Spatial Evaluation of Pond Water Quality Using Gis: A Study from Athiyannoor Block Panchayath, Thiruvananthapuram, Kerala, India

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Abstract- Ponds play many vital roles in maintaining the hydro geological equilibrium of an area. In the present investigation, an attempt has been made to determine the water quality of Athiyannoor Block Panchayath by using GIS techniques and water quality index method. A total of thirteen parameters were analyzed of which nine were considered for calculating the WQI. Water Quality Index has been proved to be a useful technique for the overall assessment of the water quality of a water body. In this study, GIS was employed for obtaining the geospatial data of the study area with respect to the themes, Drainage, DEM, TIN and Relative Relief which in turn have significant implications on the water quality of the ponds. Site specific action plans has also been suggested for this study, which ensure the protection and conservation of these small water bodies.

Index Terms- GIS, Water quality, Physico-chemical parameters, Water Quality Index(WQI)

I. INTRODUCTION

The global water demand has increased tremendously in recent years, and ponds are one of the most reliable and economical sources of water. Ponds 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. However pond may have been natural water sources exploited by man at different time to meet different needs or may have been created for a multitude of different purposes (Rajagopal et al., 2010). The present study proposes to determine the spatial variation in pond water quality of Athiyannoor Block Panchayath by using GIS techniques and water quality index method. Geographic Information System (GIS) has emerged as an effective tool for monitoring and the management of water quality and it also serves as a tool in delineating the water quality. Water Quality Index or WQI aim at giving a single value to the water quality of a source, reducing great amount of parameters in to a simpler expression and enabling easy interpretation of monitoring data (Singh et al. 2013). The quality of water may be described according to their physicochemical characteristics. The water quality was assessed and compared with the drinking water quality standards (BIS, 1992) to identify areas for potential pollution sources based on the WQI.

II. STUDY AREA

The study area selected for the present investigation is Athiyannoor Block Panchayath of Thiruvananthapuram district which is situated at 8^o 30' to 8^o 15' North latitude and 76^o 52' 30" to 77^o 7'30" East longitude, Kerala. A location map of the study area is shown in Figure 1. Drainage of this study area constitutes Neyyar River and its tributaries.

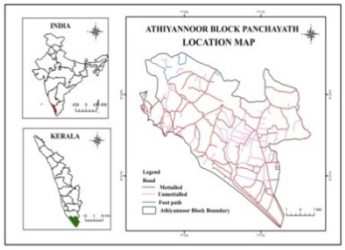

Figure 1: Location map of the study area

III. MATERIALS AND METHODS

Spatial analysis part of the study included generation of specific thematic maps of the study area using GIS. The materials used for the derivation were Survey of India Topographic sheets of No: 58H/3/NW, (1989-1990) of 1:25,000 scale. The software used for the processing was Arc GIS of version 9.3. The raster data was interpreted and digitized to generate the thematic maps of administrative boundary, transportation, drainage, DEM, TIN, etc.

The samples were collected from thirty seven ponds in Athiyannoor Block Panchayath. A map depicting the location of the water sampling sites is given as Figure 2. The sampling and analysis of various physico-chemical attributes were done following the standard procedures as detailed in APHA (1995) and by Trivedy and Goel (1984). WQI is a superior way for understanding water quality issues by integrating complex data and generating a score, which ultimately describes the water quality status (Tiwari et al., 1985, Singh, 1992, Rao, 1997, Mishra et al., 2001). Relative weight of physic-chemical parameters is shown in Table 1. WQI was calculated using the expression, WQI = $\sum_{i=0}^{n} Wiqi$. Water quality category, was determined on the basis of water quality index

Table 1: Relative weight of physic-chemical parameters

Parameter	Standard (BIS, 1992)	Weight (Wi)	Relative weight ($wi/\sum_{i=1}^{n} wi$)
pH	6.5-8.5	1	0.028
DO	5	1	0.028
TDS	500	3	0.085
Na	200	5	0.142
TH	300	5	0.142
Ca	75	5	0.142
Mg	50	5	0.142
Cl	250	5	0.142
K	200	5	0.142

