Coastal waters studies on the monitoring of water quality and substrate in Hokkaido

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(A) Global environmental issues around Hokkaido

(B) Chemical substances in the water bodies around Hokkaido

• POP’s in the waterbodies, POP’s in the substrate in the sea of Okhotsk,
• Pesticides discharged from Ishikari river.

(C) Coastal waters studies around Hokkaido

• introduce 6 case studies in brief
• cooperate with NIES

(D) Introduction of new investigations

How to make up new projects on the multidisciplinary research with the neighboring countries, specifically with China and Korea
(A) Global environmental issues around Hokkaido
- controversial issues -

- Transportation of pollutants by sea creature (ex: Big jellyfish)
- Aerosol transportation of chemical compounds (POP’s) from low latitude to high latitude
- Bioaccumulation of POP’s in sea mammals
- Supply of yellow substances, Iron and chemical compounds.
- Transportation of bird flu by migratory birds
- Northern shift of the ocean polar front.
- Floral and faunal change.
- The excelling of warm current to the sea of Okhotsk.
- (Decrease of the floating ice. precipitation increase etc)
- Fluctuation of floral-faunal habitat in the Ocean.

- Yellow sand and acid rain
- The excelling of warm current to the sea of Okhotsk.
- (Decrease of the floating ice. precipitation increase etc)
- Fluctuation of floral-faunal habitat in the Ocean.

- Blakiston line
(A) Our investigations on the global environmental issues around Hokkaido

- Evaluation of Chemical compounds such as POP’s, Dioxn, Environmental Hormone (Endocrine Disrupter)
  - Bioaccumulated POP’s in the sea creatures around Hokkaido. (Steller's sea lion, fishes, scallop etc. from 2 decade ago)
  - Sediments and sea water. (The sea of Okhotsk and water bodies in Hokkaido)

- Fluctuation of the transportation of pollutants caused by the northern move of the ocean polar-front. Where is pollutant transported from where?
  - Monitoring the water quality and SST using satellite imageries and vessel.

- Interaction between inland and coastal waters, such as chemical budget accompanied by precipitation increase with global warming.
  - Water quality of coastal area, especially Okhotsk coast, are gradually deteriorating by increase of organic matters and nutrient discharged from inland. (Lake Saroma lagoon located Okhotsk coast)
  - Influence of fresh water to macrobenthos habitat in the penumbra of river mouth.

- Spatial and temporal evaluation on the ESI along the coast of Okhotsk sea.
  - How to protect the ecological diversity in the coastal area from oil spill.
  - Make new ESI map taking macrobenthos into account.
Influence of the global warming to the sea of Okhotsk coastal sea area (most serious area)

- The excelling of warm current to the sea of Okhotsk will trigger the following phenomena.
  - Increase of the extreme rainfall at the Okhotsk coast
  - Increase of nutrient load from inland to the coastal sea areas by much rainfall.
  - Change of floral-faunal habitat both in land and marine.

- The influence over the lakes by the temperature rise.
  - Long duration of the stratification cause the eluation of a great deal of nutrients from the lake bed and cause the long duration of low alkalinity by acid rain.
  - Moreover, it makes toxic substances such as sulfuret occur much.
    - Anoxic layer will be more long duration.

- Case study at Lake Saroma running for aquiculture, located at Okhotsk coast.
  - How does the global warming influence lakes and marshes environmental quality?
  - Make the ecological model and the lake current model and verifies the reliability with the actual result of measurement.
  - Take the countermeasure based on the result.
Relationship amongst climate change, water pollution and floating ice period

The standard achievement ratio declines in accordance with the temperature rise from 1989.

Floating ice period has decreased and water pollution has increased in accordance with the extreme climate change as temperature and rainfall rise.
Seasonal change of chlorophyll by Sea WiFS

High primary productivity are observed around Hokkaido through year

By NAWPAP in 2002
(B) Chemical substances in the substrate and water bodies around Hokkaido

I  Concentration of POP’s in the substrate of water bodies in Hokkaido

II  POP’s in the substrate in the sea of Okhotsk

III Simultaneous determination of pesticides and their seasonal variation in Ishikati River basin
I. Concentration of POP’s in the substrate of water bodies in Hokkaido

<table>
<thead>
<tr>
<th>AREA NAME</th>
<th>L.NOTORO</th>
<th>L.NOTORO</th>
<th>L.NOTORO</th>
<th>L.SAROMA</th>
<th>L.SAROMA</th>
<th>TOKACHI Sea</th>
<th>TOKACHI Sea</th>
<th>TESHIO Sea</th>
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<tr>
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<td>June, 18m</td>
<td>July, 7m</td>
<td>July, 18m</td>
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<td>Total Dioxins</td>
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<td>0.57</td>
<td>4.3</td>
<td>5.4</td>
<td>3.3</td>
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</table>

