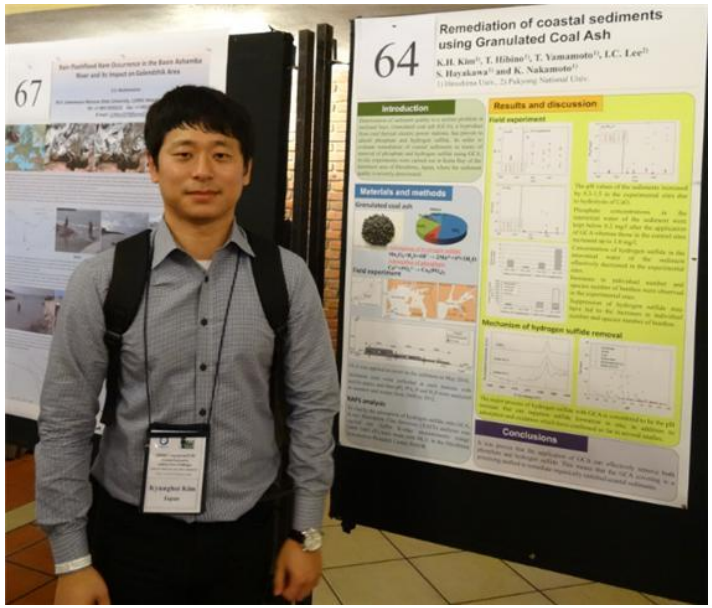
Analysis of Marine Environment and Fish Catch using Marine Monitoring Data

Dept. of Ocean Engineering, PKNU
K. Kim

Speaker information



2006-2009 Ph.D. Hiroshima University, Japan
(Minor: Marine Environmental Engineering)
2009-2014 Postdoctoral Research Fellow, Assistant Prof.
Hiroshima University
2014-Present Professor (Assistant, Associate and Full)
Dept. of Ocean Engineering
Pukyong National University
2023-Present Research Fellow, Airlangga University
(Indonesia)

Research interests

Analysis of Physical Environment in Coastal Zone

Remediation of Coastal Environment

Restoration of Ecological Zone

Renewable Marine Resource and Energy

Homepage: https://cms.pknu.ac.kr/oceanic/main.do

Introduction

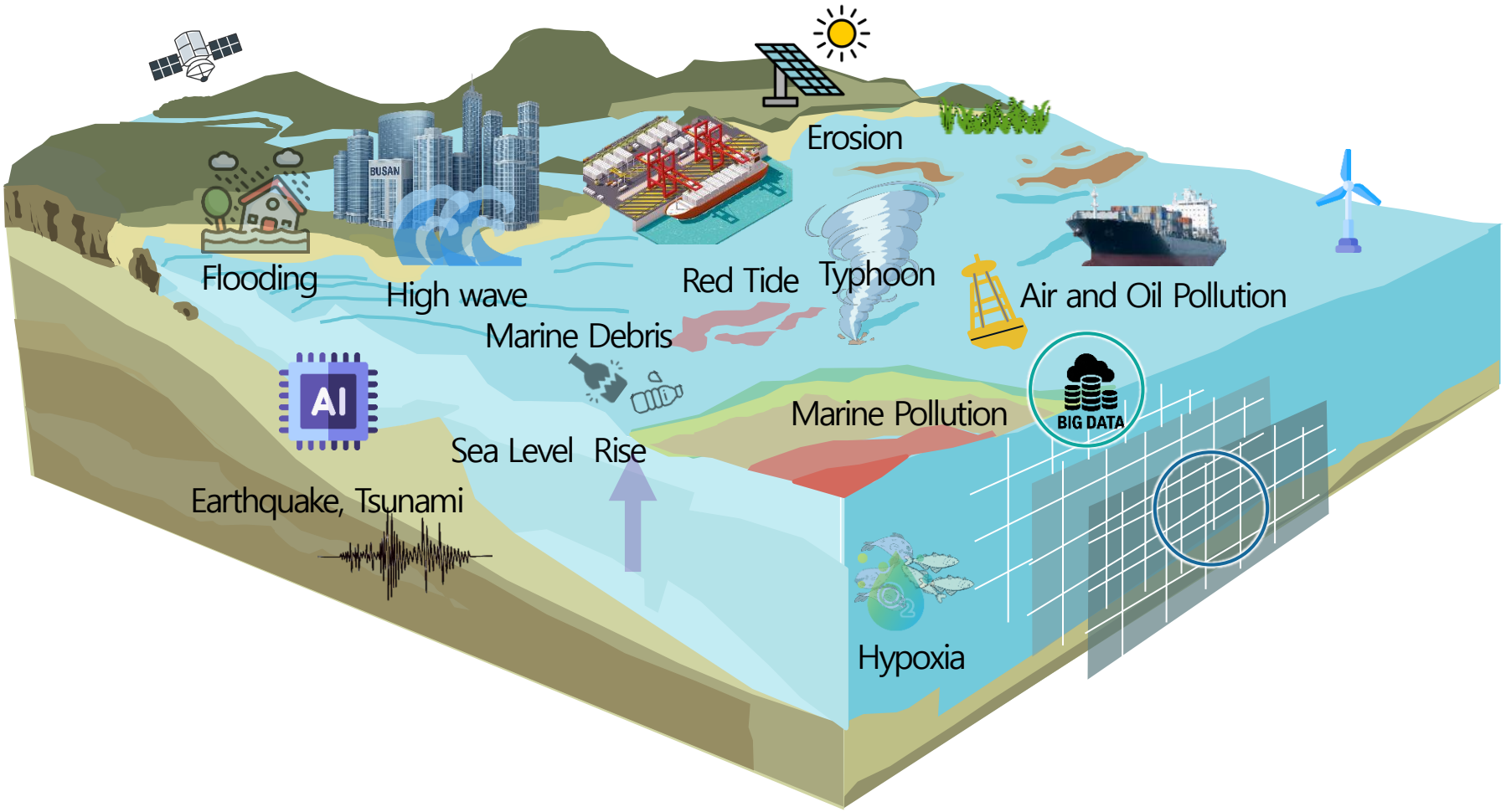


Table of Contents

Chap. 1 What types of disaster management and environmental problems exist in marine system?

Chap. 2 Marine Monitoring Technology

Chap. 3 Marine Monitoring System in Korea

Chap. 4 Application of Marine Monitoring Data

What types of environmental problems exist in marine system?

Sea Bleaching

- In coastal rocky areas, seaweeds disappear and non-geniculate coralline algae, resembling cement, cover the rocks, causing the sea to become desertified.

Occurrence of Sea Bleaching

Feeding Activity of Herbivorous Animals → Progressing of Overgrazing → Severe Overgrazing → Marine Desertification



Sea urchins and fish consume seaweeds



Reduction of brown seaweeds
→favorable environment for coralline algae



Increase of coralline algae covering the rocks.



Death of coralline algae and loss of sessile organisms

Sea Bleaching

Causes

- **Rising Sea Temperatures**

Due to global warming, ocean temperatures are increasing.

This heat stress causes corals to expel their symbiotic algae, leading to bleaching.

- **Ocean Acidification**

Higher CO_2 levels in the atmosphere are absorbed by the ocean, making it more acidic.

This reduces the ability of corals to build and maintain their skeletons.

- **Water Pollution**

Runoff from agriculture and industry introduces harmful substances into the ocean.

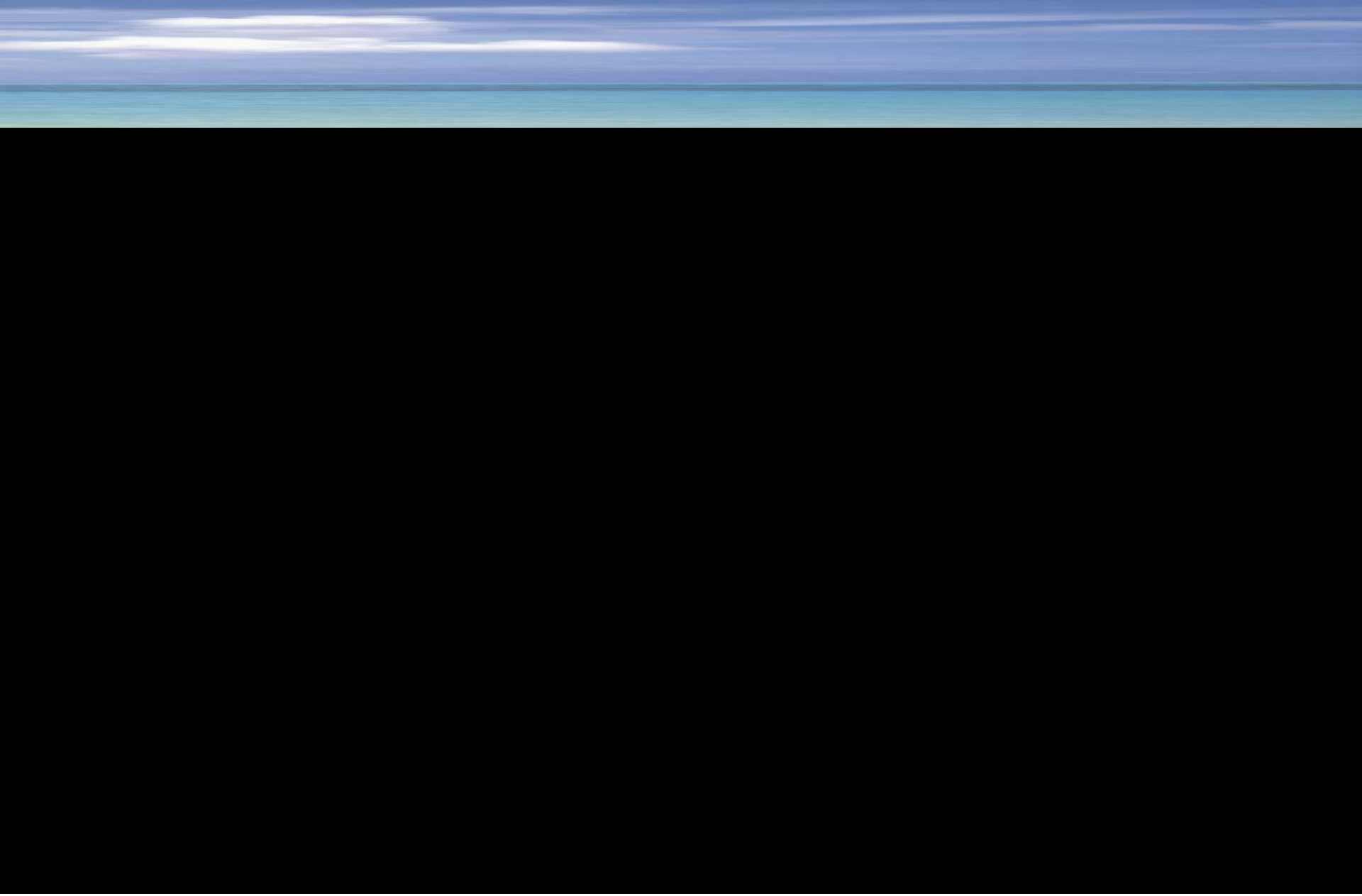
Nutrient overload and toxic chemicals put stress on coral reefs.

- **Coastal Development and Human Activities**

Construction, over-tourism, and physical contact can damage coral reefs.

Waste and sewage from human activities further harm the marine environment.

<NOAA>




BBC
www.Bandicam.co.kr

Red Tide





■ Red Tide

(1) What is a Red Tide?

