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WATER QUALITY ANALYSIS USING GIS INTERPOLATION METHOD IN SERTHALAIKADU LAGOON, EAST COAST OF INDIA

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ABSTRACT

Water quality analysis is prime important to understand the wealth of living organism and environmental condition in water bodies. In GIS, ordinary Kriging interpolation method has been applied for surface analysis of water quality parameters such as temperature, salinity, pH, chlorophyll-a (Chl-a) and suspend sediment (SS), to carried comparison analysis between monsoon and summer season in lagoon at Vedaranyam wetland. Kriging is an approach to mapping the water quality parameters for analyzing the dispersion patterns. The results of the spatial distribution analysis has been indicated in lagoon around salt pan and aquaculture area have high saline condition reach about 36 parts per thousand (ppt) and in monsoon seasons suspended sediment reach maximum due to river runoff in the study area.

Keywords: lagoon, interpolation, chlorophyll-a, suspended sediments, salt pan, aquaculture, mapping.

INTRODUCTION

Water quality parameters analyses are important process for regular monitoring and to understand the environmental conditions. In the water bodies, unfeasible to collect the water samples in all the points and which has very expansive also. For this circumstance GIS is a leading tool and has great potential for use in environmental problem solving in several areas, including engineering and environmental fields[1], interpolation method in GIS is able to predicting the value of attributes at unsampled sites from measurements made at point locations within the same area[2]using Geo Statistical Analysis Approach, it can be described as a set of techniques or tools used to predict values of a variable distributed in space or time. This is used to examine the sample data, construct variogram models and produce interpolated maps[3, 4]

Kriging method is called the best linear unbiased estimator since it tries to have a mean residual error equal to zero. It aims at minimizing the variance of the errors and hence is a strong advantage over other estimation methods like local sample mean and inverse distance weighting[5]. Inverse distance weighting (IDW) is commonly used and is easy to automate, and this particular tool has been carefully developed to work efficiently for this application; however, Environmental Protection Agency (EPA) recognized that kriging would be a more accurate option[6] other researchers have implemented kriging is surface water applications and have addressed the assumption of stationarity by either splitting the data into regions where stationarity van more reliably be assumed[7] or fitting a spatial trend to the data to remove nonstationarity[8].The main objective of this study is to prepared spatial distribution maps for water quality parameters in Seruthalaikadu lagoon, vedaranyam wetland using kriging interpolation method and comparison analysis has carried. Vedaranyam wetland is complex ecosystem comprises of mangroves, salt marshes, shrub and marine algae[9]

Study area

The study area lies in Thanjavur district of Tamil Nadu and it falls within the co-ordinates of latitude10° 15′N to 10° 25′N and longitude 79° 20′E to 79° 55′E. The location of the study area is shown in Figure-1.

This study area is called medium tropical transitional bio-climate, which is characterized by monthly average temperature above 27^0 C. total annual rainfall varies from 1000 to 1300mm with a dry period of 5 to 6 months.

