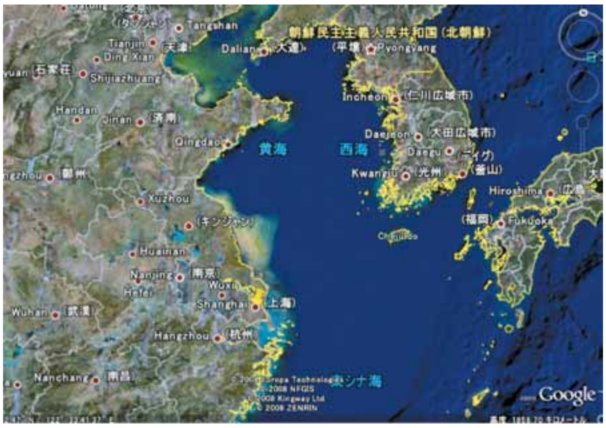
International Workshop

Sato-Umi

New Concept that Increases Biological Productivity and Biodiversity

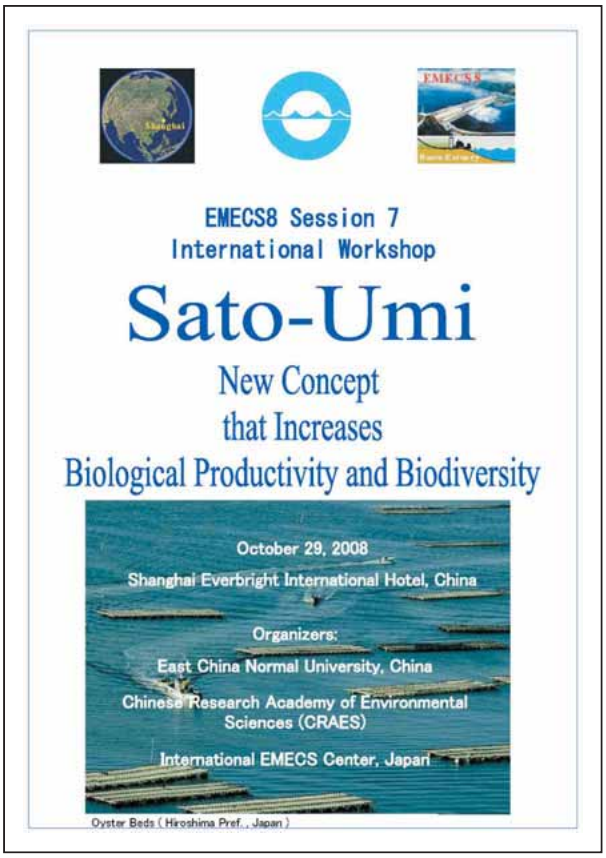
Workshop Report

International EMECS Center, Japan



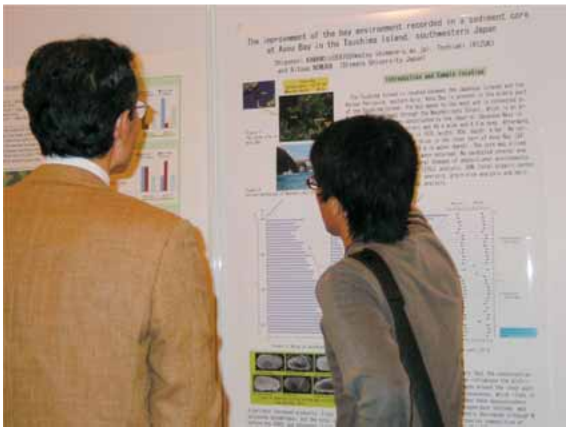
Location of the venue

The Venue - Shanghai Everbright International Hotel



Program

Reception Desk


The improvement of the bay environment recorded in a sediment core

CONTENTS

Preface

The word "Sato-Umi" was created by Professor Yanagi of Kyushu University in 1998. It is an original Japanese approach that attaches great importance to the relationship between local communities and the sea, similar to "Sato-Yama" which is the forest in the border area between the foot of the mountain and the arable flat with high productivity and biodiversity under the interaction of human activities. The Japanese Ministry of the Environment regards "Sato-Umi" as a measure for the future environmental improvement and restoration of sea areas, and is trying to spread the concept throughout the world.

Similar approaches have been found in other countries. However, such information has remained only within local communities. Researchers' network around the world for information-sharing has not yet been established. The concept of "Sato-Umi" was first introduced at the EMECS7 Conference held in Caen, France in 2006 and attracted a great deal of attention. To disseminate this concept, the "Sato-Umi" workshop was held as a session of the EMECS8 Conference which was organized by East China Normal University, Chinese Research Academy of Environmental Sciences and International EMECS Center in Shanghai, October 27 to 30, 2008.

The workshop comprised two parts: oral presentations and a poster session. There were presentations from China, South Korea, Thailand, Indonesia, the United States and the EU, and numerous case studies from Japan. Every presentation was given with eagerness. The fruits of this workshop were extensively incorporated into the Shanghai Declaration.

We believe that this workshop was a valuable opportunity for the researches around the world. It is our expectation that the concept of "Sato-Umi" will be spread out of the world and that environmental conservation and restoration activities related to enclosed coastal seas will be promoted.

We wish to express our sincere gratitude to everyone who contributed so much to this workshop, especially Professor Zhongyuan Chen of East China Normal University who has managed EMECS8 as the Secretary General, Professor Tetsuo Yanagi of Kyushu University who has developed a plan for this workshop and Dr. Won-Keun Chang who co-chaired this workshop.

We would also like to express our gratitude to the Japan Fund for Global Environment of the Environmental Restoration and Conservation Agency for providing financial assistance.

International EMECS Center

1 Outline

Theme

Sato-Umi

- New Concept that Increases Biological Productivity and Biodiversity -

Date

October 29, 2008

Venue

Shanghai Everbright International Hotel, Shanghai, China

Organizers

East China Normal University, China

Chinese Research Academy of Environmental Sciences (CRAES)

International EMECS Center, Japan

Sponser

The Japan Fund for Global Environment of the Environmental Restoration and Conservation Agency

2 Program

Chair: Prof. Tetsuo YANAGI　Kyushu University, Japan

13:45-14:00　Prof. Tetsuo YANAGI　Kyushu University, Japan　(invited)
Definition of Sato-Umi

14:00-14:15　Mr. Munesumi SHINODA　Ministry of the Environment, Japan　(invited)
Creation of Sato-Umi as a Policy in Japan

14:15-14:30　Prof. Jianguang FANG　Yellow Sea Fisheries Research Institute (YSFRI), Chinese Academy of Fishery Science　(invited)
Development of Integrated Multi-trophic Aquaculture in China

14:30-14:45　Mr. Won-Keun CHANG　Korea Maritime Institute, Korea　(invited)
National Initiative on Environment Management in Coastal Area of Korea

14:45-15:00　Dr. Putth SONGSANGJINDA　Coastal Aquaculture Research Institute, Thailand (invited)
Silvo- aquaculture: an Ecosystem Based Management for Sustainable Coastal Aquaculture in Thailand

15:00-15:15　Dr. Jack GREER　University of Maryland Sea Grant, USA　(invited)
Resolving Oyster Conflicts in the Chesapeake Bay: The Concept of Sato-Umi

15:15-15:30　**Break**

Chair: Dr. Won-Keun CHANG　Korea Maritime Institute

15:30-15:45　Dr. Jacobus W.MOSSE　University of Pattimura Poka, Indonesia　(invited)
Sasi Laut: History and its Role of Marine Coastal Resource Management in Maluku Archipelago

15:45-16:00　Prof. Jean-Paul DUCROTOY　The University of Hull, UK　(invited)
Managing Eutrophication in Megatidal Estuaries in North-Western Europe through Integrated Coastal Zone Management

16:00-16:15　Prof. Tamiji YAMAMOTO　Hiroshima University, Japan
Phytoremediation of Organically Enriched Sediment – Evaluation by a Numerical Model

16:15-16:30　Prof. Masahiko SEKINE　Graduate school of Science and Engineering, Yamaguchi, Japan
Adaptive Cooperative Management of Tidal Flat by Citizens - Governments - Researchers in the Yamaguchi Bay

16:30-16:45　Prof. Kazuhiko ICHIMI　Kagawa University, Japan
Seasonal Retention and Release of Phosphorus in Shinkawa-Kasugagawa Estuary, the Western Japan

16:45-17:00 Ms. Emily ANTONIO Kyoto University Japan, Japan

Isotopic Evidence of Seasonal Variation in Feeding Niche of River and Brackish Gastropods

17:00-17:15 Dr. Ahmed DABWAN Anotsu Reseach Institute for Environmental Restoration.Co.Ltd, Japan

Paper Sludge Ashes as Coagulant for Treating Contaminated Dredged Sediments and its Applications for Enhancement the Coastal Biodiversity in Ago Bay, Japan

17:15-17:30 Dr. Kenji SUGIMOTO Hiroshima Environment and Health Association, Japan

Restoration of Eelgrass (Zostera marina L.) Bed by Filling up a Borrow Pit with Natural Sediment

17:30-18:30 Poster session

01	Akihiko FUJII	Japan	*Proper Management of Fishery Resources Using a Bivalve Growth Model which Included Fishery Catch and Feeding Damage*
02	Daizo IMAI	Japan	*Monitoring of Macrobenthos and Bivalve for Biologically Productive Artificial Tidal Flats, Ago Bay, Japan*
03	Satoshi CHIBA	Japan	*Nutrients, Organic Carbon and Oxygen Budget in Semi-Enclosed Ago Bay, Japan*
04	Hideki KOKUBU	Japan	*Evaluation of Restoration Effect in the Coastal Unused Reclaimed Area by Promoting Sea Water Exchange in Ago Bay, Mie Prefecture, Japan*
05	Satoru TAKAHASHI	Japan	*Approach to Improve Nutrient Situation in the Seto Inland Sea, Japan*
06	Masaaki TAKAHASHI	Japan	*Nutrients Transfer between the Sea and Artificially Enclosed Waters/Feature of the Nutrient Flow in the Catchments Area in Ago-Bay*
07	Kenji TARUTANI	Japan	*Possible Bottom-up Control of Fisheries Production in the Seto Inland Sea, Japan*
08	Mika YAMADA	Japan	*Evaluation on Pb Contamination in Algae in Osaka Bay, Japan*
09	Osamu KATO	Japan	*Durability of Sand Capping Effect in the Inner Area of Ariake Bay*
10	Shigenori KAWANO	Japan	*The Improvement of the Bay Environment Recorded in a Sediment Core at Asou Bay in the Tsushima Island, Southwestern Japan*
11	Hiroshi KAWAI	Japan	*The Project for Establishment of a Monitoring System and Continual Utilization of Fishing Ground in the Bays of Parana Coastal Area, Brazil*
12	Tadaya KATO	Japan	*Up-to-date Technology for Treatment Watery Sediments*

3 Summary

Prof. Tetsuo Yanagi　Kyushu University, Japan

The Sato-Umi workshop, the Session 7 of EMECS8, was a half-day session held on October 29, 2008 attended by some 80 participants, with eight invited speakers, six general oral presenters and twelve poster presentations.