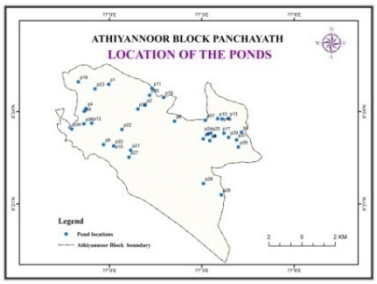

Figure 2. Location of sampling site

IV. RESULTS AND DISCUSSION

The present study assessed the spatial and hydrological variables in the study area.

Spatial Analysis:

In the present study DEM, TIN and Relative Relief is used to extract a wide variety of landscape features, conventionally associated with drainage and hydrological applications. TIN (figure 3) is a method of constructing surface from a set of irregularly space data points. In the present study area the elevation ranges from 10 to 90m. The DEM (Figure 4) generation is very useful for obtaining height information of the area. The highest points are identified on the Eastern and North Western part of the study area viz. Kanjiramkulam and Venganoor respectively. The relative relief (Figure 5) of this region gives a clear picture of nature and extent of local relief. In the study area, five relative relief classes were identified and high and Low relief of >40 and <25 respectively were also reported.

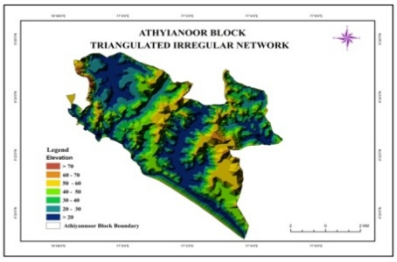

Figure 3: TIN of the study area

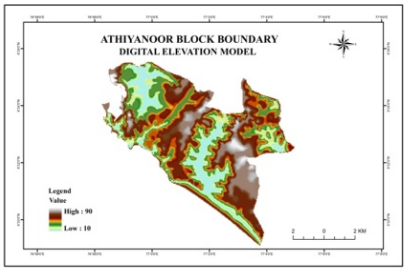

Figure 4: DEM of the study area

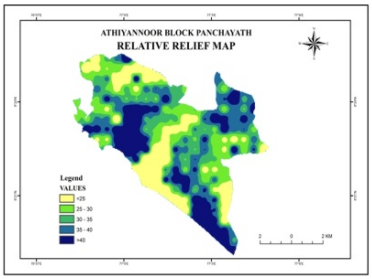

Figure 5: Relative Relief of the study area

Water quality

The study analysed variations in physico-chemical characteristics with respect to the following parameters the results of which are discussed below.

pH

In this study pH values were found in the range from 4.51 to 7.70. pH lower than 4 produce sour taste and higher value above 8.5, a bitter taste. This may be due to the enhancement of microbial activity, causing excessive production of CO_2 and reduced pH. The pH affects most of the biological processes and biochemical reactions in water body (Arya et al., 2011a, b).

Electrical Conductivity

In the present study area, the maximum value of EC 517 µS /cm was found in pond P9 and minimum was found in pond P14. The pond P9 (517.7 µS), P36(260 µS), P34(313 µS), P37(279 µS) is deviating from the standards (225 µS /cm) prescribed for drinking Water Quality (BIS, IS-10500, FAO) and other ponds within the permissible limit. It may be due to the presence of low amount of minerals. A sudden increase in conductivity indicates addition of some pollutants to it (Trivedy and Goel, 1984).

Total Dissolved Solids

The TDS concentration in the present study area ranged from 25.44 (P 25) – 486.8 (P 9) mg/L. The permissible value recommended for TDS is 500 mg/1 prescribed by IS 10500 and BIS, FAO. All ponds are observed within the permissible limit. The pond P9 (486.8) shown very high TDS. Most pond water samples are observed in low TDS so it indicates the water is less mineralized and comparatively contains lesser pollutants.

