Assessment of eutrophication status in Toyama Bay based on the “Procedures for assessment of eutrophication status including evaluation of land based sources of nutrients for the NOWPAP region”

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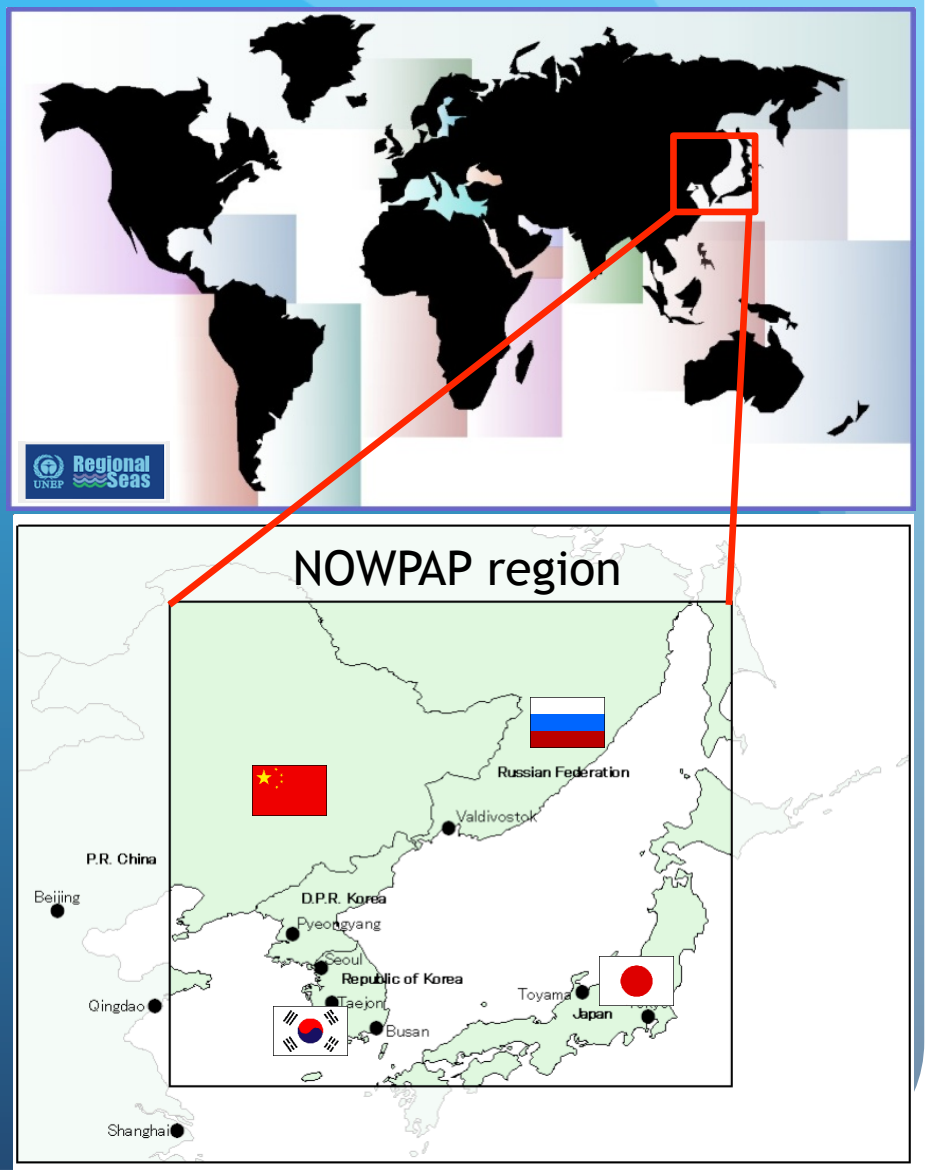
Outline

- 1. NOWPAP CEARAC and the Common Procedures for assessment of eutrophication
- 2. Preliminary assessment of eutrophication by remote sensing
- 3. Holistic assessment of eutrophication based on the Common Procedures
- 4. Potential areas of collaboration with YSLME

1. Regional Sea Program and NOWPAP

- Regional Sea Program (RSP)
  - Launched in 1974 by UNEP to address the accelerating degradation of the world's oceans and coastal areas.
  - RSP covers 18 regions across the world today
- NOWPAP
  - Adopted in 1994
  - China, Japan Korea and Russia
  - Latitude 33 - 52^{O}N
  - Longitude 121 – 143E