"Sato" means "village" and "Umi" is "sea" in Japanese, so "Sato-Umi" refers to the sea near a village. However, you will not find "Sato-Umi" in any Japanese dictionary, as it is an expression that was created by Prof. Tetsuo Yanagi of Kyushu University in 1998.

Prof. Yanagi defined Sato-Umi as a coastal sea with high biological productivity and high biodiversity due to harmonized human activities. The workshop was convened to compare the present situation of integrated coastal management worldwide, based on the concept of Sato-Umi.

The workshop started off with Prof. Yanagi explaining his definition of Sato-Umi.

By way of illustration, Dr. Jack Greer from the USA then introduced a situation in which people are suffering from a poor oyster harvest.　Due to such a decrease in the catch, there is a fundamental conflict between fishermen and environmentalists. He proposed that the new paradigm of Sato-Umi is very useful in solving such a problem and bringing about a more balanced use of the area.

Prof. Jean-Paul Ducrotoy from the EU described a different situation - an approach to the restoration of the ecosystem in the coastal sea. He pointed out that the Sato-Umi concept is similar to ecosystem-based management. We look forward　to learning many things from the ecosystem-based balanced management carried out in the EU.

Dr. Won-Keun Chang from Korea spoke of the problem of total pollution control in Masam Bay. He pointed out the importance of cooperation between science and policy.

Prof. Jianguang Fang from China discussed a very interesting and successful example of IMTA - Integrated Multi Tropical Aquaculture, which refers to fishermen cultivating fish, sea urchins and sea cucumber in the coastal sea of China. All the materials are assembled in the culture ground and there is no emission. I believe this to be a very interesting and useful method that can be used worldwide.

Dr. Putth Songsangjinda from Thailand gave a presentation on a similar example to IMTA, but which extends from the land to the sea. He refers to this as 'Mangrove Aquaculture' - a system whereby both mangrove and shrimp are cultivated. He provided a demonstration of large and small scale Mangrove Aquaculture ponds and showed how a study of the nitrogen budget suggests that mud crab and shrimp are highly suited to the system.

Dr. Jacobus Mosse from Indonesia introduced the SASI system. "SASI" is a local Indonesian expression that means "prohibition". Once community leaders announce a SASI, all public actions are prohibited for some time in certain areas. People want to conserve resources - not only fisheries but also ground resources. He also pointed out the basic similarity between the SASI and the Sato-Umi concept.

From Japan, there were many presentations based on the creation of Sato-Umi. Mr. Munesumi Shinoda of the Ministry of the Environment (MOE) announced that the creation of Sato-Umi has become official Japanese policy now.

Other topics included:

- a trial of holistic governance from mountains to the coastal sea
- restoration of tidal flats by benthic micro algae
- cooperative management for the restoration of tidal flats using cooperation between citizens, government and researchers
- seasonal retention and release of phosphorus in tidal flats
- seasonal variations in food for gastropods
- the use of ash from paper sludge in the treatment of contaminated dredged sediment
- methods for restoring eelgrass beds
- etc.

During the session, a questionnaire was distributed to the participants by the MOE of Japan, with the aim of promoting international cooperation based on the creation of Sato-Umi.

Responses to the questionnaire included the following :

- We want to know more about Sato-Umi.
- Education of fishermen and citizens is very important.
- Sato-Umi is very similar to SASI.
- Creation of Sato-Umi is a very impressive trial.
- Local wisdom is very important for the creation of Sato-Umi.

Following the oral presentations, a poster session was held at which participants enjoyed the opportunity to have a discussion with the presenter in front of his/her poster. Mr. Daizo Imai received the Best Poster Award of EMECS8.

Prof. Yanagi summarized the workshop as follows:

- Sato-Umi refers to coastal seas that have high biological productivity and biodiversity as a result of harmonized human activity.
- Sato-Umi is not only a concept of the natural sciences but also a social and cultural concept similar to “working landscape” and “EBM (Ecosystem Based Management)”.
- Sato-Umi is a new paradigm for humanity’s current lifestyle.
- Sato-Umi may prove to be one answer to the question of the best relationship between people and nature in the face of global warming.
- The concept of Sato-Umi should be improved on and developed so that it becomes a useful method in solving the problems of coastal sea areas worldwide.

4 Oral Presentation

Definition of Sato-Umi

Tetsuo YANAGI
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A new concept for coastal sea management called “Sato-Umi”, defined as “High productivity and biodiversity in the coastal sea area with human interaction”, is proposed. To establish the Sato-Umi, it is necessary to realize comprehensive material cycling and appropriate fish resource management in coastal sea areas.

It is said that “Nature takes its best state without mankind”. Would it be true that no environmental problems would exist if mankind was not present on Earth? However, there would be no meaning to a discussion regarding environmental problems without the presence of mankind.

Nature does exist that takes its best state under mankind’s interaction. In Japan, it is called “Sato-Yama”. In Japanese, “Sato” means the area where people live and “Yama” means the forest. Sato-Yama is thus the forest near where people live. In 1987, the area of Sato-Yama in Japan was about 4,500,000 ha making up about 20% of Japan’s total area of forest of 25,000,000 ha.

In this paper we discuss a new concept for coastal sea management that is based on the ideas of Sato-Yama. Is it possible to create a “Sato-Umi” similar to Sato-Yama? In Japanese, “Umi” means the sea, so “Sato-Umi” is defined as “High productivity and biodiversity in the coastal sea area with human interaction” (Yanagi, 1998, 2007).

To establish the Sato-Umi, we first need to understand quantitatively material cycling in the coastal sea area. That is, we need to know the quantity of nutrients that are loaded from the coast, and what are the primary, secondary and tertiary productions in the area. We need to clarify what kinds of actions by mankind are permissible or prohibited in the coastal sea area from the viewpoint of increasing production and biodiversity. The important focus is to establish comprehensive material cycling in Sato-Umi.

Yanagi, T. (1998) To create “Sato-Umi” in the coastal sea area. Journal of the Water Environmental Society, 21, 703 (in Japanese).

Yanagi,T. (2007) Sto-Umi; New concept for coastal sea management. TERRAPUB, Tokyo, 86pp

Definition of Sato-Umi（里海）

A New Concept for Coastal Sea Management

Tetsuo YANAGI
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We have suffered from Minamata decease, red tide, hypoxia, fish catch reduction and so on in the coastal seas all over the world

The basic reason is that human beings, who live on land, do not understand well the sea.

We have to understand more deeply the sea.

How can we associate with the sea?

Human and Nature

Some people say “Nature is at best without Human”.

Is this true?

There exists the nature which is at best under the interaction with human.

It is the “Sato-Yama”. (the forest near the village)
Sato: village in Japanese
Yama: forest in Japanese

Sato-Yama in Japan
4,500,000 ha and 20 % of the total forest area in 1987

Definition of “Sato-Yama”（里山）

Sato-Yama is the forest with
high productivity and high bio-diversity
under the interaction with human activities.

People plant oak at Sato-Yama and cut them
every 20-30 years for charcoal and mushroom cultivation.
Dropped leafs are used for the fertilizer.
high-productivity

Flora is rich at Sato-Yama due to its brightness.
Insects gather for honey of flower and oak.
Small animals come for acorn of oak.
Periodical human disturbances are good for biodiversity.
high-biodiversity

Sato-Yama（里山）

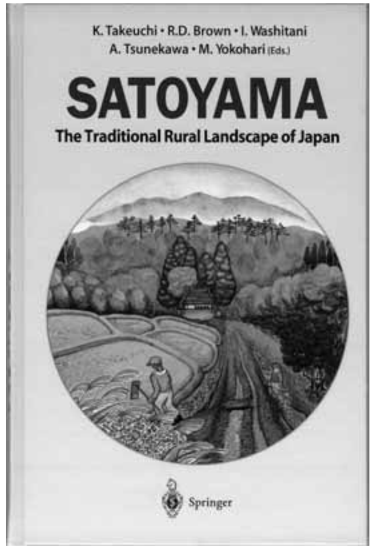
Deciduous broadleaf trees.

People work there. High productivity.

High-biodiversity

Rich flora and fauna

Sato-Yama published in (2001)



Sato-Umi（里海）

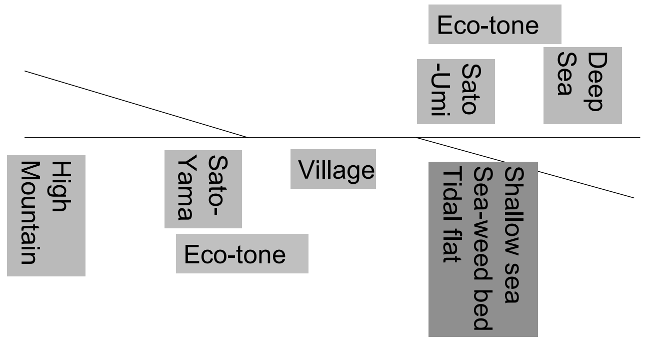
Umi（海）: the sea in Japanese

Sato-Umi（里海）: the coastal sea with high productivity and high biodiversity under the human's interaction.

