Annex XII

Development of procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP Region

1. Background

Importance of collaboration between WG3 and WG4 has been emphasized at the past NOWPAP WG3 and WG4 meetings. Especially since the 3rd NOWPAP WG3/WG4 joint meeting, joint activities between WG3 and WG4 to share common themes such as eutrophication and HAB have been suggested for future activities of CEARAC by the experts, and this idea was integrated into the mid- and long-term strategies of CEARAC and goals of NOWPAP WG3 and WG4.

Eutrophication Monitoring Guidelines by Remote Sensing for the NOWPAP Region were made in 2007 and are expected to take a role for enhancing utilization of remote sensing techniques into monitoring and assessment of HAB. However, remote sensing application methods for marine environment conservation still needs improvement in order to satisfy requirements of HAB experts.

In addition, Land Based Source for pollution was included in CEARAC activity based on the approved new direction for the NOWPAP at the 10th NOWPAP Inter-governmental Meeting (IGM) (Toyama, Japan, 24-26 November 2005).

Recognizing these backgrounds, CEARAC proposed to develop procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP Region for the 2008-2009 biennium at the 12th NOWPAP IGM and 6th CEARAC FPM, and it was approved.

2. Objective

Objective of this activity is developing useful procedures for assessment of eutrophication status (nutrient enrichment, HAB occurrence, and other direct and indirect effects from nutrient enrichment) by utilizing remote sensing techniques that can be shared among the NOWPAP member states, based on lessons learnt from a pilot study conducted in Toyama Bay.

3. Status of implementation

3.1. Development of the draft procedures for assessment of eutrophication status for the NOWPAP region

CEARAC has developed draft procedures for assessment of eutrophication status (Draft Procedures) in March 2008 (Annex 1), based on the results of a case study conducted in Toyama Bay by the Northwest Pacific Region Environmental Cooperation Center (NPEC) in reference to activities against eutrophication in other regional seas.

3.2. Nomination of national experts for review and refinement of the Draft Procedures

Following approval of the workplan of this activity at the 6th CEARAC FPM, experts to undertake review and refinement work of the Draft Procedures were nominated through Focal Points of China, Korea and Russia (table 1).

National experts for the review and refinement work of the Draft Procedures

County	Organization	Name
China	National Marine Environment Monitoring Center, SOA , P.R.China	Prof. Dongzhi ZHAO
Korea	National Fisheries Research and Development Institute	Dr. Sang-Woo KIM
Russia	V.I. Il'ichev Pacific Oceanological Institute FEB RAS	Dr. Loenid MITNIK

3.3. Interim progress of review and refinement work of the Draft Procedures

Upon the completion of the Draft Procedures, the Draft Procedures were sent to the nominated experts on August 11, 2008 to initiate review and refinement work in China, Korea and Russia with a specified format as attached Annex 2 in August 2008. An interim progress of review and refinement work will be reported at the Second Coastal Environment Assessment Workshop on 11 September 2008 (Toyama, Japan).

4. Future work

The following tasks are to be conducted by the nominated experts and the CEARAC hired consultant.

Beside the review and refinement work by China, Korea and Russia, the Draft Procedures will be refined by a CEARAC hired consultant through consultation with experts in Japan. Finally, results of review and refinement of each NOWPAP member stated will be harmonized and consolidated as common procedures for assessment of eutrophication status including evaluation of land based source of nutrients for the NOWPAP region.

<Tasks to be conducted by the nominated national experts>

- Making a final report for review and refinement work of the Draft Procedures in accordance with a format specified in Annex 2.
- Making a list of existing survey data/information from organizations that monitor

chemical, biological and physical parameters that directly or indirectly relate to eutrophication and making a list of assessment parameters, with formats specified in Annex 3, by selecting general or certain sea area.

<Tasks to be conducted by the CEARAC hired consultant>

- Making a final report for review and refinement work of the Draft Procedures in accordance with a format specified in Annex 2.
- Harmonizing the results of review and refinement work of the NOWPAP member states.
- Making consolidated common procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP region, based on harmonization results of review and refinement work of the NOWPAP member states.

5. Expected outcomes

The developed procedures will contribute to assessment of eutrophication status, including evaluation of land based sources of nutrients, by utilizing remote sensing techniques in each NOWPAP member state.

6. Schedule

Schedule of this activity and main body are as follows.

Time		Actions	Main body
/2008	Q1	• Preparation of workplan for development of procedures for eutrophication	CEARAC/ consultant
	Q1	• Review of prepared workplan by WG3/WG4 experts	WG3/WG4 experts
	Mar (6th CEARAC FPM)	• Approval of workplan and budget for development of common procedures for assessment of eutrophication status • Discussion on the interim progress of the Draft Procedures	CEARAC FPs
	Q3	• Completion of the Draft Procedures	NPEC / CEARAC
	Q3	• Conclusion of MoU with national experts	CEARAC / national experts/ consultant
	Q3	• Review and refinement of the Draft Procedures	National experts / consultant
	Q3 (4th WG3/WG4 Meetings)	• Review of interim progress of review and refinement of the Draft Procedures	WG3 and WG4 experts
	Q4	• Review and refinement of the Draft Procedures (continue)	National experts
2009	Q1 to Q2	• Harmonization of the result of review and refinement of the NOWPAP member states	CEARAC / consultant
	Q3	• Review of harmonized draft (final draft) procedures for assessment of eutrophication status	WG3 and WG4 experts /CEARAC FPs
		• Publication of common procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP region	CEARAC / consultant

7. Budget

Contract	Timing	Output	To be completed	Couterpart	Budget (US$)
MoU for refinement of the draft procedures by national experts	2008 Q3	Refined procedures	2008 end of Q4	Expert in China	2,000
				Consultant /expert in Japan	2,000
				Expert in Korea	2,000
				Expert in Russia	2,000
MoU for harmonization of refinement results of NOWPAP member states on the draft procedures	2009 Q1	Harmonized procedures based on refined procedures from NOWPAP member states	2009 Q1	Consultant	2,000
Total					10,000

Annex 1

Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (as of August 7, 2008)

—Contents—

1. Introduction

1-1. Background

1.1. Development of the 'Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (Draft Procedures)' was proposed and approved at the 5th CEARAC Focal Point Meeting (FPM).

1.2. As part of the development processes of the Draft Procedures, NPEC has implemented a case study in Toyama Bay (Toyama Bay case study), by referring to the 'Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area'. An interim progress of the Toyama Bay case study was presented at the 5th CEARAC FPM and First Coastal Environment Assessment Workshop held in Toyama from March 6-8, 2008.

1-2. Objectives of the Draft Procedures

1.3. The objectives of the Draft Procedures are to enable each NOWPAP member state to assess the status and impacts of eutrophication in their respective sea areas, by using data/information obtained through existing monitoring activities. The assessment results could hopefully then be utilized by each NOWPAP member state for consideration and development of monitoring systems and countermeasures against eutrophication. Figure 1 schematically shows the concept of the Draft Procedures.

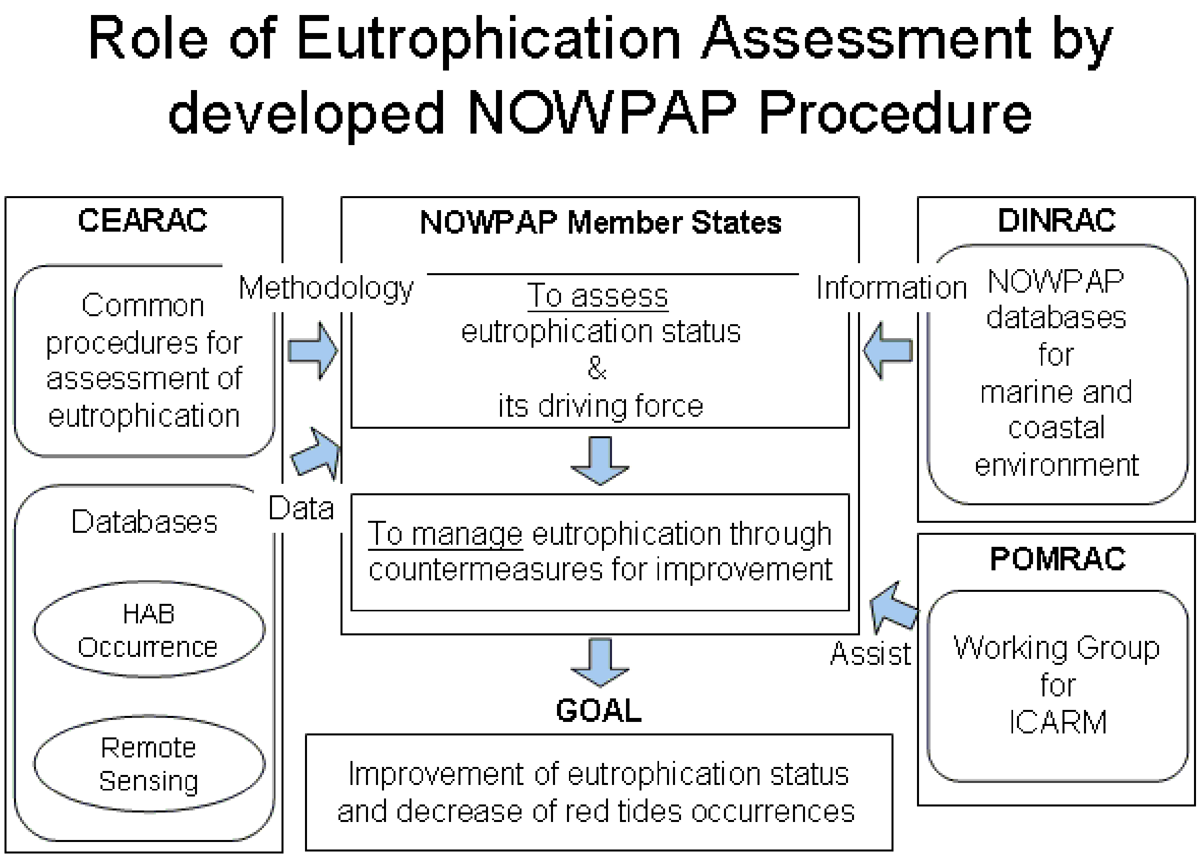

Figure 1 Concept of the Draft Procedures

1-3. Characteristics of the Draft Procedures

1.4. The Draft Procedures was developed based on the following principles:

i) It should be adaptable to various types of sea areas in the NOWPAP region.
ii) Remote Sensing data should be used in the assessment procedure.
iii) Eutrophication status is assessed through a holistic approach by integrating the following eutrophication aspects: degree of nutrient enrichment, direct/indirect effects of nutrient enrichment and other possible effects of nutrient enrichment.
iv) In general, eutrophication status is assessed in relative ways within the whole assessment area.

1-4. Overall structure

1.5. The assessment procedure is broadly separated into six parts, namely i) scope of assessment, ii) data processing, iii) setting of assessment criteria iv) assessment process and results, v) verification of results and vi) conclusion/recommendation. In the ‘scope of assessment’ part, an assessment area and parameters are selected. In the ‘data processing’ part, raw data are processed into data sets for the assessment. In the ‘setting of assessment criteria’ part, assessment criteria are set. In the ‘assessment process and results’ part, eutrophication status of the assessment area is identified. In the ‘verification of results’ part, the assessment results are reviewed and verified by new monitoring techniques such as remote sensing. In the ‘conclusion/recommendation’ part, future issues and actions are identified on the basis of the assessment results. Figure 2 shows the implementation flow of the Draft Procedures.

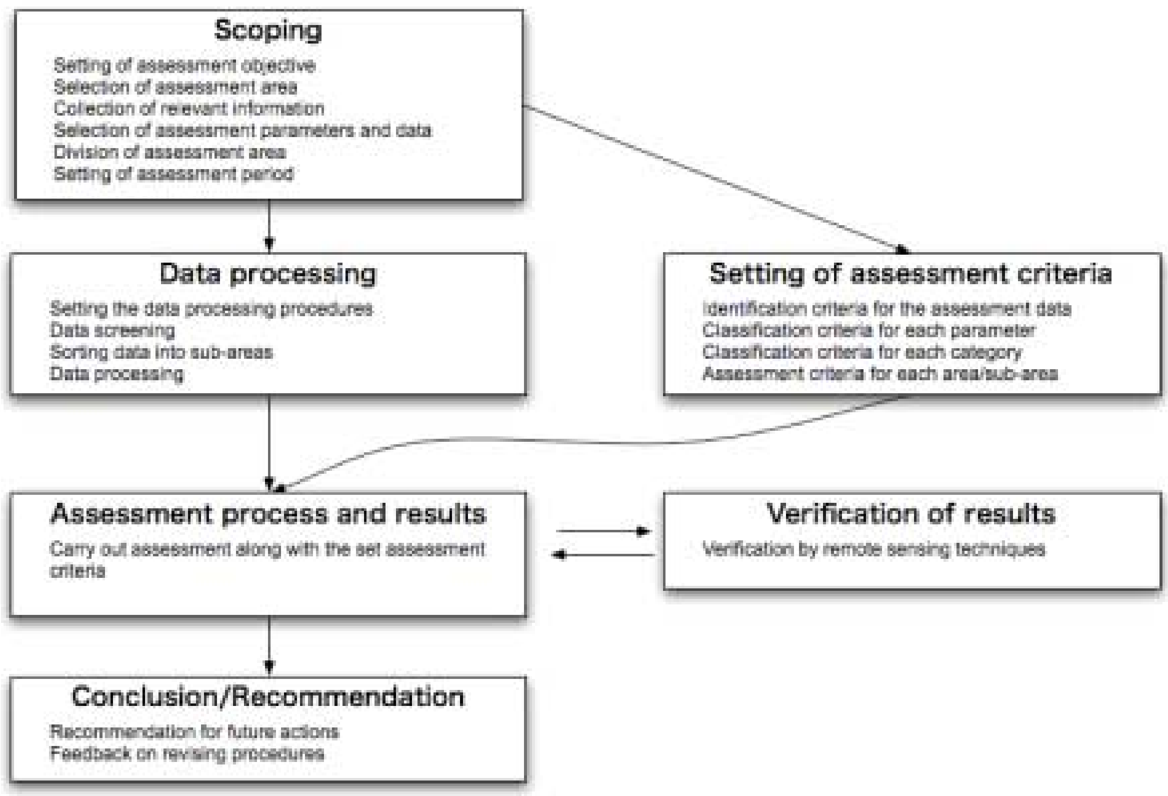

Figure 2 Basic flow of the Draft Procedures

2. Scope of assessment

2-1. Setting of assessment objective

2.1. State the objectives of the assessment.

2.2. In order to facilitate the understanding of the assessment results, clarify the preconditions and limitations involved in the assessment.

2.3. State any scientific uncertainties that future users of the assessment results should take note of, such as:

i) Application of the assessment results for forecasting environmental changes could be inappropriate.

ii) The assessment results may become less reliable/valid when scientific data/information are updated.

2-2. Selection of assessment area

2.4. Select an area that can be considered as a single sea area.

2.5. An assessment area should be an area that has ongoing environmental monitoring and assessment programs.

2.6. An assessment area must be an area that has ongoing water quality monitoring and assessment programs.

2-3. Collection of relevant information

2.7. Collect information on the assessment area such as, status of water quality monitoring (locations, frequency, parameters), ocean observations by satellite remote sensing, status of wastewater treatment, status of coastal use (e.g. location of recreational beaches), population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication).

2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations:

i) Organizations that monitor water quality for environmental conservation purposes
ii) Organizations that observe ocean with satellite remote sensing
iii) Organizations that monitor harmful algal blooms for protection of fishery resources
iv) Organizations that monitor shellfish poisoning for food safety
v) Organizations that have other relevant information such as ocean current and water temperature.

2.9. Collect existing survey data/information from the above organizations as in Table 1.

Table 1 Survey data/information collected from monitoring organizations

Survey area	Governing organization	Survey title	Aim	Survey period	Main survey parameters	Survey frequency	No. of survey points

2.10. Select the most appropriate data source for the assessment process in section 5.

2.11. Types of data sources which should not be used for the assessment procedure:

i) Surveys conducted at very limited frequency
ii) Data that are not directly related to eutrophication
iii) Surveys that are not conducted at regular locations and frequency
iv) Surveys that are not conducted for monitoring water quality and aquatic organisms
v) Surveys that employ uncommon analytical methods

2-4. Selection of assessment parameters and data

2-4-1. Categorization of monitored/surveyed parameters

2.12. Categorize all eutrophication related parameters that are monitored/surveyed within the assessment area into one of the following 4 assessment categories:

i) Category I Parameters that indicate degree of nutrient enrichment
ii) Category II Parameters that indicate direct effects of nutrient enrichment
iii) Category III Parameters that indicate indirect effects of nutrient enrichment
iv) Category IV Parameters that indicate other possible effects of nutrient enrichment

2-4-2. Selection of assessment parameters for each assessment category

2.13. After the categorization process, select assessment parameters that are applicable for the assessment procedure on the basis of their data reliability and continuity (e.g. data collected at fixed locations and at regular frequencies). The selected assessment parameters should also have established methods of analysis.

2.14. In principle, all surveyed/monitored parameters related to eutrophication should be selected for the assessment procedure. If certain parameters are to be excluded from the assessment procedures, the reasons must be stated.

2.15. Table 2 shows examples of assessment parameters that are relevant to the 4 categories.

Table 2 Examples of assessment parameters

Category		Assessment parameter
I	Degree of nutrient enrichment	Riverine input (T-N, T-P)
		Total nitrogen/Total phosphorus (T-N, T-P)
		Winter DIN/DIP concentration
		Winter N/P ratio (DIN/DIP)
II	Direct effects of nutrient enrichment	Chlorophyll-a concentration (field data)
		Chlorophyll-a concentration (remote sensing data)
		Sea area ratio with high chlorophyll-a concentration (remote sensing data)
		Red-tide events (diatom species)
III	Indirect effects of nutrient enrichment	Dissolved oxygen (DO)
		Abnormal fish kill incidents
		Chemical oxygen demand (COD)
IV	Other possible effects of nutrient enrichment	Red-tide events (*Noctiluca* sp.)
		Shellfish poisoning incidents

2-4-3. Setting of assessment value

2.16. In order to understand the interannual trends of eutrophication, assessment should be basically conducted with annual values.

2.17. Set the assessment values (e.g. annual mean, annual max., annual number of events) to be used for each assessment parameter.

2-4-4. Selection of data source for the assessment

2.18. Select the data source to be applied for each assessment parameter.

2-5. Division of assessment area into sub-areas

2.19. In order to understand and assess the causes and direct/indirect effects of eutrophication at more localized scales, the assessment area may be divided into sub-areas.

2.20. When dividing the assessment area into sub-areas, factors such as location of riverine input, monitoring locations, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red-tide events should be considered.

2-6. Setting of assessment period

2.21. Set the assessment period in accordance with the assessment objectives and availability of reliable data.

3. Data processing

3-1. Setting of data processing procedure

3.1. Based on the set assessment values, establish a common data processing method for each assessment parameter.

3-2. Data screening

3.2. Within the selected data source, exclude data that are not suitable for the assessment.

3.3. If data are excluded in the above process, state the reasons for their exclusion. Possible reasons could be related to survey location, data reliability and so on.

3-3. Sorting data into sub-areas

3.4. If the assessment area is divided into sub-areas, the data used for the assessment of each sub-area should be sorted by the location of survey/monitoring sites.

3-4. Data processing of assessment parameters

3.5. Based on the set data processing method, process the collected data.

3.6. In principal, data should be processed by each survey/monitoring site.

3.7. Data sets should be prepared for each assessment parameter and sorted by survey/monitoring site.

4. Setting of assessment criteria

4.1. In order to assess the eutrophication status of an assessment area, identification criteria for each assessment data* and classification criteria for each assessment parameter, category and assessment criteria for area/sub-area must be set.

*Assessment data: data to be used for the following identification process, which is calculated by assessment value.

4-1. Setting of identification criteria for the assessment data

4.2. The eutrophication status of each assessment parameter is assessed by its current status and future trend. The current status and future trend of an assessment parameter are identified by its assessment data with the following identification tools. Combination of these identification tools must be applied for each assessment parameter.

i) Identification by comparison (identifies current status): The eutrophication status is identified by comparing the assessment data with either the value established by environmental standards or background value set by the values measured in an area that have had negligible influence from anthropogenic activities. This identification tool is used for assessment parameters that can be represented in terms of concentration or ratio.

ii) Identification by occurrence (identifies current status): The eutrophication status is identified by occurrence or non-occurrence of events. This identification tool is used for assessment parameters that can be represented in terms of number or frequency of occurrence.

iii) Identification by trend (identifies future trend): The eutrophication status is identified by predicting future trends. This identification tool is used for all parameters.

