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Water Quality Index Assessment of Domestic Water Supplies in System Tank

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Abstract: The study was confined toa system tank zone of River Noyyal in Coimbatore. The ground water and surface water of the monsoon and post–monsoon seasons were analyzed for various physico-chemical parameters. The Parametric Water Quality values in the respective units of measurement were found to be in the IS permissible ranges prescribed for EC (3to15dS/m), pH(6.2to 6.8), Total dissolved salts (500 t0 2000) and sulphates (200 to 400). The overall quality indices for both surface and ground water were arrived at in a gradation system of weightage limits from 1 to 5, as less hazardous to severely hazardous status. The indices established the values in the moderate range of 2.3 to 3.8, suggesting the feasibility of quality sustained domestic water supplies.

Keywords: System Tank, Water Quality Index, Parametric Index, pH, EC, Turbidity, Hardness, Alkalinity, domestic water supplies

Surface water reserves such as the tanks and subterranean aquifers embedded with dug wells and bore wells store the rainwater for the diversified usage in their vicinity viz., irrigation, domestic and industrial water supplies in an ingenious way of roaster based rotational distribution through open channels and pipeline networks (Debels et al 2005,Giridharan et al2010). By and large, the system tanks constructed at various zones of Coimbatore were primarily envisaged to cater to the irrigation needs of agricultural crops in their downstream command areas. However, over the past twenty years this scenario has undergone dramatic changes partly due to extensive urbanization and intensive industrialisation as well. Eventually the agricultural land area has diminished drastically and got converted into real estate pockets. In response to this impulse the agricultural needs also got decreased but the domestic and industrial water requirements got exponentially shotup. Hence the paradigm shift of transforming agricultural requirements of the water towards domestic water supplies has become inevitable. Mostly we resort to a conjunctive use of surface and groundwater storage that is also responsible for spatial and temporal water quality changes in accordance with the contaminant solute transport (Kannel et al 2007, WHO 2008,Sener et al 2017) However, a qualitative scrutiny of the water in storage and that reaching the groundwater aquifers is indispensible. Hence it could be impeccable if the existing water distribution schedule can be modified to suit the dominating domestic water needs compared to the barest minimum agricultural water requirements. By way of incorporating suitable mechanical filtration systems and disinfection schedules assured domestic water supplies at desirable quality level can be accomplished.

Besides, the sustainability of extracting and using both surface and groundwater from the system tank storage and dispersion zone needs extensive investigation. System tanks or non-system tanks do contribute to the aquifer recharge covering a certain radius of influence both on the downstream side and upstream side of storage indicated the well water level fluctuations (Subramani et al 2005) . The present investigation was contemplated to include nodal point water samplings related to the surface storage of water in the tank and well water in the vicinity. Based on these quality indices focused for domestic water supplies, the appropriate filtration and disinfection units can be designed and installed (Horton 1965).

MATERIAL AND METHODS

Study Area: The Noyyal river stretch proliferating and meandering through Coimbatore region encompasses 21 Anaikuts and 31 Tanks, of which 8 system tanks are located within Coimbatore city urban viz.,Narasampathi tank, Krisnampathi tank, Selvampathi tank, Kumarasamy tank, Selvasindhamani tank, UkkadamPeriyakulam tank, Valankulam tank and Singanallur tank. The study was however limited only to UkkadamPeriyakulam tank that is knitted to the downstream reach of the Noyyal River feeding where the concentrated dumping of pollutants and contaminants along the stream flows gushing into the tank

water spread pose a severe threat on the surface and groundwater water qualities. The latitude of Coimbatore, Tamil Nadu (a State of India) is 11.017363, and the longitude is 76.958885. (GPS coordinates of 11° 1' 2.5068" N and 76° 57' 31.9860" E.). The experimental observations were made during the monsoon season (June – Nov, 2016) and during the non-monsoon (December- May, 2016) following the Indian Standards procedures in sample collection and analysis.

Sample sites and status of pollution: The primary data collected includes the laboratory analysis results for the water samples collected along the stretch of the UkkadamPeriyakulam tank. Secondary data such as rainfall, water quality, groundwater level, lithology, and aquifer parameters were obtained from state surface water and groundwater board. Four sampling sites were selected randomly by considering the domestic, agricultural and industrial factions. The ground water and surface water of the pre- monsoon/summer (March-June), monsoon (July-November) and post–monsoon (December-February) seasons were analyzed for various physico-chemical parameters in line with parametric considerations for 5 samples per parameter. The results were compared with the drinking water standards / guidelines by Indian Standards (IS 10500:2012) and World Health Organization (WHO 2008). The water quality indexing was done based on the weights affixed to these parameters and the overall index was taken as a weighted mean value of all the independent parametric water quality indices (Brown et al 1970).

