WATER AND SOIL QUALITY ASPECTS OF NELLIGUDDE RESERVOIR CATCHMENT AND COMMAND AREAS; MAGADI TALUK, RAMANAGAR DISTRICT: A CRITICAL STUDY

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Abstract

Tanks and lakes occupy a prominent place in the history of irrigation in South India. A tank was considered to be a useful life saving mechanism in the perennial water scarce areas, which are categorized as arid and semi-arid regions. Tanks are the main source of water supply in those areas for ages. Tanks occupy an important place in the economy of a village and are almost considered to be the back bone of rural economy. Due to urbanisation and improper management, these irrigation tanks are in the state of deterioration. Hence, management of tanks and lakes is of prime importance, and need of the hour. The paper discusses the present status of Nelligudde tank in Magadi Taluk of Ramanagara District(Karnataka). The physico-chemical analysis and results of bacteriological analysis of water samples drawn from the tank catchments and command areas are presented. The results reveal that water is highly contaminated and unfit for drinking and irrigation purposes. The micro and macro nutrient analyses of soil samples collected in the catchments, tank beds and command areas also reveal that the soil is contaminated. The tank bunds are partially eroded. The waste weirs and sluices are to be restored and modernised. Rapid urbanisation and industrialisation in the Lake Catchment and intensive irrigation have resulted in the deterioration of quality of lake water and soil in the catchment and command areas. Modernisation of tank irrigation system should be of prime importance. Illegal construction projects are coming up in the flood plain areas destroying raja kaluves. The paper also discusses some aspects of management of these lakes.

***Keywords**: Lake Catchment, Urbanisation, Irrigation Techniques, Lake Management, USSL diagram.*

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1. INTRODUCTION

The awareness that water is no longer a free and plentiful natural resource but is a precious economic commodity and imperiled social asset is yet to sink in. Experts and agencies both inside the country and outside have many times drawn attention to the depletion of water (particularly so with groundwater), shrinking of water bodies and the prospect of water in the coming years. The alarm sounded by the World Bank over the sinking groundwater table in India is not new. Therefore over-exploitation, misuse and lack of conservation and augmentation efforts are normal in the country. The scenario is bleak across the world, provoking comments that countries may in future resort to war over water. But the situation is especially critical in India (particularly in Karnataka) with an increasing population exerting greater pressure on the resource for agricultural, drinking water and industrial purposes. The over-use of water could lead to a reduction of agricultural output by as much as 25 per cent and lead to serious drinking water shortages. Industry will also be badly affected by the shortage. Better irrigation techniques, distribution of water through leak proof canals and educating farmers on the optimum use of water will help to stop the depletion of water. Economic use of water for irrigation can go a long way in maintaining the present availability. Rain water harvesting and preservation of lakes and other water bodies have been much talked about but action taken is unsatisfactory. Hence, techno ecological studies have been taken up on the status and management of Nelligudde tank located in Magadi Taluk, Ramanagaram district. Physico-chemical and bacteriological analysis of water samples in the lake catchment, in the lake and its command area were carried out. The soil samples in the catchment, lake and command area were analyzed for the presence of macro and micronutrients.

2. STUDY AREA

The study area comprises, Nelligudde tank,its catchment and command areas situated in Magadi Taluk, a part of Ramanagaram district. The Nellegudde tank catchment and its command with a total extent of 65 Sq. Km is located adjacent to the eastern boundary of the Manchanabele reservoir. About 2 Km SE of the Nelligudde tank is the Bidadi township. The area is bound between E Longitude 77 º20' 46" – 77º 24'33" and N Latitude 12º 46' 38" – 12º 57' 16" covered in Survey of India topographic map No 57H/5 of 1:50,000 scale. The subject area forms a part of semi-arid tract in the agro climatic environs of East Dry Zone of Karnataka.