In order to realize "Sato-Umi",
we first have to understand quantitatively the material cycling in the coastal sea.

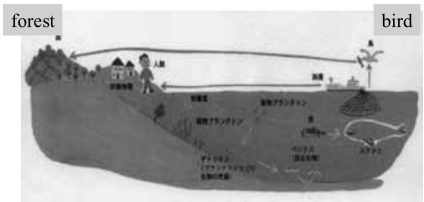
Sato-Yama and Sato-Umi

(high productivity and high bio-diversity under the interaction with human activities)



Material cycling in Sato-Umi

Thick, long and smooth material cycling
(Comprehensive materail cycling)
must be established in Sato-Umi
for high productivity and high bio-diversity.



Material cycling in the coastal sea

Red tides

Red tides mean the thick material flow but
the short and no-smooth material flow
because the big biomass of dead phytoplankton
consumes the dissolved oxygen in the bottom layer
and results in hypoxia and fish mortality.

They are not good for Sato-Umi.

Eutrophic or oligotrophic coastal seas

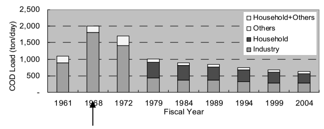
In the eutrophic coastal sea, we have to reduce the nutrient load from the land.

In the oligotrophic coastal sea, we have to increase the nutrient supply from the aphotic layer by the artificial upwelling reef.

Eutrophicated coastal sea

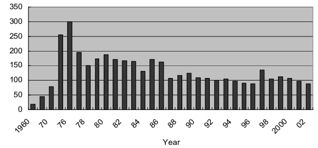
COD load and red tides in the Seto Inland Sea, Japan

COD load



1973: Law on Measures for the Environmental Preservation; COD load decrease to 1/2

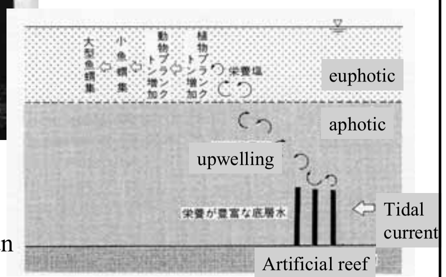
Red tides



Change in COD load and the occurrence number of red tides in the Seto Inland Sea, Japan

Oligotrophic coastal sea

Artificial upwelling reef

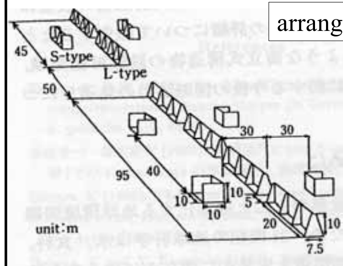


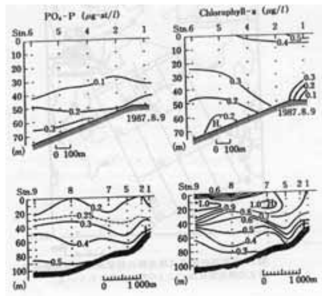
H=10m,   L=20m

Field experiment was carried out in the Seto Inland Sea, Japan in 1987.

Effect of artificial upwelling reef

arrangement





1987 before

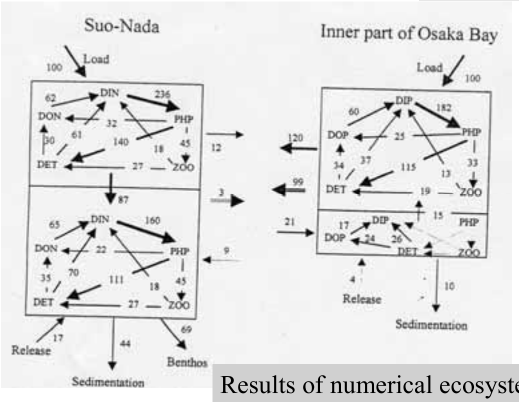
1989 after

Yanagi and Nakajima (1991)

Importance of bio-chemical processes

Hayashi and Yanagi (2002)

Nitrogen flux



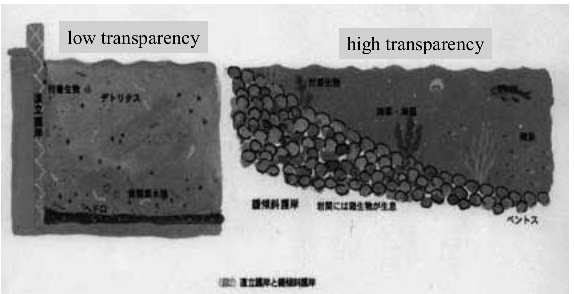
Phosphorus flux

Results of numerical ecosystem model.

Coastal sea as a habitat

- It is very important for the coastal sea as a habitat for marine biota in order to establish the comprehensive material cycling there.
- Because the bio-chemical material flux is very large in the coastal sea.

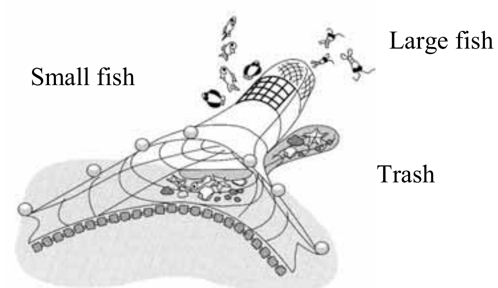
Strait-uplifted coast or gentle-sloped coast



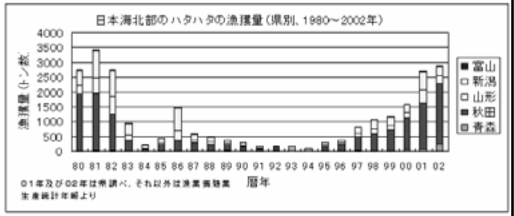
We have to provide good condition for marine life in Sato-Umi.

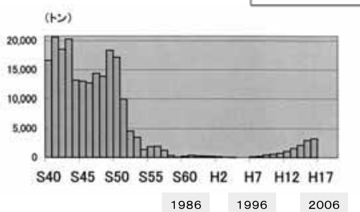
Fish resources management is also very important for the establishment of Sato-Umi.

New technology is developed: Fishing gear to avoid small fish catch



Fish resources management





Year-to-year variation in fish catch of Hata-hata in Akita Prefecture

Prohibit of fishing in 1992-1995, (Harvest moratorium)

After that
Application of TAC(Total Allowable Catch)

Sato-Umi＝Commons

Commons ; system for co-use and co-manage of resources
or
resources themselves（land or plants）

It is situated between nature and human.

Nature is humanized in Commons and
Human must be naturalized in Commons.

Then human's and nature's sustainable developments are possible in Commons.

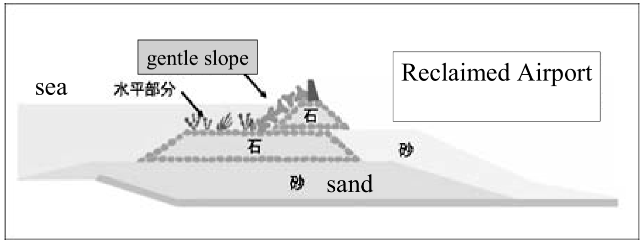
Humanized nature

- Many examples such as gentle-sloped coast of Kansai International Airport

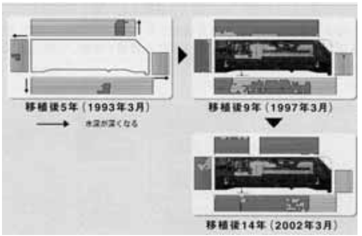
Mud ecosystem has changed to algae-bed ecosystem there by human activity.

Kansai International Airport

Artificial gentle-sloped coast.



Artificial sea-weed beds



Larvae of rockfish migrate
in the whole area of Osaka Bay
from the artificial sea-weed beds.

Artificial sea-weed beds are developed on the gentle-sloped coast of Kansai-Airport

Human naturalization

Human naturalization is to follow the natural rhythm
by pressing down the human's desire.

We have to understand the natural rhythm at first.

Marine science is important for understanding the natural rhythm.

Fishermen in Japan have many rules for preservation of fish resources
in order to follow the natural rhythm.

Many rules are necessary for sustainable development of Sato-Yama

表7-1 items of rule

	年度	条項数	道具制限	防火消火	炭焼き	山林巡回	林区の明確化	罰則規定	刈合場所芝草刈りの範囲・期限	保護掛設置	左記の職務等	制度改正要件	村会議決事項	伐採年齢	伐採方法	伐期規定	枝打間伐技術	土石採取制限	植樹義務	苗圃設置・苗木育成
1877	明治10年規約書	全5ヵ条	○	○	○	○														
1882	明治15年盟約	全5ヵ条	○	○	○	○														
1884	明治17年議案	全17ヵ条	○	○		○	○	○	○	○	○	○	○						○	
1896	明治19年規約	全36ヵ条	○	○		○	○	○	○	○	○	○	○	○	○	○			○	○
1896	明治31年規約	全28ヵ条	○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○	
1907	明治42年規約	全33ヵ条	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

（備考）『大正七年発行　滋賀縣大原村村有林経営方法および成績書』より筆者作成

This is naturalization of human in Sato-Yama.

Sasi

- The strict rules in Satoyama is similar to

  "Sasi" in the Southeast Asia countries.

"Sasi" is rules for the natural resources management in the Southeast Asia.