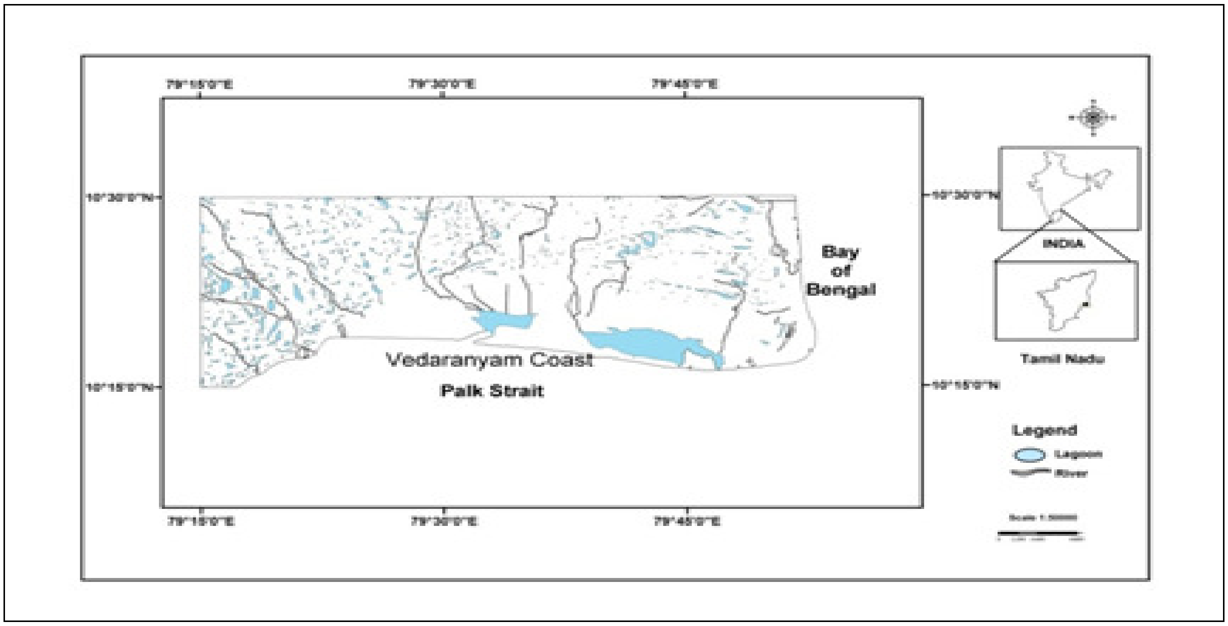

Fig.-1: Study area location map

Water Sample Analysis

Water quality parameters have been collected in the study area in November 2015 for monsoon season, June 2016 for summer season with 7 GPS (Global Positioning System) location sampling points and analyzed in the laboratory. Some water sample parameters measurements have been noted on the spot observation using aqua- instrument such as pH (relative scale of 0-14) by using LT pH meter, salinity (ppt) using salinometer, temperature (°C) by thermometer and light intensity (lux) by sacchi disk.

Laboratory Analysis

The chlorophyll-a concentrations have been estimated by using the spectrophotometer 6300 Jensey at environmental laboratory. The chlorophyll-a concentration has measured by using the technique and calculation described by Parsons *et al*[10]. Known volumes of water (500ml-1000ml) have been filtered through a filter paper (Millipore, size 0.5 mm). As the water is being filtered, a few drops of suspension of magnesium carbonate have been added to prevent acidity on the filter. Pigments have been extracted from the filters in 90% acetone. The wavelengths involved are 750nm, 664nm, 647nm, and 630nm.
Suspended particulate materials (dry weight (mg L^{-1})) were determined gravimetrically as outlined in Strickland and Parsons (1972) and as specified in JGOFS protocols[11]**.** Samples were filtered through 0.4 μm pre-weighed polycarbonate filters. The filters were washed with three 2.5 - 5 ml aliquots of distilled water and immediately dried in an oven at 75°C. The filters were then re-weighed in laboratory, using an electro balance.

Geo Statistical Analysis

Water samples have been collected with GPS location points. These are imported in GIS and have interpreted using GIS Kriging (of Geo-statistics) can be expressed as follows: There are n observation points with values Z(x1), Z(x2),..., Z(xn) at observation points x1, x2,...,xn distributed in the neighborhood of Xo. The best estimator at Xo is in the form of:

$$Z^*(x_o) = \sum_{i=1}^{N} \lambda_i Z(x_i) \qquad i = 1,\ldots, n \tag{1}$$

λ - kriging weight are determined such as to minimize the error variance σ2 k = var [Z*(xo) - Z (xo)] checking for the unbiasedness constraint : E[Z*(xo) - Z (xo)] = 0 (mean error = 0). For interpolation by kriging, one must determine correctly variograms (also called structural functions). Variogram is defined as a half of mathematical expectation of random variables. Thus,

$$\gamma\ (h) = \frac{1}{2}\,[Z(x) - Z\ (x+h)]^2 \tag{2}$$

Where, Z(x), Z(x+h): two known values with separation distance h
N (h): number of pairs of data points with separation distance h

Using kriging to mapping the water quality parameters for analyzing the dispersion patterns shown in Figure-2.

