Meteorological characteristic and satellite monitoring for red tide in the Korean coasts

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Abstract: It was studied the relationship between the red tide occurrence and the meteorological factors, and the satellite monitoring for red tide. From 1990 through 2001, the red tide continuously appeared and the number of red tide occurrence increased every year. A common condition for the red tide occurrence was heavy precipitation 2～4 days earlier, and the favorable conditions for the red tide formation were high air temperature, proper sunshine and light winds for the day in red tide occurrence. From satellite images, it was possible to monitor the spatial distributions and concentrations of red tide.
Key words: Red tide, Meteorological factors, Remote sensing

1. Introduction

Actually the heavy industrial and human activities have contributed to bring various pollutants required for the increasing of red tide occurrence from land through river discharge. This red tide has destructed the marine ecology and environments, and has given the great damage of coast fisheries and caused national problems of socio-economics [1－2]. Especially it is considered as a serious matter that red tide appears frequently to the southern coastal area and extends gradually to the all coastal areas in the Korean peninsula. Thus, it is necessary to know beforehand the characteristics of the meteorological conditions and the possibility of satellite monitoring for the prevention of disasters related to red tide in this study area [3].

2. Field observation data

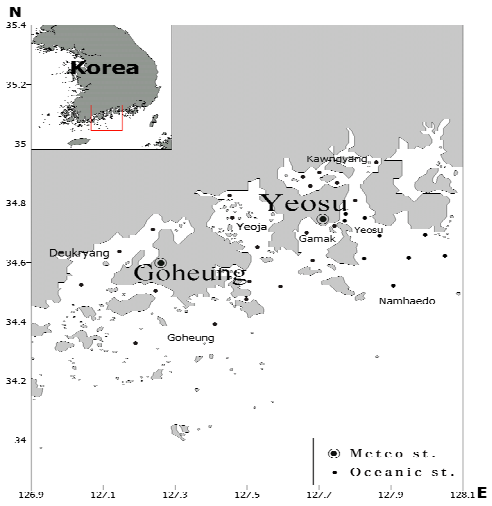

Fig. 1. Middle coastal area in the South Sea of Korea.

The study area is the middle coastal area in the South Sea of Korea (Yeosu and Goheung, Fig. 1). The reported monitoring data used are as follows: the meteorological factors are air temperature, precipitation, sunshine and winds for the periods of 1990 to 2001 and the observed intervals of 3hour. The chloroohyll_a concentrations on August 22, 2000 was calculated from the ocean chlorophyll 2 algorithm [4]. The red tide occurrence data is in-situ data for the periods of 1984 to 2001.

3. Results and Consideration

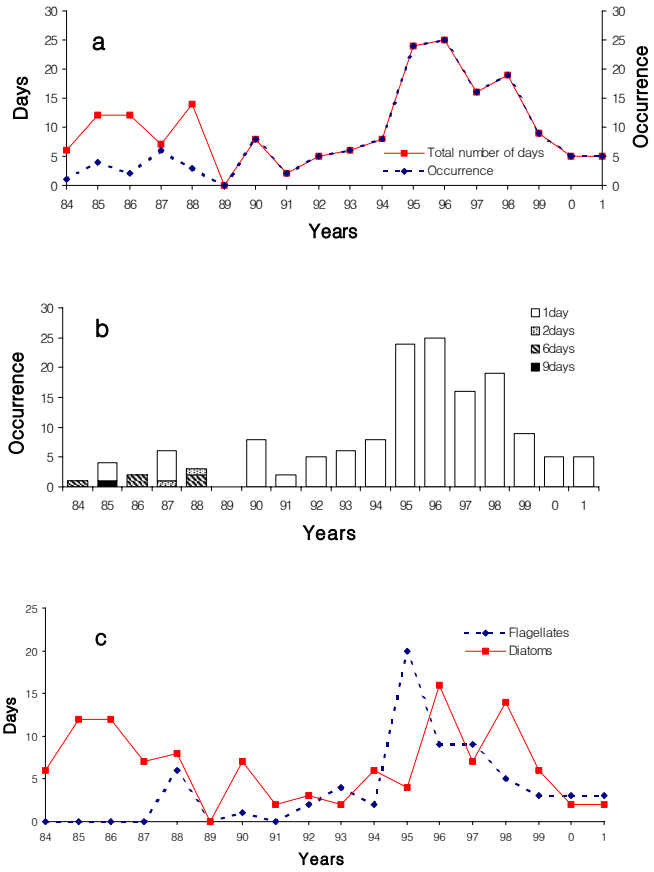

Fig. 2. Annual variations of red tide occurrence during 1984~2001. (a) Total number of days and the number of occurrence, (b) proportion of red tide forming duration, and (c) the proportion of two major phytoplankton taxonomic groups.

Fig.2 shows the annual variations of red tide occurrence.

