LAND-OCEAN INTEGRATED MANAGEMENT OF TOYAMA BAY IN THE INTERNATIONAL SEMI-ENCLOSED SEA, JAPAN SEA

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How to manage coastal area in Japan Sea?

Identification of the two impacts on environment of JS

Physical, chemical and biological environment of JS is strongly influenced from ECS and global warming
Findings from our project

Relation between JS and ECS
Origin of sea water/nutrient in JS?

Impact of global warming
Future Environmental Change of JS?

Ratio of three different sources of waters in the surface of Japan Sea

- Japan Sea
- Kuroshio
- Taiwan C.
Outcome of our project: Three Layer Management in Japan Sea

Combination of three-different-scale management

• First layer (Wide-scale management)
  Target: Global warming,
  Regional environmental change
  Int’l surveillance networks

• Second layer (Middle-scale management)
  Target: Tsushima Current
  Tsushima Monitoring network

• Third layer (Local-scale management)
  Target: Each bay
  Land-Sea Integrated management
Land-Sea Integrated Management in Toyama Bay

Coastal area of Japan Sea is strongly influenced by the impact from the East China Sea

How to manage the coastal area? What is an appropriate management method?

Characteristics of Toyama Bay:
Rich fishery resources
Rich groundwater
Submarine groundwater discharge

Management in land area

Very good site for study on land-sea integrated management
Impact of global warming in Toyama

Decrease of water stock in form of snow in mountain area

Increase of water discharge in winter, decrease of melting water discharge in late spring to summer

Decrease of nutrient supply in summer
Reduce of production in summer?
Social Changes in Toyama

Change of land use (Urbanization)

1976  2006

Decrease of rice paddy

Change of groundwater use


Decrease of rice paddy

Melting snow
Building
Industry

Change of water/groundwater circulation
Basic concept for land-sea integrated management in Toyama Bay

How was water circulation changed by GW? How was use of groundwater changed? What are their impacts?

- Nutrient supply
- Groundwater

Rich water resource

How much to contribute to coastal production from land?

- Change of water circulation
- Change of groundwater use

Global warming
Social changes

- Nutrient control
- Groundwater management

How to adapt?

How to reduce the impacts by land-area management?

- How to contribute to coastal production from land?
New numerical ecosystem model: Combined physical-ecosystem model

Resolution: $x = 1/60^\circ$, $y = 1/75^\circ$, $z = 36$ layers

<table>
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<tr>
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<th>DIN (μM)</th>
<th>DIP (μM)</th>
<th>N/P ratio</th>
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<td>Kurobe R.</td>
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</tbody>
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(a) Current vector, (b) DIN, (c) N/P ratio, (d) phytoplankton and (e) zooplankton
Impacts of offshore and land-sourced waters

What are offshore and land impacts on the environment of Toyama Bay?

Water under 32 psu is defined as impacted water from land.

10-60% of Toyama Bay is influenced by land-sourced fresh water.

Environment of Toyama Bay is well balanced by offshore and land-based impacts.
Impact of sub-marine groundwater discharge

Nutrient input of SGD=Nutrient input of rivers

Difference of DIN in coastal area between with SDG and without SDG

Simulated chl-a (top) and satellite chl-a (bottom)

SDG has strong contribution to coastal production

Change of groundwater circulation may cause change of production
Quantification of impacts of rivers and SDG

May-November: 80-90% of nutrient supply is controlled by rivers and SDG
Impacts of global warming

Global warming

Change of snowfall and snow melting

Change of river discharge

Change of coastal environment

Change of river discharge
River basin management:
Forest - Satoyama - River - Ocean
(Ministry of Environment, Japan)

Climate change
Social change

How to adapt to changes using groundwater management?
New land-ocean management
Forest-Satoyama-River-Groundwater-Ocean management
Thank you for your attention