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Full Length Research Article

Water Quality Index of Ground Water Among Selected Areas of Kolar Taluk, Karnataka

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ABSTRACT

An effort has made to study the ground water quality around the natural tanks of Lakshmisagara, Narsapura, Doddavallabhi and Singehalli in Kolar taluk as these tanks were filled by treated waste water from KC valley project. A total of 39 groundwater samples were collected randomly and were analyzed for ground water characteristics of pH, EC, TDS, TA, TH, major cations and anions like Ca, Mg, Na, K, Cl, F, SO_4, PO_4, NO_3 and, irrigational water quality parameters of SAR, RSC, %Na and PI and Water quality index (WQI) as per Standard Methods. The Iso-concentration of WQI map has been generated, WQI values revealed that 64% of the samples were categorized as good water, 2.5% of the samples as excellent and 33% of the samples as poor water class can be used for irrigation, and treatment is essential for the drinking. The groundwater falls under poor category may be due to the percolation of contaminants from the water bodies and fertilizers leaching from agricultural areas. These samples should be consumed after the treatment and groundwater can be used for the irrigation. It is suggested for continuous monitoring to track the seasonal changes in groundwater quality and pollution sources to protect the water bodies.

***Key words*:** Sodium, Ground water, PI, SAR, Kolar, WQI

Water is an essential component which plays a significant role in day-to-day life of living organisms including human beings throughout the world besides its influence on climate change and land shaping. The availability of fresh water for drinking both in quality and quantity is necessary for the sustenance of life on earth. Presently, water quality issues have become a significant concern due to the growth of population, urban expansion and technological development. Water issue among the sustainable development goals which is led by United Nation Development Programme (UNDP) for providing safe and affordable drinking water also protecting and restoring water related ecosystems, by pollution reduction, removal of dumping and control of generation of hazardous chemicals, having the proportion of untreated waste water and enhancement of recycling and safe reuse globally, this should be achieved by 2030 and important for livelihoods as having health effects [1-2].

In recent decades' water demand has been increasing continuously due to increasing water and energy balance by all these sectors and continuous increase in population leading to water shortage and quality degradation. Thirteen percent of the world populations are not having access to safe drinking water and by the year 2030, half of the world's population would suffer from a major water deficit [3]. Ground water is the major source of drinking water and other domestic water supplying rural and peri-urban areas in the country, which accounts for nearly 80% for rural area for domestic purpose and 50% for urban areas [4]. The annual ground water withdrawal in the country is 231 BCM (Billion Cubic Meters) out of which 213 BCM is used for irrigation and remaining 18 BCM for drinking and industrial use [5]. The ground water quality was affected by the increase of organic pollution of river basin activities [6]. Groundwater salinity is also due to over pumping, high evaporation rate and less recharge, seawater–freshwater interaction [7]. Variation of ground water quality in an area is a function of physical and chemical parameters that are greatly influenced by geological formation and anthropogenic activities [8-9] besides, excess usage of fertilizers and discharge of industrial effluents are considered as potential anthropogenic sources responsible for contamination of ground water and depending on the geochemistry of the underlying aquifer [10-11]. In developing countries observed that high potential for contamination and provide the unsafe water for domestic and drinking purposes [12]. The quality of drinking water is closely associated with human health, the impact of water on health derives principally from the consumption of water, containing pathogenic organisms (or) toxic chemicals. Water hardness has no adverse effects, but according to some evidence it has effects of role in heart disease. Many studies noticed to use Water Quality Indices which helps to assess the water quality and management of water resources [13-19]. In view of this, the present study was undertaken to assess the water quality index,

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39 groundwater samples in the parts of Kolar taluk surrounding Lakshmisagar, Narsapura, Doddavallabhi and Singanahalli tanks, which have received treated wastewater (= within 10, 15 and 20km radius from each filled lakes).

