Techno-ecological Studies on the Status and Management of Irrigation Tanks

[A case study for, Jigani Tank, Hennagara Tank and Muthanallur Tank in Anekal Taluk, Bangalore Urban District, Karnataka, South India]

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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 categorised 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 irrigation tanks such as Begihalli, Jigani and Hennagara Tank, in Anekal Taluk of Bangalore Urban 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 and tanks are encroached at certain areas. 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. The paper also discusses some aspects of management of these lakes.

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 of 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 has been taken on the status and management of selected irrigation tanks such as jiganitank ,Hennagara tank and Muthanallur tank located in Anekal Taluk, Bangalore urban 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.

STUDY AREA

The study area comprising, Jigani tank , Hennagara tank and Muthanallur Tank falls in Jigani hobli of Anekal Taluk, a part of Bangalore urban district. The study area lies between S12^0 46' 50" N to S 12^0 47' 54" N Latitude and E.77^0 36'30" W to E 77^0 40'13" W Longitude. (Fig.1). The study area represents an uneven landscape and marked by continuous chain of hills through which several rivulets combine together and drain into River Arkavathi. The water flowing on eastern portions of the taluk drains into south Pinakini River near Hosur, little beyond Karnataka State boundary. The study area Anekal taluk has a typical hydrogeological setting. The entire taluk comprise mainly of granitic gneiss belonging to pre Cambrian age, and on the western portion of the taluk granitic gneisses are exposed as a continuous chain of mounds of 300-500ft height above the general ground level. Temperature is lowest during December – January with mean minimum and maximum temperature as 15^0 C and 26^{0}C respectively. During the month of May the mean minimum and max temperature lies between 22^{0}C and 34^0 C. The mean annual rainfall in the study area is 782mm .The soil comprises of deep red gravelly clay lying in south Eastern dry Zone. Duration of growing season varies from 150 to 180 days.

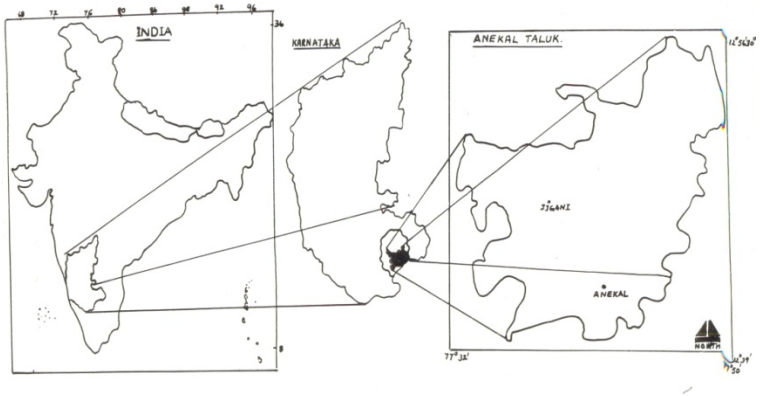

Fig:1. Location of the Study area.