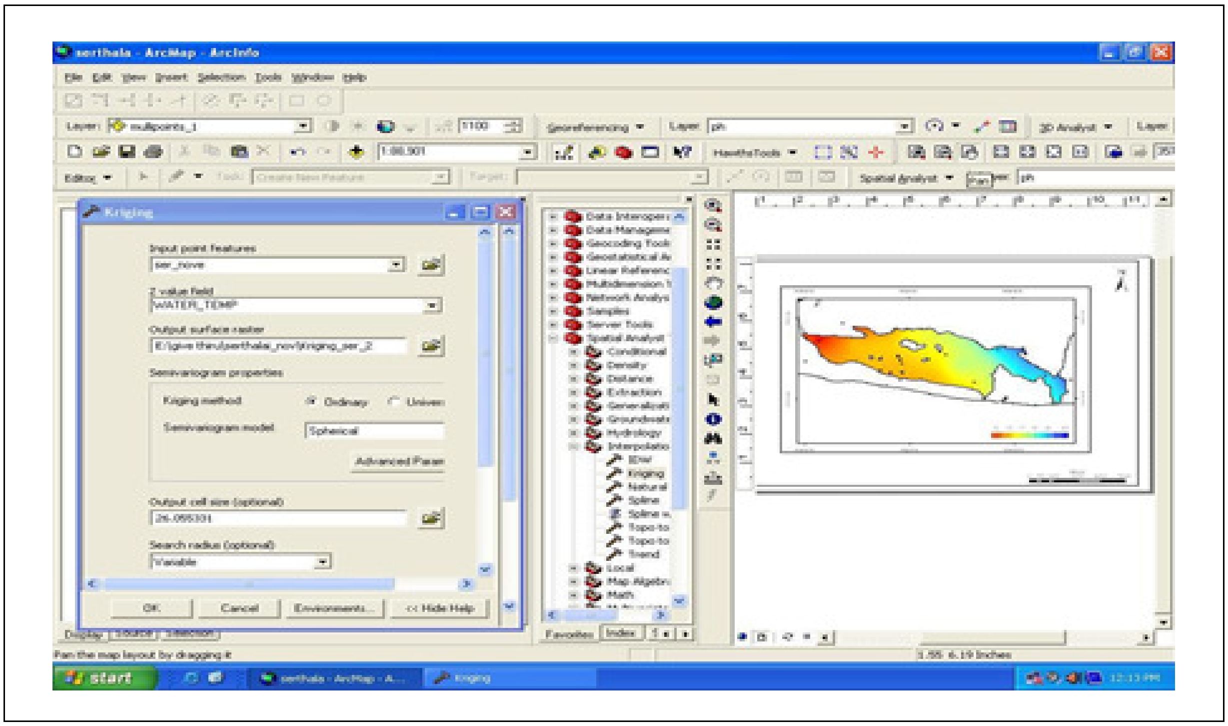

Fig.-2: Water quality parameter mapping using interpolation Kriging Method

RESULTS AND DISCUSSION

Kriging interpolation methods are frequently used to estimate values of water quality parameters in locations where they are not measured in the study area for comparison analysis between summer and monsoon season. Spatial distribution pattern of water quality parameters in the study area and they are discussed below

Temperature

During summer season, in general, sea surface temperature tends to increase from west to east. Maximum temperature of 29°C has observed in the east side and the minimum temperature of 26°C has observed in the western side of the lagoon. In monsoon season the maximum temperature of 29°C has observed in western side of the lagoon and the minimum temperature of 26°C has observed in eastern side of the lagoon. From this observation temperature does not affect the environment and it is always normal throughout the year. The temperature distribution pattern map in lagoon has shown in Figure-3.

