1. Background

WG3/CEARAC compiled “the National Reports” that introduce current situation on harmful algal blooms (HABs) in each country of the NOWPAP Member States, “the Integrated Report” based on the National Reports and “HAB Reference Database” that summarizes published papers on HABs in the NOWPAP region in the 2004-2005 biennium.

In the Integrated Report, the need to mitigate HABs in the NOWPAP region is mentioned. Based on this need, “Booklet of the countermeasures against HABs” was published in the 2006-2007 biennium, which summarizes information on countermeasures implemented in each country.

In order to share information on HAB occurrence more effectively and enhance actions against HABs in each member state, CEARAC proposed to implement HAB Case Studies in the 2008-2009 biennium at the 5th CEARAC FPM, and it was approved at the 12th NOWPAP IGM.

2. Objective

Objectives of HAB Case Studies are to establish the most effective and laborsaving ways for sharing information among the NOWPAP member states about HAB occurrence, oceanographic and meteorological condition and nutrients in selected areas for HAB Case Studies and to summarize common concerned items in the NOWPAP region in reports.

3. Main actions

CEARAC prepared this workplan for HAB Case Studies including the overview of HAB Case Studies (Annex 1). This workplan will be reviewed by WG3 experts before the 6th CEARAC FPM. Upon review by CEARAC FPs at the 6th CEARAC FPM, this workplan will be revised based on the comments of WG3 experts and CEARAC FPs and will be approved.

3.1 Selection of areas for HAB Case Studies in each member state

Upon approval of the workplan, one or two areas for HAB Case Studies will be selected in each country by CEARAC FPs and WG3 experts of each member state. Areas for HAB Case Studies should be sea areas where HAB monitoring has been already implemented regularly because HABs occur frequently or HAB occurrence will be concerned in the near future.

3.2 Implementation of HAB Case Studies

CEARAC will conclude MoU for HAB Case Studies with experts recommended by WG3 experts or WG3 experts themselves in April 2008.

Progress reports of HAB Case Studies will be introduced and reviewed at the 4th WG3/WG4 Meeting.

Based on the review at the 4th WG3/WG4 Meeting, the progress reports will be revised and finalized. Final reports (2008) will be submitted to CEARAC by the end of 2008 and will be uploaded to CEARAC website so that the information will be disclosed not only among the NOWPAP member states but also among other regional seas and international agencies. For sharing information in wider community, CEARAC will promote cooperation with other international agencies such as PICES which have HABs-related databases.

3.3 Updating the reports (2008) of HAB Case Studies

In 2009, CEARAC will conclude MoU with the same experts for updating the reports (2008). The experts will collect latest data and update the reports (2008) to establish the most effective way for updating and sharing the information. After 2009, thess reports will be updated regularly as a routine task.

4. Expected outcome

Implementation of HAB Case Studies will contribute to establish effective and laborsaving ways for sharing information. Also, the achievement of case studies will be listed on a database established by CEARAC's other activity (HAB Integrated Website), so the information will be available for wider community. At this point, synergy effect, sharing information on not only areas for HAB Case Studies but also other sea areas where HABs occur, will be promoted.

5. Schedule

Schedule of this activity and main body are as follows:

Time		Actions	Main body
2008	Q1	Preparation of workplan	CEARAC and Consultant
		Review of workplan	WG3 Experts
	Mar. (The 6th CEARAC FPM)	Approval of workplan	CEARAC and FPs
	End of Q1	Selection of areas for HAB Case Studies in each country	FPs and WG3 Experts
	Q2	Conclusion of MoU on HAB Case Studies	CEARAC and Experts
	Q2 – Q3	Making progress report	Experts
	Sep. (The 4th WG3/4 Meeting)	Review of progress report of HAB Case Studies	WG3/WG4 Experts
	End of Q4	Submission of the final report (2008) to CEARAC	CEARAC and Experts
2009	All year	Updating the reports (2008) (by conclusion of MoU)	CEARAC and Experts

6. Budget

Contract	Timing	Output	To be completed	Counterparts	Budget
MoU for HAB Case Studies	2008 end of Q1	- Progress report of HAB Case Studies - Final report of HAB Case Studies	2008 end of Q4	Expert of China	US$2,000
				Expert of Japan	US$2,000
				Expert of Korea	US$2,000
				Experts of Russia	US$2,000
MoU for updating the reports	2009	Updated report	2009 end of Q4	Expert of China	US$500
				Expert of Japan	US$500
				Expert of Korea	US$500
				Experts of Russia	US$500
Total					US$10,000

Annex 1: The overview of HAB Case Studies

Contents		Information
1	Introduction	
1.1	Objective	・ The main objectives of the case study
1.2	Definitions and rules used in the HAB case study	・ Definitions of the terms used in the case study ・ Rules regarding the use of scientific names
1.3	Overview of the target sea area	
	1.3.1 Location and boundary	・ Geographic boundary of the target sea area
	1.3.2 Environmental/ geographical characteristics	・ Environmental and geographical characteristics of the target sea area (e.g. ocean currents, topography, etc.)
	1.3.3 human activities	・ Fisheries, industries, etc.
2	Methodology used in the case study in the northwest sea area of Kyushu region	
2.1	Methodology used in the case study	・ The type and scope of data and/information used to grasp the number of HAB events
2.2	Warning/action standards against HAB events	・ The type of indicators (e.g. cell density) that are used to warn HAB events
2.3	Target HAB species	・ Identification of HAB species that cause fishery damage in the target and adjacent areas. These species will be referred to as ‘Target HAB species’
3	Monitoring framework and parameters of HAB	
3.1	Monitoring framework	・ Monitoring organizations and their monitoring areas in the target sea area
3.2	Monitoring parameters	・ Parameters monitored by the monitoring organizations and selection of parameters to be used for the case study
3.3	Data and information used	・ HAB events in the target sea area
4	Status of HAB events	
4.1	Status of HAB events from 19**-2007	
4.2	Yearly trends of HAB events	・ Present the yearly trends in the number of HAB events
4.3	Yearly trends of HAB seasons	・ Present the number of HAB events for each month and then identify the main HAB periods/seasons
4.4	Yearly trends of causative species	・ List the HAB causative species and their number of occurrences. Then identify the locations of major HAB areas

Continue of Annex 1

Contents		Information
5	Status of recent HAB events and results of environmental monitoring	
5.1	Number of HAB events	・ Present number of recent HAB events
5.2	Period of HAB events	・ Present the number of recent HAB events for each month and then identify the main HAB periods/seasons
5.3	Duration of HAB events	・ Present the duration of recent HAB events for each sea area and then identify the HAB duration characteristics
5.4	Location of HAB events	・ Present the number of recent HAB events for each sea area and then identify the locations of major HAB areas
5.5	Causative species	・ List the HAB causative species and their number of occurrences. then identify the locations of major HAB areas
5.6	Maximum density of each HAB event	・ Compile all the HAB events that occurred in the target sea area. Then identify the HAB event that had the maximum density.
5.7	Status of HAB induced damages	・ Present the fishery damage and environmental deterioration that have been induced by HAB events
5.8	Status of target species	・ Present the occurrence status of target species
5.9	Environmental monitoring results during HAB events	・ Present the results of on-site surveys (water temperature/salinity/DO) conducted during HAB events and present results of analysis of relationships with HAB occurrences
5.10	Water quality parameters of regular HAB monitoring survey	・ Present the results of the regular HAB monitoring surveys
5.11	Meteorological observation parameters	・ Present the meteorological information during HAB events
6	Eutrophication monitoring with satellite image	
6.1	Framework of satellite image monitoring	・ Present available remote sensing data in the target sea area and their characteristics
6.2	Parameters of satellite image monitoring	・ Present available remote sensing data parameters in the target sea area
6.3	Results of satellite image monitoring	・ Present sea surface chlorophyll-a data measured during HAB events
7	Conclusion	・ Consider the relationship between HAB events and environmental parameters by comparing the results of chapters 5 and 6. ・ Consider the application options of satellite images for monitoring HAB events ・ Stress the importance of international partnership and cooperation.
8	References	

