RESEARCH ARTICLE

HYDRO-CHEMICAL ANALYSIS AND EVALUATION OF LAKE WATER QUALITY IN AND AROUND MALURPATTANA USING GIS TECHNIQUES, CHANNAPATTANA TALUK, RAMANAGARA DISTRICT, KARNATAKA, INDIA.

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Manuscript Info	*Abstract*
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Lakes play an important role in urban ecosystem and also serve as an important part of ecological balance. Lakes serve as a source of water for irrigation, drinking and domestic purpose for urban and rural population. The selected area for water quality assessment is the area in and around Malurpatna Lake. As this is a drought area there is no natural source of water for these lakes, lakes get their water from nearby Iglur dam. In the study area SAR is observed in excellent group, Percentage of sodium observed 5 samples are in good category and 15 samples in permissible category, for P.I values 14 samples were marginally safe and about 6 samples were not suitable for domestic purposes. The RSC values 17 of them came under safe category with, 1 sample was marginally safe, and 2 samples namely Averahalli and Honganuru Lake were not suitable for domestic purposes.

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Introduction:-

The environmental conditions of any lake system depend upon the nature of that lake and its exposure to various environmental factors. Hence, surface water quality depends not only on natural processes (precipitation inputs, erosion, and weathering of crustal material, etc.) but also on anthropogenic influences (urban, industrial, and agricultural activities) (Papatheodorou et al. 2006). Zaporozee (1972) has summarized the various modes of data representation and has discussed their possible uses. Presentation of chemical analysis in graphical form makes understanding of complex groundwater system simpler and quicker. Methods of representing the chemistry of water like Collin's bar diagram, radiating vectors of Maucha (1940), and parallel and horizontal axes of Stiff(1940), have been used in many parts of the world to show the proportion of ionic concentration in individual samples. Physical and chemical parameters of surface water such as pH, electrical conductivity, total dissolved solids, Na, K, Ca, Mg, Fe, Cl, HCO3, SO4 and F were determined. Various water quality indices like SAR, RSC and hill piper have been calculated for each water sample to identify the irrigational suitability standard.

Location of the study area:-

Malurpatna located in Channapatna, Ramanagara district. Channapatna is located at 12.65°N 77.22°E. It has an average elevation of 739 meters (2424 ft.).The total selected area of the study is 54 sq.km. There are3 sub-watersheds (i.e. Harokoppa, Malurpatna, and Santemagenahalli).

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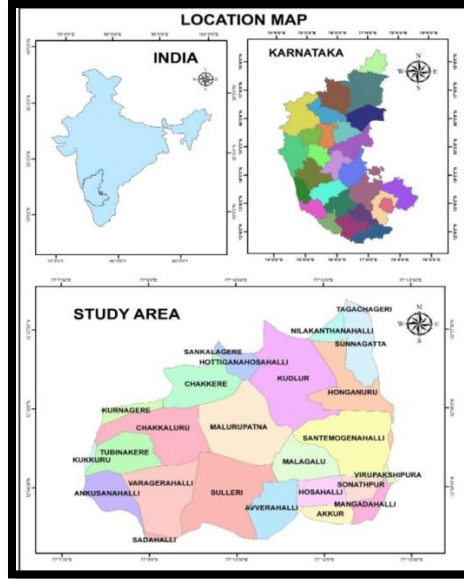
Fig.1:-Location map of study the area.

Methodology:-

The water samples were collected from different lakes of Channapatna Taluk namely (Chakkere, Malurpatna, Chakluru, Sulleri, Sadarahalli, Akkuru, Averahalli, Hosahalli, Santemogenahalli, Honganuru, Borewells in the area, and Kanva river sample) in 1 liter polythene bottles at inlet and outlet. Various physical parameters like Ph, EC, and TDS were determined in the laboratory. Calcium (Ca2+), Magnesium (Mg2+), Chloride(Cl+), Carbonate(CO3-2-), and Bicarbonate(HCO3) volumetric titration methods. Nitrate(NO3) and sulphate (SO4 2-) were estimated by turbidity method. While Sodium(Na+) and Potassium (K+) determined by Flamephotometry. Lake samples were collected from 19 lakes located in different parts of the study area during pre-monsoon (/April May/June 2018). analysis of chemical characters. Chemical analyses were carried out using the standard procedures (APHA-2002). The suitability of the surface water from these two lakes for drinking, domestic, and irrigation purposes was evaluated by comparing the values of different water quality parameters with those of the Bureau of Indian standards (BIS 1998) guideline values for drinking water.