Conservation or Preservation

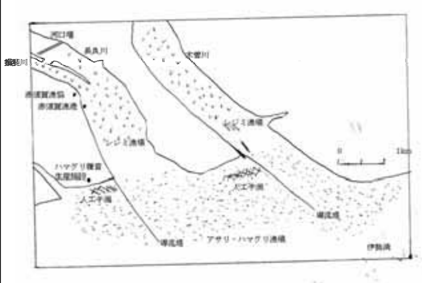
Sato-Umi does not preserve the coastal sea
but
conserve the coastal sea.

It is a way of “Wise Use” of the coastal sea.

Appropriate zoning

Forest	Sea
1)Needle-leaf forest Japanese ceder, Japanese cypress	1)Aqua-Culture sea weed, oyster, yellow tails
2)Sato-yama	2)Sato-umi
3)Chinjyu-no-mori Ever-green-leaf trees	3)MPA (Marine Protected Area)

Artificial Tidal Flat and Clam

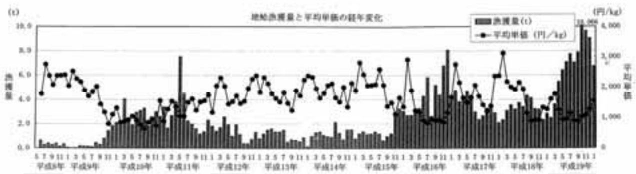


Akasuka Fishermen Union

Culture of clam juvenile

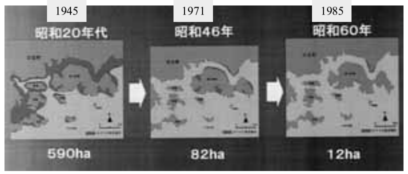
Artificial tidal flat

Harvest variation

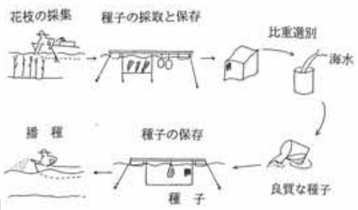


Year-to-year variations in clam harvest and price

Decrease of sea-grass bed area

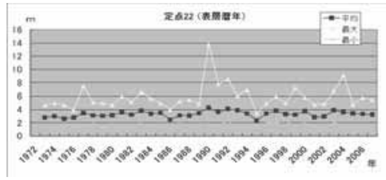


Hinasecho Fihsermen Union

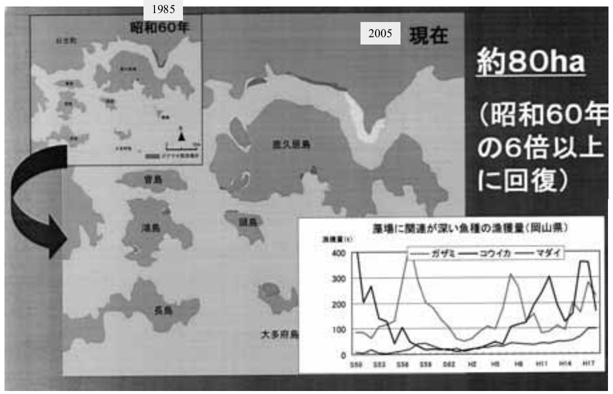


Reproduction of sea-grass bed

Sea-grass bed reproduction areas



Expanding sea-grass bed



Holistic governance from the top of the mountain to the sea

Material cycling

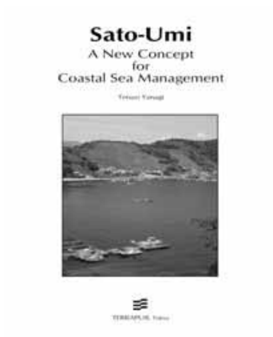
Resource management

Socia system innnovation (production・consumpotion)

Change of value

Technology innovation

Fisheries law
Navigation law →unified
Water pollution law



Terra Scientific Publishing Company
2007, 96p.

Sato-Umi
— A new concept for coastal sea management —

1.Introduction
2.Mankind and coastal sea
  2.1 Richness of the coastal sea
  2.2 Crisis of the coastal sea
3. Mankind and the forest
  3.1 Sato-Yama
4. Sato-Umi
  4.1 Concept of Sato-Umi
  4.2 Harvest of sea-glass bed
  4.3 New technology
  4.4 Stock enhancement and fish culture
  4.5 Sea farming
  4.6 Fish resources management
5. Environmental ethics
  5.1 Environmental ethics and Commons
  5.2 Preservation and Conservation
  5.3 Environmental education
6. Concluding remarks

Nutrients cycling

Nutirents (N:P:Si=16:1:16)

Tidal flat
Sea-grass bed
Benthic diatom
phytoplankton
fish

past

Multiple paths
Thick material cycling

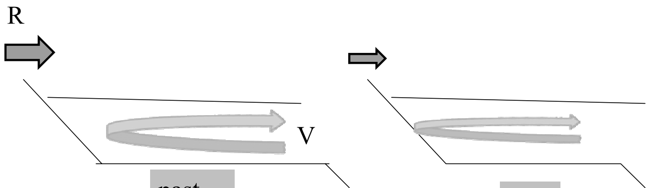
Nutirents (N,P>Si)

Red tide (dinoflagellata)
Hypoxia

now

Simple path
Narrow material cycling

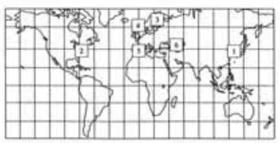
Decrease of river discharge due to dam construction

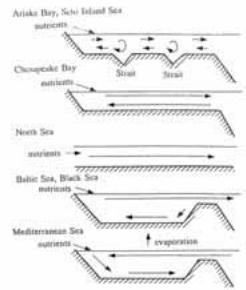


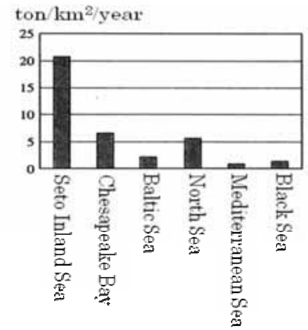
V≒10R
Weaken estuarine circulation → Red tide and Hypoxia generation

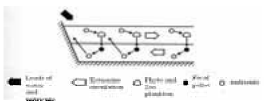
Seto Inland Sea

Fish Productivity in the Seto Inland Sea

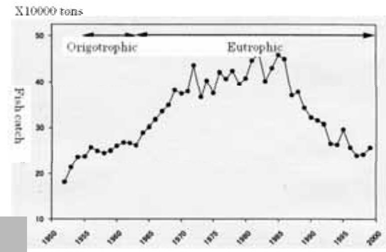








Reduce of fish catch in the Seto Inland Sea



Its causes
1) Regime shift
2) Variability of oceanic condition
3) Overfishing
4) Destruction of shallow sea
5) Marine pollution, eutrophication

8th EMECS (Environmental Management in Enclosed Coastal Seas) at Shanghai on 29 October, 2008

- Special Session on "Sato-Umi" in the 8th EMECS at Shanghai, China

- T.Yanagi (Kyushu University, Japan) "Definition of Sato-Umi"
- J.Greer (Maryland Sea Grant College, University System of Maryland, USA) "Resolving Oyster Conflicts in the Chesapeake Bay: The Concept of Sato-Umi"
- J.P.Decrotoy (University of Hull, U.K.) "Managing eutrophication in megatidal estuaries in North-Western Europe through Integrated Coastal Zone Management"
- W.K. Chang (Korea Maritime Institute, Korea) "National Initiative on Environment Management in Coastal area of Korea"
- J.Fang (Yellow Sea Fisheries Research Institute, Chinese Academy of Fisheries Science, China) "Development of integrated multi-trophic aquaculture in China"
- P. Songsangjinda (Coastal Aquaculture Research Institute, Department of Fisheries, Thailand) "Silvo-aquaculture: an ecosystem based management for sustainable coastal aquaculture in Thailand"
- B.Mosse (Pattimura University Ambon, Indonesia) "Sasi laut: History and its role of marine coastal resource management"

Creation of SATO-UMI as a Policy in Japan

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MUNESUMI_SHINODA@env.go.jp

1 Circumstance of the Environmental Coastal Seas in Japan

In Japan, Effluent Standards of nitrogen and phosphorus are applied in the enclosed coastal seas. In particularly regional area (for example: Seto Inland Sea), Total Pollutant Load Control System of CODMn, nitrogen and phosphorus is added. As a result, remarkable pollution was improved, but the functional depression of material circulation, deterioration of the ecosystem including marine resources and citizen's unconcern for water environment were advanced. Therefore the Government of Japan promotes the verification of technologies for improvement of the water environment in enclosed coastal seas, pushes forward establishment of action plan to achieve the water environment quality that should be target in future indicated by the DO in the bottom layer and transparency. And recently the restoration of enclosed coastal seas by the creation of SATO-UMI is added.

2 The Creation of SATO-UMI as a National Policy

The creation of SATO-UMI as a national policy had its inception when it was designated as the environmental policy which should be started during the next one or two years in BECOMING A LEADING ENVIRONMENTAL NATION STRATEGY IN THE 21st CENTURY (MOE, June 2007). This strategy plans the creation of seas which are full of the natural blessings that various fishery products inhabit by integrating promotion of conservation and restoration of shallow area, water pollution control, and sustainable resources management.

Therefore, MOE has started supporting the advanced activities for the environmental conservation and evaluating the effects of them since 2008, and the know-how of these activities are going to be edited as a manual which serves as a reference when a new activity is started.

3 View point at Creation of SATO-UMI

MOE tidied up the concept of SATO-UMI as follows in cooperation with some experts in 2007.

・SATO-UMI is the coastal sea where human coexist with nature tied to living and the traditional culture of people deeply with appropriate function of material circulation, high productivity and biodiversity under integrated coastal management by mankind.

・The creation of SATO-UMI can be a tool of the participatory and cooperative model for the integrated coastal management, because SATO-UMI is the concept of not only space, but also including human activities and can be gain the continuity if tied to the human habit.

