Detection of Red Tides by IRS/OCM Imagery

Y. Q. Kang
Department of Oceanography, Pukong National University
599-1 DaeyonDong, NamGu, Pusan, 608-737, Korea
yqkang@pknu.ac.kr

Y. S. Suh
Korea Ocean Research and Development Institute
408-1 SirangRi, GijangEub, GijangGun, Pusan, 619-902, Korea
yssuh@nfrdi.re.kr

Abstract: We present a simple algorithm for detection of red tide patches by remote sensing in coastal waters of Korea. The red tide patches can be identified by the relative intensity of red band signal with respect to the blue-green background signal, provided the radiometric signals only in the sea area are properly stretched. We tested our algorithm by Ocean Color Monitor (OCM) data of Indian Satellite IRS-P4, which has been received from 2001 by National Fisheries Research and Development Institute of Korea. A comparison of our results with observation shows that the locations of red tides derived from remote sending imagery by our algorithm are in accordance with observations.
Key words: Red Tides, OCM, Ocean Color

1. Introduction

Red tide is one of serious natural hazards in Korean coastal waters. Early detection of the distribution red tide patches by remote sensing is very desirable and necessary. 'Classical' approaches to detect red tides by chlorophyll-a algorithm in turbid coastal waters of Korea were not satisfactory. Yoo and Jeong (1999) and Jeong and Yoo(2000) suggested spectral band ratio algorithm as a tool to determine chlorophyll concentration and to identify red tide patches in coastal turbid waters.

The distributions of red tides in coastal waters of Korea determined by field observations are regularly reported by National Fisheries and Research and Development Institute of Korea (NFRDI). The validity of red tide detection by remote sensing can be checked by comparing spatial distributions of red tides determined by both methods. In this paper we present an algorithm to identify red tide patches by ocean color remote sensing data and show the validity of the method by comparison with observations.

Table 1. Spectral characteristics of OCM sensor

Band	Wavelength (nm)		Typical Usage
1	412	(402-422)	Yellow substance and turbidity
2	443	(433-453)	Chlorophyll absorption maximum
3	490	(480-500)	Chlorophyll and other pigments
4	510	(500-520)	Turbidity, suspended sediment
5	555	(545-565)	Chlorophyll, suspended sediment
6	670	(660-680)	Chlorophyll absorption
7	765	(745-785)	O2 absorption
8	865	(845-885)	Aerosol optical thickness, vegetation, water vapor reference over the ocean

Since 2001, the NFRDI has been receiving the Ocean Color Monitor (OCM) sensor

data of the Indian satellite Oceansat-1 (IRS-P4). The OCM sensor data have spatial resolution of 360x236m, swath of 1420km and revisit time of 2 days. The OCM data consists 8 bands of 12 bits radiometric data in the visible and near infrared (NIR) spectral ranges. Band characteristics of the OCM sensor, shown in Table 1, are identical to those of SeaWifs.

2. Red tide algorithm in coastal water

In coastal waters of Korea, the relative intensity of red color with respect to blue-green 'panchromatic' was found to be a good indicator for identification of red tide patches. However, due to relatively uniform distribution of ocean color intensity, it is necessary to intensify digital numbers (DNs) over the sea area to get 'meaningful' results. Our procedure to get the relative intensity of red color is as follows.

(1) A mask image identifying land and sea areas is made using the NIR band data (band 8, 865nm). Threshold value for land-sea distinction should be provided.
(2) From 12 bits data of OCM Band 6 (670nm), we made 8 bit image in which sea pixels are fully stretched. The histogram of DNs only in the sea area were used for stretching of sea area pixels.
(3) The 12 bits blue-green 'panchromatic' data is made by arithmetic mean of DNs of band 2 (443nm), band 3 (490nm) and band 4 (510nm). From this 12 bits blue-green panchromatic data, we made 8 bit image data by stretching sea area pixels.
(4) We computed the relative intensity of red color (band 6) image with respect to blue-green panchromatic image (combination of bands 2, 3 and 4). Probable locations of red tide patches are identified from the distribution of this relative intensity.
(5) For clear visualization of geographic locations, the land and cloud areas are masked in the image of the relative intensity.

Fig. 1 show the distribution relative intensity of red band signal with respect to blue-green panchromatic signal in the OCM image on August 26, 2001. The observed distribution of red tides on the same date by NFRDI is shown in Fig. 2. A comparison of two figures shows that the areas with high relative red color in the OCM image is in accordance with the observed areas of red tides.

3. Discussion and Conclusion

Our simple algorithm of red tide detection by relative red color in OCM ocean color imagery seems quite successful in identifying red tide patches. Our approach of relative red color (670nm) with respect to blue-green background (430-520nm) is similar to the band ratio algorithm between green (490nm) and red (665nm) suggested by Jeong and Yoo (2000). We do not insist our present algorithm is the optimal one. We are still trying to find out better algorithm for red tide detection from ocean color imagery. 'Spectral Correlation Method' is one of the candidates for 'better' red tide detection algorithm, which is under study now.

References

[1] Yoo, S. J. and J. V. Jeong (1999), Detecting red tides in turbid waters. *Journal of Korean Society of Remote Sensing*, **15**(4), 321-327.
[2] Jeong, J. C. and S. J. Yoo (2000), The validation of chlorophyll-a band ratio algorithm of coastal area using SeaWifs wavelength. *Journal of Korean Society of Remote Sensing*, **16**(1), pp. 37-46.

