A Comparative Study for Red Tide Detection Methods Using GOCI and MODIS

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Abstract: This study detected red tide areas using the existing Moderate-Resolution Imaging Spectroradiometer (MODIS) and Geostationary Ocean Color Imager (GOCI), and then compared the results between results of two sensors. The coasts of Jeollanam-do in the South Sea of Korea were set as the study area based on the red tide data which occurred on Aug. 26th, 2012. This study compared the results of sensors to detect red tides by using a satellite. In the results of analyzing MODIS by limiting it as chlorophyll concentration and the sea surface temperature which is considered to have red tides by the existing researches, it was possible to delete considerable amount of errors compared to the case of detecting red tides by using only chlorophyll while still there were differences from the range of red tides actually observed. In the results of GOCI by using empirical algorithm for detecting red tides, currently used by Korea Institute of Ocean Science & Technology (KIOST), it was possible to obtain more detailed results than MODIS. However, there was an area misjudged as red tides due to the influence of clouds. Also both MODIS and GOCI extracted red tides were not actually occurring, which might be because they were not able to perfectly distinguish red tides from turbid water in coastal areas with high turbidity.

Key Words: GOCI, MODIS/Aqua, Red Tide detection, Water-leaving radiance

1. Introduction

In the whole world coastal areas, red tides have caused massive death of marine lives, physical damage and huge influence on ecosystem, and nowadays they are more increased by climate change like rise of the surface temperature (Kang et al., 2002; Lee et al., 2006; Son et al., 2011). Rather than predicting the occurrence of red tides in advance, it might be more efficient to minimize damage through quick actions after rapidly detecting red tides. Since red tides occur in wide areas and move through ocean currents from the original spots, just marine monitoring is not enough to detect red tides. Thus it is required to detect red tides by using a satellite with high resolution in time/ space.

Researches on red tides detecting and monitoring by
using remote sensing were attempted based on chlorophyll concentration or its abnormality values, estimated by a satellite (Ishizaka, 2003; Hu et al., 2005). Since most of the chlorophyll algorithm estimated by an ocean color satellite was developed focusing on clean seas, it is hard to detect them because of time/spatial resolution problems of earth air correction and optical algorithm, due to the influence of shallow sea and dissolved organic matter/suspended sediment in coastal areas.

Hu et al. (2005) who detected red tides by using Moderate-Resolution Imaging Spectroradiometer (MODIS) data draws results saying that the estimated chlorophyll value based on MODIS fluorescence data is more accurate than the current MODIS chlorophyll data provided by National Aeronautics and Space Administration (NASA), and then areas with high chlorophyll concentration are generalized as red tides occurring regions by using this chlorophyll data. Since regions with high chlorophyll concentration are simply considered as red tides occurring regions, its accuracy is significantly low.

In order to improve the method of detecting red tides by using satellites, this study distinguished red tide areas by using the existing MODIS sensor and Geostationary Ocean Color Imager (GOCI) sensor, and then compared the results between results of two sensors.

2. DATA AND METHODS

This study selected the study area and the test date based on the geographic information data of the red tides that National Fisheries Research and Development Institute (NFRDI) provides. NFRDI makes out report data of red tides using reconsideration and acquisition information about the seas that they occur in the Korean coasts. The coasts of Jeollanam-do in the South Sea of Korea were set as the study area based on the red tide data which occurred on Aug. 26th, 2012. The MODIS image used is provided by NASA. Both MODIS and GOCI data were taken on August 26th, 2012 and also analyzed the same areas.

3. RESULTS AND DISCUSSIONS

1) RED TIDE DETECTION USING MODIS

The result which analyzed Chlorophyll with the MODIS images photographed on Aug. 26th, 2012 has found that there was the distribution of 0 ~ 5mg/m$^3$ in the study area. But Chlorophyll’s concentration is more than 15mg/m$^3$ in the coastal areas.

Fig. 1 is the distribution of chlorophyll in the research area by using MODIS chlorophyll data. Most...
of the southern coastal area in Korea can be mistakenly judged as red tide regions in case when depending on only chlorophyll concentration to judge red tide occurrence. After limiting the concentration range of chlorophyll as values more than 6mg/m³, therefore, the areas showing water temperature for red tide occurrence in MODIS Sea Surface Temperature(SST) data were overlapped. In the results of applying SST data of water temperature for red tide occurrence to the image of chlorophyll concentration, we found that considerable amount of errors were deleted from the initial image extracted only chlorophyll.

2) RED TIDE DETECTION USING GOCI

The result which analyzed Chlorophyll with the GOCI images photographed on Aug. 26th, 2012 has found that there was the distribution of 0 ~ 5mg/m³ in the study area. But Chlorophyll’s concentration is more than 5mg/m³ in the coastal areas. In the results of chlorophyll concentration, MODIS had more excessive estimation of chlorophyll concentration than GOCI when it was closer to coast with more turbid water.

Fig. 5 is the distribution of chlorophyll, analyzed on the basis of GOCI data. It showed similar distribution to the one based MODIS while there was a bit of differences in concentration. The red-tide occurring location based on GOCI image was analyzed by using empirical algorithm of Korea Institute of Ocean Science & Technology(KIOST) (Ahn and Shanmugam, 2006).
3) COMPARISON OF THE RESULTS OF MODIS AND GOCI

The location of red tide occurrence extracted from MODIS and GOCI was compared with the out report data of red tides, provided by the geographic information data of the red tides from NFRDI.

Comparing the red-tide occurring location extracted by a satellite with the out report data of red tides, the areas (marked in yellow circle) where red tides actually occurred were all extracted by MODIS and GOCI.

Though MODIS showed results similar to the actual red-tide occurrence location, there were differences from the accurate location and area. It might be because spatial resolution of MODIS is relatively low as 1 × 1 km. In case of GOCI, the red-tide occurrence location was extracted pretty accurately. However, the southern sea of the image contained an error of Water Leaving Radiance due to the influence of clouds, which caused wrong estimation of red tide even though there were no red tides in reality.

As shown in Fig. 5, both MODIS and GOCI showed areas that could be judged as red tides even though actually there were no red tides (Red dotted-line square).

4. CONCLUSIONS

This study compared the results of sensors to detect red tides by using a satellite. In the results of analyzing MODIS by limiting it as chlorophyll concentration and the sea surface temperature which is considered to have red tides by the existing researches, it was possible to delete considerable amount of errors compared to the case of detecting red tides by using only chlorophyll while still there were differences from the range of red tides actually observed. In the results of GOCI by using empirical algorithm for detecting red tides, currently used by KIOST, it was possible to obtain more detailed results than MODIS. However, there was an area misjudged as red tides due to the influence of clouds. Also both MODIS and GOCI extracted red tides were not actually occurring, which might be because they were not able to perfectly distinguish red tides from turbid water in coastal areas with high turbidity.

Thus it will be essential to develop improved Red-Tide Index that can clearly distinguish red tides from turbid water by using GOCI that has higher time/spatial...
resolution than MODIS. It is also necessary to develop evaluation methods of the detected results.

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**References**


