A Study on Estimation of Phytoplankton-Chlorophyll Level in Lakes by NDVI Sensor Based System.

(A better method for monitoring lakes)

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***Abstract*—'Phytoplankton, as an important element of the structure of various lake ecosystems', is very flexible in its ability to adapt to different environmental conditions such as light, temperature, and concentration of nutrients (mainly nitro- gen and phosphorus). Moreover, it reacts rapidly to changes in environmental conditions and, therefore, it is classified in the group of basic biological indicators of lake status. Water quality parameters studied in the current research were investigated to evaluate the input data significance using NDVI (Normalized Difference Vegetation Index (NDVI) has ever been one of the widely used indices for remote sensing based analysis. The prospect NDVI computations not only the green fraction extracted from the observed green vegetation could be used, but also soil and crop remains, which also affect NDVI values. This work describes the way to generate the Normalized Difference Vegetation Index by 'Lake Color Monitor' (LCM) data. Vegetation index are directly associated with the presence of Chlorophyll. In order to carry out the process, an estimation of biomass is carried out with respect to percentage of vegetation coverage obtained from LCM images extracted from a multispectral imaging system. Chlorophyll yield was estimated using reflectance-based NDVI generation with the help of multispectral imaging system. Measurements of Wavelengths, Photo synthetically Available Radiation (PAR), Intensity of visible and Near-Infrared light reflected by the land backup into the space are determined to enumerate the concentrations of green vegetation in lakes. The analysis of these parameters with respect to oceanic data carried from multispectral images will be used in lake water quality monitoring. The proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered. This kind of execution is suitable for large scale deployments, which enable the sensor network to provide data to the responsible authorities.**

Keywords: (NDVI) Normalized Difference Vegetation Index; MATLAB; Phytoplankton; Chlorophyll; photo-synthetically Available Radiation (PAR); Biomass; phytoplankton fluorescence; Eutrophication.

I. INTRODUCTION

The concentration and dynamics of phytoplankton in Lake were explored in relation to the environmental conditions influencing water quality'. The phytoplankton biomass and chlorophyll concentration in water were moderately low in typical lakes, with a decreasing tendency when the water transparency significantly increased. In the studies shows the water quality and pollution status of lakes were investigated by determining the phytoplankton composition and nutrient concentrations of chlorophyll, the contents of total nitrogen and total phosphorus, and Secchi disk visibility are the basis for evaluating trophic status [1], these parameters are currently used to assess the quality of water, which is classified based on, among others, chlorophyll concentration.

Photosynthesis drives the global carbon cycle. Net photo-synthesis can be quantified at the micro level by monitoring CO2 exchange using chamber enclosure systems combined with infrared gas analyzers and at the ecosystem level using flux towers and eddy covariance techniques [2]. At the landscape and regional levels, gross photosynthetic CO2 assimilation, or gross primary productivity (GPP), is inferred using models and algorithms that integrate ground observations with remotely sensed Remotely sensed data have been extensively used to infer GPP based on the light use efficiency (LUE) model In the LUE model, GPP is proportional to incoming photo synthetically active radiation (PAR), the fraction absorbed by vegetation (fAPAR), and the LUE at which absorbed radiation is used by photosynthesis:

$$GPP = PAR * fAPAR * LUE$$

The phytoplankton was not suggestively correlated with the content of nutrients in water., The general evaluation were indicated mesoeutrophy or even slight eutrophic, domination of filamentous blue-green algae, which revealed a more advanced degree of Eutrophication .

During the study phytoplankton dynamics are represented in the form of maps for which data was obtained by closely observing data from the bands in the red part of electromagnetic spectrum recorded by Moderate Resolution Imaging Spectrum radiometer (MODIS)[7] data. The lake 'Purle' near Shivamogga dist. Karnataka was selected because this area has extreme climatic parameters due to seasonal dissimilarities in environmental conditions, particularly the air and water. This area has a biodiversity, including several common and rare species of algal blooms such as seasonal brown, green, and red algal flora representing important components of the region (Raghukumar & Anil, 2003). Limited data is used in this study; larger quantities of data

may be much better for long-term assessment of plant production and its dynamics. This study, however, shows *Fig*.1, the relationship of the variables related to chlorophyll fluorescence.