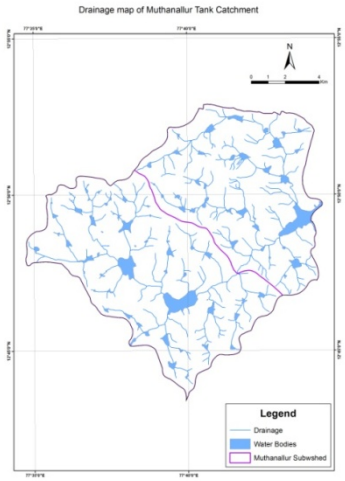

Fig:2 Drainage Map

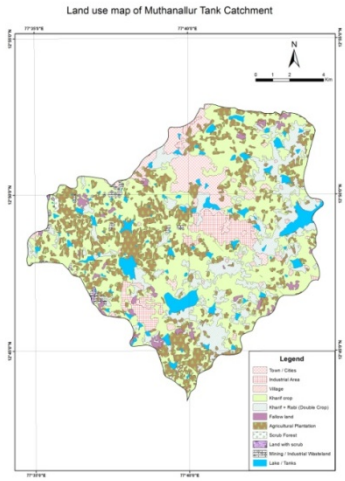

Fig 3.Land use Map

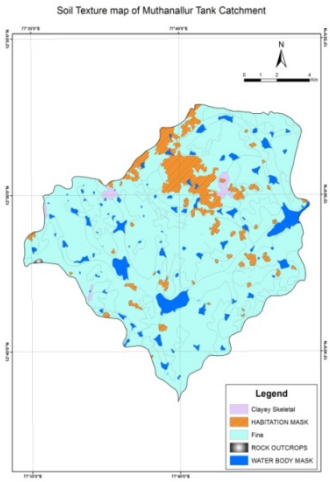

Fig 4.Soil Map

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 lakes namely, Hennagara Lake, Jigani Lake and Muthannallur Lake. For subsurface source, water samples are drawn from open wells. For ground water source, water samples 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-1994. The Physico-chemical and bacteriological analysis of water samples were conducted in the laboratory. The soil samples were analyzed for micronutrients and macronutrients, p^H and % organic carbon.

RESULTS AND DISCUSSION :

The seasonal variation of the Physico-chemical and bacteriological analyses of water samples for and premonsoon, monsoon,and postmonsoon was 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 (v) residual sodium bi carbonate. The above values for monsoon is presented in the Tables 1.The US Salinity Laboratory, Department of agriculture adopted certain techniqes based on which the suitability of water for agriculture is explained.Classification of irrigation water based on sodium water content is shown in Fig4

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

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-1. In water having high concentrations of bicarbonate,there is a tendency for calcium and magnesium to precipitate as water in the soil 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-1. 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

$$SAR = Na^+ / [(Ca^{2+} + Mg^{2+})/2]^{1/2}.$$

(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 as 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 Table1. The Piper trilinear diagram is used to infer hydro-geochemical facies. These trilinear diagrams are useful in brings out chemical relationships among water samples in more definite terms rather than with other possible plotting methods. Chemical data of represented samples from the study area presented by plotting them on Piper-tri linear diagram for pre monsoon, monsoon and post monsoon seasons. Water samples of premonsoon season are represented in Piper trilinear diagram as Fig 6. The results of analyses reveal that 90% of water samples were Ca-Mg and 95% of samples were of bi-carbonate type.

Table1. Quality of water for irrigation requirements (monsoon season)

Sampling Points	Sodium Adsopsion Ratio (meq/l)	Soluble Sodium Percentage	Magnesium Hazard (meq/l)	Chloride (meq/l)	Residual Sodium Bi-Carbonate (meq/l)	Permeability Index	Kelley's Ratio
J-w1(Jigani)	2.122	35.246	0.237	5.54	3.05	60.597	0.5443
J-w2(Jigani)	1.402	23.689	0.412	8.18	-2.04	38.575	0.3104
J-w3(Jigani)	1.451	40.659	0.250	1.27	0.79	82.275	0.6852
J-w4(Jigani)	2.445	41.306	0.652	2.16	4.75	66.765	0.7038
J-w5(Jigani)	1.972	45.308	0.097	2.95	-0.09	75.629	0.8284
J-w6(Jigani)	1.841	43.409	0.208	2.78	-0.03	72.876	0.7671
J-w7(Jigani)	1.801	43.410	0.213	2.38	0.02	73.802	0.7671
J-w8(Jigani)	2.929	60.531	0.622	2.78	1.34	91.342	1.5336
J-w9(Jigani)	1.896	38.575	0.193	2.22	0.51	66.170	0.6280
J-w10(Jigani)	3.780	46.575	0.277	10.03	-1.44	59.730	0.8718
J-w11(Jigani)	1.438	27.202	0.298	7.86	0.11	49.855	0.3737
Hw1(Hennagara)	2.637	30.527	0.278	11.88	-3.45	42.454	0.4394
Hw2(Hennagara)	2.359	39.008	0.530	5.81	2.86	61.076	0.6396
Hw3(Hennagara)	2.001	34.211	0.136	4.50	-0.81	55.215	0.5200
Hw4(Hennagara)	2.919	53.272	0.414	4.96	0.22	74.141	1.1400
Hw5(Hennagara)	2.830	53.579	0.402	4.55	0.25	75.666	1.1542
Hw6(Hennagara)	2.789	53.963	0.410	4.36	0.32	76.887	1.1722
Hw7(Hennagara)	1.388	21.920	0.270	6.68	-0.66	40.281	0.2807
Hw8(Hennagara)	0.682	15.066	0.403	3.02	0.94	41.663	0.1774
Hw9(Hennagara)	1.159	16.915	0.370	6.07	-0.42	32.961	0.2036
MAw1(Mutanallur)	0.713	35.732	0.490	0.23	0.58	114.118	0.5560
MAw2(Mutanallur)	1.996	28.291	0.391	8.16	0.93	44.843	0.3945
MAw3(Mutanallur)	0.712	28.877	0.299	0.63	0.40	85.118	0.4060
MAw4(Mutanallur)	1.644	25.895	0.196	4.36	1.78	47.792	0.3494
MAw5(Mutanallur)	4.536	57.030	0.327	7.01	2.67	75.939	1.3272
MAw6(Mutanallur)	3.233	45.786	0.454	10.06	-0.52	59.584	0.8445
MAw7(Mutanallur)	2.412	37.912	0.410	9.24	-1.35	52.264	0.6106
MAw8(Mutanallur)	2.454	41.349	0.437	7.35	-0.23	58.621	0.7050
MAw9(Mutanallur)	2.279	37.525	0.562	8.81	0.34	53.741	0.6006
MAw10(Mutanallur)	0.903	19.668	0.441	4.22	-0.54	40.982	0.2448
MAw11(Mutanallur)	1.570	18.962	0.485	15.08	1.05	31.762	0.2340
MAw12(Mutanallur)	3.144	37.631	0.670	14.06	3.54	50.644	0.6034
MAw13(Mutanallur)	2.646	31.090	0.465	13.23	0.72	43.707	0.4512
MAw14(Mutanallur)	1.556	39.826	0.363	0.37	2.15	82.880	0.6618