Annex 2: Example of the report of HAB Case Studies in the Northwestern Sea Area of Kyushu Region

Contents (Draft)

1 Introduction

1.1 Objective

The objective of conducting the HAB case study in the northwestern sea area of Kyushu region is to establish the most effective and laborsaving ways for sharing among the NOWPAP member states, information on HAB events and associated oceanographic and meteorological conditions. Furthermore, common HAB issues within the NOWPAP region will be identified through the case study. In the case study, red-tide and toxin-producing planktons will be referred as HAB species.

1.2 Definitions and rules used in the HAB case study

Mention that in general, the scientific names in the 'Integrated Report' and 'Booklet on Countermeasures' will be used in this case study.

1.3 Overview of the target sea area

1.3.1 Location and boundary

- The target sea area covers the northwest and north Kyushu sea area, which faces East China Sea and Sea of Japan, respectively. (also indicate the latitude/longitude of the target sea area)
- Inland seas such as Ariake Sea, Yatsushiro Sea and Seto Inland Sea are not covered in the case study.

(Show a map of the target sea area with some brief descriptions)

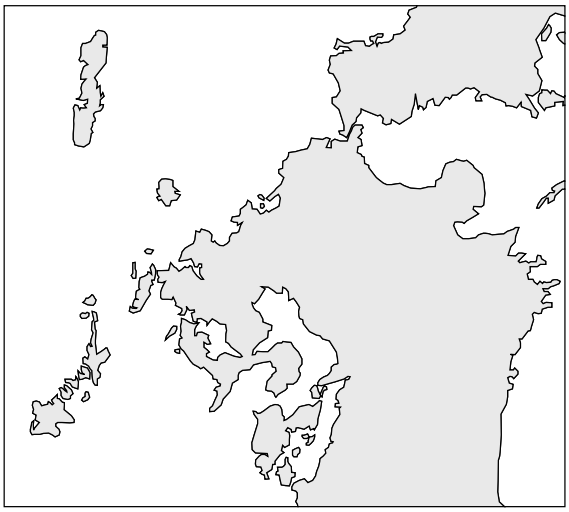


Figure 1 Proposed target sea area for the case study of Japan

1.3.2 Environmental/geographical characteristics

・The target sea area faces the East China Sea and is strongly influenced by the Tsushima Warm Current

・The topography of the coastline is complex; comprised of many small inlets and islands.

(Collect relevant information from existing reports etc.)

- Since the northwest sea area of Kyushu region is located along the path of the Tsushima

Current, and also located relatively close to the southern coast of Korea and the coasts of China, the area has been impacted recently by transboundary transportation of HAB species.

2 Methodology used in the case study in the northwest sea area of Kyushu region

2.1 Methodology used in the case study

Describe how the reports of the monitoring organizations define a HAB event. For example:

- When fishermen reported on change in seawater color
- When over one HAB cell was recorded during the regular monitoring.

Definition of a HAB event is usually stated in the HAB monitoring reports, and these definitions will also be applied to the case study. The case study will cover all HAB events recorded in the monitoring reports, and will focus especially on species that have caused significant damage to the area.

2.2 Warning/action standards against HAB events

In order to prevent fishery damage, monitoring organizations in the target sea area have established HAB warning/action standards, which if exceeded will send warnings to fishermen and coastal users. In Nagasaki Prefecture, based on cell density, warning/action standards are established for 6 types of HAB species that cause fishery damage (Table 1).

(Sea areas that have warning/action standards will be presented later)

Table 1 HAB warning/action standards of Nagasaki Prefecture

	Warning/action standards (cells/mL)		
	Warning level[*1]	Action level[*2]	Note (Affected fish/shellfish)
Chattonella antiqua	1	10	Yellowtail, cockles etc.
Chattonella marina	1	10	Yellowtail etc.
Chattonella globosa	10	100	Amberjack
Chattonella ovata	10	100	Yellowtail, Red seabream etc.
Karenia mikimotoi	100	500	Fish, shellfish, crustaceans etc.
Cochlodinium polykrikoides	50	500	Yellowtail, Red seabream, pufferfish, Striped jack etc.
Heterosigma akashiwo	1000	10000	Yellowtail, grouper etc.
Heterocapsa circularisquama	10	50	Shellfish (mainly bivalves)

[*1]Warning level: Track the movement of planktons, and prepare or implement feeding withdrawal or fish-cage mobilization

[*2]Action level: Withdraw feeding or move fish cage

Source: Nagasaki Prefectural Institute of Fisheries
(http://www.marinelabo.nagasaki.nagasaki.jp/news/gyorendayori/H13/1307no75akasio-tyui.pdf)

In Nagasaki Prefecture, harvested shellfish are monitored to check the presence of any algal toxins. Safety limits are established by the Government, which are 4 MU/g of meat for PSP and 0.05 MU/g for DSP.

2.3 Target HAB species

In this case study, the following type of HAB species will be targeted and will be referred to as 'target HAB species'.

- HAB species that have caused fishery damage in the target sea area
- HAB species that have caused fishery damage in the adjacent sea area

Table 2 shows target HAB species for Nagasaki Prefecture (information from Matsuoka et al. (2006) and web site of Nagasaki Prefectural Institute of Fisheries were referred to identify the target HAB species).

The target HAB species of the northwest sea area of Kyushu region will be selected by referring also to Yamaguchi, Fukuoka and Saga Prefecture.

Table 2 Target HAB species in this case study (Nagasaki Pref.)

	Harmful Red-tide causative species	Toxin-Producing Plankton
Dinophyceae		
Akashiwo sanguinea	○	
Karenia mikimotoi	○	
Cochlodinium polykrikoides	○	
Alexandrium affine	○	
Heterocapsa circularisquama	○	
Raphidophyceae		
Chattonella antiqua	○	
Chattonella marina	○	
Heterosigma akashiwo	○	

Source: Matsuoka et al. (2006)
Web site of Nagasaki Prefectural Institute of Fisheries
(http://www.marinelabo.nagasaki.nagasaki.jp/news/gyorendayori/H13/1307no75akasio-tyui.pdf)

3 Monitoring framework and parameters of HAB

3.1 Monitoring framework

In Nagasaki Prefecture, to prevent HAB induced fishery damage, the Nagasaki Prefectural Institute of Fisheries conducts HAB monitoring. The monitored sea area are shown in Table 3 and Figure .

