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Proceedings of the First Coastal Environmental Assessment Workshop
7 March 2008 Toyama, Japan
Northwest Pacific Regional Environmental Cooperation Center

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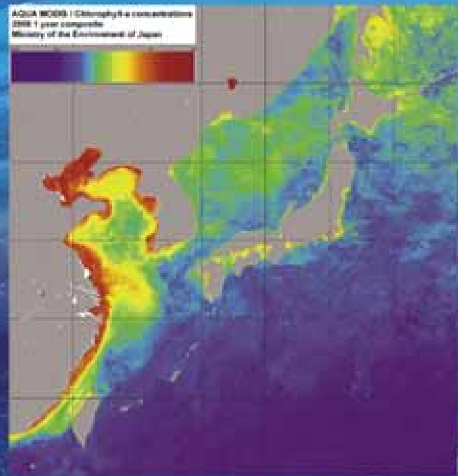

Organized by
Northwest Pacific Regional Environmental Cooperation Center

Participating Organizations

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Supported by:

The Japanese Society of Fisheries Science

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NOWPAP RCU

The Oceanographic Society of Japan

The Remote Sensing Society of Japan

Toyama Prefecture

Toyama City

Yellow Sea Large Marine Ecosystem Project
in collaboration with the Yellow Sea Partnership

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Keynote Speech

Toward the Establishment of the Regular Process for Regional and Global Marine Assessments

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1. Introduction

Marine and coastal ecosystems are amongst the most productive ecosystems in the world, providing a rich array of goods and services to human society. Their health and effective functioning are essential for human well-being and broad planetary life-support systems. Yet many of these ecosystems have become increasingly degraded. There is, though, a great deal of concern across the world as to how the goods and services that we depend on can be utilized in a sustainable manner. In light of this, the United Nations (UN) General Assembly in 2005 endorsed the need for a regular process for global reporting and assessment of the state of the marine environment, including socio-economic aspects, both current and foreseeable, and that the Regular Process should be built on existing regional mechanisms.

In November 2005, the UN General Assembly at the 60th session on Oceans and the Law of the Sea [Resolution60/30] further decided to launch the start-up phase, the Assessment of Assessments, to be completed within two years, as a preparatory stage toward the establishment of the Regular Process. It also established an organizational arrangement, including an Ad Hoc Steering Group (AHSG) to oversee its execution, two UN agencies, UNEP and UNESCO-IOC, to jointly lead the process, and a Group of Experts to undertake the Assessment of Assessments.

The first meeting of the AHSG was held in June 2006, reviewed the report of the updated survey on regional and global marine assessments prepared by UNEP-WCMC, and considered the nature, aims and expected accomplishments of the Assessment of Assessments. It recommended that the Group of Experts should undertake a critical analysis of the existing assessments in order to assess their scientific credibility, and their policy relevance, legitimacy and usefulness, in particular by identifying: (a) Best practices and approaches; (b) Thematic and geographic assessment gaps and needs; (c) Uncertainties in scientific knowledge, data gaps and research needs; (d) Networking and capacity-building needs in developing countries and countries with economies in transition; and (e) A framework and options for the Regular Process, based upon current relevant assessment process and practices.

The Group of Experts approved by the AHSG held the first meeting in March 2007, and discussed and developed the overall working approach of the Assessment of Assessments. They also agreed on a schedule of activities from 2007 up to the completion of the start-up phase in mid-2009. At the end of its work, the Group of Experts intended to be produced a report to be structured around: (a) A state-of-the assessment landscape for oceans and coasts; (b) An evaluation of existing assessments; and (c) A possible institutional framework, capacity-building, cost analysis etc. for the Regular Process. In accordance with its terms of reference, the Group of Experts is aiming to develop guidelines and methodologies and to identify best practices as to how a regular assessment should be conducted.

Although the Assessment of Assessments is still in progress, I would like to review some reports of the preliminary survey conducted in the Assessment and Assessments, and consider the elements of effective assessment of marine environment at a regional and global level. Looking at the recognized gaps in geographic and thematic coverage, etc. and newly emerging issues, future perspectives on the regional and global marine assessment are also discussed in relation to the procedure for the establishment of marine environmental assessment in the NOWPAP region.

2. Elements of effective assessment of the marine environment

An assessment of marine environment is generally taken to be a scientific evaluation of an aspect of the marine ecosystem/environment. It could also include socio-economic aspects such as interactions between stakeholders and the marine environment through such as activities as tourism, diving and fisheries. An assessment with a regular process is characterized by repeating the assessment methodology through time to detect changes.

Effective provision for the following considerations is necessary to ensure the scientific credibility, usefulness, legitimacy and policy relevance of the assessment. First, in the pre-assessment stage, it is necessary to agree clearly on (a) objectives and scope, (b) geographic coverage, (c) target audience, (d) outputs/products, (e) organization, (f) budget and funding, and (g) review and evaluation of the effectiveness. The objectives of the assessment may be structured, for example, to provide an overview of the current condition of marine ecosystems and resources, identifying any apparent patterns and trends, to identify the nature, extent and severity of marine environmental degradation, its causes and its implications for human health and socio-economic welfare, and to advise policy makers and stakeholders on response options that may reduce or reverse marine environmental degradation.

In the post-assessment stage, on the other hand, the following should be undertaken: (a) communications with target audience, (b) Ensuring the availability of reports/data, (c) Follow-up review and evaluation of the effectiveness, and (d) Evaluation of the effectiveness of any response measures subsequently adopted by decision makers.

In addition, the effective assessment on a regular basis will require adequate information to assess the current status of ecosystems regionally and globally, and also to detect, assess and evaluate trends in important environmental features. However, information deficiencies have been the major constraints particularly on global marine assessments undertaken to date. Points that will need consideration with regard to this are: (a) Geographic and thematic gaps in the information base, (b) Degree of confidence in the available data (quality requirements), (c) Methodology used for data collection and analysis. In order to accurately measure and predict trends, data needed have to have been collected over a reasonable time frame using a consistent, standardized, repeatable methodology, in a program designed to allow appropriate statistical analysis. The nature and extent of natural variability also need to be properly identified in relation to the trends.

Regarding the geographic and thematic coverage, it is important at the regional level to take into account trans-boundary issues and problems and to reflect the relative importance of particular threats and impacts at that level. At the global level, the design of the assessment can promote a framework for regional assessments that facilitates comparability and a global synthesis. A broad global assessment can encompass an overview of regional conditions, threats, impacts and response measures, and the assessment of global phenomena like the effects of climate change.

It is also critical that the actual procedures used in the assessments are clearly described in the documentation to allow for future evaluation and to facilitate comparison between assessments. The use of established assessment methodologies for sampling, data collection, statistical analysis and modeling procedures, data storage and reporting, should be subject to regular updating and quality control as best assessment practices evolve.

Sustainable funding is another critical issue for the repeatability and therefore sustainability of the assessment implementation. Outreach activities and capacity-building initiatives must be funded as well for a successful regional and global marine assessment. Participation in such assessment processes is in itself a form of capacity-building, which contributes to broader international understanding and consensus-building on problem definition and responses.

3. Recognized gaps in the existing assessments and newly emerging issues

(1) Geographic coverage gaps: Recent reports on the existing regional and global assessments and related activities of the marine environment, prepared by UNEP, UNESCO-IOC and UNEP-WCMC (hereafter UNEP reports), have pointed out that the seas within and around Europe (Mediterranean, East Atlantic, Baltic and North Sea) as well as the Northern Atlantic and the polar regions (Arctic and Antarctic Ocean) exhibit the highest abundance of assessments

undertaken, while the high seas and seas beyond national jurisdiction, deep/open oceans, and the oceans of the southern hemisphere (except the Antarctic Ocean) still exhibit a low abundance of environmental monitoring and assessments. The interactions between marine and freshwater systems are an area of growing discussion in the international community. It would be expected that increased awareness of these issues will stimulate the request for continued assessment and understanding of these linkages. Less is known about the impacts of groundwater and aquifers, and these remain as a gap in assessments.

(2) Thematic coverage gaps: Assessments can be broad-based, covering a range of issues, or can be more limited (thematic). Relatively few of the world's marine areas have been subject to broad-based assessment, while a range of thematic assessments either completed, underway or planned are apparently limited in both temporal and spatial coverage. The thematic assessments focus, for example, on particular features such as fisheries, biodiversity or specialized habitats. It is of vital importance to draw attention to the links between issues, e.g. sewage inputs and biodiversity changes, or coastal erosion and habitat destruction. Existing activities included in the UNEP reports do not appear to cover assessment of benthic habitats at the global level. Further, most of the existing activities considered the status of the marine environment, while it seemed to be difficult to obtain the data with appropriate quality to identify long-term trends. Recognizing the needs to detect and predict trends in environmental conditions, and the fact that trends are seldom detectable without time-series datasets, it is of urgent requirement to initiate trend-monitoring of key parameters such as loss of critical habitats, sediment quality, incidence of harmful algal blooms and land-based inputs of contaminants. Clearly, the sooner time-series measurements are initiated, the sooner trends will become discernible.

(3) Methodological gaps: According to the UNEP reports, consideration of the units of assessment for the marine environment is of critical importance. There is wide variation in the assessment units, and research into new methods for devising assessment units through the use of adaptive algorithms is necessary. It should also be noted that just 8 per cent of the activities included in the reports produced spatial data in the form of maps, and that only a few per cent undertook modeling to consider future scenarios. Experts were widely used in assessment processes, particularly where data/information was limited, and were engaged in different ways, whether as a peer-review mechanism, in interpretation of secondary data, or through working groups, scientific committees or advisory boards.

(4) Emerging issues: The latest years have led to massive developments in understanding deep-sea environments and habitat diversity, leading to an urgent call for conservation and sustainable use of these ecosystems. The need to look at ecosystem-wide interactions, and interactions between the land, ocean and atmosphere to better understanding the marine

environment is another emerging issue identified in the UNEP reports. Further, the impact of lowering pH of the oceans as a result of increasing atmospheric CO_2 and the additional impact of carbon sequestration in the oceans both require action initiation on the part of the global community. Taking into account the actual and potential effects of climate change on marine environment, there is a growing realization that trend-monitoring programs should include climate change indicators such as sea surface temperature, current patterns, sea level and shifts in the ranges of marine species. The difficulties of trend-monitoring may be greatly increased by shifting baselines driven by climatic factors.

The Assessment of Assessments will need to consider ways in which critical information gaps might be filled. It must be, therefore, a key question: how will the Regular Process deal with the recognized existing knowledge gaps and especially with emerging issues mentioned above, so that the international community can address these concerns in a timely and effective manner?

4. Future perspectives

Referring to the suggestions from the UNEP reports, the followings should be considered in the future for developing the appropriate procedure of marine environmental assessment in the NOWPAP region.

(1) Precise questions about the condition of marine features and processes in the NOWPAP region to promote the generation of relevant data and information.

(2) A way to promote the application of the ecosystem approach in marine environmental assessments. From this viewpoint, consideration could be given to investigating processes identifying assessment units delimited by natural processes in the NOWPAP region.

(3) Establishment of the database/meta-database as an ongoing tool for assessment and development of a data quality-control mechanism. The database should be updated on a regular basis to ensure that accurate and timely information is available for the assessment. There will be a need for improved data availability in the future, and to achieve this, a greater mobilization of effort by all sectors of the NOWPAP community interested in the marine environment will be required.

(4) Internationally accepted procedures and methodologies used in the assessment. Outreach activities such as published reports/newsletters, website and international conferences, and activities for capacity-building such as fostering collaboration, training workshops and educational cruises, will be effective for filling the methodological gaps.

Further, for developing the assessment procedure in the NOWPAP region, it may be useful to consider the following questions in more depth: (a) How data that is routinely collected by international bodies could contribute to the reporting and assessment of the state of marine environment in the NOWPAP region on a regular basis; (b) How existing datasets in the NOWPAP region might be better utilized in the regional assessment; (c) How existing assessments of varying geographical coverage and thematic scope in the NOWPAP region can be integrated into the regional assessment, and how to identify linkages between issues and regions; (d) How to identify priority themes and issues that represent common, serious problems around the NOWPAP region, requiring further data collection and assessment on the status and trends; (e) How specific needs for capacity-building to support the areas of severely limited capacity to generate data for assessments can be met, with human and financial resources, including training and the provision of essential equipment and facilities.

In the second part of the Assessment of Assessments, the Group of Experts will discuss in more detail how to identify the best practices and approaches from the existing assessments in the 21 tentatively selected regions for the Assessment of Assessments. Several considerations in establishing an assessment process, such as defining objectives, organization, outputs and provision for review and evaluation, will be given. The outcomes of the Group of Experts may greatly contribute to the development of the appropriate procedure for marine environmental assessment in the NOWPAP region.