The Nelligudde tank catchment and its command area is covered over to a large extent by the 'Younger Gneissic complex'. The hill range of the Closepet Granite marks the western boundary of the area. Towards NE part, the younger granites attains the form of isolated hills. The gneissic rocks which are fresh and massive are on the surface exposed intermittently. They are more seen as sheet rocks, stony wastes and rocky knobs. The gneissic rocks are weathered to shallow depth. The mineral foliation of the gneissic rocks is North-North Westerly. They are dipping easterly at varying angles between 70º and 85º. Dip joints are predominant. Pegmatite and quartz veins are common in the gneissic formations. The contrast between gneissic suite and granite belt in the west is marked by abrupt high rise hills.

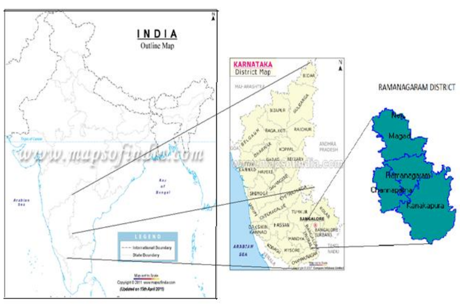

Fig 1 Location of the study area

Fig 2 Satellite Image of Nelligudde reservoir

Fig 3 A view of Nelligudde reservoir

The Ramanagaram city is situated at 622.80m above mean sea level which receives an average of 931.58 mm rainfall annually. The average temperature is 29ºC.Ramanagaram town stretches to an area of 14.531 sq Km. It is situated along Bangalore - Mysore State Highway No.17 at a distance of 50 Km from Bangalore. Ramanagaram town is the center for Sericulture activities. There are about 2000 Silk Reeling and Twisting Households units. It has one of the biggest cocoon market in Asia. Ramanagaram is also famous for its huge rocks. The magnificent rocks that form the landscape of the Handi-gundi reserve forest in Ramanagaram are 2.6 billion years old. The catchment area of the reservoir is located in South Eastern Agro-climatic Zone in Karnataka state.The soils of the reservoir catchment and command area consist of Deep red clayey soil,Medium deep red clayey soil,Deep red gravely soil and Deep alluvial clayey soil.The chief crop grown in the study area is Paddy,Ragi and pulses with Sugarcane, Coconut ,Mulbary. Mango orchards are for commercial purpose.

3. METHODOLOGY

The current study includes collection and analysis of water samples and identifying the source of pollution. For surface source water samples are drawn from the Nelligude reservoir. For subsurface source, water samples are drawn from open wells. For ground water source, water samples are drawn from tube wells located in the study area. The Physico-chemical and biological analyses were carried out for the watersamples collected from various locations using standard procedures recommended by APHA-1994in the laboratory. The soil samples were analyzed for micronutrients and macronutrients, P^H and % organic carbon.

4. RESULTS AND DISCUSSION

The seasonal variation of the Physico-chemical and bacteriological analyses of water samples for and premonsoon, monsoon,and postmonsoon were carried out.The suitability of ground water for irrigation purposes depends upon its mineral constituents. The general criteria for judging the quality are (i)total salt concentration as measured by electrical conductivity (ii)relative proportion of sodium to other principal cations as expressed by SAR,(iii) soluble sodium percentage.(iv)residual sodium carbonate and (v) residual sodium bicarbonate. The above values for monsoon is presented in the Table 1.The US Salinity Laboratory, Department of Agriculture adopted certain techniqiues based on which the suitability of water for agriculture is explained.Classification of irrigation water is based on sodium water content.

$$\%Sodium = (Na^{+}) \times 100/ (Ca^{2+} + Mg^{2+} + Na^{+} + K^{+})$$

where Ca, Mg, Na and K are expressed in milliequivalents per litre(epm).