Table 3 Monitoring organization and monitored sea areas in Nagasaki Prefecture

Monitoring organization	Monitored sea area
Nagasaki Prefectural Institute of Fisheries (http://www.marinelabo.nagasaki.nagasaki.jp/)	Northern Kyushu Imari Bay, Hirado (Usuka/Furue Bay) Western Kyushu Ohmura Bay, Tachibana Bay, coasts of Kitamatsu, Kujukushima, coast of Seihi, Ariake Sea Remote Islands Goto, Iki, Tsushima
Saga Prefectural Genkai Fisheries Promotion Center (http://www.pref.saga.lg.jp/at-contents/shigoto/suisan/gensui/)	Imari Bay, Karatsu Bay, Kariya Bay
Fukuoka Fisheries and Marine Technology Research Center (http://www.sea-net.pref.fukuoka.jp/)	Fukuoka Bay, Karatsu Bay, Genkai Sea, Hibiki Sea
Yamaguchi Prefectural Fisheries Research Center (http://www.pref.yamaguchi.lg.jp/cms/a16500/uminari/uminari-top.html)	Coastal area of Sea of Japan

Source: Nagasaki Prefectural Institute of Fisheries (2007)

The boundaries and locations of the monitored sea area will be presented on a map (Figure*).

Northwestern Sea Area of Kyushu Region

- Sub-region (Northern Kyushu, Western Kyushu, Remote Islands, coastal area of Sea of Japan)
- Spot (Imari Bay, Ohmura Bay, etc.)

Figure* Monitored sea area (under preparation)

3.2 Monitoring parameters

In the northwestern sea area of Kyushu region (Nagasaki Prefecture), the following three types of HAB related surveys are conducted: post-HAB survey, regular HAB monitoring survey and regular shellfish-poisoning survey. Post-HAB survey is conducted when water discoloration, HAB event or fishery damage (e.g. report from fishermen) occur. Regular HAB monitoring survey and shellfish-poisoning survey are conducted regularly at fixed locations, irrespective of any HAB events. Table 4 shows the objective and monitoring parameters of each survey.

This case study will focus mainly on the results of the post-HAB survey, which monitors HAB causative species, cell density, affected area, fishery damage, water temperature, salinity and DO.

Table 4 Objectives and monitoring parameters of each HAB survey

Survey type	Main objectives	Monitoring parameter				Monitoring frequency
		HAB	Water quality	Meteorology	Others	
Post-HAB survey	Monitoring of fishery damage	-HAB species (dominant/causative spp.) -Cell density -Bloom area -Water color -Fishery damage	-Water temp. -Salinity -DO	None		Immediately after water discoloration or fishery damage is reported
Regular HAB monitoring survey	To check presence of HAB spp.	-All HAB species -Cell density -Water color	-Water temp. -Salinity -DO -Transparency -Nutrients -Chl.a	-Weather -Cloud cover -Wind direction/speed		4-5/year (June-October)
Regular shellfish-poisoning survey	-To check presence of HAB spp. that induce shellfish poisoning -Contamination of shellfish products	-Species that induce shellfish poisoning -Cell density -Water color	-Water temp. -Salinity -DO -Transparency		Shellfish contamination	12/year (1/month)

Source: Nagasaki Prefectural Institute of Fisheries (2007)

3.3 Data and information used

Information on HAB events will be mainly collected from the following sources:

- Reports published by organizations that conduct HAB monitoring in the target sea area
- Reports of the Fisheries Agency Kyushu regional office

Table 5 shows the monitoring parameters that will be referred in the HAB case study

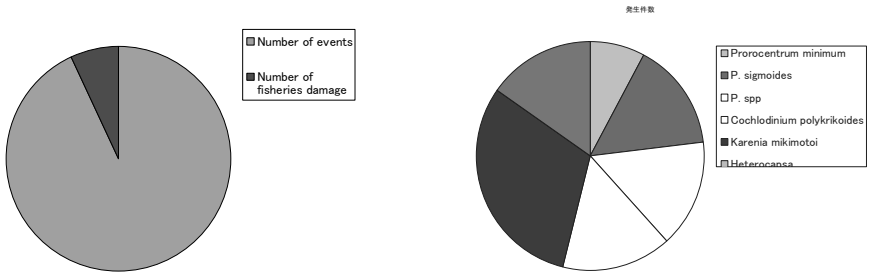
Table 5 Monitoring parameters referred in the HAB case study

	Monitoring parameter	Survey type
HAB	- HAB species (dominant/causative spp.) - Cell density - Bloom area - Fishery damage	Post-HAB survey
Water quality	- Water temp. - Salinity - DO	Post-HAB survey
Others	- Water quality Transparency, Nutrients, Chl.a - Meteorology Weather, Cloud cover, Wind, direction/speed	Regular HAB monitoring survey Regular shellfish-poisoning survey

4 Status of HAB events

4.1 Status of HAB events from year 1978-2007

From year 1978-2007, a total of ○HAB events were recorded, in which ■events induced fishery damage. The most frequently observed HAB species was ●, which was recorded○ times. HAB species that inflicted the most fishery damage was□.



(Present the results using such graphs as above)

In the following sections, the yearly trends, main seasons and duration of HAB events are analyzed.

4.2 Yearly trends of HAB events

During the 27 years between 1978 and 2004, a total of 907 HAB events were recorded, in which 64 events induced fishery damage (Figure 2).

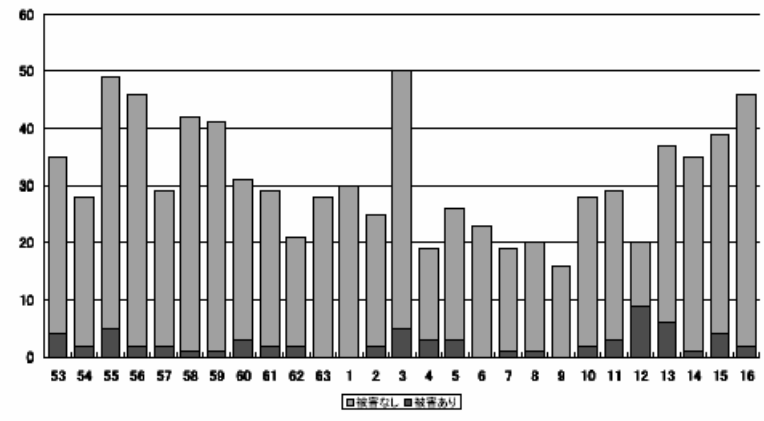


Figure 2 Number of HAB events in Nagasaki Prefecture (1978-2004) ＊Example

Source: Nagasaki Prefectural Institute of Fisheries
(http://www.marinelabo.nagasaki.nagasaki.jp/shikenjoho/PDF_1/018akashio.pdf)

4.3 Yearly trends of HAB season

According to the HAB data from 1978-2004, approximately 60% of HAB events occurred during June-September (Figure 3). Fishery damage occurred most frequently during June-August.