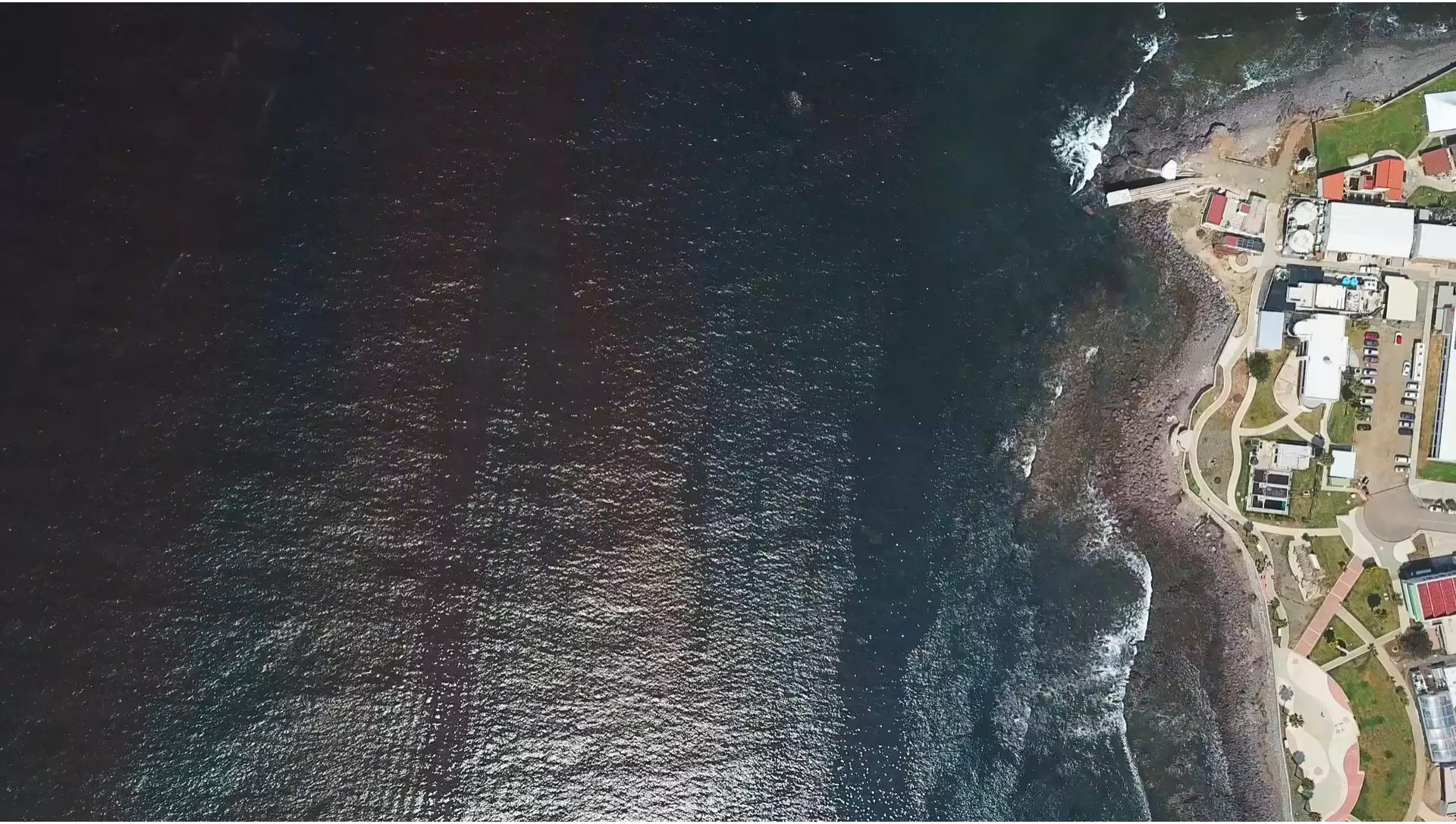
•A phenomenon where plankton proliferate beyond normal levels, causing a change in seawater color.

•Recently, the toxicity of plankton has led to contamination of shellfish and impacts on humans (**harmful algal blooms, HAB**).

•**Red tide plankton**: Includes **22 species of diatoms** and **29 species of dinoflagellates (toxic)**.

•Causes **mass fish mortality** and other damages

Red Tide



Red Tide

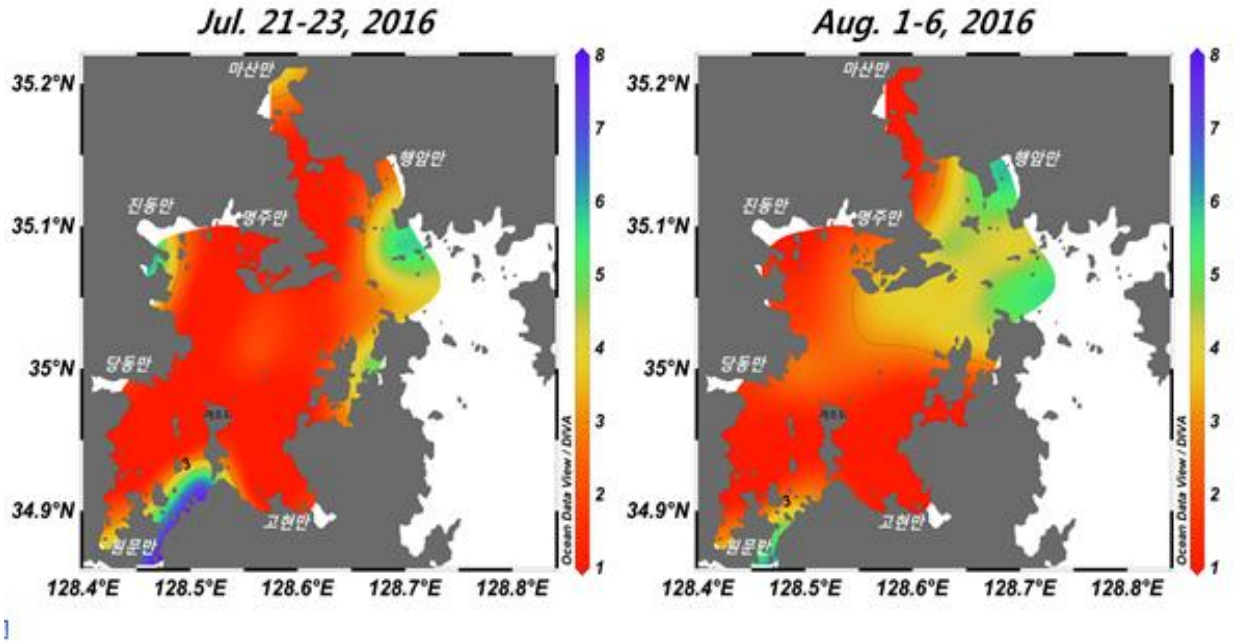
(2) Causes of Occurrence

- **Eutrophication of seawater**: Due to wastewater, rainfall, etc.
- **High water temperature and sunlight exposure**.
- **Low seawater exchange rate**.
- **Stable seawater temperature** (influenced by wind and other factors).

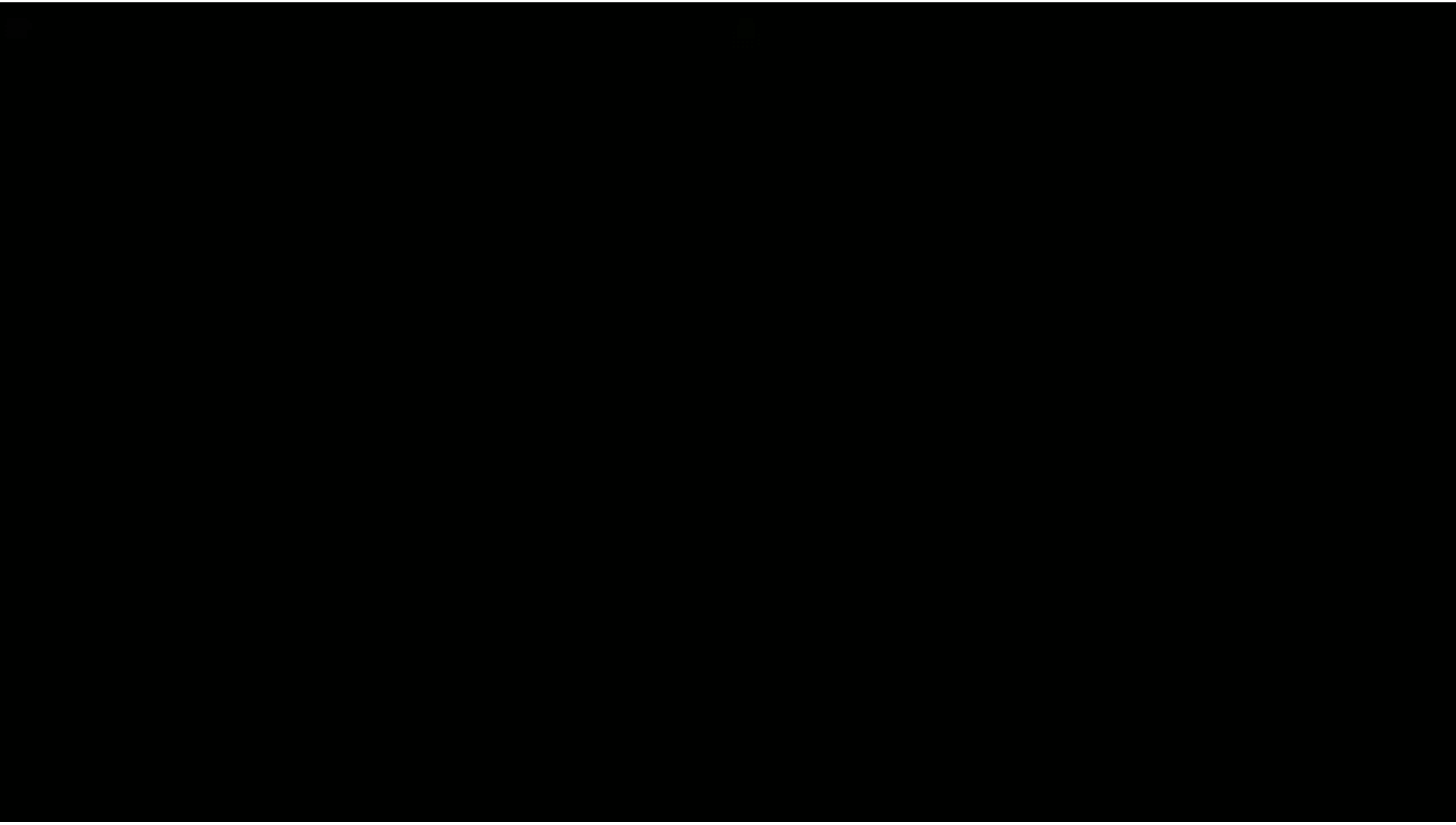
Hypoxia

(1) What is hypoxia (Oxygen Deficient Water)?

- Oxygen dissolved in seawater: Dissolved Oxygen (DO)
- A water mass with a dissolved oxygen concentration of 2.5 mg/L or less
- Anoxic water mass (Dead Zone): 0.025 mg/L or less
- Damage to aquaculture farms and mass mortality of shellfish



Hypoxia

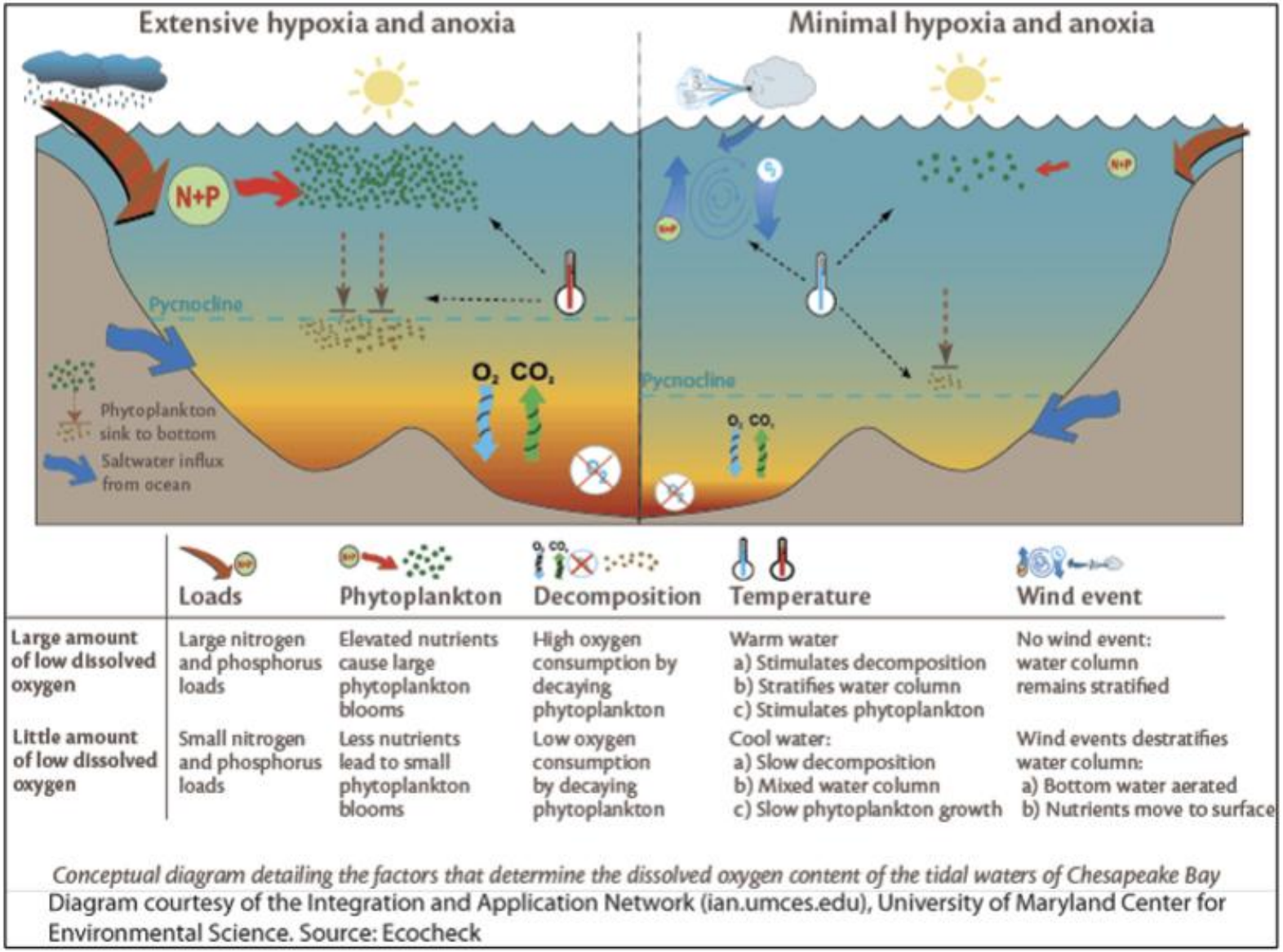


Hypoxia

Oxygen Supply

Oxygen Consumption

Hypoxia



	Loads	Phytoplankton	Decomposition	Temperature	Wind event
Large amount of low dissolved oxygen	Large nitrogen and phosphorus loads	Elevated nutrients cause large phytoplankton blooms	High oxygen consumption by decaying phytoplankton	Warm water a) Stimulates decomposition b) Stratifies water column c) Stimulates phytoplankton	No wind event: water column remains stratified
Little amount of low dissolved oxygen	Small nitrogen and phosphorus loads	Less nutrients lead to small phytoplankton blooms	Low oxygen consumption by decaying phytoplankton	Cool water: a) Slow decomposition b) Mixed water column c) Slow phytoplankton growth	Wind events destratifies water column: a) Bottom water aerated b) Nutrients move to surface

Conceptual diagram detailing the factors that determine the dissolved oxygen content of the tidal waters of Chesapeake Bay

Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Ecocheck

Hypoxia

Which marine life will be most affected by hypoxia?

