	8	800	512	12	9	268	42	24	205	23	2	43	0.54	124	0.69	20.3	0.6	60
8(GW)	8.2	1300	832	116	12	183	14	16	100	14	4	23	0.42	43	0.6	25.9	1.4	88
9(GW)	8.3	700	448	9	6	171	14	11	80	16	4	21	0.42	43	0.78	33.3	1.4	103
10(SW)	8.2	900	576	5	9	122	16	12	90	16	3	17	0.44	43	0.77	31.2	0.5	84
11(GW)	8.2	900	576	4	9	183	14	12	85	17	3	22	0.42	46	0.76	32.5	1.7	100
12(GW)	8	500	320	3	24	165	26	15	125	29	1	23	1.26	78	1.17	35	1	77
13(GW)	7.9	900	576	7	6	409	54	15	195	55	2	56	0.96	121	1.72	38.5	3	80
14(SW)	7.7	1400	896	64	18	409	46	39	275	85	3	49	1.05	280	2.24	40.7	1.8	69

(Values are in PPM, except TDS and EC, SW-Surface Water, GW-Ground Water)

Table: 2. Comparision of Physico-Chemical Parameters of Ground Waters and Surface Waters with WHO (2006) Standards

Water Parameters	Minimum	Maximum	Average	WHO 2006	No of Samples Exceeding Permissible limits
pH	7.7	8.5	8.0	6.5-8.5	0
EC	500	1700	1000	1400	2
TDS	320	1088	640	1000	1
TH	85	330	155	500	0
Ca^{2+}	12	68	30	75	0
Mg^{2+}	11	39	19	50	0
NO_3^{2-}	3	233	44	50	4
SO_4^{2-}	17	98	38	400	0
F^-	0.42	2.3	1	1.5	2
Cl^-	43	348	117	250	3
HCO_3	122	409	258	1000	0
Na	14	107	38	200	0
K	1	3	3	55	0

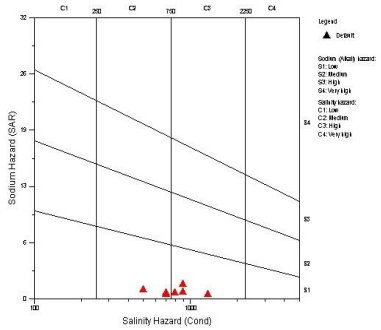

Fig. 2: USSL Diagram (SW)

Alkalinity Hazard (SAR)

SAR is an important parameter for determining the suitability of because it is a measure of alkali/ sodium hazard to crops. United States Salinity Laboratory (USSL) introduced the concept of sodium adsorption ratio (SAR) to predict sodium hazard. SAR is calculated by the following formula. The calculated value of SAR is this area ranged from 0.58-2.98meq/l where all samples fall in the low sodium class(S1) denoting little or no hazard.

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

U.S Salinity Laboratory Method (USSl)

This method is based on SAR. The analytical data plot on U.S salinity diagram(Fig: 2 & 3) shows that 93% of the surface water samples and 93% of ground water samples fall in the field of C3S1 indicating high salinity and low sodium waters which are well suitable for all types of soils with a little danger of exchangeable sodium.

Sodium Percentage (Na %):

Sodium percentage values reflects that 13 water samples are under the category of good (20-40 Na%)

class and only one(1) water sample is under the category of permissible(40-60 Na%). The sodium percentage is calculated as follows:

$$Na\% = \left(\frac{Na^{+} + K^{+}}{Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}} \right) \times 100$$

The values of sodium percent are varying from 20.3% to 49.3%. When the concentration of sodium ion is high in irrigation water, Na^{+} tends to be absorbed by clay particles, displacing magnesium and calcium ions. This exchange process of sodium in water for Ca^{++} and Mg^{++} in soil reduces the permeability and eventually results in soil with poor internal drainage.

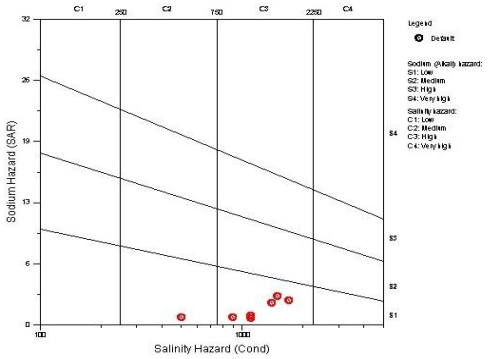

Fig. 3: USSL Diagram (GW)

Residual Sodium Carbonate (RSC):

In water having high concentrations of bicarbonates there is a tendency for Ca^{2+} and Mg^{+2} to precipitate as carbonates. To qualify this effect an experimental parameter termed as residual sodium carbonate was used. RSC is calculated as follows:

$$RSC = (CO_3 + HCO_3) - (Ca + Mg)$$

Five(5) water samples fall within good category, five(5) water samples fall within doubtful category and remaining four(4) water samples fall in unsuitable category for irrigation and agricultural purpose.

Permeability Index (PI):

High sodium in the irrigation water can cause severe soil permeability problem. Permeability is affected not only by high sodium but also by $CO_3^{2-}$and HC^{O3-} content in water. A part of $CO_3^{2-}$and HCO_3- is precipitated as $CaCO_3$ (or) $MgCO_3$ removing Ca and Mg from irrigation water and leads to increased proportion of solution. The effect onpermeability has been evaluated by the term permeability index, which is calculated as

$$PI = \frac{(Na + \sqrt{HCO_3}) \times 100}{Ca + Mg + Na}$$

All the water samples (14) permeability index exceeds 65, suitable for irrigation purpose except for 2 samples (Table:3)

Table: 3 Classification of Surface and Ground Waters for Irrigation Purpose Based on SAR, NA%, RSC, PI

Parameters	Range	Water Class	Total Samples
SAR	10	Excellent	All samples
	18	Good	Nil
	26	Doubtful	Nil
	>26	Unsuitable	Nil
NA%	20	Excellent	Nil
	20-40	Good	13
	40-60	Permissible	1
	60-80	Doubtful	Nil
	80	Unsuitable	Nil
RSC	<1.25	Good	5
	1.25-2.25	Doubtful	5
	>2.25	Unsuitable	4
PI	<65	Unsuitable	2
	>65	Suitable	12

Conclusion:

Both the surface waters and ground waters around Osmansagar lake are slightly hard to alkaline in nature. All the parameters of water samples fall within the permissible levels as compared to WHO: 2006 drinking water standards except for few samples. The different indices for evaluation of waters for its suitability for irrigation such as Sodium Adsorption Ratio (SAR), USSL, RSC, Na% and PI were also calculated. According to Sodium Adsorption Ratio (SAR) all the water samples (GW&SW) fall in low sodium class (S1) denoting little (or) no hazard. According to USSL diagram, 93% of water samples (GW&SW) fall in C3S1 indicating high salinity and low sodium class.Na% indicates that all the water samples (GW&SW) fall under the good category. Residual Sodium Carbonate (RSC) indicates that majority of the samples fall in good category. According to Permeability Index (PI) all the water samples are suitable for irrigation. Hence it can be concluded that Osmanasagar lake waters and ground waters in and around Osmansagar are well suitable for drinking and irrigation purpose exceptionally for few samples.

Acknowledgements:

Thanks are due to head, Department of Applied Geochemistry for providing necessary laboratory facilities and Soujanya (Research Scholar) for assisting in my analytical work.

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