The classification of watersamples with respect to soluble sodium percent is shown in Table-2. In water having high concentrations of bicarbonate,there is a tendency for calcium and magnesium to precipitate as water in the soil and becomes more concentrated. As a result, the relative proportion of sodium in the water is increased in the form of sodium carbonate RSC is calculated using the following equation:

$$RSC= (HCO_3^{-} + CO_3) – (Ca^{2+} + Mg^{2+})$$

where all the ions are expressed in epm

According to the US Department of Agriculture, water having more than 2.5epm of RSC is not suitable for irrigation purpose. RSC classification of water samples of the study area is presented in the Table-3. A better measure of the sodium hazard for irrigation water is Sodium adsorption ratio(SAR) ,which is used to express reactions with the soil. SAR is computed as

$$SAR= Na^{+}/[(Ca^{2+}+Mg^{2+})/2]½.$$

(All ionic concentrations are expressed in epm).
The graphical presentation of results of SAR and Specific conductance for all the water samples as per USSL diagram is made in the Fig4 The classification of water samples from the study area with respect to SAR is represented in Table4. The total concentration of soluble salts (salinity hazard) in irrigation water can be expressed in terms of specific conductance. Classification of water based on salinity hazard is presented in Table5. The Piper trilinear diagram is used to infer hydro-geochemical facees. These trilinear diagrams are useful in bringing out chemical relationships among water samples in more definite terms rather than with other possible plotting methods. Chemical data of representative samples from the study area are presented by plotting them on Piper-tri linear diagram for premonsoon, monsoon and post monsoon seasons. Water samples of pre monsoon season are represented in Piper trilinear diagram. The results of analyses reveal that 90% of water samples were Ca-Mg and 95% of samples were of bi-carbonate type.

Table 1: Classification of water based on hardness by (Sawyer and McCarthy)

Hardness as CaCo3in mg/l	Water class	Water samples
0-75	Soft	Nil
75-150	Moderately Hard	N7, N8, N9
151-300	Hard	NIL
>300	Very Hard	All Remaining samples

Table: 2 soluble sodium percentage classifications

Sodium%	Water class	Water samples
< 20	Excellent	NIL
20-40	Good	**All remaining samples**
40-60	Permissible	N4,N7, N8,N9
>60	Not suitable	NIL

Table 3: Classification of water based on RSC(Residual sodium carbonate)

RSC(epm)	Remarks on water quality	Water samples
<1.25	Good	All the samples belongs to this category
1.25-2.5	Moderate	Nil
>2.5	Unsuitable	Nil

Table 4: Classification of water for sodium hazard based on USSL classification

Sodium Hazard class	SAR	Remarks on water quality	Water samples
S1	10	Excellent	Range 1.31 to 3.11 All water samples belongs to this category
S2	10-18	Good	NIL
S3	18-26	Moderate	NIL
S4	>26	Unsuitable	NIL

Table5: Classification of water for salinity hazard

Salinity hazard class	EC (micro-mohs/cm)	Remark on water quality	Water samples
C1	100- 250	Excellent	Nil
C2	250-750	Good	N7, N8, N9
C3	750- 2250	Moderately good	All Remaining Samples
C4	2250-6000	Unsuitable	Nil
C5	>6000	Highly Unsuitable	Nil

Table 6 Water quality based on irrigation water requirements in the Nelligudde reservoir, its catchment and command area

Sample No	**Sodium Adsorption Ratio SAR**	**Soluble Sodium Percentage SSP**	**Chlorides in meq/l**	**Magnisium Hazard Mg Hazard**	**Residual Sodium Bi-Carbonate RSBC**	**Permiability Index PI**	**Keley's Ratio KR**	**EC in micro mhos/ cm**
N-W1	2.56995	33.5441	5.4699	0.25005	2.4448	51.42704	0.504756	1783
N-W2	1.57445	26.7032	2.6291	0.25458	1.9291	50.10617	0.364317	1168
N-W3	2.58998	36.7855	4.6292	0.23171	1.0803	55.59968	0.581916	1467
N-W4	3.11463	42.5746	4.8634	0.30388	2.6332	61.85274	0.74139	1343
N-W5	1.78572	29.9812	3.4611	0.3235	1.6034	52.01154	0.428187	1120
N-W6	1.82534	29.3023	4.1835	0.38511	2.225	50.16307	0.414474	1132.1
N-W7	2.201	53.8818	1.788	0.44039	0.77859	88.47447	1.168342	401
N-W8	2.14108	52.0304	1.8985	0.51086	0.9905	86.35477	1.084653	407
N-W9	1.85305	49.4669	1.481	0.48479	0.8429	86.94747	0.978903	398.4
N-W10	1.84747	26.5739	6.161	0.36808	2.1924	44.7705	0.361913	1646
N-W11	1.58143	25.6376	5.032	0.42379	1.6622	45.28252	0.344765	1156
N-W12	1.35088	25.5911	4.019	0.47667	1.5321	48.3546	0.343925	1025
N-W13	2.15263	37.6224	3.4529	0.52693	3.193	62.02092	0.60314	987.2