FUTURE, a new science program for PICES

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Session 1

CEARAC activities for the 2008-2009 biennium

Workplan of CEARAC for the 2008-2009 biennium

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1. Background

CEARAC has been working on monitoring and assessing Harmful Algal Blooms (HABs) under Working Group 3 (WG3), and developing new monitoring tools using Remote Sensing (RS) under Working Group 4 (WG4).

WG3 published National Reports and Integrated Report on HABs, Booklet of Countermeasures against HABs and *Cochlodinium* Pamphlet (in English and NOWPAP members' languages), and established HAB Reference Database and *Cochlodinium* Website in the past.

WG4 published National Reports and Integrated Report on Ocean RS and Eutrophication Monitoring Guidelines by RS, and established Ocean Remote Sensing Portal Site and Website on Oil Spill Monitoring. It also organized the first NEAR-GOOS-NOWPAP Joint Training Course on Remote Sensing Data Analysis.

To promote coastal environment assessment with HAB as an indicator and further utilization of remote sensing data for coastal zone eutrophication monitoring, CEARAC implements new activities in the 2008-2009 biennium.

2. New activities in the 2008-2009 biennium

In the 2008-2009 biennium, NOWPAP WG3 and WG4 will start the following new activities:

1. Implementation of HAB Case Studies;
2. Development of HAB Integrated Website;
3. Development of educational materials for utilization of remote sensing data for marine environment conservation;
4. Organization of the second NOWPAP training course on remote sensing data analysis; and
5. Development of procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP region

2.1 Implementation of HAB case studies

CEARAC will implement HAB case studies in each member state to establish the most effective and laborsaving way for sharing information on HAB occurrence and oceanographic and meteorological conditions.

The reports of HAB case studies will be published by the end of 2008 and the information in the reports will be shared among not only NOWPAP members but also other international organizations. In these reports, common concerned issues on HAB in the NOWPAP region will be summarized. These reports will be updated in 2009 by adding latest information, and CEARAC will establish the most effective and laborsaving way for updating information.

2.2 Development of HAB integrated website

CEARAC will develop a website to provide and share information on HAB-related issues in order to enhance activities against HAB in the NOWPAP region. Through this website, existing achievements and information of WG3 such as National and Integrated reports on HABs, countermeasures against HABs and will be provided as well as *Cochlodinium* website. Also, based on HAB case studies, its database will be incorporated into this website.

CEARAC will disseminate useful information on HABs in cooperation with other HAB-related websites. This website will start its operation officially by the end of 2009.

2.3 Development of educational materials for utilization of remote sensing data for marine environment conservation

CEARAC will develop educational materials for students, young researchers and coastal managers in the NOWPAP region to support their further utilization of "Eutrophication Monitoring Guidelines by Remote Sensing for the NOWPAP Region" and remote sensing data for marine environment conservation.

The materials consist of guidance on acquisition, analysis and assessment of remote sensing data for the marine environment depending on the purpose of data use. The materials will be disclosed on CEARAC website for wider dissemination.

2.4 Organization of the second NOWPAP training course on remote sensing data analysis

CEARAC will conduct the second NOWPAP training course on remote sensing data analysis for students, young researchers and coastal managers to obtain useful skills and knowledge to utilize remote sensing data in monitoring and assessment of marine environment.

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

As a joint activity between NOWPAP WG3 and WG4, CEARAC will develop 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, which can be shared among the NOWPAP member states, based on lessons learned from a pilot study conducted in Toyama Bay.

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.

Preparation of the draft procedures for the assessment of eutrophication for the NOWPAP region -A case study in Toyama Bay-

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Introduction

Northwest Pacific Region Environmental Cooperation Center (NPEC) has been preparing the procedures for the assessment of eutophication for the NOWPAP region based on the lessons learned from a case study conducted in Toyama Bay, in order to support activities of NOWPAP CEARAC.

The interim progress of the preparation is explained as follows.

Objective

Objective of this case study is to help develop useful procedures for NOWPAP member states to be able to assess eutrophication status (nutrient enrichment, HAB occurrence, and other direct and indirect effects from nutrient enrichment) by utilizing remote sensing techniques.

Methodology of the case study

Selecting Toyama Bay as an area of case study, basic structures and tentative procedures were prepared with the Common Procedure for the Identification of the Eutrophication Status of the Maritime Area adotped by OSPAR Commission as a reference. Along with the tentative procedures, the followings were conducted.

The area of the assessment was divided into 5 sub-areas, with considering the monitoring area of existing survey; in order to understand and assess the causes of eutrophication at more localized scales.

Relevant information and historical data of the assessment area, such as status of water quality monitoring (monitoring locations, frequency, parameters), were collected with the support of the Toyama Prefectural government, Toyama Prefectural Environmental Science Research Center and Toyama Prefectural Fisheries Research Institute.

Environmental parameters for the case study were selected from the collected information and data, and then sorted into 4 groups (Table.1) by the effect to eutrophicaiton process for the assessment of eutrophcation. Each parameter was classified based on the identification tools defined by different methods, namely comparison, occurrence and trend methods. Then, the assessment was conducted for each parameter, parameters category and area/sub-area with the incorporated data sets that were created in a common format for ease of implementation of the procedure.

Table.1. Categorized environmental parameters used in the case study of Toyama Bay.

Category	Description	Parameters
I	Parameters that indicate degree of nutrient enrichment	Nutrients load (N/P and river discharge)
		Nutrients concentration in winter (DIN、DIP)
		N/P ratio in winter
		TN and TP
II	Parameters that indicate direct effects of nutrient enrichment	Chlorophyll-a concentration (ship)
		Chlorophyll-a concentration (satellite)
		Number of red tide occurrence
III	Parameters that indicate indirect effects of nutrient enrichment	Dissolved oxygen
		Change of bentos and kills
		Fish kill
		COD
IV	Parameter that indicate other possible effects of nutrient enrichment	Shellfish poison

Verification of the results of the case study by remote sensing

Obtained results of assessment were verified by remote sensing. Characteristics of the location of existing water sampling points and divided sub-areas were studied by chlorophyll-a concentration data derived from satellite.

Output of the case study

NPEC will develop the draft procedures for the assessment of eutrophication status for the NOWPAP region. The developed procedures by NPEC will be reviewed and refined by the NOWPAP member states and shared as common procedures for the assessment of eutrophication status of the NOWPAP region.

Session 2

Current situations with coastal environmental monitoring in the NOWPAP member states

Eutrophication in the Yangtze River Estuary and Mitigation of Harmful Algal Blooms

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1. Introduction

As the economical developments and human activities increase, coastal eutrophication is getting more and more serious and quickly becoming an important marine environmental issue in the world. Yangtse River estuary is the biggest estuary in China, and it is also the most serious in eutrophication. Long term of eutrophication resulted in the changes in the function and structure of ecological system in the waters, characterized especially by the frequent outbreaks of harmful algal bloom (HAB). The study on eutrophication in the Yangtze River estuary and mitigation of harmful algal blooms (HAB) is introduced in the presentation. Based on the seasonal cruises, the eutrophication in the estuary and its adjacent waters was assessed. The formation mechanism of eutrophication in the estuary was also discussed. In addition, an effective method of HAB mitigation by means of modified clays was proposed with some successful applications.

2. Method

Eutrophication investigation: Seasonal cruises were done since 2003 on 40 survey stations in waters of 121.0°E~123.5°E、30.5°N~32.0°N. Related physical and chemical factors (T, salinity, pH, NO_3-N, NH_4-N, NO_2-N, PO_4-P, SiO_3-Si, TN, TP, DO, SS etc.), biological parameters (chl.*a*, phytoplankton, community structure, etc.), nutrient distribution and characteristic, as well as relationship among them were studied. The status and characteristics of eutrophication in the waters were assessed systematically. The influences of discharge from Yangtze river, the turbidity maximum, upwelling, atmospheric wet deposition and biological influence, on eutrophication in the waters were discussed.

HAB mitigation: Surface modification of clay was done by means of adsorption or insertion to improve the lower flocculation of original clay with HAB cells. The mitigation of HAB was practiced successfully both in coastal waters and lake waters by the modified clay method. The water quality (DO, pH, COD, transparency, Eh, TSI, TN, TP, nutrients, chl.*a*, phytoplankton, zooplankton, benthon and bacteria etc.) was monitored with no evidence of any negative impact on ecological environment.

3. Results

(1) Long term change of nutrients in Yangtze river estuary

Based on the previous data, some obvious changes were found in the concentration and ratio of nutrients in the Yangtze river estuary during the past few decades. The concentration of nitrate increased three times from 1960s to 2000s. Phosphate and silicate increased respectively 0.6 and 0.5 time from 1980s to 2000s. The N/P ratio increased from around 30 in 1960s up to around 100 in 2000s, steering far away from the Redfield ratio. Rapid increase of nitrogen in the waters is the major reason of eutrophication in Yangtze river estuary.

(2) Status and characteristics of eutrophication in Yangtze river estuary

Distribution of nutrients and COD in Yangtze river estuary was characterized by high values of nutrient and COD near the coast , with COD values that exceed 4.0 mg•L-1 in serious areas. The concentrations of nutrients in turbidity maximum zone were obviously higher than other areas. The higher values of chl.*a* was found in the east and north of investigated waters. There was also a larger anoxic zone where DO was lower than $2mg \cdot L^{-1}$ in spring and summer seasons in the south east of investigated waters. Most stations within salinity 20 were assessed as high level of eutrophication.

(3) Eutrophication model in Yangtze river estuary

According to hydrodynamic and ecological processes in Yangtze river estuary, the nutrient transportation and hydrodynamic-chemistry-biology coupled models in the waters were built based on POM and NPDZ models.

(4) Mitigation of harmful algal blooms by modified clays

Surface modification of clay can obviously improve the capability of original clay to flocculate HAB cells. In 2005 and 2007, modified clay was successfully applied in the control of lake HAB and coastal HAB. The monitoring results showed that the average removal rate of HAB cells was more than 90% and that the coagulated cells were decomposed gradually. The quality of waters had shown significant improvement. The community structure of phytoplankton was changed. There was no fact showing any negative impact of the control method on ecologic environment of the waters, such as the presence of dead fish, shrimp or water plants.

4. Discussion

Eutrophication in the Yangtze River Estuary: Yangtse River estuary is the biggest estuary in China, and it is also the most serious coastal waters in eutrophication. According to the long term change of nutrients in the waters, the evolution of eutrophication in Yangtse River estuary is considered to be associated with terrestrial human activities. For example, amount of nitrogen fertilizer used in the area along Yangtse River increased 15 times from 1960' to 1990's. Another study has demonstrated that the nitrogen concentration in the river is positively related with the amount of N fertilizer used. The eutrophication in Yangtze river estuary is just characterized by high concentration of nitrate. In addition, the effect of discharge from Yangtze river on eutrophication is also demonstrated by that most survey stations within salinity 20 were assessed as high level of eutrophication. Therefore, human activities should be an important cause of eutrophication in the waters.

Mitigation of harmful algal blooms by modified clays: The high removal capability of modified clay are attributed to three factors, 1. the change in electrostatic interaction between clay particles and HAB dells; 2. increase in the Van der Waals interaction between clay particles and HAB dells; 3. inhibition of cell movement capability by some modified compound. In addition, modified clay can not only control HAB by flocculating organism cells down to the bottom of waters, but also can improve water quality such as by increasing transparency, DO and by decreasing toxin, pH, COD, TSI, Eh, TP, TN and NH_4 by the unique adsorption property of modified clays. Generally, the biggest concern for a mitigation method is its impact on ecologic structure. The modified clay method was successfully proven to be helpful in the reestablishment of a normal ecology system.

5. Acknowledgement

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6. References

Chao Chai, Zhiming Yu, Xiuxian Song, Xihua Cao, 2006, The status and characteristics of eutrophication in the Yangtze River (Changjiang) Estuary and the adjacent East China Sea, China, *Hydrobiologia*, 563:313-328.

Shen Zhiliang, Zhou Shuqing, Pei Shaofeng, 2008, Transfer and transport of phosphorus and silica in the turbidity maximum Zone of Changjiang estuary, *Estuarine, Coastal and Shelf Science*, in press.

Liu Hao, Yin Baoshu, 2007, Annual cycle of carbon, nitrogen and phosphorus in the Bohai Sea: a model study, *Continental Shelf Research*, 27:1399-1407.

Zhiming Yu, Mario R. Sengco and Donald M. Anderson, 2004, Flocculation and removal of the brown-tide organism, *Aureococcus anophagefferens* (Chrysophyceae), using clays, *Journal of Applied Phycology*, 16:101-110.

Yu Zhiming, Sun Xiaoxia, Song Xiuxian and Zhang Bo, 1999, Clay surfaces modification and its coagulation of red tide organisms, *Chinese Science Bulletin*, 44(7): 617-620.

