Determination of Pollutants in Water Body Using Remote Sensing Techniques

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ABSTRACT

Remote sensing techniques are capable of enhancing the abilities of resource managers to monitor water bodies in a timely and cost-effective manner. Water can be used for several purposes. The water is pumped from various water bodies such as river, lake and reservoirs. Water is being polluted by direct discharge of effluents into the water bodies without proper treatment from industries. So, there is necessity for identification of the pollutants and their concentration in water. Remote sensors are capable to identify and quantify the composition of the materials in the water through their 'spectral signature'. The identification of pollutant type and their concentration in water is possible by spectral reflectance measured through spectroradiometer. There are several methods to determine the pollutants and their concentration by lab tests but it is tedious, so an innovative methodology by remote sensing techniques have proposed in this work.

The Noyyal river in TamilNadu have been selected as the study area.The reason is that the river is polluted by the dye industries in and around the Tirupur district. The type of pollutant and their concentration present in water have been determined using specroradiometer.

Three type of chemical salts calcium chloride, magnesium sulphate and sodium nitrate have been selected for this study. The spectral reflectance obtained for each salt in distilled water with various concentrations and also spectral curves were taken for water samples collected from Noyyal river. The different kind of salts identified by their absorption point 683nm,704nm and 690nm for calcium chloride, magnesium sulphate and sodium nitrate respectively. The type of pollutant in water samples from Noyyal river have identified through spectral curves of salts and mixtures of salts.

KEYWORDS:Pollutants,Spectroradiometer,Wavelength, Spectral Signature.

I. INTRODUCTION

Water pollution is becoming a huge problem which is faced by all of the human existence and as well as by every wild life species. So There is an immediate need to control water pollution by advanced technologies. The remote sensing techniques and their methods are needed to identify the pollutant and their concentration to get better solution of water pollution problem. By using remote sensing techniques the determination of pollutant and their concentrations are more advantageous than other lab experimental methods. This helps to monitor water quality and provide quality water to the users. The development of new methodology by remote sensing techniques enables to water quality monitoring and also offers a cost effective method in some cases.

II. OBJECTIVES OF THE STUDY

The objectives of this study are
1. To develop methodology to determine the type of pollutant present in water body.

III. STUDY AREA

A. Noyyal River

The river originates from the Vellingiri hills of the Coimbatore District. This River is a tributary of the Cauvery. It flows through Coimbatore, Erode and Karur districts.

The Noyyal river basin covers a total area of 3510 Sq.km. The length of Noyyal River is about 170 km from west to east. The average width of the basin is 25 km. The annual rainfall is varied for this basin.

The Noyyal is a seasonal river, which has good flow during the North-East and South-West monsoons. Apart from the monsoon periods, there is only scanty flow for most part of the year. The river supplies water to several irrigation tanks located in and around Coimbatore town and downstream. Nearly 6,000 acres of cultivable land are irrigated using the river water and the river flows to Orathupalayam dam in Erode district.

Tirupur's textile industry uses bleaching liquids, soda ash, caustic soda, sulphuric acid, hydrochloric acid, sodium peroxide, hypochlorite and various dyes and chemicals in textile wet processes, this effluents leads to increasing high salinity content in river.

IV. METHODOLOGY

The methodology developed to determine type of pollutant and its concentration present in water bodies using remote sensing techniques which helps to water quality monitoring. The Figure 4.1 depicting the methodology adopted in this study for the assessment of the water quality of surface water bodies.

