Ionic Content of Saroornagar Lake using Maucha Diagrams

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Abstract : In the present investigation, ionic content of Saroornagar lake was studied during the year 2011-2012. The ions were Carbonates, Bicarbonates, Chlorides, Calcium, Magnesium, Potassium and Sodium. Carbonates were absent throughout the study period. This may be due to the combined effect of temperature, pH and Carbonates. The Bicarbonates concentration was high throughout the study. The anion Chloride showed high values, then Sodium, Magnesium and Calcium. This may be due to the leaching of minerals from rocks and saline deposits. Seepage of sewage and industrial wastes increased the Chloride contents. It was 32 times more than the Fresh waters (Bowen, 1966) and 15 times more than Swedish Hard Waters (Rodhe, 1949). High concentration of Magnesium 31.7 mg/l was observed in summer and high concentration of calcium 68.96 mg/l was recorded in monsoon season. In the summer season, the anions HCO3- > Cl- while cations were Na+ > Ca2+ > Mg2+> K+. In monsoon and winter season, anions were HCO3- > Cl- while cations were Na+ > Ca2+ > K+> Mg2+. Only in summer season Mg2+ > K+ in Saroornagar lake. This may be due to high rate evaporation which takes place in lake water. Similar trend was observed in Mir Alam lake by Hemalatha and Johnson (2016).

IndexTerms **- Ionic content, Carbonates, Bicarbonates, Chlorides, Calcium, Magnesium, Potassium, Sodium and Maucha Diagrams.**

I. Introduction

Water is called the "mirror of life". All life depends on water for its growth and survival. Zafar 1964, Rao 1970 and Cynthia 1980 were the pioneers who studied the ionic content of South Indian lakes especially those located in the Telangana region. Maucha diagram is a powerful tool for analyzing total ionic concentration in the given water sample. It is the graphical representation of major cations and anions in water sample. R. Maucha (1932) gave diagram to represent the anions and cations in water samples. Broch & Yake (1969) modified Maucha ionic diagram. Method for drawing the Maucha diagram in R is available on GitHub. The ionic composition of surface water is typically dominated by four major anions like Carbonates, Bicarbonates, Chlorides and Sulphates which are shown on the left side of the Maucha diagram and four major cations like Calcium, Potassium, Sodium and Magnesium are on the right side of the diagram. The concentration and composition of these ions within surface waters can vary considerably as a function of catchment geology, the chemistry of precipitation and the extent of evaporative concentration.

Johnson (2004) worked on the ionic composition of two fresh water lakes. Rodhe (1949) worked on ionic compostion of lake waters. Devi and Johnson (2016) worked on the ionic composition f Ibrahimpatnam Lake. Johnson (2004) studied the chlorides in Banjara and Nadimi lakes. Hemalatha and Johnson worked on Total Hardness, Calcium and Magnesium in Mir Alam Lake. Harini and Johnson (2016) studied the chloride concentration on Durgam Cheruvu. Although much work has been done in the ionic composition of lakes, yet their representation using Maucha diagrams was limited. Hence, in this investigation, the ionic content of Saroornagar lake is represented using Maucha Diagram.

II. Materials and Methods

Surface Water samples were collected at monthly intervals during the year 2011-2012 and analyzed for the various physico-chemical parameters according to APHA (1995) and the specific titrimetric procedures as follows:

- Carbonates, Bicarbonates, Chlorides – Wilcox and Hatcher (1950).
- Potassium, Sodium, Calcium, Magnesium – Trivedy et.al. (1987)

III. Results and Discussions

Carbonates:

Carbonates are salts of Carbonic acid (H2CO3) and are characterized by the presence of the carbonate ion (CO32-). Carbonates constitute an important fraction of many lake sediments. Carbonate deposition in lakes varies depending on internal dynamics, which are ultimately controlled by climate factors (Amy Myrbo, 2001).

In the present study, carbonates are absent throughout the study period. It may be due to the effect of temperature, pH, bicarbonates, total alkalinity present in the lake water and the distribution of type of rocks present in the lakes can also have great impact on presence of carbonates in the sample.

Table 1: Showing the range and average of ions in Saroornagar Lake in mg/l

Parameters	Range	Average
Potassium mg/l	10 – 30	23.17
Sodium mg/l	23 - 200	125
Calcium mg/l	35.27 – 111.42	65.07
Magnesium mg/l	3.07 – 53.86	22.44
Carbonates mg/l	Absent	Absent
Bicarbonates mg/l	115.33 – 658.99	554.95
Chlorides mg/l	202.1 – 308.47	250.86

Bicarbonates:

Bicarbonate is an anion which plays a crucial role in pH buffering system. Bicarbonate is the dominant form of dissolved inorganic carbon and is an important thing in carbon cycle. Rocks weathered by the carbonic acid also accumulate bicarbonate ions. Its main source include the partitioning of CO2 from the atmosphere and the weathering of carbonate minerals in rocks and soils (Lone JF, 2017).