Change and Variation of Satellite Chlorophyll in the East China Sea and Yellow Sea over 10 Years

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1. Introduction

Recently red tides are frequently reported around the East China Sea coast, and large number of giant jerry fish is caught along the Japan Sea coast. Furthermore, Changjiang River, one of the largest rivers in the world, discharging to the East China Sea, has been eutrophicated, and construction of the Three Gorge Dam is now almost completed and starting the operation. It is expected that the ecosystems of the East China Sea and Yellow Sea are changing. Ocean color satellite is a new technology to monitor ocean environments, including biomass of phytoplankton which is the major primary producer of the organic matter. In this study, we use 10 years time series of Sea-viewing-Wide-Field-of-view Sensor (SeaWiFS) to understand how phytoplankton dynamics in the East China Sea is related to the Changjiang River and to examine possible changes caused by the eutrophication and the dam construction.

2. Method

SeaWiFS chlorophyll-a data (level-3 standard mapped data reprocessed in July 2007) from 1998 to 2007 was obtained from NASA Ocean Color Homepage. Salinity data in the East China Sea was obtained from Korean Oceanographic Data Center. Discharge amount of Changjiang River was supplied by J. Zhu (personal communication).

3. Result

It is known that discharge of Changjiang River is large during summer. High satellite chlorophyll-a distribution was extended from the mouth of Changjiang River to east toward the Jeju Island during summer, and the distribution in August well corresponded to the distribution of low salinity water, known as Changjiang Diluted Water (Fig. 1). This indicates that the satellite chlorophyll-a can be used as the tracer of the Changjiang Diluted Water. The distribution significantly different yeas by year, and it was expected that the amount of Changjiang River discharge influences the areal extension. When the discharge of Changjiang River was high, areal extension became larger after 1-2 month of the discharge.

Seasonal changes of satellite chlorophyll-a indicated that summer peak of satellite chlorophyll-a was observed between the mouth of Changjiang and Jeju Island and that the peak timing was June for near Chinese coast to September around Jeju Island (Fig. 2). Peaks of satellite chlorophyll-a were observed in May, and they are expected to be spring bloom. Normalizing water leaving radiance at 555 nm, nLw(555), which is the indicator of turbidity, was high around the coast and on the Changjiang Hillock, especially during winter when the water was well mixed. The higher satellite chlorophyll-a coincided with the high nLw(555) may be caused by the overestimation of satellite chlorophyll-a with the problem of satellite data processing.

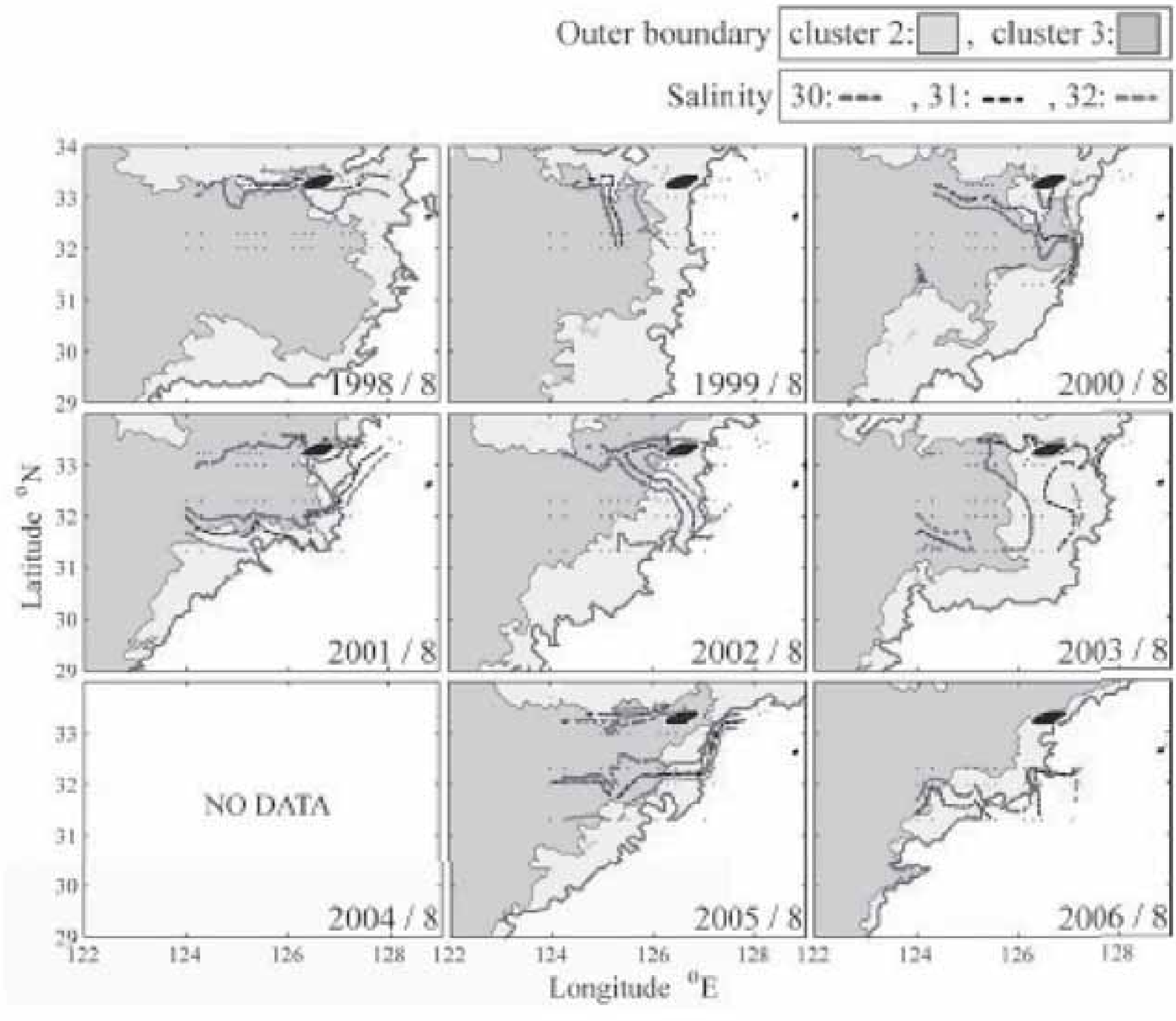

Figure 1. Distributions of salinity and satellite chlorophyll-a during August from 1998 to 2006. Satellite chlorophyll-a concentration was >0.42 and >0.92 mg m^{-3} for cluster 2 and 3, respectively.

Interannual variability of satellite chlorophyll-a during summer was well corresponded with the interannual variability of Changjiang river discharge in the area where summer peak was observed. This further indicated that the satellite chlorophyll-a was influenced by the Changjiang river discharge. On the other hand, in the middle of Yellow Sea where the summer peak was not observed, satellite chlorophyll-a concentration increased gradually from 1997 to 2006. This might be indicated the eutrophication of the Yellow Sea.

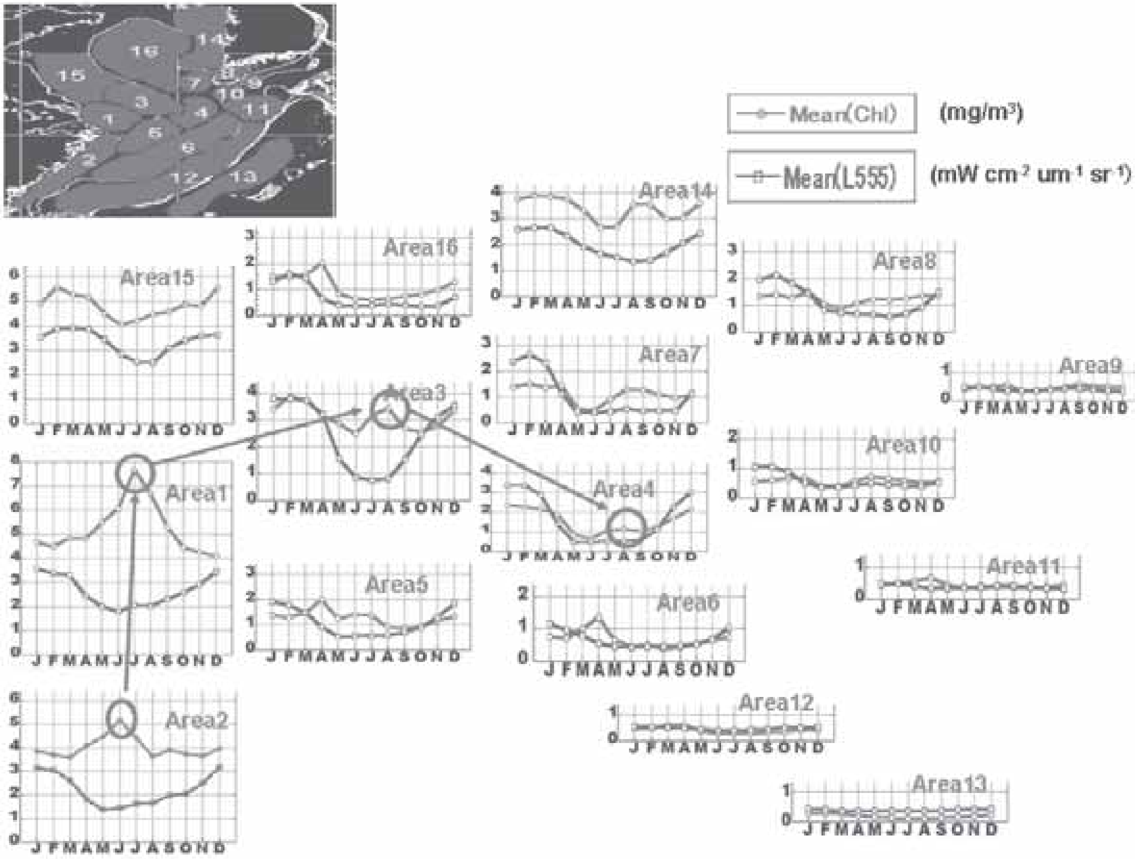

Figure 2. Seasonal change of satellite chlorophyll-a (Chl) and nLw(555) (L555) in 16 different area of the East China Sea and Yellow Sea. Arrows indicates the possible transport of Changjiang Diluted Water.

4. Discussion

Satellite chlorophyll-a data during 10 years indicated that 1) the areal extension of high satellite chlorophyll-a corresponded to the distribution of Changjiang Diluted Water, 2) the Changjiang Dilluted water reached around Jeju Island with 1-2 months after the discharge, 3) interannual variability of the areal coverage of the high satellite chlorophyll-a and the concentration well correlated with amount of summer Changjiang river discharge, and 4) satellite chlorophyll-a concentration has been increasing last 10 years in the Yellow Sea and it might be related with the eutrophication. Those indicate that the satellite data was very useful for environmental monitoring in the coastal area; although care has to be taken to the accuracy of the data. International collaboration is necessary for the further development of better algorithms of satellite, and the attempt is already started.

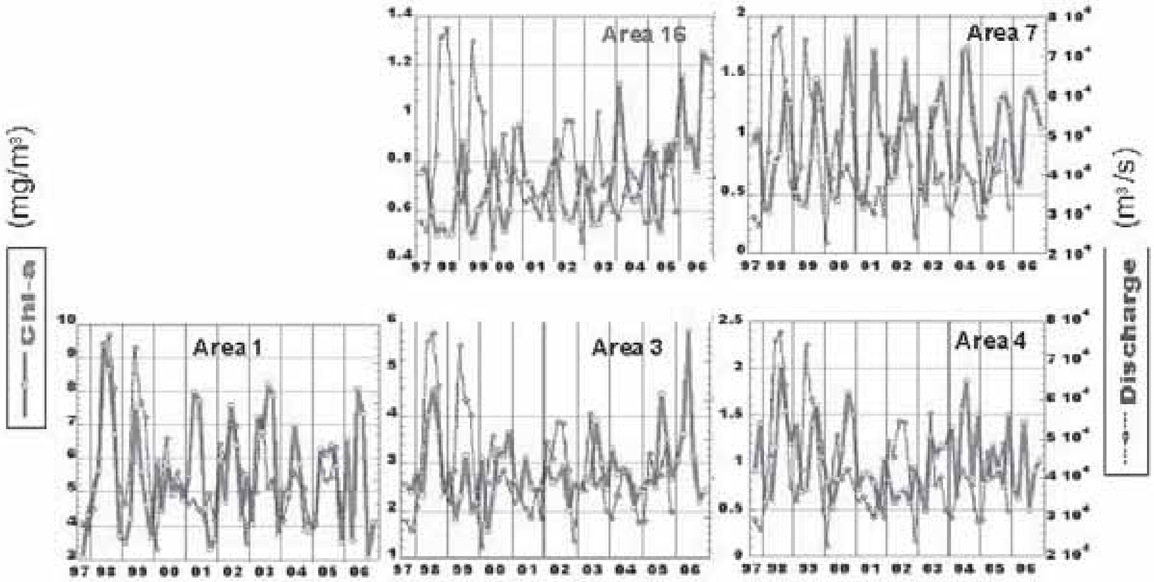

Figure 3. Interannual changes of Changjiang river discharge and satellite chlorophyll-a in 5 different areas of the East China Sea and Yellow Sea shown in Figure 2.