4.3. The basis behind the set identification criteria must be stated clearly and objectively.

4-2. Setting of classification criteria for each assessment parameter

4.4. Set the classification criteria of each assessment parameter based on the current status and future trend identified by the combination of the identification tools.

4.5. Table 3 shows an example of identification tools applied to each assessment parameter.

Table 3 Examples of identification tools applied to each assessment parameter

Category	Assessment parameter	Assessment value	Identification tools[1]			Remarks
			Comparison	Occurrence	Trend	
I	Riverine input (T-N, T-P)	Annual mean			✓	
	Total nitrogen/Total phosphorus (T-N, T-P)	Annual mean	✓		✓	
	Winter DIN/DIP concentration	Winter mean	✓		✓	
	Winter N/P ratio (DIN/DIP)	Winter mean	✓		✓	
II	Chlorophyll-a concentration (field data)	Annual max. Annual mean	✓		✓	
	Chlorophyll-a concentration (remote sensing data)	Annual max. Annual mean	✓		✓	
	Sea area ratio with high chlorophyll-a concentration (remote sensing data)	Annual max. Annual mean			✓	
	Red-tide events (diatom species)	Annual occurrences		✓	✓	
III	Dissolved oxygen (DO)	Annual min.	✓		✓	
	Abnormal fish kill incidents	Annual occurrences		✓	✓	
	Chemical oxygen demand (COD)	Annual mean	✓		✓	
IV	Red-tide events (*Noctiluca* sp.)	Annual occurrences		✓	✓	
	Shellfish poisoning incidents	Annual occurrences		✓	✓	

1) Comparison: comparison with environmental standard or background value
Occurrence: occurrence or non-occurrence
Trend: degree of increase/decrease

4.6. The proposed classification criteria for each assessment parameter are as follows. The identification result of the current status is classified as either 'high status' or 'low status', and future trend is classified as 'decrease trend', 'no trend' or 'increase trend'. Classification results of the current status and future trend are then integrated and classified into 6 eutrophication groups shown in Table 4. If the assessment parameter can only be assessed by the trend method, the assessment parameter will be classified as either 'decrease trend', 'no trend' or 'increase trend'.

4.7. Table 4 shows the classification criteria for the assessment parameter.

Table 4 Classification criteria of assessment parameter

Classification	Identification result
HI (High status and Increase Trend)	Current status high and increasing trend
HN (High status and No Trend)	Current status high but no increasing or decreasing trend
HD (High status and Decrease Trend)	Current status high but decreasing trend
LI (Low status and Increase Trend)	Current status low but increasing trend
LN (Low status and No Trend)	Current status low but no increasing or decreasing trend
LD (Low status and Decrease Trend)	Current status low and decreasing trend

Classification by trend only

Classification	Assessment result
I (Increase Trend)	Increasing trend
N (No Trend)	No increasing or decreasing trend
D (Decrease Trend)	Decreasing trend

4-3. Setting of classification criteria for the assessment category

4.8. Set the classification criteria of each assessment category based on the classification results of the assessment parameters.

4.9. Classify the assessment category by selecting one classification result of the assessment parameters within the assessment category that most appropriately represents the eutrophication status of the area. However, if the classification results among the assessment parameters in the assessment category are contradictory, and therefore it is unreasonable to select a representative classification result, this assessment category can be excluded from the classification procedure with its reasons stated.

4-4. Setting of assessment criteria for the assessment area/sub-area

4.10. Set holistic assessment criteria for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.

5. Assessment process and results

5.1. The eutrophication status of the assessment area should be assessed, on the basis of the identification results of the assessment data and classification results of each parameter and parameter's categories.

5.2. Identify the eutrophication status of the assessment data of each monitoring site based on the set identification criteria.

5.3. Classify each assessment parameter based on the identification results of the assessment data. If there are multiple monitoring sites in each sub-area, the identification results from all the monitoring sites should be taken into account.

5.4. Classify each assessment category based on the classification results of assessment parameters.

5.5. The eutrophication status of each area/sub-area should be assessed based on the classification results of each assessment parameter and category.

6. Verification of results

6.1. The assessment report should have all necessary information required for review.

6.2. Use of remote sensing is recommended for the verification of the assessment results.

7. Conclusion and recommendation

7.1. Based on the assessment results, provide recommendations for future actions.

7.2. The results of each classification process should be clearly presented, so that policy makers etc. can consider the most appropriate monitoring or countermeasures against eutrophication.

Appendix

Summary of Phase 1 of Toyama Bay case study

Aug 7, 2008

This document is prepared as a reference only for the purpose of reviewing and refining the Draft Procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region, and this shall be not cited.

- Contents -

I Introduction

1 Background and objective

Eutrophication in the Northwest Pacific region (hereinafter referred as NOWPAP region) is a major environmental issue, as population and industries continue to grow in this region. In order to solve eutrophication issues in the NOWPAP region, it is important to first understand and assess its current eutrophication status. However, at the moment, there are no established eutrophication assessment procedures that could be commonly applied to the NOWPAP region.

Assessment methods for eutrophication have developed by OSPAR Commission, NOAA and Mediterranean Action Plan of UNEP. Among these, the procedure developed in OSPAR (OSPAR procedure) seemed to be the most suitable reference material for the NOWPAP region in respect that it has been already implemented by many of the OSPAR countries, and that the selection of assessment parameters and their assessment levels for the uses in the eutrophication assessment and final judgment on the eutrophication status are entrusted to each country.

In order to develop an objective eutrophication assessment procedure for the NOWPAP region, the Northwest Pacific Region Environmental Cooperation Centre (NPEC) has conducted a case study in Toyama Bay (Toyama Bay case study) and developed the 'Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients (Draft Procedures)' by referring to the OSPAR procedure.

While remote sensing data are considered as a supplementary tool in the OSPAR procedure, the Toyama Bay case study incorporated remote sensing data into the assessment and verification processes. The aim was to establish an effective assessment and verification tool for eutrophication by utilizing remote sensing techniques.

2 Implementation processes of the Toyama Bay case study

In F.Y. 2007, the Toyama Bay case study was implemented to examine the validity of the Draft Procedures (Phase 1 of Toyama Bay case study).

As part of Phase 1, the assessment procedures set out in the OSPAR procedure were reviewed by using data obtained in Toyama Bay, and an appropriate assessment method for eutrophication in Toyama Bay was considered in the process.

The progress of the Toyama Bay case study was reviewed by experts of the following committees established by NPEC: Red tide and HAB National Review Committee, Ocean Remote Sensing National Review Committee and Toyama Bay Project Review Committee.

Based on the experiences gained in Phase 1, the Draft Procedures has being completed. The Draft Procedures will be finalized after being reviewed further by the experts of the NOWPAP member states.

3 Structure of the Toyama Bay case study

The Toyama Bay case study broadly consists of six parts, namely i) scope of assessment, ii) data processing, iii) setting of assessment criteria iv) assessment process and results, v) verification of results and vi) conclusion/recommendation. In the 'scope of assessment' part, assessment area and parameters were selected. In the 'data processing' part, raw data were processed into data sets for the assessment. In the 'setting of assessment criteria' part, assessment criteria were set. In the 'assessment process and results' part, eutrophication status of the assessment area/sub-areas was identified. In the 'verification of results' part, the assessment results were reviewed and verified by remote sensing. In the 'conclusion/recommendation' part, future issues and actions were identified. Figure I-3-1 shows the structure of the Toyama Bay case study. Also necessary feedback was made to update and improve the contents and methodologies of each part.

Details of each part are described from Chapter II.

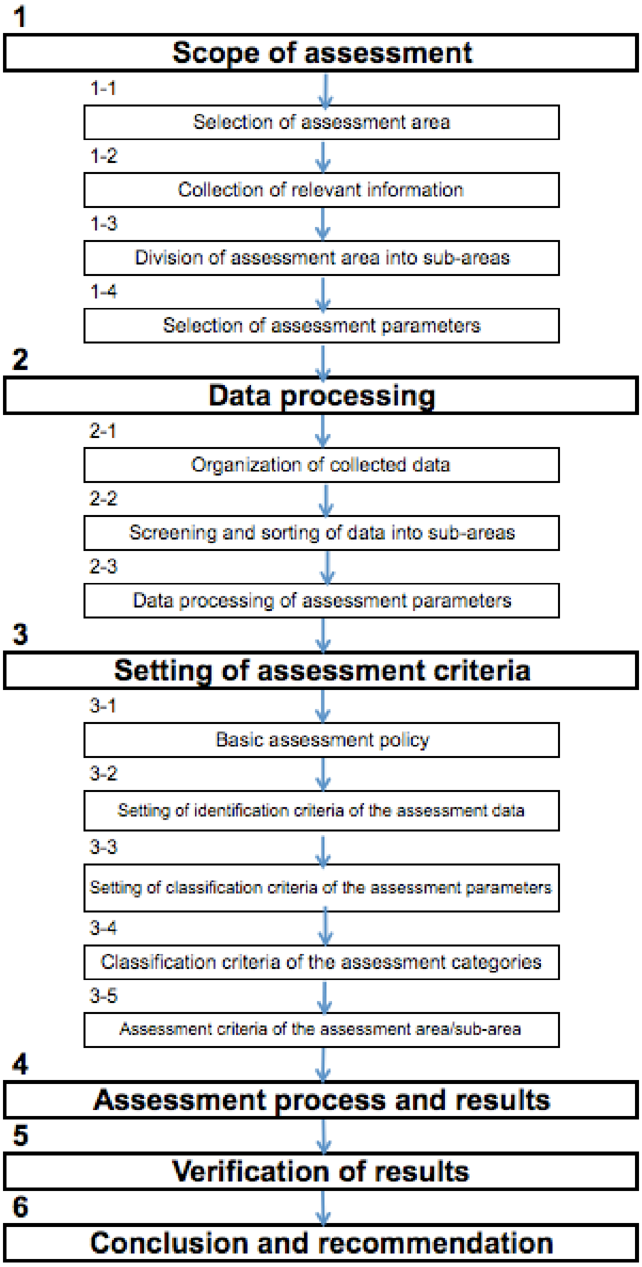

Figure I-3-1. Structure of the Toyama Bay case study.

4 Assessment results of the Toyama Bay case study

Since the primary focus of the Toyama Bay case study was to establish a common assessment procedure for various types of sea areas, the assessments conducted in the case study were based on uncertain assumptions and assessment criteria. Therefore, it is necessary to note the possibility that the obtained assessment results may not be an accurate reflection of the eutrophication status of Toyama Bay.

In F.Y. 2008, eutrophication status of Toyama Bay will be re-assessed by re-implementing the Toyama Bay case study (Phase 2 of Toyama Bay case study) with an improved assessment procedure.

II Toyama Bay case study

1 Scope of assessment

1-1 Selection of assessment area

In the OSPAR procedure, for the assessment of eutrophication, it is recommended to select an assessment area by considering factors such as oceanographic characteristics, availability of existing water quality monitoring and assessment programs.

In the Toyama Bay case study, the area for the assessment was selected by referring to existence and reliability of data/ information related to eutrophication.

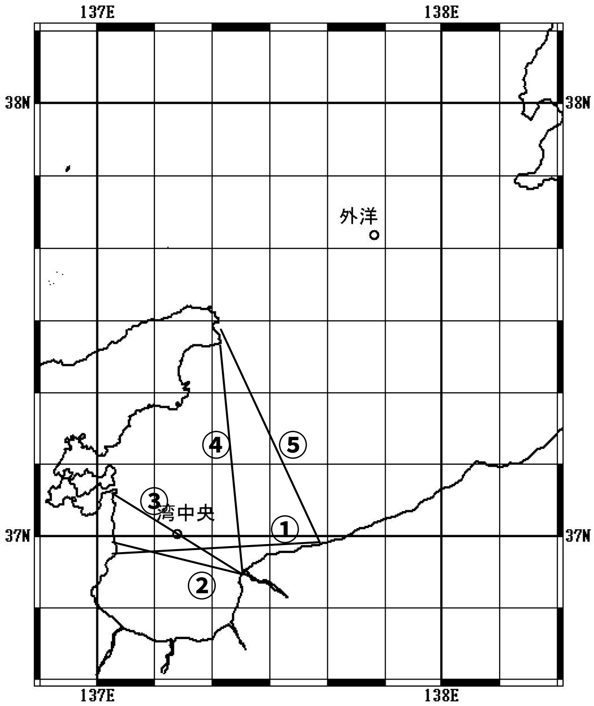

Figure II-1-1-1. Scopes of Toyama Bay sea area.

1-2 Collection of relevant information

In Toyama Bay, under the Water Pollution Control Law, the environmental department of the Toyama Prefecture government conducts monthly water quality monitoring in its public waters. From F.Y. 1997, to understand the status of eutrophication in Toyama Bay, the environmental department has supplemented the above monitoring program by adding new monitoring parameters and sites. Surveys and researches related to eutrophication have also been conducted in Toyama Bay. Water pollution incidents such as oil spills and abnormal fish kills have also been recorded.

To monitor and protect the fishing grounds in Toyama Bay, the fisheries department of the Toyama Prefecture government conducts monitoring of fishing ground (e.g. water quality, red tides, marine organisms) in the coastal areas of Toyama Bay. Oceanographic conditions are also monitored at fixed locations along the coast.

Table II-1-2-1 summarizes the monitoring and research programs related to eutrophication in Toyama Bay.

Table II-1-2-1. Monitoring and research programs related to eutrophication in Toyama Bay.

Survey type	Organization	Survey title		Aim	Survey period	Main parameters	Frequency	No. of survey sites (as of 2005)
Water quality monitoring	Toyama Pref., Dept. of Environmental Conservation	Water quality monitoring of public waters (sea area)		Monitoring of water quality	F.Y. 1976- F.Y. 1997- (T-N/T-P)	DO, COD, T-N, T-P	1/month	23 Coast: 10 Jintsu River: 7 Oyabe River: 6
	Toyama Pref., Dept. of Environmental Conservation	Supplementary water quality monitoring in Toyama Bay		Monitoring of eutrophication	F.Y 1997-	DIN, DIP, Chlorophyll-a, T-N, T-P	1/month	9
	Toyama Pref., Dept. of Environmental Conservation	Reporting of water pollution		To understand the status of water pollution	F.Y. 1975-	Pollution location/area/casues, impact on fish	Ad hoc	
Environment related survey/research	Toyama Pref., Dept. of Environmental Conservation	Basic survey for simulation model development		To improve the accuracy of simulation model	F.Y. 2005	Riverine input (T-N, T-P) (1985-2004)	1 year	5 rivers
	Toyama Pref., Dept. of Environmental Conservation/ Japan Coast Guard	Joint environmental survey of Toyama Bay	Water quality survey (Dept. of Environment	To understand diffusion of COD, nitrogen, phosphrous through river inflow	F.Y. 2004-2005	COD, T-N, T-P, DIN, DIP, Chlorophyll-a, transparency	Rivermouth: 4/year Toyama Bay: Once in 2005	Jintzu rivermouth: 10 sites Oyabe rivermouth: 10 sites Toyama Bay: 10
			Ocean current survey	To understand current movement in rivermouth area		Current direction/speed, Water temp., salinity	Once in 2005	ADCP: 48 sites Toyama Bay: 44 sites
	Toyama Prefectural Environmental Science Research Center	Reseach on water pollution mechanism in Toyama Bay		To understand the pollution mechanism of CDOM	F.Y. 2005-2007	CDOM, R-DOM, chlorophyll-a	4/year	7
	NPEC, TESC, Toyama Uni., Nagasaki Uni., etc.	Survey to promote NOWPAP activities (Toyama Bay project)		To verify the applicability of remote sensing in ocean monitoring	F.Y. 2003-	DIN, DIP, chlorophyll-a, SS, DO, T-N, T-P, transparency,	1/month	11
	NPEC	Development of current analysis program for Toyama Bay		Development of current simulation program by water temp. distribution	F.Y. 2003-2005 Analysis period: F.Y. 2002-2004	Remote sensing: chlorophyll-a, SST Fiedl survey: surface current direction, current speed, water temp.	Remote sensing: all year Field survey: May 10-13, 2005	136°E30´-136°E30´, 36°N40´-38°N40´
Water quality monitoring by fisheries department	Toyama Pref. fisheries research institute	Survey of fishing ground environment	Survey of fixed nets	To understand the water quality near fixed nets	F.Y. 1971-	COD, salinity, turbidity	1/month	36
			Survey of water quality	To understand the water quality at fishing grounds	F.Y.1995-	COD, DO, salinity, turbidity	1/month	18
			Survey of red tide	To understand the status of red tides	F.Y.1966-	Area of red tide, phytoplankton	During red tide event	Toyama Bay
Fishing ground monitoring by fisheries department		Survey of marine organisms		To monitor fishing ground environment	F.Y.1996-	Zoobenthos, pollution indicator spp., sediment quality	April, October	8
		\Observation of coastal waters of Toyama bay		To investigate the coastal oceanography of Toyama Bay	F.Y.1953-	Water temp., salinity	1/month	26
Remote sensing data	Ministry of Environment/ NPEC	Marine environmental monitoring of Northwest Pacific region		To disseminate remote sensing info. for the Northwest Pacific region	2002-	Chlorophyll-a, SST	1-2/day (chlorophyll-a) 8-10/day (SST)	Toyama Bay
	NASA	Ocean Color WEB		Provision of remote sensing data	1978-	Chlorophyll-a, SST, turbidity	1-2/day	Global
Others	Toyama Pref. (Dept. of	Reporting of food poisoning		To prevent food poisoning	1994-	Date, location, food type	Durig food poisoning	

1-3 Division of assessment area into sub-areas

In order to understand the status and causes of eutrophication at localized scales, the assessment area was divided into 5 sub-areas as shown in Figure II-1-3-1. As water quality and oceanographic characteristics within each sub-area are to be similar, factors such as riverine input, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red-tide events were considered in the division process.

Also to best utilize and to enable comparison with the survey results of existing monitoring programs, the boundaries set by the red-tide monitoring program of Toyama Prefectural Fisheries Research Institute were utilized as a basis for the sub-area division.

Figure II-1-3-1. The sub-areas of the Toyama Bay case study.

1-4 Selection of assessment parameters

All eutrophication related parameters surveyed in the assessment area were categorized into one of the following 4 assessment categories.

i) Category I Parameters that indicate degree of nutrient enrichment
ii) Category II Parameters that indicate direct effects of nutrient enrichment
iii) Category III Parameters that indicate indirect effects of nutrient enrichment
iv) Category IV Parameters that indicate other possible effects of nutrient enrichment

Among the available surveyed parameters, only the parameters that were applicable to the assessment procedure were selected based on their data reliability and continuity (i.e. data collected at fixed locations and at regular frequencies). Table II-1-4-1 shows the assessment parameters selected for the Toyama Bay case study.

Table II-1-4-1. Assessment parameters selected for the Toyama Bay case study

Category		Assessment parameter		Survey title
I	Degree of nutrient enrichment (nutrient load, nutrient concentration, etc.)	Nutrient load	Riverine input (T-N)	Data collection for simulation model [Department of environmental conservation, Toyama Prefecture]
			Riverine input (T-P)	
		Nutrient concentration (annual)	Total nitrogen (T-N)	Seawater quality survey [Department of environmental conservation, Toyama Prefecture], Toyama Bay project [NPEC]
			Total phosphorus (T-P)	
		Nutrient concentration (winterl)	Winter dissolved inorganic nitrogen (DIN)	Seawater quality survey [Department of environmental conservation, Toyama Prefecture]
			Winter dissolved inorganic phosphorus (DIP)	
			Winter DIN/DIP ratio	(Calculated value)
II	Direct effects of nutrient enrichment (increase of phytoplankton, turbidity, etc.)	Chlorophyll-a	Chlorophyll-a concentration (field data)	Seawater quality survey [Department of environmental conservation, Toyama Prefecture], Toyama Bay project [NPEC]
			Chlorophyll-a concentration (remote sensing data)	Environmental watch-system of the North west Pacific [Ministry of Environment/NPEC], Ocean Color WEB[NASA]
			Sea area ratio with high chlorophyll-a concentration (remote sensing data)	
		Phytoplankton	Red-tide events (diatom species)	Red-tide survey [Toyama Prefectural Fisheries Research Institute]
III	Indirect effects of nutrient enrichment (increase of organic matter, decrease in dissolved oxygen, etc.)	Oxygen deficiency	Dissolved oxygen (DO)	Seawater quality survey [Department of environmental conservation, Toyama Prefecture], Toyama Bay project [NPEC]
		Fish kill	Abnormal fish kill incidents	Report of maritime accidents [Department of environmental conservation, Toyama Prefecture]
		Organic carbon/oragnic matter	Chemical oxygen demand (COD)	Seawater quality survey [Department of environmental conservation, Toyama Prefecture], Toyama Bay project [NPEC]
IV	Other possible effects of nutrient enrichment (shellfish poisoning, etc.)	Plankton blooms	Red-tide events (Noctiluca sp.)	Red-tide survey [Toyama Prefectural Fisheries Research Institute]
		Algal toxins	Shellfish poisoning incidents	Report on food poisoning [Department of Health]

2 Data processing

2-1 Organization of collected data

To prepare for data processing stage, the collected raw data were first organized into tabular formats. Table II-2-1-1 and II-2-1-2 show the formats used for regular monitoring data and satellite image data, respectively. The collected data were also organized by survey year to enable interannual comparisons.