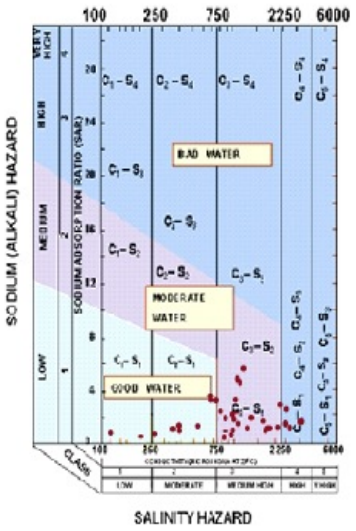

Fig: 4 USSL Diagram formonsoon (August 2012)

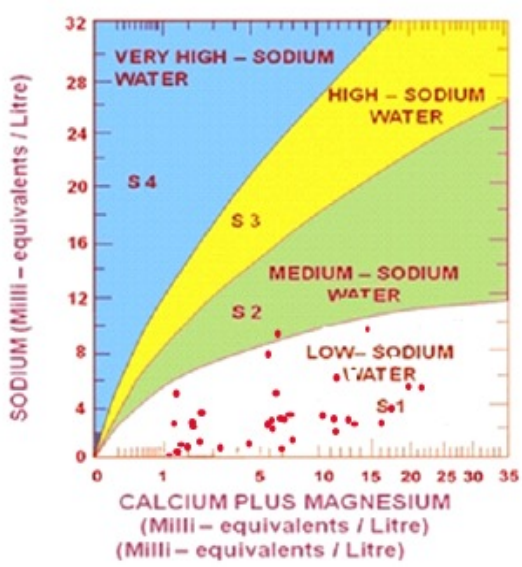

Fig:5 Classification ofIrrigation water based onSodium Water content forMonsoon (August 2012)

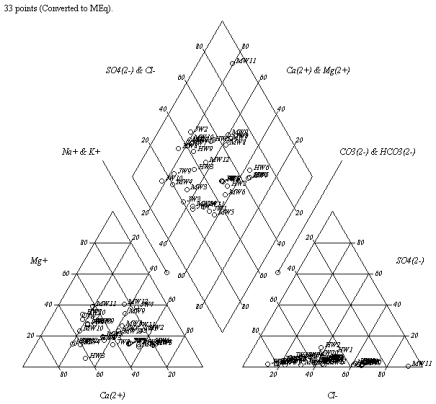

Fig:6 Monsoon samples plotted on piper-Trilinear diagram (August 2012)

Table:2 Results of Chemical Analysis of soil samples (Macro and Micro Nutrients) collected in the Jigani ,Hennagara and Muthanallur catchment and command areas