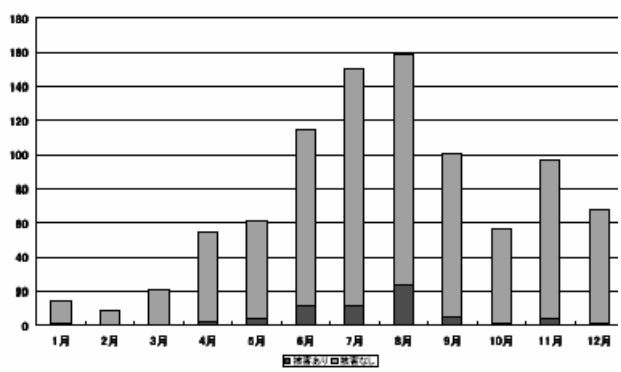


Figure 3 Number of HAB events by month in Nagasaki Prefecture (1978-2004)＊Example

Source: Nagasaki Prefectural Institute of Fisheries
(http://www.marinelabo.nagasaki.nagasaki.jp/shikenjoho/PDF_1/018akashio.pdf)

4.4 Yearly trends of causative species

Table 6 shows the HAB species that were recorded in the northwestern Kyushu sea area between 19**-2006 and their frequency of occurrences. A total of HAB species were recorded and the most frequent species were dinoflagellates such as *Karenia mikimotoi*, *Cochlodinium polykrikoides* etc. Six species caused significant fishery damage namely, *Karenia mikimotoi*, *Cochlodinium polykrikoides*, *Heterocapsa circularisquama* (dinoflagellates) and *Chattonella antique*, *C. marina*, *Heterosigma akashiwo* (raphidophytes).

Table 6 HAB species recorded in the northwestern Kyushu sea area between 19-2006 and their frequency of occurrences**

Genus and Species	Before 1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006 onwards (2006 Nagasaki)	Total
Dinophyceae								
Prorocentrum minimum							1	1
P. sigmoides							2	2
P. spp.							2	2
Cochlodinium polykrikoides							2	2
Karenia mikimotoi							4	4
Heterocapsa circularisquama								
Ceratium furca							2	2
Bacillariophyceae								
Skeletonema costatum								
Diatoms							1	1
Raphidophyceae								
Chattonella antiqua								
C. marina								
Heterosigma akashiwo							3	3
Others								
Cryptophyceae							1	1
Mesodinium rubrum							2	2
Strombidium sp.							1	1
合計							21	21

Note: The underlined species caused significant fishery damage
Source: Nagasaki Prefectural Institute of Fisheries (2007)

5 Status of recent HAB events and results of environmental monitoring

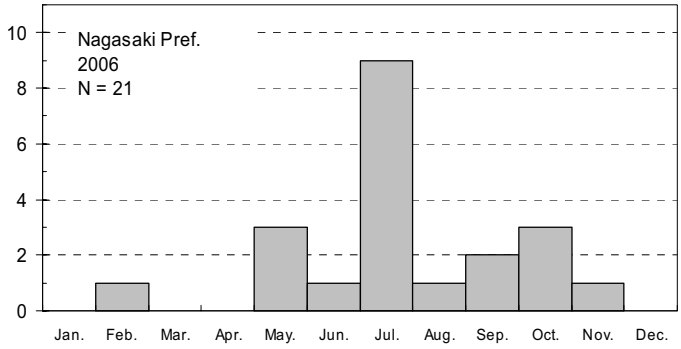
Records of HAB events in 2006 are provided in Annex1.

5.1 Number of HAB events

Records of HAB events in 2006 are provided in Annex1. In 2006, a total of 21 HAB events were recorded, in which 2 events induced fishery damage. The most frequently observed HAB species was *Karenia mikimotoi*.

5.2 Period of HAB events

According to the HAB data in 2006, approximately 43% of HAB events occurred in July (Figure 4).



5.3 Duration of HAB events

Table 7 shows the number of HAB events by duration (no. of days) in 2006. A total of 21 events occurred in 2006, in which 9 events were under 5 days, 3 events between 6-10 days, 7 events between 11-30 days and 2 events over 31 days. The longest HAB duration was 45 days by *Heterosigma akashiwo*, which occurred in Ohumra Bay during May-June.

Table 7 Number of HAB events by duration (no. of days)

	≤ 5 days	6-10 days	11-30 days	≥ 31 days	Total
Nagasaki	9	3(1)	7(1)	2	21
Saga					
Fukuoka					
Yamaguchi					
Total	9	3(1)	7(1)	2	21

Note: The number in the parenthesis shows the number of fishery damage
Source: Nagasaki Prefectural Institute of Fisheries (2007)

5.4 Location of HAB events

Table 6 shows the number of HAB events by area. Figures 4 and 5 show the location of the HAB events. In 2006, 5 events occurred in the northern Kyushu region, 13 events in the western Kyushu region and 3 events in the remote islands. HAB events were most frequent in Imari Bay area in the northern Kyushu region, and Ohmura Bay and Kujyuku Island in the western Kyushu region.

Table 8 Number of HAB events by area

Year	Sea area		No. of events	Causative species
	Sub-area	Spot		
2006	North Kyushu region	Imari Bay	4(1)	*Ceratium furca, Karenia mikimotoi, Prorocentrum sigmoides*, Diatoms
		Hirado(Usuka/Furue Bay)	1	*Cochlodinium polykrikoides*
	West Kyushu region	Ohmura Bay	7	Cryptophyceae*, Heterosigma akashiwo, K. mikimotoi,Prorocentrum* spp.*, P. sigmoides*
		Tachibana Bay	1	*C. furca*
		Kujukushima	5(1)	*Strombidium* sp.*, P.* spp.*, Mesodinium rubrum, K. mikimotoi, Prorocentrum minimum*
	Remote islands	Goto Island	1	*H. akashiwo*
		Tsushima	2	*C. polykrikoides, M. rubrum,*
	Total		21(2)	

Note: The number in the parenthesis shows fishery damage
Source: Nagasaki Prefectural Institute of Fisheries (2007)