Remote sensing data were processed into monthly merged data by calculating the monthly averaged concentration of each pixel (size: 1 km x 1 km).

Table II-2-1-1. Format for regular monitoring data.

Survey year	Site info.		Sampled date	Results			Remarks
	Site no.	Site name		DIN	DIP	Chlorophyll-a	
				mg/L	mg/L	μg/L	
1998	J-5	Jintzu River 5	1999/4/8	1.2	0.03	1.6	
1998	J-8	Jintzu River 8	1999/5/8	1.1	0.05	1.7	

Table II-2-1-2. Format for remote sensing data.

P	L	Longitude	Latitude	2002	2002	2002	2002	2002	2002
				1	2	3	4	5	6
1	1	137.5000	37.5000	0.8400	1.1000	0.8064	1.2100	0.7741	1.1616
1	2	137.6363	37.4337	0.8400	1.1000	0.8064	1.2100	0.7741	1.1616
1	3	137.7726	37.3674	0.6000	0.7857	0.5760	0.8643	0.5530	0.8297
1	4	137.9089	37.3011	0.1680	0.2200	0.1613	0.2420	0.1548	0.2323

2-2 Screening and sorting of data into sub-areas

After the data organization process, the collected data were categorized either into regular monitoring data, remote sensing data or other types of data, and then were sorted into the relevant sub-areas after excluding any unsuitable data for the assessment.

2-2-1 Regular monitoring data

For water quality parameters/data that were collected under regular monitoring programs, data obtained from the mixed waters at surface (0.5m) and middle layer (2m) were generally used for the assessment. However, surface layer data were used for monitoring site located in the central area of Toyama Bay, as only sea surface layer is being monitored.

Data that were not obtained through standardized analytical methods and data obtained from near the rivermouth areas (i.e. areas affected by freshwater input) were excluded from the assessment. After this screening process, the collected regular monitoring data were sorted into the sub-areas by the location (latitude/longitude) of their monitoring sites. Table II-2-2-1 provides information on the regular monitoring sites in Toyama Bay.

Table II-2-2-1. List of regular monitoring sites in Toyama Bay.

	Area name	Sea area	Name of survey site			Location				Status of regular monitoring			Type	Excluded sites			
			Site name	Abbreviation	Site no.	Latitude (N°)	Longitude (E°)	Implemented year	Pixel no.	Regular survey	Supplementary	Toyama Bay PJ		Rivermouth	Site location	Analysis method	Other
Toyama Bay	Sub-area A	Other sea area	Other 8	S-8	1660710	36.9131	137.3953	2005	P080L122	✔	1997-2005		A				
			Other 9	S-9	1660711	36.9700	137.4803	2005	P087L115	✔							
			Other 10	S-10	1660712	36.9925	137.5886	2005	P097L113	✔	1997-2005						
	Sub-area B	Jintzu rivermouth	Jintzu 1	J-1	1660501	36.7728	137.2086	2005	P063L137	✔			B	✔			
			Jintzu 2	J-2	1660502	36.7772	137.2222	2005	P064L137	✔				✔			
			Jintzu 3	J-3	1660503	36.7728	137.2358	2005	P066L137	✔				✔			
		Jintzu rivermouth	Jintzu 4	J-4	1660601	36.7767	137.2039	2005	P063L137	✔			A				
			Jintzu 5	J-5	1660602	36.7828	137.2222	2005	P064L136	✔	1997-2005						
			Jintzu 6	J-6	1660603	36.7764	137.2406	2005	P066L137	✔							
		Other sea area	Jintzu 7	J-7	1660702	36.7981	137.2222	2005	P064L134	✔			A				
			Other 5	S-5	1660707	36.7789	137.2786	2005	P069L136	✔							
			Other 6	S-6	1660708	36.7931	137.3311	2005	P074L135	✔	1997-2005						
			Other 7	S-7	1660709	36.8256	137.3703	2005	P078L131	✔							
			St.1 (Namekawa)	St.1		36.7933	137.3317		P074L135			✔			✔ (except COD)	✔ (except COD)	✔ (No data of ammonia
			St.2 (Namekawa)	St.2		36.8317	137.3317		P074L131			✔			✔	✔	✔ (No data of ammonia
			St.3 (Jintzu coast)	St.3		36.7933	137.2533		P067L135			✔			✔	✔	✔ (No data of ammonia
			St.4 (Jintzu offshore)	St.4		36.8317	137.2533		P067L131			✔			✔	✔	✔ (No data of ammonia
	Sub-area C	Oyabe rivermouth	Oyabe 1	O-1	1660301	36.8036	137.0681	1993	P051L134	○(1976～1993)			B	✔			✔ (Survey finished)
			Oyabe 2	O-2	1660302	36.8008	137.0764	2005	P052L134	✔				✔			
			Oyabe 3	O-3	1660303	36.7939	137.0803	2005	P052L135	✔				✔			
		Oyabe rivermouth	Oyabe 4	O-4	1660401	36.8131	137.0681	1996	P051L133	○(1976～1996)			A				✔ (Survey finished)
			Oyabe 5	O-5	1660402	36.8072	137.0847	2005	P052L133	✔	1997-2005						
			Oyabe 6	O-6	1660403	36.7939	137.0914	2005	P053L135	✔							
		Other sea area	Oyabe 7	O-7	1660701	36.8197	137.0997	2005	P054L132	✔			A				
			Other 4	S-4	1660706	36.7894	137.1356	2005	P057L135	✔	1997-2005						
			St.6 (Shinminato coast)	St.6		36.7933	137.1550		P058L135			✔			✔	✔	✔ (No data of ammonia
			St.7 (Shinminato offshore)	St.7		36.8317	137.1550		P058L131			✔			✔	✔	✔ (No data of ammonia
			St.8 (Koyabe coast)	St.8		36.8317	137.0900		P053L131			✔			✔	✔	✔ (No data of ammonia
	Sub-area D	Other sea area	Other 1	S-1	1660703	36.9081	137.0461	2005	P049L122	✔			A				
			Other 2	S-2	1660704	36.8714	137.0119	2005	P046L126	✔	1997-2005						
			Other 3	S-3	1660705	36.8353	137.0444	2005	P049L130	✔							
			St.9 (Hyomi coast)	St.9		36.8717	137.0117		P046L126			✔			✔ (except COD)	✔ (except COD)	✔ (No data of ammonia
Supplementary sites	Sub-area E	Central area	Toyama Bay central area	Central area		37.0033	137.2300		P065L111		1999-2005	✔	-				Data overlap (Chl-a)
			St.5 (Jintzu offshore)	St.5		36.8717	137.2533		P067L126			✔			✔	✔	✔ (No data of ammonia
	Background area	Open ocean	Open ocean	Open ocean		37.6950	137.8133		P117L034		1999-2005	✔	-				Data overlap (Chl-a)

Note: The shaded cells indicate the excluded monitoring sites

2-2-2 Remote sensing data

Some pixels in the assessment area could not acquire sufficient quantity of monthly merged data for assessment, due to factors such as cloud cover and land effects. Therefore, for the Toyama Bay case study, pixels that had less than 80% monthly merged data were considered as invalid and were excluded, since they may affect the reliability of the assessment. Pixels near the river mouth areas were also excluded. After these screening procedures, the monthly merged data were sorted into the relevant sub-areas.

Table II-2-2-2 and Figure II-2-2-1 show the pixels that were used in the Toyama Bay case study.

Table II-2-2-2. Pixels used in the Toyama Bay case study.

	1	2	3 =1-2	4	5 = 3-4	6
Sub-area	Total no. of pixels	No. of pixels in rivermouth area	Total no. of pixels (excluding rivermouth)	No. of invalid pixels	No. of pixels used for assessment	Percentages of valid pixels
A	183		183	43	140	76.5
B	189	7	182	58	124	68.1
C	81	3	78	38	40	51.3
D	122		122	74	48	39.3
E	1311		1311	9	1302	99.3
Total	1886	10	1876	222	1654	88.2

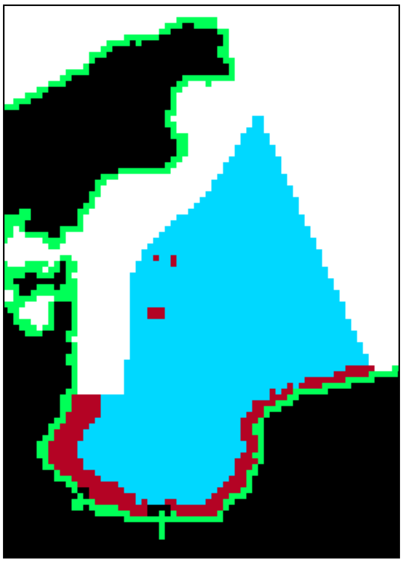

Table II-2-2-1. Pixels used in the Toyama Bay case study. (Pixels colored with blue were used for the assessment. Pixels colored with brown were excluded from the assessment)

2-2-3 Other types of data

Data that were not collected through regular monitoring or remote sensing such as amount of riverine input, area of red tide events and location of pollution/food poisoning incidents were sorted into the relevant sub-areas as shown in Table II-2-2-3.

Table II-2-2-3. Sorting other types of data into sub-areas.

Sub-area	Amount of riverine input	Area of red tide event	Locations of pollution/food poisoning incidents
A	Kurobe River	Between boundary of Niigata Pref. and Kurobe City	Sort in accordance to latitude/longitude
B	Joganji River Jintsu River	Between Kurobe City and mouth of Jintsu River	
C	Sho River Oyabe River	Between mouth of Jintsu River and Oyabe River	
D	-	Between mouth of Oyabe River and boundary of Ishikawa Pref.	
E	-	Central area of Toyama Bay	

2-3 Data processing of assessment parameters

2-3-1 Preparation of data sets

Following the sorting process, assessment values were calculated and data sets were prepared for each assessment parameter. Table II-2-3-1 shows the format of the data sets.

Table II-2-3-1. Format of the data sets.

Category	Assessment parameter	Assessment value	Sub-area	Name of survey site	Unit	Data range (initial year)	Data range (final year)	Calculated assessment values

2-3-2 Calculation of assessment data

Data that were used for the assessment (assessment data) were calculated from the assessment values. Table II-2-3-2 shows the calculation methods of assessment data.

Table II-2-3-2. Calculation methods of assessment data.

Assessment data		Calculation methods
Comparison	Latest data (b)	Calculate the mean of the last 3-years assessment values
	Ratio (b/a)	Calculate b/a a: background value
Occurrence	No. of occurrences in the last 3 years	Calculate the total no. of occurrences in the last 3 years
Trend	Results of *t*-test (all data)	Calculate if there are any statistically significant increase or decrease trend with t-test of all data (significance level=5%)
	Results of *t*-test (data after 1997)	Calculate if there are any statistically significant increase or decrease trend with t-test of data after 1997 (significance level=5%)

3 Setting of assessment criteria

3-1 Basic assessment policy

In order to assess the eutrophication status of the assessment area, identification criteria for the assessment data, classification criteria for the assessment parameters and categories, and assessment criteria for the assessment area/sub-areas were set.

3-2 Setting of identification criteria of the assessment data

The eutrophication status of the assessment data was identified by comparison, occurrence and trend identification tools, and on the basis of identification criteria set for each identification tool. The ‘comparison/occurrence’ identification tools identify the current status of eutrophication, and the ‘trend’ identification tool identifies the future trend of eutrophication.

3-2-1 Identification by comparison (current status)

With the comparison method, eutrophication status of the assessment data was identified by the ratio of assessment data and background value. Based on the calculated ratio, the assessment data was identified as 'relatively high', 'moderate' or 'similar or lower than background' on the basis of the set identification criteria.

A) Setting of background value

The background values (a) were set either by using the values of an established environmental standard or by using values measured in an area that have had negligible influence from anthropogenic activities. In regards to winter DIN/DIP ratio, the ratio in the deep ocean layer of Toyama Bay was used as the background value. Table II-3-2-1 shows the background values used in the Toyama Bay case study for each assessment parameter.

Table II-3-2-1. Background values (a) used in the Toyama Bay case study.

Category	Assessment parameter	Assessment value	Reference site	Data used	Background value (a)
I	T-N	Annual mean	Open ocean	Average of annual mean values between 1999-2005	0.100 mg/L
	T-P	Annual mean	Open ocean	Average of annual mean values between 1998-2005	0.008 mg/L
	Winter DIN	Winter mean	Open ocean	Winter mean value of F.Y. 2003	0.080 mg/L
	Winter DIP	Winter mean	Open ocean	Winter mean value of F.Y. 2003	0.009 mg/L
	Winter DIN/DIP	Winter mean	Deep ocean water	Deep ocean water data of 2001	12.3
II	Chlorophyll-a (field data)	Annual max.	Open ocean	Average of annual max. between 1999-2005	1.000 µg/L
		Annual mean	Open ocean	Average of annual mean values between 1999-2005	0.362 µg/L
	Chlorophyll-a (satellite data)	Annual max.	Max. of background area	Average of annual max. between 1998-2005	1.180 µg/L
		Annual mean	Mean of background area	Average of annual mean values between 1998-2005	0.406 µg/L
III	DO	Annual min.	-	Fisheries water quality standard	6.000 mg/L
	COD	Annual average	Open ocean	Average of annual mean values between 1998-2005	1.004 mg/L

B) Identification criteria of comparison identification tool

Table II-3-3-2 shows the identification criteria set for the comparison identification tool.

Table II-3-2-2. Identification criteria of the comparison identification tool.

Score	Identification results	Identification criteria
+	Relatively high	b/a>1.1 (upper 33%)
-	Moderate	b/a>1.1 (under the upper 33%)
	Similar or lower than background	b/a≤1.1

Note: b= average of last 3-years
a= background value

3-2-2 Identification by occurrence (current status)

The eutrophication status was identified by occurrence or non-occurrence of events. The score was '+' if there was more than one occurrence in the last 3-years, and '-' if there was no occurrence. Table II-3-2-3 shows the identification criteria for the occurrence identification tool.

Table II-3-2-3. Identification criteria of the occurrence identification tool.

Score	Identification results	Identification criteria
+	Occurrence	More than one occurrence in the last 3-years
-	Non-occurrence	No occurrence in the last 3-years

3-2-3 Identification by trend (future trend)

The future trend of eutrophication was identified by whether there was any statistically significant increasing or decreasing eutrophication trend in the assessment parameters. Table II-3-2-4 shows the identification criteria for the trend identification tool.

Table II-3-2-4. Identification criteria of the trend identification tool.

Score	Identification results	Identification criteria
+	Significant increase	Statistically significant increase identified by t-test (significance level = 5%)
±	No significant increase/decrease	No statistically significant increase or decrease identified by t-test (significance level = 5%)
-	Significant decrease	Statistically significant decrease identified by t-test (significance level = 5%)

3-3 Setting of classification criteria of the assessment parameters

3-3-1 Identification tools of the assessment parameters

The eutrophication status of each assessment parameter was classified by combining the identification results obtained by the 'comparison/occurrence' and 'trend' identification tools. Table II-3-3-1 shows the assessment values and identification tools applied for each assessment parameter.

Table II-3-3-1. Combination of identification tools applied for each assessment parameter in the Toyama Bay case study.

Category	Assessment parameter	Assessment value	Identification tools*)		
			Comparison	Occurrence	Trend
I	Riverine input (T-N, T-P)	Annual mean			✓
	T-N, T-P	Annual mean	✓		✓
	Winter DIN/DIP concentration	Winter mean	✓		✓
	Winter N/P ratio (DIN/DIP)	Winter mean	✓		✓
II	Chlorophyll-a concentration (field data)	Annual max. Annual mean	✓		✓
	Chlorophyll-a concentration (remote sensing data)	Annual max. Annual mean	✓		✓
	Sea area ratio with high chlorophyll-a concentration (remote sensing data)	Annual max. Annual mean			✓
	Red-tide events (diatom species)	Annual no. of events		✓	✓
III	DO	Annual min.	✓		✓
	Abnormal fish kill incidents	Annual no. of events		✓	✓
	COD	Annual mean	✓		✓
IV	Shellfish poisoning incidents	Annual no. of events		✓	✓
	Red-tide events (*Noctiluca* sp.)	Annual no. of events		✓	✓

* Comparison: comparison with environmental standard or background value
Occurrence: occurrence or non-occurrence of events
Trend: degree of increase/decrease

3-3-2 Classification by comparison/occurrence

For assessment parameters that the comparison or occurrence identification tools were applied to, the eutrophication status of the assessment parameters were classified as either 'high status' or 'low status' on the basis of the set classification criteria. Table II-3-3-2 shows the classification criteria for the identification results obtained by the comparison and occurrence identification tools.

Table II-3-3-2. Classification criteria for the results obtained by the comparison and occurrence identification tools.

Classification	Definition	Classification criteria
H (High status)	Relatively high eutrophication level	When there was more than one survey site within the sub-area that was identified as '+'
L (Low status)	Moderate eutrophication level or similar to background level	When all survey sites within the sub-are were identified as '-'

3-3-3 Classification by trend

For assessment parameters that the trend identification tools were applied to, the eutrophication status of the assessment parameters was classified as 'decrease trend', 'no trend' or 'increase trend' on the basis of the set classification criteria. Table II-3-3-3 shows the classification criteria for assessment parameters that the trend identification tools were applied to.

Table II-3-3-2. Classification criteria for assessment parameters that the trend identification tools were applied.

Classification	Definition	Classification criteria
I (Increase Trend)	Increasing eutrophication trend	When there was more than one survey site within the sub-area that was identified as '+'
N (No Trend)	No increasing or decreasing eutrophication trend	When all survey sites had no increasing or decreasing trend (Neither I nor D)
D (Decrease Trend)	Decreasing eutrophication trend	When all survey sites within the sub-area were identified as '-'

3-3-4 Classification of assessment parameter

After obtaining the classification results for 'current status' and 'future trend', the assessment parameters were then classified into 6 eutrophication groups in accordance to the classification criteria shown in Table II-3-3-4. If an assessment parameter could be assessed only by the trend method, the assessment parameter was classified as 'decrease trend', 'no trend' or 'increase trend'.

Table II-3-3-4. Classification criteria of assessment parameter.

Classification	Classification results
HI (High status and Increase Trend)	Current status high and increasing trend
HN (High status and No Trend)	Current status high but no increasing or decreasing trend
HD (High status and Decrease Trend)	Current status high but decreasing trend
LI (Low status and Increase Trend)	Current status low but increasing trend
LN (Low status and No Trend)	Current status low but no increasing or decreasing trend
LD (Low status and Decrease Trend)	Current status low and decreasing trend

Classification by trend only

Classification	Classification results
I (Increase Trend)	Increasing trend
N (No Trend)	No increasing or decreasing trend
D (Decrease Trend)	Decreasing trend

3-4 Classification criteria of the assessment categories

In the OSPAR procedure, the assessment categories are classified as '+', if there is more than one assessment parameter within the assessment category that is classified as '+'. The assessment categories are classified as '-', if all assessment parameters within the same assessment category are classified as '-'.

In the Toyama Bay case study, the assessment category was classified by selecting one classification result of the assessment parameters within the assessment category that most appropriately represented the eutrophication status of the area. However, if the classification results among the assessment parameters in the same assessment category were contradictory, and therefore it was unreasonable to select one representative classification result, the assessment category was not classified with its reasons stated.