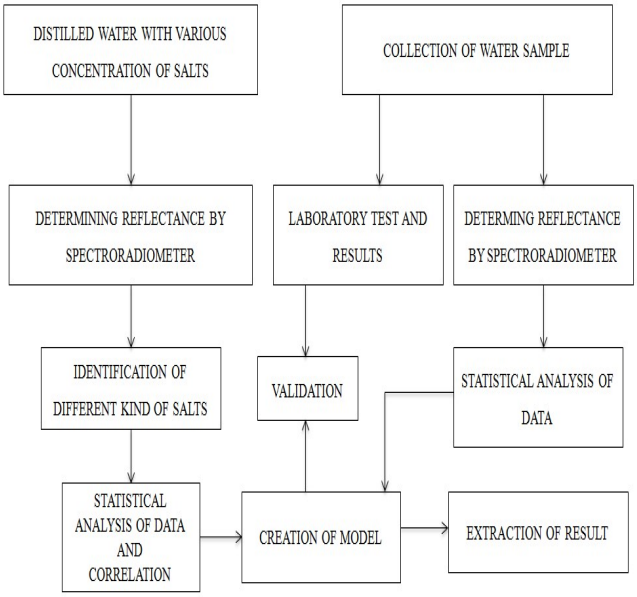

Figure 4.1 Method for Determining Pollutant and its Concentration

A. Preparation of Synthetic Samples

Salts such as Calcium Chloride, Magnesium Sulphate, sodium nitrate, mixture of calcium chloride with magnesium sulphate and calcium chloride with sodium nitrate were used for this study. These salts are mixed with one litre of distilled water with the concentration increases from 1gram to 10gram.

V. DETERMINING REFLECTANCE

A. Spectroradiometer

Spectroradiometer is an instrument used to collect the reflectance of surface materials to determine their spectral response patterns. The Field spec FHSS 325-1075P has been used for this Study. The Field Spec is a highly portable, general-purpose spectroradiometer useful in many applications requiring either the absolute or relative measurement of light energy. While its most highly regarded feature, besides its performance, is its field-portability, this unit performs competitively in the laboratory as well occupying less space in the process.

By using the instrument reflectance curves was taken for Calcium Chloride, Magnesium Sulphate, sodium nitrate, Calcium chloride with Magnesium sulphate and Calcium chloride with sodium Nitrate in distilled water with various concentrations from 1gram to 10gram.The experiment conducted in 40cm mouth pot with inner black coated bottom.

The reflectance curves and its value from 325 nm to 1075 nm retrieved by using ViewSpec software. The curve plotted between wavelength in X axis and reflectance in Y axis.

B. Reflectance Curve for River Samples

The spectral reflectance curves taken for the collected water samples from Noyyal river by using spectroradiometer. The Spectral curves and reflectance values retrieved from viewspec. The curve plotted between wavelength in X axis and reflectance in Y axis.

C. Identification of Salts

All salts have different spectral behaviour in different concentrations. The identification of each salt by its spectral behaviour. The different dips and peak reflectance seen in curves. The absorption occurred in the same wavelength for various concentrations were considered. The comparison result of the 'wave length' for all salts gives identification of salts.

D. Correlation and Statistical Analysis of Data

The large set of data retrieved from spectroradiometer. The data have been statistically analysed and correlated with its corresponding. The reflectance values increases with increase in concentration for all salts. The spectral curves should not understand visually or directly, only through mathematical models. The strength of the linear association between two variables is estimated by the correlation coefficient.

VI. RESULTS AND DISCUSSION

A. Spectral Reflectance Curves

Calcium Chloride

The spectral reflectance curve for different concentrations of calcium chloride sample is shown in Figure 6.1. The spectral reflectance curve shows that the increases in reflectance with increase in concentration. The absorption seen in 683nm in all concentration of calcium chloride. This may due to the presence of calcium chloride salt.

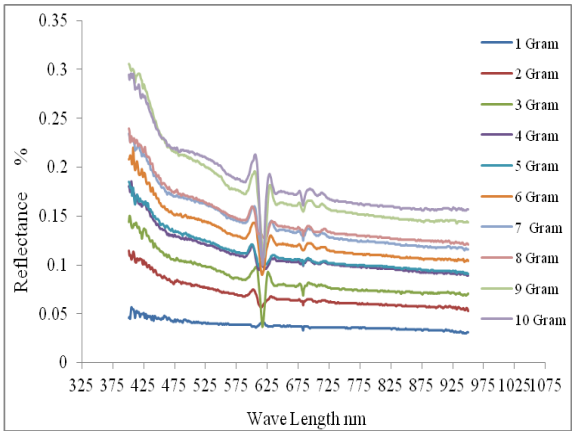

Figure 6.1 Spectral Reflectance Curve for Calcium Chloride

Magnesium Sulphate

The spectral reflectance curve for different concentrations of magnesium sulphate sample is shown in Figure 6.2.

