2002 年度修士論文

分光放射計を用いた
水面におけるクロロフィル濃度の評価

Spectroradiometer Evaluation of Water Surface Chlorophyll Concentration

2003 年 1 月

指導教員　村上雅博

高知工科大学大学院工学研究科基盤工学専攻社会システム工学コース

1055143　佐藤博信

要旨

衛星デジタルデータは，地球上の広範なエリアの環境情報の把握に有用な方法である．水域のクロロフィル濃度推定に関しても，衛星デジタルデータを用いたクロロフィル濃度分布の推定の研究が行われている．

本研究の目的は，水面のクロロフィル濃度の推定に適した波長域を，分光放射計を用いて同定することが目的である．

実験では，はじめに，分光放射計と水質測定機器を利用し，淡水と海水中のクロロフィル濃度を測定した．異なったサンプルのクロロフィル濃度の溶液を，ホテイアオイの絞り汁を用いて作成した．また，光源としては，ノイズの混入を避けるため，ハロゲンライトを用いた．

次に，分光反射率を，band 1(450~520nm)，band 2 (520~600 nm),band 3(630~690nm)，band 4(750~900nm)，band 5(1550~1750nm)，band 7(2080~2350nm)の 6 種類の band 域に分類し，それぞれの band 域の平均分光反射率を求めた．これらの 6 つのバンド域は Landsat 7/ETM+データに対応している．

最後に, それぞれのバンド域の分光反射率同士の比演算, 及び, NDVI (Normalized Difference Vegetation Index)を算出した．そして，クロロフィル濃度と算出した比演算の値（NDVI を含む）を独立変数として，クロロフィル濃度との相関を解析した．

その結果，クロロフィル濃度推定に適した独立変数は，淡水の場合は R_{band2}/R_{band1} と，海水の場合は R_{band4}/R_{band1} 及び$(R_{band4}-R_{band5})/R_{band1}$ であり，淡水と海水では，クロロフィル濃度推定に適した独立変数は異なることが明らかになった．

今後の課題として，この結果を衛星リモートセンシングに適用する場合，大気中のエアロゾルの影響を考慮し，上記結果の有効性を再評価する必要があると考えられる．

キーワード：クロロフィル濃度，分光反射率，分光放射計，Landsat 7/ETM

Spectroradiometer Evaluation of Water Surface Chlorophyll Concentration

SATO Hironobu

ABSTRACT

The satellite digital data is one of the most useful information to evaluate the environmental conditions on the large extent area of the earth. The research of estimating chlorophyll concentration in the water surface has been carried out by using remote sensing technology including Landsat-7 Enhanced Thematic Mapper (ETM) Plus multispectral digital data.

This study aims to identify the optimal spectral reflectance range of chlorophyll concentration in the water surface using a spectroradiometer.

First, in the experiments, chlorophyll concentration and spectral reflectance were measured in fresh lake water and seawater in Kochi Prefecture, using both a spectroradiometer and a water quality monitoring sonde. Squeezed water hyacinth was adapted to prepare the standard sample with different chlorophyll concentration. Halogen light was used to avoid the influence of spectral contamination.

Secondly, the spectral reflectances were divided into 6 bands, namely, band 1 (450~520nm), band 2 (520~600nm), band 3 (630~690nm), band 4 (750~900nm), band 5 (1550~1750nm) and band 7 (2080~2350nm), to calculate the average of spectral reflectances on each band. These 6 bands correspond to the band range of Landsat-7/ETM Plus multispectral digital data.

Third, the ratios of spectral reflectance on each band, NDVI (Normalized Difference Vegetation Index) were calculated to analyze the correlation of chlorophyll concentration with the ratio of spectral reflectance on each band like $Ref_{band\,i}/Ref_{band\,j}$, $(Ref_{band\,i} - Ref_{band\,j})/(Ref_{band\,i} + Ref_{band\,j})$, etc; "$Ref_{band\,i}$" refers to "Reflectance of band *i*".

In conclusion, this study demonstrates that fresh water and seawater is different in terms of the independent variables suitable for estimating chlorophyll concentration. That is to say, it was found that, as for the independent variables suitable for estimating chlorophyll concentration, they are R_{band2}/R_{band} and $(R_{band4}-R_{band5})/R_{band1}$ in the case of fresh water, whereas they are R_{band4}/R_{band1} and $(R_{band4}-R_{band5})/R_{band1}$ in the case of seawater.

It is still necessary to reevaluate the results of the experiments in this study by taking into account of the effect of aerosol in the atmosphere, in case of applying this method to satellite remote sensing.

Keywords: Chlorophyll concentration, Spectral reflectance, Spectroradiometer, Landsat-7