In which season is the damage from hypoxic water masses the greastest?

Marine Debris

■ Marine Debris

Coastal Debris



- Buoys, general waste, etc.
- Damage to scenic beauty, destruction of tourism resources
- Relatively easy to retrieve

Floating Marine Debris



- Damage to scenic beauty, safety hazards and environmental issues.
- Reduce photosynthesis and decrease DO.

Submerged Marine Debris

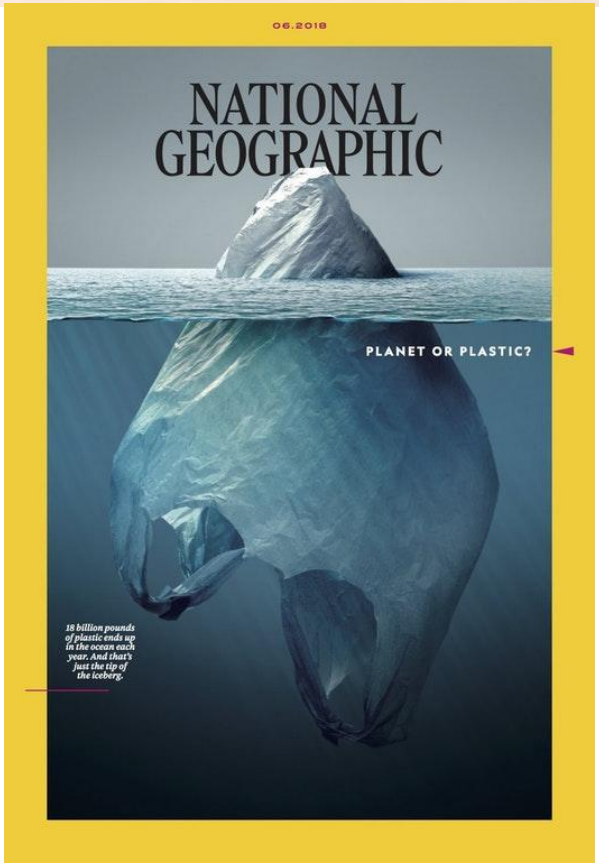


- Mainly discarded fishing gear
- Ecosystem destruction and ghost fishing
- High costs for retrieval

What is this?



Micro-plastics



Cover of NATIONAL GEOGRAPHIC in June
(illust by Jorge Gamboa)
Planet or Plastic?

Micro-plastics









Micro-plastics

Great Pacific Garbage Patch



- 1,550,000 km^2
- Plastics: over 90%

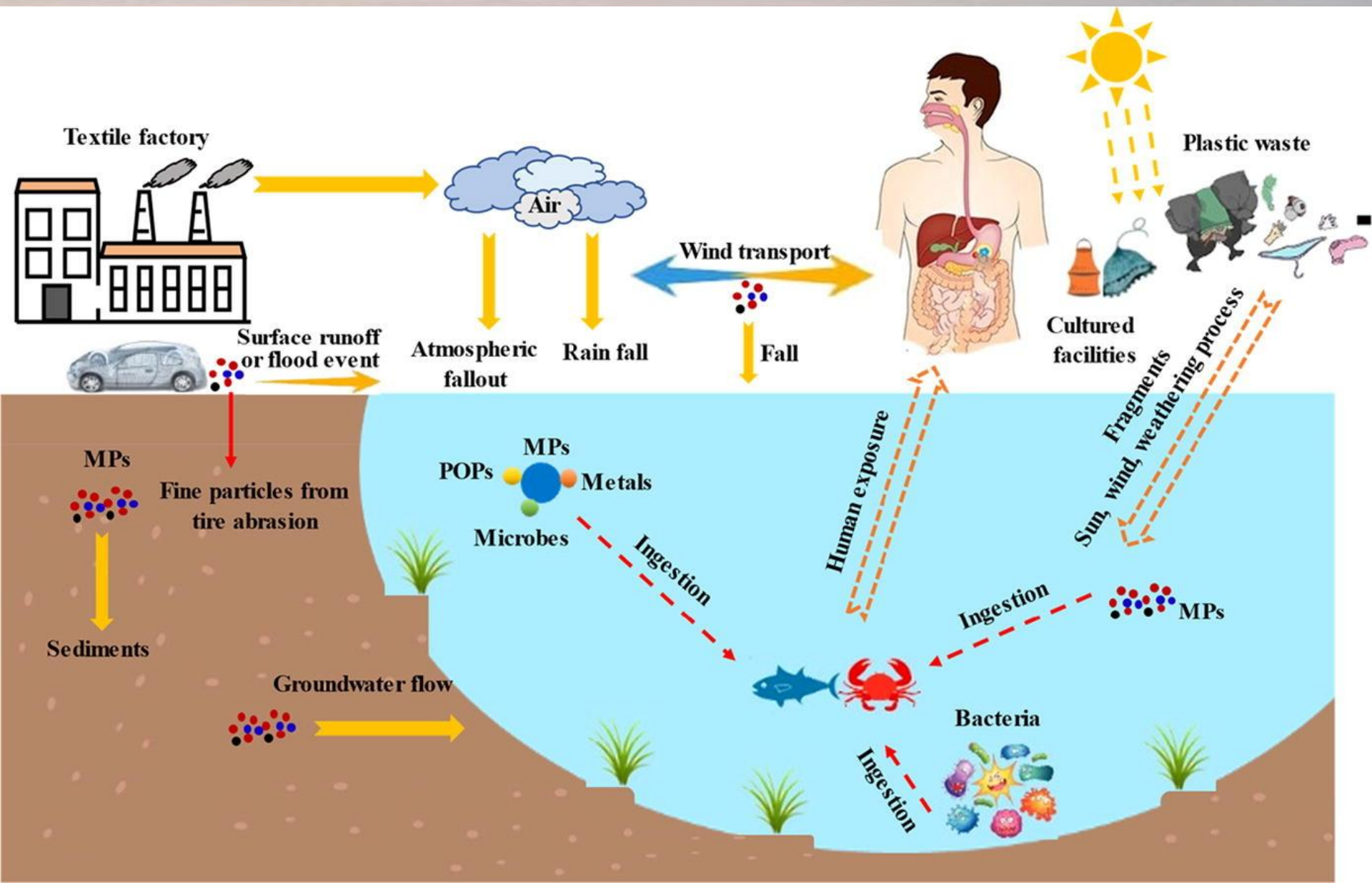
Micro-plastics



Mariana Trench



Micro-plastics



Micro-plastics

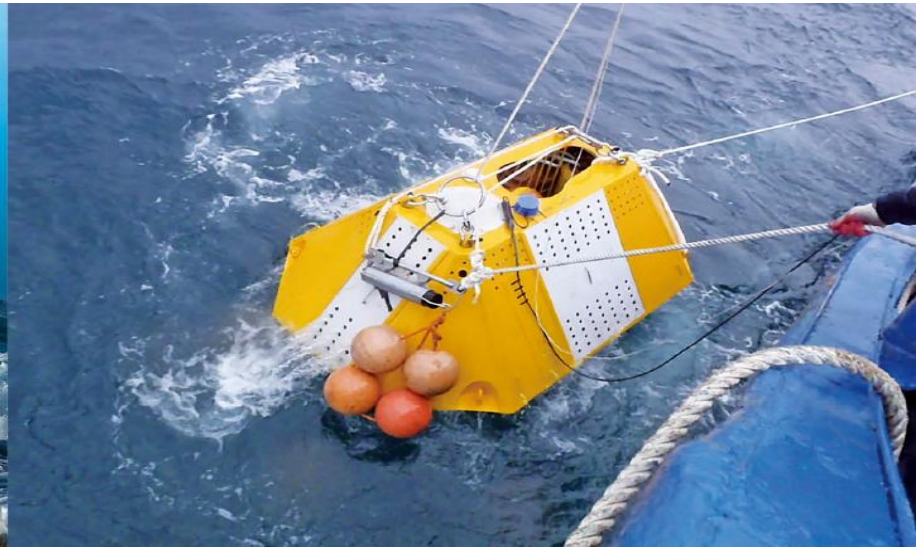
Marine Monitoring Technologies

Hydraulics and Sediment-Dynamics Investigation

The hydraulics and sediment-dynamics investigation is conducted to identify the characteristics of water flow and sediment transport in marine, estuarine, coastal, and freshwater environments through direct and indirect surveys and analyses.

Major observation items: tides, tidal currents and ocean currents, waves, suspended sediments, seabed composition, littoral currents, subsidence, and erosion.





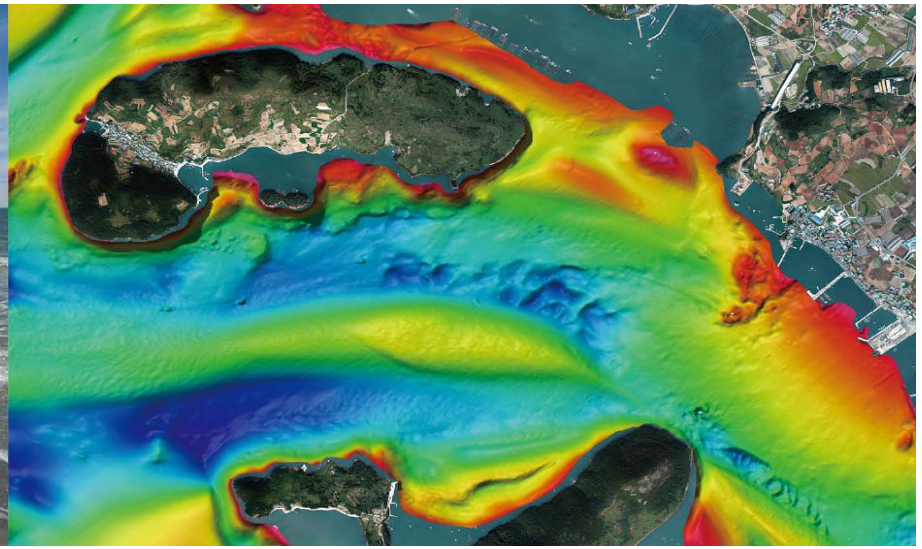
Hydraulics and Sediment-Dynamics Investigation

Hydrographic and UAV (Unmanned Aerial Vehicle) Survey

Hydrographic and UAV surveys investigate and analyze the water depth, seabed topography, shoreline position, and tidal elevations to provide essential baseline data for maritime navigation safety, port construction, naval operations, coastal development, and national maritime policy formulation.

Main Items: Multi-beam bathymetric survey, Topographic survey of reclamation areas, UAV aerial photography, Shoreline/tidal boundary survey, Baseline mapping



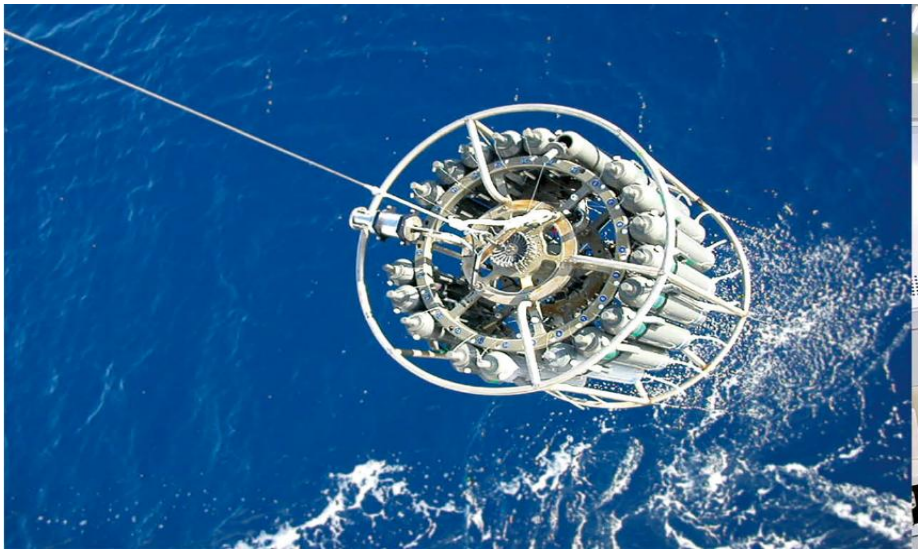


Hydrographic and UAV (Unmanned Aerial Vehicle) Survey

Water & Sediment Quality Analysis and Assessment

Through field investigations, water and sediment samples are collected and analyzed according to nationally and internationally accredited testing methods. For each analysis, Certified Reference Materials (CRM) are used to ensure data quality control.

