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Physio Chemical and Statistical Analysis of Water of Fateh Sagar Lake District Udaipur (Rajasthan)

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Abstract: ***Water is the second most important need for life to exist after air. As a result, water quality has been described extensively in the scientific literature. Water is required for different purposes, the suitability of it must be checked before use. Poor condition of water bodies are not only the indicator of the environmental degradation but also threat to the eco system. In industries, improper quality of water may cause hazards and severe economic loss. The study of water sources of the Udaipur city is necessary because they serve as source of water for people of the city, nearby town, villages and countless tourists that visit the city. In the present study an attempt has been made to study the water quality of Fateh Sagar Lake of Udaipur (Rajasthan), India. Water samples were taken near Fateh Sagar Lake District Udaipur 6km from the city Udaipur for physio-chemical and statistical analysis. In this study it was found that all the sample readings come near to the permissible limit except TDS, COD and FC in the winter season. Distinctive statistical analysis additionally clarifies the appropriateness of water for agriculture and domestic purposes.***

Keywords: Water quality, Fateh Sagar Lake, Udaipur, physio-chemical parameters, statistical analysis

1. Introduction

Water the driving force of nature is one of the basic needs required by all life on earth which dominates a majority of the space on our planet. The collective volume of water under, on and over the surface of planet earth is considered as hydrosphere. India has diversified forms of lands in which Rajasthan is situated in North-West region as a dry state. In the southern most part of Rajasthan, Udaipur is surrounded by the Aravalli range and is brimming with natural beauty.

The temperature normally varies from 11.6^{0}C in January to 45^{0}C in May. Udaipur city has a hot semi-arid climate. Average annual rainfall of the district is 637.0mm. However normal rainfall for the period 1901 to 1970 is 633.50mm. The southern part of the district receives slightly more rainfall. The cold season is from December to February and is followed by summer from March to June. Period from mid of September to end of November constitutes post monsoon season. The droughts are in general of mild or normal type. However, severe types of droughts have been recorded at Udaipur, Gogunda, Kherwara, Jharol, Kotra and Vallabhnagar. Very severe type of drought was recorded in the year 1987 at Kotra.

The quality of water is affected by industrial waste, over-exploitation of resources, anthropogenic activities, current trends of urbanization, increasing population, sewage and waste water, and excess use of chemical fertilizers and pesticides. [24]
Fateh Sagar Lake an artificial lake named after Maharana Fateh Singh of Udaipur and Mewar is situated in the city of Udaipur in the Indian states of Rajasthan. Udaipur lake conservation society's reports indicate that the lake supports and sustains ground water recharge, drinking water, agriculture use, industrial use, ecological water availability and provides employment to 60% population of Udaipur.

From Udaipur division, the selected site for the present study is the water of Fateh Sagar Lake (6km from Udaipur city railway station) and (5km from Udaipur city palace).

2. Materials and Methods

In this study, the water quality standards of different Physio-chemical parameters such as pH, Temperature, Conductivity, Turbidity, Fecal Coliform, Total dissolved solids, BOD, COD, TA, TH, Calcium, Potassium, Sodium, Magnesium, Nitrate, Sulphate, Phosphate, Chloride, Fluoride, and Boron dissolved and their statistical interpretation for domestic and agriculture purpose were evaluated for water of Fateh Sagar Lake of Udaipur division.

Various sample readings were considered for Fateh Sagar Lake of Udaipur division collected near Fateh Sagar Lake District Udaipur and readings were analyzed throughout the year.

For various physio-chemical parameters using standard methods recommended by American Public Health Association. [1] There are various methods to determine different physical and chemical parameters.

National Water Monitoring Programme (NWMP) of Rajasthan State Pollution Control Board, Jaipur produces environmental report of different physio-chemical parameters for different stations of Rajasthan State.

In this study, single sample reading is considered for the year 2019 for Fateh Sagar Lake of Udaipur division with station Code-1481. In some cases, there was increase or decrease shown in readings which was due to change in weather.