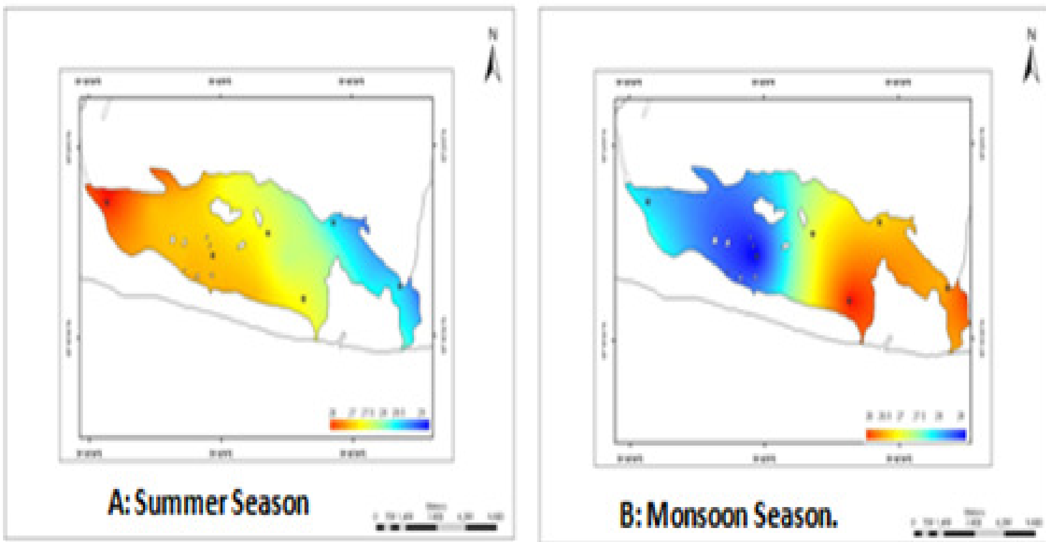

Fig.- 3: Spatial distribution of temperature (°C)

Salinity

It ranges between 29 to 36ppt during the summer season in some sampling points in the study area; this is very high comparing to other sample location points which is due to effluents coming out from salt industries. This place is famous for "Vedaranyam Thandi Yatra". During this season, the salinity tends to be higher towards northeast side of the lagoon where there are many industries present in this region. Centers of low salinity had detected in waters towards west of the lagoon. Salinity values of monsoon season had very low than those of during the summer season. The high variability of salinity in this area is affected by river inflow. During the monsoon season, is influenced by the incoming water mass from Cauvery river tributaries that has no salinity and cause low saline condition. Maximum salinity of 23ppt has observed in southern side of the lagoon and minimum salinity of 13ppt has observed in almost in the northern part of the lagoon. The spatial distribution of salinity shown in Figure-4.

pH

The distribution of pH during the summer season in lagoon, centers of high pH concentration 7.7 has recorded in the waters to the east of lagoon. A center of low pH concentration of 6.7 has found in the western part of lagoon. In monsoon season pH concentration range varied from 6.8 to 6.5. pH decreases significantly from east to western side of the lagoon (Figure-5).

Chlorophyll-a

During summer season in lagoon the chlorophyll-a concentration has high in western side and low in the eastern side of the lagoon. This is due to high saline condition occurring in western side of the lagoon and effluents coming from aquaculture pond. Maximum concentration of chlorophyll-a 3.7 mg/m^3 and the minimum 3.2 mg/m^3 has observed. In monsoon season high chlorophyll-a concentration of 2.48 mg/m^3 and lower concentration of 2.02 mg/m^3 has observed (Figure-6).