Main Activities: Water quality survey, Sediment survey, Research on Sediment Oxygen Demand (SOD) and inhibitory zones, Pollution impact assessment





Water & Sediment Quality Analysis and Assessment

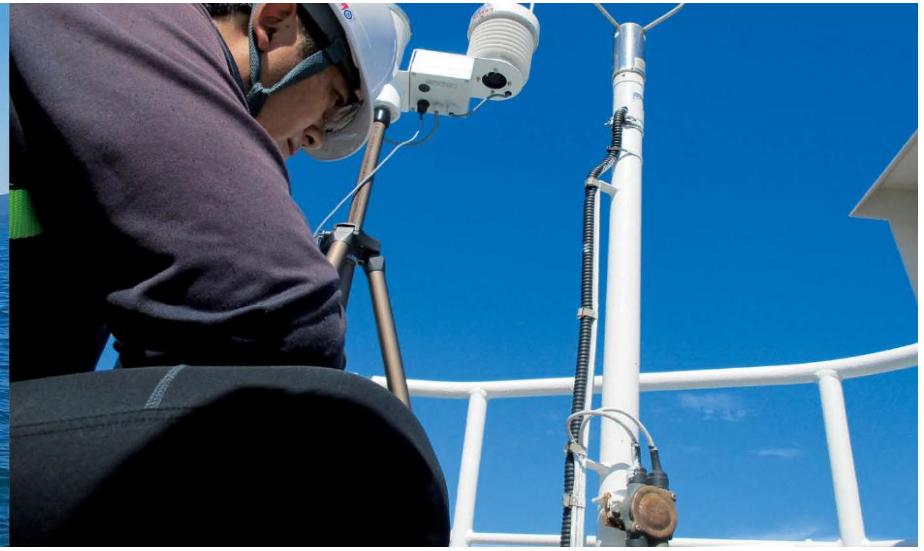


Real-Time Marine & Weather Monitoring System Development and Implementation

It is carried out the design, manufacturing, and research and development of real-time marine and weather monitoring systems for maritime and port operations.

By processing and analyzing marine and weather observation data, it is provided that real-time monitoring services optimized for various applications such as marine meteorology, ocean observation, maritime navigation, national defense, scientific research, and public safety.

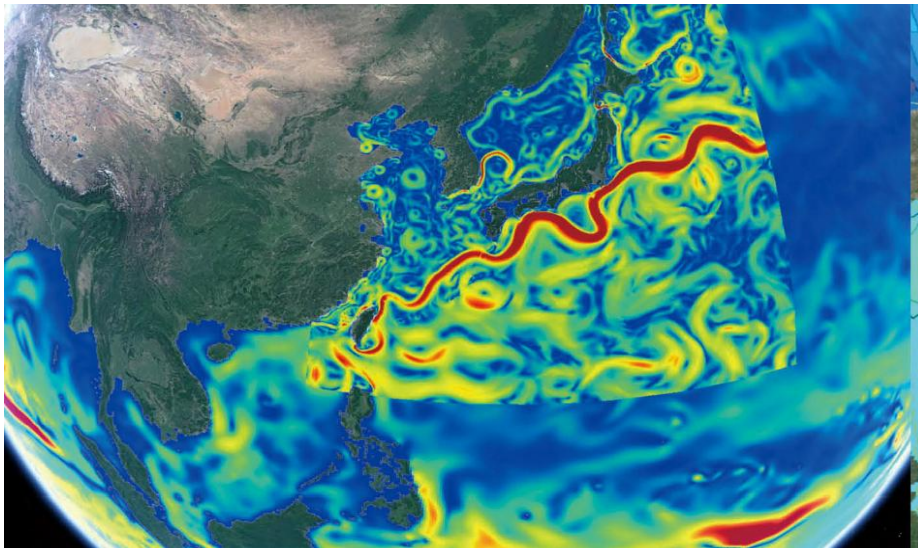


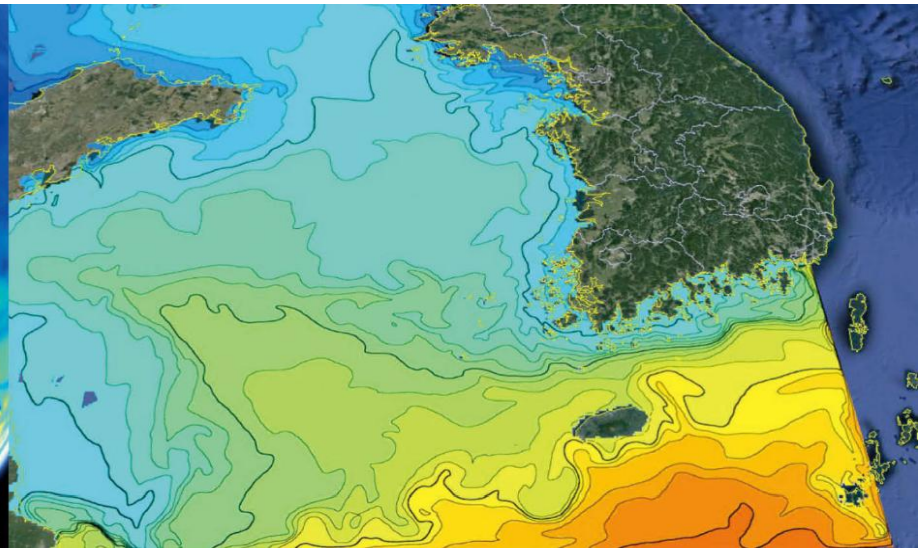


Real-Time Oceanographic Forecast System (RTOFS) Development and Operation

The Real-Time Oceanographic Forecast System utilizes numerical ocean model, hydrodynamic modeling and machine learning to predict various oceanographic conditions such as sea level, currents, temperature, and wave height in real time.

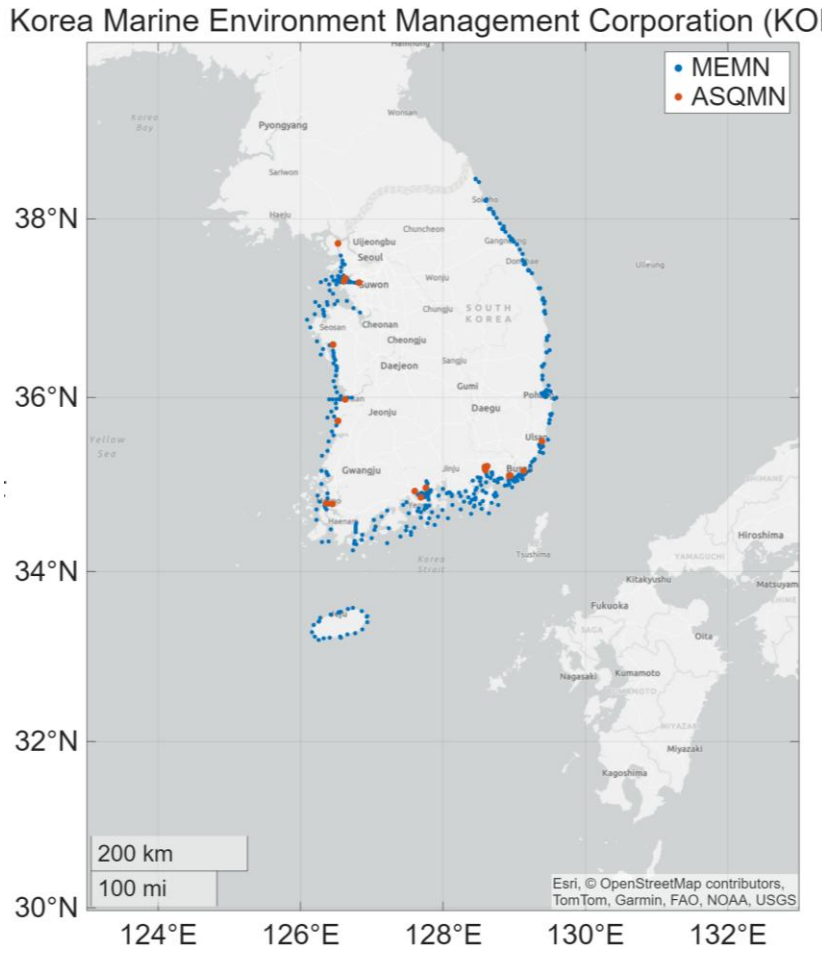
By assimilating observational data from moored and drifting buoys, we have established and operate a real-time ocean forecasting.





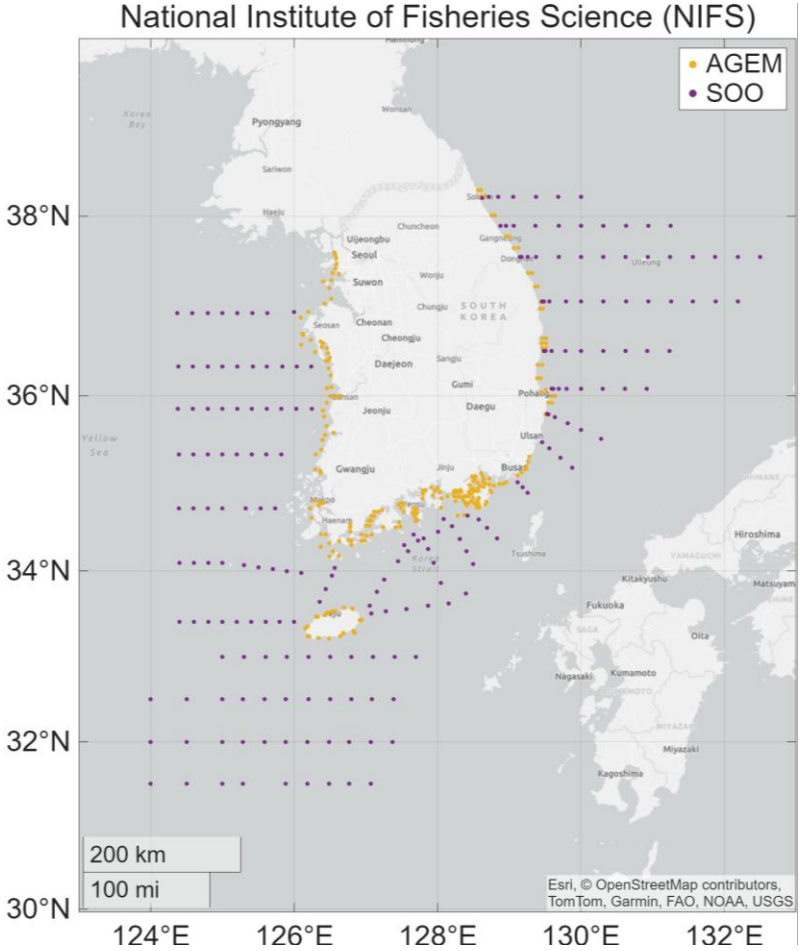
Marine Monitoring System in Korea

Korea Marine Environment Management Corporation



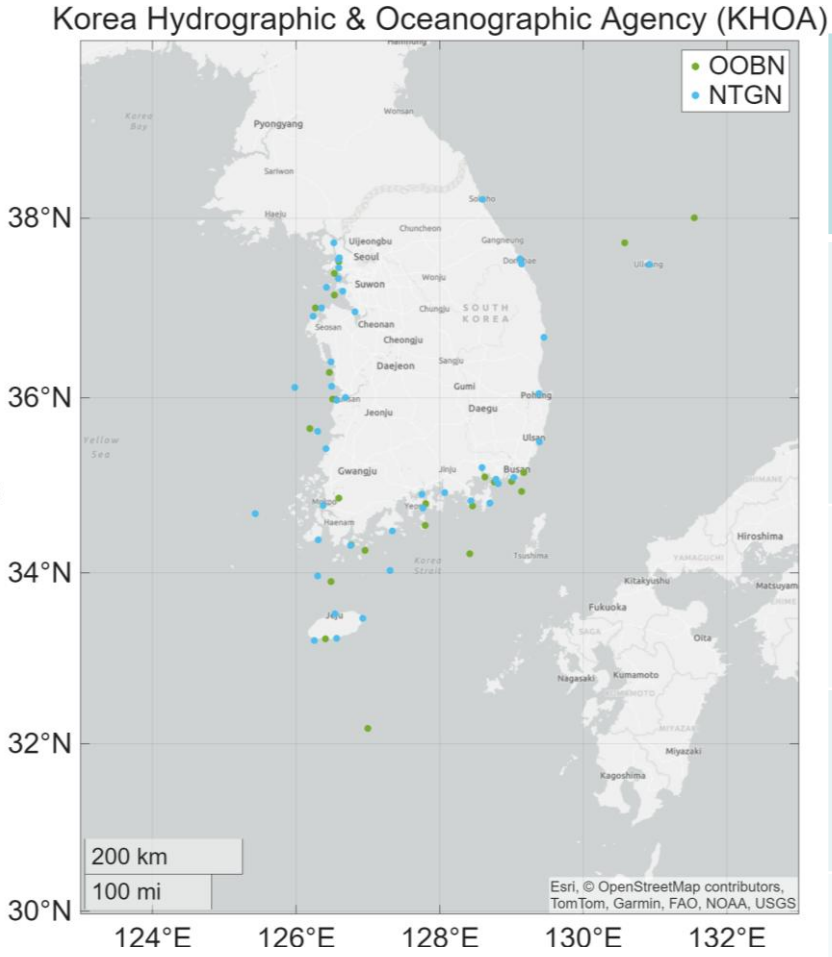
	Marine Environment Measurement Network (MEMN)	Automatic Seawater Quality Monitoring Network (ASQMN)
Parameter	General items of seawater (16 items including water temperature, salinity, etc.)	Temperature, Salinity, pH, DO, turbidity, Chl-a
Period / sampling	1998 – present 4 × yr (ports 12 × yr)	2003 – present 5-10 min
Vertical coverage	Surface and bottom layer	Surface layer
Stations	425 fixed sites	20 real-time stations