Unit: pg/g(dry) Only. Total Dioxins are pg-TEQ/g(dry)

Differences among the sites were observed, however, each concentration are low level.
II  POP’s in the substrate in the sea of Okhotsk

Sea current in the sea of Okhotsk especially in the vicinity of Hokkaido

Courtesy of Prof. Kay I. Ohshima (Institute of Low Temperature Science, Hokkaido University)
Ocean currents in the sea of Okhotsk

Courtesy of Prof. Kay I. Ohshima (Institute of Low Temperature Science, Hokkaido University)
Monitoring of chemical substances in the sea bed of the sea of Okhotsk in 2006.
project 1: conducted by Kyoto Univ. Analyzed by HIES

A difference among the spots is admitted but the absolute values are a very low.

Sampling site: Courtesy of Dr. Nakatsuka (Nagoya Univ.) and Prof. Minami (Tohkai Univ.)
A difference among the spots is admitted but the absolute values are a very low.
Concentration of PCBs and DXNs in the substrate in the sea of Okhotsk

Concentrations of PCBs and DXNs are highest at ST-4.

These concentrations are thought to be not so serious for the sea creatures.
Simultaneous determination of pesticides and their seasonal variation in Ishikati River basin

Hideharu KONDOH, Ryuji FUKUYAMA, Ai-Min LIU (China)

- 81 compounds (pesticides and transformation products)
  Detected 20 herbicides, 12 fungicides, 13 insecticides and 3 transformation products.
- Approximately 200 water samples
- 2 years monitoring (1998-2000)
- Seasonal peak in herbicide concentration is during June and July
- While those peak of fungicide and insecticide concentration are during July and August
- The load of these compound to the Ishikari bay was estimated using the flow rate of the river measured at the Ishikariohhashi Bridge
- The total annual loads of pesticides was estimated as 4.53 tons.
The fresh water discharged from Ishikari river move to the sea of Okhotsk by the excelling Tsusima warmcurrent. Especially, observed clearly in case of extreme rainfall.

Red marked water plume means fresh water from Ishikari river. May be identified as SS.

Pesticide concentration in the Ishikari river water (Insecticide 1998-1999)

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>March</th>
<th>April</th>
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<td>0.05</td>
<td>0.05</td>
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<tr>
<td>Isoprothiolane</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
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<tr>
<td>Fenitrothion</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
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<tr>
<td>Phenthoate</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
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<td>0.05</td>
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<tr>
<td>Fthalide</td>
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<tr>
<td>Edifenphos</td>
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<tr>
<td>Ferimzone</td>
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<td>0.05</td>
<td>0.05</td>
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</table>

Full scale conc. (ug/l)
Pesticide concentration in the Ishikari river water (Insecticide 1999-2000)

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Full scale conc. (ug/l)</th>
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</thead>
<tbody>
<tr>
<td>Fenobucarb</td>
<td>0.34</td>
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<td>Isoprothiolane</td>
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<td>Fenitrothion</td>
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<td>Phenthoate</td>
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<td>Tolclofos-methyl</td>
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<td>Fthalide</td>
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<td>Ferimzone</td>
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<tr>
<td>Iprobenfos</td>
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## Pesticide concentration in the Ishikari river water (Herbicide 1998-1999)

<table>
<thead>
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<th>Herbicide</th>
<th>Full scale conc. (ug/l)</th>
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<tr>
<td>Prethilachlor</td>
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<td>pyributicarb</td>
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<td>Bromobutide</td>
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<tr>
<td>Dimethametryn</td>
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<tr>
<td>Dimepiperate</td>
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<tr>
<td>Benfuresate</td>
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<tr>
<td>Simetryn</td>
<td>0.23</td>
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</table>


Pesticide concentration in the Ishikari river water (Herbicide 1999-2000)

Herbicide

- Esprocarb: Full scale conc. (ug/l) 0.16
- Prethilachlor: Full scale conc. (ug/l) 0.85
- Thenylchlor: Full scale conc. (ug/l) 0.11
- Bromobutide: Full scale conc. (ug/l) 0.15
- Dimepiperate: Full scale conc. (ug/l) 0.006
- Mefenacet: Full scale conc. (ug/l) 0.16
- Benfuresate: Full scale conc. (ug/l) 0.80
- Molinate: Full scale conc. (ug/l) 0.050
- Piperophos: Full scale conc. (ug/l) 0.011
- Thenylchlor: Full scale conc. (ug/l) 0.11
- Simetryn: Full scale conc. (ug/l) 0.17
(C) Coastal waters studies around Hokkaido
-introduction of six case studies in brief-  
-Each study have each objective-

