A Methodology Adopted towards Analysis of Spatial Patterns of Chlorophyll Distribution in Coastal Areas

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ABSTRACT

A proposed methodology to design a GIS program, GISChlorophyllPattern is planned to develop with .NET and ArcGIS tools. It is proposed to design for assisting the investigation of chlorophyll distribution patterns (Based on the threshold pattern of water quality) and to report the impact factors on climate change. GISChlorophyllPattern is the first software methodology of its kind. It can be used to analyze the health of a particular body of water, helps in estimating the water quality, direct way of tracking algal growth, indicator of nutrient levels, determining factors that affect the growth of fishing production. GISChlorophyllPattern may also be applicable to the spatial point pattern analysis such as marine life habitat, oceanography and geography.

Keywords

GIS, Spatial pattern, Chlorophyll distribution

1. INTRODUCTION

Chlorophyll is a key component that is responsible for the photosynthesis, the critical process in which the energy from the sunlight is used to produce life sustaining oxygen (YSI Environmental, 2005). It is the most fundamental of all biochemical reactions and one that helps plants to grow, flower, produce seed and sustain life on earth (Science Reporter, 2005). In general, spatial pattern plays a central role in analyzing the living community dynamics. In the past decade, there have been an increase in the application of species distribution models (SDM) in the ecological and conservation fields which require only the present data.

These models, relate the species distribution to their current environment through a range of predictor variables (Static and Probabilistic) believed to limit the species distribution (Guisan and Zimmermann, 2000). These SDM models can also be extrapolated beyond the current distribution of the species to show the potential distribution further a field. Some of these SDM models proved the predictive ability equal to or greater than that of traditional statistical methods (Elith et al., 2006).

In our coastal system, we found that every country are in need of an easy and efficient method to analyze chlorophyll distribution pattern (threshold pattern and impact on climate change) and to simulate the pattern to improve the water quality as well as to improve marine life habitat. To carry on manual analysis is tedious process and time consuming with less accuracy. Analyzing hundreds of data is also an impractical task (Yanli Zhang et al., 2011). Advanced data mining applications to this problem requires an intensive knowledge about marine ecosystem. Thus we planned to propose GISChlorophyllPattern, a methodology on the creation of GIS (Geographic Information System) tool to analyze local spatial pattern of chlorophyll distribution and it is efficient in generating report, simulating the results in order to improve the marine ecosystem which stands as the backbone of economical factor of every country.

2. METHODOLOGY

GIS Chlorophyll Pattern is planned to develop as a tool to help the marine ecosystem to retain its originality. There are two main processes: one process P1 is to analyze the pattern towards the chlorophyll distribution and P2 the other is to generate report on climate change, i.e., a report on climate change influencing factors based on dissolved O_2 content.

The overall methodology Fig. 1 is described in two processes namely Pattern analysis Fig. 2 and Climate change prediction report Fig. 3.

The required input data is stored in the form of data store D1, D2, D3, D4, D5, D6. The data store D1, D2, D3, D4, D5 Table. 1-5 utilized in the process of analyzing the pattern of chlorophyll distribution. The data store D6 Table. 6 utilized in the process of predicting the climate change.

Table 1: States of the Coastal Areas (States_Coastal)

S.no	Field	Description	Units
1.	D1_states	States of the Coastal Areas	Nos

Table 2: Key Substances (Key_Sub)

S.no	Field	Description	Units
1.	D2_salinity	Salt content	PSU
2.	D2_BOD	Biochemical Oxygen Demand	mg/l
3.	D2_NO_2	Nitrite	µ mol/l
4.	D2_NO_3	Nitrate	µ mol/l
5.	D2_NH_4	Ammonia	µ mol/l
6.	D2_TN	Total Nitrogen	µ mol/l

| 7. | D2_IP | Inorganic Phosphate | µ mol/l |
| 8. | D2_TP | Total Phosphorous | µ mol/l |

Table 3: Tide Measurement (Tide_Measure)

S.no	Field	Description	Units
1.	D3_LT	Low Tide	LT
2.	D3_HT	High Tide	HT
3.	D3_AT	Atmospheric Temperature	° C
4.	D3_WT	Water Temperature	° C
5.	D3_SSC	Suspended sediment Concentration	mg/l

Table 4: Chlorophyll Measurement (Chl_Measure)

S.no	Field	Description	Units
1.	D4_ChlA	Chlorophyll a	mg/m3

Table 5: Monsoon and Surface (Monsoon_Surface)