National Institute of Fisheries Science



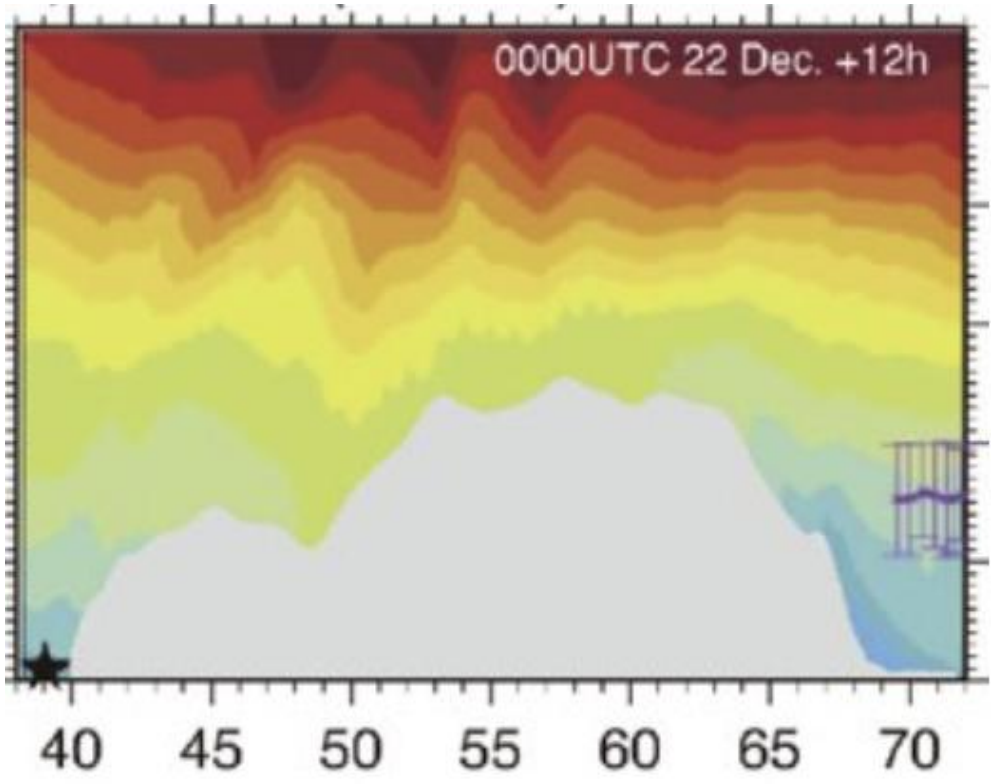
	Aquaculture-Ground Environment Monitoring (AGEM)	Serial Oceanographic Observation (SOO)
Parameter	General items of seawater (water temperature, salinity, etc.)	Full-depth CTD (T–S), nutrients, DO, Chl-a, plankton, meteorology
Period / sampling	1997 – present / 6 × yr (Feb–Dec)	1961 – present, 6 × yr (Feb, Apr, Jun, Aug, Oct, Dec)
Vertical coverage	Surface and bottom layer	Full-depth CTD
Stations	265 sites	207 stations / 14 depth levels

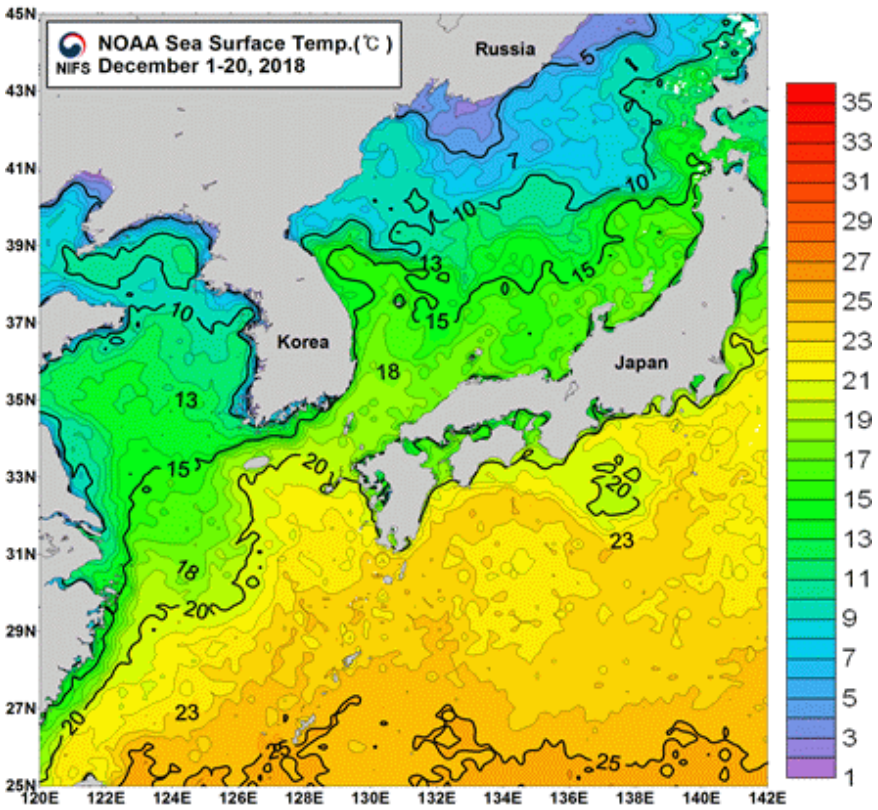
Korea Hydrographic & Oceanographic Agency



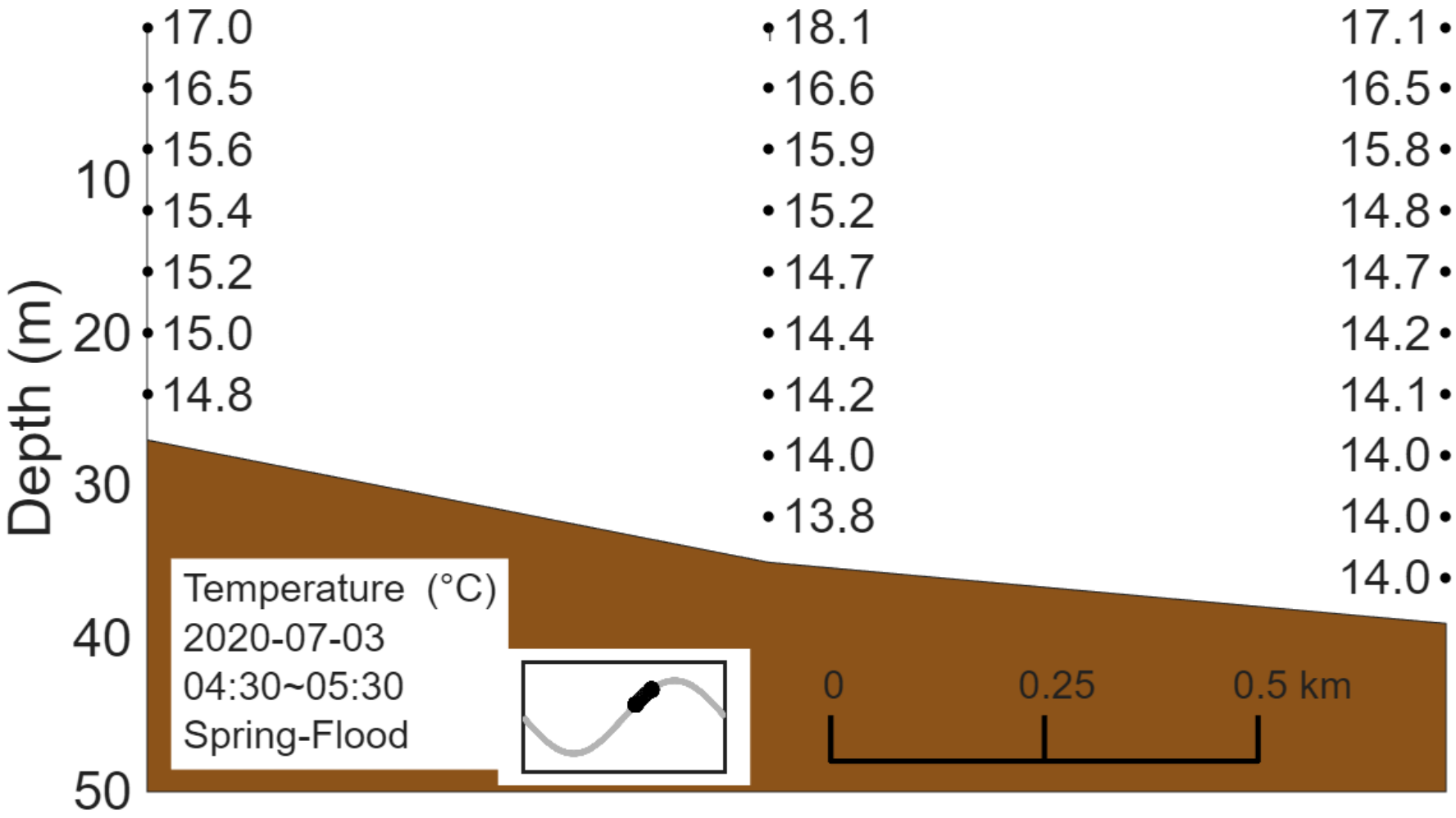
	Ocean Observation Buoy Network (OOBN)	National Tide-Gauge Network (NTGN)
Parameter	SST, SSS, currents (ADCP), wave height/period, wind, air P/T, etc.	Sea-level (1 min), SST, air P/T; some sites include waves & wind
Period / sampling	1998 – present / 10–30 min	1917 – present / 1 min
Vertical coverage	Surface layer	Surface layer
Stations	~30 moored buoys	53 stations

Practice

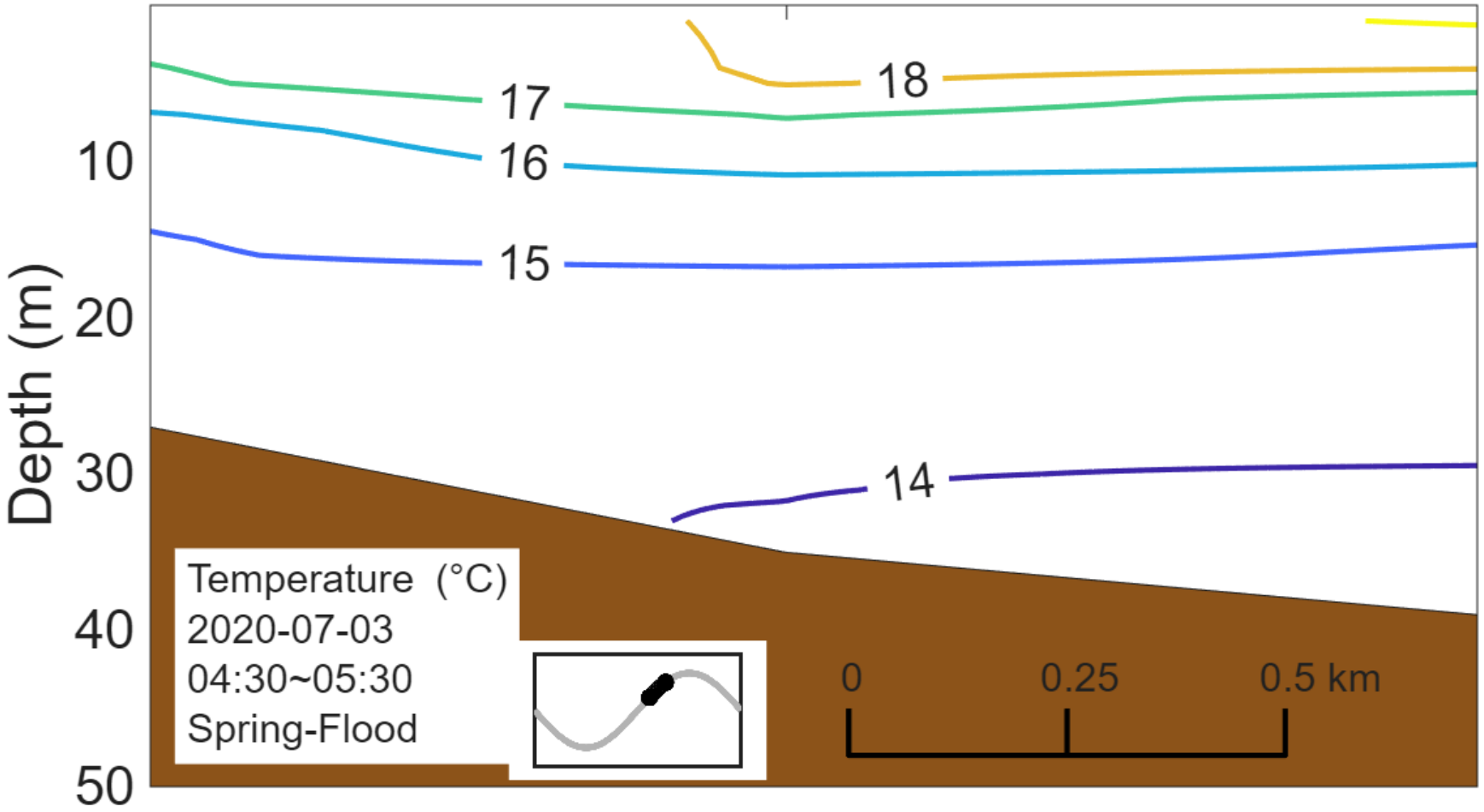

0000UTC 22 Dec. +12h
40
45
50
55
60
65
70


NOAA Sea Surface Temp.(℃)
NIFS December 1-20, 2018
Russia
Korea
Japan
45N
43N
41N
39N
37N
35N
33N
31N
29N
27N
25N
120E
122E
124E
126E
128E
130E
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134E
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138E
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1