The occurrence of red tide appeared each year except only 1989 and commonly increased each year (Fig. 2a). It was particularly prominent on 1995, 1996, 1997 and 1998 with the total number of days reaching up to 24, 25, 15 and 19 days, respectively. The duration of red tide tended to be shorter since 1990 and is only 1 day at present (Fig. 2b). The phytoplankton groups increased from 1994 (Fig. 2c). Then, the standing crops are flagellates on 1995 and diatoms on 1985, 1986, 1996 and 1998, respectively. In the monthly variation of red tide occurrence (Fig. 3), the occurrence of both diatom and flagellate red tide during last 18 years (1981～2001) appeared usually from April to October(significantly July, August and September). For the total number of days, diatoms showed 63.4% and flagellates showed 36.6%. For the standing crops, diatoms appeared from April to July and flagellates appeared from September to October.

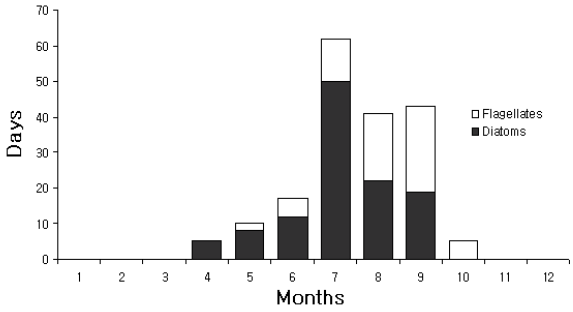

Fig. 3. Monthly variations of red tide occurrence during 1984~2001.

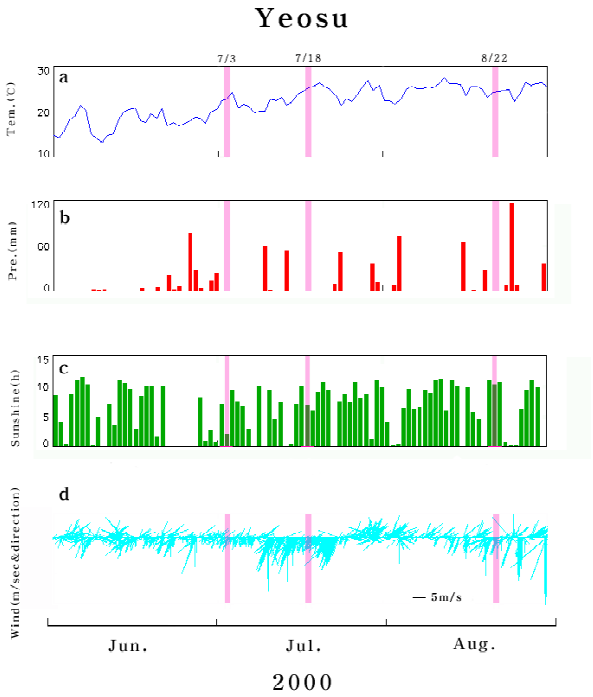

Fig. 4. Daily variations in Yeosu during June～July 2000. Shadow regions denote the time when the red tide was occurred.

Fig. 4 shows the daily variations of meteorological factors in monthly data. This is the case studies for the days in the red tide occurrence from June to August, 2000. The first case is the Gamak bay. In July 1, 2000 before the red tide occurrence, the daily accumulated precipitation was 23.4mm. In July 3, 2000 in red tide occurrence, the daily average air temperature was 24.66℃ (max.: 27.3℃), the daily accumulated precipitation was 0mm, the daily accumulated sunshine was 2h, and the main wind speed was 0.25m/s in southwest direction (max.: 5.5m/s and 200 from the north). The second case is the Yosu～Dolsan coast. In July 14, 2000 before the red tide occurrence, the daily accumulated precipitation was 54.4mm. In July 18, 2000 in red tide occurrence, the daily average air temperature was 26.48℃ (max.: 29.4℃), the daily accumulated precipitation was 0mm, the daily accumulated sunshine was 6.9h, and the main wind speed was 0.25m/s in southwest direction (max.: 5.1m/s and 200 from the north). Finally, the third case is the Dolsan coast. In August 20, 2000 before the red tide occurrence, the daily accumulated precipitation was 27.5mm. In August 22, 2000 in red tide occurrence, the daily average air temperature was 25.85℃ (max.: 28.7℃), the daily accumulated precipitation was 0mm, the daily accumulated sunshine was 10.3h and the main winds was 0.46m/s in the southwest direction (max.: 7.7m/s and 180 from the north), respectively.