3-5 Classification criteria of the assessment area/sub-areas

In the OSPAR procedure, the assessment area is classified into 'problem area', 'potential problem area' or 'non-problem area' by integrating the classification results of the 4 assessment categories. An assessment area is classified as 'potential problem area' when the quantity/quality of data were insufficient to perform an assessment. The OSPAR procedure developed this classification system to identify areas that require further environmental monitoring and nutrient reduction measures in terms of eutrophication.

In this study, holistic assessment criteria were set for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.

4 Assessment process and results

The eutrophication status of each sub-area was assessed based on the set assessment criteria.

4-1 Assessment results of sub-area A

Table II-4-1-1 shows the classification results of the assessment categories of sub-area A. According to the classification results, there were no categories in sub-area A that showed progress in eutrophication.

Table II-4-1-1. Classification results of sub-area A.

Category	Basis of classification	Classification results	
I	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of degree of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
II	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of direct effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
III	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of indirect effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
IV	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of other possible effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend

4-2 Assessment results of sub-area B

Table II-4-2-1 shows the classification results of the assessment categories of sub-area B. According to the classification results, the assessment categories I-III were at relatively high levels with no decreasing trend.

Table II-4-2-1. Classification results of sub-area B.

Category	Basis of classification	Classification results	
I	T-N, T-P and winter DIN were at high levels with no decreasing trend	HN	In terms of degree of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
II	Chlorophyll-a of field and remote sensing were at high levels with no decreasing trend	HN	In terms of direct effects of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
III	COD was at high levels with no decreasing trend	HN	In terms of indirect effects of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
IV	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of other possible effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend

From the above results, sub-area B has been identified as ‘having relatively high levels of eutrophication and direct/indirect eutrophication impacts’. Therefore, it is necessary to strengthen monitoring activities and consider countermeasures on the basis of the monitoring results.

4-3 Assessment results of sub-area C

Table II-4-3-1 shows the classification results of the assessment categories of sub-area C. According to the classification results, the assessment categories I-III were at relatively high levels with no decreasing trend.

Table II-4-3-1. Classification results of sub-area C.

Category	Basis of classification	Classification results	
I	T-N, T-P, winter DIN and winter DIP were at high levels with no decreasing trend	HN	In terms of degree of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
II	Chlorophyll-a of field and remote sensing were at high levels with no decreasing trend	HN	In terms of direct effects of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
III	COD was at high levels with no decreasing trend	HN	In terms of indirect effects of nutrient enrichment, current status was relatively high and there was no increasing or decreasing trend
IV	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of other possible effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend

From the above results, sub-area C has been identified as ‘having relatively high levels of eutrophication and direct/indirect eutrophication impacts’. Therefore, it is necessary to strengthen monitoring activities and consider countermeasures on the basis of the monitoring results.

4-4 Assessment results of sub-area D

Table II-4-4-1 shows the classification results of the assessment categories of sub-area D. According to the classification results, all the assessment categories were at relatively low levels, but categories I and II showed increasing trend.

Table II-4-4-1. Classification results of sub-area D.

Category	Basis of classification	Classification results	
I	Current status of all parameters were classified as low status, but T-N and T-P showed significant increasing trend	LI	In terms of degree of nutrient enrichment, current status was relatively low but there was an increasing trend
II	Current status of all parameters were classified as low status, but chlorophyll-a (remote sensing) showed significant increasing trend	LI	In terms of direct effects of nutrient enrichment, current status was relatively low but there was an increasing trend
III	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of indirect effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
IV	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of other possible effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend

Since some categories were under increasing trend, it is necessary to strengthen the monitoring activities so that the causes can be identified.

4-5 Assessment results of sub-area E

Table II-4-5-1 shows the classification results of the assessment categories of sub-area E. According to the classification results, there were no categories in sub-area E that showed progress in eutrophication.

Table II-4-5-1. Classification results of sub-area E.

Category	Basis of classification	Classification results	
I	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of degree of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
II	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of direct effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
III	Current status of all parameters were classified as low status and all parameters had no significant increasing trend	LN	In terms of indirect effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend
IV	Although there were some red tide events (*Noctiliuca* sp.), it was probably wind transported from another sub-area	LN	In terms of other possible effects of nutrient enrichment, current status was relatively low and there was no increasing or decreasing trend

5 Verification of results

5-1 Verification of water characteristics of field monitoring sites by remote sensing

Water characteristics in two regular monitoring sites in sub-area B were verified by comparing the remote sensing chlorophyll-a (satellite chlorophyll-a) data.

5-1-1 Verification by satellite chlorophyll-a mean concentration for the entire assessment period

Mean chlorophyll-a concentration for the entire assessment period in the regular monitoring site pixels (monitoring sites J-5 and S-5) and the spatially averaged sub-area B were compared.

The mean chlorophyll-a concentration in J-5 and S-5, located near the mouth of Jintsu River and in between Jintsu River and Joganji River, respectively, were higher than that of the spatially averaged sub-area B.

5-1-2 Verification by satellite chlorophyll-a monthly mean concentration

The monthly mean chlorophyll-a concentration in J-5 and spatially averaged sub-area B was compared. The results are shown in Table II-5-1-1. Large differences between J-5 and sub-area B values were observed especially during summer, which explains why chlorophyll-a concentration in J-5 was higher than that of the sub-area B.

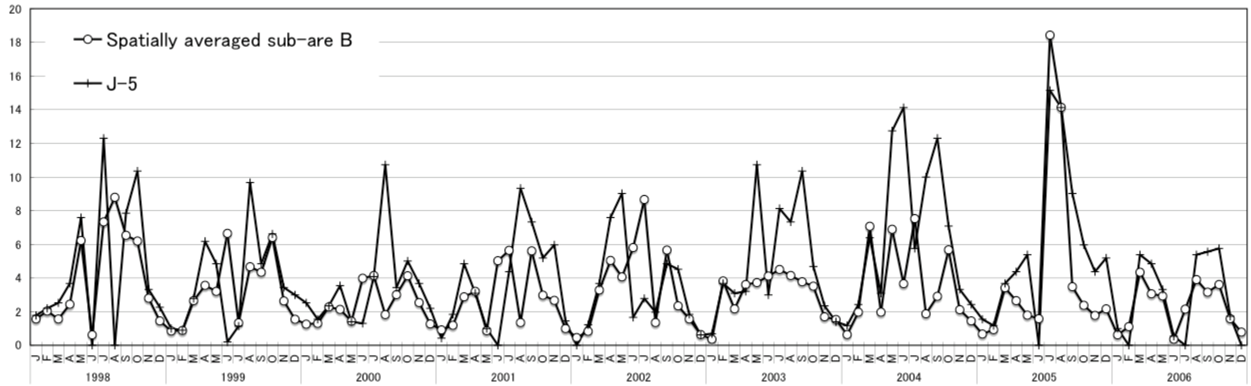

Figure II-5-1-1. Comparison of monthly mean chlorophyll-a concentration in J-5 and the spatially averaged sub-area B from 1998 to 2006.

5-2 Identification of new regular monitoring points

In order to identify new regular monitoring points, values such as maximum concentration and fluctuation range of satellite chlorophyll-a concentration were calculated for each pixel in sub-area B. Based on the calculated values, areas that require more intensive monitoring were identified by taking into account the locations of existing regular monitoring sites.

According to the above examination, there were no regular monitoring sites in areas that had large fluctuation range of satellite chlorophyll-a concentration (Figure II-5-2-1). This showed that remote sensing data could be applied when considering locations of new regular monitoring sites.

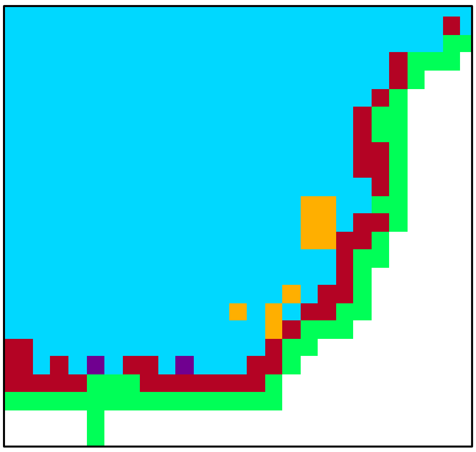

Figure II-5-2-1. Locations of the top 10 pixels with the large fluctuation range of satellite chlorophyll-a concentration (yellow pixels) and existing chlorophyll-a regular monitoring sites (purple pixels).

5-3 Verification of chlorophyll-a concentrations of regular monitoring

The monthly averaged chlorophyll-a concentration from F.Y. 1998 to 2005 obtained by remote sensing and regular monitoring were calculated and their seasonal variations were compared.

Chlorophyll-a concentration obtained by both remote sensing and regular monitoring gradually increased towards summer. However, while satellite chlorophyll-a peaked in July and decreased afterward, chlorophyll-a concentration obtained by regular monitoring remained at high levels until October. Causes of these differences should be further examined.

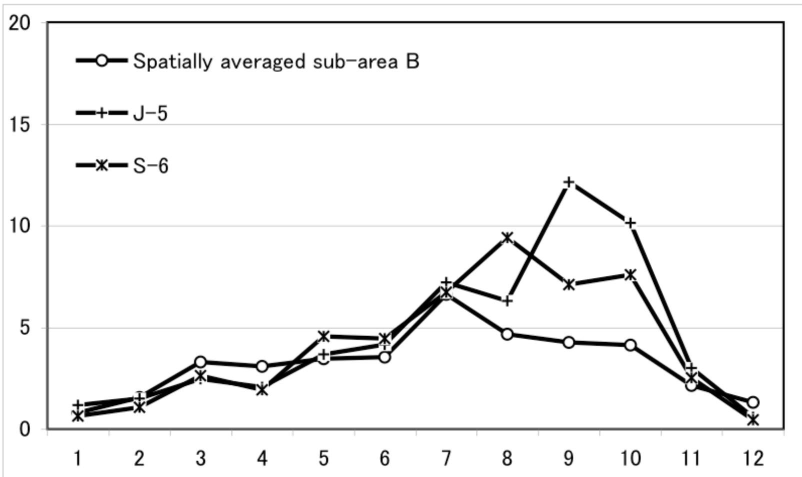

Table II-5-3-1. Comparison of monthly averaged chlorophyll-a concentration of remote sensing data and field data from F.Y. 1998 to 2005.

5-4 Verification of sub-area boundaries

Sub-area boundaries were verified by monthly averaged satellite chlorophyll-a data from1998 to 2006. For seasonal comparison of chlorophyll-a, the data from February to April were merged to represent spring season chlorophyll-a, and April to July to represent summer season chlorophyll-a.

The result showed that chlorophyll-a concentration was higher in summer season than in spring season in the inner bay area and along the eastern coast, and it corresponded to the boarder between sub-areas A-C and D-E.

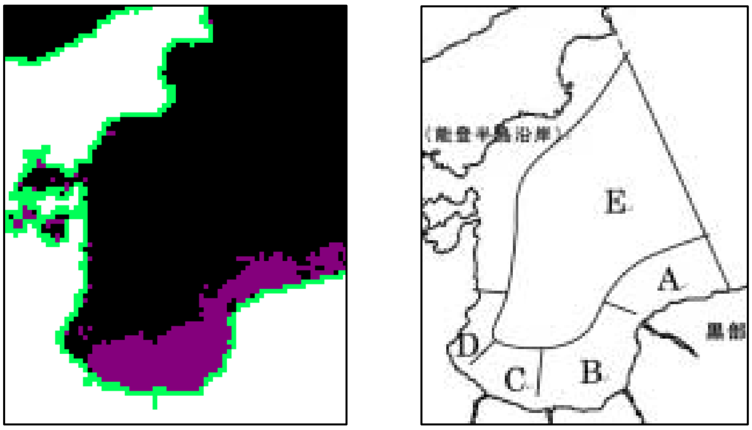

Figure II-5-4-2. Left image shows areas where chlorophyll-a concentration was higher in summer season than in spring season (purple pixels). Right image shows the sub-areas of the case study.

6 Conclusion and recommendation

- Re-examination of the Draft Procedures

  The identification criteria of assessment data should be re-examined to improve its reliability with more appropriate scientific approaches.

- Further utilization of remote sensing techniques

  Assessment and analysis techniques of remote sensing must also be improved in accordance with its technological development.

- Improvement of the Draft Procedures

  The validity and effectiveness of the Draft Procedures must be examined by collecting opinions from experts of various fields.

Annex 2

An interim progress of review and refinement work of the Draft Procedures for assessment of eutrophication status for the NOWPAP region in China

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1. Introduction		
1-1. Background	Are the backgrounds leading to the development of the Draft Procedure appropriately described?	The background decribed appropriately
1.1. Development of the 'Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (Draft Procedures)' was proposed and approved at the 5th CEARAC Focal Point Meeting (FPM).		
1.2. As part of the development processes of the Draft Procedures, NPEC has implemented a case study in Toyama Bay (Toyama Bay case study), by referring to the 'Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area'. An interim progress of the Toyama Bay case study was presented at the 5th CEARAC FPM and First Coastal Environment Assessment Workshop held in Toyama from March 6-8, 2008.		
1-2. Objectives of the Draft Procedures	Are the objectives of the Draft Procedures clearly and appropriately described? Does Figure 1 appropriately show the concept of the Draft Procedures?	The objectives decribed appropriately
1.3. The objectives of the Draft Procedures are to enable each NOWPAP member state to assess the status and impacts of eutrophication in their respective sea areas, by using data/information obtained through existing monitoring activities. The assessment results could hopefully then be utilized by each NOWPAP member state for consideration and development of monitoring systems and countermeasures against eutrophication. Figure 1 schematically shows the concept of the Draft Procedures.		
1-3. Characteristics of the Draft Procedures	Are the principles of the Draft Procedures stated from i)-v) appropriate? Please comment if is necessary to add or delete sentences by specifying the reasons.	The principles stated appropriately
1.4. The Draft Procedures was developed based on the following principles: i) It should be adaptable to various types of sea areas in the NOWPAP region. ii) Remote Sensing data should be used in the assessment procedure. iii) Eutrophication status is assessed through a holistic approach by integrating the following eutrophication aspects: degree of nutrient enrichment, direct/indirect effects of nutrient enrichment and other possible effects of nutrient enrichment. iv) In general, eutrophication status is assessed in relative ways within the whole assessment area.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1-4. Overall structure 1.5. The assessment procedure is broadly separated into six parts, namely i) scope of assessment, ii) data processing, iii) setting of assessment criteria iv) assessment process and results, v) verification of results and vi) conclusion/recommendation. In the 'scope of assessment' part, an assessment area and parameters are selected. In the 'data processing' part, raw data are processed into data sets for the assessment. In the 'setting of assessment criteria' part, assessment criteria are set. In the 'assessment process and results' part, eutrophication status of the assessment area is identified. In the 'verification of results' part, the assessment results are reviewed and verified by new monitoring techniques such as remote sensing. In the 'conclusion/recommendation' part, future issues and actions are identified on the basis of the assessment results. Figure 2 shows the implementation flow of the Draft Procedures.	Are the overall structure and the terms used in each part appropriate?	The overall structure is suggested to rebuild. See later comments in detail

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2. Scope of assessment		
2-1. Setting of assessment objective 2.1. State the objectives of the assessment. 2.2. In order to facilitate the understanding of the assessment results, clarify the preconditions and limitations involved in the assessment. 2.3. State any scientific uncertainties that future users of the assessment results should take note of, such as: i) Application of the assessment results for forecasting environmental changes could be inappropriate. ii) The assessment results may become less reliable/valid when scientific data/information are updated.	Are there any other possible scientific uncertainties that may arise with the assessment results?	no
2-2. Selection of assessment area 2.4. Select an area that can be considered as a single sea area. 2.5. An assessment area should be an area that has ongoing environmental monitoring and assessment programs. 2.6. An assessment area must be an area that has ongoing water quality monitoring and assessment programs.	Are the process and conditions of selecting assessment area appropriate?	2.4 select an area can be considered as a individual geographic unit(such as bay, inlet,bight,estuary etc.). The section 2.5 and 2.6 are same in meaning. Please combine them together.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-3. Collection of relevant information 2.7. Collect information on the assessment area such as, status of water quality monitoring (locations, frequency, parameters), ocean observations by satellite remote sensing, status of wastewater treatment, status of coastal use (e.g. location of recreational beaches), population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication).	Are the listed information appropriate for the assessment?	The list information is not appropriate for the assesement. Two category is suggust. The first is pollutant source of nutrient load and the second one is parameters related to eutrophication in sea area. The fist category is divided furtherly into Atmospheric deposition of nutrients, land based, sea source(such as marine cultivating industry) etc. The second category shoud be sort based on the relations to eutrophication. They are Direct parameters such as Nutrients and calculated Ratio(N/P,Si:DIN,Si:P etc.;Indirect parameters such as Biological(species、community、structure etc.),hydrodynamic item etc.,and Accessorial parameters such as Meteorologic factor etc.
	Are the listed information available in your country?	The list information is available in P.R.China.
	Are there any information that should be added, corrected or deleted?	The measuring techniques acquiring above stated parameters should involved analysed method in laboratory, equipments in situ, remoet sensing etc..

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations: i) Organizations that monitor water quality for environmental conservation purposes ii) Organizations that observe ocean with satellite remote sensing iii) Organizations that monitor harmful algal blooms for protection of fishery resources iv) Organizations that monitor shellfish poisoning for food safety v) Organizations that have other relevant information such as ocean current and water temperature.	Are there any organizations that should be added or deleted?	The data is better to collect from the organizations such as ocean,fishery,environment,traffic management which operate routine monitoring works. The table 1 should be redesign based on the parameter,time, location,concentration,governing organization etc.
2.9. <u>Collect existing survey data/information from the above organizations as in Table 1.</u>		
2.10. <u>Select the most appropriate data source for the assessment process in section 5.</u>	Are the conditions stated in i) to v) appropriate?	quality control of collected data
2.11. Types of data sources which should not be used for the assessment procedure: i) Surveys conducted at very limited frequency ii) Data that are not directly related to eutrophication iii) Surveys that are not conducted at regular locations and frequency iv) Surveys that are not conducted for monitoring water quality and aquatic organisms v) Surveys that employ uncommon analytical methods		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-4. Selection of assessment parameters and data	Are the 4 assessment categorizies appropriate?	Heres, it is necessary to insert a section named method or model for eutrophication assesement. That means we should guid the user a method which is used in China such eutrophication index etc. to calculate some eutrophication indexs to partition eutrophication level.
2-4-1. Categorization of monitored/surveyed parameters 2.12. Categorize all eutrophication related parameters that are monitored/surveyed within the assessment area into one of the following 4 assessment categories: i) Category I Parameters that indicate degree of nutrient enrichment ii) Category II Parameters that indicate degree of nutrient enrichment iii) Category III Parameters that indicate direct effects of nutrient enrichment iv) Category IV Parameters that indicate other possible effects of nutrient enrichment		I suggust to combine section 2.12 together with 2.7 to show aclear description.
2-4-2. Selection of assessment parameters for each assessment category 2.13. After the categorization process, select assessment parameters that are applicable for the assessment procedure on the basis of their data reliability and continuity (e.g. data collected at fixed locations and at regular frequencies). The selected assessment parameters should also have established methods of analysis.	Are the conditions for selecting assessment parameters appropriate?	It is appropriate and is necessary to give futher explain for the established method of analysis about each parameters..
2.14. In principle, all surveyed/monitored parameters related to eutrophication should be selected for the assessment procedure. If certain parameters are to be excluded from the assessment procedures, the reasons must be stated.		
2.15. Table 2 shows examples of assessment parameters that are relevant to the 4		
2-4-3. Setting of assessment value 2.16. In order to understand the interannual trends of eutrophication, assessment should be basically conducted with annual values.	Should the assessment be conducted with annual values?	It is operable and acceptbale.
2.17. Set the assessment values (e.g. annual mean, annual max., annual number of events) to be used for each assessment parameter.		
2-4-4. Selection of data source for the assessment 2.18. Select the data source to be applied for each assessment parameter.	No need to check. Provide comment if any.	