Table 1: Physio-chemical analysis of water of Fateh Sagar Lake of Udaipur division for year (2019)

Physio-chemical parameters	2019
pH	7.62
Tempt.	22^0C
Turbidity	0.3 NTU
TDS	650 mg/l
EC	1020 µmho/cm
T A	225 mg/l
T H	201 mg/l
BOD	33.9 ppm
COD	29.2 mg/l
FC	4 (MPN/100ML)
Ca^{2+}	72.8 mg/l
Mg^{2+}	12.28 mg/l
Na^{+}	75 mg/l
K^{+}	4.9 µg/l
Cl^{-}	116 ppm
SO_4^{2-}	156 mg/l
NO_3^{-}	1.2 mg/l
PO_4^{3-}	0.15mg/l
F^{-}	1.1 mg/l
Boron	0.29 mg/l

Note: All ionic concentration are expressed in mg/lit. except EC(µmho/cm), Tempt. (^{0}C) Turbidity (NTU) and Fecal Coliform (MPN/100 ml)

3. Result and Discussion

3.1 Water Quality Parameters

Different physio-chemical parameters were reported in Table-1. A single sample was taken for 2019 year and was analyzed for following parameters: pH, temperature, turbidity, TDS, EC, TA, TH, BOD, COD, Fecal Coliform, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, $SO4^{2-}$, $NO3^{-}$, $PO4^{3-}$, F^{-} and boron dissolved. Following water quality parameters were studied in the water and compared with standard permissible limits.

3.1.1 pH - An important parameter which represents acidic and alkaline nature of water. It is vital for varied biochemical reactions. [23][26]. Permissible limit for pH in water is 6.5 – 8.5. [1] Less pH causes tuberculation and corrosion while higher pH causes Incrustation and sediment deposit. [14]

3.1.2 Temperature- A vital parameter which not only influence chemistry of water but also governs biological activity and growth of living organisms. It also influences the different kinds of organisms that can live in water bodies.

3.1.3 Turbidity-Turbidity represents cloudiness of the liquid which is formed by the accumulating individual particles which are not visible by the naked eyes like smoke in air. Permissible limit for turbidity is 5-10 NTU

3.1.4 Total Dissolved Solids (TDS)- TDS measures the total amounts of charged ions including minerals, salts or metals dissolved in a given volume of water. It is expressed in mg/lit. TDS originates from natural sources, sewage, urban runoff, chemicals used in water treatment processes, industrial waste water and nature of hardware used in water transport. [28] Permissible limit is 1500mg/lit. [4]

3.1.5 Electrical conductance-The measure of water's capacity to pass electric flow. [27] Electrical conductance is represented in ionized form of dissolved salts and other inorganic chemicals present in the water. This concentration of ionized form contributes to conductance. Permissible limit is 200-1000 µmho/cm.

3.1.6 Total Alkalinity- The measure of the buffering capacity of water or the capacity of bases to neutralize acids. It basically regulates pH of a water body and also maintains the metal content. It refers to the ability of water to resist change in pH. The general level of fresh water for alkalinity level is 20-200 mg/lit.

3.1.7 Total Hardness-An important parameter which is a measure of polyvalent cations in water. Polyvalent cations mainly include concentration of calcium and magnesium including other cations like aluminium, barium, manganese and iron etc also contribute to it. 300 mg/lit is permissible limit of total hardness of water by ICMR. The higher content of the hardness is due to the industrial and chemical affluent with excessive use of lime. [18]

3.1.8 Biochemical Oxygen Demand (BOD)-BOD measures the oxygen utilized for the biochemical degradation of organic material(carbonaceous demand) and oxidation of inorganic material such as sulphides and ferrous ions during a specified incubation period. Permissible limit for BOD is 3-5 ppm which represents moderately clean level.

3.1.9 Chemical Oxygen Demand (COD) -The measure of the capacity of water to consume oxygen during the process of decomposition of organic matter and oxidation of inorganic compounds like Ammonia, nitrite. It also means mass of oxygen consumed in Volume of the solution. It is expressed in mg/lit. Ideally COD should be zero.

3.1.10 Fecal Coliform-A group of total Coliform that are found in the gut and faeces of animals. Fecal Coliform bacteria may occur in ambient water as a significance of overflow of domestic sewage. At the same time it may cause some waterborne diseases such as typhoid fever, viral and bacterial gastroenteritis. The acceptable level of coliform should be non-detectable in 100 ml.