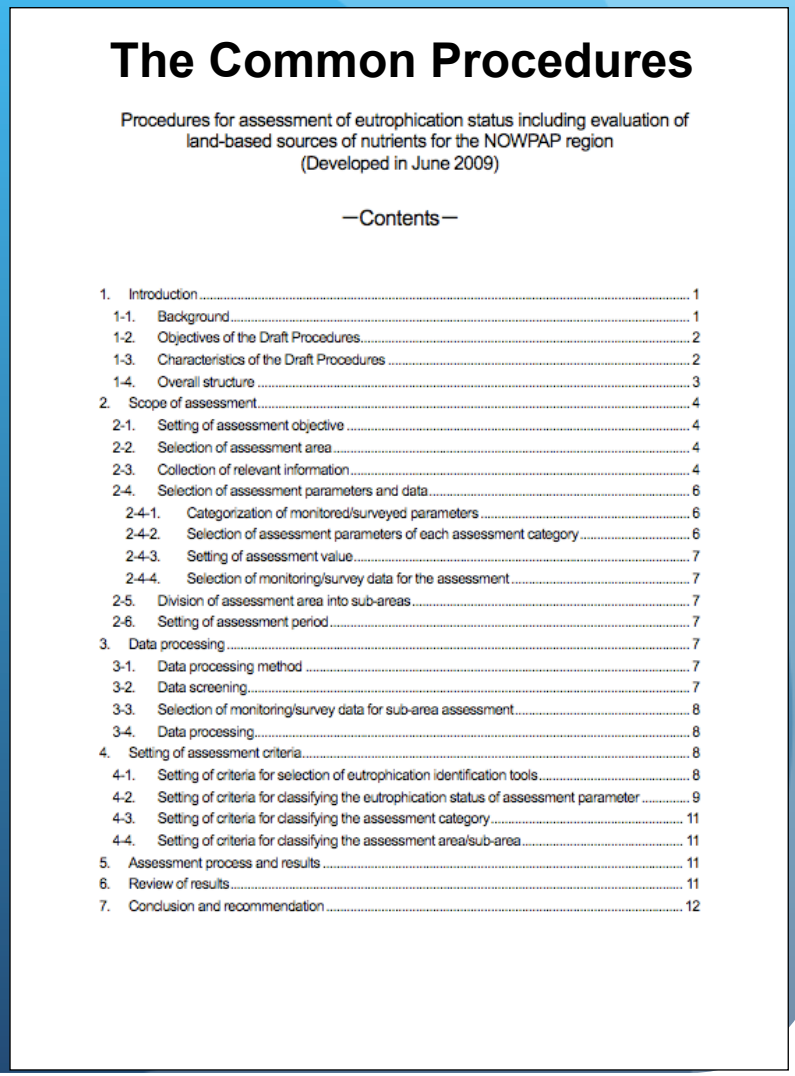
Mission of NOWPAP CEARAC

UNEP NOWPAP CEARAC

- Mission
  - Assessment of the state of the marine, coastal associated fresh water environment
  - Development of tool for environmental assessment
- Activities
  - Harmful Algal Blooms
  - Remote Sensing of Marine Environment
  - **Assessment of eutrophication**
  - Marine Litters
  - Marine biodiversity

Development of procedures for holistic eutrophication assessment

- Procedures for assessment of eutrophication status including evaluation of land-based sources for nutrients for the NOWPAP region (June, 2009)
- Developed with experts of HAB and Ocean Remote sensing, referring to experiences in European countries such as HELCOM and OSPAR
- Available on CEARAC Website at http://cearac.nowpap.org/



The Common Procedures

Procedures for assessment of eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region
(Developed in June 2009)

—Contents—

2. Preliminary assessment of eutrophication by remote sensing

- Objective
  - To detect potential eutrophic area only with satellite derived Chlorophyll-a concentration (satellite Chl-a)

Preliminary Assessment for screening

Detection of potential eutrophic areas by satellite Chl-a

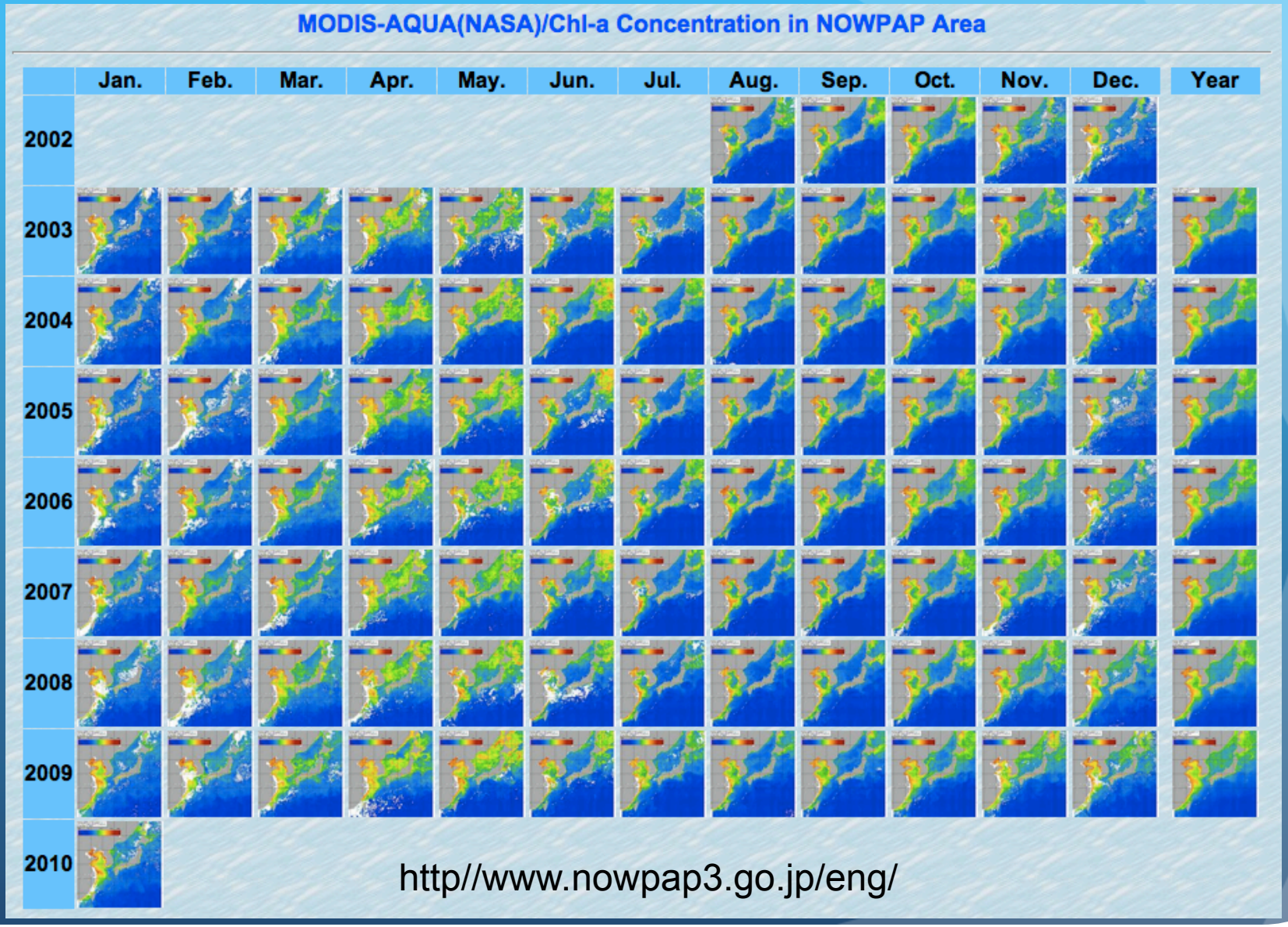
Holistic Assessment for finding drivers

Detailed assessment in the detected potential eutrophic areas with the Common Procedures