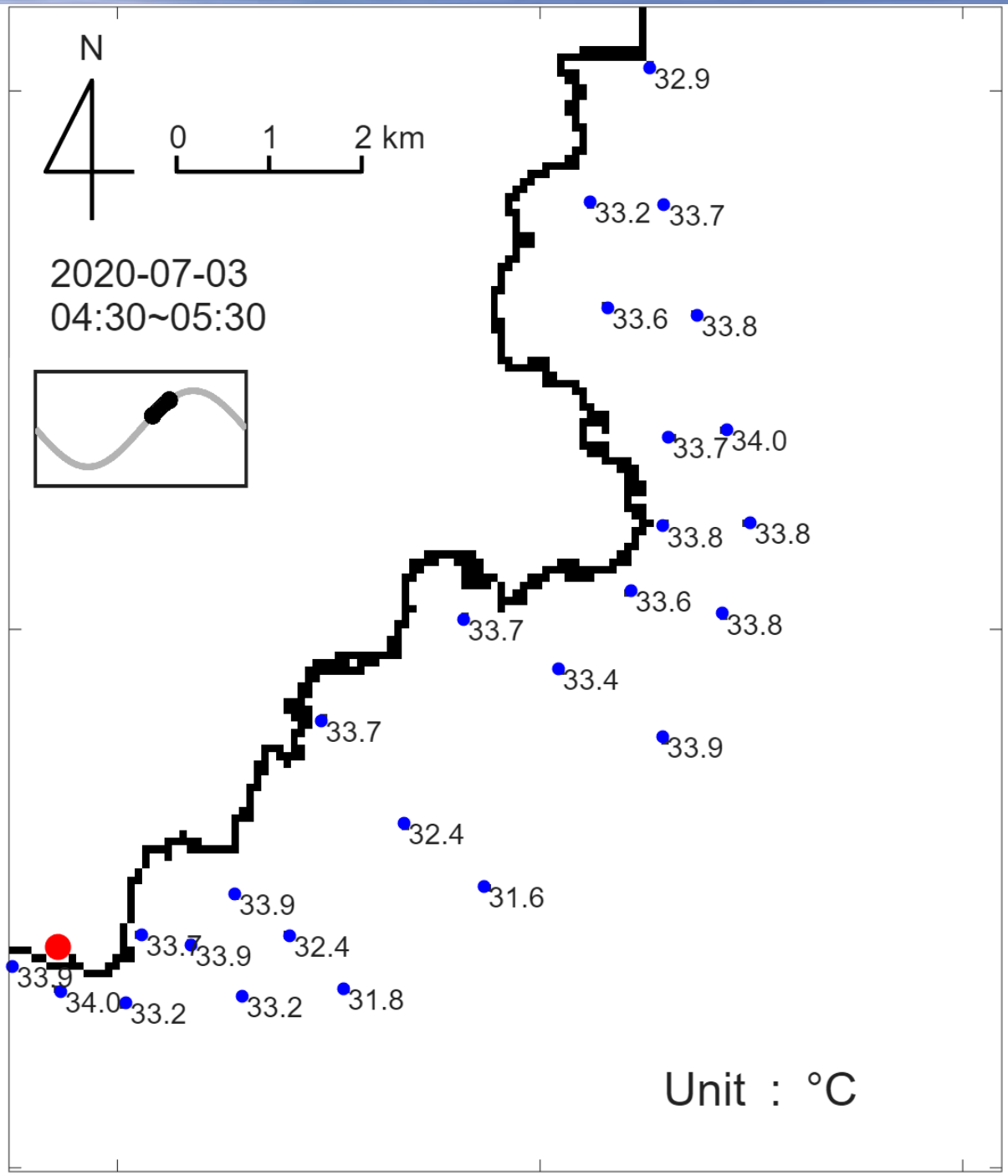
Practice

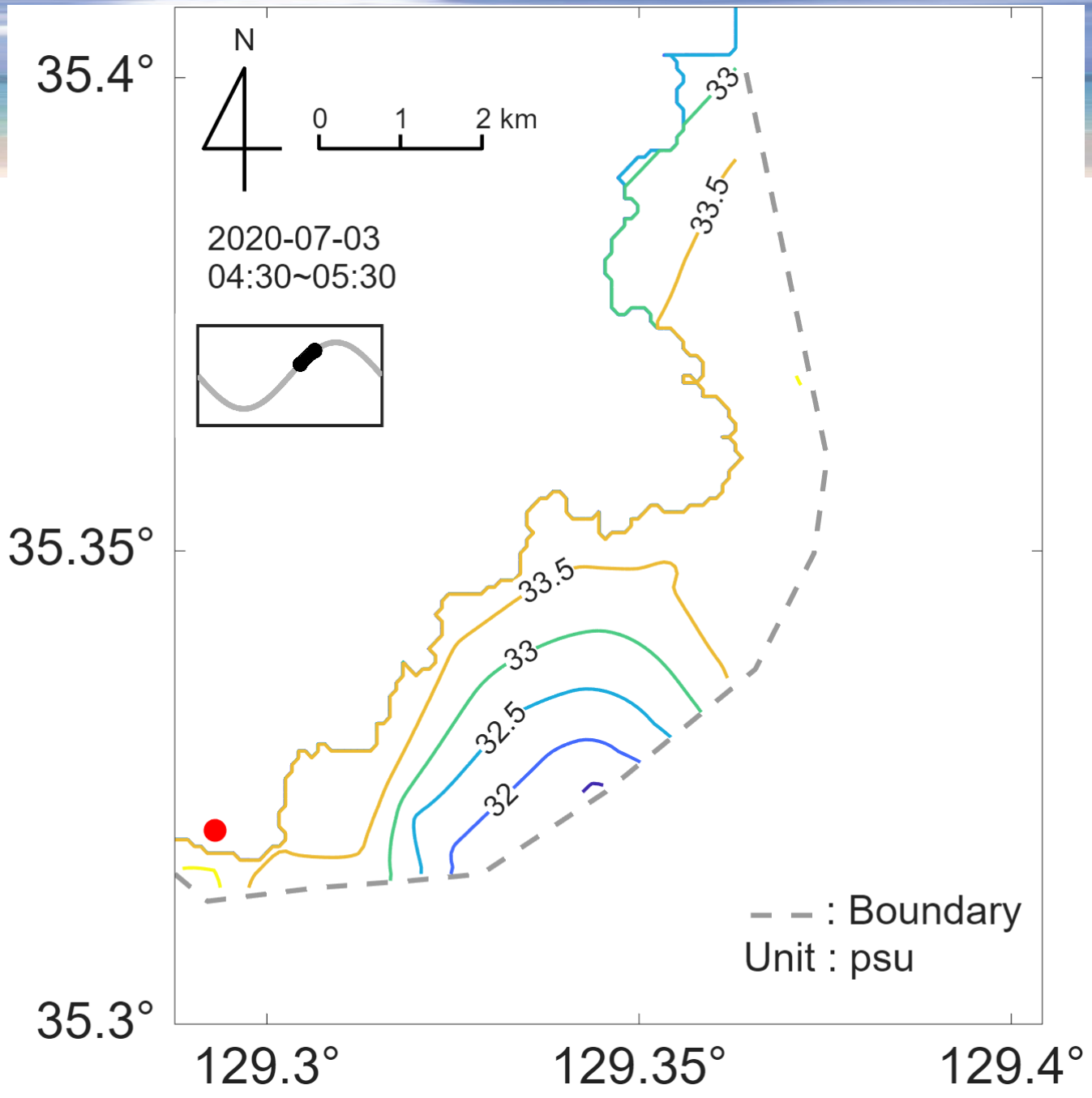

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16.5
15.6
15.4
15.2
15.0
14.8
18.1
16.6
15.9
15.2
14.7
14.4
14.2
14.0
13.8
17.1
16.5
15.8
14.8
14.7
14.2
14.1
14.0
14.0
14.0
Depth (m)
10
20
30
40
50
Temperature (°C)
2020-07-03
04:30~05:30
Spring-Flood
0
0.25
0.5 km

Practice


Depth (m)
10
20
30
40
50
18
17
16
15
14
Temperature (°C)
2020-07-03
04:30~05:30
Spring-Flood
0
0.25
0.5 km

Practice

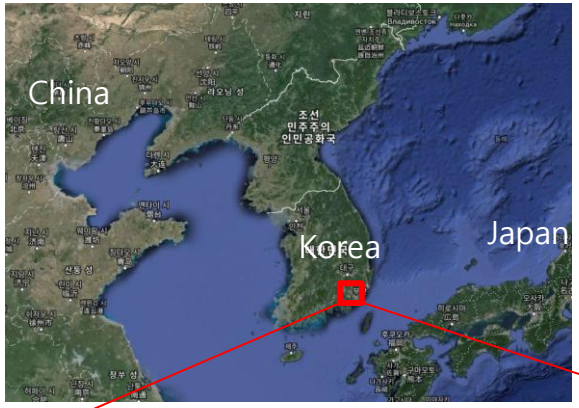

N
0
1
2 km
2020-07-03
04:30~05:30
32.9
33.2
33.7
33.6
33.8
33.7
34.0
33.8
33.8
33.6
33.7
33.8
33.4
33.7
33.9
32.4
31.6
33.9
33.7
33.9
32.4
33.9
34.0
33.2
33.2
31.8
Unit : °C


N
0
1
2 km
2020-07-03
04:30~05:30
33
33.5
33.5
33
32.5
32
: Boundary
Unit : psu
35.4°
35.35°
35.3°
129.3°
129.35°
129.4°

Application of marine monitoring data

-Jinhae Bay, Korea-

1 Jinhae Bay





- ▷ **Area: 25 km x 35 km**
- ▷ **Ave. Depth: 20 m**
- ▷ **Semi-enclosed Bay**

- ▷ **Intensive aquaculture**

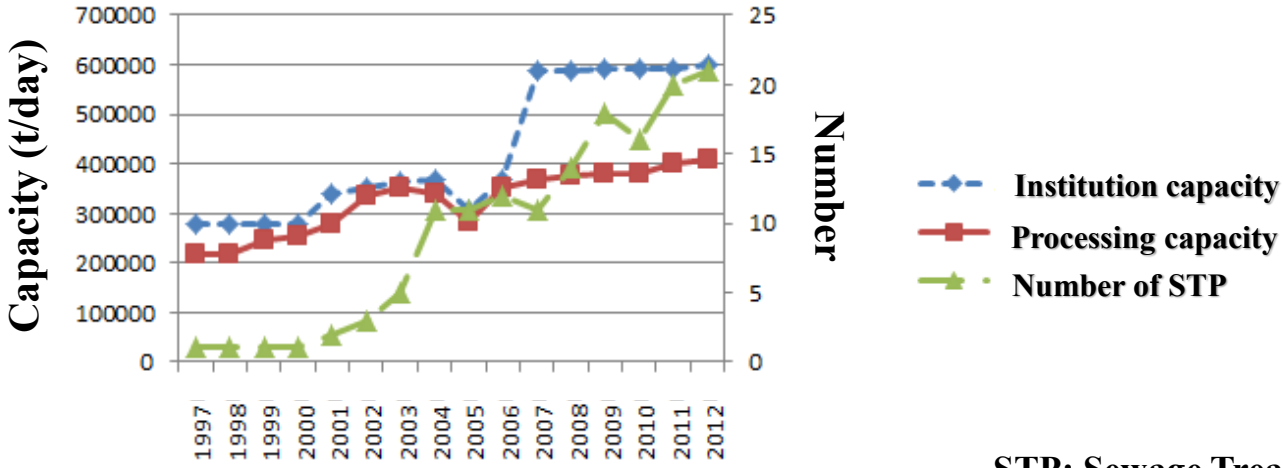
- ▷ **Industrialization, urbanization**
- ▷ **Increase of sewage discharge**
- ▷ **Eutrophication and red tide**