S.no	Field	Description
1.	D5_Pre	Premonsoon
2.	D5_Mon	Monsoon
3.	D5_Post	Postmonsoon
4.	D5_Summer	Summer
5.	D5_Shore	Shore (<1km)
6.	D5_Near	Nearshore (1-5km)
7.	D5_Off	Offshore (>5km)
8.	D5_Surface	Surface of the Coast
9.	D5_Mid	Middepth of the Coast
10.	D5_bottom	Bottom of the Coast

Table 6: Measurement of Dissolved O_2 (O_2_Content)

S.no	Field	Description	Units
1.	D6_DO	Dissolved Oxygen	mg/l

Table 7: Patterns on Chlorphyll Distribution(Threshold_Patterns)

S.no	Field	Description
1.	D7_TH_CH_PA	Threshold Chlorophyll Pattern
2.	D7_LCH_PA	Low Chlorophyll Pattern
3.	D7_HCH_PA	High Chlorophyll Pattern

The first process Fig. 2 pattern analysis has two interfaces to analyze chlorophyll community distribution patterns. It involves the process of clustering and finding the threshold patterns of chlorophyll community distribution. The required input data follows the general and recommended datasets of the marine ecosystem. Along with this approach, the end users are required to specify the chlorophyll community measure. It allows the analysis and identification of different distribution patterns with different chlorophyll measure. The probability of occurrence is calculated based on the frequency of the chlorophyll measure in the given dataset. The first interface contains the predefined function clustering technique to be performed based on the data store D1.

The D1 data store contains the states of the coastal areas. After the clustering process, the second interface contains the function for finding the pattern on threshold chlorophyll measure (TH_CH_PA) Table. 7. The threshold pattern of chlorophyll measure indicates the standard measure of other parameters too. Hence, the threshold pattern of the chlorophyll measure is always compared with the end user chlorophyll measure and recorded as a high or low chlorophyll distribution pattern of that particular coastal area. If the decision making process results in the low chlorophyll distribution pattern, actions can be carried out to make the situation stable by the advice of experts. On the other hand, if it results in the high chlorophyll distribution pattern steps should be carried out immediately in order to reduce the adverse or harmful effects on the marine ecosystem. Overall the analyzes of the chlorophyll community distribution patterns helps in supporting the marine life, water quality, fishing production etc.

The second process Fig. 3 of GISChlorophyllPattern, prediction report on climate change with known chlorophyll distribution pattern, is achieved with one interface. On the first interface, the function requires an input data store D6 which contains the dissolved O_2 measure and calculates the threshold dissolved O_2 measure (TH_DO). Before the first interface execution, the required input data should be read and they are the content of the resultant chlorophyll distribution pattern from the first process P1.

The resultant threshold dissolved O_2 measure (TH_DO) is compared against the dissolved O_2 measure (TH_CH_DO) of the resultant chlorophyll distribution pattern of the first process P1. If the comparison process results in less dissolved O_2 measure, no report will be generated. On the other hand if it results in the high dissolved O_2 measure, report will be generated based on the impacts on the other parameters of the resultant pattern. This will help the experts to analyze the factors which impacts the climate change. The prediction of the climate change is one of the challenging area of research to be addressed for the benefit of human life on the earth. Here is our try to initiate a better tool to understand the