Dissolved Oxygen

Measurement of dissolved oxygen is a primary parameter in all pollution studies. The minimum DO was recorded as 0.62mg/L in the pond P9 and the maximum was recorded as 10.96 in the pond P37. The permissible value recommended for DO is 5mg/L as per Indian standard. Low value of DO is observed due to the high rate of oxygen consumption by oxidisable matter. In the present study, most of the ponds shows high DO which may be due to the increased solubility of oxygen at lower temperature.

Salinity

The NaCl concentrations in the study area ranges between 27.99 (p14) to 260.5 (P9) ppm which are well within the drinking water quality standards.

Temperature

Temperature is one of the most important factors in the aquatic environment (Dwivedi et.al, 2002). The temperature variation in the study area ranges between 26.5^{o}C (P18) and 29.6^{o}C (P28).

Sodium and Potassium

Na and K concentration varied from 2(P26) to 67(P33) mg/L and 0 to 10mg/L respectively. The maximum value was observed in pond P28. The present study indicates that the Na and K values are within the permissible limit (200mg/L) as per Indian standards.

Chloride

In the concentration of chloride ranges from 6.75 (P6) to 42.6(P34) ppm. 250 mg/1 being the desirable limit for chlorides, concentration greater impart a salty taste to water.

Total Hardness

Hardness concentration values ranged from 15 to 105 ppm. The maximum value was observed in the pond P9. The minimum concentrations were observed in the ponds P6, P7, P14, P11, P15. Hence in the study area, pond water is considered as moderately soft water. According to the APHA (1998), the desirable limit for total hardness is 300 mg/l.

Calcium and Magnesium

Ca and Mg values varied from 0 to 28.6 ppm and 0 to 10.89ppm. Magnesium is often associated with calcium in all kind of water, but it's concentration remain generally lower than the calcium (Venkatasubramani et al., 2007).

Alkalinity

The permissible value of alkalinity as recommended by the Indian standards is 250 mg/L as $CaCo_3$. In the study area, alkalinity varied from10 (p22) to 100 (P9) mg/L.

Water quality index

In this study, the water quality index of pond water samples are found in the range of 3.86 to 38.11. This shows that almost 91% of water sample is belonging to excellent category whereas the rest falls in good category (ie. P10, P34, P37). Different levels of Water quality index and their respective water quality status are shown in Table 2. . WQI classification for individual sample (Table 3) is categorized by using this expression. As per the water quality rating, the status of water body is suitable for the human use since it falls under excellent to good conditions. However, the three ponds which do not fall in the excellent category (P37, P34, and P9) undoubtedly has issues as far as certain parameters are concerned. The values of parameters, pH (figure 6), DO (figure 7) and EC (figure 8) found to be exceeding the limits prescribed for drinking water standards (BIS, 1992). Hence the study identifies three critically polluted sites in the study area viz. Pond, 39, 34 and 9, the reason for which can be attributed to high inhabitation and human influences such as disposal of wastes, washing of clothes and cattles by the local people.

Table 2: Water Quality Index (WQI) and water quality status

WQI	Water Quality Status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unfit for drinking

Table 3: WQI of pond water samples in Athiyannoor Block

Pond no	WQI index	Status
P1	13.95	Excellent
P2	15.98	Excellent
P3	12.72	Excellent
P4	13.94	Excellent
P5	16.61	Excellent
P6	6.26	Excellent
P7	6.47	Excellent
P8	10.82	Excellent
P9	38.11	Good
P10	11.15	Excellent
P11	14.67	Excellent
P12	18.58	Excellent
P13	8.50	Excellent
P14	3.86	Excellent
P15	5.66	Excellent
P16	20.58	Excellent
P17	10.34	Excellent
P18	13.91	Excellent
P19	17.40	Excellent
P20	7.88	Excellent
P21	8.40	Excellent
P22	15.11	Excellent
P23	16.88	Excellent
P24	13.27	Excellent
P25	5.06	Excellent
P26	13.41	Excellent
P27	18.32	Excellent
P28	22.06	Excellent
P29	12.82	Excellent
P30	9.79	Excellent
P31	16.17	Excellent
P32	11.91	Excellent
P33	20.25	Excellent
P34	30.77	Good
P35	11.03	Excellent
P36	25.56	Excellent
P37	29.01	Good