In the present study, bicarbonates are predominant which shows that the pH of water is ranged between 7 to 8.5. Bicarbonates were ranged from 115.33 mg/l – 658.99 mg/l and averaged to 554.95 mg/l. The seasonal values were recorded as 608.65 mg/l in summer, 434.6 mg/l in monsoon and 621.62 mg/l in winter. In winter high values were recorded and similar observation was made by Ruth and Johnson (2012).

Table 2: Showing the Seasonal Variations of ions in Saroornagar Lake mg/l

Parameters	Summer	Monsoon	Winter
Potassium mg/l	26.75	25	17.75
Sodium mg/l	177.5	111	86.5
Calcium mg/l	61.92	68.98	64.32
Magnesium mg/l	31.79	22.72	12.8
Carbonates mg/l	Absent	Absent	Absent
Bicarbonates mg/l	608.65	434.6	621.62
Chlorides mg/l	273.46	222.93	256.18

Chlorides:

Chloride is one of the major inorganic anion in waters. The chloride concentration is higher in polluted water sample and is used as important parameter for detection of contamination.

In the present study chlorides are ranged from 202.1 – 308.47 and averaged to 273.46 mg/l, 222.93 mg/l and 256.18 mg/l in summer, monsoon and winter respectively.

There is an increase in chlorides level in summer season and low in rainy season. This was due to evaporation in summer and dilution and seepage in monsoon. The same was given by Rama Devi and Johnson (2016), Bheemappa (2015), Laxminarayana (1965), Venkateswarlu (1969), Jana (1973), Verma et,al. (1978) and Billore (1981).

In the present survey, Chloride ions showed high values than Sodium, Magnesium and Calcium. It is because of leaching from minerals, from rocks and from saline deposits. It is also in atmospheric precipitation and is mainly due to the seepage of industrial and municipal waters. It is 32 times more than the Fresh waters (Bowen, 1966) and 15 times more than Swedish Hard waters (Rodhe, 1949).

Table 3: Major ions in mg/l in Saroornagar Lake with World Fresh Waters, Swedish Hard waters, Banjara, Nadimi and Ibrahimpatnam Lake

Ions	Saroornagar Lake (2019)	Fresh Waters (Bowel, 1966)	Swedish Hard Waters (Rodhe, 1949)	Banjara Lake (Johnson, 2004)	Nadimi Lake (Johnson, 2004)	Ibrahimpatnam Lake (Devi, 2016)
K	23.17	2.3	6.0	Traces	Traces	-
Na	125	6.3	16.6	78.0	77.08	-
Ca	65.07	15.0	59.0	94.32	92.85	-
Mg	22.44	4.1	9.9	257.40	250.84	-
CO3	Absent	55.0	103.2	16.74	35.61	27.3
HCO3	554.95	-	-	-	-	219.4
Cl	250.86	7.8	16.6	50.12	102.15	230.28

Magnesium:
Magnesium is most commonly found cation in water samples, which is responsible for water hardness. It also contributes to undesirable tastes to drinking water. The major source of Magnesium ions is due to chemical weathering of rocks.

In this paper, magnesium is ranged between 3.07 mg/l – 53.86 mg/l and averaged to 22.44 mg/l. Seasonal concentrations were recorded as 31.79 mg/l in summer, 22.72 mg/l in monsoon and 12.8 mg/l in winter. High concentration of Magnesium is seen in summer and the same reported by Hemalatha and Johnson (2016). Moreover, Magnesium ions occur in lower concentrations than Calcium ions.

Calcium:
Calcium is one of the major inorganic cation in lake water where the CO2 availability is low. It originates from the dissociation of salts in water. The abundance of these materials is depended on the rock type and their solubility. A level of 50 mg/l of Calcium is recommended and high values are not considered as health concern according to Rachna Bhateria and Disha Jain (2016).

In the present survey, calcium is ranged from 35.27 mg/l – 111.42 mg/l and averaged to 65.07 mg/l. Seasonal recordings were 61.92 mg/l, 68.98 mg/l and 64.32 mg/l in summer, monsoon and winter respectively. High concentrations were recorded in monsoon season which was also observed by Harini and Johnson (2016).

Table 4: Relative proportions of Ions in Saroornagar Lake

Season	Relative proportions
Summer	HCO3>Cl>Na>Ca>Mg>K
Monsoon	HCO3>Cl>Na>Ca>K>Mg
Winter	HCO3>Cl>Na>Ca>K>Mg

Sodium:
It is measured with the help of flame photometer. Sodium is always present in natural waters. Sodium in surface waters may arise from sewage and industrial effluents which directly released into lake water (Worako, 2015).

In the present study, sodium values were ranged from 23 mg/l – 200 mg/l and averaged as 125 mg/l. Seasonal concentrations were observed as 177.5 mg/l in summer, 111 mg/l in monsoon and 86.5 mg/l in winter.

Higher concentrations of sodium were recorded in summer. The same was stated by Bheemappa et.al, (2015). Evaporation of water is a significant factor in increasing the sodium level during summer season. According to Solanki (2001), the highest volume of sodium during summer is due to shrinkage of water volume. Anthropogenic activities like, water treatment chemicals, domestic water softeners, sewage effluents and even agriculture seepage also contribute to the raise in sodium levels in lake waters.

