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Spatial Distribution Characteristics of Red Tide (Cochlodinium polykrikoides) in the South Sea of Korea using SST

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Abstract. In this study, the characteristics of the location of red tides occurrence from 2013 to 2015 were Hot Spot analyzed using the SST and occurrence area. The SST was using the Group for High Resolution Sea Surface Temperature (GHRSST) data from the Jet Propulsion Laboratory in NASA. The occurrence area of the red tide was obtained from the red tide alert data of the National Institude of Fisheries Science. As a result of SST hot spot analysis, hot spots were formed in Central Sea of the South Sea. The occurrence area of red tide formed hot spots in Tongyeong and Namhae. However, in 2015, hot spots were formed near Wando.

Keywords: Red tide, Hot Spot Analysis, the Group for High Resolution Sea Surface Temperature

1 Introduction

The seas of Korea have distinct marine characteristics due to the influx of Kuroshio Current from the outside and seasonal characteristics. However, the prediction of marine ecology has become complicated due to recent marine environmental and meteorological fluctuations, indiscriminate coastal development, and influx of pollutants from rivers [1]. It is necessary to analyze physical, chemical and spatial characteristics on red tide in this marine environment. Red tide is a phenomenon in which a lot of phytoplankton reproduce and the sea turns red. Recently, around the sea of Korea have been eutrophicated in almost all the waters, and tend to last for a long-term when red tides occur. Until the 1980s, red tide were mainly caused by diatoms in the south of Korea, but since 1985, the red tides by flagellates have increased [1-3]. Cochlodinium *polykrikoides*(C. *Polykrikoides*) is a non-toxic phytoplankton that attaches to the gills of fish and causes the fish to suffocate.
[4] is currently actively studying the causes of biochemical red tide. [5] analyzed the early occurrence, progression and extinction of C. *polykrikoides* red tide in the south

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of Korea using in situ data and NOAA satellite SST data. However, studies on the cause, distribution, and time series of spatial red tide are insufficient and research is needed to understand spatial characteristics of red tide in a scientific and rational way. In this study, characteristics of occurrence area and SST of red tides were analyzed by using spatial statistical techniques.

2 Data and Methods

The study area is South Sea of Korea, and the study period was selected from 2013 to 2015, when C. *polykrikoides* red tide occurred. The red tide occurrence location information was used by the red tide alert data provided by the National Institute of Fisheries Science. National Institute of Fisheries Science Acquisition data on the location and status when red tide occurs, and provides red tide alert data once a day. After that, Georeferencing process was performed. The red tide occurrence map is composed of x and y, and the geographic coordinates are assigned to each pixel through the georeferencing process in order to acquire the red tide occurrence location information because coordinate system are not allocated. After that, the area of the polygon with respect to the actual red tide occurrence location is extracted and made into a point.

To extract the SST data corresponding to the extracted points, the Group for High Resolution Sea Surface Temperature (GHRSST) was used. GHRSST Level 4 sea surface temperature analysis data is provided by Jet Propulsion Laboratory in NASA and is generated daily on a 0.01 ° grid. SST is made using observations from the Advanced Microwave Scanning Radiometer for EOS (AMSR-E), Advanced Very High Resolution Radiometer (AVHRR), and the Geostationary Operational Environmental Satellite (GOES) sensor.

The extracted SST and occurrence area was used to analyze the hot spot. Hotspot analysis is a technique that distinguishes spatial clusters of high values (hot spot) and low values (cold spot). Getis-Ord`s GI * is one of the spatial autocorrelation techniques and is a tool for statistically measuring the degree of spatial autocorrelation. To do this, the GI * value is calculated for each data and the statistical significance of the hotspot can be grasped through the GI * value. It is a tool to statistically classify input data into high-value (hot spot) and low-value (cold spot) sections using probability P-value and standard deviation Z-Score [6-8]. When a Z-Score is surrounded by a high value in a cluster of data with similar Z-Score, a hotspot is formed, and when the Z-Score is surrounded by a low value, a cold spot is formed.

3 Results and Conclusions

In this study, hot spots of SST and occurrence area of C. *polykrikoides* red tide from 2013 to 2015 were analyzed. The occurrence area of red tide formed hot spots in Tongyeong and Namhae. However, in 2015, hot spots were formed near Wando. In the case of SST, hot spots were formed in Wando and Goheung, which is known as

the early occurrence area of red tide. Hotspot analysis showed no significant agreement between hotspots and area of occurrence of red tide. However, it was confirmed that the hot spots were formed in the area where the red tide was early occurred area and red tide was accumulated for a long-term.

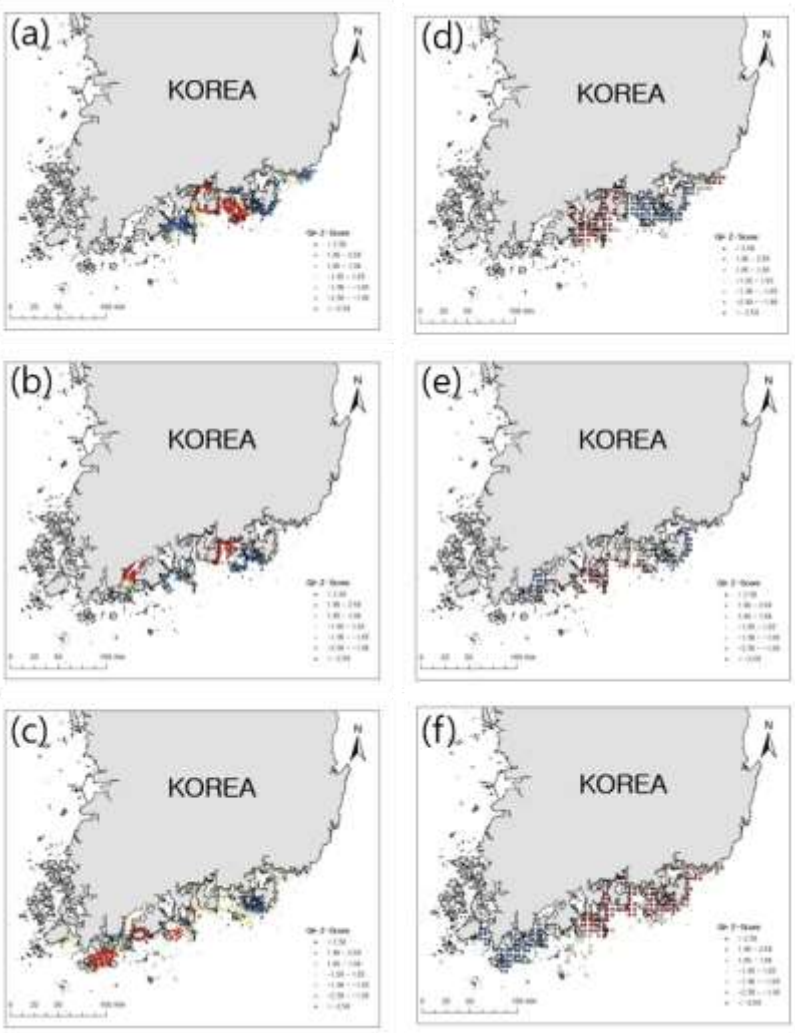

Fig. 1. (a) is the hot spot of the red tide occurrence area in 2013, (b) is the hot spot of the red tide occurrence area in 2014, (c) is the hot spot of the red tide occurrence area in 2015, (d) is the hot spot of SST in 2013, (e) is the hot spot of SST in 2014, (f) is the hot spot of SST in 2015.

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