A Study on Spectral Reflectance with Surface Water Quality and Chlorophyll-A Concentrations in Muthupet Lagoon of Thiruvarur District, Tamilnadu

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Abstract- In this paper, processing techniques for field measurements of spectral reflectance on chlorophyll-a in part of Muthupet lagoon, Thiruvarur district, Tamilnadu. This study focused upon improving the accuracy of chlorophyll quantification by applying wavelet analysis to reflectance spectra. Spectral reflectance measurement was carried out 5 different locations using ASD Field spectrometer in month of July 2011. The reflectance factor was computed and analyzed in RS3 software package the compared spectral curve shows peaks between 400 to 850 nm in most of the measuring locations. The chlorophyll-a content in spectral investigated locations 0.046, 2.258, 2.181, 3.569, 2.378 µg/l. Our results show that spectral signatures for chlorophyll-a observed in the lagoon and the field had similar characteristics with high reflectance in visible region of the spectrum from 500 to 650 nm, but low in the NIR region from 750 to 850 nm.

Key Word: chlorophyll-a, Reflectance, Spectral Signature.

I. INTRODUCTION

Lagoons are the coastal areas of extraordinary importance in terms of natural surroundings. Due to their general morphological features, they have a very sensitive naturally dynamics balance in all aspects. Although the lagoons have direct connection the sea, they still display fairly different characteristics then those of the sea as far as the hydrodynamic structure, ecological features and water quality are concerned. Therefore, they have to be protected to maintain the native wild life on the other hand because of their sensitive natural balance; they are affected to a great extent by the changes in the hydrodynamic and morphological conditions arising out of the artificial influences. It is fairly frequent their especially the lagoons near the estuaries are affected by the problems carried to the sea by the rivers that start from the source outside coastal areas [(1).] Muthupet lagoon is the biggest lagoon in Tamilnadu and located in the southernmost end of the Cauvery delta in the district of Nagapatinam, Thanjavur and Thiruvarur. Muthupet mangrove was declared as reserve forest in 1911 and the total wetland area is about 11,885 ha (2).

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The chlorophylls are essential pigments in the process of photosynthesis; therefore, it has been argued that they are the most important organic molecules on Earth [(3)]. Changes in the total concentration of foliar chlorophyll and the relative proportions of chlorophyll a and chlorophyll b are brought about by a variety of physiological stresses, leaf development and senescence.

Such pigment variations relate directly to the rate of primary production. Furthermore, the chlorophylls contain a large proportion of total leaf nitrogen therefore measurements of chlorophyll concentration can provide an accurate indirect assessment of plant nutrient status [(4)]. Hence, information concerning the spatial and temporal dynamics of leaf chlorophyll is of considerable value from a scientific viewpoint, particularly in investigations of plant–environment interactions, and from an applied perspective in agriculture, forestry and environmental management [(5)].

Satellite remote sensing is a powerful and cost-effective tool to monitor systematic changes in the lagoon environment, when calibrated with in situ time series measurements of water quality. This is possible because the spectral behavior of the reflected signal is a function of the combined optical characteristics of the water column and bottom reflectance, due to dissolved and suspended optically active substances, i.e. the suspended solids, photosynthetic pigments, detritus and dissolved organic matter [(6)]. Chlorophyll-a concentration is a particularly good estimator of the trophic level and can readily be used for purposes of classification from satellites [(7, 8, 9, and 10)]. Suspended sediment concentration varies with the amount of freshwater input. It can affect both the ecology and recreational potential of a lagoon, and can also be quantified by means of satellite remote sensing. Detection depends on colour, mineralogy, and size of sediment particles [(11, 12, and 13)]. There are several studies in the literature using multispectral data for this purpose [(14, 15, 16, 17, and 18)] which have mainly been based on empirical models, using regression analysis to relate remote sensing and in situ data.

II. STUDY AREA

Muthupet is a semi enclosed coastal lagoon located at the end of Cauvery delta in the southeast coast of Bay of Bengal. The lagoon is connected to the Palk Strait by a wide mouth at the southern part. The study area lies betweenLatitude 10°15' to 10°23'N and Longitude 79°24' to 79°27'E and it falls in Survey of India toposheet58 N/6 (Fig-1).