Evaluation of surface water quality for irrigation:-
Chemical analysis of major ions in groundwater, standard analytical chemistry procedures, comprising titrimetry and spectrophotometry, were employed following American Public Health Association guidelines (APHA 1995)

Sodium Adsorption Ratio (SAR):-
If the SAR ratio of the water samples in the study area is less than 10, it is excellent for irrigation purposes. The SAR values for each water sample were calculated using the following equation (Richards 1954). The sodium or alkali hazard in the use of water for irrigation is determined by the absolute and relative concentration of cations and is expressed in terms of sodium adsorption ratio. If the proportion of sodium is high, the alkali hazard is high and conversely if calcium and magnesium is predominant, the hazard is less. In the study area, 20 samples come under the excellent category that is SAR content is less than 10 (fig 1.1).

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

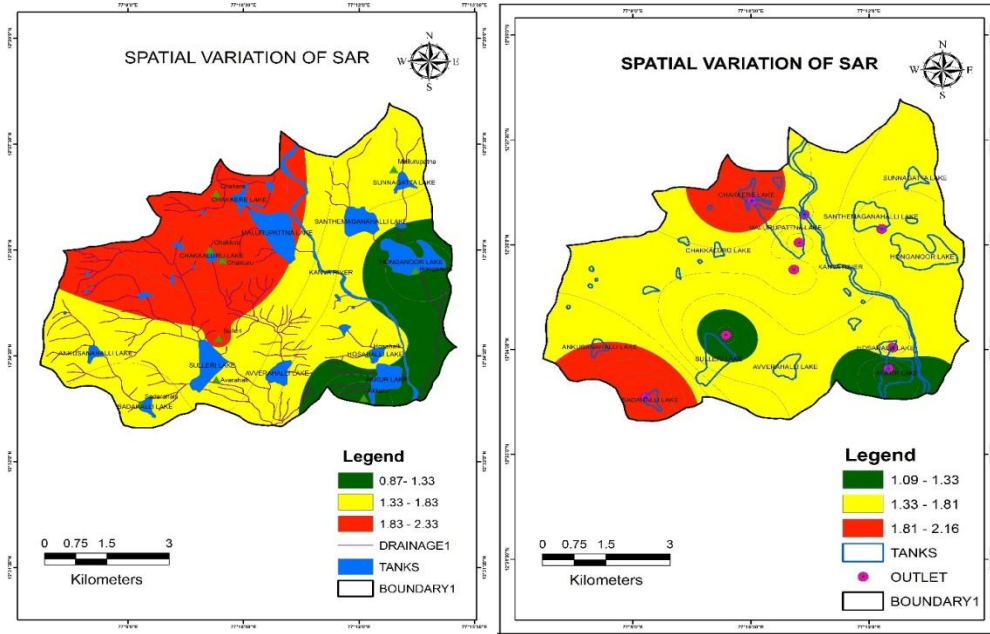| SAR (epm)	Quality	No of samples
<10	Excellent	20
11-18	Good	nil
19-26	Fair	nil
>26	Poor	nil

Fig 1.1:-Spatial variation of SAR Map of Inlet and Outlet.