Present Status of Coastal Environmental Monitoring in Korean Waters Using Remote Sensing Data

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1. Introduction

Korean waters around the Korean Peninsula are connected in the eastern parts with East /Japan Sea (EJS), western parts with Yellow Sea (YS) and southern parts with the East China Sea (ECS) as shown in Fig. 1.

The water of the EJS is in communication with the ECS and YS to the south through the Tsushima (Korea) Strait, with Pacific Ocean to the east through the Tsugaru Strait, and with the Sea of Okhotsk to the north through the Soya and Tartar Straits. The ECS is bounded by the Izu Island Chain to the east, and includes the narrow the deep Okinawa Trough, which rises steeply to the northwest, onto a broad and shallow shelf bounded by China to the west and Korea to the north. The YS is bounded by the land in the north, west and east, connected in the south with the ECS, is a marginal sea of the western Pacific Ocean. The southern YS is located between the mainland China and the Korea Peninsula, representing a typical shallow epicontinental sea. The southern boundary between the YS and ECS runs from the mouth of the Yangtze River to Jeju Island.

NFRDI (National Fisheries Research and Development Institute) under the Ministry of Maritime Affairs and Fisheries of Korea has been receiving the satellite data since 1989 and operating five kinds of the earth observing satellites. The satellite ocean information are obtained the sea surface temperature (SST) data, which is related to the cold water mass, thermal front etc in Korean waters, from the NOAA satellite series and the MTSAT (Multi-functional Transport Satellite) satellite, and the ocean color data such as phytoplankton pigment (Chl-a), turbid water distributions from the SeaWiFS (Sea-viewing Wide Field of view Sensor), MODIS (MODerate resolution Imaging Spectroradiometer) and OCM (Ocean Color Monitor) satellites. The monitored data in Korean waters are distributed through the website of the NFRDI, the public PC communication network and a facsimile system on a daily base.

The objective of this presentation is to evaluate the usefulness of remote sensing techniques as a monitoring tool for the marine environment in Korean waters.

2. Method

In order to the coastal environmental monitoring in Korean waters, we used Chl-a and SST data. The Chl-a data set utilized in this study consists of the results in the global SeaWiFS processing project at NASA Goddard Space Flight Center (GSFC). The data products are monthly global composite images of Chl-a with 9 km x 9 km spatial resolution from 1998 to 2005.

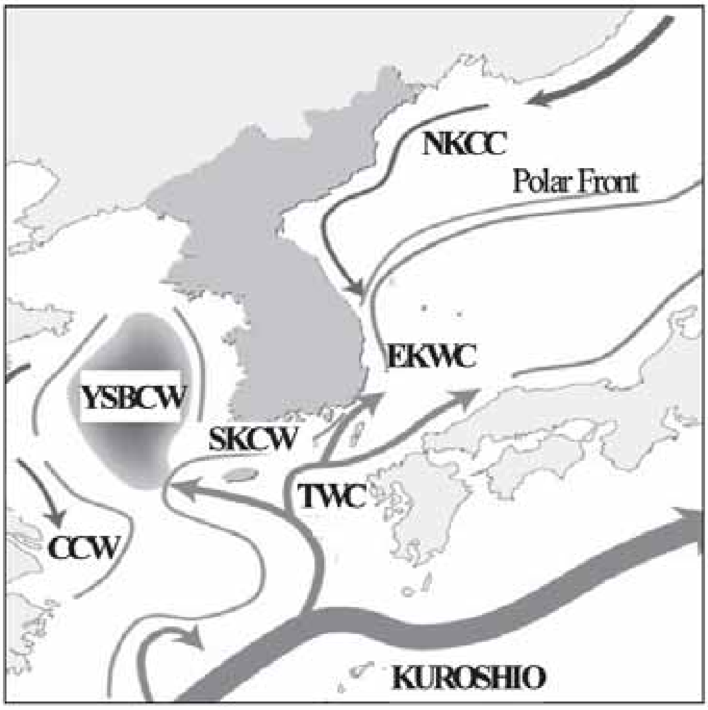

Fig. 1. Schematic diagram showing oceanic currents adjacent to the Korean Peninsula (Naganuma, 1973; Inoue, 1974).

Map projection is a linear latitude-longitude projection with a global dimension of 1024 x 2048. We also used the local area coverage images of Chl-a with 1 km x 1 km spatial resolution supported by KEOC (Korea Earth Observation Center). Map projection is a linear latitude-longitude projection with a dimension of 2000 x 2000. The data was processed based on the OC2 algorithm, which was developed by NASA.

SST data utilized the AVHRR data by the receiving of NFRDI. These data products are the daily data of SST with 1 km x 1 km (2000 x 2000 pixels) spatial resolution from 1990 to 2007. The QuikScat images used in order to get a wind data about the coastal upwelling in the southeast coast of Korea in summer.

3. Result

In order to evaluate the usefulness of remote sensing techniques as a monitoring tool for the marine environment including coastal area, a case study was conducted in the southern waters of the Korean Peninsula and northern part of the ECS. We also monitored cold water mass in the southeast of Korea.

The Chl-a concentrations around the bay in the South Sea of Korea are higher in summer and early fall (October) than those in the other seasons (Fig. 2). Two peaks of Chl-a concentration occurred, one was in spring (March, April and May) and the other was in fall (October and November).

The monthly average SeaWiFS Chl-a concentration images from 1998 to 2005 are as shown Fig. 3. The concentrations of indicates high Chl-a more than 5 mg/m^3 occurred in the coast water of China every year. In the northern part of the ECS, the Chl-a concentrations are higher in summer (July, August and September) than those in the other seasons.

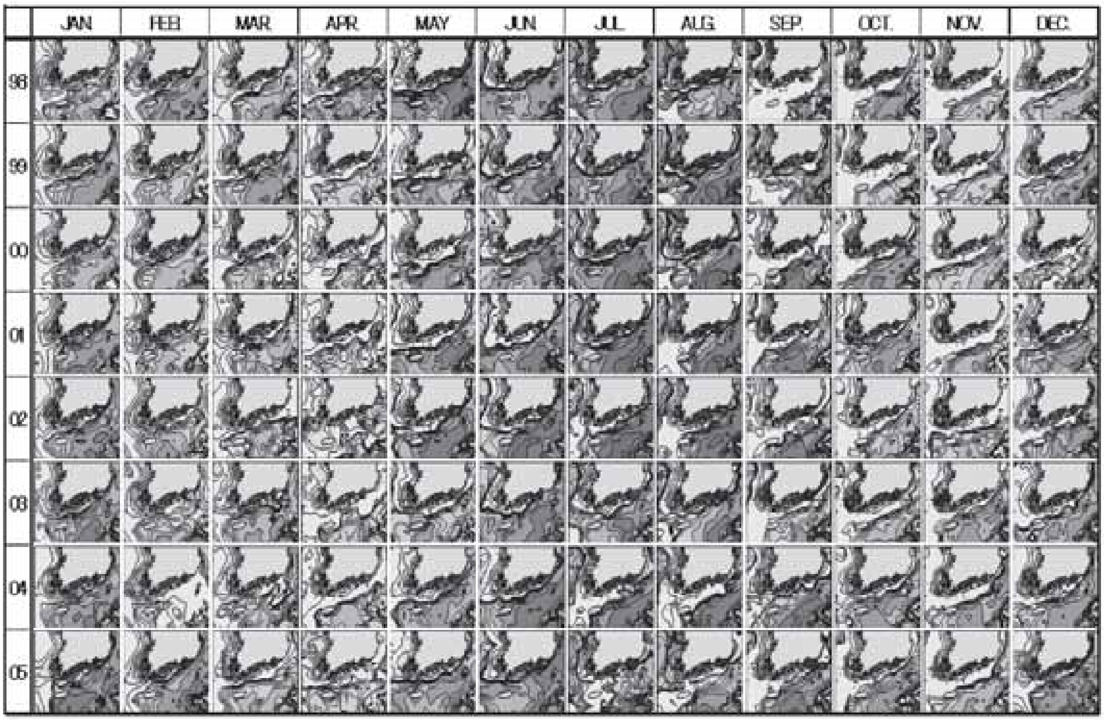

Fig. 2. Monthly average SeaWiFS Chl-a images in the South Sea of Korea from 1998 to 2005.

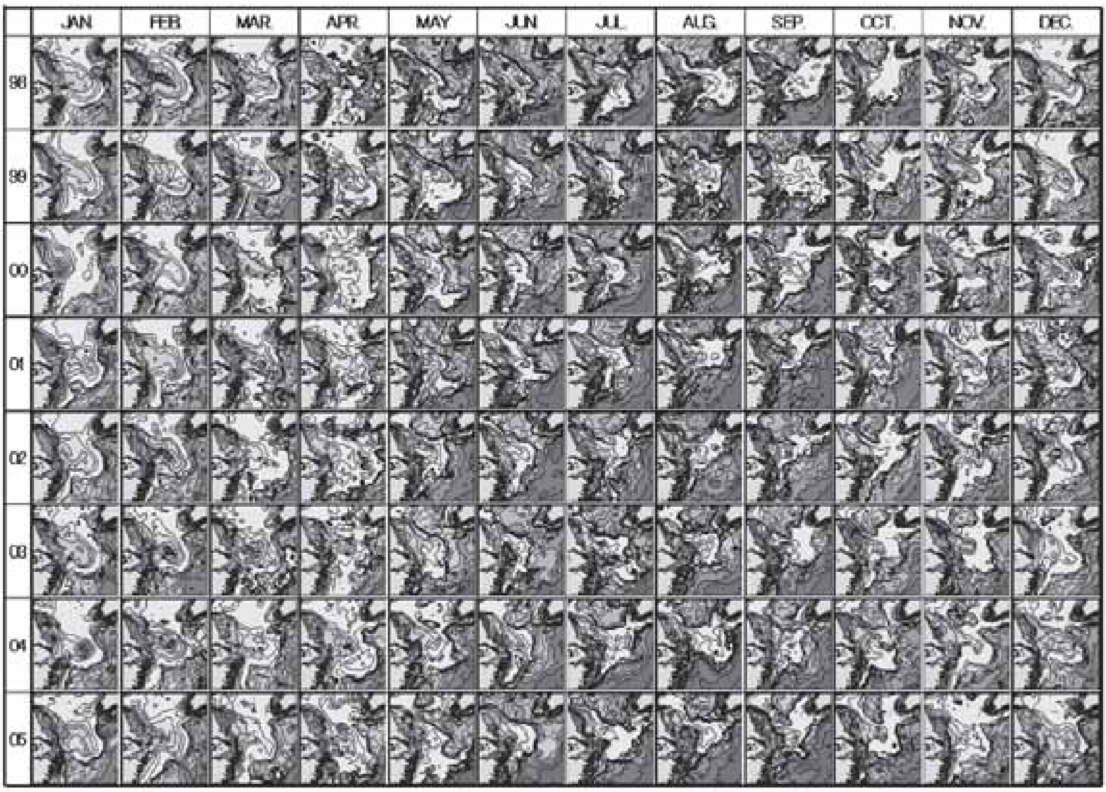

Fig. 3. Monthly average SeaWiFS Chl-a images in the East China Sea from 1998 to 2005.

It is well known that cold water mass appears off the southeast coast of Korea in summer. The prominent feature is that the appearance of cold water is quite localized. NFRDI has been monitoring the cold surface water using NOAA data in summer. Spatial distribution of SST and Chl-a in the southeast of Korea are described using SeaWiFS and AVHRR images on August 24, 2007. Spatial distribution of SST and Chl-a around East Korean Warm Current can be classified into four categories in the profile of SST and Chl-a images: (1) coastal cold water region, (2) cold water region of thermal front, (3) warm water region, (4) cold water of offshore region (Figs. 4-5). In the daily mean wind vector derived from QuikScat images, the winds occurs mostly southerly wind as shown in Fig. 4.

