1 Background

NOWPAP CEARAC developed Procedures for the assessment of the eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (the NOWPAP Common Procedure) in June 2009 with the help of nominated experts in the NOWPAP member states. Then, the Procedure was used to assess the eutrophication status in the selected sea areas in the member states (Yangtze River Estuary and adjacent area in China, Northwest Kyushu sea area and Toyama Bay in Japan, Jinhae Bay in Korea, and Peter the Great Bay in Russia) in 2010-2011. In 2011, the results of the assessments were combined and published as the Integrated Report on Eutrophication Assessment in Selected Sea Areas in the NOWPAP Region: Evaluation of the NOWPAP Common Procedure.

Realizing the technical problems of the NOWPAP Common Procedure in its application to the selected sea areas and assessment of the eutrophication status of each sea area, the NOWPAP Common Procedure was refined and re-applied to selected sea areas in the NOWPAP region (a newly selected Jiaozhou Bay in China and the same areas in Japan, Korea and Russia in the previous assessment) in 2012-2013. At the same time, literature review on negative impact of eutrophication, ecological modeling and investigation of availability of monitoring data were conducted in comparison with the obtained assessment results. After the assessment results were reviewed, the refined NOWPAP Common Procedure was finalized by the end of 2013, and an overview of the eutrophication status in the NOWPAP region was published in 2014.

In the refined NOWPAP Common Procedure (UNEP/NOWPAP/CEARAC/FPM 13/Ref3), there are two steps in assessing the eutrophication status: screening procedure (initial diagnosis) to detect symptoms of eutrophication with the minimum required parameters; and comprehensive procedure (second diagnosis) to assess the status and possible causes of eutrophication using the existing four categories (Degree of nutrient enrichment, Direct effects of nutrient enrichment, indirect effects of nutrient enrichment, and other possible effects of nutrient enrichment).

Although it is expected that the eutrophication status of entire NOWPAP sea area is to be assessed by each member state in the long run, autonomous application of the refined NOWPAP Common Procedure may not be fully realized due to lack of data and/or knowledge/skills of coastal managers. Therefore, CEARAC proposed a new project for the 2014-15 biennium to apply the screening procedure to the entire NOWPAP sea area, and to identify potential eutrophic zones which require application of the comprehensive procedure. The proposal was reviewed and adopted at the Eleventh CEARAC FPM held on 11-12 September 2013 in Toyama.

It was agreed to propose CEARAC workplan for the 2014-2015 biennium including this activity to the 18th NOWPAP IGM (December 2013). The workplan and budget was then approved by correspondence by the member states in April 2014.

2 Objective

Objective of this activity is to encourage autonomous use of the NOWPAP Common Procedure by the member states by applying the screening procedure of the refined NOWPAP Common Procedure to the entire NOWPAP sea area to identify potential eutrophic zones as well as to verify the suitability of the screening procedure.

3 Tasks

3.1 Trial application of the screening procedure of the NOWPAP Common Procedure to the entire NOWPAP sea area

Three parameters were used in the screening procedure: COD trend, occurrences of red tides and hypoxia, and remotely sensed chlorophyll-*a* concentration to identify potential eutrophic zones in the NOWPAP sea area (UNEP/NOWPAP/CEARAC/FPM 13/Ref1). CEARAC has concluded MoUs with the following experts in table 1 and to carry out tasks described in 3.1.1, 3.1.2 and 3.1.3.

Table 1 Experts nominated from NOWPAP member countries

Country	Organization	Experts
China	Institute of Oceanology, Chinese Academy of Science	Dr. Zhiming YU Dr. Xupeng HU
Japan	NPEC	-
Korea	National Fisheries Research & Development Institute	Dr. Changkyu LEE
Russia	Pacific Geographical Institute Far Eastern Branch of the Russian Academy of Sciences	Dr. Vladimir SHULKIN

3.1.1 Collection and analysis of data on COD (or TOC) trend

The experts in each member state collected and analyzed time series COD to detect their trend in the NOWPAP Sea area of each country.

Annual mean COD data from 2005 to 2012 in 7 water-sampling stations have been collected and analyzed in China. In Japan, Annual mean data from 1970s for 333 water-sampling stations have been collected and analyzed. COD data from 1998 for 10 water-sampling stations have been collected and analyzed in Korea. In Russia, COD in the north part of the Amursky Bay from 2010 to 2014 have been collected and analyzed. Since COD is not regularly monitored in Russia,

total nitrogen and total phosphorus data from 2004 to 2013 were collected and analyzed to complement insufficient length of available COD data.