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-5. Division of assessment area into sub-areas 2.19. In order to understand and assess the causes and direct/indirect effects of eutrophication at more localized scales, the assessment area may be divided into sub-areas. 2.20. When dividing the assessment area into sub-areas, factors such as location of riverine input, monitoring locations, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red-tide events should be considered.	Are the listed factors appropriate when dividing the assessment area into sub-areas?	I can't understand why divide the assessment area in to sub-areas. I think it not necessary to do this work for assessment in sea area other than on land due to the dynamic water body.
2-6. Setting of assessment period 2.21. Set the assessment period in accordance with the assessment objectives and availability of reliable data.	Are the considerations required for setting of the assessment period appropriate?	appropriate

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
3. Data processing		
3-1. Setting of data processing procedure 3.1. Based on the set assessment values, establish a common data processing method for each assessment parameter.	No need to check. Provide comment if any.	It is very important issue.but the description shows here is not enough and clear.The assessment method of eutrophication should present in detail, espcially how to difine the level of different eutrophication status. I suggust to make it in appendix.
3-2. Data screening 3.2. Within the selected data source, exclude data that are not suitable for the 3.3. If data are excluded in the above process, state the reasons for their exclusion. Possible reasons could be related to survey location, data reliability and so on.	Are the data screening conditions appropriate?	I suggest to combine this section together with section 2-4.
3-3. Sorting data into sub-areas 3.4. If the assessment area is divided into sub-areas, the data used for the assessment of each sub-area should be sorted by the location of survey/monitoring sites.	Are the data sorting conditions appropriate?	not appropriate
3-4. Data processing of assessment parameters 3.5. Based on the set data processing method, process the collected data. 3.6. In principal, data should be processed by each survey/monitoring site. 3.7. Data sets should be prepared for each assessment parameter and sorted by survey/monitoring site.	Are the data processing methods appropriate?	The data processing method should be illuminated in detail.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4. Setting of assessment criteria		
4.1. In order to assess the eutrophication status of an assessment area, identification criteria for each assessment data* and classification criteria for each assessment parameter, category and assessment criteria for area/sub-area must be set. *Assessment data: data to be used for the following identification process, which is calculated by assessment value.	Are the sequence of setting assessment criteria appropriate?	Criteria difining different eutrophication status should be described in detai as appendix or tabales.
4-1. Setting of identification criteria for the assessment data 4.2. The eutrophication status of each assessment parameter is assessed by its current status and future trend. The current status and future trend of an assessment parameter are identified by its assessment data with the following identification tools. Combination of these identification tools must be applied for each assessment parameter. i) Identification by comparison (identifies current status): The eutrophication status is identified by comparing the assessment data with either the value established by environmental standards or background value set by the values measured in an area that have had negligible influence from anthropogenic activities. This identification tool is used for assessment parameters that can be represented in terms of concentration or ratio. ii) Identification by occurrence (identifies current status): The eutrophication status is identified by occurrence or non-occurrence of events. This identification tool is used for assessment parameters that can be represented in terms of number or frequency of occurrence. iii) Identification by trend (identifies future trend): The eutrophication status is identified by predicting future trends. This identification tool is used for all parameters. 4.3. The basis behind the set identification criteria must be stated clearly and objectively.	Are the identification criteria for assessment data appropriate?	The identification criteria should be the unique common standard among member states in order to compare in different period and at different places. The parameters and relevant criteria should be set in detail.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4-2. Setting of classification criteria for each assessment parameter	Are the classification criteria for assessment parameter appropriate?	
4.4. Set the classification criteria of each assessment parameter based on the current status and future trend identified by the combination of the identification tools.		
4.5. Table 3 shows an example of identification tools applied to each assessment parameter.		
4.6. The proposed classification criteria for each assessment parameter are as follows. The identification result of the current status is classified as either 'high status' or 'low status', and future trend is classified as 'decrease trend', 'no trend' or 'increase trend'. Classification results of the current status and future trend are then integrated and classified into 6 eutrophication groups shown in Table 4. If the assessment parameter can only be assessed by the trend method, the assessment parameter will be classified as either 'decrease trend', 'no trend' or 'increase trend'.		Please give the quantificational difine of classification in Table 4.
4.7. Table 4 shows the classification criteria for the assessment parameter.		
4-3. Setting of classification criteria for the assessment category	Are the classification criteria for the assessment category appropriate?	
4.8. Set the classification criteria of each assessment category based on the classification results of the assessment parameters.		
4.9. Classify the assessment category by selecting one classification result of the assessment parameters within the assessment category that most appropriately represents the eutrophication status of the area. However, if the classification results among the assessment parameters in the assessment category are contradictory, and therefore it is unreasonable to select a representative classification result, this assessment category can be excluded from the classification procedure with its reasons stated.		
4-4. Setting of assessment criteria for the assessment area/sub-area	Are the assessment criteria for the assessment area/sub-area appropriate?	not appropriate
4.10. Set holistic assessment criteria for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
5. Assessment process and results	Are the assessment processes to conduce to results appropriate?	The result shows no obvious conclusion about the evalution of land based soures of nutrients.
5.1. The eutrophication status of the assessment area should be assessed, on the basis of the identification results of the assessment data and classification results of each parameter and parameter's categories.		
5.2. Identify the eutrophication status of the assessment data of each monitoring site based on the set identification criteria.		
5.3. Classify each assessment parameter based on the identification results of the assessment data. If there are multiple monitoring sites in each sub-area, the identification results from all the monitoring sites should be taken into account.		
5.4. Classify each assessment category based on the classification results of assessment parameters.		
5.5. The eutrophication status of each area/sub-area should be assessed based on the classification results of each assessment parameter and category.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
6. Verification of results 6.1. The assessment report should have all necessary information required for review. 6.2. Use of remote sensing is recommended for the verification of the assessment results.	No need to check. Provide comment if any.	There are some key points that didn't manifest in this paragraph. The first is that report ,the summary of phase 1 of Toyama bay case study, used the chlorophyll a as parameter for verification of results, but in the table 2, the chlorophyll a was put in the second category as direct effects of nutrient enrichment rather than degree of nutrient enrichment. In the general way, chlorophyll a indicates partly degree of eutrophication status. What relations between this two parameters are in local area? Please describe in detail. The second one is that all the draft procedures didn't give relation between the parameters of eutrophication and the parameters such as chlorophyll a, SPM, CDOM etc. Which is aquired conveniently from remote sensing. Their validity as a indicater for eutrophication assessment should be point out. The third one is that the developement of local bio-optical algorithm in case II water area and its precision was not shown clearly. It is suggust to represent a technical specification as appendix.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
7. Conclusion and recommendation	No need to check.	
7.1. Based on the assessment results, provide recommendations for future actions.	Provide comment if any.	
7.2. The results of each classification process should be clearly presented, so that policy makers etc. can consider the most appropriate monitoring or countermeasures against eutrophication.		

Annex 2

An interim progress of review and refinement work of the Draft Procedures for assessment of eutrophication status for the NOWPAP region in Korea

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1. Introduction		
1-1. Background 1.1. Development of the 'Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (Draft Procedures)' was proposed and approved at the 5th CEARAC Focal Point Meeting (FPM). 1.2. As part of the development processes of the Draft Procedures, NPEC has implemented a case study in Toyama Bay (Toyama Bay case study), by referring to the 'Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area'. An interim progress of the Toyama Bay case study was presented at the 5th CEARAC FPM and First Coastal Environment Assessment Workshop held in Toyama from March 6-8, 2008.	Are the backgrounds leading to the development of the Draft Procedure appropriately described?	Why marine eutrophication is one of the major issues in NOWPAP region? (Description) For example; Marine eutrophication is one of the major issues that has been tackled from the late-1980 by OSPAR. Much of this work has followed the decisions of North Sea ministers in the framework of the International Conference on the Protection of the North Sea. ....
1-2. Objectives of the Draft Procedures 1.3. The objectives of the Draft Procedures are to enable each NOWPAP member state to assess the status and impacts of eutrophication in their respective sea areas, by using data/information obtained through existing monitoring activities. The assessment results could hopefully then be utilized by each NOWPAP member state for consideration and development of monitoring systems and countermeasures against eutrophication. Figure 1 schematically shows the concept of the Draft Procedures.	Are the objectives of the Draft Procedures clearly and appropriately described? Does Figure 1 appropriately show the concept of the Draft Procedures?	Figure 1 schematically shows the concept of the Draft Procedures. => NOWPAP has been carrying out the Draft Procedures for the assessment of eutrophication by the flow chart shown in Figure 1. In Figure 1, HAB occurrence => HAB. Remote Sensing => Satellite Remote Sensing. (GOAL) Improvement of eutrophication status and decrease of red tides occurrences => Management and assessment of eutrophication status. In Figure 1 caption, Figure 1. Concept of the Draft Procedures. (period add)

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1-3. Characteristics of the Draft Procedures 1.4. The Draft Procedures was developed based on the following principles: i) It should be adaptable to various types of sea areas in the NOWPAP region. ii) Remote Sensing data should be used in the assessment procedure. iii) Eutrophication status is assessed through a holistic approach by integrating the following eutrophication aspects: degree of nutrient enrichment, direct/indirect effects of nutrient enrichment and other possible effects of nutrient enrichment. iv) In general, eutrophication status is assessed in relative ways within the whole assessment area.	Are the principles of the Draft Procedures stated from i)-v) appropriate? Please comment if is necessary to add or delete sentences by specifying the reasons.	Appropriate
1-4. Overall structure 1.5. The assessment procedure is broadly separated into six parts, namely i) scope of assessment, ii) data processing, iii) setting of assessment criteria iv) assessment process and results, v) verification of results and vi) conclusion/recommendation. In the 'scope of assessment ' part, an assessment area and parameters are selected. In the ' data processing' part, raw data are processed into data sets for the assessment. In the 'setting of assessment criteria' part, assessment criteria are set. In the 'assessment process and results' part, eutrophication status of the assessment area is identified. In the 'verification of results ' part, the assessment results are reviewed and verified by new monitoring techniques such as remote sensing. In the ' conclusion/recommendation ' part, future issues and actions are identified on the basis of the assessment results. Figure 2 shows the implementation flow of the Draft Procedures.	Are the overall structure and the terms used in each part appropriate?	Figure 2 caption add. Figure 2. Implementation flow of the Draft Procedures.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2. Scope of assessment		
2-1. Setting of assessment objective	Are there any other possible scientific uncertainties that may arise with the assessment results?	
2.1. State the objectives of the assessment.		
2.2. In order to facilitate the understanding of the assessment results, clarify the preconditions and limitations involved in the assessment.		
2.3. State any scientific uncertainties that future users of the assessment results should take note of, such as: i) Application of the assessment results for forecasting environmental changes could be inappropriate. ii) The assessment results may become less reliable/valid when scientific data/information are updated.		
2-2. Selection of assessment area	Are the process and conditions of selecting assessment area appropriate?	Appropriate.
2.4. Select an area that can be considered as a single sea area.		
2.5. An assessment area should be an area that has ongoing environmental monitoring and assessment programs.		
2.6. An assessment area must be an area that has ongoing water quality monitoring and assessment programs.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-3. Collection of relevant information 2.7. Collect information on the assessment area such as, status of water quality monitoring (locations, frequency, parameters), ocean observations by satellite remote sensing, status of wastewater treatment, status of coastal use (e.g. location of recreational beaches), population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication).	Are the listed information appropriate for the assessment?	Appropriate.
	Are the listed information available in your country?	yes
	Are there any information that should be added, corrected or deleted?	We would like to delete on the population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication). It is difficult to collect data.
2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations: i) Organizations that monitor water quality for environmental conservation purposes ii) Organizations that observe ocean with satellite remote sensing iii) Organizations that monitor harmful algal blooms for protection of fishery resources iv) Organizations that monitor shellfish poisoning for food safety v) Organizations that have other relevant information such as ocean current and water temperature. 2.9. Collect existing survey data/information from the above organizations as in Table 1.	Are there any organizations that should be added or deleted?	2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations: => Collect data from organizations that monitor chemical, biological, physical and supporting environmental factors (physical and hydrodynmic aspects, and weather/climate conditions (e.g. flushing, wind, temperature, light availability)): Table 1. Survey data/infromation collected from monitoring organizations (period add) We would like to suggest modifying the orders of table 1. For example; ①Survey type ②Governing organization ③ Survey title ④Aim ⑤Survey area ⑥Survey period ⑦Survey frequency ⑧No. of survey sites ⑨Main survey parameters ⑩Remarks

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2.10. Select the most appropriate data source for the assessment process in section 5. 2.11. Types of data sources which should not be used for the assessment procedure: i) Surveys conducted at very limited frequency ii) Data that are not directly related to eutrophication iii) Surveys that are not conducted at regular locations and frequency iv) Surveys that are not conducted for monitoring water quality and aquatic organisms v) Surveys that employ uncommon analytical methods	Are the conditions stated in i) to v) appropriate?	Appropriate.
2-4. Selection of assessment parameters and data 2-4-1. Categorization of monitored/surveyed parameters 2.12. Categorize all eutrophication related parameters that are monitored/surveyed within the assessment area into one of the following 4 assessment categories: i) Category I Parameters that indicate degree of nutrient enrichment ii) Category II Parameters that indicate degree of nutrient enrichment iii) Category III Parameters that indicate direct effects of nutrient enrichment iv) Category IV Parameters that indicate other possible effects of nutrient enrichment	Are the 4 assessment categorizies appropriate?	Appropriate. Categoriories I and II are same. Actually, the contents of Annex 1.1_Draft Procedures in attached file are as follow. i) Category I Parameters that indicate degree of nutrient enrichment ii) Category II Parameters that indicate direct effects of nutrient enrichment iii) Category III Parameters that indicate indirect effects of nutrient enrichment iv) Category IV Parameters that indicate other possible effects of nutrient enrichment ※
2-4-2. Selection of assessment parameters for each assessment category 2.13. After the categorization process, select assessment parameters that are applicable for the assessment procedure on the basis of their data reliability and continuity (e.g. data collected at fixed locations and at regular frequencies). The selected assessment parameters should also have established methods of analysis. 2.14. In principle, all surveyed/monitored parameters related to eutrophication should be selected for the assessment procedure. If certain parameters are to be excluded from the assessment procedures, the reasons must be stated. 2.15. Table 2 shows examples of assessment parameters that are relevant to the 4 categories.	Are the conditions for selecting assessment parameters appropriate?	Table 2. Examples of assessment parameters (period add) in Category I, Riverine input => Riverine inputs; Winter DIN/DIP concentration => Winter (or Seasonal) DIN/DIP concentrations, Winter N/P ratio (DIN/DIP) => Winter (or Seasonal) N/P ratio (Redfield N/P = 16), in Category II, Red-tide events (diatom species) => Red-tide events (phytoplankton (diatom and dinoflagellate species)). Addition parameter in Category II is the Region/Area specific phytoplankton indicator species. We would like to add the parameter of Algal toxins (Alexandrium spp.) in Category IV (related to Category II. 4 and 5 (added parameter))

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-4-3. Setting of assessment value 2.16. In order to understand the interannual trends of eutrophication, assessment should be basically conducted with annual values. 2.17. Set the assessment values (e.g. annual mean, annual max., annual number of events) to be used for each assessment parameter.	Should the assessment be conducted with annual values?	yes
2-4-4. Selection of data source for the assessment 2.18. Select the data source to be applied for each assessment parameter.	No need to check. Provide comment if any.	
2-5. Division of assessment area into sub-areas 2.19. In order to understand and assess the causes and direct/indirect effects of eutrophication at more localized scales, the assessment area may be divided into sub-areas. 2.20. When dividing the assessment area into sub-areas, factors such as location of riverine input, monitoring locations, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red-tide events should be considered.	Are the listed factors appropriate when dividing the assessment area into sub-areas?	Appropriate.
2-6. Setting of assessment period 2.21. Set the assessment period in accordance with the assessment objectives and availability of reliable data.	Are the considerations required for setting of the assessment period appropriate?	Appropriate.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
3. Data processing		
3-1. Setting of data processing procedure 3.1. Based on the set assessment values, establish a common data processing method for each assessment parameter.	No need to check. Provide comment if any.	
3-2. Data screening 3.2. Within the selected data source, exclude data that are not suitable for the 3.3. If data are excluded in the above process, state the reasons for their exclusion. Possible reasons could be related to survey location, data reliability and so on.	Are the data screening conditions appropriate?	Appropriate
3-3. Sorting data into sub-areas 3.4. If the assessment area is divided into sub-areas, the data used for the assessment of each sub-area should be sorted by the location of survey/monitoring sites.	Are the data sorting conditions appropriate?	Appropriate
3-4. Data processing of assessment parameters 3.5. Based on the set data processing method, process the collected data. 3.6. In principal, data should be processed by each survey/monitoring site. 3.7. Data sets should be prepared for each assessment parameter and sorted by survey/monitoring site.	Are the data processing methods appropriate?	Appropriate

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4. Setting of assessment criteria		
4.1. In order to assess the eutrophication status of an assessment area, identification criteria for each assessment data* and classification criteria for each assessment parameter, category and assessment criteria for area/sub-area must be set. *Assessment data: data to be used for the following identification process, which is calculated by assessment value.	Are the sequence of setting assessment criteria appropriate?	Appropriate
4-1. Setting of identification criteria for the assessment data 4.2. The eutrophication status of each assessment parameter is assessed by its current status and future trend. The current status and future trend of an assessment parameter are identified by its assessment data with the following identification tools. Combination of these identification tools must be applied for each assessment parameter. i) Identification by comparison (identifies current status): The eutrophication status is identified by comparing the assessment data with either the value established by environmental standards or background value set by the values measured in an area that have had negligible influence from anthropogenic activities. This identification tool is used for assessment parameters that can be represented in terms of concentration or ratio. ii) Identification by occurrence (identifies current status): The eutrophication status is identified by occurrence or non-occurrence of events. This identification tool is used for assessment parameters that can be represented in terms of number or frequency of occurrence. iii) Identification by trend (identifies future trend): The eutrophication status is identified by predicting future trends. This identification tool is used for all parameters. 4.3. The basis behind the set identification criteria must be stated clearly and objectively.	Are the identification criteria for assessment data appropriate?	Appropriate

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4-2. Setting of classification criteria for each assessment parameter	Are the classification criteria for assessment parameter appropriate?	Please see table 2 for details of each assessment parameters in table 3. In Category I.3 and 4, we would like to suggest modifying the winter mean of assessment value (=> winter (or seasonal) means). The annual min (minimum ?, oxygen-deficient water) of DO assessment value in category III. If it is not correct, the annual min is to modify the annual mean.
4.4. Set the classification criteria of each assessment parameter based on the current status and future trend identified by the combination of the identification tools.		
4.5. Table 3 shows an example of identification tools applied to each assessment parameter.		
4.6. The proposed classification criteria for each assessment parameter are as follows. The identification result of the current status is classified as either 'high status' or 'low status', and future trend is classified as 'decrease trend', 'no trend' or 'increase trend'. Classification results of the current status and future trend are then integrated and classified into 6 eutrophication groups shown in Table 4. If the assessment parameter can only be assessed by the trend method, the assessment parameter will be classified as either 'decrease trend', 'no trend' or 'increase trend'.		Appropriate
4.7. Table 4 shows the classification criteria for the assessment parameter.		In table 4, N (no trend) is no increasing or decreasing trend. We would like to suggest modifying as follow. No increasing or decreasing trend => Stationary state (Not enough data to perform an assessment or the data available is not fit for the purpose)
4-3. Setting of classification criteria for the assessment category	Are the classification criteria for the assessment category appropriate?	Appropriate
4.8. Set the classification criteria of each assessment category based on the classification results of the assessment parameters.		
4.9. Classify the assessment category by selecting one classification result of the assessment parameters within the assessment category that most appropriately represents the eutrophication status of the area. However, if the classification results among the assessment parameters in the assessment category are contradictory, and therefore it is unreasonable to select a representative classification result, this assessment category can be excluded from the classification procedure with its reasons stated.		Appropriate

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4-4. Setting of assessment criteria for the assessment area/sub-area	Are the assessment criteria for the assessment area/sub-area appropriate?	Appropriate
4.10. Set holistic assessment criteria for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.		

5. Assessment process and results	Are the assessment processes to conduce to results appropriate?	Appropriate
5.1. The eutrophication status of the assessment area should be assessed, on the basis of the identification results of the assessment data and classification results of each parameter and parameter's categories.		
5.2. Identify the eutrophication status of the assessment data of each monitoring site based on the set identification criteria.		
5.3. Classify each assessment parameter based on the identification results of the assessment data. If there are multiple monitoring sites in each sub-area, the identification results from all the monitoring sites should be taken into account.		
5.4. Classify each assessment category based on the classification results of assessment parameters.		
5.5. The eutrophication status of each area/sub-area should be assessed based on the classification results of each assessment parameter and category.		

6. Verification of results	No need to check. Provide comment if any.	
6.1. The assessment report should have all necessary information required for review.		
6.2. Use of remote sensing is recommended for the verification of the assessment results.		

