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Generation of water quality index map using geographical information system

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■ **ABSTRACT :** In this study different physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), calcium (Ca^+), magnesium (Mg^+), sodium (Na^+), potassium (K^+), bicarbonate (HCO_3), carbonate (CO_3), chloride (Cl^-) and sulphate (SO_4) present in pre and post-monsoon samples of the study area were determined using standard methods. Spatio-temporal variations of water quality parameters in the study area were analysed by using GIS techniques. The water quality index was computed by adopting the method of Tiwari and Mishra (1985) and Sinha and Saxena (2006) to determine the suitability of the groundwater for drinking purpose. The results show that in the pre monsoon period the 22.40 per cent area has good quality water for drinking purpose. The 61.62 per cent area has poor quality and 15.98 per cent area has very poor quality groundwater for drinking purpose. The 40.30 per cent has good quality and 59.70 per cent area has poor quality ground water for drinking purpose in post monsoon. The good quality water mainly occurred in East and middle portion of catchment area.

■ **KEY WORDS :** GIS Techniques, Physico-chemical parameters

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Groundwater has become the major source of water supply for domestic, industrial and agricultural sectors of many countries. In recent years, many cities of developing countries are experiencing rapid demographic growth due to rural exodus. Urbanization and the unregulated growth of the population have altered the local topography and drainage system directly which affect both quality and quantity of the groundwater (Vasanthavigar *et al.*,2010). Inadequate environmental protection measures in coal mining, waste dumps, thermal power plants, steel plants, sugar factories, fertilizer production units and cement plants have resulted in significant water pollution (Chatterjee *et al.*,2010). Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and sub-surface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrological and human factors frequently cause periodic changes in groundwater quality (Milovanovic, 2007; Sreedevi, 2004 and Nag and Das, 2014). In this study groundwater quality was assessed for drinking purpose by analysing different physico-chemical parameters.

■ METHODOLOGY

Study area:

The Jaisamand lake catchment is located in the Udaipur district which falls semi-arid region of Rajasthan bounded by Longitude 73^{0}45' E to 74^{0}25'E and Latitude 24^{0}10' N to 24^{0}35' N. The lake is also a prime source supply drinking water for the city of Udaipur located at a distance of about 52 km from the lake. The Jaisamand lake with a gross capacity of 414.6 Mm^3 and live storage of 296.14 Mm^3, is Asia's second largest artificial water storage reservoir built across the Gomati river. In Jaisamand catchment Gomati, Thavaria, Siroli, Vagurwa, Jhamri, Sukhali, Godi, Makradi and Bhangar are the major rivers. The total catchment of Jaisamand lake is 1857.87 km^2 with highest elevation is 693 m above mean sea level.

Data collection:

For the analysis of groundwater quality of the catchment, pre and post monsoon groundwater samples were collected in sampling bottles by dividing the entire basin into 6km x 6km grid. Fig. A shows the location map of groundwater sampling sites. The groundwater samples were collected in plastic bottles thoroughly cleaned and sterilized. The samples were collected using rope and bucket. These samples were analysed in the laboratory using standard methods to find out different water quality parameters such as pH, EC, TDS, CO_3, HCO_3, SO_4, Cl, Ca, Mg, Na and K. AR grade reagents were used for the analysis and double distilled water was used for preparation of solutions. The suitability of groundwater for drinking purpose was determined on the basis of water quality index.