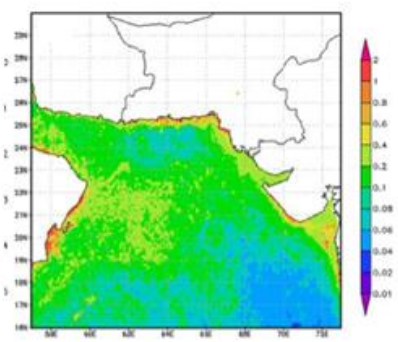

Fig.1 photo synthetically Available Radiation 2km (Einstein/m sq./Day), Normalized Fluorescence Line Height (nFLH) 2km [(10^-2) mW cm-2 µm-1

II. RELATED WORK

Satellite-based NDVI are influenced by a number of non-vegetation factors: atmospheric conditions [3] (e.g. clouds and atmospheric path-specific variables, water vapor), satellite geometry and calibration (view and solar angles), as well as soil backgrounds and crop canopy (Holben 1986; Soufflet et al. 1991; Justice et al. 1991). The angle of incidence of solar radiation also has a strong effect on vegetation indexes (Pinter 1993). However, these complications can be avoided by using the hand held optical sensor unit to measure NDVI. Designed at Oklahoma State University, and commercialized by Ntech Industries [3], the cancels out the disturbing effects of atmospheric interference and satellite geometry since it is held closely above the crops. Lack of effect of climate as well as sun angle was confirmed by an independent study as reported on the Oklahoma State University website (http://nue. okstate.edu). This is a great advantage compared to the satellite-based measurements. The high resolution obtained with this handheld sensor makes proper measurement possible at the plot level in contrast with the low resolution typical for air or space remote sensing material. The handheld sensor is non-destructive and the sensor samples at a very high however, still important scope for research on the comparison of the NDVI handheld sensor with satellite imagery, especially when scaling out of results and models becomes important. Proposed by Tucker [4], NDVI is generally used to track vegetation situation and changes. The index is based on the characteristics of chlorophyll to absorb red light and reflect near infrared and so makes possible distinction of different proportions of vegetation. NDVI values range between -1 and 1. Positive values indicate that vegetation is present, 0 where vegetation is absent and -1 for water [4]. TARBIL is a Turkish government founded project aimed to remotely monitor and support agricultural activities and to analyze the acquired data. Agricultural parcels are monitored by cameras and meteorological stations installed on 10m poles. Currently more than 100 stations have been deployed on Southeastern Anatolian part of Turkey, where each station monitors on average more than two parcels.

III. PROPOSED SYSTEM

The main aim here is to develop a system for continuous monitoring of chlorophyll at remote places using NDVI sensor networks with low power consumption, and high detection accuracy. The parameters that are analyzed to improve the water quality. Following are the objectives of idea implementation [5], to collect data from various sensor nodes and send it to base station by wireless channel and to simulate and analyze quality parameters for monitoring and quality control by responsible authorities.

IV. METHODS

The data set used in this study consists of spot images recorded Fig.1 shows the acquisition date of used satellite images. Spot5 Images have 10m spatial resolution spectral bands (Green: 500-590 nm Red: 610-680 nm, Near IR: 780-890 nm. Monitoring phytoplankton at a constant frequency allows us to observe different phytoplankton response to monitored climate conditions on soil types that have been previously examined. To achieve this, digital cameras are installed on 10m poles, looking down at an angle of 60°. Images are captured during daytime, twice per hour at IX and lO X zoom levels. Only images recorded between 13:00 and 14:00 were used in this study to avoid shadow effect. The resolution of each image is of 1712x2288. The angle and height of monitoring give us panoramic view covering the field, generating a good estimate. Such a large number of stations distributed over such a wide area record actual situation on the field without any intervention and effect on surveyed evolution. Real-time monitoring at heights of 2m would not be practical on such a large scale.

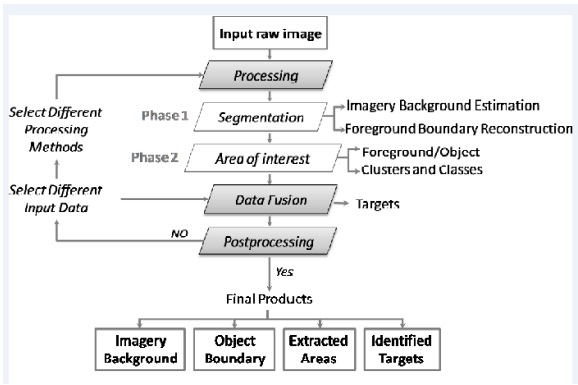

Fig.2 general frame work of image processing

A. Hardware Design:

The proposed system based on NDVI sensor, can be divided into two parts: • Data monitoring nodes • Data center (a) Data Monitoring Nodes illustrates the data monitoring nodes which consist of 'Sentera' NDVI camera, signal conditioning circuit, a controller and controller module. The data sensed by the sensor will be passed through a signal conditioning circuit. Then the operated data will be given to the controller digital signal for further processing (b) Data monitoring Station the

data from all the nodes is collected at the data base station consisting of processor and then data from each node is collected one after another i.e. using time multiplexing. This obtained data is displayed on a display. Also, this data is forwarded to the remote monitoring station via 2.4-GHz Zigbee module. In remote Monitoring Station the remote monitoring station consists of a Zigbee module which will receive the data sent by the data base station. This data will be fed to a server PC consisting of Graphic User Interface via serial communication. The obtained data will be represented graphically with the help of MATLAB and will be saved for further reference as shown in *Fig. 6*. Also the obtained data is compared with the standard values of the water parameters. If the obtained water parameters do not match the preset values then SMS will be sending to an authorized person in order to take preventive measures.