7. Conclusion and recommendation	No need to check. Provide comment if any.	
7.1. Based on the assessment results, provide recommendations for future actions.		
7.2. The results of each classification process should be clearly presented, so that policy makers etc. can consider the most appropriate monitoring or countermeasures against eutrophication.		

Annex 2

An interim progress of review and refinement work of the Draft Procedures for assessment of eutrophication status for the NOWPAP region in Russia

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1. Introduction		
1-1. Background 1.1. Development of the 'Draft procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (Draft Procedures)' was proposed and approved at the 5th CEARAC Focal Point Meeting (FPM). 1.2. As part of the development processes of the Draft Procedures, NPEC has implemented a case study in Toyama Bay (Toyama Bay case study), by referring to the 'Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area'. An interim progress of the Toyama Bay case study was presented at the 5th CEARAC FPM and First Coastal Environment Assessment Workshop held in Toyama from March 6-8, 2008.	Are the backgrounds leading to the development of the Draft Procedure appropriately described?	See Review_Introduction
1-2. Objectives of the Draft Procedures 1.3. The objectives of the Draft Procedures are to enable each NOWPAP member state to assess the status and impacts of eutrophication in their respective sea areas, by using data/information obtained through existing monitoring activities. The assessment results could hopefully then be utilized by each NOWPAP member state for consideration and development of monitoring systems and countermeasures against eutrophication. Figure 1 schematically shows the concept of the Draft Procedures.	Are the objectives of the Draft Procedures clearly and appropriately described? Does Figure 1 appropriately show the concept of the Draft Procedures?	Add Observations to Databases. Observations are used as input data for physical and biological modeling.
1-3. Characteristics of the Draft Procedures 1.4. The Draft Procedures was developed based on the following principles: i) It should be adaptable to various types of sea areas in the NOWPAP region. ii) Remote Sensing data should be used in the assessment procedure. iii) Eutrophication status is assessed through a holistic approach by integrating the following eutrophication aspects: degree of nutrient enrichment, direct/indirect effects of nutrient enrichment and other possible effects of nutrient enrichment. iv) In general, eutrophication status is assessed in relative ways within the whole assessment area.	Are the principles of the Draft Procedures stated from i)-v) appropriate? Please comment if is necessary to add or delete sentences by specifying the reasons.	It should be adaptable to various environmental conditions of sea areas in the NOWPAP region. Remove ii): it is evident that only remote sensing provides the spatial physical and biological data important for eutrophication monitoring.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
1-4. Overall structure 1.5. The assessment procedure is broadly separated into six parts, namely i) scope of assessment, ii) data processing, iii) setting of assessment criteria iv) assessment process and results, v) verification of results and vi) conclusion/recommendation. In the 'scope of assessment ' part, an assessment area and parameters are selected. In the ' data processing' part, raw data are processed into data sets for the assessment. In the 'setting of assessment criteria' part, assessment criteria are set. In the 'assessment process and results' part, eutrophication status of the assessment area is identified. In the 'verification of results ' part, the assessment results are reviewed and verified by new monitoring techniques such as remote sensing. In the ' conclusion/recommendation ' part, future issues and actions are identified on the basis of the assessment results. Figure 2 shows the implementation flow of the Draft Procedures.	Are the overall structure and the terms used in each part appropriate?	In the 'data processing' part, raw data including recent remote sensing data are processed and combined with the existing database (Figure1) into data sets for the assessment. In the 'verification of results' part, the assessment results are reviewed and verified by traditional and new monitoring techniques such as remote sensing and modeling. In the 'conclusion/ recommen-dation' part, future measures are suggested with estimates of Costs and Benefits and issues are identified on the basis of the assessment results. Figure 2. Verification by remote sensing and modelling.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2. Scope of assessment		
2-1. Setting of assessment objective 2.1. State the objectives of the assessment. 2.2. In order to facilitate the understanding of the assessment results, clarify the preconditions and limitations involved in the assessment. 2.3. State any scientific uncertainties that future users of the assessment results should take note of, such as: i) Application of the assessment results for forecasting environmental changes could be inappropriate. ii) The assessment results may become less reliable/valid when scientific data/information are updated.	Are there any other possible scientific uncertainties that may arise with the assessment results?	i) Application of the assessment results for forecasting environmental changes could be inappropriate (forecasting model should be tuned). ii) The preliminary assessment results may become less reliable/valid when scientific data/information are updated.
2-2. Selection of assessment area 2.4. Select an area that can be considered as a single sea area. 2.5. An assessment area should be an area that has ongoing environmental monitoring and assessment programs. 2.6. An assessment area must be an area that has ongoing water quality monitoring and assessment programs.	Are the process and conditions of selecting assessment area appropriate?	iii) Insufficient data (time series is too short or do not cover studied season, long interruption due to weather conditions (gale winds, typhoon passing, amount of precipitation exceeds significantly the average values, etc.). 2.5. An assessment area should be an area for which there are ongoing environmental monitoring and assessment programs and where eutrophication was earlier observed or amount of nutrients increases. 2.6. An assessment area must be an area for which there are ongoing water quality monitoring and assessment programs and where eutrophication was earlier observed or amount of nutrients increases. To combine 2.5 and 2.6

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-3. Collection of relevant information 2.7. Collect information on the assessment area such as, status of water quality monitoring (locations, frequency, parameters), ocean observations by satellite remote sensing, status of wastewater treatment, status of coastal use (e.g. location of recreational beaches), population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication).	Are the listed information appropriate for the assessment?	A list of the main and additional monitoring parameters and a list of satellite-derived parameters should be given, first of all, supporting environmental factors (physical and hydrodynamic aspects and climatic/weather conditions (e.g. flushing, wind, temperature, light)).
	Are the listed information available in your country?	yes
	Are there any information that should be added, corrected or deleted?	Organizations that have other relevant information such as water temperature and salinity, wind, waves, tides and currents.
2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations: i) Organizations that monitor water quality for environmental conservation purposes ii) Organizations that observe ocean with satellite remote sensing iii) Organizations that monitor harmful algal blooms for protection of fishery resources iv) Organizations that monitor shellfish poisoning for food safety v) Organizations that have other relevant information such as ocean current and water temperature. 2.9. Collect existing survey data/information from the above organizations as in Table 1.	Are there any organizations that should be added or deleted?	Organizations that have other relevant information such as water temperature and salinity, wind, waves, tides and currents.
2.10. Select the most appropriate data source for the assessment process in section 5. 2.11. Types of data sources which should not be used for the assessment procedure: i) Surveys conducted at very limited frequency ii) Data that are not directly related to eutrophication iii) Surveys that are not conducted at regular locations and frequency iv) Surveys that are not conducted for monitoring water quality and aquatic organisms v) Surveys that employ uncommon analytical methods	Are the conditions stated in i) to v) appropriate?	Conditions stated in i), ii), iii) and v) can be useful especially when there are time series of satellite remote sensing data (images).

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
2-4. Selection of assessment parameters and data	Are the 4 assessment categorizies appropriate?	
2-4-1. Categorization of monitored/surveyed parameters 2.12. Categorize all eutrophication related parameters that are monitored/surveyed within the assessment area into one of the following 4 assessment categories: i) Category I Parameters that indicate degree of nutrient enrichment ii) Category II Parameters that indicate degree of nutrient enrichment iii) Category III Parameters that indicate direct effects of nutrient enrichment iv) Category IV Parameters that indicate other possible effects of nutrient enrichment		iii) Category III Parameters that indicate indirect effects of nutrient enrichment. These categories are appropriate and are in agreement with OSPAR Common Assessment Criteria for determination of Eutrophication Status (see Table 1 in Introduction).
2-4-2. Selection of assessment parameters for each assessment category 2.13. After the categorization process, select assessment parameters that are applicable for the assessment procedure on the basis of their data reliability and continuity (e.g. data collected at fixed locations and at regular frequencies). The selected assessment parameters should also have established methods of analysis. 2.14. In principle, all surveyed/monitored parameters related to eutrophication should be selected for the assessment procedure. If certain parameters are to be excluded from the assessment procedures, the reasons must be stated. 2.15. Table 2 shows examples of assessment parameters that are relevant to the 4	Are the conditions for selecting assessment parameters appropriate?	It is necessary to note the ranges and/or threshold levels (absolute or relative) for such parameters as chl-a concentration, Dissolved oxygen (DO), etc. (see Table 1 in Introduction).
2-4-3. Setting of assessment value 2.16. In order to understand the interannual trends of eutrophication, assessment should be basically conducted with annual values. 2.17. Set the assessment values (e.g. annual mean, annual max., annual number of events) to be used for each assessment parameter.	Should the assessment be conducted with annual values?	yes
2-4-4. Selection of data source for the assessment 2.18. Select the data source to be applied for each assessment parameter.	No need to check. Provide comment if any.	
2-5. Division of assessment area into sub-areas 2.19. In order to understand and assess the causes and direct/indirect effects of eutrophication at more localized scales, the assessment area may be divided into sub-areas. 2.20. When dividing the assessment area into sub-areas, factors such as location of riverine input, monitoring locations, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red-tide events should be considered.	Are the listed factors appropriate when dividing the assessment area into sub-areas?	When dividing the assessment area into sub-areas, factors such as location of estuaries and typical values of river discharge, SST and salinity distribution, underwater topography, ocean/tidal currents, fishery activities, location and amount of aquaculture farms, red- tide events and monitoring locations should be considered. See: Another approach
2-6. Setting of assessment period 2.21. Set the assessment period in accordance with the assessment objectives and availability of reliable data.	Are the considerations required for setting of the assessment period appropriate?	yes

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
3. Data processing		
3-1. Setting of data processing procedure 3.1. Based on the set assessment values, establish a common data processing method for each assessment parameter.	No need to check. Provide comment if any.	
3-2. Data screening 3.2. Within the selected data source, exclude data that are not suitable for the 3.3. If data are excluded in the above process, state the reasons for their exclusion. Possible reasons could be related to survey location, data reliability and so on.	Are the data screening conditions appropriate?	Suitable or not suitable for the assessment – should be defined for each data source (selection criteria).
3-3. Sorting data into sub-areas 3.4. If the assessment area is divided into sub-areas, the data used for the assessment of each sub-area should be sorted by the location of survey/monitoring sites.	Are the data sorting conditions appropriate?	Data near the sub-areas boundaries can be used in both subareas taking into account environmental conditions (surface currents, satellite images, evolution of observed surface signatures).
3-4. Data processing of assessment parameters 3.5. Based on the set data processing method, process the collected data. 3.6. In principal, data should be processed by each survey/monitoring site. 3.7. Data sets should be prepared for each assessment parameter and sorted by survey/monitoring site.	Are the data processing methods appropriate?	The optimal version is to get the processed data. Usually each survey/monitoring site carries out data processing. However the monitoring center where all data are gathered should have software to process various raw data.

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4. Setting of assessment criteria		
4.1. In order to assess the eutrophication status of an assessment area, identification criteria for each assessment data* and classification criteria for each assessment parameter, category and assessment criteria for area/sub-area must be set. *Assessment data: data to be used for the following identification process, which is calculated by assessment value.	Are the sequence of setting assessment criteria appropriate?	
4-1. Setting of identification criteria for the assessment data	Are the identification criteria for assessment data appropriate?	yes
4.2. The eutrophication status of each assessment parameter is assessed by its current status and future trend. The current status and future trend of an assessment parameter are identified by its assessment data with the following identification tools. Combination of these identification tools must be applied for each assessment parameter. i) Identification by comparison (identifies current status): The eutrophication status is identified by comparing the assessment data with either the value established by environmental standards or background value set by the values measured in an area that have had negligible influence from anthropogenic activities. This identification tool is used for assessment parameters that can be represented in terms of concentration or ratio. ii) Identification by occurrence (identifies current status): The eutrophication status is identified by occurrence or non-occurrence of events. This identification tool is used for assessment parameters that can be represented in terms of number or frequency of occurrence. iii) Identification by trend (identifies future trend): The eutrophication status is identified by predicting future trends. This identification tool is used for all parameters.		
4.3. The basis behind the set identification criteria must be stated clearly and objectively.		
4-2. Setting of classification criteria for each assessment parameter	Are the classification criteria for assessment parameter appropriate?	
4.4. Set the classification criteria of each assessment parameter based on the current status and future trend identified by the combination of the identification tools.		
4.5. Table 3 shows an example of identification tools applied to each assessment parameter.		
4.6. The proposed classification criteria for each assessment parameter are as follows. The identification result of the current status is classified as either 'high status' or 'low status', and future trend is classified as 'decrease trend', 'no trend' or 'increase trend'. Classification results of the current status and future trend are then integrated and classified into 6 eutrophication groups shown in Table 4. If the assessment parameter can only be assessed by the trend method, the assessment parameter will be classified as either 'decrease trend', 'no trend' or 'increase trend'.		
4.7. Table 4 shows the classification criteria for the assessment parameter.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
4-3. Setting of classification criteria for the assessment category	Are the classification criteria for the assessment category appropriate?	yes
4.8. Set the classification criteria of each assessment category based on the classification results of the assessment parameters.		
4.9. Classify the assessment category by selecting one classification result of the assessment parameters within the assessment category that most appropriately represents the eutrophication status of the area. However, if the classification results among the assessment parameters in the assessment category are contradictory, and therefore it is unreasonable to select a representative classification result, this assessment category can be excluded from the classification procedure with its reasons stated.		
4-4. Setting of assessment criteria for the assessment area/sub-area	Are the assessment criteria for the assessment area/sub-area appropriate?	yes
4.10. Set holistic assessment criteria for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.		

Contents of Draft Procedure for assessment of eutrophication status for the NOWPAP region	Points to Check	Please provide your comments for refinements (addition, delete, modifications, inserting chart, etc)
5. Assessment process and results	Are the assessment processes to conduce to results appropriate?	yes
5.1. The eutrophication status of the assessment area should be assessed, on the basis of the identification results of the assessment data and classification results of each parameter and parameter's categories.		
5.2. Identify the eutrophication status of the assessment data of each monitoring site based on the set identification criteria.		
5.3. Classify each assessment parameter based on the identification results of the assessment data. If there are multiple monitoring sites in each sub-area, the identification results from all the monitoring sites should be taken into account.		
5.4. Classify each assessment category based on the classification results of assessment parameters.		
5.5. The eutrophication status of each area/sub-area should be assessed based on the classification results of each assessment parameter and category.		
6. Verification of results	No need to check. Provide comment if any.	
6.1. The assessment report should have all necessary information required for review.		
6.2. Use of remote sensing is recommended for the verification of the assessment results.		
7. Conclusion and recommendation	No need to check. Provide comment if any.	
7.1. Based on the assessment results, provide recommendations for future actions.		
7.2. The results of each classification process should be clearly presented, so that policy makers etc. can consider the most appropriate monitoring or countermeasures against eutrophication.		

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Interim Review and Refinement of the Draft Procedures in Russia

1.Introduction

Expend 1-1 Background

It is relatively recent that anthropogenic eutrophication is perceived as a potential threat for the NOWPAP region. CEARAC WG3 and WG4 have decided, in the absence of good scientific information, to develop OSPAR-based procedures for assessment of eutrophication status considering that the obtained assessments will provide arguments to limit or if possible to reduce unnatural change of the coastal ecosystem. OSPAR defines "eutrophication" as the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients. Usually eutrophication does not occur in the open shelf and deep areas of the OSPAR region. However, within the coastal zone, embayment and estuarine areas of some parts of the maritime area, there is clear evidence of eutrophication. Marine and coastal eutrophication is caused by the presence of an excess of nutrients, principally nitrates and phosphates. Unlike freshwaters, nitrate is usually the limiting factor in eutrophic events in marine and coastal systems. The sources of nutrients in marine systems are riverine, atmospheric and direct inputs. OSPAR (2002) identifies that the relative proportions of nitrogen input for riverine, atmospheric and direct inputs are typically in the range of 10:3:1. Addressing marine eutrophication is therefore are restricted to the consideration of marine based activities but also embraces land based activities that result in elevated nutrient concentrations in rivers and direct inputs.

In the NOWPAP region, increased runoff and discharge of nitrogen and phosphate from land since the fifties or sixties (?) have caused higher concentrations of these elements in rivers and coastal waters, reaching a maximum in the late eighties and early ninetieth (?). While consistent data sets on nutrient concentrations for the period 1950-2003 are not available to prove these trends, estimations and extrapolations of known nutrient concentrations allow the nutrient enrichment to be estimated. The anthropogenic fraction of the total nutrient input in the NOWPAP seas is estimated to be ?? % for phosphate and ?? % for nitrogen in 1985? In 1992?, it was estimated that riverine inputs of phosphate and nitrogen were still 1.5 to 10 times and 3.5 to 12 times the natural range, respectively.

What about the winter concentration of phosphorus in the past decades: decreased or increased? If it decreased, it can be suggested that phosphorus concentrations can be significantly influenced by human activities. The high nutrient inflow through river discharge alters the N:P:Si (nitrogen:phosphorus:silicate) ratio in coastal waters, which can have an impact on phytoplankton species composition and therefore on the rest of the food web. The extent of the impact of anthropogenic eutrophication on phytoplankton concentrations is not known, since consistent and long time series of parameters - such as chl *a* concentration - from the period before increased anthropogenic nutrient inflow are lacking. Available data on chl *a* concentrations for the period 1975-1991 in the NOWPAP region show or does not show a clear trend (?). In the China (Japan, Korean, Russian) coastal waters an increase in mean annual chl *a* levels has been observed since the mid-seventies (?), while the duration of the blooms seems to have increased (?).

The application of the new Water Framework Directive (WFD) of the European Union to the NOWPAP region will require a dense and frequent monitoring of chl *a* near the coast. Not counting the transitional water bodies located in the vicinity of estuaries, not less than (how many - tbd) coastal water bodies have to be monitored along the coast of the NOWPAP region. All the available data have to be gathered to implement a comprehensive monitoring scheme. To this purpose, the capacity of ocean color imagery to complete the conventional *in situ* data set collected in coastal networks should be evaluated. Satellite-derived chl *a* concentration can be obtained by the application of regional algorithms to water-leaving radiance of the Sea-viewing Wide Field Instrument Sensor (SeaWiFS) for the 1998–2007 period (also Terra MODIS since 1999 and Aqua MODIS since 2002). 10 years of satellite-derived and *in situ* chl-*a* concentrations were compared at many representative stations of different water bodies. These comparisons have shown that the satellite products are reliable in most of the situations studied and throughout the seasons

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OSPAR has developed a harmonized assessment of eutrophication through the **Common Procedure** to identify the regions of the OSPAR Marine Area in which these recommendations apply. This consists of an **Initial Screening Procedure** (a "one-off broadbrush approach") to identify obvious Non-Problem Areas, followed by the application of the **Comprehensive Procedure** to identify whether other waters should be classified as *(Potential) Problem Areas* or *Non-Problem Areas* with respect to eutrophication. The **Comprehensive procedure** is applied as an iterative process, with periodic reassessments and feedback from its application being used to refine the procedure. The screening procedure has been finalized in 2004. The **Comprehensive Procedure (COMPP)** consists of a set of assessment criteria that are linked to form a holistic assessment of eutrophication status (OSPAR Commission 2005-3). It is based on a conceptual framework of the eutrophication process and a checklist of qualitative parameters for a holistic assessment. The conceptual framework and these categories take into account interactions and cause and effect relationships.

In the frame of the OSPAR convention, a set of parameters to determine the eutrophication status was established (Table 1). Classification ***in problem, potential problem or non-problem areas*** is determined by one or more parameters of Categories I and II and/or one or more parameters of Categories III and IV. The degree of nutrient enrichment is measured by the amount of inorganic phosphate and/or nitrogen in winter (DIN and DIP) and the direct effects of nutrient enrichment by maximum and mean chl *a* concentrations.