・By material circulation, ecosystem and water amenity(these 3 elements are conserved by SATO-UMI), spot and body of activity, SATO-UMI is categorized into some patterns like Basin type, Fishing Village type and others.

Keyword: Environmental policy, integrated coastal management, material circulation, ecosystem

Creation of SATO-UMI as Policy in JAPAN

Office of Environmental Management of Enclosed Coastal Seas,
Water Environment Department, Environmental Management bureau,
Ministry of the Environment, JAPAN

Munesumi SHINODA

Environmental Policies of Enclosed Coastal Seas in JAPAN

1950-70's

- **Development by high economic growth and expansion of industrial activity**
- **Water pollution by plant effluent and living drainage**
- **Loss of Shallow zone by reclamation**
- **Frequent occurrence of large-scale red tide**
- **Frequent occurrence of oil spill**

Response of environmental administration

- Restrict laws were enacted
- 1967 Basic Law for Environmental Pollution Control
- 1970 Water Pollution Control Law
- 1971 Environment Agency was established
- 1972 Nature Conservation Law
- 1973 Interim Law for Conservation of the Environment of the Seto Inland Sea
  → reduced by half COD from industrial drainage
- 1978 Total pollutant load control (TPLC) was adopted for COD

2

Environmental Policies of Enclosed Coastal Seas in JAPAN

1980-90's

- **Continuous occurrence of red tide**
- **Generation of anoxic water**
- **Occurrence of large-scale oil spill**
- **Collection of sea gravel**

1990's-

- **Creation of environments to pass on to future**
- **International contributions**

Response of environmental administration

- 1993 Basic Environmental Law
- 1993 Nitrogen and Phosphorus were added to the effluent standard
- 1994 NOWPAP was established
- 2000 EMECS was established
- 2000 Basic Plan for Conservation of the Environment of the Seto Inland Sea
  → prohibition of sea gravel collection
- 2001 Reorganized as Environment Ministry
- 2001 Nitrogen and Phosphorus were added to TPLC
- 2004 WEPA was established

3

Introduction of New Concept 'Creation of SATO-UMI'

-Improvements in water quality have leveled off and "red tides" still occur frequently
-Little progress has been made in the improvement of bottom sediment, and anoxic water in bottom layers continue to occur
-Rapid decline in fishing catches and fishery production
-Rapid degradation of island living environments
-Dilution of environmental awareness with respect to the ocean
-The waste water treatment equipment was improved, and the reduction in the loading dose became a limit.
etc.

Enclosed coastal seas face devastation

-Degradation of ecosystems

-Reduced material circulation functions
- Degradation of ecosystems
- Widespread lack of concern on the part of the general public

Policy on New Concept

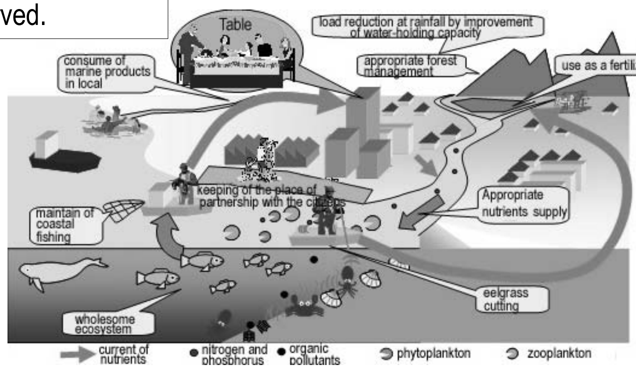
- 21st Century Environmental Nation-Building Strategy (2007)
  Creation of SATO-UMI rich in natural bounties listed
- Third National Strategy for Biodiversity (2007)
- Basic Act on Ocean Policy (2008)
  Materialized of SATO-UMI concept and describing of importance

The activities begin under 'Creation of SATO-UMI'

4

Concept & Image of SATO-UMI

Coastal zone where land and coastal zone are managed in an integrated and comprehensive manner by human hands, with the result that material circulation functions are appropriately maintained and both high productivity and biodiversity are preserved.



5

Case Study : Urban Activity @Tokyo Bay

Water purification experiment by oyster cultivation participated in by the public is being conducted.

Increase the number of organisms that ingest the nutrients discharged, and regenerating the purification functions is expected.

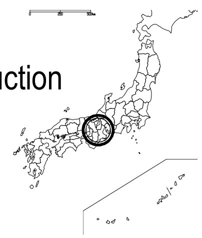
experiment facility

Children participate by Placing oysters

placing cartons for oysters

6

Case Study : Fishing Village Activity @Ise Bay



To achieve the balance between environmental preservation and pearl production by creating tidal flats & marine forests to improve the natural purifying functions and establishing the cultivation system based on forecasts of water quality.

- Effect of activities

-Shima City plans to set up ‘Ago Bay Nature Restoration Council’ to enable effective utilization of the achievements of this project.

-Based on the achievements of the project, Mie Prefecture initiated ‘the Enclosed Coastal Sea Restoration Program’ in 2007

survey of marine forest growth status

7

Case Study : Integrated River Basin Activity @Suo-Nada

In the ‘FUSHINO’ river, the activities based on the plan considered the whole river basin to be integrated by various participants are promoted

- Period of implementation
  2003:plan’’ was established
  2004:Nature Restoration Council was established
  2005:Overall plan for restoration of nature in the Fushino River estuary tidal flats was established

- Effect of activities

-Increased biodiversity and population of bivalves in the Fushino River tidal flats etc.

-Expanded Zosteraceae beds

8

Case Study : Fishing Village Activity @Iyo-Nada

Creation of marine forests and Coastal clean-up by fishermen and NPO participated in by the public are being promoted.
Promotion wide-ranging awareness and education about sea environment are expected.

Explanation of how create marine forests

Eelgrass are thriving

Participation by elementary school students

9

Activities of Creation of SATO-UMI by MOE

1. Assistance for Forward-looking Sea Areas
2. Establishment of Manual for Creation of SATO-UMI
3. Publicity and Education
4. Provide information(our outputs) Overseas

Now, examination of increase the number of model SATO-UMI is underway to enable the manual to be applied to the actual circumstances in individual seas

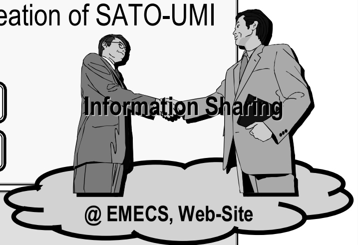
10

Future Unfolding

JAPAN

Output of the Activities of Creation of SATO-UMI

- Manual for Creation of SATO-UMI
- Casebook 'SATO-UMI Selection 30'
- Web-Site for Creation of SATO-UMI



Countries in the World

Needs & Problems of Creation of SATO-UMI

Preservation & restoration of environment of seas all over the world

11

Address of MOE JAPAN

Thank you for your attention!

Address of MOE JAPAN is as follows

mizu-hesasei@env.go.jp

謝謝

12

DEVELOPMENT OF INTEGRATED MULTI-TROPHIC AQUACULTURE IN CHINA

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With the rapid growth of population and development of urbanization in China, the Per capita agricultural land has steadily decreased from 0.19 hectares (ha) in 1949 to 0.076 (ha) in 2005. These considerations and the rapid changes in population structure, and rising living standards, have presented the Chinese with several challenges and opportunities to meet the rising demand for high quality seafood products.

The challenge facing mariculture is to increase the production capacity of an existing site without exceeding ecosystem capacity. One method is to maximize resource utilization by adding functionally different species to the cultivation system. One of the innovative solutions being proposed and accepted for environmental sustainability, economic diversification and social acceptability, is integrated multi-trophic aquaculture (IMTA).

After 30 years rapid development, the inshore areas have almost been full exploited for mariculture in China. In order to produce the higher quality seafood as much as demand by both international and domestic market, The IMTA has been implemented in China for years and is recommended and promoted as the new concept of mariculture by Chinese government. Two variations of the IMTA approach have been developed in China: suspended multi-species aquaculture in inshore and multi-species large scale sea ranching in offshore, deeper waters.

An example of suspended multi-species aquaculture is being developed in Sungo Bay, in the East of the Shandong Peninsula, China. Here, in an area of 13,300 ha the annual production is 2,100 ton of scallop Chlamys farreri in fresh weight, 110,000 ton of oysters Crassostrea gigas in fresh weight, 80,000 ton of kelp Laminaria japonica in dry weight, and about 100 tones of finfish in 2005. The co-cultivation of abalone Haliotis discus hannai with L. japonica is also being developed, with abalones kept in lantern nets hanging vertically from the long lines and being manually fed with the kelp that is grown on ropes maintained horizontally between long. Once the kelp is harvested, the abalones are fed with dried kelp. With such kind of IMTA, the benefit is about 10 times higher than that of monoculture of kelp. Now the experiment is carried out in the bay to develop a new IMTA by co-culturing sea cucumber with abalone together in lantern net. In this system, the kelp can control the eutrophication by absorb the nutrient and provide the food to abalone, sea cucumber can feed the faeces and detritus produced by abalone so as to reduce the influence of bio-deposit on environment. Furthermore, the economic benefit of such mariculture model will be significantly increased.

The most successful multi-species large scale sea ranching is taking place near Zhangzidao Island, 40 miles away from Dalian, in the northern Yellow Sea (water depth from 20 to 40 m). Sea ranching is usually practiced for the enhancement of natural stocks such as Japanese scallop, sea cucumber, abalone, sea urchin and finfish. The Zhangzidao Fishery Group Co., Ltd., is authorized to farm up to approximately 40,000 ha, and presently cultivates 26,500 ha of the scallop, Patinopecten yessoensis, 10,000 ha of the arkshell, Scapharca broughtonii, 660 ha of the sea cucumber, Apostichopus japonicus, and 100 ha of the abalone Haliotis discus hannai. The company has been in existence for more than 10 years. The total harvest in 2005 reached 28,000 tones, valued at more than US$60 million (US$18 million in net profit). To improve ecological conditions and the sustainability of the operation, the company is now thinking of developing seaweed cultivation and the construction of artificial reefs in more offshore environments. To date, about 13,300 ha have been optimized in this way.