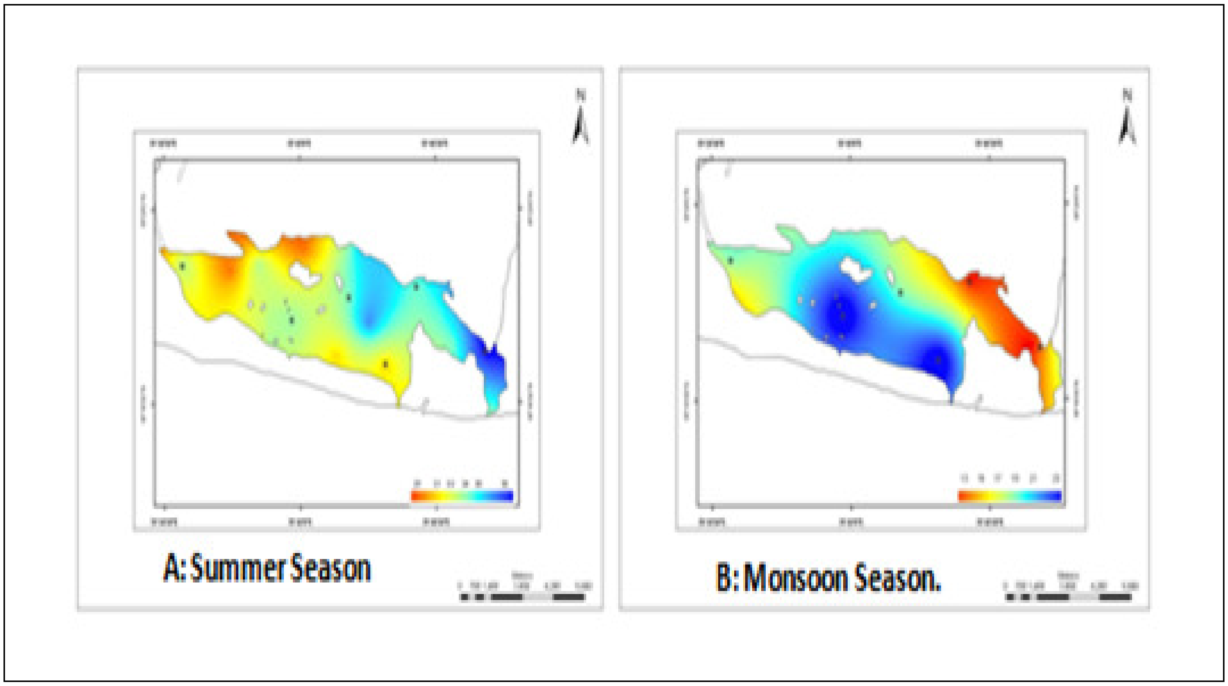

Fig.- 4: Spatial distribution of salinity (ppt)

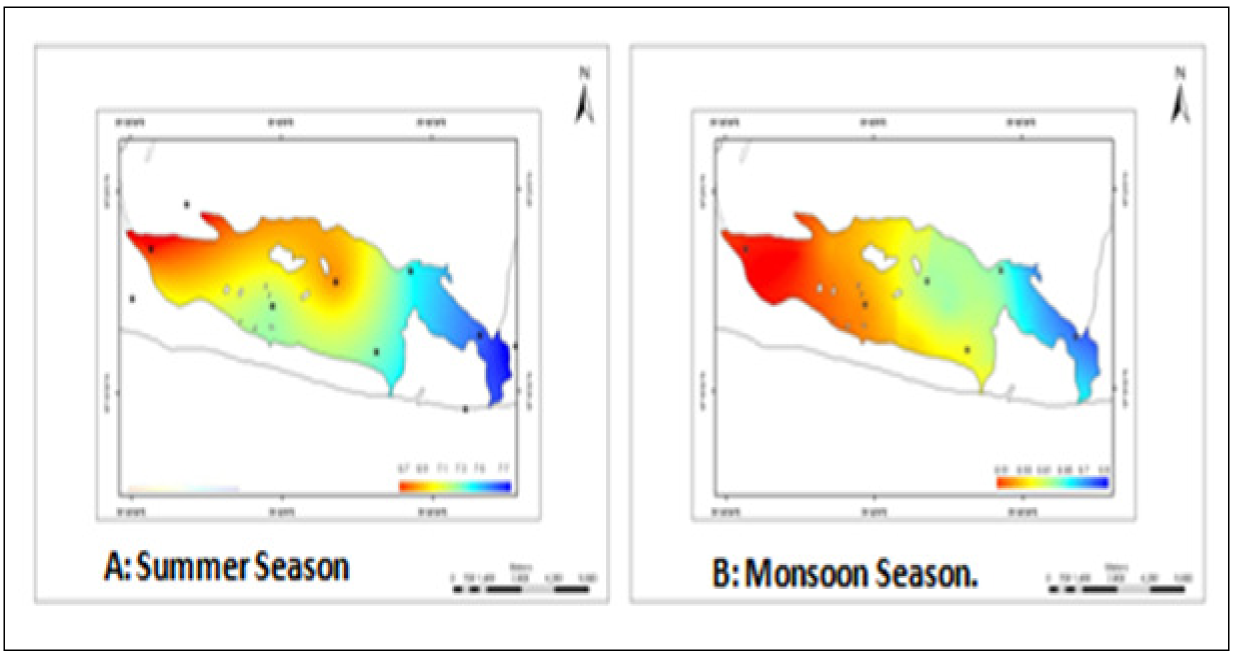

Fig.-5: Spatial distribution of pH

Suspended Sediment (SS)

The distribution of suspended sediment concentration in lagoon during summer season, high concentration of SS has observed in the eastern and southern part of the lagoon and in the monsoon season it has high in northern part of the lagoon like the same as is Mullipallam lagoon. Maximum concentration of SS has observed of 12 mg/l during monsoon season and minimum concentration of 7.3 mg/l has observed in summer season. The spatial distribution of ss has shown in Figure-7.