Ideas behind the preliminary assessment

Means of observation	Strength	Weaknesses
Satellite Remote Sensing **Preliminary Assessment for screening**	•Wider area and higher temporal coverage •Free data access over the Internet •Objectively detect relative change	•Low accuracy in estimation of Chl-a in coastal area •No data obtained under cloud •Data is available only at sea surface
Ship board measurement **Holistic Assessment for finding drivers**	•Obtain data under sea surface •Can obtain actual measured value	•Data represent only point of information •Analysis of Chl-a need expertise •Costly

Marine Environment Watch Project

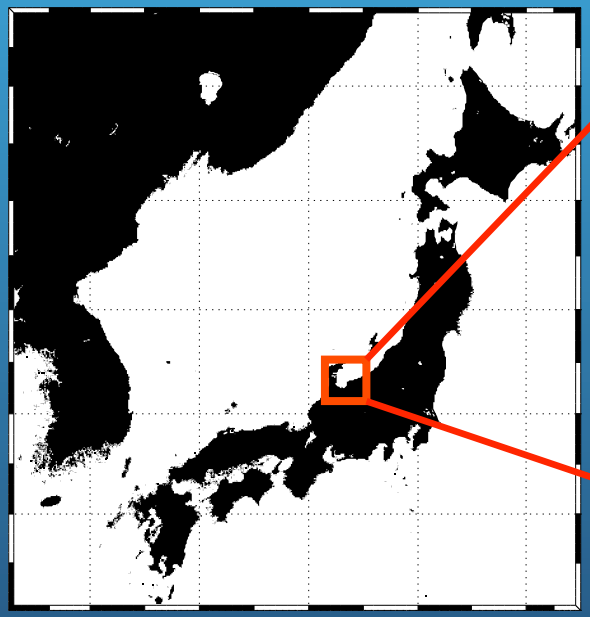


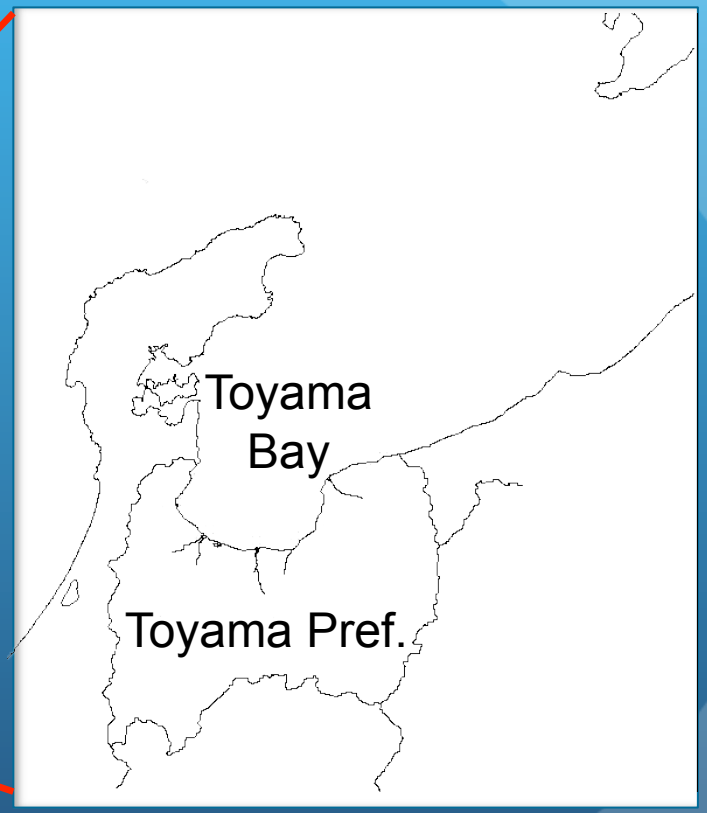
http//www.nowpap3.go.jp/eng/

Location of study area

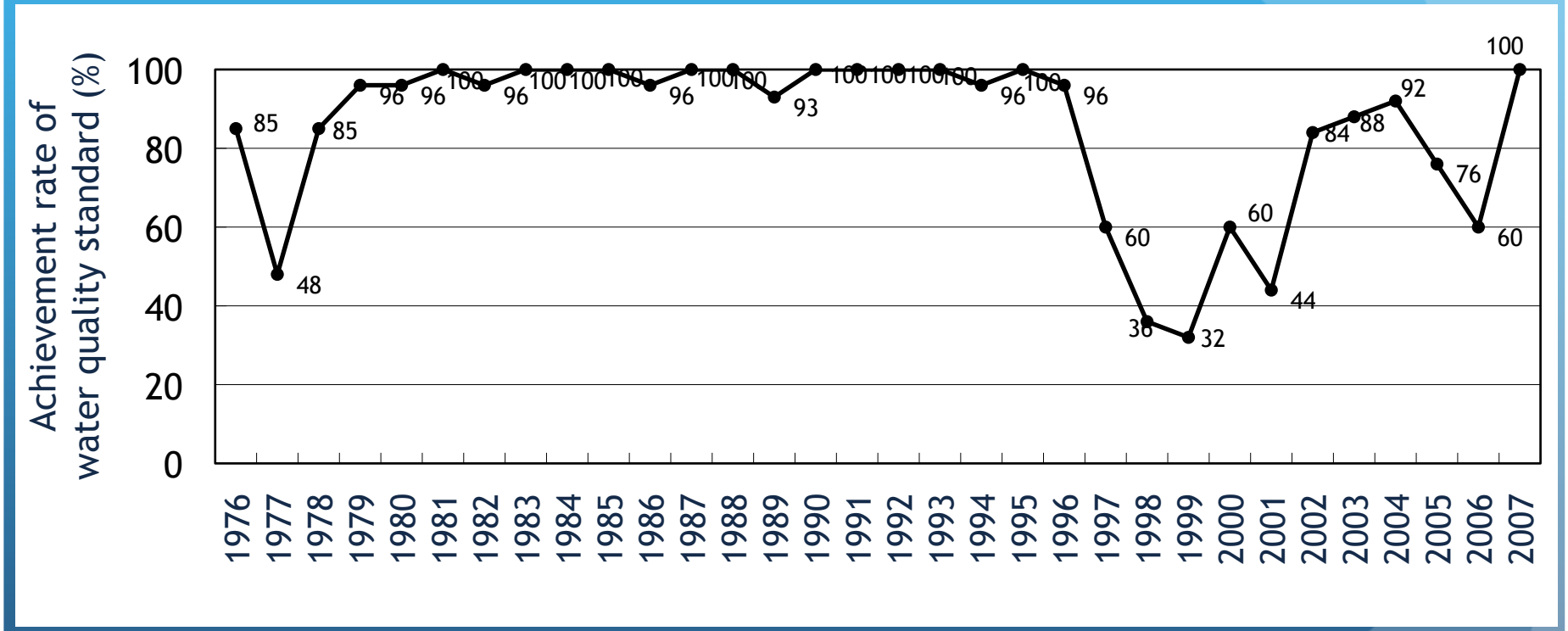
36.5 to 38.0°N

136.5 to 138.5°E





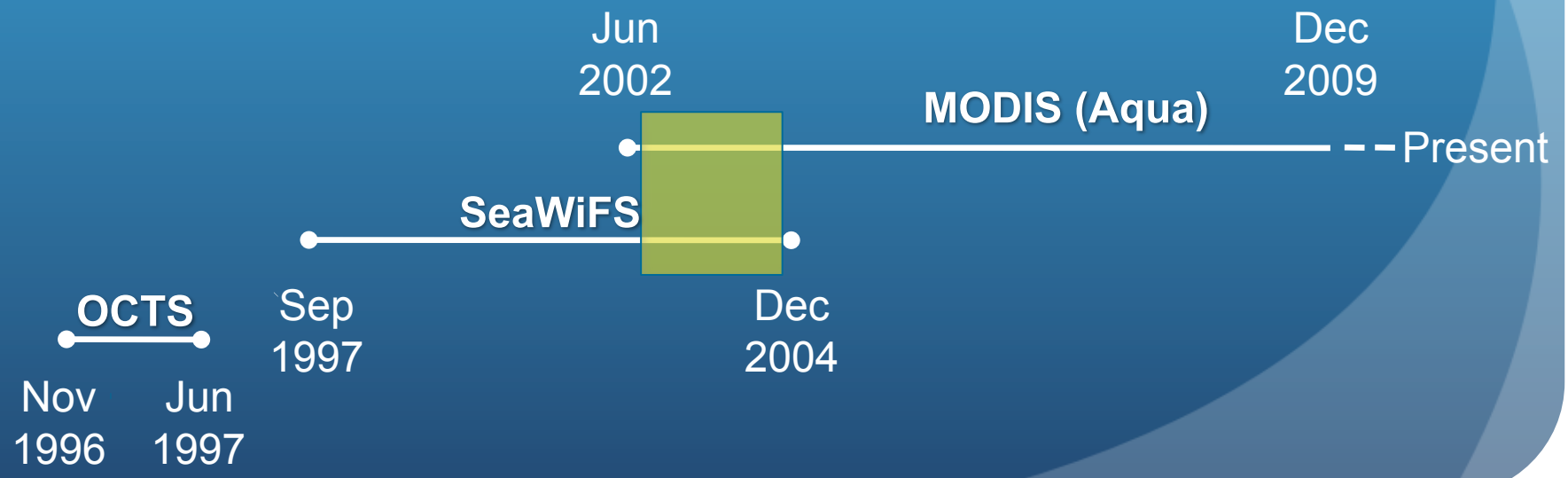
Water quality degradation in coastal area of Toyama Bay



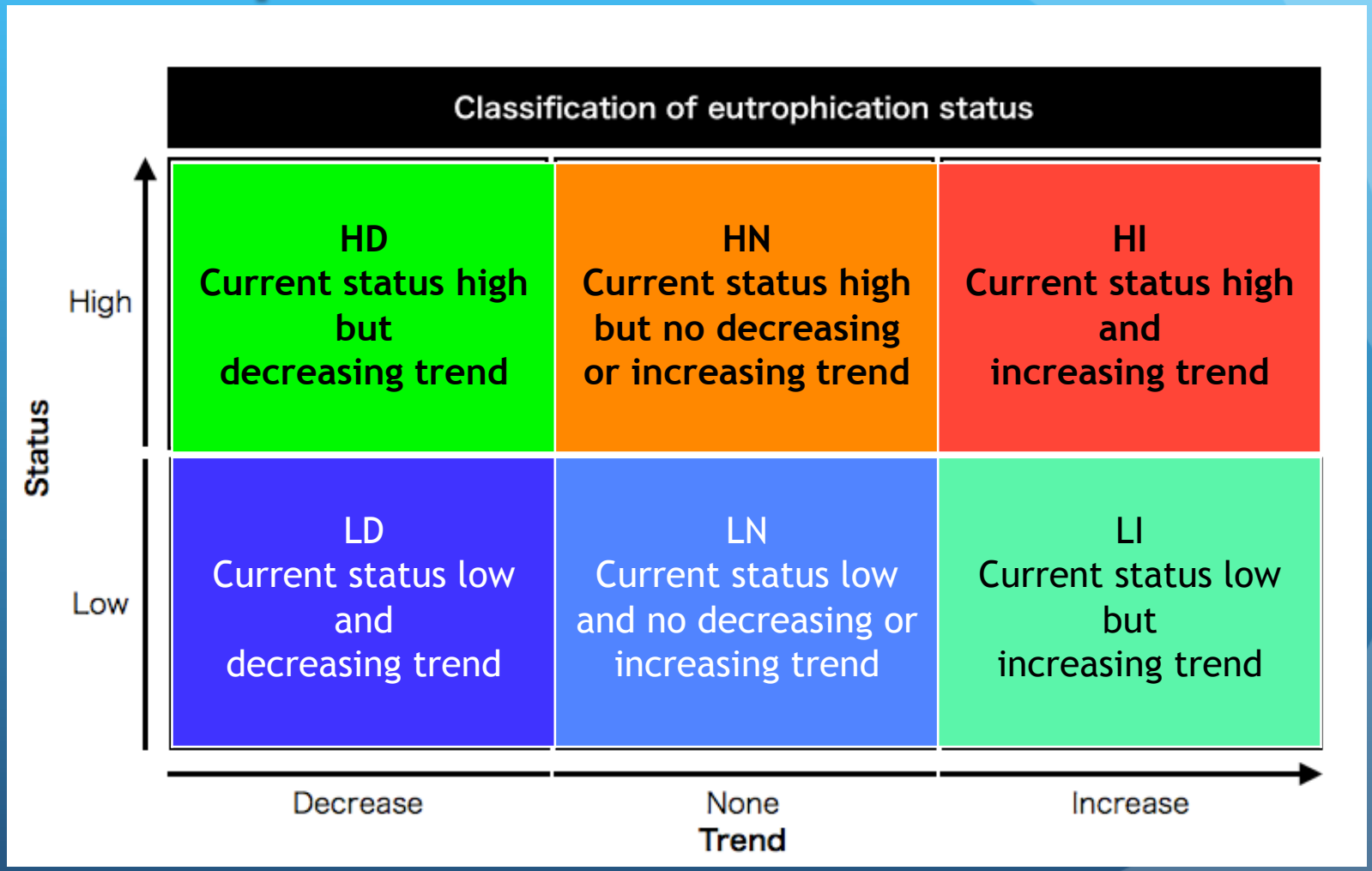
Inter-annual change of water quality measured by COD in coastal area of Toyama Bay