Besides the development of demonstration activities and applied research to clearly show farmers and regulators the benefits of IMTA, basic research on IMTA has also been performed by some institutions of China, for example, the environmental requirements for the growth of seaweeds and shellfish to maximize the nutrient recycling efficiency tp the culture conditions (depths, relative position with respect to the fish cages in relation to the prevailing currents, distance from the cages and culture density).

To avoid spatial competition and serious environmental impacts in inshore region, developing the IMTA in offshore areas, such as suspending culture of fish, shellfish and kelp, sea ranching of sea cucumber, sea urchin, abalone, seaweeds and scallop is a trend for mariculture industry in China.

Key words: Mariculture, IMTA, Sungo Bay, Inshore, Offshore, Seaweeds, Shellfish

Y S F R I

Development of Integrated Multi-trophic Aquaculture (IMTA) in China

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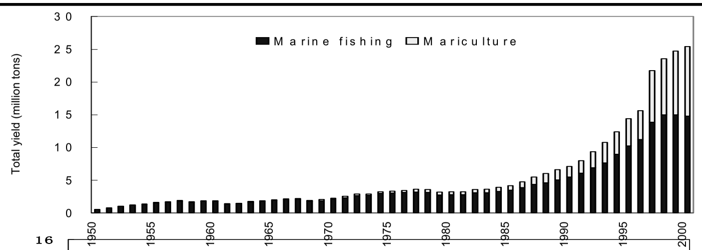
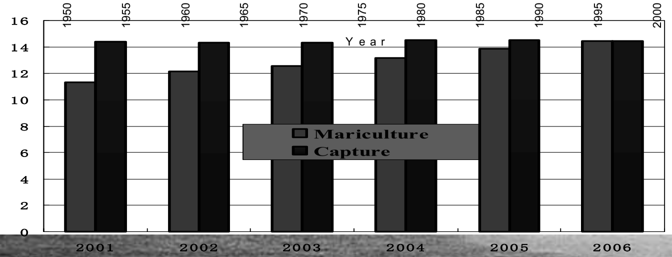
Y S F R I

Outlines of Presentation

- Status and trend of mariculture of China
- Positive and negative influences of large scale mariculture on environment and ec osystem
- Development of IMTA in China
- Summary and Suggestion

http://www.ysfri.ac.cn





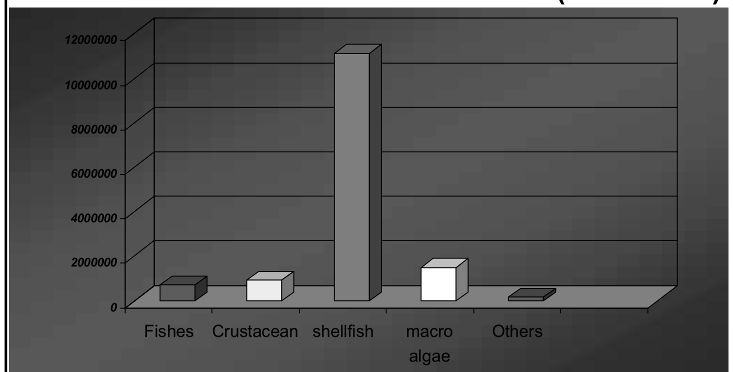
Mariculture status in China

2006: Mariculture 14,456,399 MT

Marine catch 14,420,359 MT

Mariculture status of China

Mariculture Yields of China in 2006(Million MT)



Groups	Total	Bivalves	Macroalgae	Fishes	Crustacean	Others
Yield (M MT)	14.456	11.356	1.503	0.715	0.938	0.165

Outlines of Presentation

YSFRI

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http://www.ysfri.ac.cn

Carbon and Nitrogen removal by harvest of shellfish in 2006

Unit: MT

Species	Production	Soft tissue		Shell		Sum	
		C	N	C	N	C	N
Scallop	1148764	36789	10365	74382	585	111172	10950
Mussel	746058	15780	3912	66788	2897	82567	6809
Oyster	3892027	22718	4503	286054	2980	308772	7124
Clam	3018803	99580	25011	172760	8486	272340	33498
Other	2330281	53656	12663	163560	3653	217217	16316

Total Sum: 992068 74697

Carbon and Nitrogen removal by harvest of seaweed in 2006

C: 377,000万 MT，N: 21,400 Mt 。

The total C and N removal by harvest of shellfish and seaweed in 2006 is 1.37 million MT and 96,000 MT respectively

Mariculture Activities of China have made great contribution on reducing CO2 and eutrophycation

Negative influence of culture shellfish and fish on environment and Ecosystem

The Nitrogen excreted by scallop and fish

Species	Quantity (ind.)	Culture period (d)	Total N excreted (KG)
Scallop	10000	500	50
Fish	10000	300	114

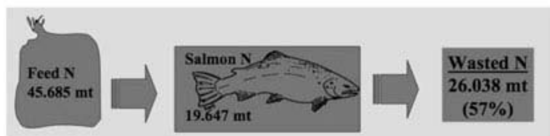
If co-cultured with seaweeds, the N excreted by 10000 scallop can meet the growth demand of 1500 kg kelp in dry weight;

If co-cultured with seaweeds, the N excreted by 10000 fishes can meet the growth demand of 3350 kg kelp in dry weight;

7

Problems in Norwegian aquaculture

- Norwegian salmon culture is based on **fishmeal** feed
- 60% of nutrients added are lost to surroundings
- Sustainability?
- Ecology?



NTNU
Norwegian University of Science and Technology

Challengers

- How to eliminate the eutrophication caused by mariculture?
- How to convert or utilize the un-used Nutrients coming from mariculture practices to produce higher quality protein for human?

IMTA (Integrated Multi-trophic Aquaculture) is the best practice to meet the above challengers

Y S F R I

Our Knowledge on the IMTA …

Concepts based on ecosystem

1: IMTA (Integrated Multi-trophic Aquaculture) is an ecosystem based management approach that effectively mitigates the overabundance of nutrients introduced by fish farming. The lower trophic level organisms provide a biofiltration (filtering the water clean of small particles) service to cleanse the excess particulate matter (via shellfish) and nutrients (via seaweeds) from the environment and incorporate that material into their tissues (Folke et al. 1998, Neori et al. 2004, Whitmarsh et al. 2006).

2: IMTA is a form of marine farming that utilizes the ecosystem services provided by organisms of low trophic levels (e.g. shellfish and seaweed) raised in appropriate ratio to mitigate the effects of organisms of high trophic levels (e.g. fish)(White 2007, Troell et al.2003)

The Contribution of IMTA is to recycle food and energy for increased sustainability and profitability of the aquaculture industry.