Percentage Sodium (%Na):-
The percentage of sodium in water is a parameter computed to evaluate the suitability for irrigation. As per the Indian standards a maximum of 60% sodium is permissible for irrigation water. The relative proportion of sodium to other cations in water is usually expressed as percentage of sodium among the principle cations. In the study area 5 samples are of good quality that is it had about 20-40% sodium and 15 samples came under permissible category that is it had sodium content of about 40-60% (fig 1.2).

$$\% \ Na = \left| \frac{Na+k}{Ca+Mg+Na+k} \right| \times 100$$

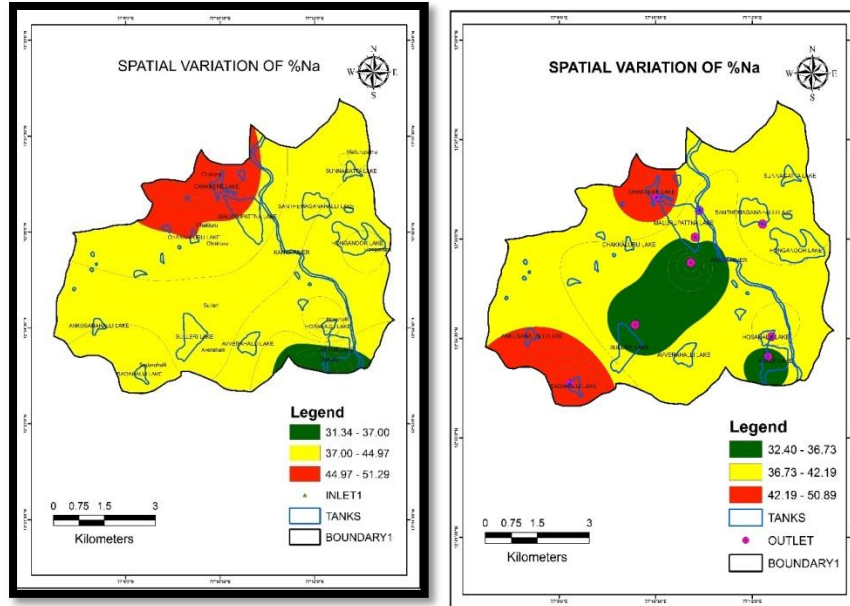| % Na	Quality	No of samples
<20	Excellent	nil
20-40	Good	5
40-60	Permissible	15
60-80	Doubtful	nil
>80	Unsuitable	nil

Fig 1.2:-Spatial variation of %Na Map of Inlet and Outlet.

Residual Sodium Carbonate (RSC):-
The total concentration of soluble salts (salinity hazard) in irrigation water can be expressed in terms of specific conductance. Thematic maps of Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) were created for both Pre-monsoon and Post-monsoon seasons using Arc GIS 10.3 software. Bicarbonate concentration in water affects the suitability of water for irrigation purpose. If the water has high concentration of bicarbonate ion, there is a tendency for Ca and Mg ions to precipitate as carbonates. As a result, relative proportion of sodium increases and gets fixed in the soil. As the increase in proportion of sodium gets fixed in the soil, decreasing the permeability. In the study area out of 20 samples 17 of them came under safe category with RSC values less than 1.25 epm , 1 sample was marginally safe, and 2 samples were not suitable for domestic purposes with RSC values greater than 2.5 epm (fig 1.3).

RSC index = $[HCO_3 + CO_3] - [Ca + Mg]$

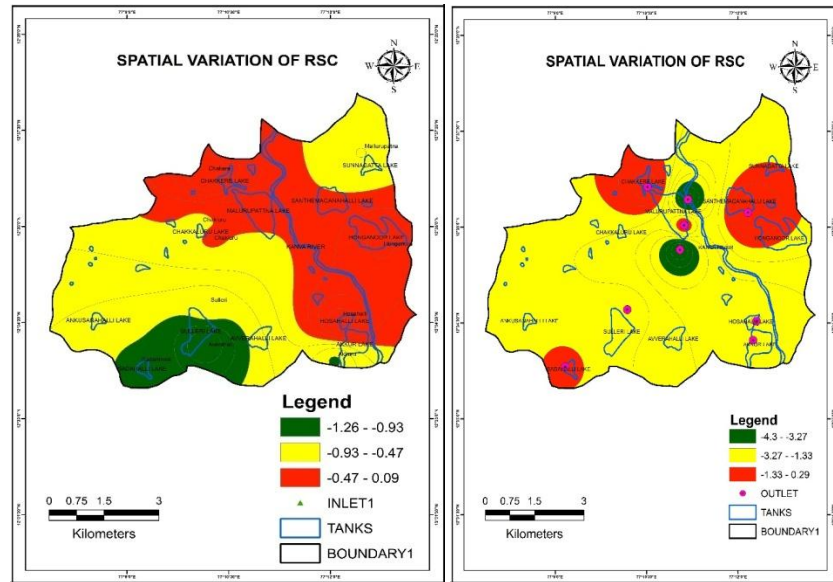| Range of RSC (epm)	Quality	No of samples
<1.25	safe	17
1.25-2.50	marginal	1
>2.50	Not suitable	2