deviation factors and prediction which impact the climate   change.
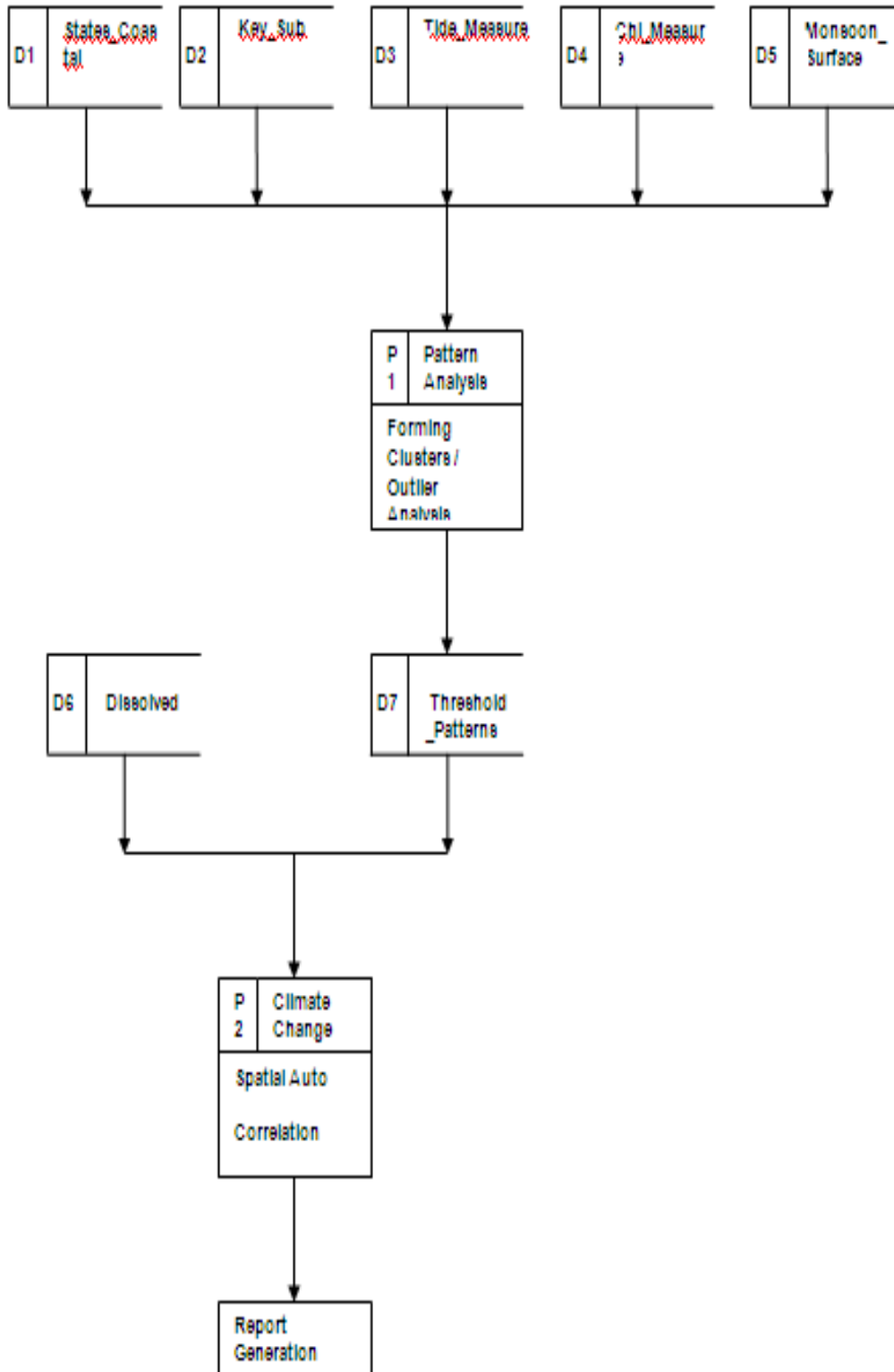

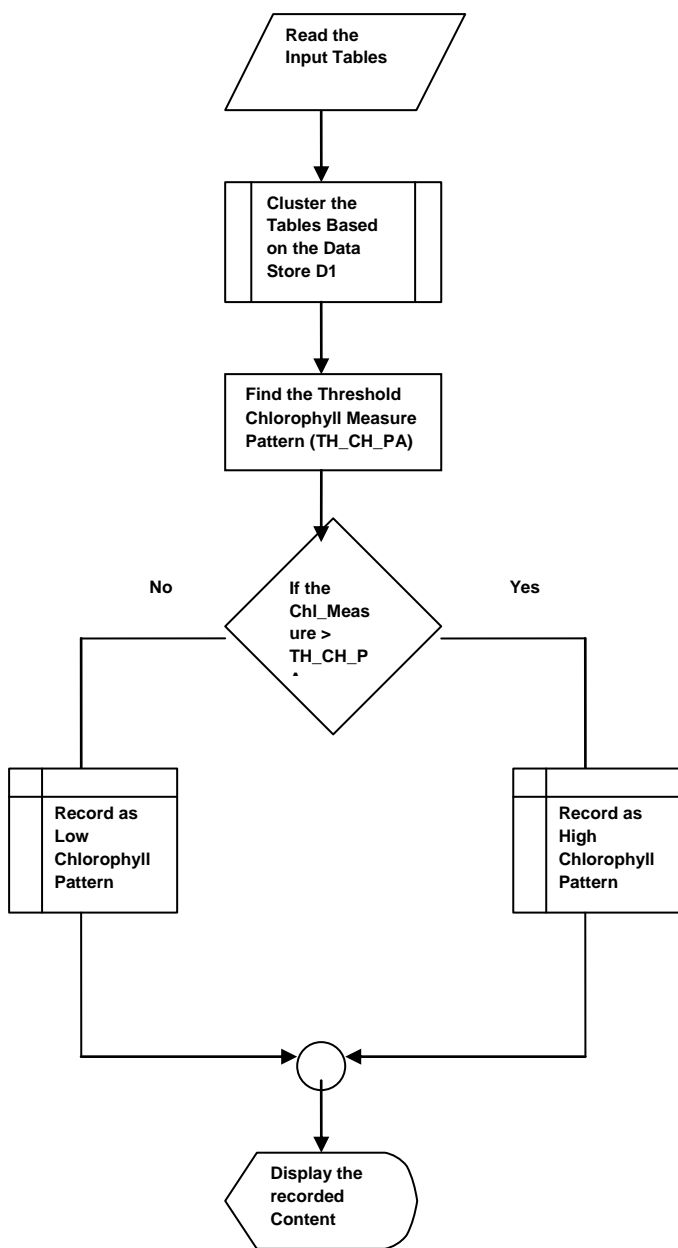**Fig 1: Flowchart of the procedures to describe the overall methodology**