Study area

Ishikari Bay

Sediment core

Nemuro Bay

Ishikari Bay: LANDSAT ETM+ 29/5/2002

Nemuro bay: LANDSAT ETM+ 26/9/2001

Sapporo
Plume over the coastal sea areas in the vicinity of Lake Saroma lagoon.
Case 1 Ishikari Bay

- Fresh water discharged from Ishikari river (> 3 million population) diffuse mainly to the northern direction.
- Water plume covering over a wide area of the bay was observed annually when a large quantity of fresh water discharged from Ishikari river during thaw and heavy rain event.

Objective

- Vertical and horizontal distribution of the chemical species in the bay.
- Fluctuation of the components of the sediment column such as metal, organic carbon, chemical compounds and diatom frustules.
- Categorize the diffusion pattern of fresh water inside and outside the bay using satellite derived imagery.
- Comparison of the satellite-derived imagery and analyzed chemical indices. (Sea truth)
High concentration of organic matters are observed during the high economic growth period. And Diatom frustules shows a similar tendency.
Sea-Truth

How to make an algorithm fitting for coastal sea areas

(Compare with satellite-derived imagery and measured contour of chemical species)

Sea-WiFS at nLw 555

SS (mg/l)

Salinity (PSU)

W-Temp (°C)

Chl-a (µg/l)

Monitoring point

Sea-WiFS derived-imageries (nLw 555) which algorithm was made by empirical method are usually identifying chlorophyll. But not available for river mouth, because SS mistaken as Chlorophyll.
Can Sea-WiFS (a sensor of satellite) use for monitoring coastal water?

Relationship between SS and SeaWiFS·nLw555 (R=0.702) May 18/2000

It may be available for SS.
Kushiro Sea Area

[Main objectives]
☆ DMS (Dimethylsulfide)
☆ Chemical substances

Tokachi Sea Area

[Main objectives]
☆ Relationship between river water and macrobenthos
☆ Origin of the nutrient in phytoplankton

Monitoring points of Kushiro sea area and Tokachi sea area
Chemical compounds in the sediment at Kushiro sea area

Distance from coast
- 0.5km
- 3km
- 9km

TEQ
- PCBs
- HCB
- HCHs
  - α-HCH
  - β-HCH
  - γ-HCH
- DDTs
  - p,p'-DDT
  - p,p'-DDD
  - p,p'-DDE
- Chlordane
  - trans-ca
  - cis-ca
  - trans-nona
  - cis-nona

PCDDs
PCDFs
Total PCDD/DFs
Non-ortho coplanar PCBs
Mono-ortho coplanar PCBs
Total Coplanar PCBs

Total TEQ values
- S2
- S5
- S9

MBT (モノブチルスズ)
DBT (ジブチルスズ)
TBT (トリブチルスズ)
Σ BTs

Σ dioxin

TBT
Pesticide・PCBs

you can see differences between near the shore and off the coast
Tesio Sea Areas

Water cloudiness are observed near the mouth of river.

Tesio sea areas are affected by the Tesio river in the coast side and by the Ishikari river off the coast.

Objective
- Relationship between coastal water quality and faunal habitat (especially macrobenthos)
- Relationship between amino acid components in river water and salmon homing.
- Investigate the relationship between the diffusion of river water and salmon homing using remote sensing.
How to apply the diversity of macrobenthos for ESI

How chemical substances, such as pesticide discharged from river, affect to the diversity of macrobenthos.

Diversity map of macrobenthos

Diversity of macrobenthos in the vicinity of river mouth are degraded than those of off the shore.
Lake Saroma lagoon

Use for aquaculture (Scallop, Oyster, Shrimp etc)
Dead water (sometime lethal condition) affect to these marine products during the stratification especially in hypolimnion.
Once the amount of marine products died by flood (fresh water).

Objectives
Make clear the mechanism of the death of these marine product.
Investigate the threshold of sulfide on its lethal concentration.
Make an ecological model.
How to keep the best environmental condition for aquiculture.
The exchange research with Brazil in 2008
- Hydrological condition of Lake Saroma resembles to Parana Bay (Brazil)-

Lake Saroma
In Hokkaido
Half closed
Meromictic saline lake

(same scale)

Parana Bay
How to improve the water quality at a half closed sea
Make an ecological model and an lake current model and check with the actual measurement. Use for prediction and countermeasure.