Data used for preliminary assessment

Sensor	NASDA (JAXA) OCTS on ADEOS NASA SeaWiFS on Orbview 2 NASA MODIS on Aqua
Algorithm	NASA OC4 (standard algorithm)
Duration	13 Years from Jan 1997 to Dec 2009
Data	Monthly composite

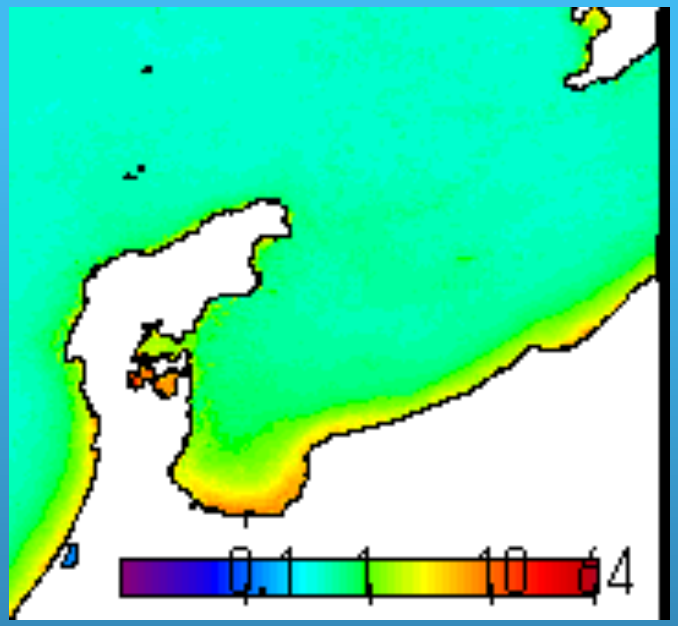


Classification of Eutrophication Assessment



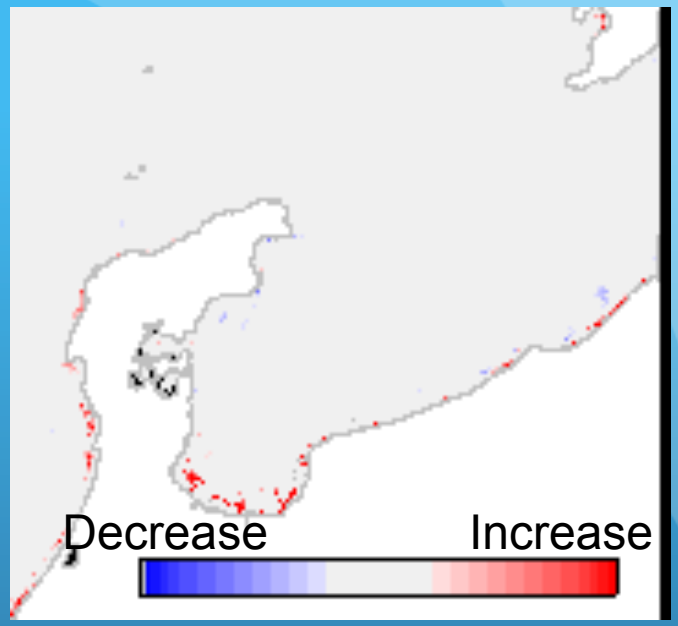
Classification base on the Common Procedures (NOWPAP CEARAC, 2009)

Methods



Overall mean for 13 years divided by 5μg L^{-1} based on Bricker *et al*. (2003)