MATERIALS AND METHODS

Kolar taluk of Kolar district is located between north latitudes of 13^0 02′ 03″ and $13^0$19′11″and east longitudes of 77^0 56′ 02″ and 78^0 13′ 02″. It has an elevation of 822m (2,697 ft). Kolar district has been divided into 7 taluks for administration purpose. There are 328 inhibited and 34 uninhabited villages in Kolar taluk. Kolar is located at a distance of 72Km (45mi) from Bengaluru and 32Km (20mi) from Kolar gold fields. The city is located on the southern maidan (plains) region of Karnataka. The main source of water supply is from Kodikannur. A total thirty-nine sample were collected from the area with a proximity of 10, 20 and 30 km radius from Lakshmisagara, Narsapura, Doddavallabhi and Singehalli lakes during March 2019 (Fig 1-2). The selected lakes were filled with treated waste water under KC valley project to recharge the ground water. The ground water samples were transferred into pre-cleaned polyethylene bottles after 10 minutes of pumping. Parameters like Electrical conductivity, pH and total dissolved solids were measured in the field using portable meters (HACH HQ30d multiparameter Kit). To analyze remaining parameters, samples were acidified with 1:1 HNO_3 without disturbing the sample volume to maintain the pH value ≤ 2.0 so that changes in chemical equilibrium and adsorption on the inner surface of the water bottles, the samples can be prevented. The sample bottles were sealed, labelled and transported to the laboratory and analyzed as per Standard Methods [20]. During groundwater sample collection, geographical coordinates, depth of bore wells, source type, etc., were recorded.

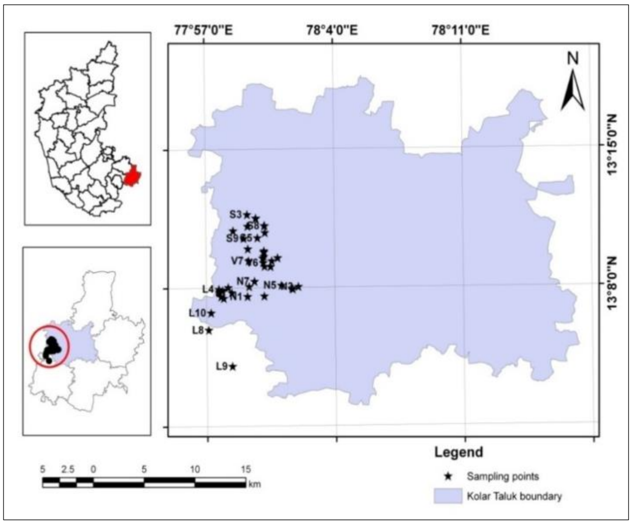

Fig 1 Geographical location map of the study area

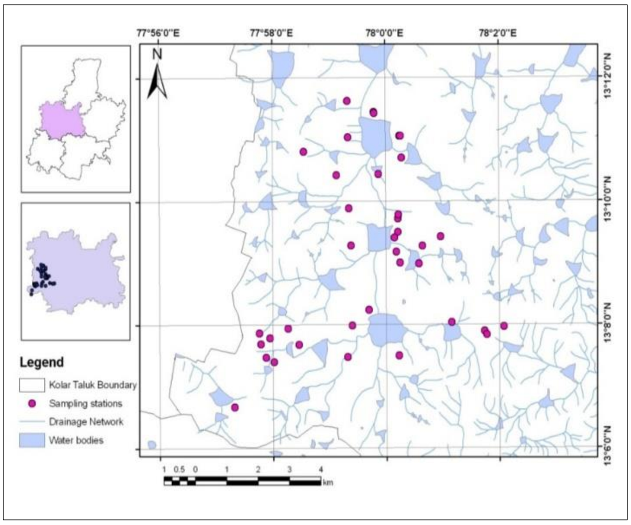

Fig 2 Map showing the location of sampling stations in Kolar taluk

RESULTS AND DISCUSSION

The groundwater quality data of pH, EC, TDS, TA, TH, major cations and anions like Ca, Mg, Na, K, Cl, F, SO_4, PO_4, NO_3 for 39 groundwater samples of Kolar taluk was used to estimate irrigational water quality parameters (SAR, RSC, %Na and PI) and Water quality index (WQI).