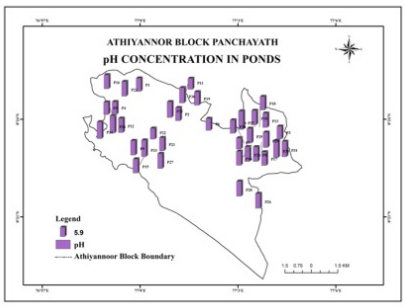

Figure 6: pH variation in the study area

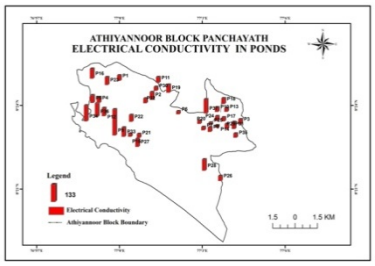

Figure 7: EC variation in the study area

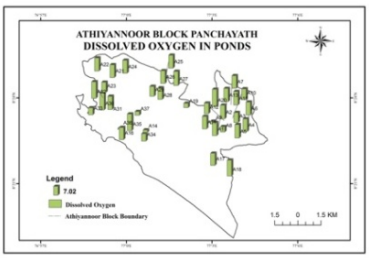

Figure 8: DO variation in the study area

V. CONCLUSION

In this study GIS was employed for obtaining the geospatial data of the study area viz. Drainage, DEM, TIN and Relative Relief which in turn have significant implications on the water quality of the ponds in the study area. The present findings indicate that water quality of the majority ponds in Athiyannoor Block are in excellent condition and hence suitable for drinking and domestic purposes. Stringent rejuvenation and reconstruction methods need to be adopted for the said sites since these are used as domestic sources of drinking water. The study has thus proved the application of Water Quality Index as a useful technique for the overall assessment of the water quality of a water body.

REFERENCES

[1] APHA, "Standard Methods for the Examination of water and wastewater", American Public Health Association, Washington D. C., 1000p, 1998.

[2] BIS, "Indian standard specification for drinking water", BIS 10500, 1992.

[3] P.C. Mishra and R.K Patel, "Study of the pollution load in the drinking water of Rairangpur, a small tribal dominated town of North Orissa", Indian J. Environment and Ecoplanning, 5(2): 293-298, 2001.

[4] T.Rajagopal, A.Thangamani, S.P.Sevarkodiyone, Sekar M. and G. Archunan ," Zooplankton diversity and physicochemical conditions in three perennial ponds of Virudhunagar district, Tamilnadu", Journal of Environmental Biology 31:265-272, 2010

[5] N.S Rao, "Studies on Water Quality Index in Hard rock Terrain of Guntur District, Andhra Pradesh, India", National Seminar on Hydrogeology of Precambrian Terrains and Hard Rocks Areas, Dharwad, 129-134, 1997.

[6] D.F Singh, "Studies on the water quality index of some major rivers of Pune, Maharashtra" Proceedings of the Academy of Environmental Biol., 1(1), 61-66, 1992.

[7] P.K. Singh, A.K. Tiwari and M.K.Mahato, "Qualitative assessment of surface water of west Bokaro Coalfield, Jharkhand by using Water Quality Index method" Inter National journal of chem. Tech Research, 5(5), 2013.

[8] T.N. Tiwari, and M.A. Mishra, "A preliminary assignment of water quality index of major Indian rivers", Indian J. Environmental Protection, 5: 276-279, 1985.

[9] A.K. Trivedy and P.K. Goel, "Chemical and Biological methods for pollution studies". Environmental studies, Karad, India, 1984.

[10] R.Venkatasubramani and T.Meenambal, "study of subsurface water quality in mattupalayam Taluk of Coimbatore district Tamil Nadu", Nat. Environ. Poll. Tech 6,307-310. 2007

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