Water Quality Index Determination of Ponds in Anad Panchayath, Thiruvananthapuram, Kerala – A Geospatial Approach

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Abstract- Water Quality Index (WQI), a technique of rating water quality, is a effective tool to assess overall quality of water and ensure sustainable safe use of water for various purposes. The present work is aimed to assess the pond water quality of Anad panchayath in Nedumangadu block for knowing the suitability of various purpose by calculating the WQI and using Geographical Information System **(**GIS) techniques. Thirteen pond water samples were collected from the ponds of Anad panchayath for comprehensive physico-chemical analysis. Nine parameters were considered for calculating the WQI such as: pH, chloride, calcium, magnesium, total hardness and total dissolved solid, potassium, dissolved oxygen. The spatial distribution maps of the 13 parameters were prepared by using GIS software. The computed WQI value ranges from 10 to 23. The pond water of the study area fall in Good category indicating the pond water in the area is suitable for domestic and agricultural purposes.

Index Terms- Water quality, GIS, Physico-chemical parameters

I. INTRODUCTION

The ponds, where were associated with day to day activities of the people of yester generations is under severe neglect now. Pond play a dual role of storing water on the surface and transmitting water to the subsurface, thus rejuvenating the surface and subsurface water environments in terms of quantity and quality. Water quality index (W.Q.I) provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters (Sen et al., 2011), (Chauhan and Thakor, 2012) Physicochemical properties of water in any aquatic ecosystem are largely governed by the existing meteorological conditions and are essential for determining the structural and functional status of natural water (Parashar et. al., 2006). GIS is an effective tool not only for collection, storage, management and retrieval of a multitude of spatial and non-spatial data, but also for spatial analysis and integration of these data to derive useful outputs and modeling (Gupta and Srivastava, 2010). The major objective of the present study to assess the suitability of pond water quality for various purpose and generated water quality maps using GIS based on the available parameters from 13 ponds in Anad panchayat in Nedumangadu block. This study will be use full in current water resource planning and provide some basic data for the rational exploitation and use of water resources in the future.

Study Area

Anad village in Thiruvananthapuram district in the state of Kerala, India. It is located around 20 km to the north-east of Thiruvananthapuram, between latitudes $8^0 39' 35.812''$, $8^0 36' 38.495''$ and longitude $76^0 57' 40.52''$, $77^0 39.029'$. In accordance with general land scape Anad panchayath lies north to south direction (Fig.1).

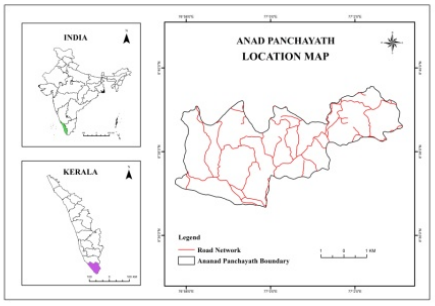

Fig 1: Location of the study area

II. MATERIALS AND METHODS

For the assessment of pond water quality of the Anad panchayat, a total of thirteen pond water samples were collected and analysed for 13 physico-chemical parameters. Na and K were analysed using flame photometry and the other parameters pH , Electrical conductivity, Temperature, Salinity, TDS, Total hardness, Dissolved oxygen, Total alkalinity, Calcium, Magnesium, Chloride, were analysed in the laboratory as per the standard procedures of (APHA, 1998) The WQI has been calculated by using the standards of drinking water quality recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS), and Indian Council for Medical Research (ICMR). The weighted Arithmetic index method has been used for the calculation of WQI of the water body.

WQI = ∑**SIi**
Where
SIi is the sub-index of **ith** parameter
GIS Analysis

Spatial distribution maps were generated from the estimated results of the present study for parameters, pH, Salinity, total hardness, total dissolved solid, alkalinity, Chloride, sodium, potassium, dissolved oxygen, electric conductivity, magnesium, calcium and temperature using GIS. Further, geospatial parameters viz. Digital Elevation Model (DEM), Triangulated Irregular Network (TIN) and Relative Relief maps were created for analyzing earth surface features of the study area. The data base used for the present study is survey of India toposheet No.58 H/2/NW 1985 and 58 D/14/NE of scale 1: 25,000. The maps are created using the ARC GIS 9.3 software.