The spectral reflectance curve shows that the increases in reflectance with increase in concentration. The absorption seen in 704nm in all concentration of magnesium sulphate. This may due to the presence of magnesium sulphate salt

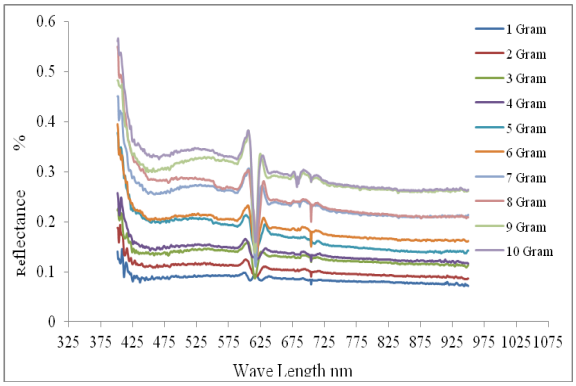

Figure 6. 2 Spectral Reflectance Curve for Magnesium Sulphate

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Sodium Nitrate

The spectral reflectance curve for different concentrations of magnesium sulphate sample is shown in Figure 6.3.

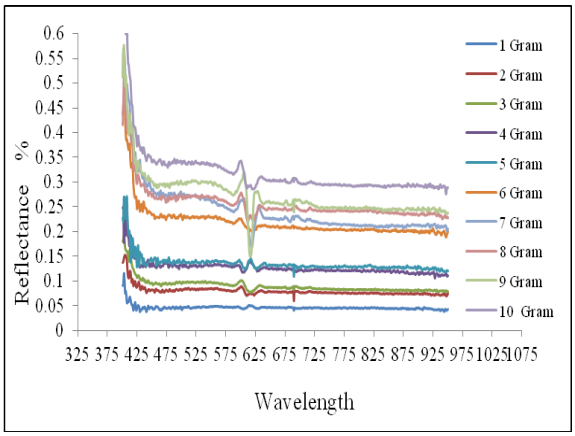

Figure 6.3 Spectral Reflectance Curve for Sodium Nitrate

The spectral reflectance curve shows that the increases in reflectance with increase in concentration. The absorption seen in 690nm in all concentration of sodium nitrate. This may due to the presence of sodium nitrate salt.

Calcium Chloride with Magnesium Sulphate

The spectral reflectance curve for different concentrations of calcium chloride with magnesium sulphate sample is shown in Figure 6.5.

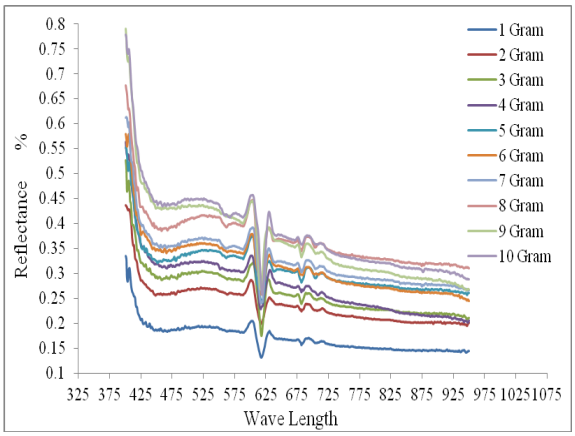

Figure 6.4 Spectral Reflectance Curve for Calcium Chloride With Magnesium Sulphate

The spectral reflectance curve shows that the increases in reflectance with increase in concentration. The absorption seen in 683nm in all concentration of calcium chloride with magnesium sulphate. The same kind of dip seen in calcium chloride spectral curves hence absorption in 683 nm may due to the presence of calcium chloride salt.

Calcium Chloride with Sodium Nitrate

The spectral reflectance curve for different concentrations of calcium chloride with sodium nitrate is shown in Figure 6.5. The spectral reflectance curve shows that the increases in reflectance with increase in concentration. The absorption seen in 683nm in all concentration of calcium chloride with sodium nitrate. The same kind of dip seen in calcium chloride spectral curves hence absorption in 683 nm may due to the presence of calcium chloride salt.

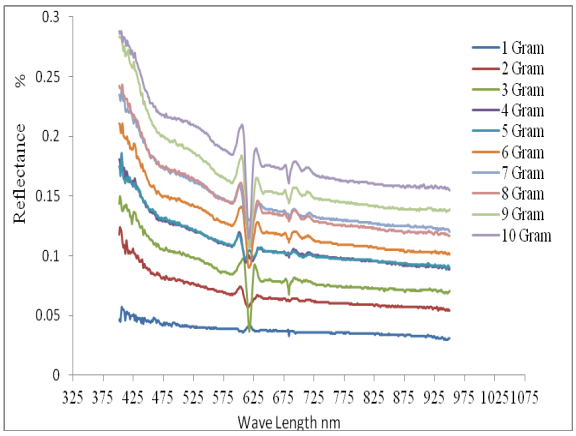

Figure 6.5 Spectral Reflectance Curve for Calcium chloride with Sodium Nitrate

B. SPECTRAL REFLECTANCE FOR NOYYAL WATER

The spectral reflectance curve for Noyyal River water sample 1 and sample 2 is shown in Figure 6.6.