High or Low

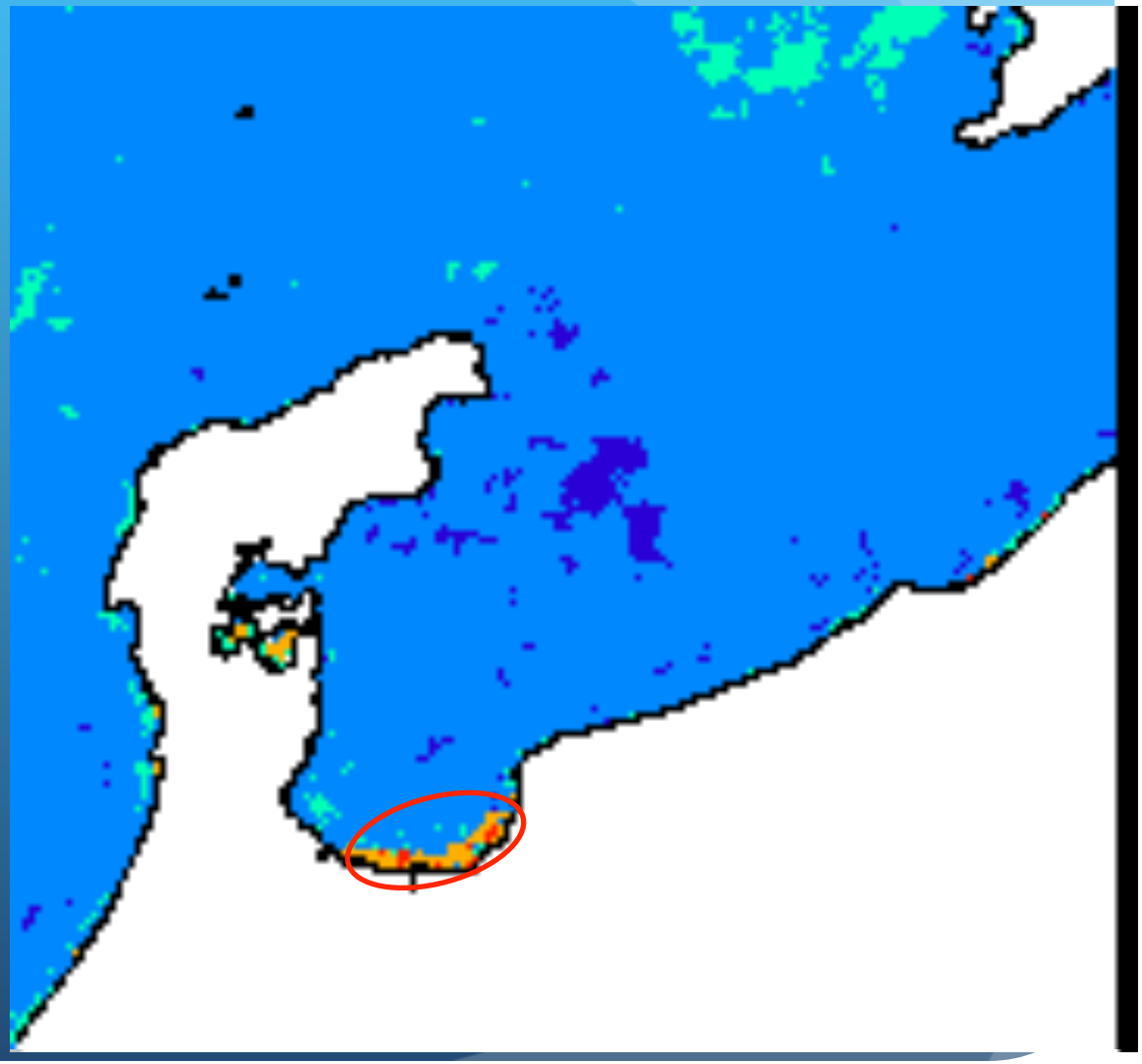


Trend and its significance of annual Chl-a max in each pixel detected by Sen's slope test at 90% (Kahru, 2008)

Increase (red), Decrease (blue) and Non Trend (white)

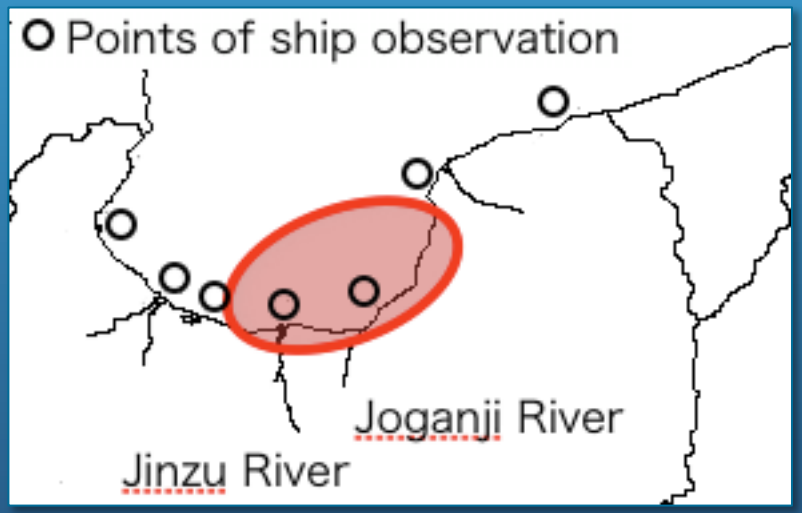
Results of eutrophication classification

HI	Severe eutrohic area -> Holistic assessment needed
HN	Eutrophic area -> Holistic assessment needed
HD	Potential eutrophic area -> Holistic assessment needed
LI	Potential eutrophic area -> Holistic assessment needed
LN	Non eutrophic area -> No Holistic assessment needed
LD	Non eutrophic area -> No Holistic assessment needed



3. Holistic assessment in the detected potential eutrophic area

- Objectives
  - To find out drivers of eutrophication in the detected potential eutrophic area with shipboard measured data



Detected eutrophic area by preliminary assessment

Holistic Assessment for finding drivers

Detailed assessment with the Common Procedures in the detected potential eutrophic areas by satellite Chl-a