3.1.11 Calcium- Most abundant natural element present in all natural water sources. The main source is erosion of rocks such as limestone and minerals like calcite. Permissible limit for Calcium is 75-200 mg/lit. Excess amount of calcium concentration causes the less absorption of essential minerals in the human body.

3.1.12 Magnesium- Its higher concentration renders undesirable tastes in water. The main source of magnesium in water is by erosion of rocks and minerals like dolomite or magnetite. Permissible limit of Magnesium is 30-150 mg/lit.

3.1.13 Sodium- Permissible limit for sodium in drinking water must be in range of 30 to 60 mg/lit. Hypertension, Kidney and Heart related diseases are caused by higher concentration of sodium.

3.1.14 Potassium– The lower concentration of potassium is beneficial for humans as well as plants. Hypertension, diabetes, adrenal insufficiency, kidney and heart related diseases are caused by higher concentration of potassium.

3.1.15 Chloride- Chlorides are present in almost all natural water resources. As we all know, the concentration of chloride content varied widely and it is maximum in ocean water. Maximum permissible limit of Chloride ion by WHO 1991 is 200 ppm and maximum allowable limit is 600 ppm.[26] It is considered as essential water quality parameter by affecting its usability and aesthetic property with taste and make it unfit for drinking purpose. Main source of Chloride concentration are formation of rocks and soil with sewage wastes.

3.1.16 Sulphate –Sulphate is present in almost all drinking natural water sources[27]. The sources for sulphate concentration are rocks and geological formation. The excess amount of sulphate content causes laxative effect. Permissible limit for sulphate is 200-400 mg/lit.

3.1.17 Nitrate–Maximum permissible limit of nitrate is 50 mg/lit [4]. The higher concentration of nitrate causes blue-baby disease or Methemoglobinemia.

3.1.18 Phosphate- Permissible range for phosphate is 0.005 to 0.05 mg/lit. Main source of phosphate are sewage and industrial waste disposal in fresh water. Basically it promotes growth of micro-organism. [8]

3.1.19 Fluoride- The controlled addition of fluoride in water supplies to maintain public health is known as water fluoridation. So fluoridated water is used to prevent cavities by maintaining concentration of fluoride in water. Required level is 1.0-1.5mg/lit. Excess concentration causes fluorosis and deformation in joints.

3.1.20 Boron Dissolved- Permissible concentration of boron in surface water is 1-5 mg/lit for a day. It is an essential nutrient present in plants.

3.2 Water quality criteria for irrigation

The suitability of water for agricultural use is determined by its quality for irrigation purpose. The quality of water for irrigation purpose is determined by the concentration and composition of dissolved constituents in water. Quality of water is an important aspect in any appraisal of salinity or alkalinity conditions in an irrigated area. Good soil and water management practices result in good quality of water which can promote maximum yield of crop.

Total dissolved Solids and the sodium content in relation to the amounts of calcium and magnesium or SAR [2] determines the suitability of water for irrigation. The suitability of groundwater for irrigation use was evaluated in the form of salinity by different statistical calculations such as (Sodium absorption ratio (SAR), soluble sodium percentage (SSP) and Chloro alkaline indices (CAI).

Statistical Representation of Water Parameters

3.2.1 Sodium Absorption Ratio (SAR): SAR is an vital parameter given by Richard in 1954 [19]. The basic concept behind the sodium absorption is to find out the soil alkalinity of water used for irrigation purposes.[12]

SAR (Sodium Absorption Ratio) = $\frac{Na}{\sqrt{Ca+Mg/2}}$

Note: Ca^{2+}, Mg^{2+} and Na^{+} are expressed in mg/l.

3.2.2 Chloro alkaline indices (CAI): Chloro alkaline indices is used to calculate the base exchange proposed by Schoeller [20]. Chloro alkaline indices are used to calculate ion exchange between the water and its surrounded area.

It is measured by following equation CAI = $[Cl^{-} - (Na^{+} + K^{+})/Cl^{-}$

Note: all ionic concentrations are measured in mg/l.