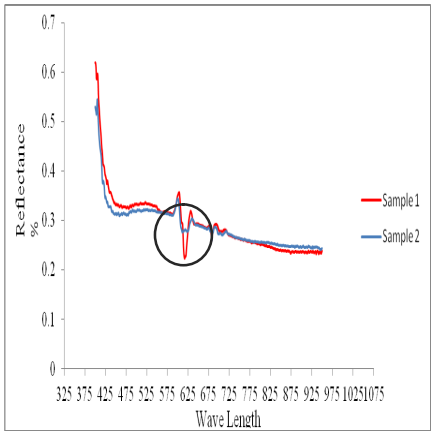

Figure 6.6 Spectral Reflectance Curve for Noyyal River

The absorption seen in 683nm for sample1 and sample 2 may due to the presence of high amount of calcium or chloride in Noyyal river. The amount of calcium present in sample 1 is 176mg/l and sample 2 is 172mg/l which exceeds the permissible limit of 75mg/l and the amount of chloride present in sample 1 is 685mg/l and sample 2 is 680mg/l is also exceeds the limits of 200mg/l.

VII. SUMMARY AND CONCLUSIONS

A. Summary

The spectral curves were taken for calcium chloride, magnesium sulphate and sodium nitrate, combinations of mixtures of calcium chloride with magnesium sulphate and calcium chloride with sodium nitrate for various concentrations (1 gram to 10 gram). The spectral curves are obtained for water samples from Noyyal river. The spectral curves of a each salt shows dip at particular wavelength (683nm, 704nm and 690nm) showing absorption of energy at that wavelength. The dip occurred for a salt of various concentrations was noticed at the same wavelength and found to increase with the increase in concentrations showing increase in reflectance. Some other absorption were also occurred in the spectral curves but it does not have same wave length for different concentrations so they were not considered.

The absorption in the spectral curves occurred at 683nm, 704nm and 690nm for different concentrations indicated calcium chloride, magnesium sulphate and sodium nitrate absorption respectively. Apart from individual salts the combinations such as calcium chloride with magnesium sulphate and calcium chloride with sodium nitrate curves also showed the dip at 683nm for different concentration is due to presence of calcium chloride. The spectral curves for two water samples collected from Noyyal river have also dip at 683nm. This dip is due to presence of high amount of calcium present in sample 1 (176mg/l) and in sample 2 (172mg/l) which exceeds permissible limit of 75mg/l in water. The amount of chloride present in sample 1

(685mg/l) and sample 2 (680mg/l) which is also exceeds the permissible limits of 200mg/l. The absorption point in the curves of calcium chloride and water samples occurred at 683 nm showing the presence of calcium or chloride in the water samples.

B. Conclusions

The observations made from the spectral signature curve is that the absorption points in 683 nm, 704 nm and 690 nm is may be due to the presence of calcium chloride, magnesium sulphate and sodium nitrate respectively. The Noyyal river water sample spectral signature also has the absorption at 683 nm and has the high concentration of calcium and chloride, so the 683 nm wavelength is significant for identification and quantification of calcium or chloride. The chemicals are available only in the form of salts as calcium chloride, magnesium sulphate, etc,. and this type of chemicals used for this study. The absorption point of each salt represents that presence of two kinds of chemicals. Also there is no instruments and methods to quantifying the presence of salts (acid and base) in water, so modelling is not possible for quantification. This is possible by taking spectral curves for individual chemicals (calcium, magnesium, chloride, etc,.) which are not available in market.

C. Scope for Future Studies

The methodology and retrieved results from this work will helpful for developing methods and models for determining pollutants and its concentration in water body through remote sensing techniques. It is suggested to take spectral curves for individuals chemicals (chloride, calcium, sulphate, etc,.) with possible combinations in different concentrations which will help to create correlation between spectral signature and chemical concentration. Then the modelling is possible for the quantification of pollutant present in water body through remote sensing.

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