The relative severity grading has been done on 1 to 5 grade scale in which <1 is hazard free or low, (>1to 2) is medium, (>2 to 3) is high, (>3 to 4) is severe and (>4) is critical. These gradations followed by the parametric Water Quality Indices obtained are discussed as follows. In case of Total Alkalinity (TA) the following gradation grouping was done:

TA, mg/l	<200	200 – 400	400 – 600	600 – 800	> 800
Hazard rating	Low	Medium	High	Severe	Critical
Weight	1	2	3	4	5

The grouping was done for total hardness (TH) as metioned below:

TH, mg/l	<200	200 – 400	400 – 600	600 - 800	> 800
Hazard rating	Low	Medium	High	Severe	Critical
Weight	1	2	3	4	5

In case of electrical conductivity status assessment the following criteria was used:

EC, dS/m	< 3	3 – 6	6 - 9	9 - 12	12 - 15
Hazard rating	Low	Medium	high	severe	critical
Weight	1	2	3	4	5

The classified as mentioned below

Cl, mg/l	<200	200 – 400	400 – 600	600 - 800	> 800
Hazard rating	Low	Mediu m	High	Severe	Critical
Weight	1	2	3	4	5

For the status of dissolved oxygen levels indicating the relative contaminant levels, the following IS gradation was reckoned:

DO, mg/l	<2	2 – 4	4 – 6	6 -8	> 8
Hazard rating	Critical	Severe	High	Medium	Low
Weight	5	4	3	2	1

RESULTS AND DISCUSSION

The distinctive effects on physio-chemical characteristic variations between the monsoon season contaminant dumps and the post-monsoon season residuals were not so distinct (Table1). However, marked differences was observed during the pre-monsoon water table depletion phase. As regards the colour and odour both surface and groundwater samples exhibited satisfactory appearance from clear to slight grey waters and not much of odour diffusion in the vicinity during the monsoon season and the variations were within the quality criteria as agreeable by the IS or WHO guidelines. Hence the weights for these two parameters were reckoned as unity without much error.

Water Quality Indices (WQI): Parametric Water Quality Indices within the stipulated ranges on a 5 grade system suggested and the overall Water Quality indices for the monsoon and non-monsoon seasons. The weighted mean values of the parametric pre-monsoon $(WQI)_t$ for the surface water was 4.6 and for groundwater 3.6. The same for monsoon quality rating were registered at 3.8 and 3.2, respectively. The corresponding values for the post-monsoon sampling were 3.2 for surface water and 2.5 for groundwater.

Turbidity: The respective parametric indices of turbidity for monsoon season were 81.4and 77.48 NTU. During post-monsoon season were declined to 76.33 and 74.30 NTU respectively.

Total Dissolved Solids (TDS): The weighted mean values of the parametric pre-monsoon $(WQI)_t$ for the surface water was 1.9 and for the groundwater1.4. The same for monsoon and post-monsoon quality rating were registered

respectively at 1.

Electrical Conductivity (EC): By and large the level of contaminant concentration in domestic or irrigation or industrial waters are limited in the EC range of 3 to 15 dS/m. However, the tested values of EC fluctuated from 2 to 6 dS/m close range. Hence, the weight ranges were stipulated as indicated in the methodology.

On this gradation criterion, the WQI during pre-monsoon period was reckoned as 2.8 for surface water and 1.8 for groundwater. During monsoon season the WQI were obtained as 1.2 for surface water and 1.1 for groundwater. However, during the post-monsoon season the WQI values were obtained as 1.3 for surface water and 1.8 for groundwater.

pH: A perusal of the pH values from the tables suggests that the pH is well within the prescribed range of 6.5 to 8.5 as per IS or WHO guidelines in relation to the relative salinity/alkalinity/neutral levels. Hence, the parametric $(WQI)_{pH}$ is taken as 1 irrespective of the monsoon or post monsoon or pre-monsoon seasons for the surface and groundwater sampling.

Total Alkalinity (TA): The level of contaminant concentration in surface and groundwater sampling irrespective of the monsoon are contained well within the IS prescribed TA range of 200 - 600 mg/l. The parametric indices of total alkalinity for monsoon season stood at 378.46 mg/l for surface water and 430.00 mg/l for the groundwater. In the same line, the parametric indices of TA for the post-monsoon season were reckoned to be 359.15 mg/l and 308.13 mg/l respectively.