**Make an ecological model**
- How to treat some black boxes
- How many parameters to use

**Make an Lake current model**
1. True lake current covered with a lot of aquiculture shelf
2. Estimated lake current, if there are no shelf

**Actual measurement**
- COD, SS, Chl-a, POC, PON, Nutrients, Salinity etc.

**Measured the lake current**
- 2 months in each winter and Summer in 2006 and 2007, respectively.

**Verify**

Sea water from the lake mouth
Seawater is the origin of density current.

Fresh water from the basin
Involved a lot of pollutants

Lake Saroma

Increase of the juvenile scallop mortality

Anoxic layer

Long term stratification

Nutrients, sulfret (H$_2$S etc.)
Anoxic zone progresses to the summertime in the hypolimnion.
Measurement of the sulfuret in the water column at hypolimnion (Sulfuret, nutrients, Dissolved Oxygen)

Undisturbed water sampler

The rubber pucking prevents contact with the atmosphere

Half closed sea areas are suffered from its sulfuret caused by dead water

Figure

Fluctuation of sulfide from lake bed

Distance From lake bed

1cm 5cm 10cm 15cm 20cm

D5 2007/8/

D7 2007/8/

D5 2007/9/

D7 2007/9/

Fluctuation of sufret in the hypolimnion water column
A great deal of nutrients dissolved from lake bed during anoxic term, and cause eutrophication.
Simulation of lake current at Lake Saroma using three dimensional analysis software.

The real lake current were measured to verify the model in summer and winter season using several pieces of ADCP in detail.
Case 6. Nemuro Sea area

- The bay was once peat marsh in prehistoric era
- There often observed water cloudiness over the bay by satellite-derived imagery
- Land use is mainly grazing
- More than 40mm rainfall induced on increase of river surface effluence.

Objectives
- Water quality and substrate in the Bay
- Calculation of the water and the chemical budgets in lake Huuren
- Resident time of the fresh water in the Nemuro Bay
- Relationship between satellite derived data and Chlorophyll-a.

Nemuro Bay is located in the vicinity of the border between Japan and Russia.
The distribution of Temp., Chlorophyll and salinity in Nemuro bay. (Observed in July 1998)

About 2,000*10E4 m³ of fresh water discharged from the Lake Huuren in case of tide range 113cm. (July 1998)

Fresh water retained in the half closed bay about 30days estimated by salinity as fresh water marker. (July 1998)

\[ F = \sum V_n \cdot f_n \]

Where \( F \) is amount of fresh water, \( V_n \) is the volume in the same concentration volume, \( f_n \) is the ratio of fresh water (\( f_n = (1 - S_n/33.5) \)), \( S_n \) is salinity of same concentration sea area, 33.5 is used as standard salinity of off shore sea water.
Relationship between Chlorophyll-a and satellite derived data at the Nemuro Bay.


\[ y = 0.4362x - 4.2298 \]

\[ R^2 = 0.4408 \]

Relationship between COD and UV254

There is a good relationship between COD and UV254 in water bodies which involved mainly humic substances.
(D) Introduction of new investigations

New program with NIES — How to protect the coast from oil spill

First of all, make ESI map. In the Second, trace the spilled oil using GPS monitoring system. Finally, estimates arrival spots and takes measures.

ESI (Environmental sensitivity index)
For coastal creature

Environmental risk management for the emergency response

Courtesy of Satoshi Kameyama (NIES)
Corbicula live in Lake Oikamanai (eastern Hokkaido) is the huge size than other lakes

- Same species?
- Difference of the growth rate?
- Long life?
- Difference of environmental condition?

- The collection of the gene information
- Investigate the relationship between the environmental quality and growth rate (Year and date ring, quality of the water and substrate)
- Comparison with other corbicula (Japan and Okhotsk region)

(courtesy of Prof. Sonoda  Tokyo Agricultural Univ.)

Finally, make the actual state of the local adaptiogenesis clear.
For Prospective Research (Hokkaido’s Concern)

- **How to resolve the global environmental issues around Hokkaido**
  
  How to appeal the environmental importance of Hokkaido which have quite different floral-faunal habitat than those of southern part of Japan and have vulnerability against the influence of global warming.

- How to build the domestic research system with other region centered on NIES
  
  The present situation is only collaborate with Universities and companies in Hokkaido

- How to build new projects on the multidisciplinary research with the neighboring countries, specifically with China and Korea

- How to get the funding for these researches