  → **subject of legislation**

1 Efforts to improve water quality

After 2000

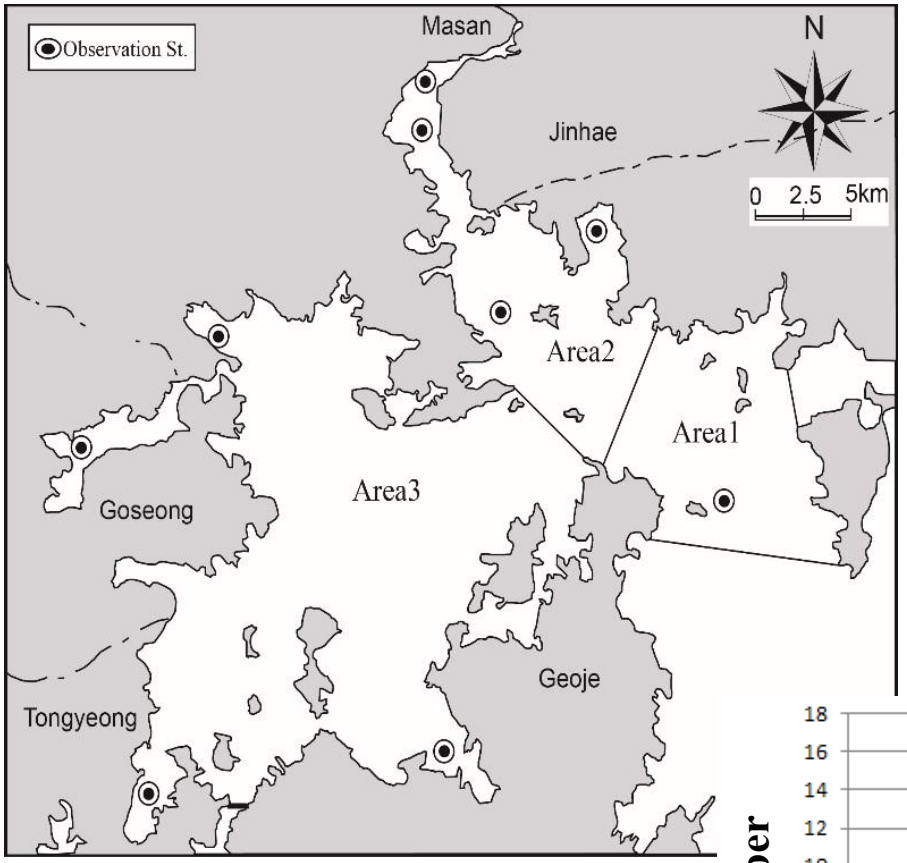
- ▷ **Construction of sewage treatment plant (2002)**
- ▷ **Dredge of polluted sediment**
- ▷ **Special law for restriction of total COD discharge (2007)**



STP: Sewage Treatment Plant

Variations in water quality and fish catch?

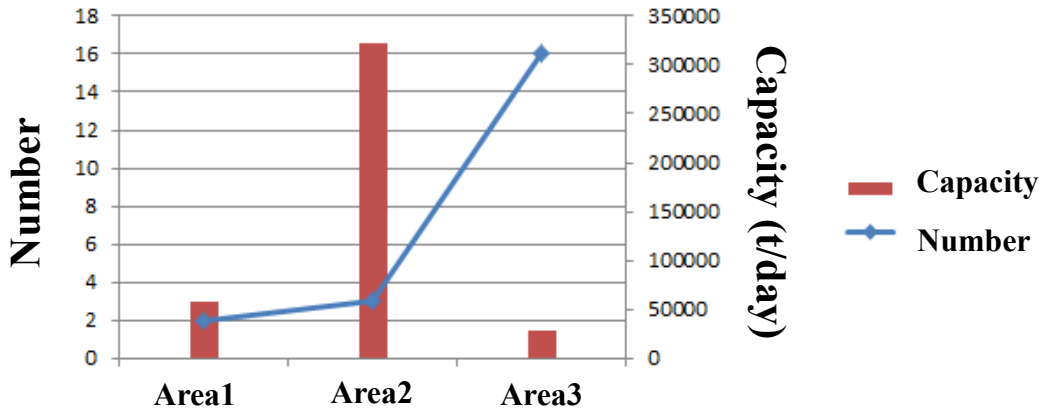
2 Materials and methods



Section division : Cluster analysis

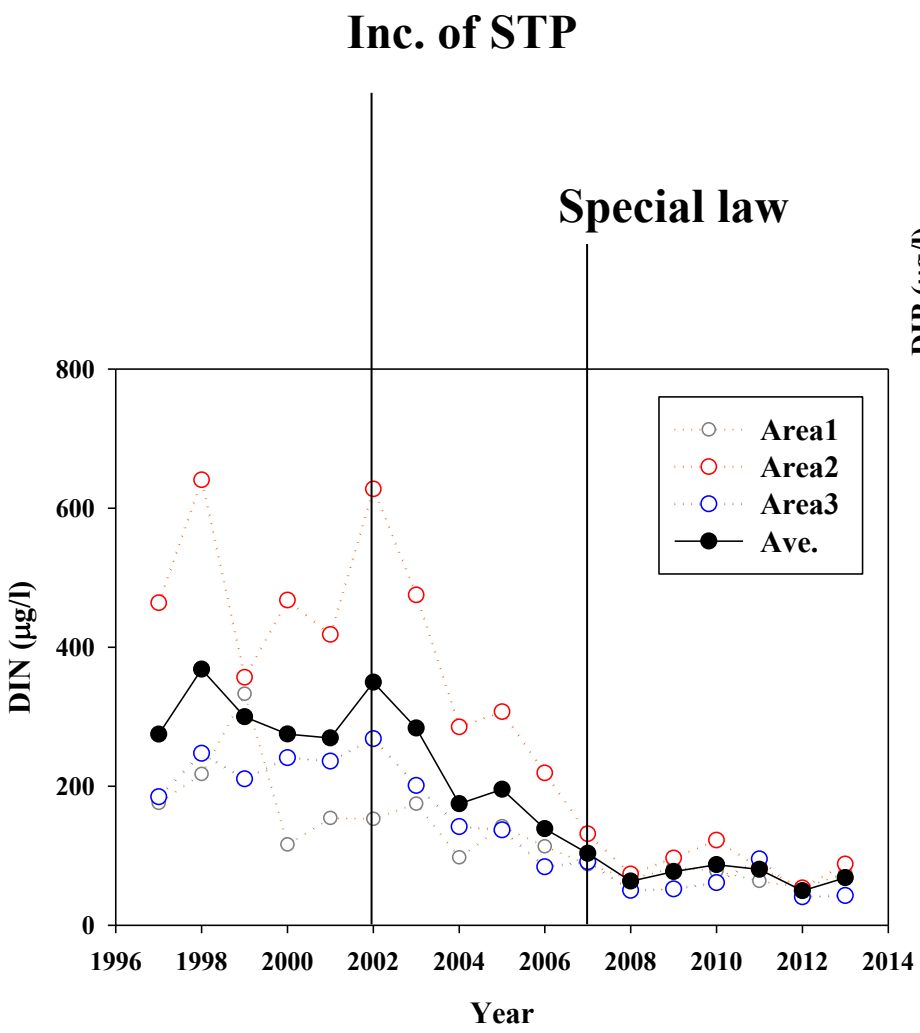
Data analysis : 1997-2013

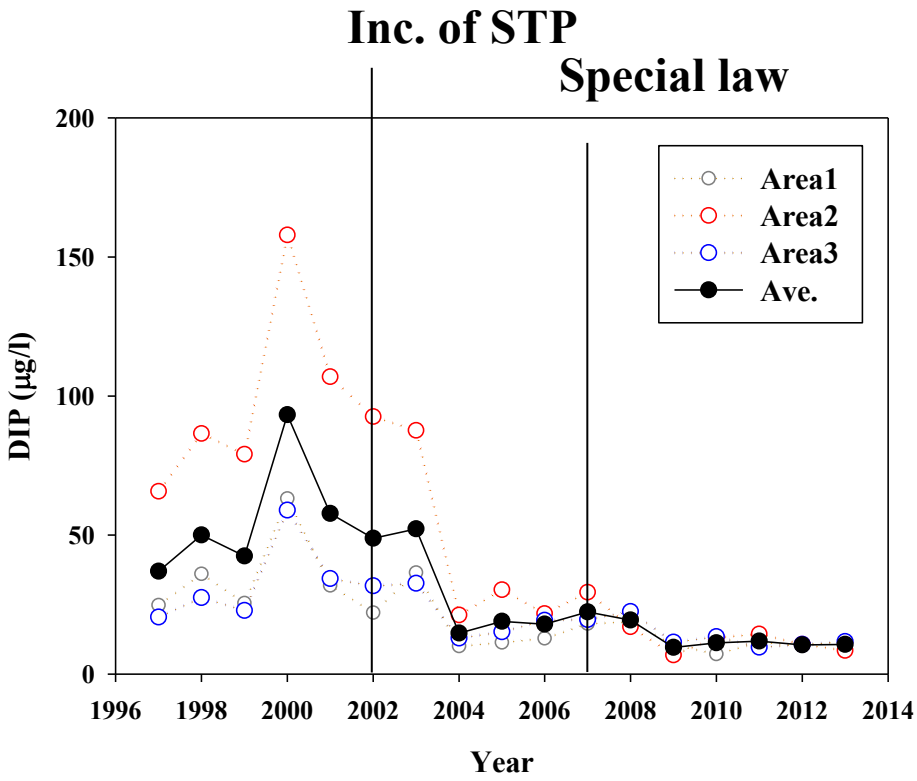
- **nutrients**
- **occurrence of red tide**
- **catch of fish**