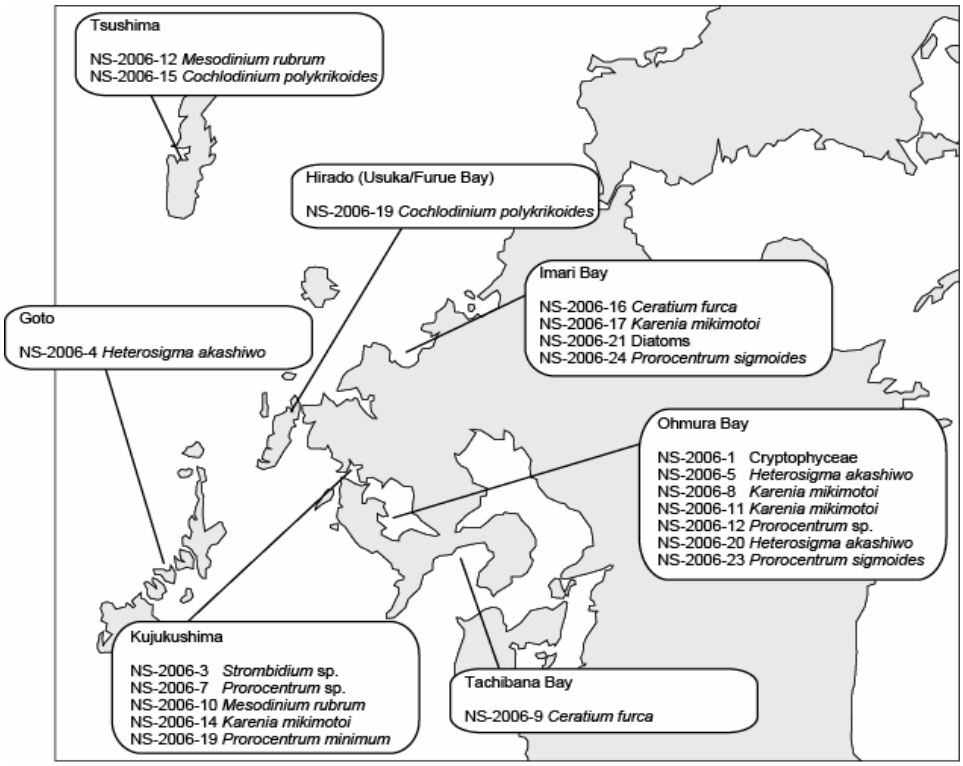
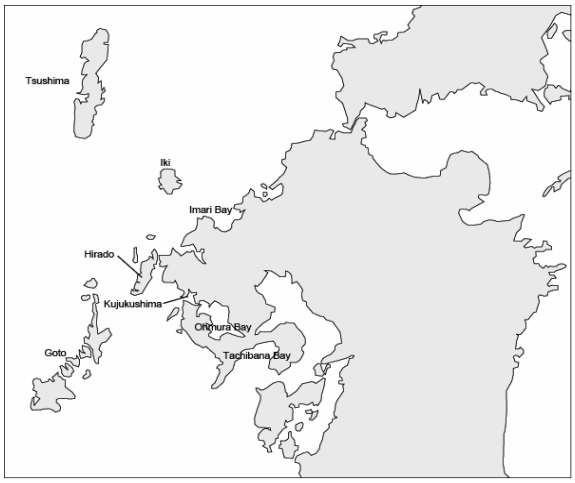
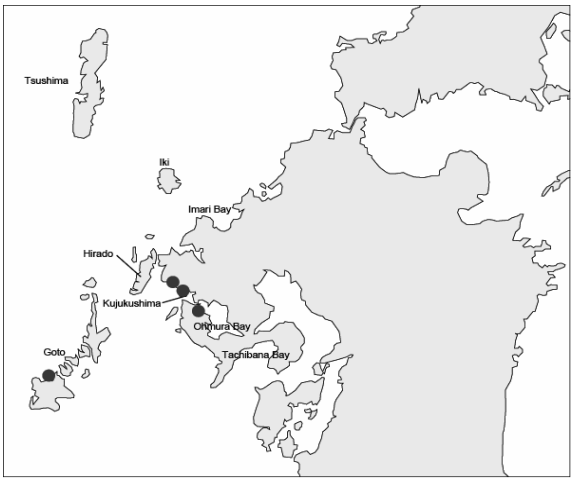


Figure 4 Location of HAB events (event no. and causative species)

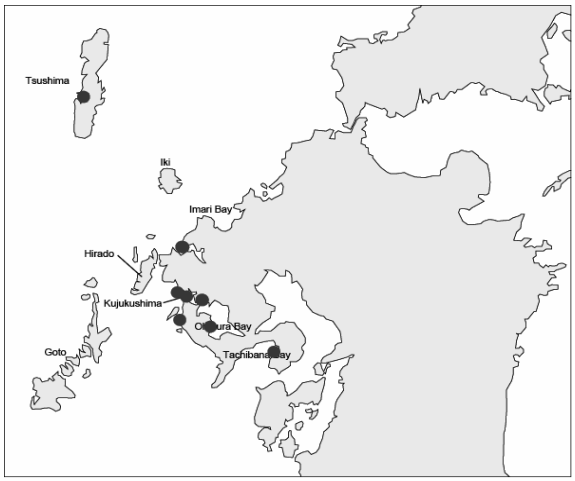
Jan-Feb, 2006



Mar-Apl, 2006

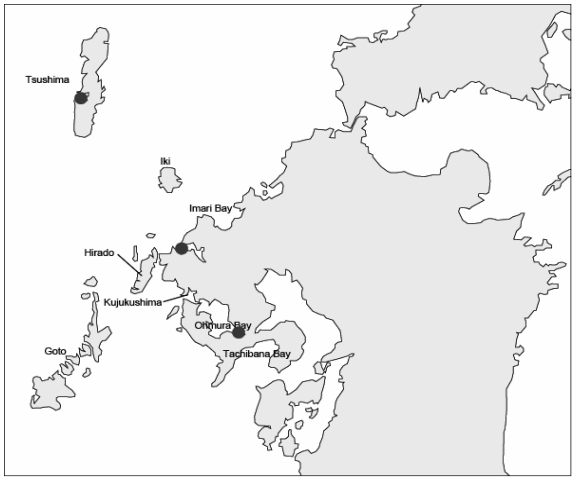


May-Jun, 2006



July-Aug, 2006

Sep-Oct, 2006



Nov-Dec, 2006

Figure 5 Location of HAB events by months (red dots show the location of HAB event)

5.5 Causative species

Table 9 shows the HAB species that were recorded in the northwestern Kyushu sea area in 2006 and their frequency of occurrences. A total of HAB species were recorded and the most frequent species were dinoflagellates such as *Karenia mikimotoi*, *Cochlodinium polykrikoides* etc. Six species caused significant fishery damage namely, *Karenia mikimotoi*, *Cochlodinium polykrikoides*, *Heterocapsa circularisquama* (dinoflagellates) and *Chattonella antique*, *C. marina*, *Heterosigma akashiwo* (raphidophytes).

Table 9 HAB species recorded in the northwestern Kyushu sea area in 2006 and their frequency of occurrences

Genus and Species	2006 onwards (2006 Nagasaki)	Total
Dinophyceae		
Prorocentrum minimum	1	1
P. sigmoides	2	2
P. spp.	2	2
Cochlodinium polykrikoides	2	2
Karenia mikimotoi	4	4
Heterocapsa circularisquama		
Ceratium furca	2	2
Bacillariophyceae		
Skeletonema costatum		
Diatoms	1	1
Raphidophyceae		
Chattonella antiqua		
C. marina		
Heterosigma akashiwo	3	3
Others		
Cryptophyceae	1	1
Mesodinium rubrum	2	2
Strombidium sp.	1	1
合計	21	21

Note: The underlined species caused significant fishery damage
Source: Nagasaki Prefectural Institute of Fisheries (2007)

5.6 Maximum density of each HAB event

Table 10 shows the maximum density of each HAB event that occurred in Nagasaki Prefecture in year 2006. Within these HAB events, the highest maximum density was recorded in May 2006 at Ohmura Bay western Kyushu by *Heterosigma akashiwo*. The recorded maximum density was 225,000 cells/mL.