The lagoon wet lands occupies approximately 12000ha [19]. Many tidal creeks, channels and small bays, bordered by thick mangroves has been developed number of manmade canals dug across the mangroves wetlands, which become a potential zone for intensive fishing [20]. At the tail end, the rivers form a lagoon before meeting the sea. The northern and western borders of the lagoon are occupied by muddy siltwhich is devoid of mangroves. The mangroves beyond Muthupet lagoon are discontinuously found along the shore and extended up to Point Calimere.

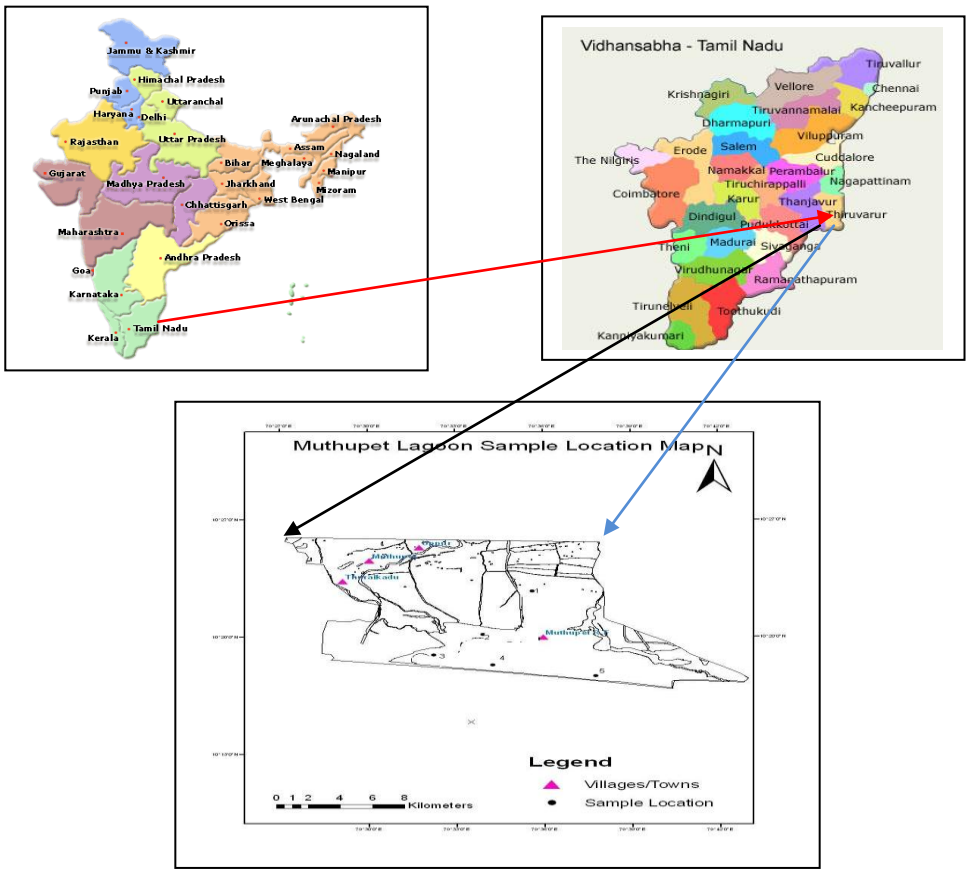

Fig.1 study area map

III. MATERIALS AND METHODOLOGY

All the data were positioned in UTM WGS84 zone 44 N using Magellan GPS unit. Lagoon water spectral reflectance were acquired within the lagoon on July 2011, there are five different places at equal interval using an Analytical Spectral Devices FieldSpec®Prospectroradiometer operating between 350 and 2500 nm with a spectral resolution of 3 nm for the region 350-1000 nm and 10 nm for the region 1000-2500 nm. A fibre optic cable fitted with a cosine diffuser was used to acquire underwater irradiances in the lagoon at equal distance, in five well distributed regions of the study area, chlorophyll-a content. The instrument was initially stabilized on proper place and the field gun pointed over the target material of interest i.e. surface water, and then white reference panel was placed between the target and the instrument point. The process of collecting spectral reflectance of plant species involved the some steps such as, 1) The instrument has been adjusted by the optimization according to the specific conditions of illumination at the time of spectra collection, 2) After optimization the measure in the Dark Current (DC), it is refers to the amount of electrical current that is inherent in the spectroradiometer's electrical components and creeps into the detection and photon measurement of the light signals and another important measurement is White Reference (WR) the reference panel gives the 100% reflectance of incident energy to calibrate the reflectance of target. After collecting the spctrum of all locations, correlated the species spectra using Spectral matching in ASD ViewSpecPro software to ensure the obvious errors and to develop spectal libraries.To calculate the spectral signatures (in terms of reflectance) of the submerged chlorophyll - a, spectral radiances of the cholorophyll-a of a white reference panel are necessary. The measurements were taken on chlorophyll- a, with different water depths between 30cm and 45cm at equal intervals, to take the influence of the water on spectral signatures into account. Furthermore, we are hypothesising that the spectral characteristics of the submerged vegetation in the neighbouring sites are similar, whereas water depth, turbidity, salinity, hydrodynamic and microclimatic conditions could actually influence and their contents in terms of photosynthetically active sub-stances (e.g. chlorophyll and carotene).