	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
J- S1	7.30	0.39	0.96 H	46.8 H	136H	2.27S	7.10S	21.70S	57.18 S
J-S2	7.60	0.90	0.72 M	>64H	197H	1.18S	2.16S	7.16SS	32.85 S
J-S3	7.60	0.36	1.04 H	>64H	130H	0.80 D	6.17S	21.30S	38.37 S
J-S4	8.50	0.35	0.49 L	>64H	131H	2.31S	2.57S	12.75S	16.80 S
J-S5	8.40	0.48	0.28 L	31.4H	109M	1.26S	1.83S	10.48S	26.65 S
J-S6	7.30	0.45	1.04 H	55.2H	112M	0.95D	5.32S	11.32S	32.31 S
J-S7	8.20	0.38	0.95 H	58.9H	156H	1.56S	1.43S	14.32S	29.09 S
J-S8	7.50	0.43	0.76 H	42.4H	132H	0.78D	2.45S	8.32S	30.63 S
J-S9	8.30	0.81	0.67 M	36.8H	112M	0.75D	1.85S	1.82S	28.32 S
J-S10	7.15	0.56	0.29 L	44.2H	119M	1.71S	3.67S	13.2S	22.5 S
J-S11	6.90	0.08	0.54 M	15 M	172H	1.13S	2.8S	22.6S	64.8 S
H-S1	5.90	0.03	0.19 L	48H	62M	1.2 S	1.1S	27.4S	63.6 S
H-S2	4.50	0.13	0.39L	54H	59L	2.1S	1.9S	33.9S	72.3S
H-S3	5.10	0.10	0.27L	66H	76L	3.1S	1.7S	44.5S	46.2S
H-S4	7.80	0.11	0.35L	24H	300H	2.15S	1.9 S	38.9 S	18.4 S
H-S5	5.40	0.02	0.19L	6.0L	90M	0.41 D	1.5 S	27.0 S	39.0 S
H-S6	6.90	0.07	0.42L	5.0L	150H	1.92S	3.0S	44.3S	18.4S
H-S7	6.50	0.09	0.36L	4.2L	122H	2.35S	4.1S	52.4S	32.6S
H-S8	6.8	0.11	0.62M	64H	180H	4.04S	1.1S	35.5S	30.6S
M-S1	6.5	0.05	0.19L	4.0L	250H	0.54D	2.2S	42.0S	31.4S
M-S2	6.1	0.06	0.67M	12M	176H	1.9S	1.7S	53.0S	38.6S
M-S3	6.5	0.13	0.34L	15M	219H	2.8S	4.2S	32.9S	54.3S
M-S4	6.9	0.07	0.44L	7.0L	205H	1.72S	1.9S	40.5S	32.1S
M-S5	6.7	0.05	0.46L	12M	186H	2.24S	2.9S	42.4S	27.7S
M-S6	6.1	0.16	0.66M	5.0L	162H	0.86D	3.1S	40.1S	56.6S
M-S7	6.0	0.12	0.52M	9.0L	178H	1.91S	2.1S	36.8S	38.9S
M-S8	5.7	0.05	0.41L	36H	112M	2.62S	1.82S	41.9S	20.8S
M-S9	6.6	0.01	0.35L	6.0L	120M	0.87D	0.7S	31.7S	17.7S
M-S10	6.2	0.11	0.47L	29H	109M	1.3S	1.72S	39.8S	39.4S
M-S11	6.4	0.03	0.23L	6.0L	100M	1.08S	1.2S	29.1S	26.8S
M-S12	5.9	0.03	0.46L	5.0L	140H	0.97D	1.4S	40.6S	29.4S

From the above results following discussions can be drawn.

1. The results of the 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 standards.
2. The presence of Total –Coli form 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 148ppm.to a max of 1815ppm.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 6 locations and unfit for drinking purpose.
6. The nitrates level varies between 0.4ppm to 244.8ppm, and exceeds the drinking water standards at 6 locations in the catchment and command area.
7. The result of the analysis reveals that the 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, 5samples are grouped within C_2S_1 and 20 samples are grouped within $C_3S_2$and 11 samples were grouped under C_4S_1.
10. The results of the chemical analysis 50% of the soil samples in the study area has low organic Carbon, 20% of the samples are having low zinc content.

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 inconsumable. 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 pollution into these tanks is from ground water, as one of the sources, hence pollution of the round 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 on 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 two lakes Jigani Lake and Hennaegere Lake. The sewerage system should also be well designed, the soak pits and septic tanks should be closed and the entire study are 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 people 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 three lakes Jigani and Hennagara and Muthannalur have 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.

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