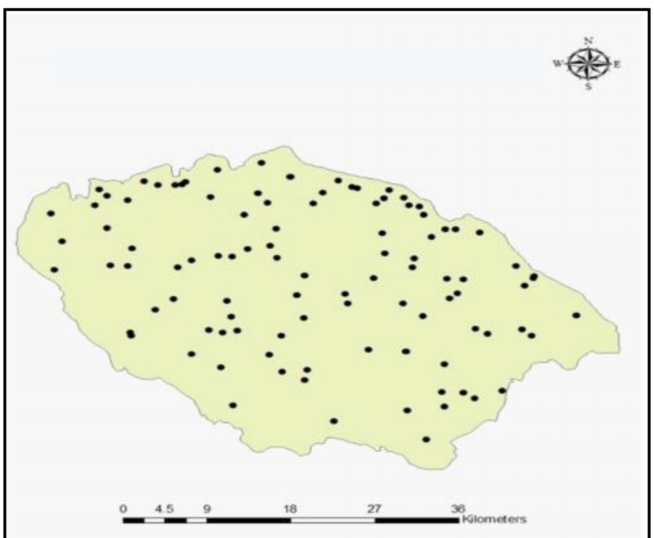

Fig. A : Location map of groundwater sample sites

Water quality index (WQI):

WQI is computed to reduce the large amount of water quality data to a single numerical value. WQI reflects the composite influence of different water quality parameters on the overall quality of water. The detail procedure as shown in Fig. B and classes of water quality index as shown in Table A. Water quality index was computed by adopting the method of Tiwari and Mishra (1985) and Sinha and Saxena (2006) to determine the suitability of the groundwater for drinking purpose as follows:

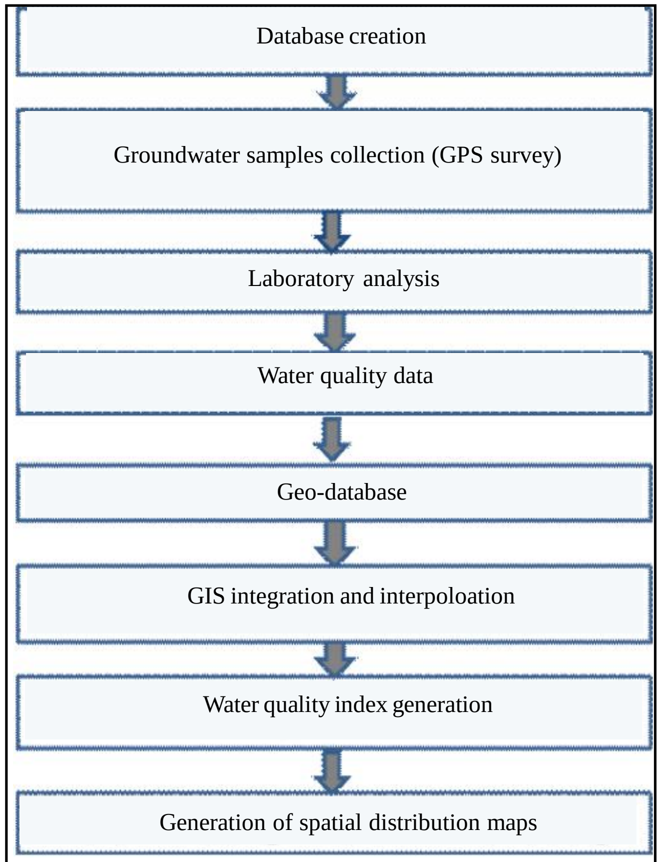

Fig. B : Flow chart of generation of WQI maps

Table A : Water quality index and status of water quality

Water quality index	Water quality status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unsuitable

$$WQI = \text{Antilog}\left(\sum_{i=1}^{n} W_i \log_{10} q_i\right)$$

where,

w_i = Weightage factor of i^{th} parameter

q_i = Quality rating of i^{th} parameter

w_i is calculated from the following equation,

$w_i = k/s_n$

where,

$$k = \frac{1}{\frac{1}{Vs_1} + \frac{1}{Vs_2} + \cdots\ldots\ldots\frac{1}{Vs_n}}$$

s_n = Standard value of i^{th} parameter

q_i is calculated from the following equation,

$$q_i = \left[\frac{(V_a - V_i)}{(V_s - V_i)} x100\right]$$

where,

V_a = Actual value obtained from laboratory analysis of i^{th} parameter

V_s = Standard value of i^{th} parameter obtained from BIS standard of the water quality parameter

V_i = Ideal value obtained from the standard table (pH = 7 and 0 for all parameters).