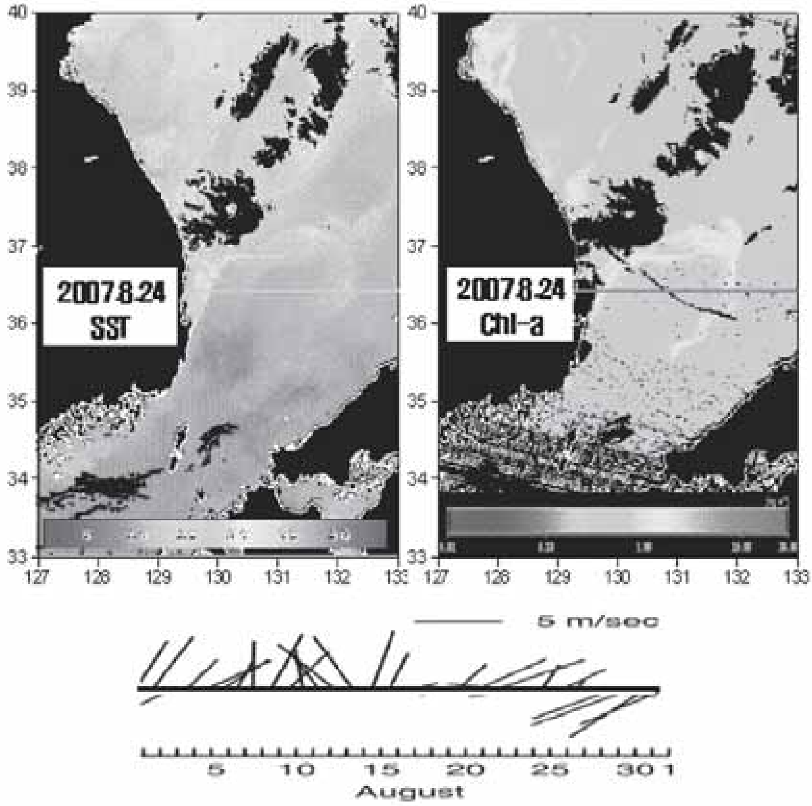

Fig. 4. The satellite image of the SST and Chl-a on August 24, 2007.

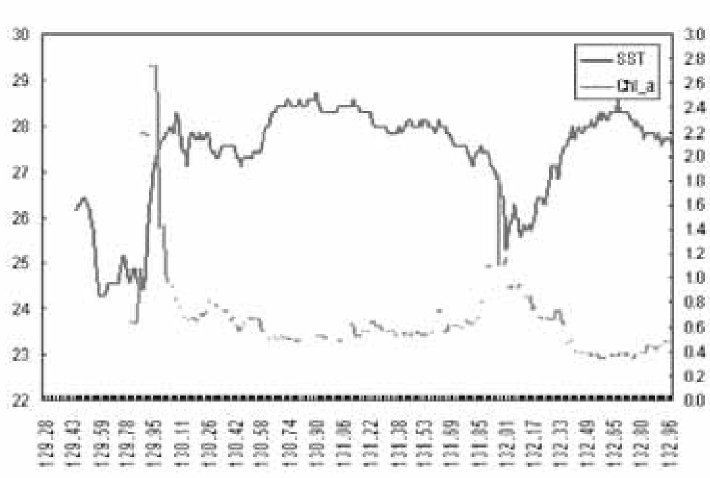

Fig. 5. Profile of SST and Chl-a along the 36.3°N on August 24, 2007.

4. Conclusion

In this report, we reviewed the present status of coastal environmental monitoring in Korean waters using remote sensing data. In future, we will share the information of coastal environmental monitoring for establishment of marine environmental assessment in the NOWPAP region using satellite remote sensing data. We will also contribute to development of NOWPAP coastal environmental assessment procedure.

Current situation and perspective for HABs Monitoring on the Russian Pacific Coast

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1. Introduction

Long-term observations that were performed for many years in the northern East/Sea show that there has been an apparent increase in the frequency, intensity and geographical distribution of harmful algal blooms during the last two decades in the Russian coastal waters. HABs monitoring program was conducted by the Institute of Marine Biology in the coastal waters of Amurskii Bay since 1993. The objectives of HABs monitoring were: monitor HAB species, tracking the blooms, early warning of potentially harmful species, to document ecological harm or dysfunction. Current situation and perspective for HABs Monitoring on the Russian Pacific Coast are presented.

2. Method

Monitoring on HABs has been conducted by Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology (FEB RAS) in the coastal waters of Amurskii Bay. The samples were collected once to three times a month. One-liter bathometric samples were collected at different depths with sampling intervals of 2–5 m. Plankton net with the mesh size of 20 mkm was used only for qualitative analysis. Samples were fixed immediately after the collection with Utermöhl's solution. The numbers of nanoplankton (2.0–20 mkm) were counted using Nojotta type Cell (0.05 mL) at total magnification of 300-400, and those of microplankton (> 20.0 mkm), using Sedgewick Rafter Cell (1 mL) at 100 X under a light microscope. The cell biovolume was calculated based on cell linear dimensions using appropriate geometric formulae. HABs monitoring data were stored using standard forms including the following fields: sampling site, sampling depth, data, volume of sample, counting cell type, ID of the responsible person.

3. Result and Discussion

Two types of HAB were observed in the study area. The first type is "red tide", when the water is discolored by high algal biomass. The second type is blooming of toxin-producing phytoplankton. In the Russian NOWPAP area, 11 potentially toxic species were found belonging to dinoflagellates and diatoms. Diatoms of the genus *Pseudo-nitzschia* are known as domoic acid–producing species. Electron microscopy revealed the presence of ten *Pseudo-nitzschia* species in the Russian coastal waters (Orlova, Stonik., 2001; Stonik et al., 2001). Four of them, *P. pungens, P. multiseries, P. pseudodelicatissima,* and *P. calliantha,* are known to be potentially toxic. *Pseudo-nitzschia* species are the most common species. The density of *Pseudo-nitzschia* spp. varied from 2 044 to 35 000 000 cells/l. Strong blooms of *Pseudo-nitzschia* species were registered between 1991 and 1997. The maximum density of the *Pseudo-nitzschia multiseries/pungens* complex (35 million cells/l) was registered in June 2002 in Amurskii Bay (Orlova et al., 1996). Some *Dinophysis* species are known as ocadaic acid–producing species, causing the syndrome of diarrhetic shellfish poisoning (DSP). Four of them, *D. acuminata, D. acuta, D. fortii,* and *D. rotundata,* were observed (Orlova et al., 2002). These species occurred in plankton in March–December. Its density reached a peak in summer. *D. acuminata* is one of the most widespread and abundant species in the Russian NOWPAP area. In Amurskii Bay its maximum density was 11 000 cells/l. The maximum concentration (3000 cells/l) of *D. fortii* was observed in the coastal waters in August. *D. rotundata* was common in the however, its concentration didn't exceed 400 cells/l.

Dinoflagellates of the genus *Alexandrium* may cause paralytic shellfish poisoning (PSP). Seven *Alexandrium* species were found in this part of the Russian coastal zone (Konovalova, 1998; Selina, Konovalova, 2001). Four of them, *A. tamarense, A. acatenella, A. pseudogonyaulax, and A. ostenfeldii,* are potentially toxic species. *A. tamarense* was widespread in this zone and the density of this species varied between 300 and 51 360 cells/l. *A. acatenella* was observed at a low concentration (200 cells/l) in the Peter the Great Bay (Morozova et al., 2002). The highest density of *A. pseudogonyaulax* (5600 cells/l) was registered in the coastal waters of Primorye (Selina, Konovalova, 2001. Our recent examination of living dinoflagellate cysts from recent sediment samples collected along the eastern Russian coasts revealed cysts of potentially toxic species, *Alexandrium* cf. *minutum* and *A. tamarense* (Orlova et al., 2004). Ellipsoidal *Alexandrium tamarense* cysts were widespread in the survey area and predominated in many localities. The density of cysts varied from 100 to 11,000 g^{-1}. The above data suggest that the distribution of toxic algal blooms, causing paralytic shellfish poisoning, is more widespread than it was previously considered.

The HABs monitoring revealed the appearance and massive blooms of new, uncommon for this area raphidophytes and dinoflagellates of the genera *Karenia* and *Prorcentrum.* Every year we observed recurrent blooms of nontoxic species (*Sceletonema, Chaetoceros, Thalassionema* and other) at numbers of more than dozens millions cells per liter in the hypereutrophic coastal waters of during the summer-autumn period. The majority of harmful species which are known for this area can produce cysts (hypnozygotes like *Alexandrium* spp.) and resting cells (like *Pseudo-nitzschia* spp.). Currents and ballast waters to the new location and remaining dormant until conditions are right for germination may distribute the cysts and resting cells.

Most of the harmful species and their blooms events occurred in the coastal waters subjected to the most powerful anthropogenic influence. In our opinion, a complex of factors favorable for the outbreaks of harmful algae exists in those areas. The major factors are high levels of mineral and dissolved organic substances, as well as the vertical stability of the water layers, associated with the substantial freshening and warming-up of the surface waters during the summer period.

For solving the problem of biological safety of the Russian marine waters the Center of Monitoring of HABs & Biotoxins was established in September 2007 in the Institute of Marine Biology, FEB RAS. The DSP, ASP and PSP toxins were analyzed in the tissues of mollusk, water samples and cultures of potentially toxic species, which were established form Peter the Great Bay. Samples were analyzed for toxins by the immunoassay method ELISA using the test-systems «RIDASCREEN^R FAST Saxitoxin», okadaic Acid ELISA (Abraxis LLC) and ASP direct ELISA (Bioscence Laboratory AS). ASP, PSP and DSP toxins were detected both in mollusks and water samples. Total DSP content in the mullucs exceeded toxic level > 160 mkg/kg.

The perspective for HABs monitoring in Russian waters are:

to assess actual or potential anthropogenic effects on HAB events, such as aquaculture activities or the introduction of novel species through discharge of ballast water; to estimate the pre-existing normal (baseline) conditions and their variability; distinguish anthropogenic changes from those attributable to natural variance. It's particularly important for biodiversity and stability of coastal marine ecosystems.

Arrangement of toxin analysis in water samples, cultures and shellfish continue to be among main national priorities, though some progress had been made. Development and implementation of schemes of observation upon plankton communities using the remote sensing techniques should be the one of national priorities in the HABs issues. The national priority to cope with HABs is prevention of HABs through obligatory monitoring and proper arrangement of aquaculture strategy. Increase of high skilled specialists for the investigation in the biology and ecology of the plankton species leading to HABs events continues to be the national priority also.

4. References

Konovalova, G.V. (1998). Dinoflagellate (Dinophyta) of the Far Eastern Seas of Russia and adjacent waters of the Pacific Ocean. Dalnauka, Vladivostok, 300 pp. (in Russian).

Morozova, T.V., Orlova, T.Yu. and Selina, M.S. (2002). Phytoplankton in the Scallop Culture Area in Minonosok Bight (Pos'eta Bay, Sea of Japan). Russian Journal of Marine Biology, 28(2), 94-99.

Orlova, T.Y., Zhukova, N.V. and Stonik, I.V. (1996). Bloom-forming diatom Pseudo-nitzschia pungens in Amurskii Bay (the Sea of Japan): Morphology, ecology and biochemistry. In "Harmful and Toxic Algal Blooms (eds by T. Yasumoto, Y. Oshima and Y. Fukuyo)", IOC of UNESCO, 147-150.

Orlova, T.Yu. and Stonik, I.V. (2001). The species of the genus Pseudo-nitzschia (Bacillariophyta) found in the Far Eastern seas of Russia. Russian Journal of Botany, 86(4), 47-52.

Orlova, T.Yu., Konovalova, G.V., Stonik, I.V., Selina, M.S., Morozova, T.V. and Shevchenko, O.G. (2002). Harmful algal blooms on the eastern coast of Russia, in "Harmful Algal blooms in the PICES Region of the North Pacific (eds by F.J.R."Max" Taylor and V.L. Trainer)", PICES Scientific Report, No.23, North Pacific Marine Science Organization, 47-73.

Orlova T.Yu., T. Morozova, K.E. Gribble, D.M. Kulis, D. M. Anderson (2004). Dinoflagellate Cysts in Recent marine Sediments from the East Coast of Russia. Botanica Marina, 47(3) 184-201.

Selina, M.S. and Konovalova, G.V. (2001). Morphology of Alexandrium pseudogonyaulax (Dinophyta) from the Far Eastern Seas of Russia. Russian Journal of Botany, 86(10), 22-25.

Stonik, I.V., Orlova, T.Yu. and Schevchenko, O.G. (2001). Morphology and ecology species of genus Pseudo-nitzschia (Bacillariophyta) from Peter the Great Bay, Sea of Japan. Russian Journal of Marine Biology, 27(6), 416-420.

Session 3

Coastal environmental assessment in the NOWPAP member states

Coastal Environment Remote Sensing in Bohai and Yellow Sea in China

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1. Introduction

Bohai Sea, the inland water of China, and Yellow Sea as a part of the northwest Pacific region are affluent in natural resources and play an important role in human life and economy exploitation at Chinese eastern littoral. To achieve sustainable development, the environment of this region should be monitored and assessed routinely, especially along the coast.

In this paper, the current marine environment status derived from routine in-situ data in this region is described. Some representative progresses in marine environment monitoring with optical remote sensing are presented. The current status of red tide monitoring with remote sensing is introduced. Some remaining problems and suggestions in marine environment assessment with remote sensing are put forward.