IV. RESULT AND DISCUSSION

We found in our study that reflectance at wavelengths out of the pigment absorption maxima could be successfully used for assessment of chlorophyll content in lagoon water. We tested the techniques for lagoon water.

Spectra of the determination chlorophyll content in study area are shown in Fig. 2. Previously all five points chlorophyll-a content have been monitored by using spectrophotometer in the laboratory shows table.1. The reflectance of lagoon water was around 0.06 percent between 650 and 700 nm and dropped to less than 0.04 percent at wavelengths beyond 810 nm. For lagoon water, five pronounced absorption features of chlorophyll were found the low reflectance between 650 and 700 nm (Red absorption) and the conspicuous reflectance minimum around 530 nm (blue absorption) due to chlorophyll [21], the broad reflectance maximum around 550 nm (green peak) caused by low absorption of algae [22], and the prominent reflectance maximum around 700 nm (NIR peak) caused by an interaction of algal cell scattering and a minimum combined effect of pigment and water absorption [23]. In addition, for both treatments, there were two minor peaks at 700 and 815 nm, respectively. It appears that the former was caused by the reflection of the liner used inside the lagoon was due to low water absorption.

Table.1 Muthupet lagoon Chlorophyll-a content

Location	Chlorophyll-a in µm/l
1	0.046
2	2.2258
3	2.181
4	3.569
5	2.378

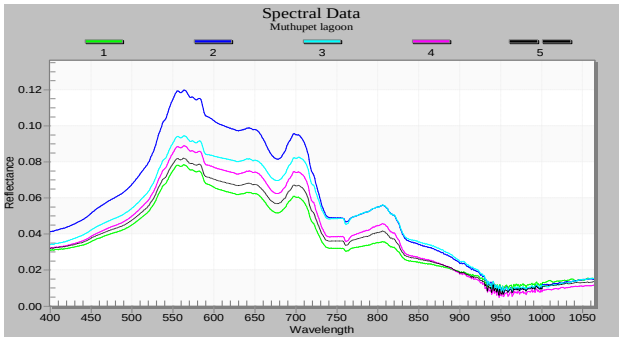

FIg.2. Spectral reflectance of Muthupet lagoon

Fig.3. Spectral signature collections field photos

V. CONCLUSIONS

For reaching the first objective in situ, reflectance spectra have been used to identify optimal spectral regions from which Chlorophyll-a can be retrieved. The results summarized in this research show that the lagoon water between 500 and 850 nm, due to the blue and red absorption of algal chlorophyll-a. The results demonstrated that by decomposing lagoon water reflectance spectra using wavelet analysis, the resultant wavelet coefficients can be used to generate models capable of providing accurate predictions of chlorophyll-a concentration. This study has refined and demonstrated the value of wavelet analysis of spectra for quantifying the lagoon water chlorophyll-a in principle, it is now important that this is tested in practice and that the generality of the technique for hyperspectral remote sensing of surface water quality is explored, particularly at the canopy and landscape scales

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