Fig 2: Generating the pattern for chlorophyll distribution change.

Fig 3: Generating report on the factors of climate

The methodology will be implemented by using the ArcGIS and Visual .Net tool. Broadly it is planned to cover the techniques of spatial data mining in order to handle the large data base efficiently. The proposed methodology can be extended to monitor the water quality as well.

3. SUMMARY

The processes, main functions, interfaces, algorithms and sample applications of the newly developed methodology are reported to introduce the tool GISChlorophyllPattern to the scientists and oceanography research community. The methodology can be used to analyze chlorophyll community distribution patterns with coastal field collected data t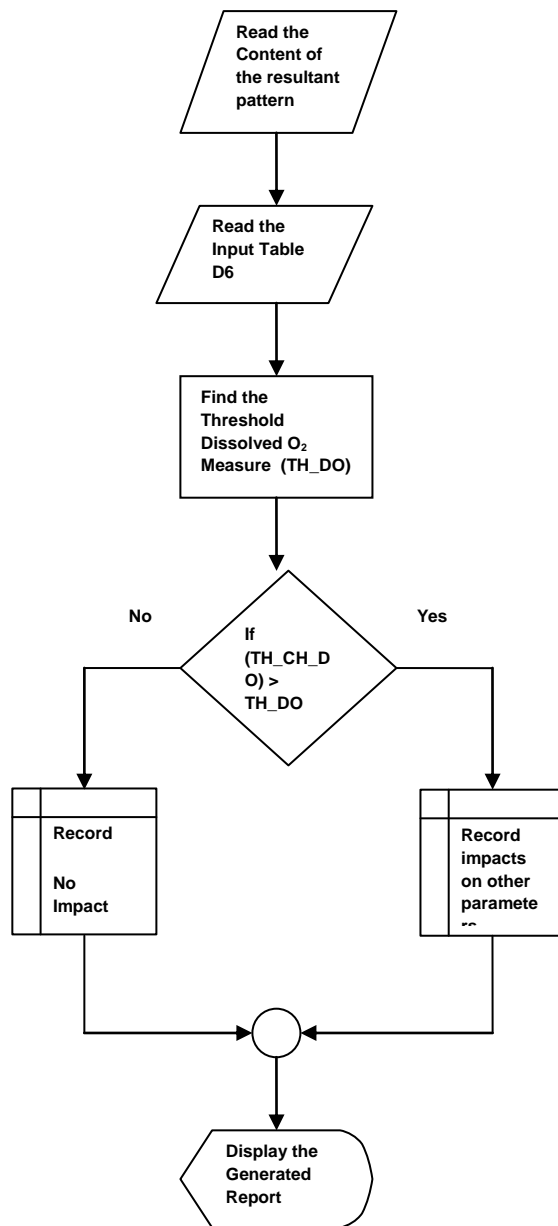hrough satellite sensors. When a chlorophyll community distribution pattern is available, the adverse or harmful effects on the marine ecosystem can be reduced and steps can be taken to make the stable condition in coastal areas. GISChlorophyllPattern may also be applicable to other studies of marine life, water quality, fishing production etc. Hereby, we will keep doing research on GISChlorophyllPattern to incorporate more ecological factors such as aspect (fishing production, water quality) and keep it updated for user and researchcommunity

4. REFERENCES

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