Table 10 Maximum density of HAB events that occurred in the northeastern Kyushu sea area

Year	Event No.	Causative species	Maximum density (cells or inds/mL)	Affected Area (km^2)
2006	NS-2006-1	Cryptophyceae	148,000	No info.
2006	NS-2006-3	*Strombidium* sp.	55	0.00005
2006	NS-2006-4	*Heterosigma akashiwo*	11,800	0.005
2006	NS-2006-5	*Heterosigma akashiwo*	225,000	No info.
2006	NS-2006-7	*Prorocentrum* sp.	3,400	0.0001
2006	NS-2006-8	*Karenia mikimotoi*	15,800	No info.
2006	NS-2006-9	*Ceratium furca*	6,650	0.44
2006	NS-2006-10	*Mesodinium rubrum*	13,570	No info.
2006	NS-2006-11	*Karenia mikimotoi*	92,200	No info.
2006	NS-2006-12	*Prorocentrum* spp.	721	0.5
2006	NS-2006-14	*Karenia mikimotoi*	8,504	No info.
2006	NS-2006-15	*Cochlodinium polykrikoides*	135	No info.
2006	NS-2006-16	*Ceratium furca*	667	No info.
2006	NS-2006-17	*Karenia mikimotoi*	16,100	No info.
2006	NS-2006-19	*Prorocentrum minimum*	12,800	No info.
2006	NS-2006-20	*Heterosigma akashiwo*	11,500	No info.
2006	NS-2006-21	Diatoms	16,220	No info.
2006	NS-2006-22	*Cochlodinium polykrikoides*	646	0.25
2006	NS-2006-23	*Prorocentrum sigmoides*	160	5.3
2006	NS-2006-24	*Prorocentrum sigmoides*	14,980	2.1
2006	NS-2006-25	*Mesodinium rubrum*	490	No info.

5.7 Status of HAB induced fishery damage

Table 11 shows the fishery damage caused by HAB in Nagasaki Prefecture in year 2006. Fishery damage was recorded twice, both during June. One occurred in Kujukuri Island (western Kyushu) and the other in Imari Bay (north Kyushu). Both incidents were caused by *Karenia mikimotoi*. Cultured puffer fish and Red seabream were affected and the financial loss amounted to 184,000 yen and 10,350,000 yen, respectively.

For further consideration→environmental deterioration by HAB (e.g. deterioration of sediment quality)
(No descriptions in Nagasaki Prefectural Institute of Fisheries (2007))

Table 11 Fishery damage caused by HAB in northeastern Kyushu sea area in year 2006

Month/ Year	Event No.	Sub-area	Spot	Causative Species	Fishery damage		
					Fish/Shellfish Species	Quantity	Economic loss (1,000 yen)
July, 2006	NS-2006-14	West Kyushu	Kujukushima	*Karenia mikimotoi*	Pufferfish Red seabream	Pufferfish: 1000 ind. Red seabream: 70 ind.	184
July, 2006	NS-2006-17	North Kyushu	Imari Bay	*Karenia mikimotoi*	Pufferfish	6900 ind.	10,350

Source: Nagasaki Prefectural Institute of Fisheries (2007)

5.8 Status of target species

(Proposed contents)

- Comment on the yearly and monthly trends of the target HAB species mentioned in Section 3.2 and present the results using a table or figure.

5.9 Environmental monitoring results during HAB events

During the post-HAB survey, water temperature, salinity and DO are measured. Table 12 shows the data obtained for each HAB event. During the HAB events, water temperature ranged between 12.7-27.5 C°, salinity between 26.3-34.9 and DO between 5.2-14.5 mg/L.

Table 12 Data of post-HAB surveys in the northeastern Kyushu sea area

Year	Event No.	Duration	Spot	Water temp. (C°)	Salinity	DO (mg/L)
2006	NS-2006-1	2.24-3.15	Ohmura Bay	12.7	27.4	14.5
2006	NS-2006-3	5.1-5.2	Kujukushima	17.7	33.8	8.6
2006	NS-2006-4	5.15-5.26	Goto	19.5	27.0	9.5
2006	NS-2006-5	5.16-6.29	Ohmura Bay	-	-	-
2006	NS-2006-7	6.1-6.3	Kujukushima	-	-	-
2006	NS-2006-8	7.3-7.14	Ohmura Bay	-	-	-
2006	NS-2006-9	7.4-7.12	Tachbana Bay	-	-	-
2006	NS-2006-10	7.9-7.11	Kujukushima	-	-	-
2006	NS-2006-11	7.8-7.31	Ohmura Bay	-	-	-
2006	NS-2006-12	7.14-7.18	Ohmura Bay	25.3	29.1	8.1
2006	NS-2006-14	7.20-7.25	Kujukushima	-	-	-
2006	NS-2006-15	7.20-7.25	Tsushima	22.8	26.3	5.2
2006	NS-2006-16	7.21-7.23	Imari Bay	26.0	-	-
2006	NS-2006-17	7.25-8.11	Imari Bay	-	-	-
2006	NS-2006-19	8.21-8.25	Kujukushima	26.1	31.9	10.1
2006	NS-2006-20	9.6-9.21	Ohmura Bay	27.5	30.1	-
2006	NS-2006-21	9.22-9.26	Imari Bay	23.0	-	-
2006	NS-2006-22	10.11-10.13	Hirado(Usuka/Furue Bay)	23.0	33.0	7.9
2006	NS-2006-23	10.26-11.6	Ohmura Bay	-	-	-
2006	NS-2006-24	10.30-12.7	Imari Bay	-	-	-
2006	NS-2006-25	11.1-11.3	Tsushima	22.5	34.9	5.8

Source: Nagasaki Prefectural Institute of Fisheries (2007)

5.10 Water quality parameters of regular HAB monitoring survey

Table 13 shows the results of the regular HAB monitoring survey

Table 13 Water quality data obtained during regular HAB monitoring survey in northwestern Kyushu sea area

Survey date	Spot	Survey point	Transparency (m)	Water temp. (C°)	Salinity	DO (mg/L)	NO3-N (μM)	NO2-N (μM)	NH4-N (μM)	PO4-P (μM)	Chl.a (μg/L)
2006/6/21	Imari Bay	1	9.0	22.0	33.4	5.0	0.25	0.01	0.40	0.01	0.9
2006/6/21	Imari Bay	3	5.0	23.5	32.7	5.0	0.04	0.03	0.19	0.06	1.5
2006/6/21	Imari Bay	4	6.0	23.5	32.7	5.2	0.05	0.06	0.30	0.02	1.6
2006/7/18	Imari Bay	1	8.0	24.1	32.7	5.2	-	-	-	-	2.7
2006/7/18	Imari Bay	3	7.0	26.8	31.8	4.7	-	-	-	-	2.1
2006/7/18	Imari Bay	4	7.0	25.9	32.3	4.9	-	-	-	-	2.3
2006/8/7	Imari Bay	1	7.5	29.3	32.2	5.6	1.37	0.07	0.31	0.02	2.0
2006/8/7	Imari Bay	3	7.0	30.1	31.0	5.1	0.24	0.05	0.41	0.03	0.6
2006/8/7	Imari Bay	4	7.0	28.6	31.7	5.4	0.08	0.04	0.32	0.03	1.0
2006/10/18	Imari Bay	1	5.0	23.5	33.1	5.0	0.23	0.06	0.67	0.07	4.8
2006/10/18	Imari Bay	3	3.5	22.9	32.8	4.7	0.05	0.04	0.28	0.13	6.3
2006/10/18	Imari Bay	4	4.5	22.7	32.9	4.8	0.67	0.06	0.22	0.07	4.0
2006/8/29	Ohmura Bay	b	2.5	28.0	30.1	4.5	0.19	0.04	0.29	0.05	3.9
2006/8/29	Ohmura Bay	c	3.0	28.5	30.0	4.2	0.17	0.07	1.41	0.04	2.7
2006/8/29	Ohmura Bay	P	3.0	30.2	29.6	5.3	0.10	0.07	1.24	0.07	3.1
2006/8/29	Ohmura Bay	Z	3.0	29.5	29.7	4.9	0.04	0.07	0.33	0.12	3.0
2006/9/20	Ohmura Bay	b	3.5	25.6	29.5	5.0	3.98	0.34	0.33	0.07	18.7
2006/9/20	Ohmura Bay	c	3.5	26.5	31.0	5.0	0.23	0.05	0.45	0.06	3.7
2006/9/20	Ohmura Bay	P	5.0	26.5	31.6	4.5	0.39	0.12	0.48	0.17	3.9
2006/9/20	Ohmura Bay	Z	4.5	26.5	31.6	4.6	0.42	0.24	0.58	0.22	9.5