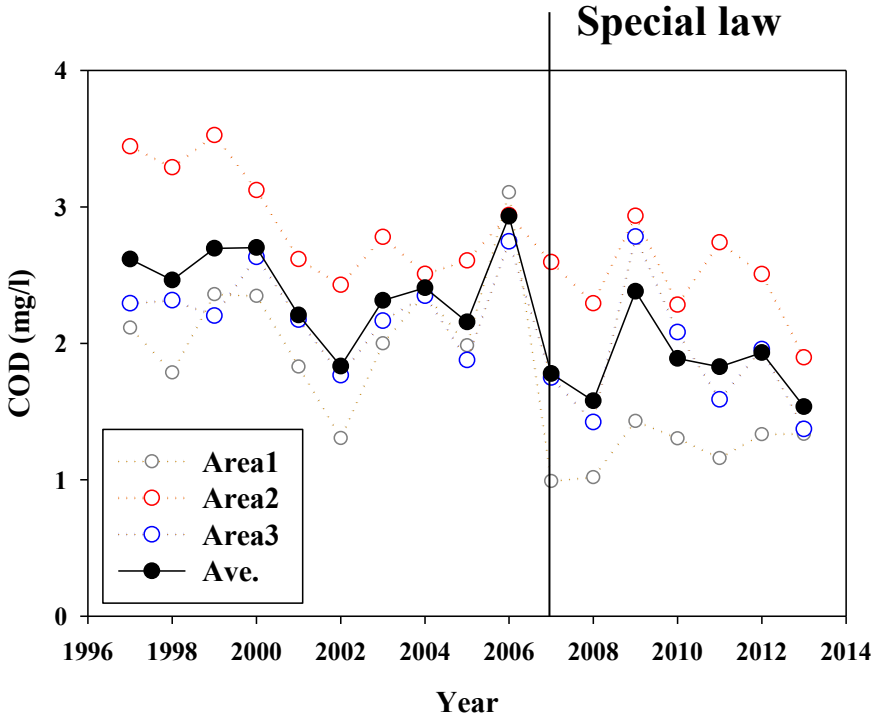
3 Variation of water quality

STP: Sewage Treatment Plant





3 Variation of water quality

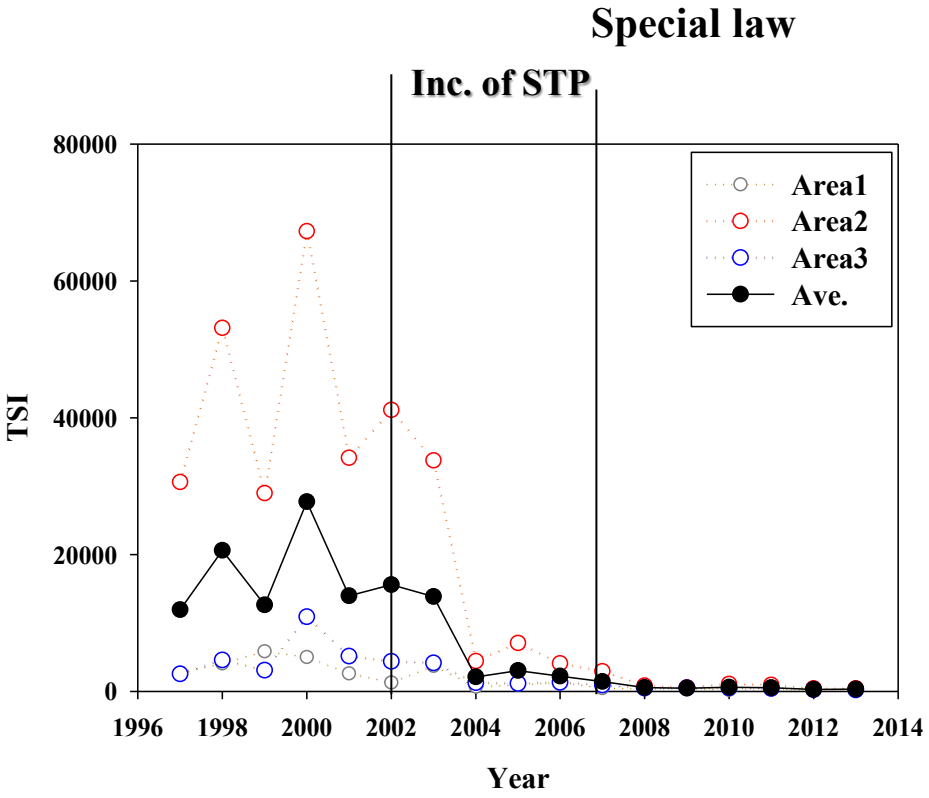


▷ Ave. COD : 2.5 mg/l → 1.5 mg/l

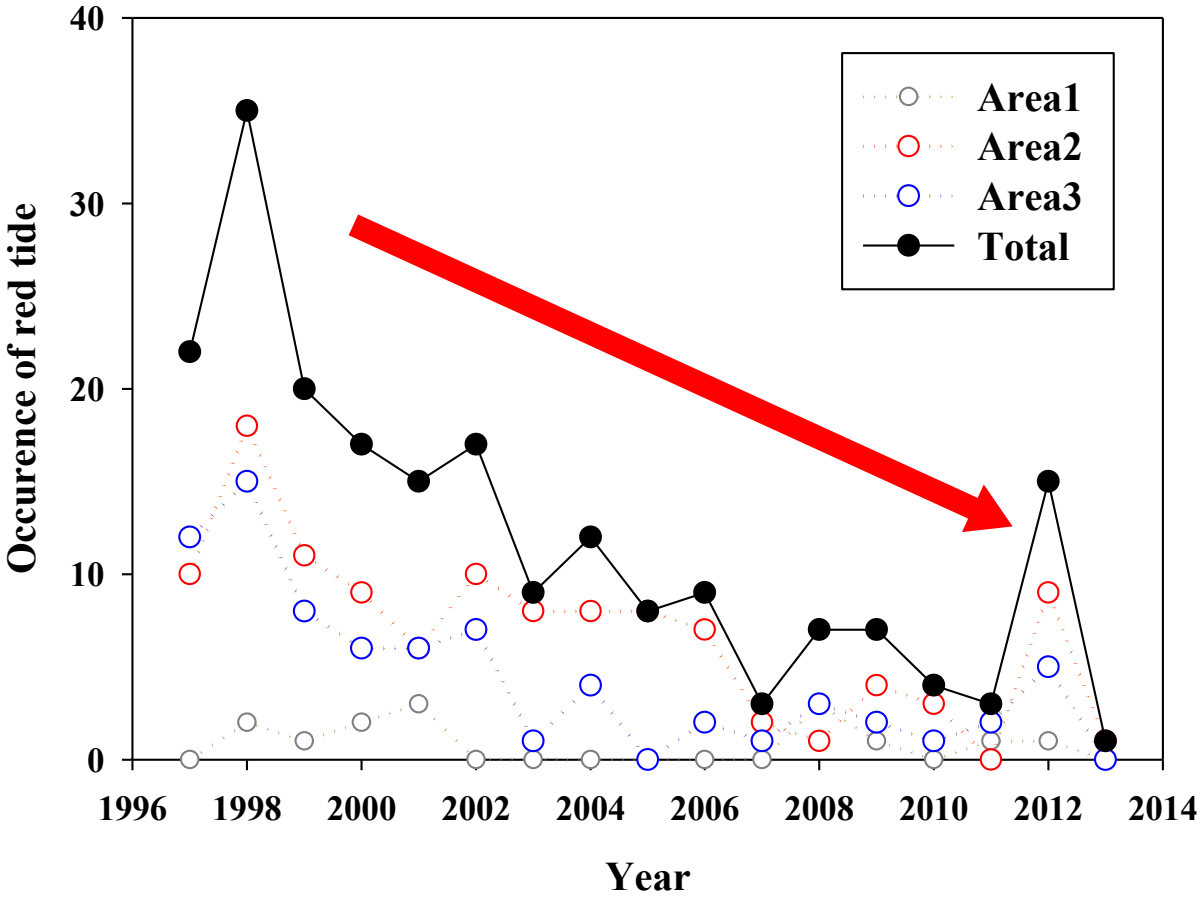
▷ Area2 COD : 3.5 mg/l → 2 mg/l

Trophic State Index (TSI):

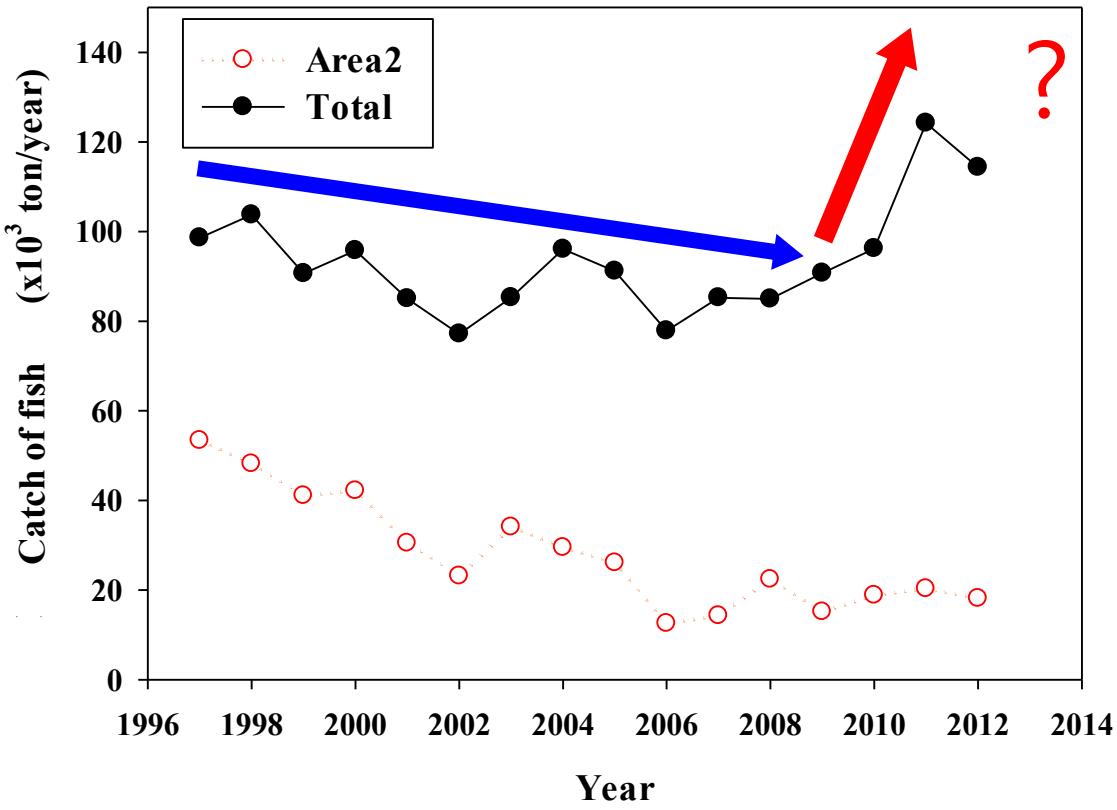
$$\frac{COD(mg/L) \times DIN(\mu g-at/L) \times DIP(\mu g-at/L)}{3.43}$$



4 Occurrence of red tide



4 Catch of fish



▷ Decrease of catch of fish in Jinhae Bay (Area 2)

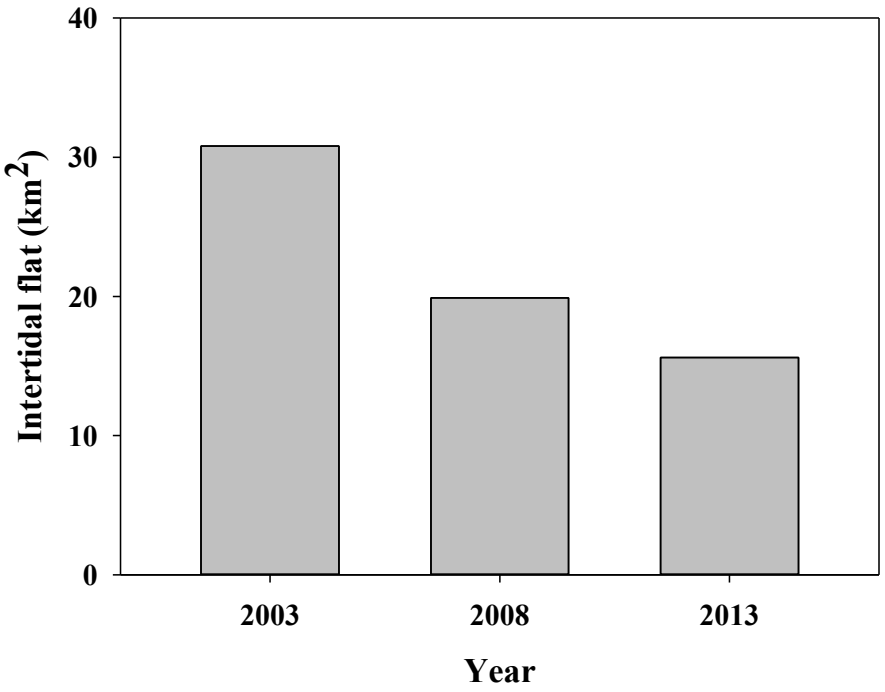
▷ Increase of catch of fish after 2010???

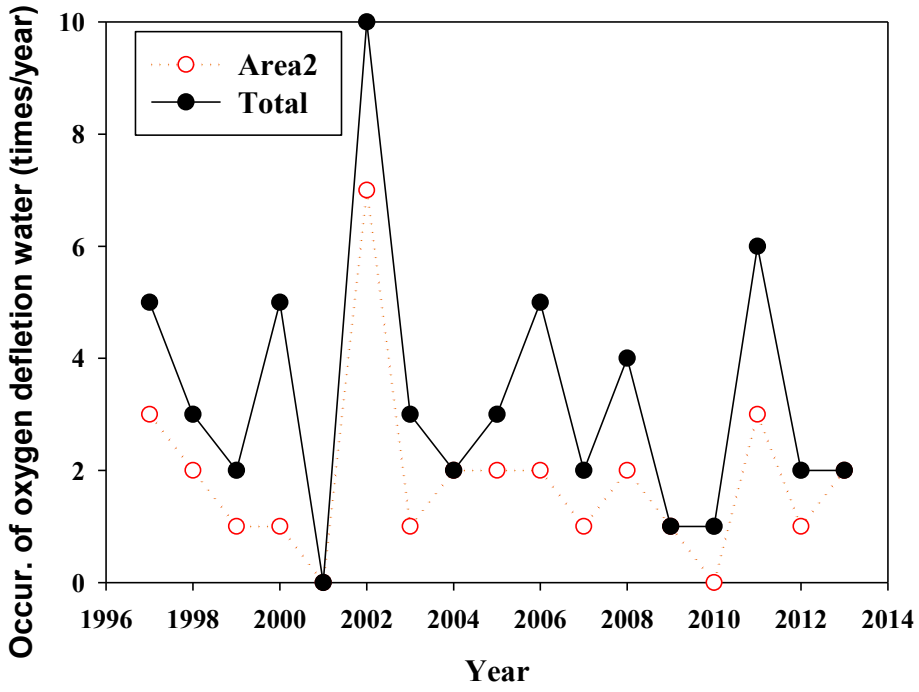
5 Discussion

(1) Need more time for ecosystem recovery.

(2) Decrease of tidal flat and seaweed bed (spawning ground).

(3) Benthic pollution → occurrence of oxygen depletion water.





6 Conclusions

1. A marked decrease in the number of red tide occurrence is due to the effectiveness of the law and sewage treatment plant that has targeted the reduction of COD in the effluent water since early 2000.

2. Although improvement of water quality, increase in catch of fish was not observed.

3. For the recovery of catch of fish, processes for restoration of entire ecosystem such as construction of artificial intertidal flat, seaweed bed and remediation of organic-rich sea bed should be accompanied with improvement of water quality.


Thank you
for your attention