Fig 1.3:-Spatial variation of RSC Map of Inlet and Outlet.

Hill Piper Trilinear diagram:-
The Piper-Hill diagram (1953) is used to infer hydro-geochemical facies. These plots include two triangles, one for plotting cations and the other for plotting anions (figure 1.4). The cations and anion fields are combined to show a single point in a diamond-shaped field, from which inference is drawn on the basis of hydro-geochemical facies concept. These tri-linear diagrams are useful in bringing out chemical relationships among groundwater samples in more definite terms rather than with other possible plotting methods.

The Hill Piper diagram is used to infer hydro geochemical facies. A trilinear diagram was created to classify the water from different parts the study area and to reveal any groupings, similarities or trends of the samples. The HCO_3, Cl, SO_4, anion triangle shows groundwater samples have plotted bicarbonates and chloride type end members, and sulphate is not present in any significant proportion. The Ca and Mg-Na cations triangle shows that the major cations present in the sample are Na and Mg.

With the above procedure, the location of each corresponding sample of the study area was made on the central diamond shaped field. Samples falling in different sub-divisions of diamond shaped field indicate the type of water. Class-A: Ca + Mg + CO_3 + HCO_3, Class-B: Na + K + CO_3 + HCO_3, Class-C: Ca + Mg + Cl + SO_4, Class-D: Na + K + Cl + SO_4.
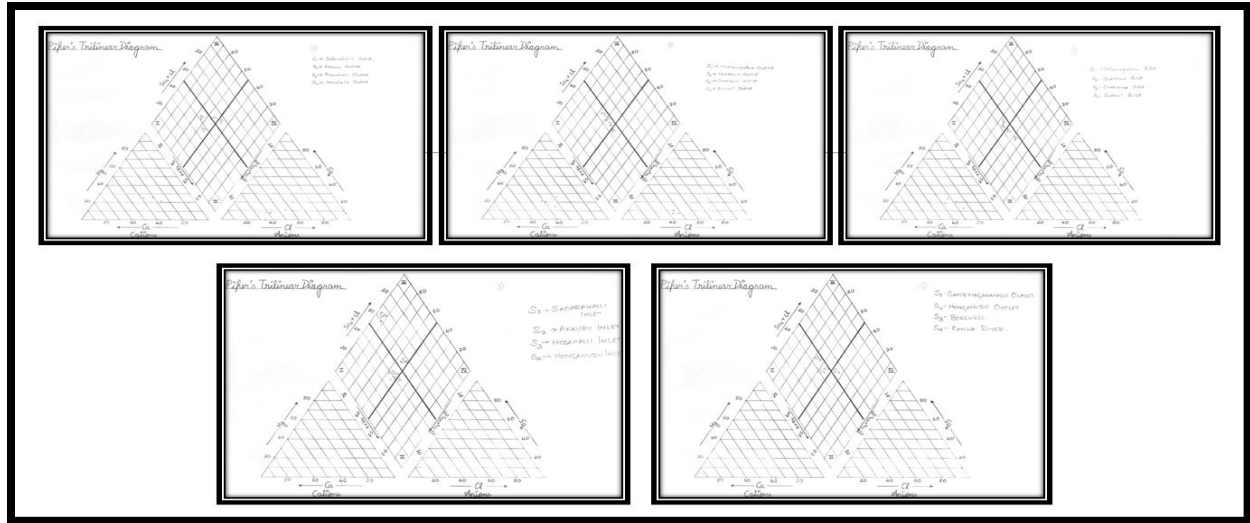
Fig 1.4:-Hill piper Diagram of Inlet and Outlet.