Sodium absorption ratio

Sodium adsorption ratio (or) sodicity is the measure of relative concentration of sodium with respect to calcium and magnesium in groundwater. Based on SAR ground water can be classified as excellent (0-10), good (10-18), permissible (18-26) and unsuitable (>26) for agricultural purposes [6]. The analytical results were revealed that all the samples were ranged between 0 and 4. Based on the classification, Samples were under excellent group and are suitable for agricultural purposes.

Table 1 Range and classification based on SAR for irrigation purposes

SAR value	Suitability for irrigation	Number of samples	Percent of samples
0-10	Excellent	36	100
10-18	Good	0	0
18-26	Permissible	0	0
>26	Unsuitable	0	0

Source: Richards *et al.* [21]

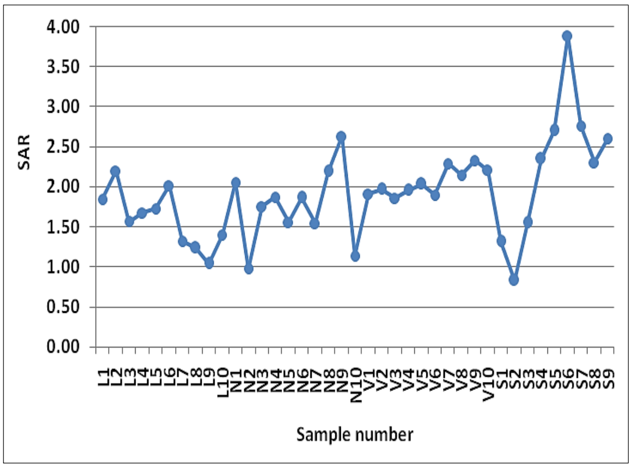

Fig 3 Distribution of SAR value in the study area

Soluble percent sodium (%Na)

Sodium concentration in excess reduces the permeability of soil, destroys the soil structure and affects the drainage of the area which eventually leads to reduction of crop production and plant growth [7]. Based on the %Na groundwater can be grouped as Excellent (<20), good (20-40), permissible (40-60), Doubtful (60-80) and unsuitable (>80) (Table 2) for irrigation purposes. The result also indicated that, 36 samples were fall under the classification of good (20-40) and 3 samples were under excellent group (Fig 4) and hence the groundwater can be used for irrigation purposes.

Table 2 Percent sodium range and classification for irrigation purposes

Percent sodium value	Suitability for irrigation	Number of samples	Percent of samples
<20	Excellent	3	7.69
20-40	Good	36	92
40-60	Permissible	0	0
60-80	Doubtful	0	0
>80	Unsuitable	0	0

Source: Eaton [22]

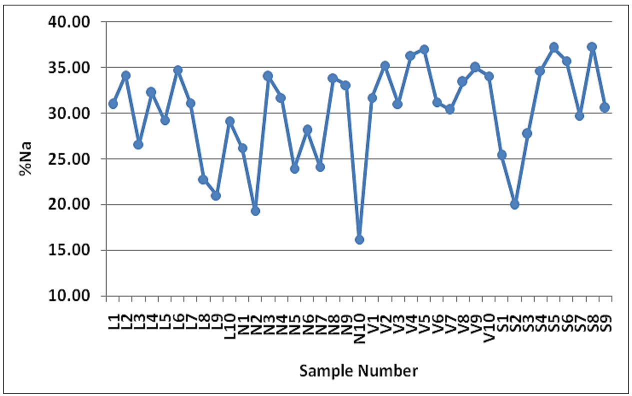

Fig 4 Distribution of percent sodium content of water sample

Residual sodium carbonate

The physical properties of soil and ground water quality are getting affected by presence of excess concentration of bicarbonates and carbonates over calcium and magnesium [7]. Groundwater can be classified with Residual sodium carbonate as good (<1.25), doubtful (1.25-2.5) and unsuitable (>2.5) for agricultural purposes.

