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Review on Study of Lake Water Using Multi Sensor Remote Sensing Data

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Abstract : *In this paper multi sensor satellite data i.e. IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4) consisting of an Ocean Color Monitoring operating in eight spectral band data are used for extracting information useful to hydrological projects such as monitoring the water quality of lakes. Changes of the area extent of the lakes are estimated from the multitemporal satellite images. Surface water temperature patterns of the lakes are mapped and anomalies are identified. Emphasis is given on the investigation of capabilities of IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4) data in monitoring water quality of lakes. A classification scheme regarding various water quality parameters (Secchi depth, Turbitidity, Chlorophylle –α and Total* Total phosphorus*) is created based on combinations of different bands.*
Keywords - *Remote sensing, Spectral band, lake monitoring, water quality*

I. INTRODUCTION

Remote sensing has the advantage to repeatedly perform measurements from a great distance which means that large and transboundary areas can be covered easily. The objective of this work is the application of cost effective integrated remote sensing / GIS techniques for mapping features that are of interest to hydrology projects. Multi sensor satellite data such as IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4*)* data are used. Emphasis is given on the investigation of capabilities of IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4*)* data in monitoring water quality of lakes. in order to address both spatial and temporal variability, remote sensing-based methods can be used in determining various water quality-related parameters [1]. These methods are having several benefits, which include (i) near continuous spatial coverage of satellite data over a complete geographic area of water body; (ii) capable of assessing water quality in remote areas; (iii) availability of satellite data in all seasons (iv) relatively low cost associated with satellite data and (v) efficient analysis. In this paper, our objectives are to (i) review existing remote sensing-based method in determining water quality variables; and (ii) develop a remote sensing based methodology to predict water quality of different sources across Lake. A review has been presented on retrieval of major independent water quality variables (chlorophyll-a, Secchi disk depth, turbidity and Total phosphorus) from the satellite data. A methodology has been developed for assessment of water quality variables using satellite and ground measured data [1].

II. DATA AQUISATION

The material used for the present work falls into four main categories (i) satellite images and associated information, (ii) hydrologic field measurements like water levels and water quality parameters, (iii) topographic, land cover maps & DEM information derived from SRTM data (iv) hydrologic information in GIS format (springs, watershed boundaries, mapped lake coast lines etc). Landsat MSS, TM, ETM+, IRS LISS III and OCEANSAT-1(IRS-P4*)* images have been used in the analysis. The satellite images have various acquisition dates and field details of same date of pass are to use for developing different methodologies [1] [2]. The Landsat and OCEANSAT-1(IRS-P4*)* images can be mainly analyzed in order to extract certain features like the surface extent of lakes. Temporal changes for the last 15 years can be analyzed with the use of satellite imagery. OCEANSAT-1(IRS-P4) consisting of an Ocean Color Monitoring operating in eight spectral band data can be used to estimate land cover and water quality parameters of the lakes.

III. CHANGE ANALYSIS

Change of a lake's surface may influence the hydrologic regime and the water quality parameters of the lake ecosystems. Remotely sensed data can be used in mapping the different lakes in different dates. Mapped Lakes from satellite data are displayed in relation to the Lake regime of the 1:50,000 topographic maps. The remotely sensed data can be effectively used for map updating procedures [3]. Various estimates of the surface area of the lakes can be done by using different methodologies and digitization of data can be done by using any one of the frame work as shown in Figure 1.

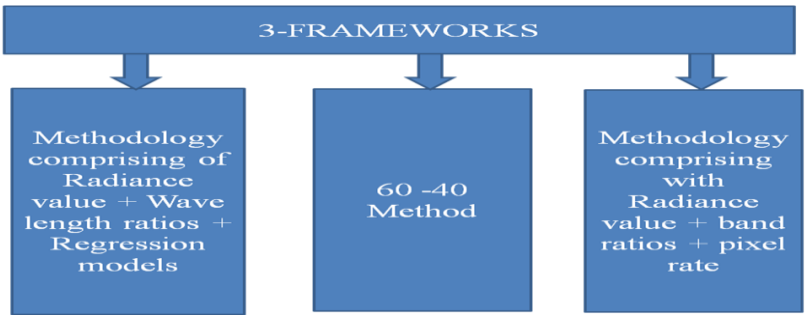
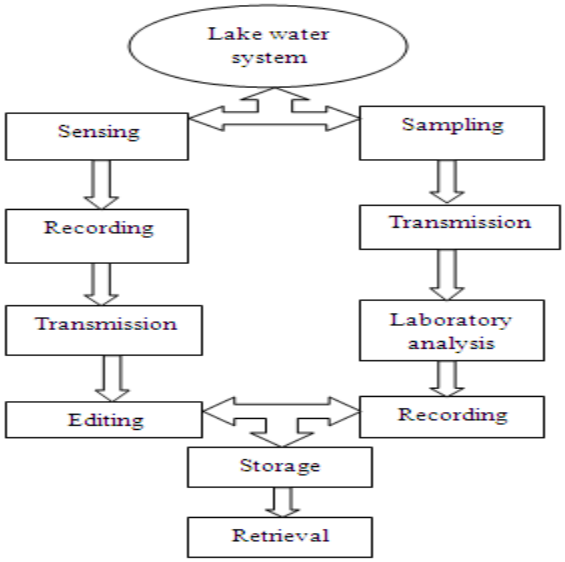