2. Marine Environment Status in Bohai and Yellow Sea along China

According to the "2007 Marine Environment Quality Communique in China", pollution in Bohai Sea was still serious. The area that did not reach the quality standard of clean waters amounted to $\sim 2.4\times10^4$ km^2, amounting to 31% of the total area. The areas of heavily, medium, slightly polluted and comparatively clean waters were about 0.6, 0.5, 0.6 and 0.7×10^4 km^2, respectively. Heavily polluted areas were mainly centered at the seashore of Liaodong Bay, Bohai Bay, Yellow River estuary and Laizhou Bay. As for the Yellow Sea, the area that did not reach the quality standard of clean waters amounted to $\sim 2.8\times10^4$ km^2, about 1.5×10^4 km^2 less than 2006.The areas of heavily, medium, slightly polluted and comparatively clean waters were about 0.3, 0.4, 1.2 and 0.9×10^4 km^2, respectively. The areas of heavily polluted waters were significantly reduced in comparison with 2006. Heavily polluted areas were mainly centered at Yalujiang River estuary, Dalian Bay and the seashore of Suibei. Main pollutants in this region were inorganic nitrogen, active phosphate and oil kind.

3. Coastal Water Quality Monitoring and Assessment

Water quality assessment with remote sensing is the combination of environmental parameters retrieval indicative of water quality and the specific assessment criteria. With remote sensing, the spatio-temporal distribution and variation of marine environment can be obtained more rapidly, frequently and simultaneously.

In China, the coastal environment is seriously polluted with complex composition and obvious regional features. Operational global algorithms are mostly invalid or can't get reasonable results. Relative to the expanse marine abutted and various problems to be solved, researches in ocean color remote sensing are much dispersed. Investigations in the Bohai and Yellow sea are not very systemic and integrated. Remote sensing models applied with good validation results have not been constructed yet.

Atmospheric correction is the premise of effective acquisition of water environmental parameters with remote sensing, and algorithms suitable for the very turbid waters is a hotspot. Simplified procedures with an assumption of fixed property of aerosol scattering and water-leaving reflectance in the NIR bands were experimented in certain regional waters. An optimization method over highly turbid waters based on the Rrs relations among visible bands derived from in-situ data and the simple c exponent model for aerosol scattering was tried in East China Sea using SeaWiFS. Adopting SWIR bands instead of NIR bands, an algorithm based on look-up tables including 9 aerosol models was presented for MODIS and applied to China coastal regions with a primary validation in the Yellow and East China Sea.

Concentration retrieval models for the three major components (Chl, TSM and gelbstoff) were studied extensively. Statistical model was still most widely used while ANN and semi-analytical models were also tried. These models were derived from different in-situ dataset among which data collected in Yellow Sea and East China Sea in spring and autumn 2003 were intensively investigated. Limited data amount restricted the comprehensive understanding of water optical properties and the model construction with more universal suitability among regions and seasons.

Other biochemical parameters not optically-active but important for water quality assessment such as DOC, COD, TN and TP were tried to be retrieved. These parameters were either related to Chl or TSM, or directly modeled as functions of Rrs. But most researches were done with limited data in a small region. Because of the nature of indirect and unclear relationships between these non-optically-active parameters and water optical property, models were more localized.

According to the national standard of sea water quality in China, 4 grades are defined. But chlorophyll concentration is not included in the standard. With limited remote sensed parameters, proper water quality assessment method should be built up, including the parameters used, assessment model and classification thresholds. Besides the simple factor method, integrative index method such as TSI or TSI_M commonly used in inland waters for eutrophication evaluation may be adopted.

Some remote sensing results are presented, among which the monthly mean distributions of water-leaving reflectance and chlorophyll for Apr. and Sep. 2003 are shown in Fig 1and Fig 2, separately.

4. Red Tide Monitoring

Red tide has become the second serious marine disaster along the China coast with increasing occurring frequency, area and lasting time. Red tide happens more frequently in Bohai Sea, while relatively less along the coast of Yellow Sea. Red tide remote sensing can provide the information of occurring position, area and trend.

The basis for red tide remote sensing is the knowledge of the biological, environmental conditions and optical properties. Some red tide remote sensing techniques have been developed, mainly based on the variation features of chlorophyll concentration, phytoplankton sell amount, ocean color and SST and using threshold or ANN techniques. The threshold method based on spectral features of red tide water was most widely used, and the interpretation based on image composition was also very important in practice.

Because of the limited precision of red tide related parameters in coastal regions, spectral feature differences among red tide waters and the mixing pixel effect caused by the irregular shape of red tide water, red tide remote sensing was still on the stage of experiment, and no method with sufficient veracity and suitability was presented.

Some red tide detection cases are introduced.

5. Remaining Issues

To promote the development of coastal environmental assessment, some insufficiencies of remote sensing should be overcome, such as precision, valid data frequency and fusion of different data. Besides the consistent assessment standard, more self-contained in-situ dataset covering the variation in space and time should be collected to get more reliable retrieval model and carry out effective satellite product validation, which needs long time efforts.

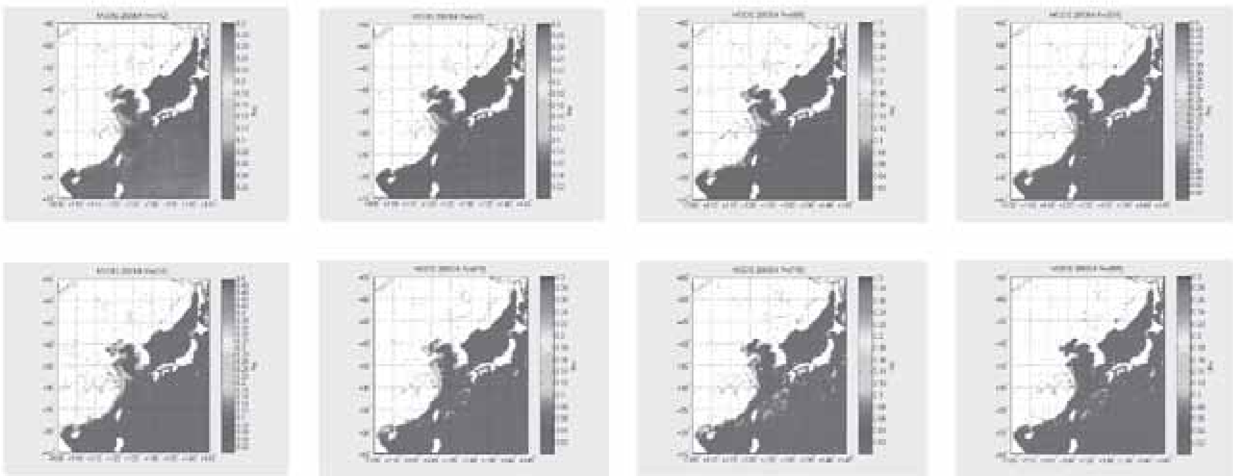

Figure 1. Monthly Mean Water-leaving Reflectance Distribution (Apr. 2003)

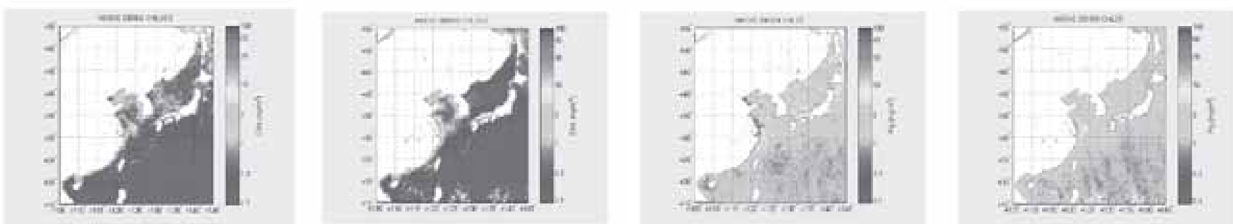

Figure 2. Monthly Mean Chl a Concentration Distribution (Apr. and Sep. 2003)

Reference:

[1] Ding Jing, Tang Jun-wu, Song Qing-jun, Wang Xiao-mei. 2006. Atmospheric Correction for Chinese Coastal Turbid Waters Using Iteration and Optimization Method. Journal of

Remote Sensing, 10(5): 732-741.

[2] Li Hua. 2006. The Study on Atmospheric Correction Algorithm of Case-2 Turbid Water and the Infection in the Extraction of Ocean Color Information. Guangzhou: Master dissertation of Sun Yat-sen University.

[3] Li Xiao-bin, Chen Chun-qun, Shi Ping, Li Xing. 2007. Retrieval of Total Inorganic Nitrogen Concentration in Pearl River Estuary by Remote Sensing. Acta Scientiae Circumstantiae, 27(2): 313-318.

[4] Liu Liang-ming, Zhang Hong-mei, Zhang Feng. 2007. Atmospheric Correction of MODIS Imagery for Turbid Coastal Waters. Geomatics and Information Science of Wuhan University, 32(2): 104-107.

[5] Lou Xiu-lin, Huang Wei-gen. 2003. An Artificial Neural Network Method for Detecting Red Tides with NOAA AVHRR Imagery. Journal of Remote Sensing, 7(2):125-130.

[6] Mao Xian-mou, Huang Wei-gen. 2003. Algorithms of Multiband Remote Sensing for Coastal Red Tide Waters. Chinese Journal of Applied Ecology, 14(7): 1200-1202.

[7] Qiu Zhong-feng. 2006. Ocean Color Remote Sensing Algorithms and Red Tides Detection in the High Frequency Red Tides Areas of the East China Sea. Qingdao: PhD dissertation of Institute of Oceanology, CAS.

[8] State Oceanic Administration. 2007. Marine Environment Quality Communique of China in 2007.

[9] Sun Ling, Zhang Jie, Guo Mao-hua. 2007. Atmospheric Correction over Case 2 Waters Using Neutral Network. Journal of Remote Sensing, 11(3): 398-405.

[10] Sun Ling. 2005. Atmospheric Correction and Water Components Retrieval for HY-1A CCD. Qingdao: PhD dissertation of Institute of Oceanology, CAS.

[11] Tang Jun-wu, Wang Xiao-mei, Song Qing-jun, et al. 2004. The Statistic Inversion Algorithms of Water Constituents for Yellow Sea & East China Sea. Acta Oceanologica Sinica, 23(4): 617-626.

[12] Zhang Xiao-yu, Lin Yi-an, Tang Ren-you, Pan De-lu, Wang Di-feng, Gong Fang. 2005. Preliminary Study of Concentration Distribution of Total Particulate Phosphorus in Estuary by Remote Sensing Technology. Acta Oceanologica Sinica, 27(1): 51-56.

[13] Zhao Dong-zhi, Zhang Feng-shou, Zhao Ling, Cong Pi-fu. 2003. Detect of Chlorophyll a and Red Tide in Coastal Water Using Band Ration of AVHRR. Marine Environmental Science, 22(4): 9-12.

[14] Zhao Dong-zhi. 2004. The Distribution Rule of Red Tide in China and Red Tide Remote Sensing Detection Model. Shanghai: PhD dissertation of East China Normal University.

Health Examination of Enclosed Coastal Seas in Japan

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Introduction

Environmental management of enclosed coastal seas in Japan has been so far made mainly from the viewpoint of water quality management with use of indicators such as COD (chemical oxygen demand), TN (total nitrogen) and TP (total phosphorus) in sea water. Although water quality management including "the area wide total pollution load control" was evaluated to be very successful by some many evidences, it is very clear that more holistic approach is necessary for coastal environmental assessment and management because deterioration of coastal environment evaluated by indicators other than water quality data is so obvious.

"Health Examination" of enclosed coastal seas is one of the possible promising approach essential for not only diagnosis of the present status of coastal environment but also for more holistic environmental assessment (Fig.1). Since the present status of the enclosed seas along the coast of Japan is more or less "damaged" or "deteriorated" mainly due to prolonged impact of human activities, "Health Examination" was conducted in the officially accepted 88 enclosed coastal seas in Japan.

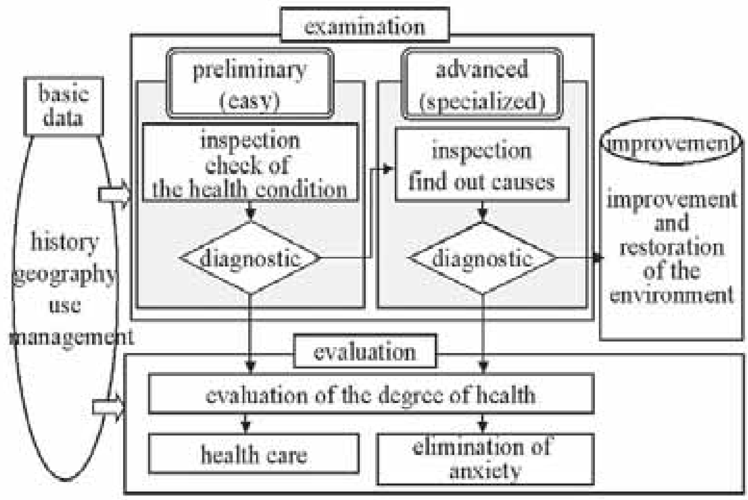

Fig.1. Organization of "Health Examination".