Table 1:-Water quality analysis of Inlet and Outlet of lake and river water samples.

	MPT Inlet	MPT Outlet	chakere Inlet	Chakere Outl	Chakluru Inle	Chakluru O	Sulleri Inle	Sulleri Out	Sadarahall	Sadarahall
Ca	32.543828	39.037017	26.1199418	34.1435954	32.4013341	28.59653	36.97644	41.05256	30.17048	25.99037
Mg	24.135813	21.445586	12.914456	15.0058514	20.3892822	26.00688	19.34803	22.1428	28.27391	22.02924
Na	40.410571	36.932071	43.0244998	47.6846596	42.9954956	41.97862	40.59529	31.02071	39.75721	46.66877
K	2.9097886	2.5854471	17.9411023	3.16589364	4.21388804	3.417973	3.080245	5.783923	1.79839	5.311623
CO3	0	0	0	0	0	0	0	0	0	0
HCO3	53.537519	51.030329	50.0996138	52.411342	49.0880996	50.13553	48.47142	47.58914	41.81498	39.00404
Cl	36.861248	42.452737	40.466854	39.8549814	40.8285626	40.24967	43.04415	44.61412	49.52075	49.15989
SO4	9.6012332	6.5170418	9.433534	7.73368227	10.0833434	9.614806	8.484439	7.79674	8.664282	11.83606
	Akkuru Inlet	Akkuru Outle	Averahalli Ou	Hosahalli Inle	Hosahalli O	Santemaga	Honganuru	Honganuru	Borewell	Kanva Rive
Ca	60.330621	38.4445632	30.422582	34.8845203	34.88452	39.7297	37.00495	36.51922	39.61885	37.42681
Mg	32.459481	25.3441413	25.5743476	19.7119012	19.7119	19.64351	21.95558	14.44493	27.98386	21.66077
Na	0.0175731	33.7735945	37.9510205	42.4330512	42.43305	38.25861	37.51026	42.94076	30.59798	37.93788
K	7.1923255	2.29158766	6.05205286	2.97054584	2.970546	2.368192	3.529241	6.095103	1.799302	2.974562
CO3	0	0	0	0	0	0	0	0	0	0
HCO3	28.907054	54.5529976	45.9272313	58.6897445	58.68974	54.01407	53.30763	47.36012	51.59327	48.82917
Cl	21.848472	37.8799316	44.3184416	34.0571009	34.0571	36.03937	41.17306	48.41692	39.6246	41.80386
SO4	49.244475	7.5670887	9.7543271	7.25315918	7.253159	9.946571	5.51932	4.222947	8.782126	9.366982

Result:-

Physico-Chemical Analysis of 19 samples was conducted in the study area for inlet and outlet of lakes.SAR values of all samples obtained are in good condition. RSC values of collected samples are in good condition and it is suitable for agricultural and drinking purpose. Using Hill Piper method, 13 samples collected from study area are observed in Ca, Mg, CO3, HCO3 class In the study area the fluoride range is less than 1 ppm. Hence it is suitable for drinking purpose. According to the SAR graph, the points plotted are in S1, C1 class. Hence these type of water are suitable for irrigation purpose. In Hill Piper Diagram majority of water lies in class-A. Hence it is suitable for domestic purpose. Physico-Chemical Analysis of 19 samples was conducted in the study area for inlet and outlet of lakes. SAR values of all samples obtained are in good condition. RSC values of collected samples are in good condition and it is suitable for agricultural and drinking purpose. Using Hill Piper method, 13 samples collected from study area are observed in Ca, Mg, CO3, HCO3 class In the study area the fluoride range is less than 1 ppm. Hence it is suitable for drinking purpose.

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