Data used for secondary checkup

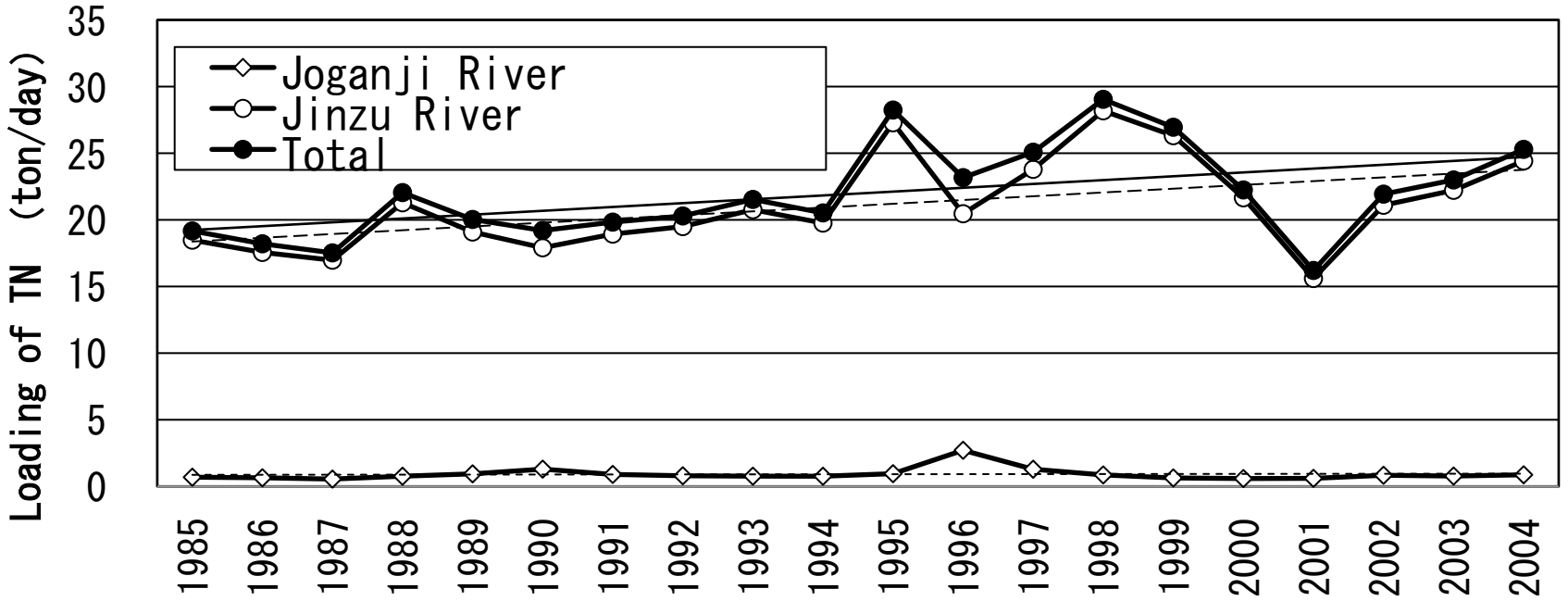
Category	Parameters	Application of identification tools		
		Status (High or Low)		Trend
		Comparison	Occurrence	
I Degree of nutrient enrichment (NE)	Loading of TN and TP	-	-	✓
	TN and TP	✓	-	✓
	Winter DIN and DIP	✓	-	✓
	Winter DIN/DIP ratio	✓	-	✓
II Direct effects of NE	Chl-a (field data)	✓	-	✓
	Chl-a (satellite)	✓	-	✓
	Red tide (diatom)	-	✓	✓
III Indirect effects of NE	DO	✓	-	✓
	Fish kill	-	✓	✓
	COD	✓	-	✓
IV Other possible effects of NE	Food poisoning	-	✓	✓
	Red tide (*Noctiluca* sp.)	-	✓	✓

Criteria to indentify status

Category	Parameters	Status (High or Low)	
		Comparison	Occurrence
I Degree of nutrient enrichment (NE)	TN TP Winter DIN Winter DIP Winter DIN/DIP ratio	0.3 mg/L 0.03 mg/L 0.144 mg/L 0.017 mg/L 16	- - - -
II Direct effects of NE	Chl-a (for both field and satellite data) Red tide (diatom)	6 μg/L (annual mean)/ 20 μg/L (annual max) -	- - 1 occurrence
III Indirect effects of NE	DO Fish kill COD	6.0 mg/L - 3.0 mg/L	- 1 occurrence -
IV Other possible effects of NE	Food poisoning Red tide (*Noctiluca* sp.)	- -	1 occurrence 1 occurrence

Criteria to indentify trend (I)

Category I - Loading of TN

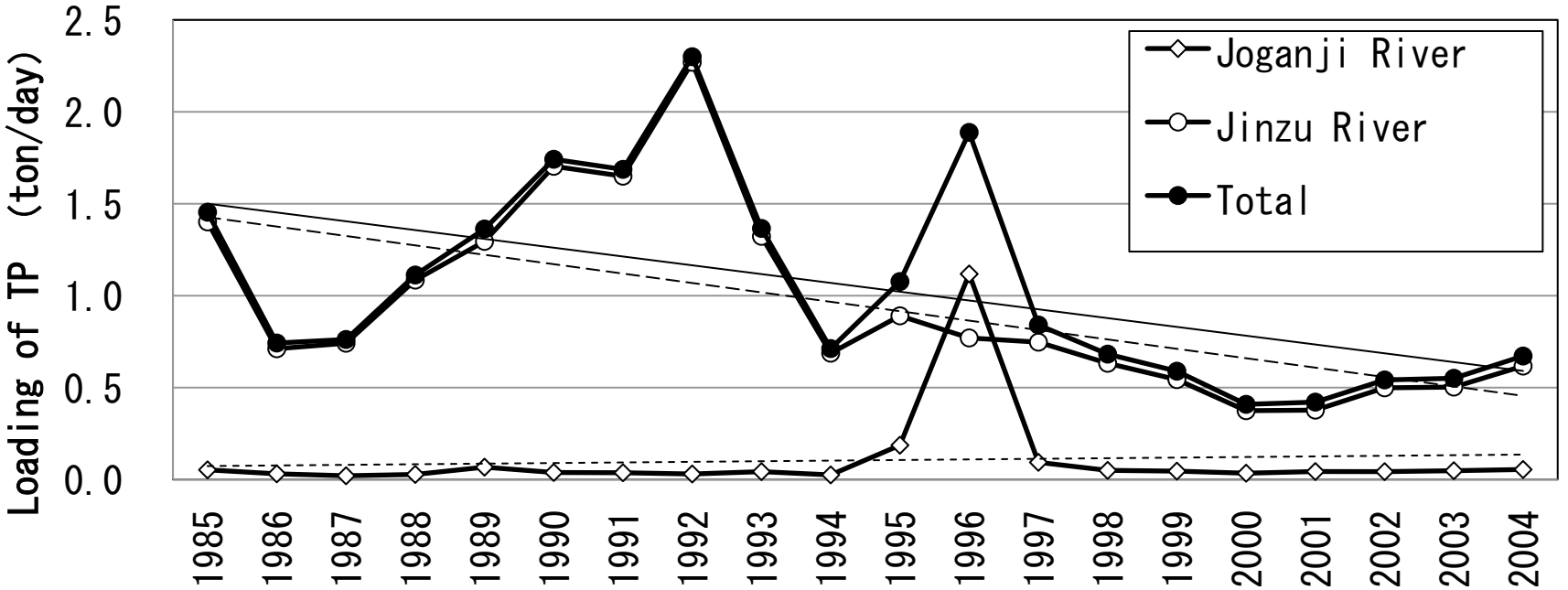


Location	Kendall tau rank correlation coefficient (τ)	Probability (p)	Significant difference	Identification Result
Joganji R.	0.064	0.697	ns	N
Jinzu R.	0.453	0.005	**	I
Total	0.449	0.006	**	I

ns: no significant difference detected, *:<0.05, **:<0.01

Criteria to indentify trend (II)