In the present survey, Sodium ions occur third in concentration and it is 19.8 times more than Fresh waters by Bowen, 1966 and 7.5 times more than Swedish Hard waters by Rodhe, 1949.

Potassium:
Potassium is important constituent of many artificial fertilizers. It occurs widely in environment. Potassium is commonly found in all natural waters and is usually the least abundant cation than sodium.

In the present study, potassium is ranged between 10 mg/l – 30 mg/l and averaged as 23.17 mg/l and the seasonal concentrations were recorded as 26.75 mg/l in summer, 25 mg/l in monsoon and 17.75 mg/l in winter.
Potassium ions occur in lower concentrations in surface waters as it has weak migratory ability. This is due to its active participation in biological processes. Even though it occurs in low concentrations in the present study, it showed 10 times more than Fresh waters given by Bowen, 1966.

Table 5: Table showing Seasonal Variations of Anions and Cations.

Summer	Anions	HCO3- > Cl-
	Cations	Na+ > Ca2+ > Mg2+> K+
Monsoon	Anions	HCO3- > Cl-
	Cations	Na+ > Ca2+ > K+> Mg2+
Winter	Anions	HCO3- > Cl-
	Cations	Na+ > Ca2+ > K+> Mg2+

In the summer season, as shown in fig. 2, the anions HCO3- > Cl- while cations were Na+ > Ca2+ > Mg2+> K+. In monsoon fig. 3 and winter season fig. 4, anions were HCO3- > Cl- while cations were Na+ > Ca2+ > K+> Mg2+. Only during summer season, Mg2+ > K+ in Saroornagar lake. This may be due to high rate evaporation which takes place in lake water. Similar trend was observed in Mir Alam lake by Hemalatha and Johnson (2016).

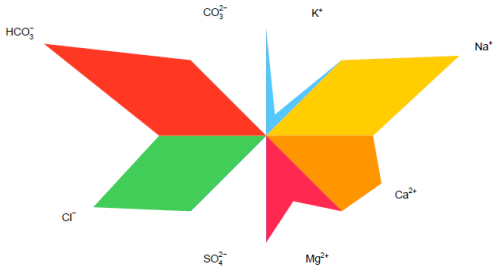

Fig. 1 One Year data

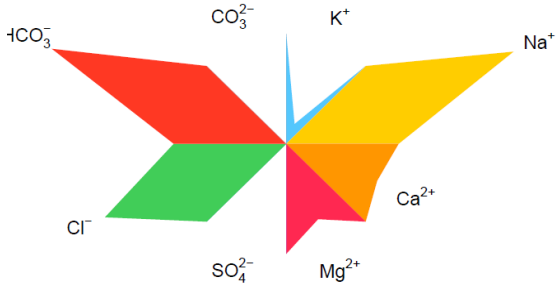

Fig. 2 Summer

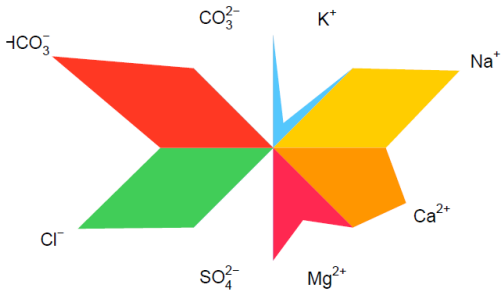

Fig. 3 Monsoon

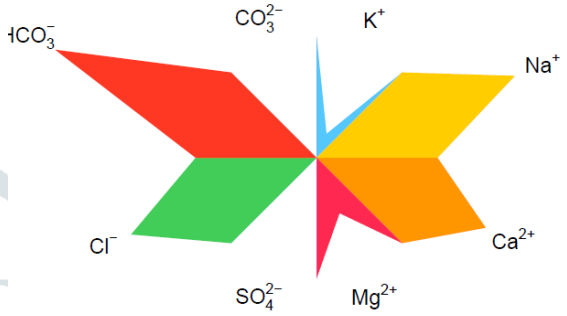

Fig. 4 Winter

IV. Conclusions:

In the present study, the concentrations of total ions ranged as:
HCO3- > Cl- > Na+ > Ca2+ > K+ > Mg2+.

Maucha Diagram illustrates relative proportions of ions and gives the total ionic concentrations of the water samples. In the study it clearly shows the high concentrations of Bicarbonate ions. The anion Chloride was 32 times more and the cation Sodium is 19.8 times more than Fresh waters given by Bowen, 1966 and Chloride is 15 times more and Sodium is 7.5 times more than Swedish Hard waters given by Rodhe, 1949. Potassium showed 10 times more when compared to Fresh waters given by Bowen, 1966.

Humans have profound influences on Lake Chemistry. High rates of leaching and erosion, run off of fertilizers, waste water and sewage input causes higher rise in the ion concentration in lake waters.

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