

Preparation of a web-based map on potential eutrophic zone in the NOWPAP region

As part of one activity for the 2014-2015 biennium: trial application of the screening procedure of the NOWPAP Common Procedure for eutrophication assessment, CEARAC has been constructing a web-based map on potential eutrophic zone in the NOWPAP region. The map is built upon the website of Marine Environmental Watch System of CEARAC, and it provides trend of chemical oxygen demand (COD), frequencies of red tides and hypoxia events, and satellite derived chlorophyll-*a* concentration (satellite Chl-*a*) in the NOWPAP region.

1. Outline of a web-based map on potential eutrophic zones in the NOWPAP region

The map consists of two parts: a main tab that provides assessment results of eutrophication potentials in the NOWPAP region and a sub tab that provides detailed data used for the assessment (Figure 1). Three colored circles on the map indicate eutrophication potential in each area: eutrophic, potential eutrophic, non-eutrophic, as shown in Table 1. By clicking each colored circle, a brief explanation of assessment results are shown.

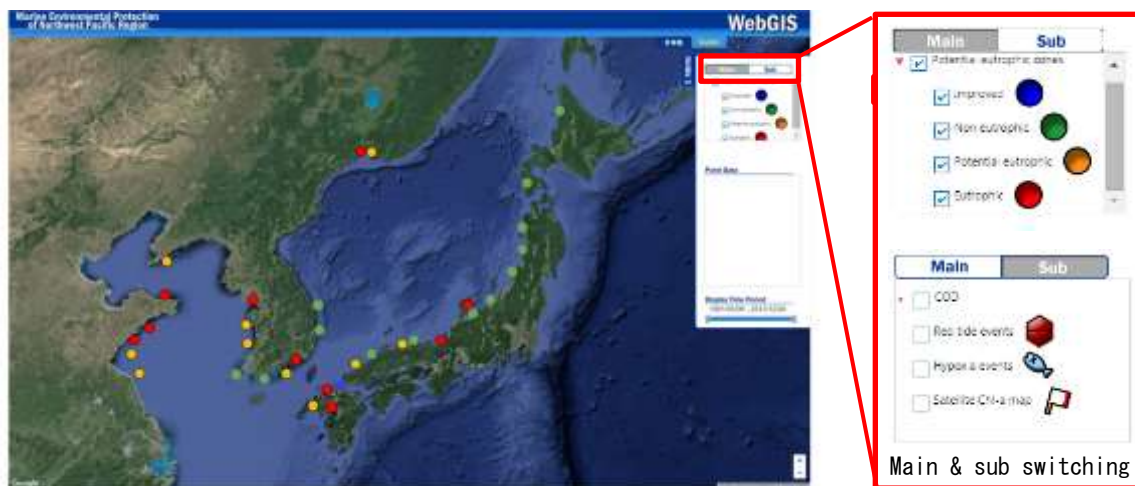





Fig. 1 Example of a web-based map on potential eutrophic zone in the NOWPAP region.

Table 1 Diagnosis of eutrophication status.

	<p>Eutrophic area</p> <p>All parameters among COD, frequencies of red tides and hypoxia events and satellite chlorophyll-<i>a</i> indicate symptoms of eutrophication.</p>
	<p>Potential eutrophic area</p> <p>More than two parameters among COD, frequencies of red tides and hypoxia events and satellite chlorophyll-<i>a</i> indicate symptoms of eutrophication.</p>
	<p>Non eutrophic area</p> <p>Only one parameter among COD, frequencies of red tides and hypoxia events and satellite chlorophyll-<i>a</i> indicates symptoms of eutrophication. Or, neither of these parameters indicates symptoms of eutrophication.</p>

2. How to show data used for eutrophication assessment

2.1 Annual trends in Chemical Oxygen Trend (COD)

Triangles under the sub tab indicate annual COD trends on the map. By clicking each triangle, the time series charts are shown (Fig. 2). When increasing trend is detected in annual COD values, it is regarded as a symptom of eutrophication.