Table 7 Results of chemical analysis of soil samples (Macro and Micro Nutrients) collected in the Nelligude catchment and command Area

Location	pH	EC µmhos/cm	Organic Carbon	Avg .Phosphorus (P) Kg/acre	Av. Potash (K) Kg/acre	Available Micro nutrients			
			%			Zn ppm	Cu ppm	Mn ppm	Fe ppm
N-S1	6.1	0.02	0.47 L	8 L	146 H	1.62 S	1.9 S	42 S	43.4 S
N-S2	5.7	0.01	0.22 L	4 L	64 M	0.85 D	2.1 S	34 S	46.3 S
N-S3	7.9	0.08	0.38 L	5 L	92 M	0.97 D	2.2 S	35.1S	39.9 S
N-S4	6.2	0.05	0.52 L	8L	86M	0.65D	1.98S	62.3S	56.2S
N-S5	6.8	0.02	0.64M	11M	112M	0.98D	2.76S	56.5S	60.4S
N-S6	6.3	0.03	0.33L	9L	108M	1.14S	2.98S	33.7S	43.2S
N-S7	7.1	0.07	0.59M	6L	75M	0.73D	1.15S	42.1S	55.3S
N-S8	6.1	0.12	0.48L	10M	69M	0.98D	2.05S	45.1S	59.4S

N-S9	6.9	0.09	0.37L	7L	89M	1.12S	1.99S	29.2S	38.6S
N-S10	7.2	0.14	0.69M	12M	102M	1.56S	1.79S	25.1S	32.1SS
N-S11	7.0	0.09	0.42L	9L	72M	0.68D	1.49S	58.1S	44.6S
N-S12	6.5	0.11	0.39L	13M	138H	1.99S	2.36S	47.5S	52.7S
N-S13	7.3	0.03	0.51M	14M	121H	2.13S	1.56S	49.5S	55.8S
N-S14	6.2	0.04	0.72M	11M	101M	1.48S	1.62S	39.5S	40.3S
N-S15	7.9	0.06	0.49L	12M	87M	0.98D	1.49S	27.9S	39.1S