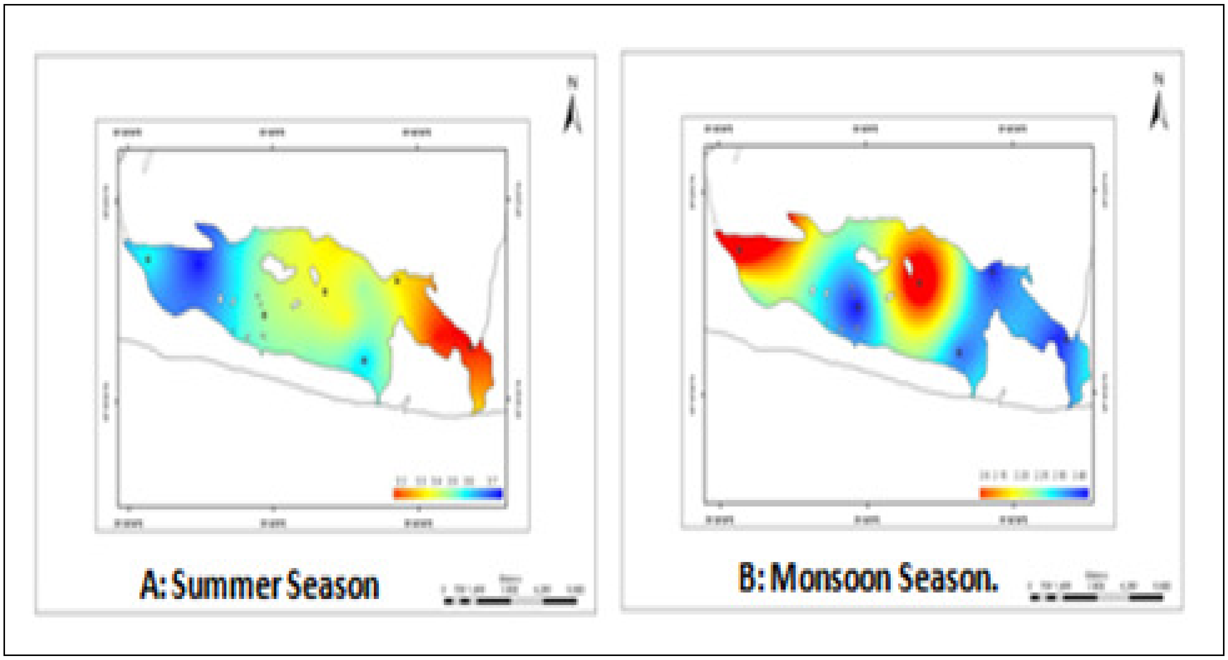

Fig.-6: Spatial distribution of Chl-a (mg/m^3)