On this gradation criterion, the WQI during pre-monsoon period was reckoned as 4.5 for surface water and 3.9 for groundwater. During monsoon season the values of WQI were obtained as 3.4 for surface water and 3.1 for groundwater. However, during the post-monsoon season the WQI values were obtained as 4.5 for surface water and 3.1 for groundwater.

Total Hardness (TH): The parametric indices of total hardness for monsoon season were 628.21 mg/l for surface water and that for the groundwater at 596.67 mg/l. The same indices of TH for the post-monsoon season were reckoned to be 563.33 mg/l and 571.00 mg/l respectively. Even as during the monsoon rains and catchment inflows the surface and ground waters are getting softened, the receding water table during the post monsoon dry spells may again impart hardness to the fluctuating waters. The TH indexing is slightly deviating from TA, with the same permissible range of 200-600 mg/l. The observed test values of the samples are also showing a trend of variations similar to that of TA, but some sample values exceeding upto 900mg/l.By this gradation criterion, the WQI during pre-monsoon period was reckoned as 3.6 for surface water and 3.4 for groundwater. During monsoon season the values of WQI were obtained as 3.7 for surface water and 3.4 for groundwater. However, during the post-monsoon season the WQI values were obtained as 3.9 for surface water and 3.6 for groundwater.

Chlorides (Cl): Based on the gradation criterion, the WQI during pre-monsoon period was reckoned as 2.6 for surface water and 2.4 for groundwater. During monsoon season the values of WQI were obtained as 1.5 for surface water and 1.5 for groundwater. However, during the post-monsoon season the WQI values were obtained as 1.6 for surface water and 1.8 for groundwater.

Sulphate (SO_4): WHO suggests a limiting value of 500, IS 10500:2012 prescribes the range from 200 to 400 mg/l. The values for pre-monsoon, monsoon and post monsoon

Table 1. Parametric water quality indices

Parameter	Pre - Monsoon		Monsoon		Post Monsoon	
	Surface water	Ground water	Surface water	Ground water	Surface water	ground water
Turbidity	4.6	3.6	3.8	3.2	3.2	2.5
Total Dissolved Salts	1.9	1.4	1	1	1	1
EC	2.8	1.8	1.2	1.1	1.3	1.8
pH	1.5	1.3	1	1	1	1
Total Alkalinity	4.5	3.9	3.4	3.1	4.5	3.1
Total Hardness	3.6	3.4	3.7	3.4	3.9	3.6
Chlorides	2.6	2.4	1.5	1.5	1.6	1.8
Sulphates	1	1	1	1	1	1
Dissolved Oxygen	5.2	5.2	4.3	4.2	5.4	5.1
Overall Index	3.15	2.75	2.35	2.32	2.42	2.31
Overall Hazard Rating	High to severe	Medium to high	Medium to high	Medium to high	Medium to high	Medium to high

situations indicated less than 200mg/l only. Hence, the parametric water quality $(WQI)_{sui}$ in the study area confined is taken as 1 irrespective of surface or groundwater sampling

Dissolved Oxygen: By the traditional quality standards prescribed by Thomann and Miller (1987) the saturated solubility of Oxygen in water at 1 atm. pressure and an ambient temperature of 20°C is 9.09mg/l with zero chloride concentration. However, it is a bit red-signalling to observe that the contamination levels have impaired both surface and groundwater qualities with DO alarmingly less than 3 mg/l only irrespective of whether monsoon and post monsoon seasons. They have also prescribed optimum levels in the range of 5 mg/l to 8 mg/l for the survival base to fish and other water borne entities. Hence, the following weight factor distribution in the reverse grade order was made. On the gradation criterion indicated in the methodology for DO status, the WQI during pre-monsoon period was 5.2 for both surface water and groundwater. During monsoon season the values of WQI were obtained as 4.3 for surface water and 4.2 for groundwater. However, during the post-monsoon season the WQI values were obtained as 5.4 for surface water and 5.1 for groundwater.

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CONCLUSIONS

The dissolved oxygen status was low for both surface and groundwater irrespective of the monsoon and non-monsoon phases falling below the safe recoverable range 6.5 to 9 mg/L. The Electrical Conductivity criterion for irrigation and drinking water suitability was in the safe range of 2 to 6 dS/m as against the permissible range of 3 to 15dS/m irrespective of the seasons. The pH was also within safe neutral range of 6.8 to 7.2 indicating the suitability for crop production and domestic water usage. Chloride concentration for drinking water usage was out of safe range indicating the need for dilution. Sulphate content was well within the safe water quality range of 5.1 to 5.4 only against the prescribed limit of 500.

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