Source: Nagasaki Prefectural Institute of Fisheries (2007)

5.11 Meteorological observation parameters

(*this section requires further consideration)

No meteorological information is included in the Nagasaki Prefectural Institute of Fisheries reports of the post-HAB surveys and HAB regular monitoring surveys. Therefore, it is necessary to confirm the status of meteorological observation, and the appropriate meteorological data for the case study.

6 Eutrophication monitoring with satellite image

6.1 Framework of Satellite image monitoring

The following remote sensing data are available for the case study:

- Data from the Marine Environmental Watch Project

The Marine Environmental Watch Project was established at NPEC through the initiative of Japan's Ministry of the Environment, and has been under operation since 2002. It provides remote sensing data of chlorophyll-a concentration and sea surface temperature.

Data of chlorophyll-a concentration are obtained from either NASA's (Terra) or JAXA's (Aqua) satellite, which are installed with MODIS sensor. MODIS data are processed with a chlorophyll-a algorithm developed by JAXA. Data from Terra is considered to be unreliable.

Observation parameters: chlorophyll-a, sea surface temperature (SST), etc.
Available data period (chlorophyll-a): August 2002 onwards (February 2003 onwards for MODIS (Aqua))
Observation frequency (chlorophyll-a): 1-3 per day
Resolution (chlorophyll-a): 1 km x 1 km

- Web site of 'Ocean Color Web'

NASA's web site 'Ocean Color Web' provides global chlorophyll-a concentration data, which are downloadable. Chlorophyll-a concentration data are obtained from CZCS, OCTS, SeaWiFS and MODIS sensors, and are processed with an algorithm developed by NASA. These data are currently considered as the global standard. With SeaWifs data, only five-year post-observation data are accessible. NASA considers that the quality is inadequate with CZCS and OCTS data. Also, all satellites except Aqua (MODIS) are already out of operation.

6.2 Parameters of satellite image monitoring

Table 14 shows available remote sensing data for the case study.

Table 14 Remote sensing data available for the case study

Organization	Name of system	Monitoring Parameters	Data Set available					
			Sensor	Period of data	Unit of data set	Resolution	Product data level	Processing algorithm
NPEC	Marine Environmental Protection of Northwest Pacific Region	Chlorophyll a	MODIS (Aqua/Terra)	2002.8-2011	Pass	1 km	Level 2	JAXA GLI Chl-a algorithm
		SST	AVHRR (NOAA)	2002.1-2012	Pass	1 km	Level 0	Tera Scan SST algorithm
			MODIS (Aqua)	2002.8-2011	Pass	1 km	Level 2	JAXA GLI Chl-a algorithm
NASA	Ocean Color Web	Chlorophyll a	CZCS (SeaStar)	1978.11-1986.6	Daily, 8 Day, Monthly, Seasonal, Annual	4 km	Level 3	NASA OC4 Chl-a algorithm
						9 km		
			OCTS (ADEOS)	1996.8-1997.7	Daily, 8 Day, Monthly, Seasonal, Annual	9 km	Level 3	
			SeaWiFS (Orbview-2)	1997.9-2004.12	Daily	1 km	Level 2	
					Daily, 8 Day, Monthly, Seasonal, Annual	9 km	Level 3	
			MODIS (Aqua)	2002.6-2011	Pass	1 km	Level 1	
					Pass	1 km	Level 12	
					Daily, 8 Day, Monthly, Seasonal, Annual	4 km	Level 13	
						9 km		

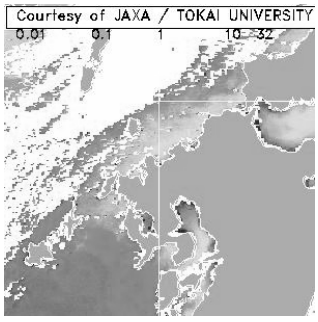
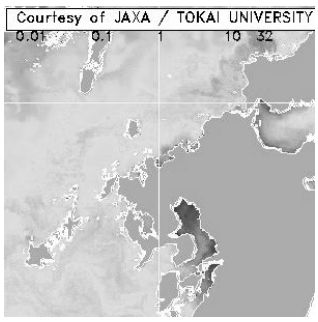
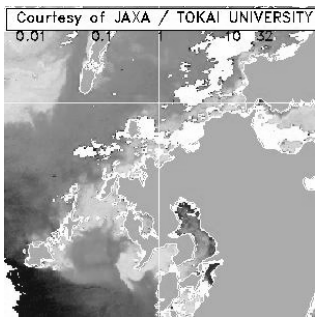
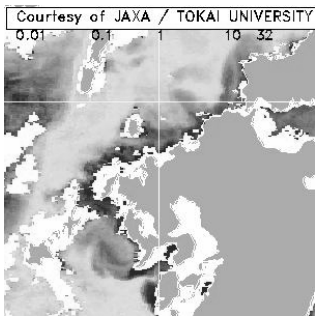
6.3 Results of satellite image monitoring

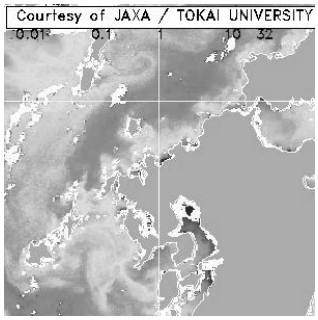
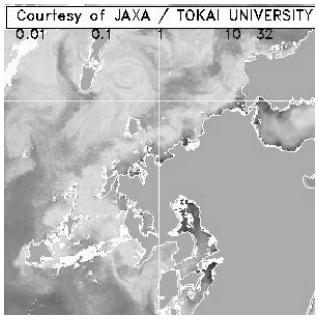
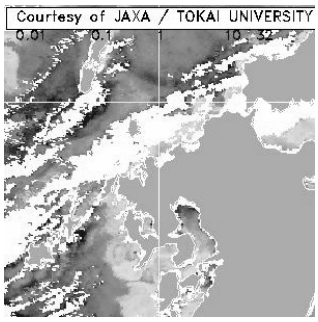
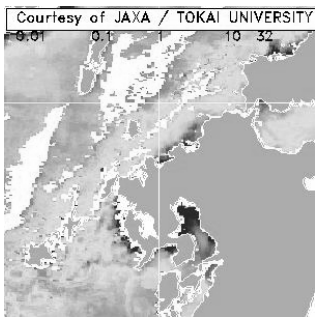
The case study will provide the following information:

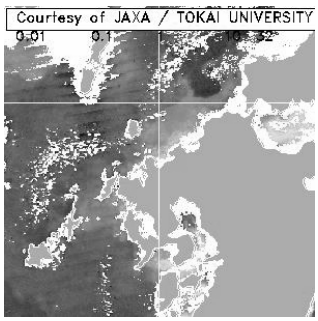
- Average chlorophyll-a concentration within the study period
- Monthly average chlorophyll-a concentration
- Images of chlorophyll-a concentration and SST for each HAB event

The following table shows satellite images during HAB events.