Table 3 Range and classification based on RSC for irrigation purposes

RSC	Suitability for irrigation	Number of samples	Percent of samples
<1.25	Good	18	46.15
1.25-2.5	Doubtful	4	10.25
>2.5	Unsuitable	17	43.5

Source: Eaton [22]

The analytical result revealed that 46% of the samples were good for agricultural purposes, four samples were neither good nor unsuitable and 43% of the samples were unsuitable for agriculture (Table 3, Fig 5). This may be due to the high concentration of carbonates and bicarbonates in water samples.

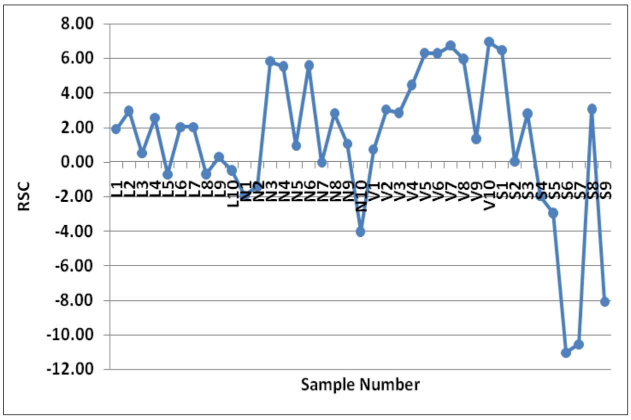

Fig 5 Distribution of RSC in the study area

Permeability index (PI)

The impact of long-term practices of irrigation can affect the permeability of the soil. The ions such as HCO_3, Ca, and Mg in groundwater also can influence the permeability of soil [7]. Based on the classification groundwater can be classified as good (<80), Moderate (80-100) and poor (100-120). The results were indicated that all the samples were observed with a range of 0 to 80 which are suitable for agricultural purposes [23]. That indicates the samples were having permissible concentration of ions such as HCO_3, Ca and Mg (Table 4, Fig 6).

Table 4 Range and classification of PI for irrigation purposes

Permeability index	Suitability for irrigation	Number of samples	Percent of samples
<80	Good	39	100
80-100	Moderate	0	0
100-120	Poor	0	0

Source: Doneen [24]

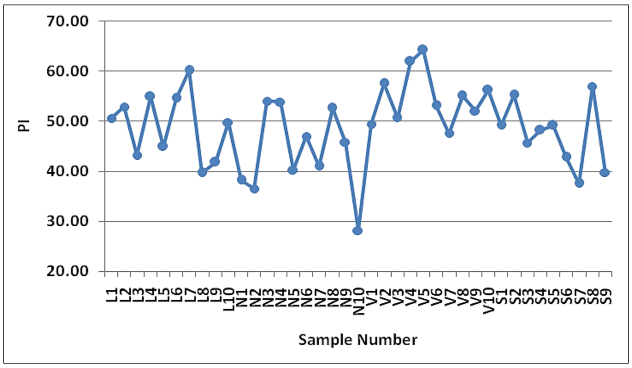

Fig 6 Distribution of permeability Index in the study area

Water quality index (WQI)

Water quality index determines the quality of water for human consumption and it provides water quality information to policy makers [25]. A total of 14 parameters of pH, EC, TDS, Alkalinity, Calcium, Magnesium, Total hardness, chlorides, Nitrates, phosphates, Sulphates, fluorides, Sodium, and Potassium for 39 samples were used to calculate WQI. The classification of water for drinking purposes can be classified as Excellent (<50), good water (50-100), Poor (100-200), very poor (200-300), and unsuitable for drinking (>300) [26]. The pH indicates the type of geochemical equilibrium or solubility calculation and is considered as an important ecological factor [27].