Method

"Health Examination" was made by the special committee of Ship & Ocean Foundation (Ocean Policy Research Foundation: OPRF) following the proposed examination scheme based on the "Master Plan and Guideline" developed by OPRF. In this scheme, two major functions of marine ecosystem which are "ecosystem stability" and "smoothness of material cycling" are highlighted (Fig.2). Although health examination of coastal marine environment is widely accepted as a concept of analogy to the human health examination, definition of marine environmental health and practical methodology of examination has not been adequately developed. In the "Health Examination" activities initiated by ORPF, a health examination scheme as a new ecosystem approach to environmental monitoring and assessment which consist of "preliminary examination" and "advanced examination" have already been proposed. In the present study, "preliminary examination" was applied to particular 88 areas with use of varieties of published data on the individual item related to "ecosystem stability" and "material cycling".

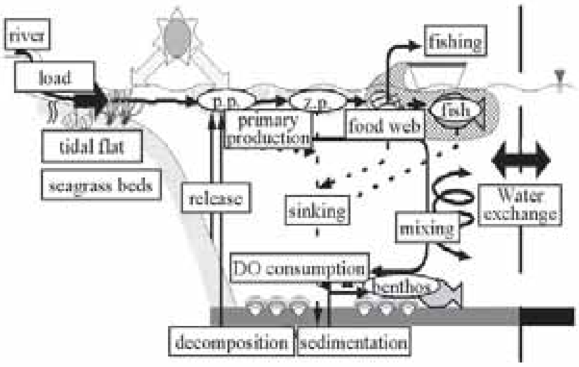

Fig.2. Structure of the ecosystem and material circulation.

Result and Discussion

As results, according to "ecosystem stability", conditions on species composition change indicated by fish catch data are most serious in almost all the areas examined. As to "smoothness of material cycling", conditions related to primary productivity indicated by transparency data, benthic environment indicated by sediment quality data, material cycling through benthic fish catch have been seriously damaged in more than half of the areas examined. Worsening of the benthic environment and ecosystem suggested by these results are the most critical items threatening the environmental health of the enclosed coastal seas in Japan.

Characterization of 88 enclosed coastal seas based on the result of the examination is also made in relation to the natural environment of the individual area. Some results on the trial of "advanced examination" and future perspective for the "Health Examination" is also discussed from the view point of environmental assessment and resource management of enclosed coastal seas.

Retrospective Eutrophic Assessment of the NOWPAP Coastal Areas to Identify Hot Spots on the Viewpoint of Harmful Algal Blooms

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1. Introduction

NOWPAP area encompassed by 33-52°N and 121-143°E is a semi-enclosed marginal sea surrounded by five countries. It is shallow with average depth of less than 200meters in most of the western and southern part, but the eastern NOWPAP whose average depth is about 1mile. Kuroshio warm current transports heat energy, and dissolved nutrients could be supplied from the land whose population is approximately 560millions (UNEP/NOWPAP/CERAC/FPM 3/13, 2005).

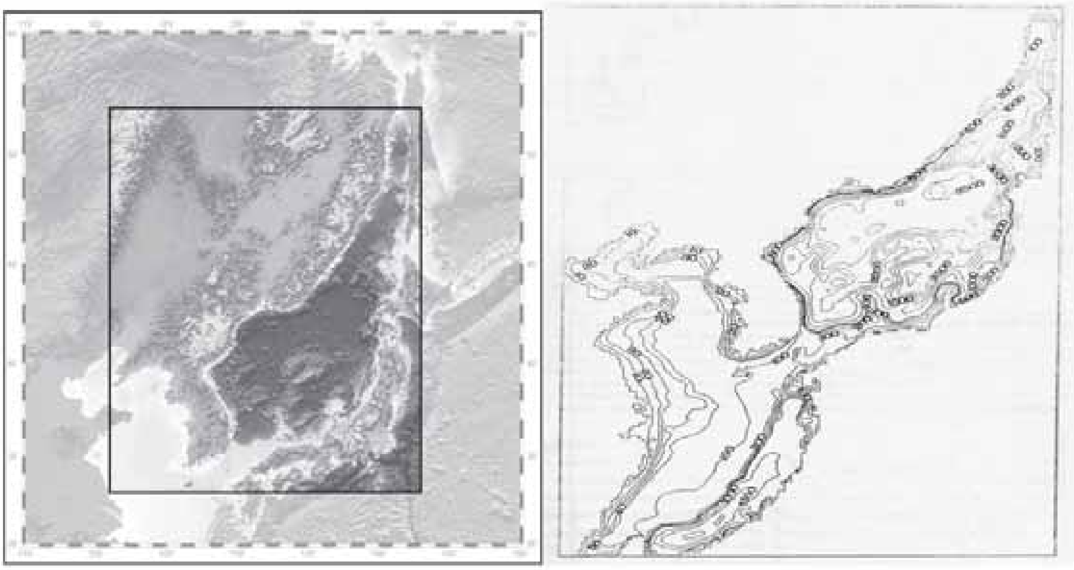

Fig. 1. Area of the NOWPAP region (33-52°N and 121-143°E) and bathymetries(in meter).

This is why the NOWPAP seas are vulnerable to coastal eutrophication by terrestrial and atmospheric pollutant inputs partially by such high anthropogenic loads and partially by the geographic characteristics of land altitude which cause the assemblage of river runoffs into the WNS, and land-enclosed ENS. Such on-going increase of terrestrial effluents and domestic wastewaters into the NOWPAP Seas has degraded the water quality of high eutrophic state. This degradation will be maintained due to the increase of population and high economic growth. Such consecutive increase of terrestrial effluents all along the coast of NOWPAP Sea has been induced a significant eutrophicantion and subsequent harmful algal blooms (HABs). As one of action plans for the conservation of north Pacific marine ecosystem, it needs to assess the water quality and should take relevant management actions to keep the water quality from an unconcerned change for the worse. Here, environmental risk assessment has been carried out to assess the eutrophic state and to identify hot spots in association with HABs.

2. Material and methods

The concentration of nutrients and outbreaks of harmful algal blooms (HABs) are good parameters to assess the risk of environment. Most of the nutrients and HABs data and information cited herein have been collected from national reports of four countries submitted to NOWPAP CEARAC and POMRAC. Besides, environmental data and information from the regular monitoring of the member countries and archives on oceanographic and environmental changes are also cited. According to oceanographic properties and anthropogenic pollution loads, the NOWPAP sea can divide into the western NOWPAP sea (WNS) consist of the Bohai Bay, Yellow Sea and south sea of Korean peninsula, and the other eastern NOWPAP sea (ENS) composed of the East/Japan Sea extending to Tartar Strait.

To conduct retrospective risk assessment, the working procedures have taken four steps such as problem formulation, retrospective and prospective risk assessment, and risk management (GEF/UNDP/IMO, 1999). At the first phase of problem formulation, NOWPAP Sea is decided as to the target area, and nutrients such as nitrogen and phosphate are chosen as suspected agent. The endpoint to be considered in the target is the outbreaks of harmful algal blooms (HABS). At the second phase of retrospective risk assessment, nutrients levels and the outbreaks of HABs have been investigated to assess the nutrients as one of risk agents causing HABs in this sea. For prospective risk assessment, the sources of risk agent, the likely routes of exposure, and the likely critical levels were estimated according to the retrospective risk assessment.

Taking the variability in measured environmental concentrations into account, here quantify the risk quotients (RQs) by using Hadaka's eutrophic index (Hanaoka et al., 1972). This index is applied to assess the nutrient level and subsequent susceptible capability of initiating red tides. This index is the eutrophic value of COD 1ppm x DIN(7.14μg-at/ℓ=0.14㎎/ℓ) x DIP (0.48μg-at/ℓ=0.02㎎/ℓ) divided by 3.43, by which the index 1 means the eutrophic level of water quality is quite enough to initiate the red tide. At the last phase of risk management, hot spots in association with HABs are determined based on the high nutrients and persistent HABs. Finally the likely route of nutrient loads and haunting zone of HABs have been suggested for the risk management.

3. Results and discussions

According to the national reports on river and direct inputs of contaminants into the marine and coastal environment in NOWPAP region, the major sources of water pollution were domestic wastewater and industrial effluents (UNEP/NOWPAP/CERAC/FPM 3/13, 2005). Based on national reports (NOWPAP POMRAC, 2006), the river and direct inputs of contaminants into NOWPAP coast and seas are enough to cause eutrophic pollution, especially in the WNS where is highly vulnerable to anthropogenic pollutants.

The nitrogen and phosphorus concentration in the WNS and ENS have shown high due to much of terrestrial uptake and shallow water depth of no good exchanges with offshore waters (Kim, 2007). In case of ENS, the dissolved nutrients concentration has been relatively low owing to deep water and relatively not much of river runoffs. At this retrospective eutrophic assessment, terrestrial pollutants through river and direct inputs have been playing an important role on the degradation of coastal water quality. The high amount of river runoffs are found at the estuaries of Yangze, Songhua, Huang ho, Yalu, and Han rivers in WNS, and Nakdong, Ishikari, Mogami, Agano, Tumen, and Razdolnaya rivers in ENS. Such configuration of high eutrophic state can tell us that the likely source and routes are attributable to neighboring land by doing casual chain analysis. Based on this retrospective eutrophic assessment, the potential hot spots could be figured out in the estuaries of Huang Ho, Yangze, Yalu, and Han rivers in WNS, and Nakdong estuary, the eastern coast of Kyushu and Honshu, and the transboundary area of Tumen river and Primorski Krai.

With respect to the outbreaks of HABs, harmful dinoflagellate blooms have taken place every year in summer season in the coast of WNS especially in Bohai Bay, Yellow Sea and the south sea of Korean peninsula. In ENS, there were red tides between April to September with peak in June and July along the Japanese Kyushu coast (UNEP/NOWPAP/CERAC/FPM 3/13, 2005). Mass mortalities of fish and shellfish have been observed at the red tides caused by *Heterocapsa circularisquama, Heterosigma akashiwo, Cochlodinium polykrikoides,* and *Noctilluca scintillans* both in WNS and ENS. However in the coast of Eurasian continent of the northern part of ENS, most of red tide events were observed from March to September with the peak in June and July, and caused no damages on marine living organisms. Such frequent HABs have caused massive fish kills, and contaminate seafood with PSP, DSP and ASP toxins. There has been a dramatic increase in the impacts of HABs for the last decade especially in WNS, and that the HABs problem is now become one of serious socio-economic issues in NOWPAP region.

4. Conclusions

The NOWPAP Region comprises semi-enclosed marginal seas situated in both the sub-polar and temperate zones. It has a wide variety of marine life and commercially important fishing and mariculture grounds. However, industrial wastes, untreated municipal sewage, and nutrients in run-off stimulate eutrophication and subsequent HABs resulted in widespread damages. The NOWPAP programme aims to mitigate the degradation of coastal pollution through the sustainable management and use of the marine and coastal environment by engaging in comprehensive and specific actions to protect marine environment. A retrospective risk assessment is the first step for specific actions to conserve northwest Pacific ecosystem. Well-designed strong prevention actions should be taken to the potential hot spots associated with HABs in order to delay present accelerating eutrophication areas especially the WNS, the most highly populated and industrialized area..

In this regards, NOWPAP member countries are responsible for protecting people from adverse health effects that arise from environmental exposure to contaminants, and also for protecting flora and fauna. It is time to develop cooperative management strategies such as coordinated and collaborative monitoring and marine policy of pollution prevention to secure sustainable production and biodiversity of the northwest pacific.

Keywords: terrestrial pollutants, eutrophication, risk assessment, hot spots, HABs

5. Bibliography cited

GEF/UNDP/IMO. 1999. Environmental risk assessment manual : A practical guide for tropical ecosystems. GEF/UNDP/IMO regional programme for the prevention and management of marine pollution in the East Asian Seas. ISBN 971-91912-7-9, 88 pp.

Hanaoka, T., H. Irie, F. Ueno et al., 1972. The cause of red-tide in neritic waters. Japan Fisheries Resources Conservation Association, Fisheries Research Series 23, 105pp.

Kim, H.G., 2007. Pollution. In : UNDP/GEF 2007. The Yellow Sea : Analysis of environmental status and trends, Volume 3 : Regional Synthesis Reports. UNDP/GEF Yellow Sea Project, Ansan, Republic of Korea, 408pp.

NOWPAP POMRAC, 2006. National reports on river and direct inputs of contaminants into the marine and coastal environment in NOWPAP region. POMRAC Technical Report No. 2.,256pp.