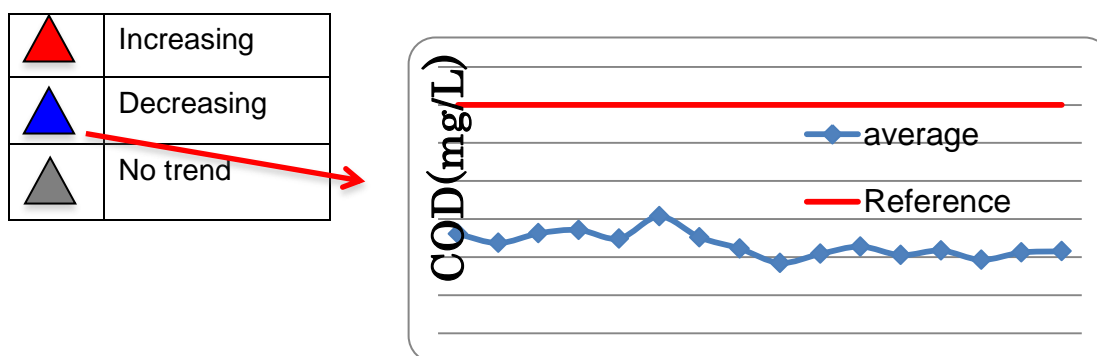


Fig. 2 Example of COD time series charts

2.2 Frequencies of red tide and hypoxia events

The areas where red tides and/or hypoxia occurred are shown on the map with red hexagonal shapes and dead fish shapes, respectively (Figure 3 and 4). By clicking each icon, detailed data (e.g. red tide species, fishery damage, oxygen levels at hypoxia events) are shown. How to show the intensity of events (e.g. by the different size of each icon) has been under consideration.

When one or more events of red tides and/or hypoxia are reported in recent three years, it is regarded as a symptom of eutrophication.



Fig.3 Example of mapping red tide events locations

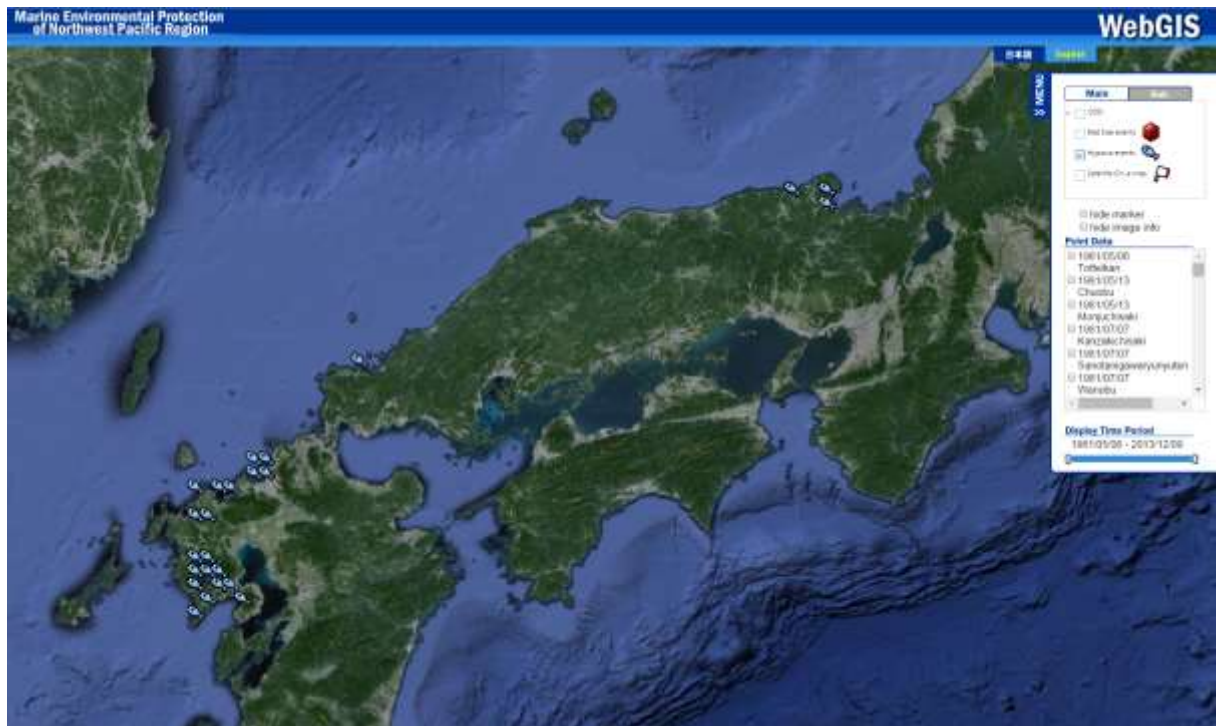


Fig. 4 Example of mapping hypoxia events locations

2.3 Satellite Chl-a map

Preparation of a long-term consistent satellite Chl-*a* is essential for eutrophication assessment. Satellite data of two reliable ocean color sensors from 1998 to 2015, SeaWiFS and

MODIS on board Aqua (MODIS-A) level 2 data (Reprocessing Version 2014), were obtained from the NASA ocean color website. Daily composite of satellite Chl-*a* data of each sensor was first computed by the NASA standard algorithm. Next, SeaWiFS and MODIS-A data for July 2002 and December 2004, when data for both sensors exists, were averaged respecting the consistency of these 2 sensors validated by NASA. Monthly mean satellite Chl-*a* from 1998 to 2015 was then prepared from the daily composite data for eutrophication assessment.