Figure 1 shows the frame works for data digitization

We can perform satellite based surface lake estimation by determination of Radiance values, Pixel rate analysis, wavelength ratios and Regression values. The satellite based surface estimates were examined in relation to archived in situ water level measurements and the water quality indicators (that include physical, chemical, and biological properties) which are determined by collecting samples from the sources of interest and analyzing them in a laboratory setup. In above three frame works, in first methodology Radiance Values, Band Ratios are calculated by using NRSA algorithm which gives required results according to need of work. In second method where the ground measurements are calibrated for 60 percent and validation have been done for remaining 40 percent. For third frame work band value or radiance value can be find out by using different software available and u can generate your own algorithm by using JAVA scripte or by coding the calibrated and validated data [4].

IV. MAPPING WATER QUALITY PARAMETERS USING REMOTE SENSING DATA

The Remote sensing based methods are having several benefits, which include (i) near continuous spatial coverage of satellite data over a complete geographic area of water body; (ii) capable of assessing water quality in remote areas; (iii) availability of satellite data in all seasons (iv) relatively low cost associated with satellite data and (v) efficient analysis. As evident from the numerous national and international studies have suggested that the integrated use of RS and GIS for the assessment of water quality is a superior method as compared with the convectional water quality assessment method. Integrated RS and GIS also provide a suitable alternative to the convectional approach [5]. It is evident from the literature that the RS and GIS techniques are playing a rapidly increasing role in the field of water resource management. Retrievals of conventional data and Remote sensing data is as shown in figure 2.



In our framework we propose four major independent water quality variables instead of three that impact trophic status of Lake Water quality in India. These water quality variables include chlorophyll-a, Secchi disk depth, turbidity and total phosphorus. The turbidity is associated with suspended particles in water like soil, sediments, sewage, and plankton due to which sunlight needed for photosynthesis gets blocked in water bodies

and it affects nutrient growth and Secchi depth. Review has been presented on the water quality assessment based on remote sensing techniques are as follows:

1. Chlorophyll-a

Chlorophyll-a is a photosynthetic pigment in plants, algae and cyanobacteria. Since it acts as a link between nutrient (in particular to phosphorus) concentration and algal production it is considered a major indicator of Indian lakes. From literature, it is noted that the ratio between various visual spectral bands are used in quantifying chlorophyll-a. For example: (i) ratio between green (0.50-0.60 μm) and red (0.60- 0.70 μm) or vice-versa were used and (ii) ratio between blue (0.40- 0.50 μm) and red or vice-versa were used in different studies. In most of the instances, empirical relationships were developed between remote sensing-based indices and ground based measurements of the water quality variables [6].

2. Secchi disk depth

Secchi disk depth is used to measure the transparency of water bodies. The ratios of visual spectral bands, e.g., (i) blue and green (ii) green and red (iii) individual band like red were used to quantify Secchi disk depth in water bodies [7].

3. Turbidity

Turbidity is a measure of water clarity caused by the amount of particles suspended in water like soil, sediments, sewage, and plankton. It is considered as a variable in our framework due to its linkage with incoming sunlight which affects photosynthesis for growth of algae and plankton and it is also directly associated with Secchi depth. Literature showed that turbidity could be quantified using visual spectral bands: (i) green and red (Wang et al. 2006) and (ii) green and (iii) ratio of red and blue [8].

4. Total phosphorus

Total phosphorus is a measure of inorganic, organic and dissolved forms of phosphorus. Phosphates are plant nutrients and their increased quantity help plants and algae to grow quickly. Total phosphorus can be directly related to the biomass of phytoplankton (i.e. suspended algae and cyanobacteria, typically estimated by chlorophyll-a concentration) and indirectly related to water clarity or transparency, as estimated by Secchi depth. IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4) consisting of an Ocean Color Monitoring operating in eight spectral band there the use of bands, such as, green band (545 – 565nm), and integration of red (620- 670nm) and green showed significant relationship with total phosphorus [7][8].

V. CONCLUSION

With remote sensing we can gather information on the relative variation of water quantity and quality parameters and make some qualitative comparisons. Multisensor satellite data such as IRS LISS III or Landsat TM/ETM+ or OCEANSAT-1(IRS-P4*)* data proved to be effective in extracting useful information regarding land cover change, and water clarity which serves as an indicator of water quality in a lake. The findings are interpreted in the light of in-situ observations of several parameters that characterise the fluctuation of the quality of lake's water as a function of depth and time. Changes of the lake and its surrounding environment can be reliably assessed from the multitemporal satellite images. Satellite data are effective in generating GIS database information required for hydrological studies and the application of models. Remotely sensed data contribute to a lake water quality assessment project through its ability to show spatial patterns of various environmental parameters.

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[5]. Kumar et al. (2005) mention that for the complete assessment of lake water, management and restoration of our water resources.
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