III. RESULT AND DISCUSSION

pH

The pH is an expression of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. pH in the present study, the fluctuation of pH in the samples was from 4.67 to 7.91. This means that they were slightly acidic, soft and corrosive. The highest value obtained was in the pond A2 while the lowest value in the pond A6.

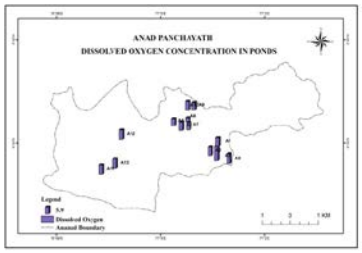

Fig 2: PH Variation in the study area

Temperature

The temperature ranges from 26.7^{0}c to 32.7^{0}c. The highest temperature value present in the pond A1 while the lowest temperature value present in the pond A4. In this study area most of the pond water was found to be slightly of higher temperature. High temperature in drinking waters leads to low oxygen because the rate of dissolution of gases in water decreases with increasing temperature and low oxygen in water affects the taste and other aesthetic property of water. The study on ground water quality assessment conducted by (Kumar et. al.,2014) show that the temperature variation ranges from 26^0 to 27^{0}c.

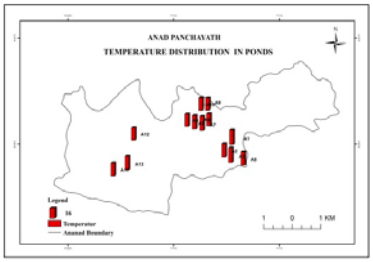

Fig 3: temperature concentration map

Total Dissolved Solid

In the study area TDS values varied from 23.56 to 127 mg/l. The highest TDS value was obtained in pond A7 while the lowest value in pond A13. In the study of (thakre et. al., 2010) maximum value was reported about 683.2 mg/l and minimum of 7.381 mg/l in Tapti pond. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing color, taste and odour.

Chloride

The ecological significance of chloride lies in its potential to regulate salinity of water and exert consequent osmotic stress on biotic communities (Shinde et. al., 2011). In the present investigation chloride content varied between 10.6 – 24.8mg/l. Here the chloride concentration is found to be within permissible limit.

Dissolved Oxygen

Dissolved oxygen content in water reflects the physical and biological with organic pollution. DO is ranged from 2.97 to 11.9 mg/l in the study area, where as the prescribed limit for DO is 5.0 mg/l. Dissolved oxygen value is higher in the pond A3 and lower values are present in the pond A6. In A4 and A6 pond have dissolved oxygen below the permissible limit same observation found in (Mishra et. al.,1994) which indicate the these two pond water contain the organic pollutants.

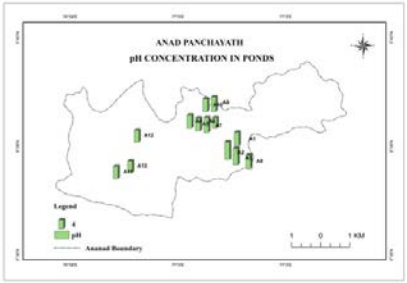

Fig 4: dissolved oxygen concentration in ponds

Conductivity

Conductivity in the water is due to salt present in water and current produced by them. Electrical Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolve solid content. In the present study the electrical conductivity ranged between the 44.8 mS/m – 250.67 mS/m. Electrical conductivity maximum found in pond A7 and minimum found in pond A13. Here the conductivity is within the permissible limit.

Alkalinity

The change in alkalinity depends on carbonates and bicarbonates, which in term depend upon release of CO_2. The amount of total alkalinity in the ponds ranged between 10 – 105 mg/l. The minimum value of alkalinity was recorded in pond A13 and maximum value was recorded in pond A7. In this study the alkalinity of all the ponds are within the permissible limit.