High or low Chl-*a* area (divided by 5 $\mu\text{g/l}$ as reference value) were detected from three-year-means satellite Chl-*a* from 2013 to 2015. The trends of the annual maximum Chl-*a* were estimated pixel wise and their significance were examined by the Sen Slope test (Salmi *et al.*, 2002) at 90% confidence level. The study area was then divided into ‘Increasing trend’, ‘Decreasing trend’ and ‘No trend’ areas. Through the combination of Chl-*a* level and its trend, selected sea areas were classified into one of six eutrophication status classifications (HI: High-Increase, HN: High-No Trend, HD: High-Decrease, LI: Low-Increase, LN: Low-No trend and LD: Low-Decrease). HI and HN areas were then regarded as areas with symptoms of eutrophication.

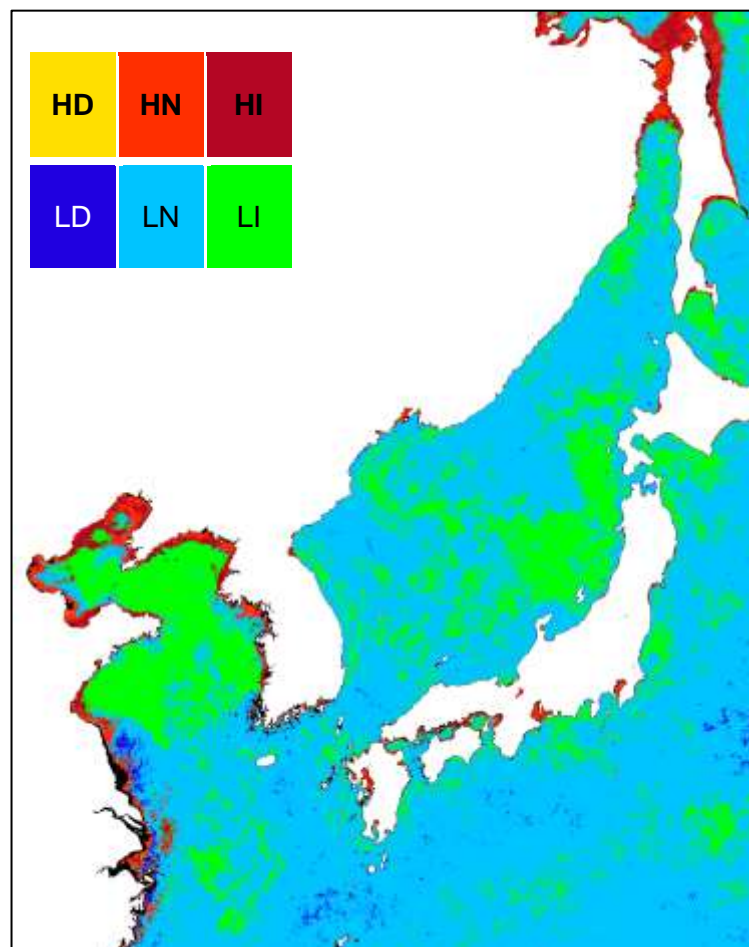


Fig. 5 Satellite Chl-*a* map of the NOWPAP region

However, it is known that in the areas with turbid water (e.g. coastal areas), values of

satellite Chl-*a* processed by the NASA standard algorithm are often higher than chlorophyll-*a* concentration retrieved *in situ*. This tendency was observed in comparison between the satellite Chl-*a* concentration data and the *in situ* Chl-*a* concentration data provided from the NOWPAP member states. Therefore, a different algorithm developed by Siswanto *et al.* (2011) that performs better in turbid waters is being applied in turbid sea areas such as in the Yellow Sea, coastal areas of China, and western coast of Korea.

3. Summary of assessment results

After the review and revision of the satellite Chl-*a* map in the 2.3 above, summaries of eutrophication assessment in each sea area will be reflected on the WebGIS which is being developed. The map will be open to the public in the third quarter of 2016 after review by national experts and CEARAC Focal Points.