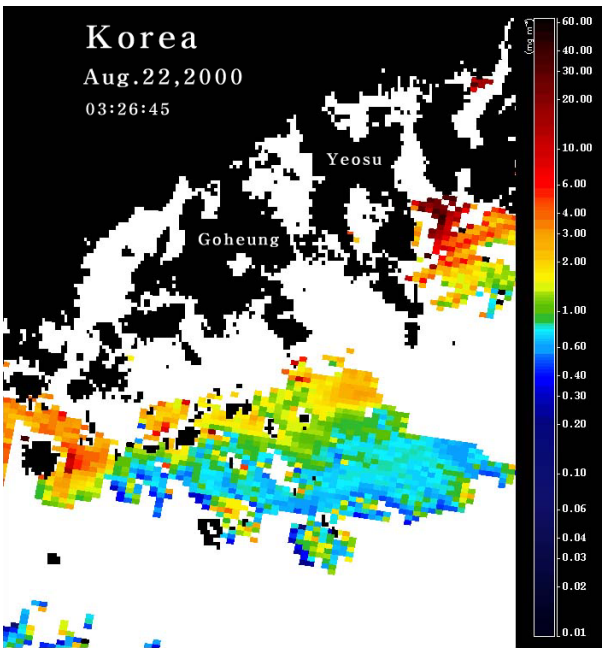

Fig. 5. Areal distributions of Chlorophyll_a from SeaWiFS image on August 22, 2000.

Chlorophyll_a in August 22, 2000 was obtained from SeaWiFS image by using the ocean chlorophyll 2 algorithm(OC2) (Fig. 5). Fig. 6 shows the comparison between satellite data and in-situ data. Here,

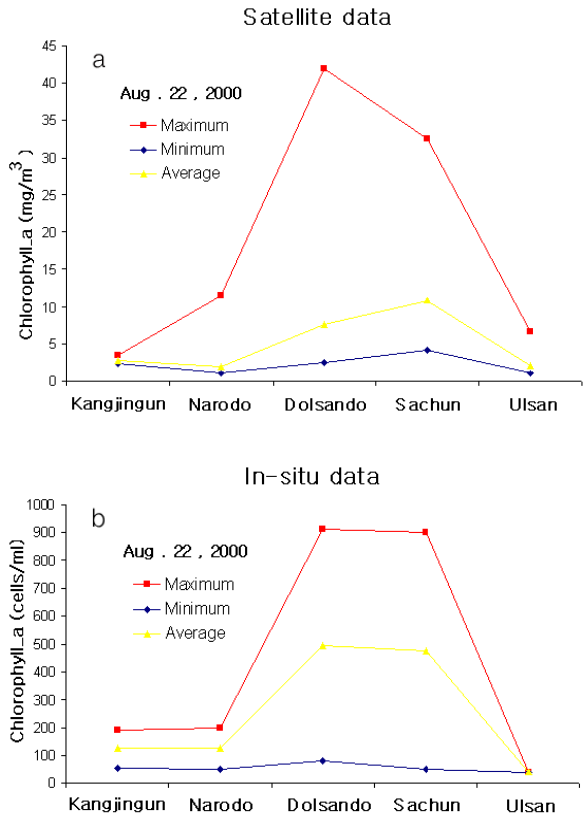

Fig. 6. Comparisons of (a) satellite data and (b) in-situ data in Kangjin, Naroda, Dolsando, Sachun and Ulsan on August 22, 2000.

Chlorophyll_a showed approximately the same trends, for example, in the case of the Dolsan coast, the satellite values presented 2.509～41.879 mg/m (average: 7.699 mg/m) and the in-situ values presented 80～910 cells/l(average: 495 cells/l), respectively. This result means that the possible monitoring involved the spatial distributions and concentrations in red tide occurrence.

Conclusions

In the middle coastal area of the South Sea, the occurrence of red tide appeared and increased every year, enlarged from Yeosu to Goheung after 1994, and concentrated in July, August, and September. The duration of red tide tended particularly to be shorter as 1 day after 1992. In the total number of days, diatoms and flagellates presented 63.4% and 36.6%, respectively.

The important meteorological factor governing the mechanism of the increasing number of red tide occurrence is heavy precipitation. This appeared to bring nutrients and other chemical substances required for growth of phytoplankton from land through river discharge(eg: Sumjin river near Yeosu～Dolsan coast). The common condition for the red tide occurrence is heavy precipitation(23.4～54.5mm) 2～4 days earlier. The commonly favorable conditions for the red tide formation was as follows; high air temperature (24.64～25.85℃), proper sunshine (2～10.3h) and light winds (2～4.6m/s & SW) in the day in red tide occurrence. The calm weather with warm temperature and low wind velocity results in less dispersion of the vegetative cells of red tide organisms and it was possible to monitor the spatial distributions and concentrations of red tide by satellite images.

Acknowledgements

The work was supported by grant on Technological Marine Meteorological and Climatological Data Utilization for Korean Meteorological Administration, and partially grant No R01-2002-000-00369-0 for The Basic Research Program of Korea Science & Engineering Foundation.

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