■ RESULTS AND DISCUSSION

Water quality index maps for pre monsoon and post monsoon period were prepared by assigning weights to the parameters (Table 1). The Fig. 1 shows that in the pre monsoon period 22.40 per cent area has good quality water for drinking purpose and this zone includes Ajani, Agar, Deoliya, Kund, Tekan, Kelwa, Sakalda, Arniya etc, villages. The 61.62 per cent area has poor quality and 15.98 per cent area has very poor quality groundwater for drinking purpose. The Fig. 2 shows that 40.30 per cent has good quality and 59.70 per cent area has poor quality groundwater for drinking purpose in post monsoon.

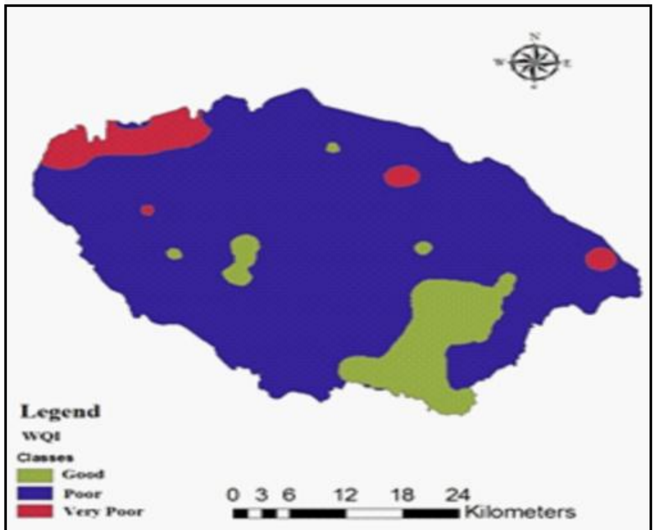

Fig. 1 : Water quality index map for pre-monsoon period

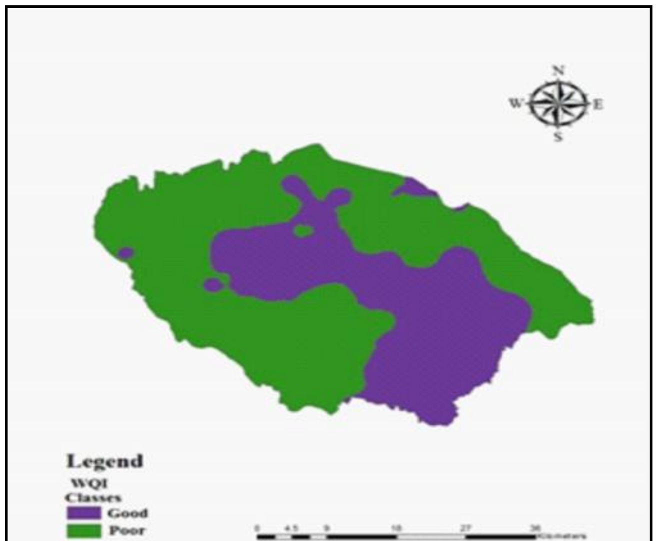

Fig. 2 : Water quality index map for post-monsoon period

Table 1 : Water quality parameters, their BIS standards and assigned weights

Parameter	Standard (mg/lit)	$1/S_n$	k	Weightage (W_n)
pH	8.5	0.118	6.05	0.71
EC	300	0.003	6.05	0.02
TDS	500	0.002	6.05	0.01
Ca	75	0.013	6.05	0.08
Mg	50	0.020	6.05	0.12
Cl	250	0.004	6.05	0.02
SO_4	200	0.005	6.05	0.03
Sum		0.165		1.00

The good quality water mainly occurred in East and middle portion of catchment area.

Conclusion:

On the basis of the results it is concluded that most of the study area in post monsoon period shows the groundwater suitable for the drinking purpose.

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