Hardness

The total hardness recorded in the pond water in Anad ranges between 15 – 100mg/l . Here the hardness is within the permissible limit. The maximum amount of total hardness in the Pond water was recorded in pond A7 and minimum amount was recorded in the pond A6.

Calcium and Magnesium

The calcium and magnesium in waters are generally used to classify the suitability of water. Calcium and magnesium are directly related to hardness of the water and these ions are the most abundant elements in the surface and groundwater and exist mainly as bicarbonates and to a lesser degree in the form of sulphate and chloride. The concentration of Ca is between 4.08 and 32.64 mg/l, and concentration of Mg varied from 2.33 – 13.29 mg/l. The higher concentration of calcium is found in the pond A2 and lower concentration in pond A12. Magnesium Concentration is higher in pond A13 and lower in the pond A11. Ca-H and Mg-H were observed in the range of 130 - 210, mg/l and 8 – 12 mg/l by (shastri and das 2007) in ponds.

Sodium and Potassium

The concentration of Na is varied from 9 to 25 mg/l. The maximum value of sodium present in the pond A1 and minimum concentration value is present in the pond A13. From the study of (Kumar et. al.,2014) the amount of sodium recorded in the Pond ranges between 36 to 68 mg/l. The potassium concentration ranges between 1 – 12 mg/l. Potassium concentrations is higher in the pond A2 and lower in the ponds A6 and A13. Potassium and sodium concentration of pond water in the study area is within the permissible limit.

Salinity

Salinity is the component of the conductivity it is critical to the survival of aquatic plants and animals. The value of salinity ranges between 21.6 – 124.31 mg/l. The highest value of salinity present in the pond A7 and the lowest value present in pond A13.

WQI is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall water quality. (World Health Organization 2011) standards for drinking water quality have been used to calculate the WQI. In this study area the Water Quality Index varies between 10 and 23 and hence falls under the 'Good' water quality category. Water Quality Index (W.Q.I) and status of water quality are shown in table.1 and table.2 shows Weighted mean for nine parameter. Results of samples and their water quality index are tabulated in table.3.

Table 1: Water Quality Index (W.Q.I) and status of water quality

Water Quality Index	Water Quality Status
0 – 50	Good Water Quality
51 – 75	Poor Water Quality
76 – 100	Very poor water Quality
>100	Unsuitable for drinking purpose

Table 2: Weighted mean for nine parameter

Chemical Parameter	WHO Standards	Weight(wi)	Relative weight Wi = wi / $\sum_{i=1}^{n}$
P^H	6.5 – 8.5	1	0.028
TDS (mg/l)	500	1	0.028
DO (mg/l)	5	3	0.085
TH (mg/l)	300	5	0.142
Na (mg/l)	200	5	0.142
K (mg/l)	200	5	0.142
Ca (mg/l)	75	5	0.142
Mg (mg/l)	50	5	0.142
Cl (mg/l)	250	5	0.142

Table 3: Results of samples and their water quality index

Pond No.	WQI	Quality
A1	14.32456973	Good
A2	23.09065253	Good
A3	22.8662168	Good
A4	10.99326307	Good
A5	18.26743227	Good
A6	11.55324107	Good
A7	22.77429773	Good
A8	14.10726973	Good
A9	12.4037552	Good
A10	12.48499307	Good
A11	13.4378672	Good
A12	12.7376276	Good
A13	16.45844973	Good

GIS Analysis

Fig.16 shows the surface elevation of the study area. In this figure, the study area has elevation range between 31 – 294. The maximum elevation value is 294 and the minimum elevation value 31. In this study area only a small portion of then area is highly elevated and most of the portion of the study area is low elevated. TIN represents the elevated earth surfaces in triangular shape. The classification of the study area according to their elevation value represented in the fig.5. Relative relief maps show the ground height variation or slope of that location. From the fig.16 slope value ranges between 30 and 50. Low relative relief indicates that the region is almost flat land and appearing mature stage of geomorphic evolution .