3.1.2 Collection of data and mapping of occurrences of red tides and hypoxia

The experts in each member state collected information on occurrences of red tides and hypoxia in their respective sea areas.

Information of red tide and hypoxia events such as date, locations, species and associated fish kills were collected in each member state. Since information of red tide events in the NOWPAP region is already available up to 2008, information after 2009 has been collected.

There were 41 red tide events recorded in China from 2009 to 2014 in China, but few economic losses are recorded in China. Among 444 red tide events recorded in Japan, 57 events led to fish kills. 99 red tide events were recorded in Korea, and 15 events led to fish kills. In Russia, 8 red tide events were recorded and one event led to fish kills.

3 hypoxia events were recorded from 2009 to 2014 in China, but no fish kill were reported. 139 hypoxia events were recorded in 5 enclosed bays in Japan from 2009 to 2013, but no fish kills were reported. In Korea, 12 hypoxia events were recorded after 2009, but no fish kills were reported. In Russia, 3 hypoxia events were recorded and one led to fish kills.

3.1.3 Development of satellite map of chlorophyll-a concentration

According to the refined NOWPAP Common Procedure for eutrophication (revision 2015-Feb), a long-term satellite derived Chl-*a* data sets in the NOWPAP sea area are being prepared by CEARAC with the support of Nagoya University, Japan. High spatial resolution (closed to 1 x 1 km) remotely sensed Chl-*a* data sets from 1998 to 2013 are being processed using an empirical ocean color algorithm developed by Siswanto *et al.* (2011) from two ocean color satellite sensors: Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and follow-on Moderate Resolution Imaging Spectroradiometer on board the Aqua satellite (MODIS-A) launched by NASA in 1997 and 2002 have been obtained from NASA Ocean Color website.

Upon completion of the data processing, level and trend of satellite derived Chl-*a* data will be examined based on the method proposed by Terauchi *et al*. (2014). If the mean Chl-*a* level in the recent three years exceeds 5 *u*g/L and an increasing trend or no trend in annual mean Chl-*a* is observed, it will be regarded as a symptom of eutrophication.

Reliability of the satellite derived Chl-*a* will be validated against *in situ* Chl-*a* data collected by the nominated experts. 32, 2001, 810, 330 *in situ* Chl-*a* data samples were provided from China, Japan, Korea, Russia, respectively for validation of satellite Chl-*a*.

3.2 Mapping potential eutrophic zones in the NOWPAP region

CEARAC is now developing a web GIS map prototype to show the results of the trial

application of the screening procedure the NOWPAP Common Procedure.

If no symptom or one symptom is detected in the screening procedure, the area is considered as "Non eutrophic area". If two symptoms are detected, the area is considered as "Potential-eutrophic area". If all three symptoms are detected, the area is considered "Eutrophic area". In case that trend of COD or frequency of red tides and hypoxia show growing signs of a recovery, the area is considered as "Improved area".

4 Expected outcomes

By applying the screening procedure of the refined NOWPAP Common Procedure to the entire NOWPAP sea area, it is possible that potential eutrophic zones are identified and visualized on a map. A web GIS map will be constructed on the Marine Environmental Watch Project and will be open to the public.

5 Schedule

The time line of tasks in this activity is shown as follows.

Time	Action	Main body
2014 July	CEARAC FPM12 - Review and approval of the work plan and budget	CEARAC Secretariat and CEARAC FPs
Q3-Q4	Revision of the NOWPAP Common Procedure for eutrophication assessment	Experts of NOWPAP member states and CEARAC
2015 Q1	Nomination of national experts	CEARAC FP
Q2	Trial application of the screening procedure in the refined NOWPAP Common Procedure	Experts of NOWPAP member states and CEARAC
Q3	Compilation of assessment results by application of the screening procedure	Experts of NOWPAP member states and CEARAC
Q4	Preparation of a web-based map on potential eutrophic zone in the NOWPAP region	CEARAC Secretariat and consultant

6 Budget

Task	Timing	Output	To be completed	Main body	Budget (US$)
Trial application of the screening procedure of the refined NOWPAP Common Procedure	2014 Q3 – 2015 Q2	Assessment results based on the screening procedure of the refined NOWPAP Common Procedure	2015 Q3	Expert in China	4,000
				Japanese Consultant	~~4,000~~
				Expert in Korea	4,000
				Expert in Russia	4,000
Preparation of a web-based map on potential eutrophic zones in the NOWPAP region	2015 Q3 – Q4	A web-based map on potential eutrophic zones in the NOWPAP region	2015 Q3 to Q4	Consultant	~~4,000~~ 8,000
Total					20,000