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Y S F R I

Outlines of Presentation

- Status and trend of mariculture of China
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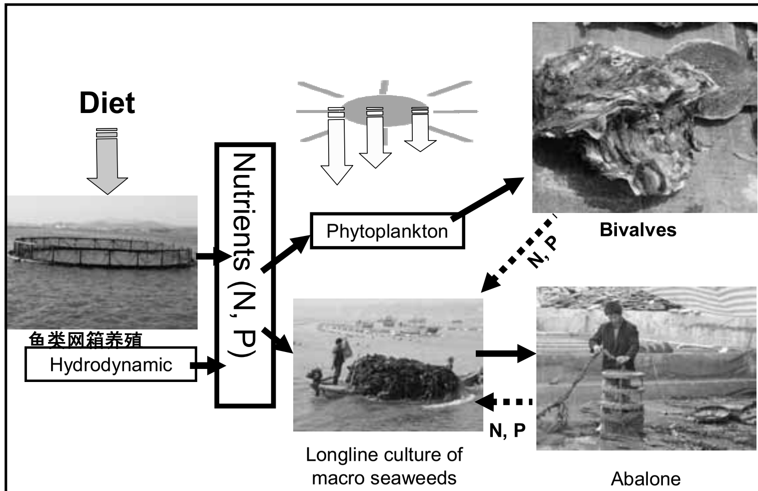
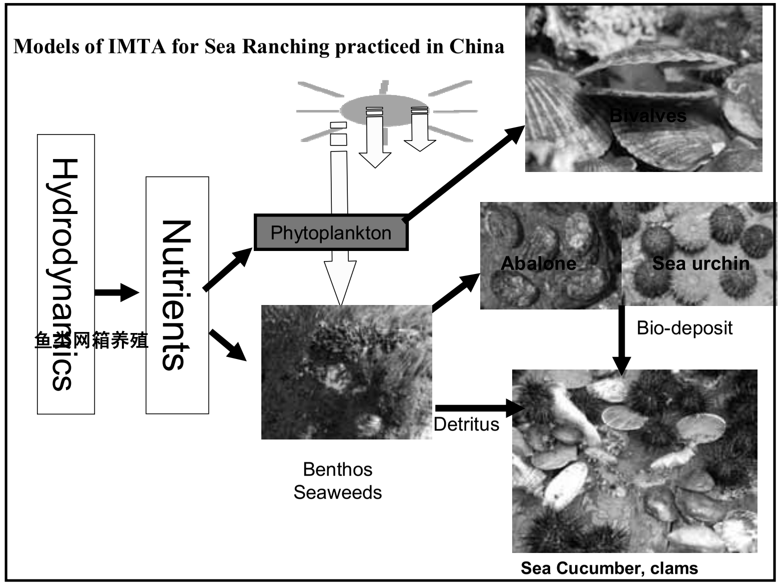
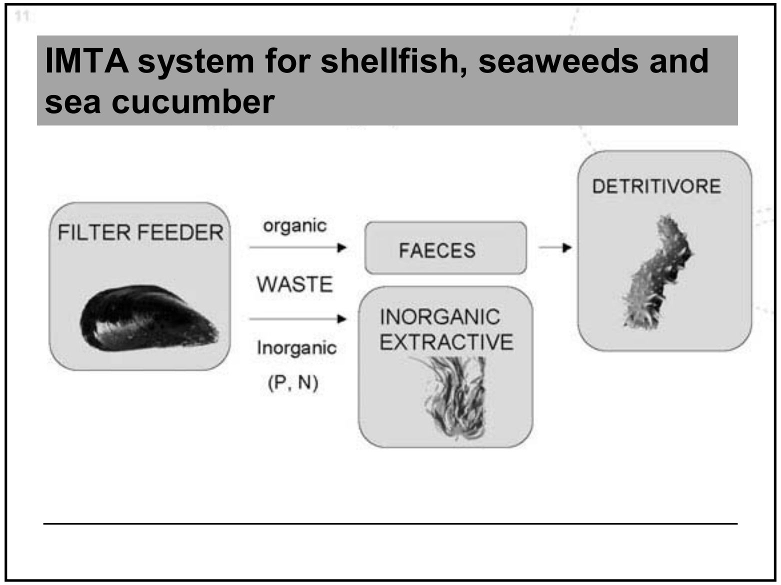
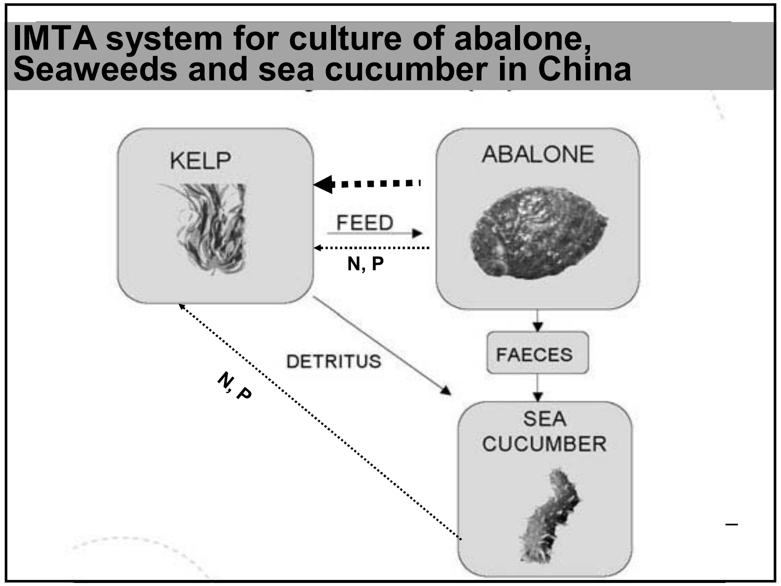
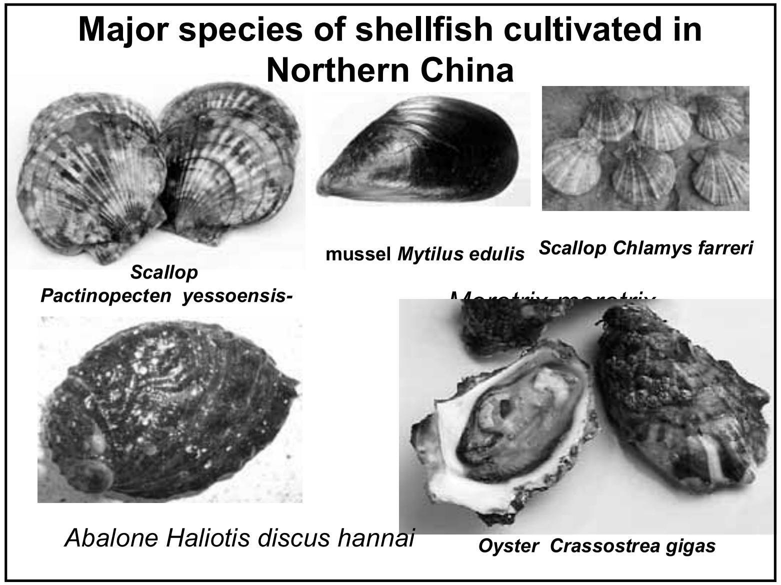


The Models of IMTA Practiced for Suspending Mariculture in China

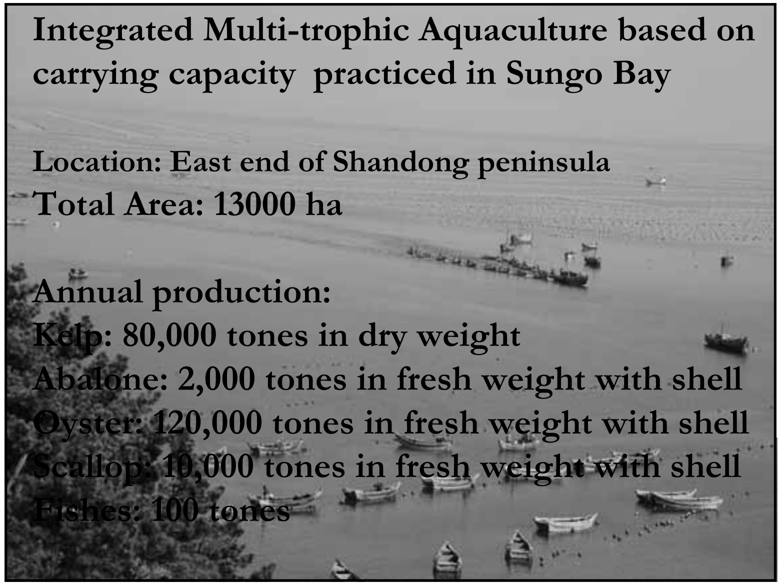

Models of IMTA for Sea Ranching practiced in China
Hydrodynamics
鱼类网箱养殖
Nutrients
Phytoplankton
Bivalves
Abalone
Sea urchin
Bio-deposit
Detritus
Benthos
Seaweeds
Sea Cucumber, clams

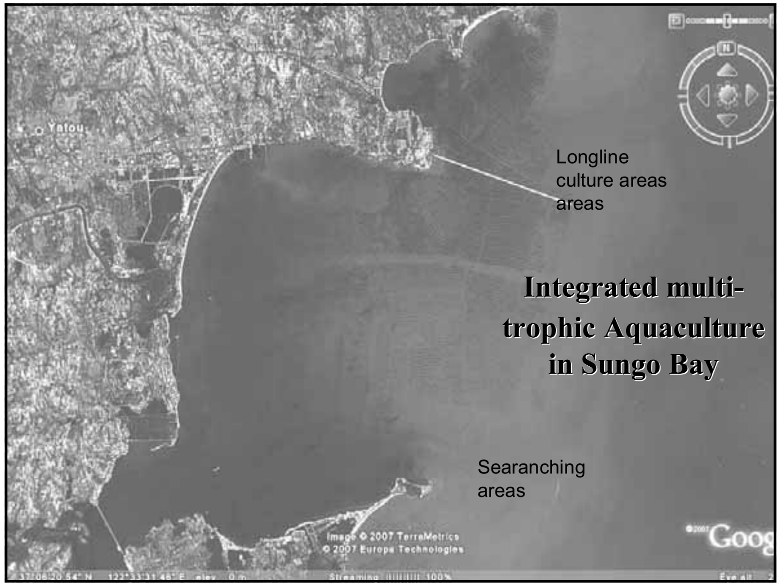

IMTA system for shellfish, seaweeds and sea cucumber
FILTER FEEDER
organic
WASTE
Inorganic
(P, N)
FAECES
INORGANIC EXTRACTIVE
DETRITIVORE


IMTA system for culture of abalone, Seaweeds and sea cucumber in China
KELP
ABALONE
FEED
N, P
DETRITUS
N, P
FAECES
SEA CUCUMBER


Major species of shellfish cultivated in Northern China
Scallop
Pactinopecten yessoensis-
mussel Mytilus edulis
Scallop Chlamys farreri
Abalone Haliotis discus hannai
Oyster Crassostrea gigas


Seasonal alternative culture of seaweeds cultivated in low and higher temperature seasons in Sungo Bay
Nov-Jun
Laminaria Japonica
Jun-Oct
Sargassum sp
Jun-Oct
Gracilaria sp


Integrated Multi-trophic Aquaculture based on carrying capacity practiced in Sungo Bay
Location: East end of Shandong peninsula
Total Area: 13000 ha
Annual production:
Kelp: 80,000 tones in dry weight
Abalone: 2,000 tones in fresh weight with shell
Oyster: 120,000 tones in fresh weight with shell
Scallop: 10,000 tones in fresh weight with shell
Fishes: 100 tones


Yatou
Longline
culture areas
areas
Integrated multi-trophic Aquaculture in Sungo Bay
Searanching
areas
Image © 2007 TerraMetrics
© 2007 Europa Technologies


Integrated culture of fish, seaweed, and shellfish in Sungo Bay
Fish+seaweed+shellfish

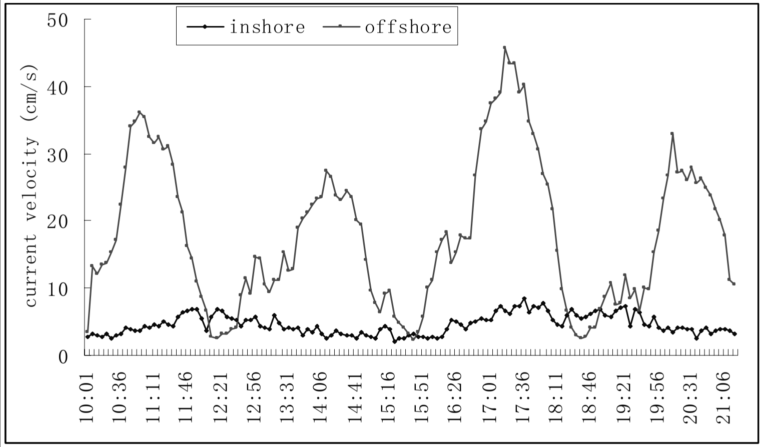
1. Integrated culture of fish and seaweeds

When kelp cultivated inside the fish cages culture area, the seaweed can directly absorb the nutrients produced by the fish. This model not only can yield extra income by kelp, but can prevent the culture regions from eutrophication.