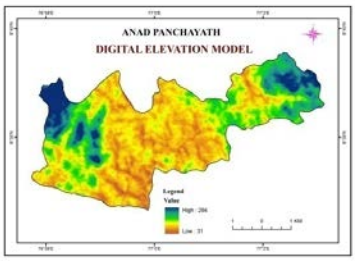

Fig 5: DEM of the study area

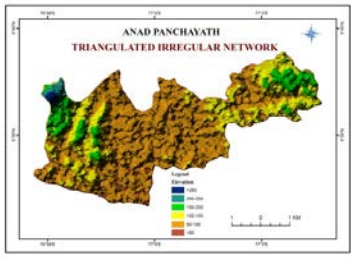

Fig 6: TIN of the study area

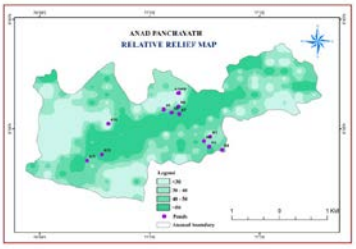

Fig 7: relative relief of the studyarea

IV. CONCLUSIONS

The present study shows that Water Quality of 13 ponds in Anad panchayath is of good quality and this pond water is suitable for domestic and agricultural purposes. At the same time, Slight variations in one or two parameters from the permissible limits need to be given solemn consideration. Based on the findings of the study, an Action Plan is also suggested for improving the quality of the ponds. This ensures sustainable utility of this resource for the benefit of the present as well as the future generations.

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REFERENCES

[1] APHA, 1998. Standars methods for examination of water and waste water 20th Edition. Public Health Association, Washington.

[2] Chauhan N. B. and Thakor F.J (2012). A Study of Water Quality Index (W.Q.I) of Heranj Lake, Dist. Kheda – Gujarat, Asian J. Exp. Biol. Sci.,3(3), 582-588.

[3] Gajanand thakre, neelesh shrivastava, D. Mishra and A. Bajpai (2010). Limnological studies to assess the water quality of “tapti pond” at multai district, betul (m.p.), int. J. Chem. Sci.: 8(4), , 2105-2114.

[4] Gayatri neelam shastri, M.L sonar and C. DAS (2007). Physico-chemical studies of ponds water with special reference to water quality Vol. 2(1), 71-72.

[5] Gupta M. and Srivastava, P.K.,(2010). Integrating GIS and remote sensing for identification of groundwater potential zones in the hilly terrain of Pavagarh, Gujarat, India, Water Int., 35 : 233–245.

[6] Krishna Kumar S, A. Logeshkumaran N. S., Magesh Prince S, GodsonN., Chandrasekar (2014). Hydrogeochemistry and application of water quality index(WQI) For ground water quality assessment , Anna Nagar, part of Chennai City, Tamil Nadu, India.

[7] Mishra, A., J.S. Datta Munshi, M. Singh (1994). Heavy metal pollution of river Subarnarekha in Bihar. Part I: Industrial effluents. J Fresh Water Bio, 6(3): 197-199.

[8] Parashar C., Dixit S. and Shrivastava R (2006). Seasonal Variation in Physico-chemical characteristics in Upper Lake Bhopal. Asian J.Exp. Sci., 20 (2), 297-302.

[9] Sen S., Paul M.K and Borah M (2011). Study of some Physico-Chemical Parameters of Pond and River water with reference to Correlation Study, Int. J. Chem Tech Res., 3(4), , 1802-1807.

[10] Shinde, S.E., Pathan, T.S., Raut, K.S. and Sonawane, D. L.(2011). Middle East J.of Sci. Research.8(3): 544-554.

[11] Suresh Kumar, Roshni Adiyecha and Tarun Patel(March 2014). Seasonal Variation in the Water Quality of Lahru Pond Located In Himachal Pradesh Int. Journal of Engineering Research and ISSN : 2248-9622, Vol. 4, Issue 3(Version 1), pp.507-513.

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