Table 15 Satellite images during HAB events in the northeastern Kyushu sea area

Year	Event No.	Duration	Spot	Sea surface chlorophyll concentration (from Marine Calendar)	SST (from Marine Calendar)
2006	NS-2006-1	2.24-3.15	Ohmura Bay		
2006	NS-2006-3	5.1-5.2	Kujukushima		–
2006	NS-2006-4	5.15-5.26	Goto	–	–
2006	NS-2006-5	5.16-6.29	Ohmura Bay	–	–
2006	NS-2006-7	6.1-6.3	Kujukushima		
2006	NS-2006-8	7.3-7.14	Ohmura Bay		
2006	NS-2006-9	7.4-7.12	Tachibana Bay	–	–
2006	NS-2006-10	7.9-7.11	Kujukushima	–	–
2006	NS-2006-11	7.8-7.31	Ohmura Bay		
2006	NS-2006-12	7.14-7.18	Ohmura Bay	–	–

2006	NS-2006-14	7.20-7.25	Kujukushima	–	–
2006	NS-2006-15	7.20-7.25	Tsushima	–	–
2006	NS-2006-16	7.21-7.23	Imari Bay	–	–
2006	NS-2006-17	7.25-8.11	Imari Bay		–
2006	NS-2006-19	8.21-8.25	Kujukushima		
2006	NS-2006-20	9.6-9.21	Ohmura Bay		
2006	NS-2006-21	9.22-9.26	Imari Bay	–	–
2006	NS-2006-22	10.11-10.13	Hirado(Usuka/Furue Bay)	–	–
2006	NS-2006-23	10.26-11.6	Ohmura Bay		
2006	NS-2006-24	10.30-12.7	Imari Bay	–	–

2006	NS-2006-25	11.1-11.3	Tsushima		–

Note: '－' in the satellite image column means that sea color and SST could not be recorded due to cloud cover
Source: Marine Environmental Protection of Northwest Pacific Region Marine Calendar
（http://www.nowpap3.go.jp/jsw/jpn/callender/index.html）

7 Conclusion

(Proposed contents)

- Examine the relationship between HAB events and environmental parameters (water quality and meteorology) by comparing the results of Chapters 5 and 6.
- Consider the application options of satellite image for monitoring HAB events
- Stress the importance of international partnership and cooperation.

8 References

Annex1 Records of HAB events in the Northwestern Sea Area of Kyushu Region

Event No.			Duration(Start)			Duration(End)			Continuous days	Locatio of occurrence		Causative species	Maximum density (cells･inds./mL)	Fishery damage			Environmental parameters			Size of bloom (km^2)
Pref. Code	Year	No.	Year	Month	day	Year	Month	day		Sub-area	Spot			Fish/Shellfish species	Quantity	Economic loss (1,000 yen)	Temp. (℃)	Salinity	DO (mg/L)	
NS	2006	1	2006	2	24	2006	3	15	20	West Kyushu	Ohmura Bay	Cryptophyceae	148,000				12.7	27.4	14.5	-
NS	2006	3	2006	5	1	2006	5	2	2	West Kyushu	Kujukushima	Strombidium sp.	55				17.7	33.8	8.6	0.00005
NS	2006	4	2006	5	15	2006	5	26	12	Remote Is.	Goto	Heterosigma akashiwo	11,800				19.5	27.0	9.5	0.005
NS	2006	5	2006	5	16	2006	6	29	45	West Kyushu	Ohmura Bay	Heterosigma akashiwo	225,000				-	-	-	-
NS	2006	7	2006	6	1	2006	6	3	3	West Kyushu	Kujukushima	Prorocentrum sp.	3,400				-	-	-	0.0001
NS	2006	8	2006	7	3	2006	7	14	12	West Kyushu	Ohmura Bay	Karenia mikimotoi	15,800				-	-	-	-
NS	2006	9	2006	7	4	2006	7	12	9	West Kyushu	Tachibana Bay	Ceratium furca	6,650				-	-	-	0.44
NS	2006	10	2006	7	9	2006	7	11	3	West Kyushu	Kujukushima	Mesodinium rubrum	13,570				-	-	-	-
NS	2006	11	2006	7	8	2006	7	31	24	West Kyushu	Ohmura Bay	Karenia mikimotoi	92,200				-	-	-	-
NS	2006	12	2006	7	14	2006	7	18	5	West Kyushu	Ohmura Bay	Prorocentrum spp.	721				25.3	29.1	8.1	0.5
NS	2006	14	2006	7	20	2006	7	25	6	West Kyushu	Kujukushima	Karenia mikimotoi	8,504	Pufferfish Red seabream	Pufferfish: 1000 ind. Red seabream: 70 ind.	184	-	-	-	-
NS	2006	15	2006	7	20	2006	7	25	6	Remote Is.	Tsushima	Cochlodinium polykrikoides	135				22.8	26.3	5.2	-
NS	2006	16	2006	7	21	2006	7	23	3	North Kyushu	Imari Bay	Ceratium furca	667				26.0	-	-	-
NS	2006	17	2006	7	25	2006	8	11	18	North Kyushu	Imari Bay	Karenia mikimotoi	16,100	Pufferfish	6900 ind.	10,350	-	-	-	-
NS	2006	19	2006	8	21	2006	8	25	5	West Kyushu	Kujukushima	Prorocentrum minimum	12,800				26.1	31.9	10.1	-
NS	2006	20	2006	9	6	2006	9	21	16	West Kyushu	Ohmura Bay	Heterosigma akashiwo	11,500				27.5	30.1	-	-
NS	2006	21	2006	9	22	2006	9	26	5	North Kyushu	Imari Bay	Diatoms	16,220				23.0	-	-	-
NS	2006	22	2006	10	11	2006	10	13	3	North Kyushu	Hirado(Usuka/Furue Bay)	Cochlodinium polykrikoides	646				23.0	33.0	7.9	0.25
NS	2006	23	2006	10	26	2006	11	6	12	West Kyushu	Ohmura Bay	Prorocentrum sigmoides	160				-	-	-	5.3
NS	2006	24	2006	10	30	2006	12	7	39	North Kyushu	Imari Bay	Prorocentrum sigmoides	14,980				-	-	-	2.1
NS	2006	25	2006	11	1	2006	11	3	3	Remote Is.	Tsushima	Mesodinium rubrum	490				22.5	34.9	5.8	-