Category I - Loading of TP



Location	Kendall tau rank correlation coefficient(τ)	Probability(p)	Significant difference	Identification result
Joganji R.	0.218	0.205	ns	N
Jinzu R.	-0.512	0.002	**	D
Total	-0.432	0.008	**	D

ns: no significant difference detected, *:<0.05, **:<0.01

Results from secondary checkups

Category	Parameter	Identification			Classification	
		Status		Trend	by Parameter	by Category
		Comparison	Occurrence			
I	Loading of TN	-	-	I	I	HI
	Loading of TP	-	-	D	D	
	TN	L	-	None	LN	
	TP	L	-	None	LN	
	Winter DIN	H	-	None	HN	
	Winter DIP	L	-	None	LN	
	Winter DIN/DIP ratio	-	-	None	N	
II	Annual max Chl-a (field)	L	-	None	LN	HN
	Annual mean Chl-a (field)	L	-	None	LN	
	Annual max Chl-a (satellite)	H	-	None	HN	
	Annual mean Chl-a (satellite)	L	-	None	LN	
	Red tide (diatom)	-	None	D	LD	
III	DO	H	-	D	LI	LI
	Fish kill	-	None	None	LN	
	COD	L	-	I	LI	
IV	Food poisoning	-	None	None	LN	LN
	Red tide (Noctiluca)	-	None	None	LN	

Summary

- 1. Preliminarily assessment by remote sensing was useful to detect potential eutrophic area
- 2. Holistic assessment of eutrophication based on the Common Procedures was useful to find drivers

Category	Classification results	Interpretation of results
I Degree of nutrient Enrichment (NE)	HI	Nitrogen was considered as a driver of eutrophication, because loading of TN was increased and winter DIN was also high
II Direct effects of NE	HN	Annual max of Chl-a over 20μg/L was recorded in satellite observation, and therefore routine observation is required
III Indirect effects of NE	LI	Continuous observation is necessary, because decrease of DO and increase of COD was found.
IV Other possible effects of NE	LN	Eutrophication is not yet proceeded in category IV, but continuous observation is necessary.

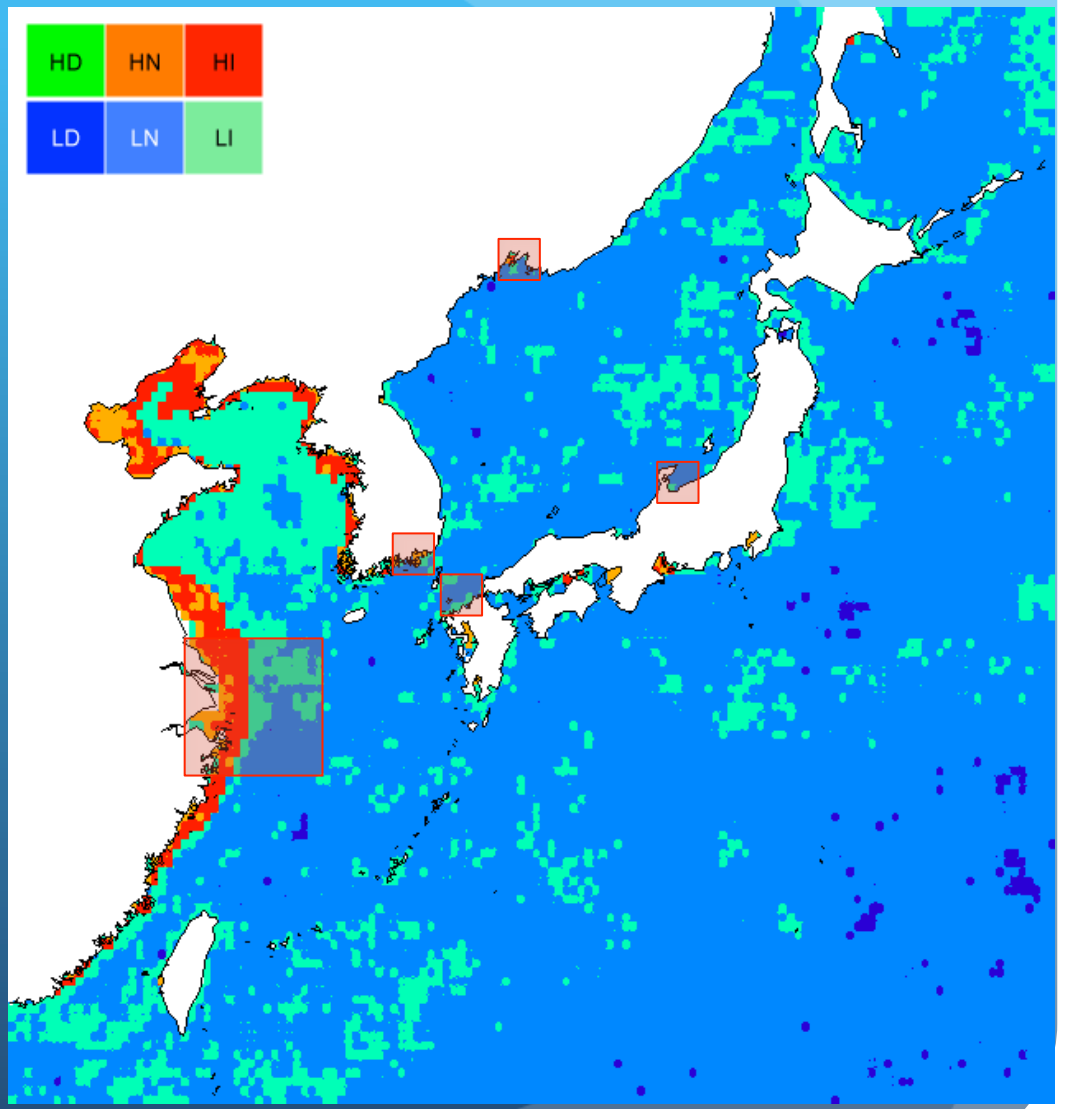
4. Potential collaboration with YSLME

Preliminary Assessment by remote sensing

- Refining of satellite Chl-a algorithm by YSLME Ocean Color project

Holistic Assessment by the Common Procedures

- Addition of area for case study
- Building bridge between policy makers and local communities




Thank you very much!