L- Low M-Medium D- Deficient S-Sufficient

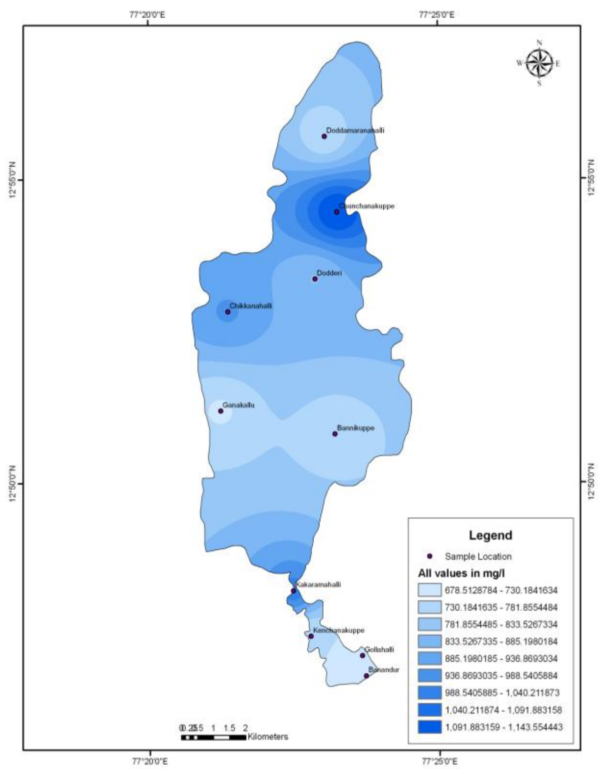

Fig 4 Spatial distribution of TDS in the watersamples in the study area

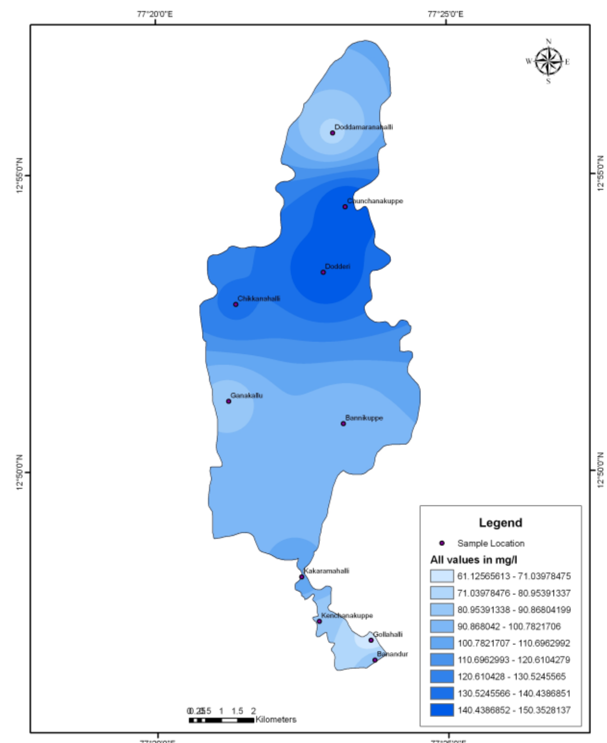

Fig 5 Spatial distribution of sodium in the watersamples in the study area

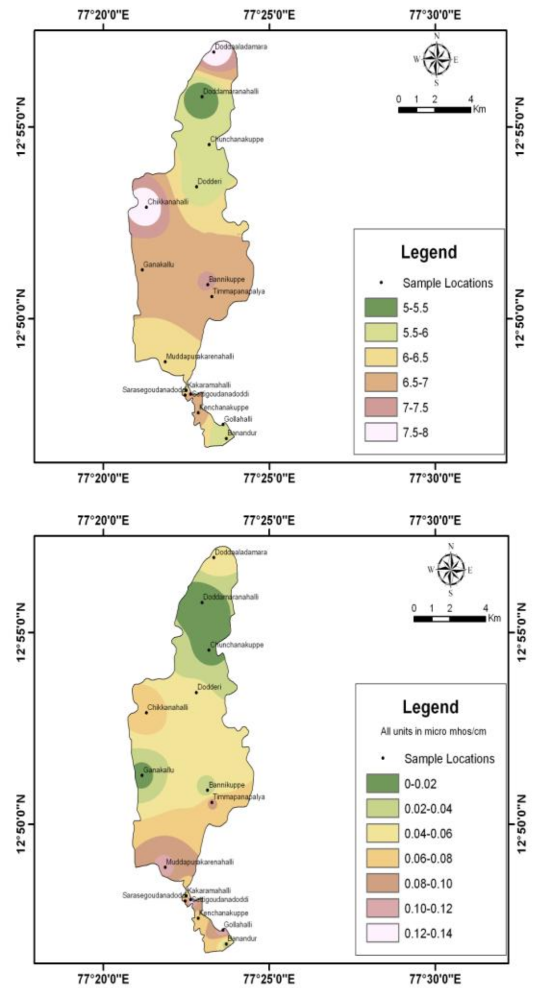

Fig6 Spatial distribution of pH and electric conductivity in the soil samples of the study area

From the above results following discussions are drawn:

1. The results of analysis of water samples at various locations of catchment area, reservoir and command area reveal that water is polluted at certain locations and exceeds permissible limits of drinking water standards.
2. The presence of Total –Coliform and Faecal-Coliform in ground water and reservoir and lake water at certain locations indicates that water is polluted with waste water.
3. The value of TDS varies between min of 258ppm.to a max of 1144 ppm.The presence of higher TDS at various locations indicates that water in unfit for drinking.
4. The inflow of urban runoff into the surface water bodies has resulted in pollution of reservoir and ground water at certain locations.
5. The hardness of water is high at 10 locations and unfit for drinking purpose.
6. The nitrates level varies between 0.75 to 65.3 ppm, and exceeds the drinking water standards at 6 locations in the catchment and command area.
7. The results of analysis reveal that 90% of water samples were Ca-Mg and 95% of samples were bi-carbonate type
8. The suitability of water for irrigation is evaluated based on SAR, %Na, RSC and Salinity hazards. Most of the samples fall in the suitable range for irrigation purpose either from SAR, %Na or RSC.
9. The salinity levels as per USSL classification reveal that 2samples are grouped within C_1S_1, 2samples are grouped within C_2S_1 and 9samples are grouped within $C_3S_2$and 11 samples were grouped under C_4S_1.
10. The results of the chemical analysis reveal 45 % of the soil samples in the study area have low organic Carbon, 18% of the samples are having low zinc content.

5. CONCLUSIONS

Industrial waste is a major contributor to the pollution of tanks. Once the waste is disposed of into adjacent tanks without proper treatment it renders the tank water unfit for use. The factors that affect the pollution of water depends on the type of industries, the nature of waste disposal etc.

Considering the above reason, it is important to note that intensive farming in the village should be reduced. In many cases it is seen that the inflow of pollutants into these tanks is from ground water, as one of the sources, hence pollution of the ground water by the source has to be eliminated. Chemical fertilizers are a major contributor to the pollution of ground water. Hence, it is recommended that biofertilizers or organic fertilizers be used for crops rather than chemical fertilizers.

Many industries are situated in and around the tanks and most of these industries dispose of their effluents without any primary treatment. Once these pollutants enter the water it pollutes the entire lake and makes the water unsuitable. The most important aspect is that the illegal disposal of industrial effluent must be curbed and penalties must be levied on industries violating such rules. Every industry should strictly adhere to the effluent disposal system by providing necessary treatment unit at the source of disposal of waste water before it is finally released into the tank.

Another important aspect of ground water pollution is urbanization in the neighboring area. Rapid urbanization has resulted in discharging sewage into road side drains which resulted in ground water contamination and also directly discharged in to Nelligudde reservoir. The sewerage system should also be well designed, the soak pits and septic tanks should be closed and the entire study area should be laid with sewers and domestic sewage should be treated in this urbanizing areas. The solid waste generated from industries should not be dumped near the water source and should be carried away and disposed of into the solid waste disposal sites specifically designed.

Even with all the measures in place, it is essential that the community should be educated about the hazards of pollution. Public awareness camps should be conducted in the study area with Industry-public interaction to educate the people to reduce problem of further contamination. In all these areas, door to door collection of garbage system should be strictly implemented.

The lakes in the village should be protected by fencing to prevent illegal encroachment. Public and industries should not be allowed to dump any solid waste into the lakes. Illegal dumping of industrial waste into the lakes during night times and during storms should be prevented and a watch has to be kept on such activities. The Nelligudde lake has been observed to be polluted. Protection should be done by avoiding industrial waste disposal and illegal dumping. If such lakes are properly maintained, then the same lake water can be used for irrigation which can be highly beneficial to the farming community in and around the lake.

ACKNOWLEDGEMENTS:

The authors are thankful to the Management , Principal and Head of the Civil Department , Dr.Ambedkar Institute of Technology, Bangalore and MEI Polytechnic,Rajajinagar, Bangalore for their encouragement and support for carrying out this research work.

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