- CAI >0 : No Base Exchange reaction i.e. there is any existence of anion cation exchange type of reactions.
- CAI <0 : Exchange between sodium and potassium in water with calcium and magnesium in the rocks by a type of Base Exchange Reactions [17]

3.2.3 Percentage Sodium (%Na): A method used for rating the irrigation waters which is utilized on the basis of percentage and electrical conductivity given by Wilcox.

It is calculated by the formula:- %Na = $\frac{(Na+K)}{Na+K+Mg+Ca} \times 100$

Note: All ionic concentration are expressed in mg/l.

3.2.4 Kelly's ratio (KR): Kelly ratio represents the assessment ratio for calculating the suitability of water for agriculture purpose. The suitability and unsuitability of water for agricultural purpose on basis of KR is due to alkali hazards. [9]

Kelly's ratio was calculated by using the following expression

Kelly Ratio (KR) = $\frac{Na}{Ca+Mg}$

KR ≤1: Suitable for Irrigation and represent good quality
KR>1: Unsuitable for irrigation purpose
Note: All ionic concentration are expressed in mg/l.

3.3.5 Calculation of Indices: Langelier Saturation Index (LSI)

LSI is an equilibrium index which represents thermodynamic driving force for calcium carbonate scale formation and growth given by Langelier. It is explained with the use of pH. [13]

- LSI <0: No potential scale and water will dissolve $CaCO_3$.
- LSI >0: Scale can form and CaCO3 precipitation may occur.
- LSI =0: Border line scale potential.

To calculate LSI, value of total alkalinity (as $CaCO_3$), Calcium hardness as $CaCO_3$), total dissolved solids (TDS) and value of pH and temperature of water (°C) required.
Note: All ionic concentration are expressed in mg/l.

LSI = pH – pHs
pHs is defined as the pH at saturation in calcite or calcium carbonate.
It is calculated by following formula
pHs = (9.3 + P + Q) – (R + S)
Where P = ($\log_{10}$ [TDS] –1)/10
Q = –13.12 × $\log_{10}$ (°C + 273) + 34.55
R = $\log_{10}$ [Ca Hardness as $CaCO_3$] –0.4
S = $\log_{10}$ [Total alkalinity as CaCO3]
We can calculate LSI by help of these equations.

LSI is helpful in predicting the scaling or corrosive tendencies of the water.

- If water dissolves calcium carbonate, water is corrosive and has a negative value.
- If the water deposits calcium carbonate; it has a scaling tendency and a positive value.

Table 3: Statistical Analysis of Water Sample Readings

Statistical Parameters	2019
SAR	11.49
CAI	48.43
% Na	0.311
KR	0.88
LSI	-0.454

Note: All ionic concentrations are expressed in mg/lit.

Table 4: Classification on the basis of Statistical Analysis

Statistical Analysis Parameters	Categories	Range
Sodium Absorption Ratio (SAR)	Excellent	0-10
	Good	10-18
	Fair	18-26
	Poor	>26
Chloro Alkaline Indices (CAI)	Base Exchange Reaction	Negative value
	Cation Exchange Reaction	Positive value
Sodium Percentage (%Na)	Excellent	0-20
	Good	20-40
	Permissible	40-60
	Doubtful	60-80
	unsuitable	>80
Kelly Ratio(KR)	Suitable	<1
	Marginal suitable	1-2
	Unsuitable	>2

Table 5: Interpretation of Langelier Saturated Index (LSI) Test result

Serial No.	LSI index	Appearance	Water conditions issues required
1	-4.0	Very severe corrosive	Conditioning required
2	-3.0	Severe corrosive	Conditioning usually suggested
3	-2.0	Moderate corrosive	Some conditioning is suggested
4	-1.0	Mild corrosive	Required some conditioning
5	-0.50	Slight corrosive	May need some conditioning
6	0.00	Balanced	Conditioning not suggested
7	0.50	Faint scale coating	Conditioning not suggested
8	1.0	Slight scale coating	Some visual appearance shown
9	2.0	Mild scale coating	Should consider some Conditioning
10	3.0	Moderate scale coating	Should use some Conditioning
11	4.0	Severe scale coating	Usually Conditioning required

4. Conclusion

On the basis of the above observations during this study, following conclusions are drawn:

- All parameter readings fall in the permissible range, except few which exceeds the limit due to anthropogenic activities.
- Talking about the Statistical analysis most of the samples are alkaline in nature and are present in the good range and may need some conditioning also.
- The concentrations of cations and anions are within the allowable limits for drinking water standards except a few samples.
- The suitability of water for irrigation is evaluated based on SAR, CAI, % Na, KR and salinity hazards. Most of the samples fall in the suitable range for irrigation purpose based on SAR, CAI, % Na and KR values, but very few samples that are exceeding the permissible limits. These variations are observed to be in different kind of geological areas and different anthropogenic activities were carried in the study area.
- This study will be helpful in sustainable development of water sources in the district Udaipur, Rajasthan.