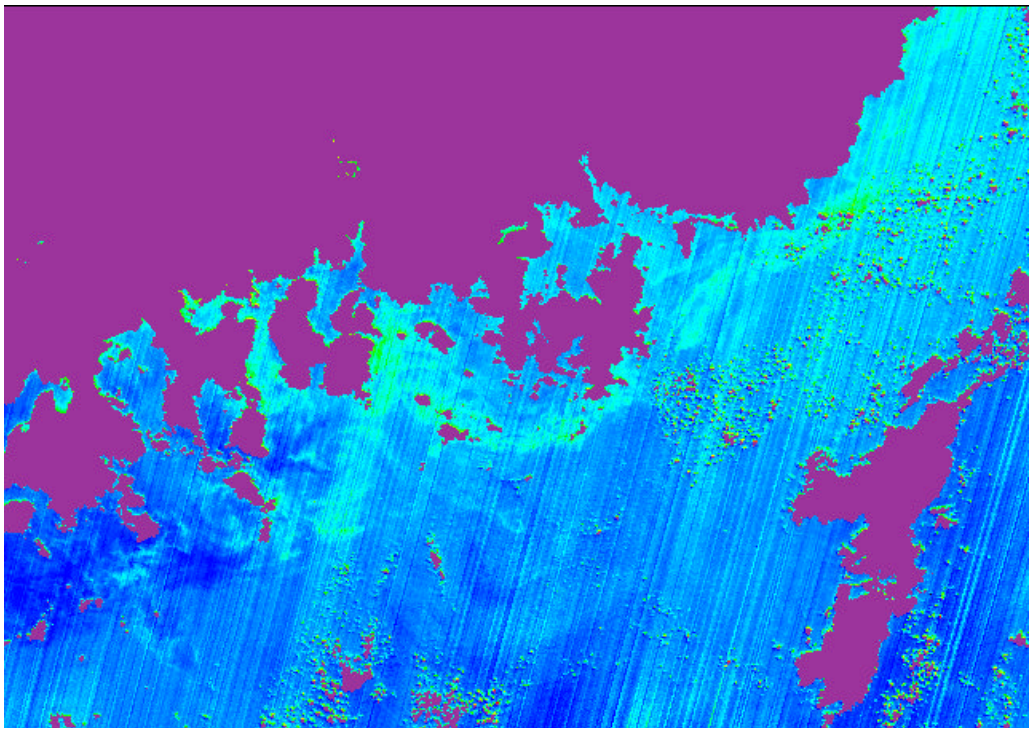

Fig. 1. Relative intensity of red with respect to blue-green (OCM: Aug. 26, 2001).

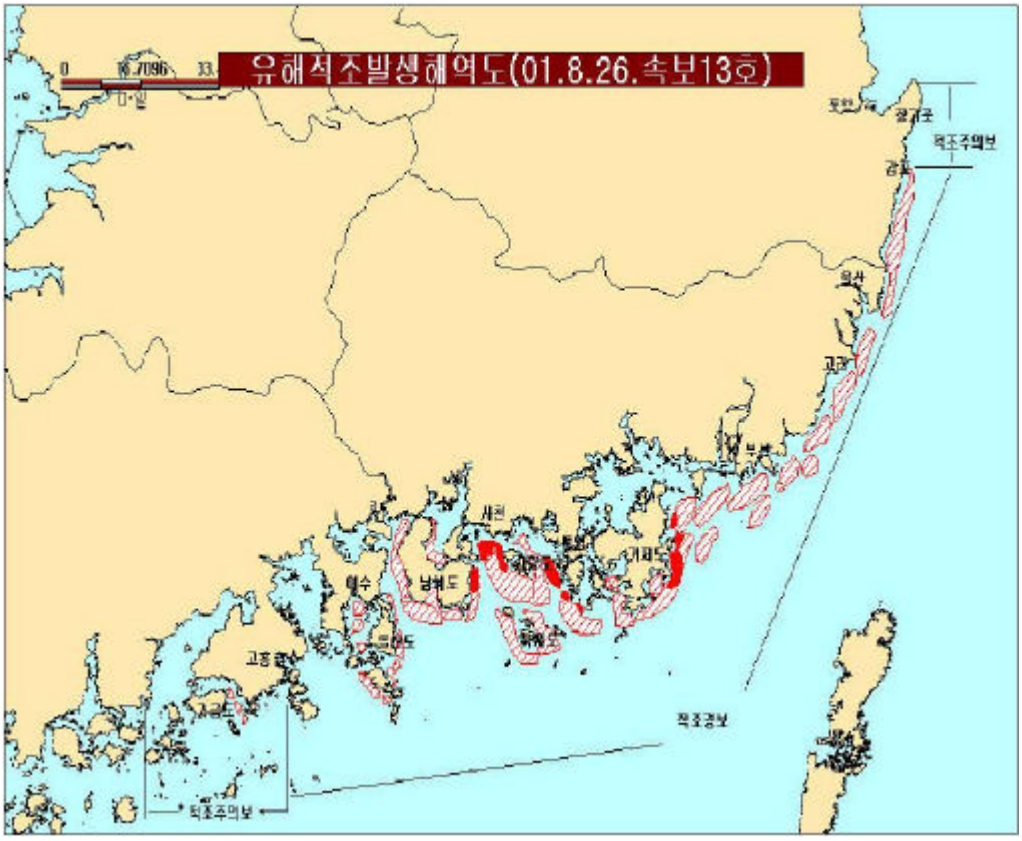

Fig. 2. Observed distribution of red tides on August 26, 2001 (NFRDI report).