Table 5 Assigned and relative weight for WQI computation with standards [28]

Parameters	Sn	Ideal value (Vid)	Weight (wi)	Relative weight (RWi)
pH	8.5	7	4	0.091
EC	2000	0	3	0.068
TDS	500	0	4	0.091
TA	200	0	2	0.045
TH	300	0	3	0.068
NO_3	45	0	5	0.0114
SO_4	200	0	2	0.045
PO_4	0.3	0	2	0.045
K	10	0	3	0.068
Na	200	0	3	0.068
F	1	0	5	0.114
Ca	75	0	3	0.068
Mg	30	0	3	0.068
Cl	250	0	2	0.045
	Total		44	1.000

Using above (Table 5) WQI can be calculated for Thirty-nine samples based on 14 parameters. As per classification criteria [26] it was used to interpret the overall groundwater quality and tabulated below.

Table 6 Range and classification based on WQI

WQI value	Drinking water quality	Number of samples	Percent of samples
<50	Excellent	1	-
50-100	Good	24	51.28
100-200	Poor	13	43.58
200-300	Very poor	1	5. 12
>300	unsuitable	0	0

Source: Acharya *et al.* [26]

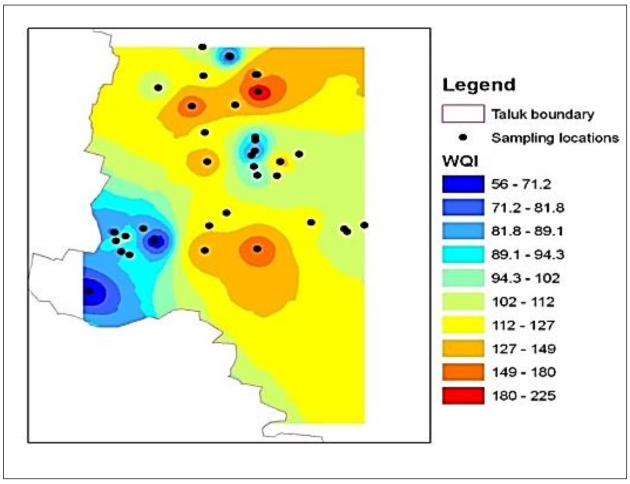

Fig 7 Iso-concentration map of WQI

The results were showed that, 51.28% of the samples were range in the good water, 43.58% samples were in the range of poor water and, 5.12% of the samples were range in the very poor (Table 6, Fig 7). This may be the possible clue of percolation of contaminants from sewage through water bodies and fertilizers leaching from agricultural areas and samples which fall under poor need to be consumed after the treatment of water such as heating, reverse osmosis etc. And continuous monitoring of ground water quality is necessary to prevent further deterioration and related problems.

CONCLUSION

Water quality Indices helps to assess the water quality for specific applications, in view of this, the present study was undertaken to assess the water quality index, 39 groundwater samples in the parts of Kolar taluk surrounding Lakshmisagar, Narsapura, Doddavallabhi and Singanahalli tanks, which have received treated wastewater (= within 10, 15 and 20km radius from each filled lakes). The samples were analyzed for physico-chemical properties of pH, EC, TDS, TA, TH, major cations and anions like Ca, Mg, Na, K, Cl, F, SO4, PO4, NO3 and, as well as irrigational water quality parameters of SAR, RSC, %Na and PI and Water quality index (WQI). The results of above parameters were used to apply the assigned and Relative Weight for WQI Computation with Standards and iso-concentration of WQI map has been generated. WQI values revealed that a wide range of values, 64% of the samples were categorized as good water, 2.5% of the samples as excellent and 33% of the samples as poor water class can be used for irrigation. The groundwater falls under poor may be due to the percolation of contaminants from the water bodies and fertilizers leaching from agricultural areas. It was recommending for continuous monitoring of the ground and surface water and identifying the pollution sources to protect the fresh water bodies.

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