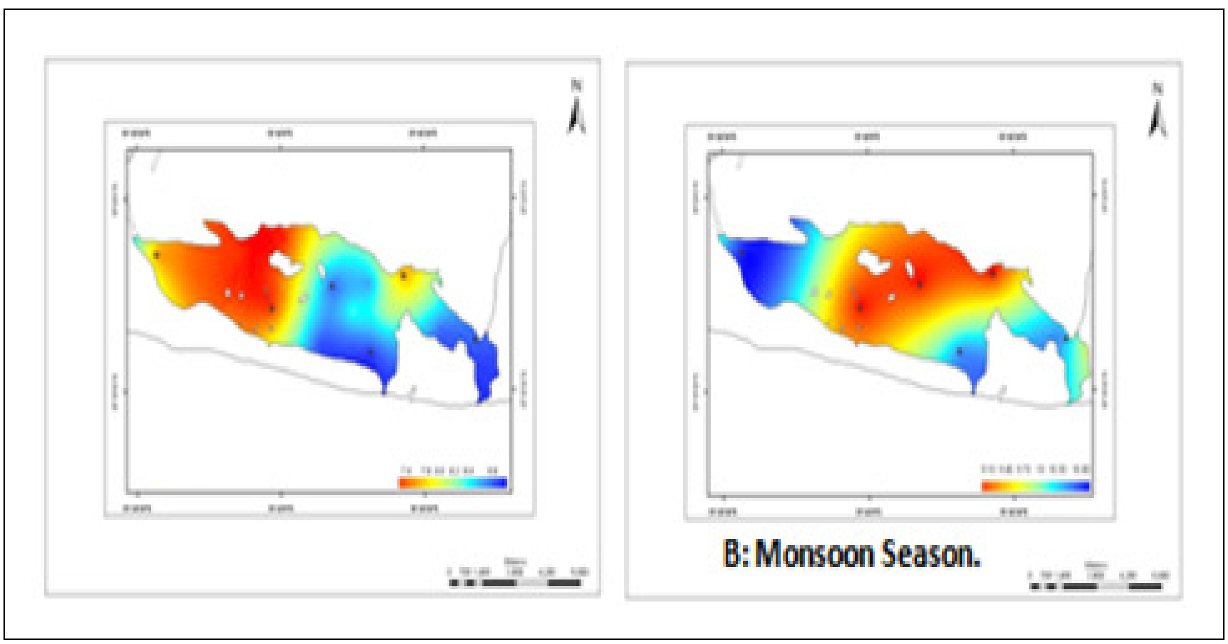

Fig.-7: Spatial distribution of SS (mg/l)

CONCLUSION

Water quality parameters have been analyzed using geo-statistical analysis approach. This analysis indicated around salt pan and aquaculture area have high saline and pH in summer which has created complicated environmental problem and by visual observation algal bloom high in summer season and in monsoon season suspended sediments concentration high in the study area. From this analysis Environmental Impact Assessment (EIA) study and regular monitoring need around the industrial area for lagoon management and conservation.

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REFERENCES

1. M.F.Godchild, 1993, The state of GIS environmental problem-solving, in: M.F., Parks, B.O and Steyart, L.T. (Eds), Good Child, Environmental Modeling GIS, Oxford University Press, New Yark, pp. 8-15.
2. P.A. Burrough and R.A.S.McDonnell, Principles of Geographical Information Systems. Oxford University Press, Oxford, pp. 333 (1998).
3. R. G. Nijmeijer, A. de Haas, R.J.J. Dost and P.E. Budde, Ilwis 3.0 Academic User's Guide, ITC, Enschede (2001).
4. S.P.S. Kushwaha, A. Kahn, B. Habib, *Current Science*, **86 (10)**, 1390(2004).
5. B. Isaac, C. Raylene, D. Simmons and F. Hogan, *Landscape and Urban Planning* , **84**, 212(2008).
6. USEPA, and Region III Water Protection Division. "Ambient water quality criteria for dissolved oxygen, water clarity and chlorophyll a for the Chesapeake Bay and its tidal tributaries 2007 addendum." *Rep. No.* EPA 903-R-07-003, U.S. Environmental Protection Agency Region III, Chesapeake Bay Program Office, and Region III Water Protection Division, Annapolis, Md (2007).
7. Y. Simard, P. Legendre, G. Lavoie and D. Marcotte, *Can. J. Fish. Aquat. Sci.,* **49,** 32(1992).
8. S. Georgakarakos and D. Kitsiou, *Hydrobiologia* , **612** , 155 (2008).
9. R. Nagalakshmi, M. Ramalingam, R. Santhi Devi, V. Vidya Priya and L. Subba Raj, *International Journal of Design and Manufacturing Technologies,* **2(1)**, 119(2008).
10. L.R. Parsons, K.T. Morgan and T.A. Wheaton, *Proc. Fla. State Hort. Soc*., **114**, 97(2001).
11. WMO Guide to Hydrological Practices. Fifth edition, WMO Publication No. 168, World Meteorological Organization, Geneva, 735, (1994).

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