B. Software Design:
Method to generate Normalized Difference Vegetation Index of Chlorophyll from LCM data is given below in figure 3.

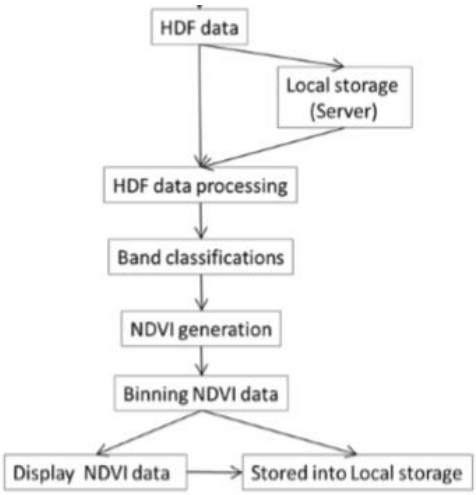

Fig.3 Frameworks of NDVI generation methodologies

Some processes are there to convert the HDF file format data to computer supported image file formats. First the HDF file taken as input in Image processing software. Then the software can easily read Meta data of the HDF file. The framework of Chlorophyll NDVI generation, the chlorophyll concentrations on a lake and take it as data. That data is converted in the Hierarchical Data Setup.

a)Algorithm for Band Classification:
Read HDF data
Pull the bands from the HDF
Band 1, Band2, Band 3,. . Band n
If band 1 or band 2 or band 3= 'Geospatial data'
Store Geospatial data in different names
Else leave the HDF.
Bands are classified *Fig.4* based on the colors. It depends on sensors also. In this study we are using HDF data for NDVI chlorophyll data, within the HDF data there are many attributes and datasets are available with respect to HDF data. HDF data can have a Longitude and Latitudinal information with it.

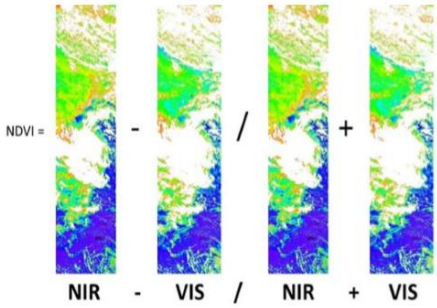

Fig.4 sample of Band classification and NDVI generation from NIR, VIS

b) Binning of NDVI:
Algorithm for Binning the NDVI image:
Read the NDVI image;
Check NDVI resolution i ;
If resolution i>Large Resize the resolution i as low;
Resolution Check image quality after resizing;
If Image quality i% < original image quality;
Enlarge the image;
Else Store the image;
Else Show the original NDVI image;

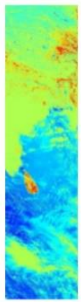

Fig.5 sample NDVI image from LCM HDF data after Binning operation

The (NDVI) is a basic graphical indicator[7] that can be used to study of remote sensing measurements, normally but not automatically from a space platform, and assess whether the target being observed contains live green vegetation or not.
Binning method [6] used here for the better visualization of NDVI generated images. It helps to decrease the resolution without destructive the image quality. Likening with other research works they won't apply and introduced the technique of Binning *Fig.5*. One more new thing in this research work is clear classification of bands and how those bands are used for assessment of different vegetation indices [8].

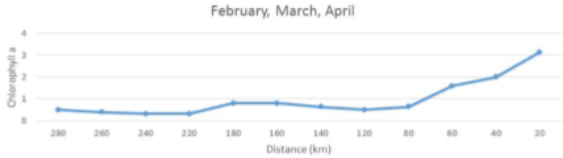

Fig 6: MATLAB screenshot of Chlorophyll concentration levels at different time periods.

V. CONCLUSION

The NDVI data acquired using the LCM data and multispectral imaging system was sensitive to find the changes in lake chlorophyll content by NDVI generation technique and able to tell the status of lakes. This study is to find chlorophyll concentrations and growth of phytoplankton plants in water. Here everything is explained about chlorophyll measurements of lake colors and its respective things.

Some eutrophic species of phytoplankton with high levels of chlorophyll and nutrients indicated that the state of the lake is near to eutrophic or under threat.

Chlorophyll concentration analysis increases the guessing ability and accuracy of NDVI. This system can be improved by including other vegetation indices for better prediction, analysis and monitor the lakes with ease and immediate actions can be done under protection by the environmental regulations.

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