UNEP/NOWPAP/CERAC/FPM 3/13, 2005. Report of 3rd NOWPAP CERAC Focal Points Meeting. CERAC, Toyama, 15-16 September 2005, 311pp.

Satellite monitoring of algal bloom in coastal zone: problems and achievements

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1. Introduction

Satellite monitoring of harmful algal blooms (HABs) is one of the important tasks of the environment control. The task is not solved yet in spite of significant achievements for last years in the field of satellite facilities and appropriate algorithms of water bio-parameter calculation. Good indicators for red-tide events such as chlorophyll-a concentration, turbidity, fluorescence parameter and others are not specific to HABs. Red-tide is not HAB often and during the HAB the phytoplankton concentration does not reach red-tide one. By this reason it is the only one way to solve the task - to detect plankton species concentrations.

Most of the existing algorithms for HAB detection are empirical, they operates in appropriate regions only with certain bio-optical conditions and do not operate in the coastal zones. There are two ways the task solution on the base of satellite information. First is the use of "satndard" ocean colour products and a knowledge about the regional peculiarities of plankton species bloom for interpretation of satellite images. The approach fails often because of unstable pattern of a plankton community evolution. Another approach is phytoplankton species detection on the based of the plankton species peculiarity of sun light diffusion and absorption in the sea water. This approach is the most promising but and the most heavy. The sense of the approach is in the use of radiance characteristics of each plankton species in different spectral bands (or appropriate absorption and scattering characteristics) together with traditional level-2 products to classify the colour satellite information, detect the main plankton species and it's concentrations. There are follow main difficulties and unsolved tasks of the approach in according to its decreasing significance.

- Bio-optical algorithms do not work in coastal area usually. Bottom influence in the shallow waters is the main problem. Another problem is an influence of different impurities such as suspended sediments and other contaminations.
- Atmosphere correction errors are significant, especially in the coastal zone (no good aerosol models for atmosphere formed over the land). As the sequence the normalise water leaving radiance in violet and red spectral bands is wrong or negative.
- No dominant algae in the water. Plankton community consists of 10 and more species and each alga concentration is less 20% of total bio-mass usually. It is difficult to solve the identification task correctly.
- Water leaving radiance has significant dependence on the alga stage of life. Radiance characteristics in the end of bloom have low coincidence with ones in the beginning stage.
- Alga species detection is invert mathematical task. Such tasks have no single solution usually and rather sensitive to data errors. Heterogeneity of alga distribution in depth and plankton migration makes difficult the solution verification.
- Low spatial and radiance resolution of satellite information.

Shallow water.

The task of the bottom influence estimation is not solved yet, but a good progress has been achieved last years. A solution of the direct task of radiance propagation in a water was presented in a set of works of Dr. Kopelevich and oth. According to which the ratio $R(z,\lambda)$ of upwelling and downwelling irradiance in the water at the depth z can be described as:

$R(z,\lambda)=E_u(z,\lambda)/E_d(z,\lambda)=R_\infty(\lambda)+(R_b(\lambda)-R_\infty(\lambda))\cdot e(\lambda,z)$,

where λ - wave length, $R_\infty(\lambda)$,$R_b(\lambda)$- spectral diffuse reflection for a deep ocean and the bottom albedo, $e(\lambda,z)=\exp(-2K_d(H-z))$, K_d -spectral diffuse attenuation coefficient, H - the bottom depth. This model has a good accordance with in situ measurements. There are two parameters account for the bottom influence only - $R_b(\lambda)$ and H. The first results have been received to use the propagation model for Chlorophyll-a and suspended matter estimation.

Atmosphere correction.

Atmosphere correction presented in SeaDAS package try to estimate some terms of an equation for water leaving radiance. Errors of aerosol radiance estimation have greatest consequence on bio-parameter values calculated with satellite information usually (as the results, we have chlorophyll-a concentration exceeded in times the real one and negative water leaving radiance in violet and red spectral bands). The algorithm of aerosol radiance estimation is based on aerosol model selection by atmosphere humidity field in according to a scheme selected. Predicted humidity field is used for the final result reception. It is possible to control and delete rough errors of atmosphere correction and increase the product quality on the base satellite estimation of the humidity field. But the problem will not be solved problem as a whole soon. It is necessary an additional procedure for recalibration of water leaving radiance using as a standard a pure water radiance parameters.

Estimation the alga species concentrations.

There 2-3 dominant algae in sea water often during the intense algal bloom. It allows to form and solve a task for alga species detection and its concentration estimation. Some experiments were made in the Amursky bay near Vladivostok on the base of satellite and *in situ* measurements in August 2006. Two algal species (Coscinodiscus oculus-iridis и Ditylum brightwellii) have 70-90% of bio-mass measured. The approach used was based on a simple states. Satellite radiance value of any spectral band (charnel) is depend on pure water radiance, alga concentration and its spectral properties. Thus, we can write the normalise water leaving radiance variability of a channel *k*:

$R_k-R_w=\Sigma C_i\cdot R_{i,k}$,

where R_w – pure water radiance; C_i – biomass concentration of an alga *i*; $R_{i,k}$ –radiance variability due to the algae *i* for the channel *k*.

It was used 17 parameters produced with SeaDAS program (both level 1 and level 2). 10 of them were sensitive to the alga concentration. Square root method allowed to get stable and good accuracy results. Each alga can be characterised by unique spectral properties of bio-mass unit (alga passport) which may be use to detect the alga species with satellite information.

Conclusion.

The experiments allowed to make follow conclusion. The approach tested is rather promising for a satellite HAB monitoring. There are 30-50 alga species in Far-Eastern seas of Russia, which can have significant intense bloom. And less 20 species of them can produce toxins. To make efficient HAB monitoring it is necessary to measure spectral properties of each species in a laboratory for each alga life stage. An easy way and inexpensive realisation of monitoring technology creation is to organise the regular measurements on any test sea area near a shore of the Amursky bay. It should be lidar and spectroradiometer remote measurements from the shore and in situ measurement of alga composite and water radiation properties both in deep and shallow waters. Lidar sounding of the atmosphere together with AMSU atmosphere profiles should allow to control the key atmosphere parameters: aerosol particle size, its height, humidity, ozone and others.

Multisensor monitoring of Peter the Great Bay

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1. Introduction

Peter the Great Bay is the largest bay of the Japan/East Sea (JES). Seasonal changes of oceanic conditions in the bay are expressed very clearly. In winter a significant part of the bay is covered by ice, thickness of which can reach 50-70 cm. In summer the sea surface temperature increases till 22-25°C. Chlorophyll-a concentration is also very variable in time and in space. The highest values are observed in the coastal zone in spring and in autumn and in the open sea they are in several times less. Anthropogenic load is very large near Vladivostok and decreases in the open sea. Oil spills caused by illegal discharge of waste waters by ships and rivers are numerous. Sea ice surface collect dust and litter and transfer them in spring to the south that pollutes waters and the coast in the Marine Reserve area. Oceanic conditions in Peter the Great Bay are determined by water exchange with the JES, atmospheric influence (wind patterns, cloudiness), river discharge and orography. Monitoring of environmental conditions in the bay should consists of measurements of physical parameters (water temperature and salinity, currents, sea surface roughness, sea ice characteristics, air temperature and humidity, wind speed and direction, etc), biological parameters (chl-*a* concentration, turbidity, etc.), pollution (oil spills, litter). Simultaneously it is necessary to trace fishery and transport activity. Monitoring can be realized by combination of satellite, ship, buoy and coastal observations carried out by various sensors operating at different spectral bands and having different spatial resolution. The main attention in a paper will be given to:

- consideration of multisensor satellite monitoring of phenomena and processes in the bay,
- description of the developed optical polarization systems for measurements of physical parameters and for continuous monitoring of the sea surface and
- short description of system of operational monitoring which is under construction at POI.

2. Multisensor satellite monitoring

The advantage of satellite data is well known. It provides at any scale, up to date, inexpensive information on digital form. Many tools, which allow to extract environmental data from satellite imagery, have been developed. With the rapid development of remote sensing technologies, such as the development of the new generation imaging sensors, leading to enhanced performance at a cheaper price, multisensor systems have become a reality in a growing quantity of applications. Larger and spectrally more independent sensor arrays provide for increased spatial resolution and better spectral discrimination of the image data available for these applications. However, implementation of such sensor arrays has resulted in a significant increase in the raw amount of image data which needs to be processed.

Monitoring of the mesoscale (50 m - 20 km) oceanic phenomena is the most important for such bays as Peter the Great Bay. These phenomena were revealed by analysis of multisensor satellite datasets. The datasets consist of ERS-1/2 SAR, Envisat ASAR and ALOS PALSAR images , Landsat TM and ETM+, NOAA AVHRR and Terra and Aqua MODIS visible and infrared images, QuikSCAT-derived sea surface winds and ocean color data (SeaWiFS, MODIS), as well as of the weather maps, ship surveys and ground truth data acquired in 1991-2008. Spatial resolution of SAR images is in the range of 10 -150 m and a swath width changes from about 70 till 400 km. This combination is unique and allows revealing the synoptic-scale, mesoscale and fine-scale features of the surface circulation, oceanic dynamic phenomena, wind field and oil spills independently on sun illumination and cloudiness. Measurements of the SST and wind speed and direction were carried out at POI Marine Stations and at several coastal points during the ASAR and SAR data acquisitions. Characteristics of the sea surface roughness were determined by processing of time series of images of a system of small floats and thin disc floats of various sizes as well as by analysis of images of the sea recorded by a polarization video system.

The surface manifestations of the current fronts, eddies of different sizes, internal waves and other oceanic phenomena were revealed on the SAR images. Spiral eddies of different scales were detected in the Bay both in warm and in cold seasons. The signatures of the Tumen, Razdolnaya and Partizanskaya river plums were detected on true color MODIS images with spatial resolution of 250 m. Velocity of internal waves propagation, surface currents and ice drift was estimated from displacement of radar signatures on SAR images taken by ERS-2 and Envisat images with 30 min delay and visible signatures on Terra and Aqua MODIS images with time delay of 100 min. In a cold season, the grease ice, pancake ice and other forms of sea ice were reliably detected on SAR images of Peter the Great Bay.

3. Optical polarization complex

Complex was developed at POI FEB RAS to study the sea surface roughness characteristics, slicks, internal waves and other oceanic dynamic phenomena/processes and carry out ground truth measurements. Characteristics of the sea surface roughness and their spatial variations determine the spatial variations of the SAR image brightness (Normalized Radar Cross Section σ°). Measurements of the sea surface slope distribution and the mean-square slope (MSS) during field experiments are required for interpretation of the radar signatures. Techniques based on light reflection ('shape from reflection') turn out to be most suitable to take wave slope images. The results obtained earlier show that the measurements of the water surface shape are accurate enough to compute two-dimensional wave number spectra. The original optical devices (video cameras, polarization spectrophotometer, etc.) and techniques were developed and used to derive the characteristics of gravity and gravity-capillary waves under variable environmental conditions in particular during Envisat ASAR and ALOS PALSAR sensing.

The characteristics of the sea surface roughness were estimated from displacements of a light float and a system of light floats. They were also retrieved from the brightness variations of the sea surface images which were recorded at three polarizations with frequency of 6-50 Hz. Original software was developed for processing of the time series of these polarization images. Calibration was suggested to eliminate the random fluctuations of viewing direction of optical devices. Results of measurements and their interpretation will be presented.

Another optical system consisting of three rotating video cameras mounted on a common base carries out panoramic images of the sea surface around Cape Shults at three polarizations every 30 sec. Analysis of time series of panoramic images allows to trace movement of the contrast features (slicks, oil spills, internal waves, etc.), estimate their velocities and evolution. Animation will be presented demonstrating evolution of oil spill and propagation of a packet of internal waves from the open sea to Vityaz' Bay.

4. Operational monitoring of Peter the Great Bay

Since 2005 POI began to develop a system for operational monitoring of Peter the Great Bay. The system should provide information from the coast, buoys and ships and its transfer in real time to the coastal centers of data storage and processing. Telecommunication infrastructure was created with the usage of fiber-optic, wire and radio connections to solve this task. Several Marine experimental stations and Institutes of FEB RAS in Vladivostok are combined into the structure. A subsystem of video monitoring of the sea surface is an important component of the system. The subsystem will use IP- video cameras which is planned to install on coastal hills. Remote control of camera operation will be realized. This subsystem will allow to get and accumulate the information on environmental conditions in the various parts of the bay. These data can be useful for validation of satellite-based algorithms of geophysical parameter retrieval.

Pilot project of the video monitoring system is tested now at Marine Station Cape Shults. Apart of polarization video cameras, there is another video camera FCS-1040 which transmit the images from Cape Shults to the FEB RAS Institutes. Camera has 10-fold optical magnification and allows to remote control magnification and angle of observations. The static panoramic images of the sea surface around Cape Shults are retained in data bases of oceanic informative-analytical system of FEB RAS.

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