Table 1: OSPAR Common Assessment Criteria for determination of Eutrophication Status

OSPAR assessment parameters
Category I.
Degree of Nutrient Enrichment
1. Riverine total N and total P inputs and direct discharges (RID) Elevated inputs and/or increased trends (compared with previous years)
2. Winter DIN- and/or DIP concentrations Elevated level(s) (conc >50 % above salinity related and/or region specific background conc.)
3. Increased winter N/P ratio (Redfield N/P = 16) Elevated cf. Redfield (>25)
Category II.
Direct Effects of Nutrient Enrichment (during growing season)
1. Maximum and mean chl *a* concentration Elevated level (defined as concen > 50 % above spatial (offshore) / historical background conc.)
2. Region/area specific phytoplankton indicator species Elevated levels (and increased duration)
3. Macrophytes including macroalgae (region specific) Shift from long-lived to short-lived nuisance species (e.g. *Ulva*)
Category III
Indirect Effects of Nutrient Enrichment (during growing season)
1. Degree of oxygen deficiency Decreased levels (< 2 mg/l: acute toxicity; 2 - 6 mg/l: deficiency)
2. Changes/kills in Zoobenthos and fish kills Kills (in relation to oxygen deficiency and/or toxic algae) Long term changes in zoobenthos biomass and species composition
3. Organic Carbon/Organic Matter Elevated levels (in relation to III.1) (relevant in sedimentation areas)
Category IV Other
Possible Effects of Nutrient Enrichment (during growing season)
1. Algal toxins (DSP/PSP mussel infection events) Incidence (related to II.2)

The disturbance caused by increased nutrient loads in coastal areas may also have an effect on marine ecosystems outside the immediate area. Problems associated with eutrophication are most visibly associated with the development of potentially harmful or nuisance marine algal blooms. These are not always associated with anthropogenic inputs of nutrients and associated eutrophication, but the two are connected.

Phytoplankton supports most of the life in the ocean. However, some phytoplankton species can have deleterious impacts, primarily by producing toxins that are transferred to marine life and to people, by physically damaging or causing dysfunction of vital tissues (e.g., fish gills and skin), and by depletion of oxygen during respiration and decay of dense blooms. Blooms of these species are termed harmful algal blooms (HABs). HABs can be quick events that begin and end within a few days or they may stay for several weeks; they can occur on a relatively small scale or cover hundreds of square kilometers of the ocean's surface and can be mapped from satellites. The excessive growth of algae during a bloom usually causes water discoloration, turning it red to brown or green, depending on the predominant species and it may disrupt higher links of the local food web. Cells that die and sink to the bottom stimulate bacterial growth and deplete oxygen near the bottom layers that can kill fish and other organisms, leading to the eutrophication of the system (Quilliam, 2003). Greater understanding of HABs is prompted not only by their impacts, but also by the apparent global increase in their occurrence. Among the most challenging aspects of eutrophication research is **investigation of the physical oceanography** that influences bloom initiation and development in complex, rapidly changing coastal environments.

The collective experience over the last decade clearly illustrates the urgent need to coordinate efforts to obtain spatially coherent data that can be used by modelers. This will allow for both hindcast synthesis studies as well as nowcasting/forecasting applications. Remote sensing from airplanes and satellites offers the opportunity to detect large-scale changes in the biological properties of the NOWPAP region (e.g. use of color data and fields of physical parameters), to detect changes in coastal areas and to detect and monitor accidental pollution (EEA/UNEP, 1999). Therefore, eutrophication can be an important aspect of these activities. Remote sensing and automatic buoys are recommended among the supplementary techniques for monitoring eutrophication in the framework of the MED POL medium/long term strategy (Document UNEP(DEC)/MED/WG.231/14).

Multidisciplinary, multi-scale in situ and remote sensing observations of the coastal areas and adjacent sea in the NOWPAP region provide a lens through which eutrophication genesis and evolution are viewed and assessment of eutrophication status is performed.

1-2. Objectives of the Draft Procedures

Are the objectives of the Draft Procedures clearly and appropriately described?

1.3. The objectives of the Draft Procedures are to enable each NOWPAP member state:

- to consider applicability of the existing *in situ* and remote sensing monitoring systems for assessment of the status of eutrophication in their respective sea areas;
- to assess the status and impacts of eutrophication in these areas if the existing monitoring activities provide required data/information for this assessment.

The assessment results together with modeling could hopefully then be utilized by each NOWPAP member state for development of countermeasures to decrease the anthropogenic fraction of eutrophication.

Figure 1 schematically shows the concept of the Draft Procedures.

Add: Databases and Observations
Observations are input for modeling (physical, biological).

1-3. Characteristics of the Draft Procedures

1.4. The Draft Procedures was developed based on the following principles:

i) It should be adaptable to various environmental conditions of sea areas in the NOWPAP region.
ii) Remote sensing data should be used in the assessment procedure
iii) Eutrophication status is assessed through a holistic approach by integrating the following eutrophication aspects: degree of nutrient enrichment, direct/indirect effects of nutrient enrichment and other possible effects of nutrient enrichment.

iv) In general, eutrophication status is assessed in relative ways within the whole assessment area.

Are the principles of the Draft Procedures stated from i)-v) appropriate? Please comment if is necessary to add or delete sentences by specifying the reasons.

Remove ii): it is evident that only remote sensing provides the spatial physical and biological data important for eutrophication monitoring.

1-4. Overall structure

1.5. The assessment procedure is broadly separated into six parts, namely:

i) scope of assessment, ii) data processing, iii) setting of assessment criteria, iv) assessment process and results, v) verification of results and vi) conclusion/recommendation.

In the '*scope of assessment'* part, an assessment area, period and parameters are selected.

In the '*data processing*' part, raw data including recent remote sensing data are processed and combined with the existing database (Figure1) into data sets for the assessment.

In the '*setting of assessment criteria*' part, assessment criteria are set.

In the '*assessment process and results*' part, eutrophication status of the assessment area is identified.

In the '*verification of results*' part, the assessment results are reviewed and verified by traditional and new monitoring techniques such as remote sensing and modeling.

In the '*conclusion/recommendation*' part, future measures are suggested with estimates of Costs and Benefits and issues are identified on the basis of the assessment results.

This currently amounts to around 900 hours aerial surveillance at a cost of £500 per hour, together with random satellite images (around 100 per year at £1000 per image) UK

Are the overall structure and the terms used in each part appropriate?

Small corrections are shown by color.

Figure 2 shows the implementation flow of the Draft Procedures.

Verification by remote sensing? and modeling.

2-1. Setting of assessment objective

2.1. State the objectives of the assessment.

2.2. In order to facilitate the understanding of the assessment results, clarify the preconditions and limitations involved in the assessment.

State any scientific uncertainties that future users of the assessment results should take note of, such as:

i) Application of the assessment results for forecasting environmental changes could be inappropriate (forecasting model should be tuned).
ii) The preliminary assessment results may become less reliable/valid when scientific data/information are updated.

Are there any other possible scientific uncertainties that may arise with the assessment results?

iii) Insufficient data (time series is too short or do not cover studied season, long interruption due to weather conditions (gale winds, typhoon passing, amount of precipitation exceeds significantly the average values, etc.).

2-2. Selection of assessment area

2.4. Select an area that can be considered as a single sea area.

2.5. An assessment area should be an area for which there are ongoing environmental monitoring and assessment programs and where eutrophication was earlier observed or amount of nutrients increases.

2.6. An assessment area must be an area for which there are ongoing water quality monitoring and assessment programs and where eutrophication was earlier observed or amount of nutrients increases.

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Are the process and conditions of selecting assessment area appropriate? To combine 2.5 and 2.6?

2-3. Collection of relevant information

2.7. Collect information on the assessment area such as, status of water quality monitoring (locations, frequency, parameters), ocean observations by satellite remote sensing, status of wastewater treatment, status of coastal use (e.g. location of recreational beaches), population of catchment area, land use and industrial activities (e.g. industries that have potential impacts on eutrophication).

Are the listed information appropriate for the assessment?
A list of the main and additional monitoring parameters and a list of satellite-derived parameters should be given, first of all, supporting environmental factors (physical and hydrodynamic aspects and climatic/weather conditions (e.g. flushing, wind, temperature, light)).

Are the listed information available in your country? Yes
Are there any information that should be added, corrected or deleted?
Coastal fishery and aquaculture (quantitative estimates and their dynamic).

2.8. Collect data from organizations that monitor chemical, biological and physical parameters that directly or indirectly relate to eutrophication. The following are some relevant organizations:

i) Organizations that monitor water quality for environmental conservation purposes
ii) Organizations that observe ocean with satellite remote sensing
iii) Organizations that monitor harmful algal blooms for protection of fishery resources
iv) Organizations that monitor shellfish poisoning for food safety
v) Organizations that have other relevant information such as water temperature and salinity, wind, waves, tides and currents.

Are there any organization that should be added or deleted?
2.9. Collect existing survey data/information from the above organizations as in Table 1.

2.10. Select the most appropriate data source for the assessment process in section 5.
2.11. Types of data sources which should not be used for the assessment procedure:

i) Surveys conducted at very limited frequency
ii) Data that are not directly related to eutrophication
iii) Surveys that are not conducted at regular locations and frequency
iv) Surveys that are not conducted for monitoring water quality and aquatic organisms
v) Surveys that employ uncommon analytical methods

Are the conditions stated in i) to v) appropriate?
Conditions stated in i), ii), iii) and v) can be useful especially when there are time series of satellite remote sensing data (images).

2-4. Selection of assessment parameters and data

2-4-1. Categorization of monitored/surveyed parameters

2.12. Categorize all eutrophication related parameters that are monitored/surveyed within the assessment area into one of the following 4 assessment categories:

i) Category I Parameters that indicate degree of nutrient enrichment
ii) Category II Parameters that indicate degree of nutrient enrichment
iii) Category III Parameters that indicate indirect effects of nutrient enrichment
iv) Category IV Parameters that indicate other possible effects of nutrient enrichment

Are the 4 assessment categorizies appropriate?
These categories are appropriate and are in agreement with OSPAR Common Assessment Criteria for determination of Eutrophication Status (see Table 1 above).

2-4-2. Selection of assessment parameters for each assessment category

2.13. After the categorization process, select assessment parameters that are applicable for the assessment procedure on the basis of their data reliability and continuity (e.g. data collected at fixed locations and at regular frequencies). The selected assessment parameters should also have established methods of analysis.
2.14. In principle, all surveyed/monitored parameters related to eutrophication should be selected for the assessment procedure. If certain parameters are to be excluded from the assessment procedures, the reasons must be stated.

2.15. Table 2 shows examples of assessment parameters that are relevant to the 4 categories.
Are the conditions for selecting assessment parameters appropriate?
It is necessary to note the ranges and/or threshold levels (absolute or relative) for such parameters as chl-*a* concentration, Dissolved oxygen (DO), etc. (see Table 1).

2-4-3. Setting of assessment value
2.16. In order to understand the interannual trends of eutrophication, assessment should be basically conducted with annual values.
2.17. Set the assessment values (e.g. annual mean, annual max, annual number of events) to be used for each assessment parameter.
Should the assessment be conducted with annual values? Yes

2-4-4. Selection of data source for the assessment
2.18. Select the data source to be applied for each assessment parameter.
No need to check. Provide comment if any.

2-5. Division of assessment area into sub-areas
2.19. In order to understand and assess the causes and direct/indirect effects of eutrophication at more localized scales, the assessment area may be divided into sub-areas.
2.20. When dividing the assessment area into sub-areas, factors such as location of riverine output and monitoring locations, fishery activities, underwater topography, salinity distribution, ocean/tidal currents and red- tide events should be considered.
Are the listed factors appropriate when dividing the assessment area into sub-areas?
When dividing the assessment area into sub-areas, factors such as location of estuaries and typical values of river discharge, SST and salinity distribution, underwater topography, ocean/tidal currents, fishery activities, location and amount of aquaculture farms, red- tide events and monitoring locations should be considered.

Discussion. Another approach for eutrophication assessment.
There are:

- ground stations that receive satellite ocean color and infrared data
- nowcast/forecast data assimilative models
- coastal surface current radars (in several places) and
- fleet of autonomous underwater vehicles (new technique).

These systems will allow the mean behavior in marine ecosystems to be defined while also *providing real-time data that will allow adaptive sampling*. The ability to adaptively sample the environment will allow scientists to decide ***when, where and what samples*** to collect, to develop the new approaches to measure *critical biological processes and the geographic boundaries of those processes*. This adaptive sampling capability will open an exciting new era for biologists, which, at present, can only gather a limited number of labor-intensive samples.

2-6. Setting of assessment period
2.21. Set the assessment period in accordance with the assessment objectives and availability of reliable data.
Are the considerations required for setting of the assessment period appropriate? Yes.

3. Data processing
3-1. Setting of data processing procedure
3.1. Based on the set assessment values, establish a common data processing method for each assessment parameter. *No need to check. Provide comment if any.*

3-2. Data screening
3.2. Within the selected data source, exclude data that are not suitable for the assessment.
3.3. If data are excluded in the above process, state the reasons for their exclusion. Possible reasons could be related to survey location, data reliability and so on.

Are the data screening conditions appropriate?
Suitable or not suitable for the assessment – should be defined for each data source (selection criteria).

3-3. Sorting data into sub-areas

3.4. If the assessment area is divided into sub-areas, the data used for the assessment of each sub-area should be sorted by the location of survey/monitoring sites.
Are the data sorting conditions appropriate?
Data near the sub-areas boundaries can be used in both subareas taking into account environmental conditions (surface currents, satellite images, evolution of observed surface signatures).

3-4. Data processing of assessment parameters

3.5. Based on the set data processing method, process the collected data.
3.6. In principal, data should be processed by each survey/monitoring site.
3.7. Data sets should be prepared for each assessment parameter and sorted by survey/monitoring site.
Are the data processing methods appropriate?
The optimal version is to get the processed data. Usually each survey/monitoring site carries out data processing. However the monitoring center where all data are gathered should have software to process various raw data.

4-1. Setting of identification criteria for the assessment data

4.2. The eutrophication status of each assessment parameter is assessed by its current status and future trend. The current status and future trend of an assessment parameter are identified by its assessment data with the following identification tools. Combination of these identification tools must be applied for each assessment parameter.
i) Identification by comparison (identifies current status): The eutrophication status is identified by comparing the assessment data with either the value established by environmental standards or background value set by the values measured in an area that have had negligible influence from anthropogenic activities. This identification tool is used for assessment parameters that can be represented in terms of conc. or ratio.
ii) Identification by occurrence (identifies current status): The eutrophication status is identified by occurrence or non-occurrence of events. This identification tool is used for assessment parameters that can be represented in terms of number or frequency of occurrence.
iii) Identification by trend (identifies future trend): The eutrophication status is identified by predicting future trends. This identification tool is used for all parameters.
4.3. The basis behind the set identification criteria must be stated clearly and objectively.
Are the identification criteria for assessment data appropriate? Yes

4-2. Setting of classification criteria for each assessment parameter

4.4. Set the classification criteria of each assessment parameter based on the current status and future trend identified by the combination of the identification tools.
4.5. Table 3 shows an example of identification tools applied to each assessment parameter.
4.6. The proposed classification criteria for each assessment parameter are as follows. The identification result of the current status is classified as either ‘high status’ or ‘low status’, and future trend is classified as ‘decrease trend’, ‘no trend’ or ‘increase trend’. Classification results of the current status and future trend are then integrated and classified into 6 eutrophication groups shown in Table 4. If the assessment parameter can only be assessed by the trend method, the assessment parameter will be classified as either ‘decrease trend’, ‘no trend’ or ‘increase trend’.
4.7. Table 4 shows the classification criteria for the assessment parameter.

4-3. Setting of classification criteria for the assessment category

4.8. Set the classification criteria of each assessment category based on the classification results of the assessment parameters.
4.9. Classify the assessment category by selecting one classification result of the assessment parameters within the assessment category that most appropriately represents the eutrophication status of the area. However, if the classification results among the assessment parameters in the assessment category are

contradictory, and therefore it is unreasonable to select a representative classification result, this assessment category can be excluded from the classification procedure with its reasons stated.
Are the classification criteria for the assessment category appropriate? Yes

4-4. Setting of assessment criteria for the assessment area/sub-area

4.10. Set holistic assessment criteria for the assessment area/sub-area so as to diagnostically explain classification results of each assessment parameter and category.
Are the assessment criteria for the assessment area/sub-area appropriate? Yes

5. Assessment process and results

5.1. The eutrophication status of the assessment area should be assessed, on the basis of the identification results of the assessment data and classification results of each parameter and parameter's categories.
5.2. Identify the eutrophication status of the assessment data of each monitoring site based on the set identification criteria.
5.3. Classify each assessment parameter based on the identification results of the assessment data. If there are multiple monitoring sites in each sub-area, the identification results from all the monitoring sites should be taken into account.
5.4. Classify each assessment category based on the classification results of assessment parameters.
5.5. The eutrophication status of each area/sub-area should be assessed based on the classification results of each assessment parameter and category.
Are the assessment processes to conduce to results appropriate? Yes

6. Verification of results

6.1. The assessment report should have all necessary information required for review.
6.2. Use of remote sensing is recommended for the verification of the assessment results.
No need to check. Provide comment if any.

7. Conclusion and recommendation

7.1. Based on the assessment results, provide recommendations for future actions.
7.2. The results of each classification process should be clearly presented, so that policy makers etc. can consider the most appropriate monitoring or countermeasures against eutrophication.
No need to check. Provide comment if any.

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Review Meeting of MED POL Monitoring Activities and the use of indicators. Athens, 12-14 Decr 2007

APPROACHES TO THE ASSESSMENT OF EUTROPHICATION IN MEDITERRANEAN COASTAL WATERS (FIRST DRAFT) 98 pp

The Comprehensive Procedure (COMPP) consists of a set of assessment criteria that are linked to form a holistic assessment of eutrophication status (OSPAR Commission 2005-3). It is based on a conceptual framework of the eutrophication process (Fig. 6) and a checklist of qualitative parameters for a holistic assessment. The conceptual framework and these categories take into account interactions and cause and effect relationships.
Fig. 6 The Eutrophication Process. Cause-effect relationships (OSPAR, 2002)
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7. CONCLUSIONS AND RECOMMENDATIONS
7.1 Conclusions

Eutrophication is defined as an environmental perturbation caused by an excess in the rate of supply of organic matter as proposed in document UNEP(DEC)/MED WG.231/14.
The information collected from countries through the questionnaire has been analysed. It must be noted, however, that only 14 out of 21 countries have responded.

The conclusions based on the DPSIR approach are:
i. The 14 countries, which responded, designated 72 sites as being eutrophic or at risk to become eutrophic (see Table 4).
ii. Most countries defined nutrient inputs and organic material from domestic sewage due to dense population coastal agglomerations and tourism, as the most important pressure related to coastal eutrophication in most sites.
iii. Riverine inputs of nutrients and organic material as well as diffuse sources related to agriculture and animal husbandry activities are also very important throughout Mediterranean.
iv. A significant part of coastal eutrophication is due to industrial activities, such as food industry, tanneries, chemical industry, textiles, petroleum refineries and shipyards, located in coastal areas and discharging in enclosed sensitive bays, estuaries, etc. both in the North and South Mediterranean.
v. The role of fish and shelfish farming was also pointed out as significant in several cases for coastal nutrient enrichment and pollution.
vi. In some cases port activities were also indicated as related to eutrophication problems.
vii. Most countries use as eutrophication state parameters the nutrients' concentrations (N, P) and in one case salinity and pH.
viii. As impact parameters the chlorophyll-a concentrations are used, dissolved oxygen and in several cases toxic phytoplankton occurrence, toxins in shellfish tissues, mortality of organisms, N/P or even faecal coliforms.
ix. Only some countries reported thresholds for the above parameters. It is not clear whether the other countries neglected to report them or such values have not been defined in the countries. In all cases, no information is provided regarding the methodology used for the calculation of the threshold.
As regards monitoring, it may be concluded that most Mediterranean countries that had reported, undertake classical monitoring activities. However, not all the countries that participated in the eutrophication pilot programs with MED POL assistance followed the MED POL monitoring strategy. The majority followed their national or other strategies.
The main conclusions are that:
i. Most countries do not monitor all parameters required by the MED POL strategy, though in several cases they monitor many more other parameters.
ii. Most countries agree to amend their monitoring strategy to include all MED POL proposed parameters. This is easier for European countries, which due to their obligations to EU directives undertake more detailed monitoring projects.

iii. Most countries have a positive thinking regarding introduction of the new proposed parameters, related to the benthic ecosystem, though many countries have not received that information, before the questionnaire was sent to them. However, macroalgae and benthos along with phytoplankton are at the basis of the ecological status assessment for the classification of coastal waters according to WFD and other policies, conventions, therefore inclusion of these parameters will help not only understanding the system's behaviour and efficiency/status, but also for compliance and harmonization of methods.
iv. Sampling frequency is in most cases seasonal, which is the minimum requirement within MED POL, though it is recommended to perform monthly samplings.
v. Many countries especially from southern Mediterranean coasts stressed the need for more quality assurance exercises.
vi. Considering the on-going activities in Mediterranean coastal waters, the monitoring strategy proposed by MED POL seems to be reasonably applicable with only a small effort by countries. In a number of countries national eutrophication assessment methods are performed. The TRIX index has already been used in some European countries for classification of trophic status, due to its simplicity of application. In the present study data from case studies from Slovenia, Italy, Turkey and Greece were used for testing the TRIX index. Regarding eutrophication assessment methods and the TRIX index the conclusions are:

TRIX (Trophic Index) =(Log(Chla*aD%O*DIN*TP)+ 1.5)/1.2

i. Most European countries have adopted national assessment methods, due to their obligations to EU directives, or to follow assessment methods proposed by conventions such as OSPAR (Spain).
ii. Italy has already fully adopted TRIX, whereas other European countries have only tested it in some case studies (Slovenia, Greece, Cyprus). It seems to work properly, except in the case of Cyprus.
iii. More testing is needed to further evaluate TRIX applicability all over Mediterranean. Southern Mediterranean countries in their majority have not tested TRIX, though they are willing to do so. Also, in many cases they were not familiar with the DPSIR approach.
iv. Eutrophication parameters, reference values and class boundaries are not defined in most cases, even in European countries.
v. It is interesting that all countries that sent information are active in performing even a simple monitoring and assessment activity relevant to eutrophication.