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References

[1] APHA (1989), Standard methods for the examination of water and waste water, 17th Ed.American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington D.C.
[2] Algae SA (2006) Preliminary evaluation of hydrochemistry of the Kalambain Formation, Sokoto Basin, Nigeria. Environ Geol 51:39–45.
[3] Doneen L.D. (1964), Notes on water quality in agriculture Published as a water science and engineering paper 4001, Department of water Science and engineering, University of California.
[4] Indian Council of Medical Research (ICMR), New Delhi, India
[5] Indian standard specification for drinking water. IS:10500, Ind. Standard Institute, India, ISI, 1983.
[6] Indian standards specification for drinking water specification. Bureau of Ind. Standard, New Delhi (BIS 10500), 2012
[7] Jain C K, Bhatia K K and Kumar S R. (2005), Int J Environ Protect, 23(3), 321-329.
[8] Jothivenkatachalam K, Nithya A and Chandra Mohan S. (2010), Rasayan J Chem, 3(4), 649-654.
[9] Karanth KR (1987) Ground water assessment, development and management. Tata McGraw Hill Publishing Company Ltd., New Delhi, p 720

[10] Katachalam K, Nithya A and Chandra Mohan S. (2010), Rasayan J Chem, 3(4), 649-654.
[11] Kemmer (1979), Ed, The NALCO water hand book, Mc Graw-Hill, New York, 4-13.
[12] Kumaresan M. and Riyazuddin P. (2006), Major ion chemistry of environmental samples around sub-urban of Chennai City, Current Science, 91(12), PP 1668-1677.
[13] Langelier W.F. (1936), J AWWA, 28,1500-1521.
[14] Prasad B. Guru (2003), Evaluation of water quality in Tadepalli Mandal of Guntur.
[15] Distt. A.P., Nature, Environ. and Poll. Techn., 2(3) 273-276.
[16] Rajawat A K and Kumar P, (2017), 'Physico-chemical Aspects of Yamuna River at Gokul Barrage, Mathura (UP) India'. Flora and Fauna: 23(2); 359-362
[17] Raju N. Janardhana (2007), Hydrogeo chemical parameters for assessment of ground water quality in the upper Gunjanaeru River basin, Cuddapah, District, Andhra Pradesh, South India, Environmental Geology, 52 PP 1067-1074.
[18] Ravikumar P, Somashekhar R K and Angami M. (2011), Environ Monito Assess; 173(1-4), 459-487; DOI 10.1007 /S-10661-010-1399-2
[19] Richard L.A. (1954), Diagnosis and improvement of Saline and Alkali soils, Agric. handbook 60, USDA, Washington D.C., PP 160.
[20] Schoeller H. (1967), Geochemistry of ground water. An international guide for research and practice, UNESCO, 15, pp 1-18.
[21] Shyam R and Kalwania, G.S. (2011), Health risk assessment of fluoride with other parameters in ground water of Sikar city (India), Environ. Earth Science, OI 10.1007/S12665-011-1375-3.
[22] Sravanthi K and Sudarshan V. (1998), Environ Geochem. 1(2), 81-88. |
[23] Sreenivason A. (1967), F.A.O., Fish Rep., 44(3), 101.
[24] Subramani T, Elango L and Damodarasamy SR. (2005), Environ Geol., 47(8), 1099-1110; DOI 1007/500254-005-1243-0.
[25] Wilcox L.V. (1955), Classification and use of irrigation water, Agric Circ. 969, USDA, Washington D.C., PP 19.
[26] WHO, International Standards for Drinking Water, world health Organisation, Geneva, 1971.
[27] www.cwejounal.org
[28] www.water-research.net