As far as the examined case studies on TRIX are concerned:
i. The use of TRIX Index and the related trophic scale seem to be particularly useful to represent adequately various trophic conditions that may characterise Mediterranean coastal waters.
ii. The examples reported in this study demonstrate that different values assumed by TRIX means, allow discriminating typical oligotrophic coastal environments from eutrophied areas. Consequently, critical situations can be immediately identified, in order to plan and promote the necessary actions of nutrient control and removal, avoiding the harmful effects of eutrophication.
iii. By inspecting the results derived from the case studies, no critical situations (*bad* status) are highlighted, but in some cases the risks associated to the eutrophication are to be considered unacceptable, as e.g. the case of NW Adriatic Sea (Emilia Romagna and Slovenian coasts).
iv. The results refer to the whole regional data set from each case study. Meaning that locally, in these coastal environments, we can surely find evident *mediocre* or *bad* trophic conditions, as in the case of Station MR5 (Mersin Bay), or in Emilia Romagna (Porto Garibaldi transect, close to the Po river mouth) and is not a disadvantage of TRIX to highlight these bad trophic conditions.
v. The adopted approach allows also characterizing coastal environments that show typical low productivity conditions e.g. Saronikos Gulf should be classified in a "good" or "very good" trophic status. Nevertheless, in that area also, by means of TRIX Index we can identify, and compare in quantitative terms, trophic changes that reflect an evident differentiation in nutrients (in particular nitrogen) and chlorophyll average concentrations between on-shore and off-shore sampling stations. Offshore sampling stations seem to represent adequately the natural trophic status of low productivity of the Saronikos Gulf. Although the TRIX average values are not comparable with e.g. those related to NW Adriatic situation, we have to remark that a

further increase in the nutrient concentrations in this gulf, can produce harmful effects on a marine coastal ecosystem that, due to its own nature of oligotrophy, results to be highly vulnerable.
vi. It is obvious from the above that TRIX is an index of trophic status and that its use as an indicator has not yet been fully evaluated or established.

7.2 Recommendations

Obviously the first issue to be stressed is the harmonization of the monitoring strategies and assessment methods on a basin-wide scale. Before that, it is necessary to validate the proposed procedures and the applicability of TRIX in the framework of the MED POL programme, to fully explore its suitability and potentiality. This evaluation must be part of the biological quality assessment of phytoplankton and be complemented with information on frequency and intensity of algal blooms and composition of abundance of taxa. Towards this objective, the organization of training workshops for Mediterranean scientists involved in eutrophication monitoring and assessment, both on TRIX application and laboratory methods (including taxonomy and toxic species identification) is very important for the successful application of the MED POL eutrophication strategy.
As noted above, eutrophication parameters, reference values and class boundaries are not defined in most cases, even in European countries. Therefore, there is an urgent need for all Mediterranean countries (not only European) to participate in exercises, organized within the framework of the MED POL programme, which would aim towards the definition of such values. Since historical data exist in most countries, their assessment for TRIX tests is very important to trigger a stronger support for the long-term MED POL eutrophication strategy. Such an exercise would also help towards the definition of reference and threshold values.

Abbreviation

Aqua
CEARAC
Chemical oxygen demand (COD)
DINRAC
DIN
DIP
DO - Dissolved oxygen
EEA - European Environment Agency
FPM – Focal Point Meeting
HAB - Harmful Algal Bloom
HD - High status and Decrease Trend
HI- High status and Increase Trend
HN - High status and No Trend
I - Increase Trend
ICARM
LD - Low status and Decrease Trend
LI - Low status and Increase Trend
LN - Low status and No Trend
MODIS
N - No Trend
NOWPAP
NPEC
N/P ratio (DIN/DIP)
OSPAR Commission. The term ‘OSPAR Commission’ is used to refer to both the OSPAR Commission and the former Oslo and Paris Commissions. The 1972 Oslo Convention and the 1974 Paris Convention were replaced by the 1992 OSPAR Convention when it entered into force on 25 March 1998
POMRAC
RID - Riverine total N and total P inputs and direct discharges

SeaWiFS -Sea-viewing Wide Field Instrument Sensor
Terra
T-N - total nitrogen
T-P - total phosphorus
UNEP the United Nations Environment Programme
WFD - Water Framework Directive
WG3 – Working Group 3 (
WG4 – Working Group 4 (Remote sensing)

PARCOM recommendation 88/2 deals with the reduction of nutrient inputs by 50 percent from 1985 to 1995 in regions where these inputs may likely, directly or indirectly to cause pollution. PARCOM recommendation 89/4 deals with the set up of national action plans to reach the aims set out in PARCOM Recommendations 88/2.

Then the satellite imagery is used to classify the coastal waters following the eutrophication risk criterion of the WFD. This classification is made according to the percentile-90 of chl-*a* calculated during the productive season, from March to October. Despite a lack of sensor coverage over a small fraction of the near shore waters, this work shows that the satellite monitoring can considerably ease the application of the WFD.

Phytoplankton blooms are events of proliferation of microalgal organisms in an aquatic environment. They can be quick events that begin and end within a few days or they may stay for several weeks; they can occur on a relatively small scale or cover hundreds of square kilo-meters of the ocean's surface. The excessive growth of algae during a bloom usually causes water discoloration, turning it red to brown or green, depending on the predominant species and it may disrupt higher links of the local food web. Cells that die and sink to the bottom stimulate bacterial growth and deplete oxygen near the bottom layers that can kill fish and other organisms, leading to the eutrophication of the system (Quilliam, 2003).
Quilliam, M.A. 2003. The role of analytical chemistry in the hunt for red tide toxins. In: Bates, S.S. (Ed.), Proc. Eighth Canadian Workshop on Harmful Marine Algae. Canadian Technical Report of Fisheries and Aquatic Sciences 2498:xi+141pp.

A second group of optical instruments includes passive sensors that measure irradiance or radiance, and thereby the apparent optical properties (AOPs) of seawater, namely the vertical diffuse attenuation coefficient (*Kd*) and water reflectance (*R*; the ratio of upward radiance or irradiance to downward irradiance) at different wavelengths from the UV to the near-infrared. Because they depend on the sun for illumination rather than on internal optics, AOP sensors cannot measure spectral absorption or scatter directly, or at night. But the attenuation coefficient is strongly a function of absorption, and reflectance depends on the ratio of backscatter to absorption, so the constituents of the water can be retrieved from AOPs. AOP inversion models discriminate phytoplankton from CDOM and non-algal particles, and may even identify pigment-based taxonomic groups if the sensors are hyperspectral (Figures 6 and 7).
One of the most spectacular approaches for AOP measurement is ocean color remote sensing from space. There are now several operational sensors in flight providing global and recurrent coverage, with spatial and spectral resolution that has progressively improved with newer sensors. Ocean color remote sensing has been successfully used, in a limited number of cases, to detect HABs. Current limitations of this technique are related to atmospheric corrections and interpretation of the signal in coastal waters where interference from CDOM and suspended sediment can confound conventional algorithms. The optical signal of chlorophyll *a in vivo* fluorescence, stimulated by sunlight, is another powerful tool for detecting phytoplankton in seawater despite the large variability of the fluorescence quantum yield always observed in the natural environment (Babin, in press).

Many environmental properties must be measured for effective early warning, monitoring, and prediction of blooms progressing along a coast. For early warning, species- or group-level observation technologies are generally necessary (Figures 1 to 4, Figure 6). Once the species forming a bloom is known, and when conditions permit, remote sensing from satellites and aircraft can provide key information on distributions and transport of biomass (Ruddick et al., in press; Stumpf et al., 2003), especially when supplemented by observation networks that include direct sampling, for instance, for microscopic examination (Figure 7) (Johnsen et al., 1997). Even if surface distributions of developed blooms are resolved with remote sensing, early stages and subsurface distributions signatures must be described by other means. In particular, vertical distributions of phytoplankton should be well resolved because the interaction of swimming, sinking, or floating with frontal features, aggregation of seed populations in subsurface layers near the pycnocline, and changes of behavior in mixed waters landward of a front (possibly associated with nutrition) all may be important in initiation, maintenance, and transport of extensive, progressive, coastal blooms (Donaghay and Osborn, 1997; Cowles, 2003). Consequently, for early warning and monitoring, observation systems must resolve vertical distributions of phytoplankton in relationship to temperature, salinity, and currents, and they must have the means to detect target species (and, optimally their toxins) *in situ*. Because nutrient availability can influence toxicity and depletion of nutrients can terminate a bloom, the nutrient regime should also be assessed as part of monitoring and modeling strategies.

Progressive coastal blooms move with coastal currents and can appear or disappear on the time scale of days. Effective monitoring thus requires nearly continuous measurements, and mitigation responses (such as the movement of aquaculture cages) require communications in near-real-time. Strategies for management, such as controls on coastal nutrient loading or site selection for aquaculture, depend on sustained observations over many years to determine the relationships among environmental variability (e.g., climate change), human influences (e.g., nutrient loading), bloom occurrences, and their impacts.

For extensive blooms in open waters, long records that can characterize fundamental changes in both the physicochemical environment and the ecological system, including the frequency, duration, and extent of blooms, are needed for observation and prediction. Predictions could include long-term trends in bloom frequency and yearly projections of probabilities. Except for properties like N:P ratios and deep water salinity and oxygen, periodic surveys are inadequate for developing and testing predictive models because transient and patchy events cannot be resolved. The strategy of continuous sampling from ferries and remote sensing, supplemented with research cruises, appears to be on the right track. Although this does not reach the ideal of continuous and synoptic observations, data obtained through these approaches can be used to describe the variability of phytoplankton with unprecedented temporal and spatial resolution, so the occurrence of HABs can be related directly to environmental forcing, including climate change and nutrient loading from terrestrial sources.

Prediction is the stated objective of most plans for real-time coastal observation systems. It can be defi ned as the estimation of properties that are not observed directly with known certainty (IOC, 2003). This broad defi nition includes hindcasts, nowcasts, and forecasts. The latter two are key products of real-time systems, but their development and evaluation depends on the former. Nowcasts serve as the best possible assessment of current conditions, useful in early warning. Also, as a time series, nowcasts provide a record of environmental change that is richer than a compilation of direct observations alone; this is the future of coastal monitoring (Cullen, in press). Forecasting of HABs, however, is clearly an ultimate goal. All prediction depends on models, which include conceptual descriptions of ecological relationships, statistically based empirical models, and a range of numerical models of varying complexity. For many, the Holy Grail is the coupled, physical-biological, ocean-atmosphere, data assimilative model of coastal dynamics including HABs.

Introduction

It is relatively recent that anthropogenic eutrophication is perceived as a potential threat for the NOWPAP region. CEARAC WG3 and WG4 have decided, in the absence of good scientific information, to develop OSPAR-based procedures for assessment of eutrophication status considering that the obtained assessments will provide arguments to limit or if possible to reduce unnatural change of the coastal ecosystem. OSPAR defines "eutrophication” as the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients. Usually eutrophication does not occur in the open shelf and deep areas of the OSPAR region. However, within the coastal zone, embayment and estuarine areas of some parts of the maritime area, there is clear evidence of eutrophication. Marine and coastal eutrophication is caused by the presence of an excess of nutrients, principally nitrates and phosphates. Unlike freshwaters, nitrate is usually the limiting factor in eutrophic events in marine and coastal systems. The sources of nutrients in marine systems are riverine, atmospheric and direct inputs. OSPAR (2002) identifies that the relative proportions of nitrogen input for riverine, atmospheric and direct inputs are typically in the range of 10:3:1. Addressing marine eutrophication is therefore are restricted to the consideration of marine based activities but also embraces land based activities that result in elevated nutrient concentrations in rivers and direct inputs.

In the NOWPAP region, increased runoff and discharge of nitrogen and phosphate from land since the sixties (?) have caused higher concentrations of these elements in rivers and coastal waters, reaching a maximum in the late eighties and early ninetieth (?). While consistent data sets on nutrient concentrations for the period 1960-1990 are not available to prove these trends, estimations and extrapolations of known nutrient concentrations allow the nutrient enrichment to be estimated. The anthropogenic fraction of the total nutrient input in the NOWPAP seas is estimated to be ?? % for phosphate and ?? % for nitrogen in 1985? In 1992?, it was estimated that riverine inputs of phosphate and nitrogen were still ?? to ?? times and ?? to ?? times the natural range, respectively.

It is necessary to have assessment of the winter concentration of phosphorus in the past decades. If it decreased, it can be suggested that phosphorus concentrations can be significantly influenced by human activities. The high nutrient inflow through river discharge alters the N:P:Si (nitrogen:phosphorus:silicate) ratio in coastal waters, which can have an impact on phytoplankton species composition and therefore on the rest of the food web. The extent of the impact of anthropogenic eutrophication on phytoplankton concentrations is not known, since consistent and long time series of parameters - such as chl *a* concentration - from the period before increased anthropogenic nutrient inflow are lacking. Available data on chl *a* concentrations for the period 1975-1991 in the NOWPAP region does not show a clear trend (?). In the China (Japan, Korean, Russian) coastal waters an increase in mean annual chl *a* levels has been observed since the mid-seventies (?), while the duration of the blooms seems to have increased (?). **Consultations with WG3**.

The application of the new Water Framework Directive (WFD) of the European Union to the NOWPAP region will require a dense and frequent monitoring of chl *a* near the coast. Not counting the transitional water bodies located in the vicinity of estuaries, not less than (how many - tbd) coastal water bodies have to be monitored along the coast of the NOWPAP region.

All the available data have to be gathered to implement a comprehensive monitoring scheme. To this purpose, the capacity of ocean color imagery to complete the conventional *in situ* data set collected in coastal networks should be evaluated. Satellite-derived chl *a* concentration can be obtained by the application of regional algorithms to water-leaving radiance of the Sea-viewing Wide Field Instrument Sensor (SeaWiFS) for the 1998–2007 period (also Terra MODIS since 1999 and Aqua MODIS since 2002). 10 years of satellite-derived and *in situ* chl *a* concentrations were compared at many representative stations of different water bodies. These comparisons have shown that the satellite products are reliable in most of the situations studied and throughout the seasons.

OSPAR has developed a harmonized assessment of eutrophication through the **Common Procedure** to identify the regions of the OSPAR Marine Area in which these recommendations apply. This consists of an **Initial Screening Procedure** (a "one-off broadbrush approach") to identify obvious Non-Problem Areas, followed by the application of the **Comprehensive Procedure** to identify whether other waters should be classified as *(Potential) Problem Areas* or *Non-Problem Areas* with respect to eutrophication. The **Comprehensive procedure** is applied as an iterative process, with periodic reassessments and feedback from its application being used to refine the procedure. The screening procedure has been finalized in 2004. The **Comprehensive Procedure** consists of a set of assessment criteria that are linked to form a holistic assessment of eutrophication status (OSPAR Commission 2005-3). It is based on a conceptual framework of the eutrophication process and a checklist of qualitative parameters for a holistic assessment. The conceptual framework and these categories take into account interactions and cause and effect relationships.

In the frame of the OSPAR convention, a set of parameters to determine the eutrophication status was established (Table 1). Classification ***in problem, potential problem or non-problem areas*** is determined by one or more parameters of Categories I and II and/or one or more parameters of Categories III and IV. The degree of nutrient enrichment is measured by the amount of inorganic phosphate and/or nitrogen in winter (DIN and DIP) and the direct effects of nutrient enrichment by maximum and mean chl *a* concentrations.

Table 1: OSPAR Common Assessment Criteria for determination of Eutrophication Status

OSPAR assessment parameters
Category I.
Degree of Nutrient Enrichment
1. Riverine total N and total P inputs and direct discharges (RID) Elevated inputs and/or increased trends (compared with previous years)
2. Winter DIN- and/or DIP concentrations Elevated level(s) (concentration >50 % above salinity related and/or region specific background concentration)
3. Increased winter N/P ratio (Redfield N/P = 16) Elevated cf. Redfield (>25)
Category II.
Direct Effects of Nutrient Enrichment (during growing season)
1. Maximum and mean chl *a* concentration

Elevated level (defined as concentration > 50 % above spatial (offshore) / historical background concentration)
1. Region/area specific phytoplankton indicator species Elevated levels (and increased duration)
2. Macrophytes including macroalgae (region specific) Shift from long-lived to short-lived nuisance species (e.g. *Ulva*)
Category III
Indirect Effects of Nutrient Enrichment (during growing season)
1. Degree of oxygen deficiency Decreased levels (< 2 mg/l: acute toxicity; 2 - 6 mg/l: deficiency)
2. Changes/kills in zoobenthos and fish kills Kills (in relation to oxygen deficiency and/or toxic algae) Long term changes in zoobenthos biomass and species composition
3. Organic Carbon/Organic Matter Elevated levels (in relation to III.1) (relevant in sedimentation areas)
Category IV Other
Possible Effects of Nutrient Enrichment (during growing season)
1. Algal toxins (DSP/PSP mussel infection events) Incidence (related to II.2)

The disturbance caused by increased nutrient loads in coastal areas may also have an effect on marine ecosystems outside the immediate area. Problems associated with eutrophication are most visibly associated with the development of potentially harmful or nuisance marine algal blooms. These are not always associated with anthropogenic inputs of nutrients and associated eutrophication, but the two are connected.

Phytoplankton supports most of the life in the ocean. However, some phytoplankton species can have deleterious impacts, primarily by producing toxins that are transferred to marine life and to people, by physically damaging or causing dysfunction of vital tissues (e.g., fish gills and skin), and by depletion of oxygen during respiration and decay of dense blooms. Blooms of these species are termed harmful algal blooms (HABs). HABs can be quick events that begin and end within a few days or they may stay for several weeks; they can occur on a relatively small scale or cover hundreds of square kilometers of the ocean's surface and thus can be mapped from satellites. The excessive growth of algae during a bloom usually causes water discoloration, turning it red to brown or green, depending on the predominant species and it may disrupt higher links of the local food web. Cells that die and sink to the bottom stimulate bacterial growth and deplete oxygen near the bottom layers that can kill fish and other organisms, leading to the eutrophication of the system (Quilliam, 2003). Greater understanding of HABs is prompted not only by their impacts, but also by the apparent global increase in their occurrence. Among the most challenging aspects of eutrophication research is **investigation of the physical oceanography** that influences bloom initiation and development in complex, rapidly changing coastal environments.

The collective experience over the last decade clearly illustrates the urgent need to coordinate efforts to obtain spatially coherent data that can be used by modelers. This will allow for both hindcast synthesis studies as well as nowcasting/forecasting applications. Remote sensing from airplanes and satellites offers the opportunity to detect large-scale changes in the biological properties of the NOWPAP region (e.g. use of color data and fields of physical parameters), to detect changes in coastal areas and to detect and monitor accidental pollution (EEA/UNEP, 1999). Therefore, eutrophication can be an important aspect of these activities. Remote sensing and automatic buoys are recommended among the supplementary techniques for monitoring eutrophication in the framework of the MED POL medium/long term strategy (Document UNEP(DEC)/MED/WG.231/14).

Multidisciplinary, multi-scale in situ and remote sensing observations of the coastal areas and adjacent sea in the NOWPAP region provide a lens through which eutrophication genesis and evolution are viewed and assessment of eutrophication status is performed.