Integrated culture of Oyster and Laminaria

Integrated culture of abalone (Sea urchin) and Kelp *Laminaria japonica*)

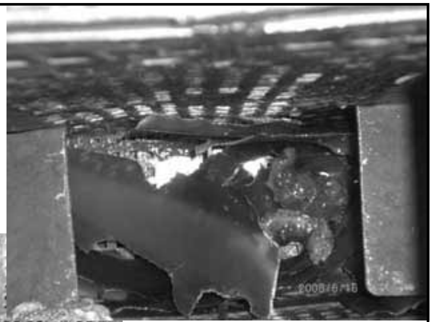
The current velocity of inshore and offshore in Sungo Bay

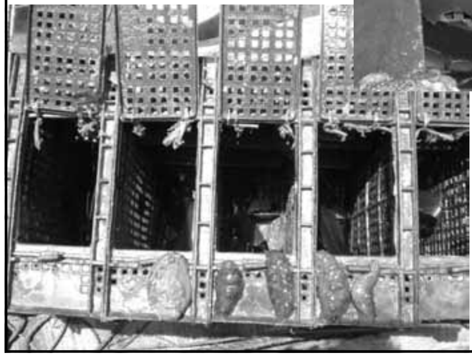


SOME RESULTS OF INSHORE AND OFFSHORE MARICULTURE IN SUNGO BAY IN OCTOBER, 2007

INSHORE			OFFSHORE		
Species	SCALLOP ***Chlamys farreri***	ABALONE ***Haliotis discus hannai***	Species	SCALLOP ***Chlamys farreri***	ABALONE ***Haliotis discus hannai***
Survival (%)	80	60	Survival (%)	>95	100
Shell height (cm)	5.8	6.7	Shell height (cm)	6.6	7.5

IMTA of Kelp/sea cucumber/abalone





In this system, Abalone feeding kelp, while sea cucumber feeding the faeces of abalone, silt inside the cage, detritus of kelp. There is no food competition among the animals in the system. Farmers can get higher economic benefit than monoculture.

Ecological Benefit from IMTA for both suspending and Enhancement in Sungo Bay

- **Economic Benefit of IMTA of scallop, abalone, seaweeds and fish based on aquaculture carrying capacity is more than 40000RMB/1600m²**

  Economic Benefit of of IMTA of sea ranching of scallop, abalone, seaweeds, clams, sea cucumber based on carrying capacity is about 10000RMB/667m2

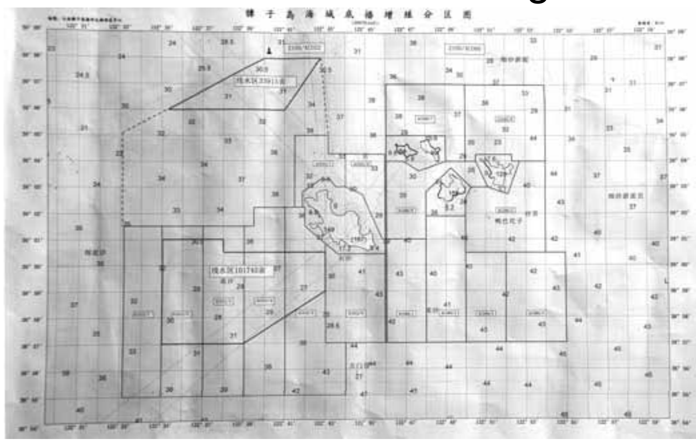
- **Economic Benefit of Monoculture of kelp and bivalves is 3000RMB/1600m² and 5000-8000RMB/1600m² respectively**

IMTA Model is an Environmental friendly and high economic benefit technologies

Sea ranching in ZZD

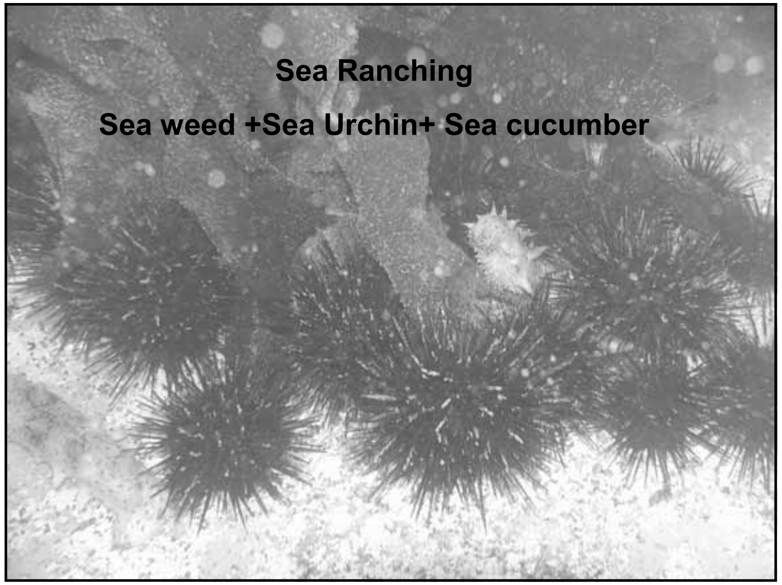
(Zhangzi Islands, Dalian, Liaoning Province)

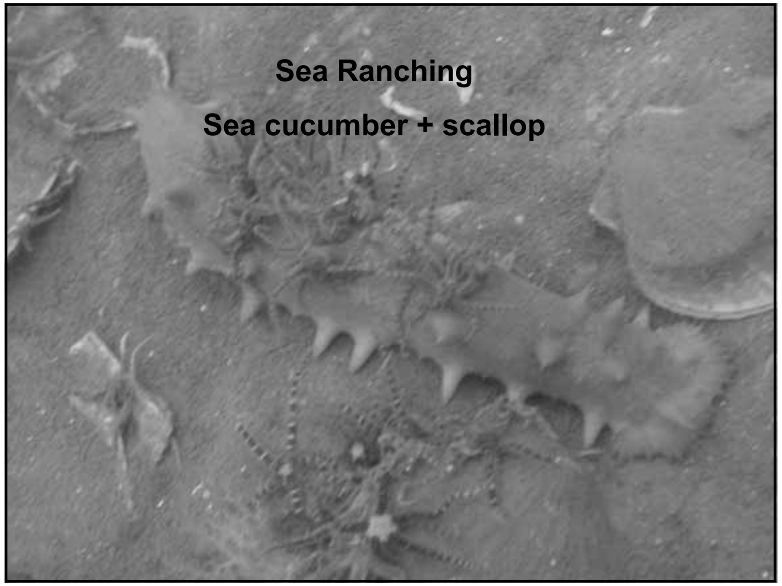
Distribution of Sea ranching in ZZD

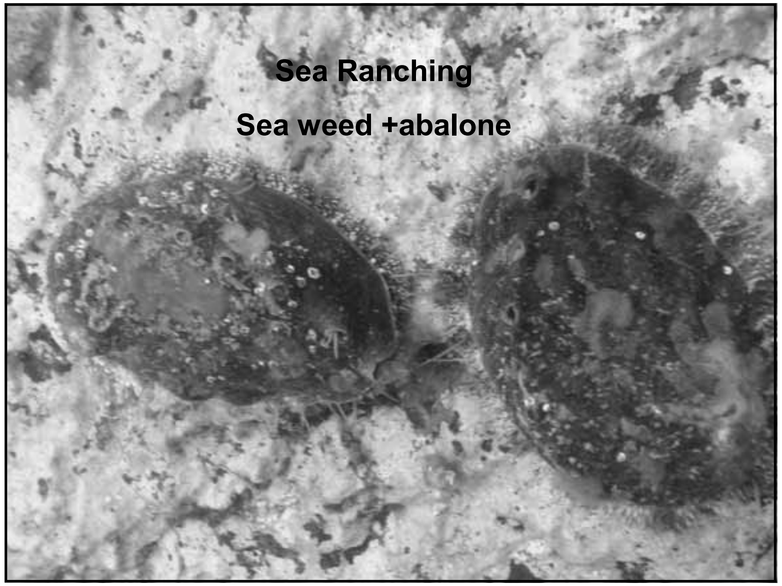


Status of sea ranching in ZZD

Species	Sea ranching area (ha)	Annual yield (ton)
Scallop *Patinopecten yessoensis*	40,000	20,000
Abalone *Haliotis discus hannai*	1,000	100
Sea Cucumber *Apostichopus japonicus*	1,000	400
Sea urchin *Strongylocentrotus mudus*	1,000	300
Ark shell *Scapharca broughtonii*	3,000	500







Harvest of sea ranching scallop by Boat

IMTA for Sea ranching or sea bottom culture in subtidal zone in Zhangzi Island, Dalian, Liaoning Province

IMTA of pearl oyster, seaweed and fish in Hainan Province

Summary and Suggestion

---What we should think about Integrated multi-trophic Aquaculture?

- Carrying capacity for each species
- Economic benefit
- Environment friendly
- Scio- Economic
- Fouling Control
- ◆ Predator remove
- ◆ Extending mariculture from inshore to offshore

National Initiative on Environment Management in Coastal Area of Korea

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Korea Maritime Institute
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The Korean coast, with fascinate landscapes and vibrant ecosystems, has been enduring intensive coastal developments since 1970s. More than 90% of national industrial complexes have been located in the coastal area. Population growth rates of highly developed coasts are often three times higher than that of inland. Annual pollution load to the coastal area has increased 40 percent since 1990s; coastal wetlands were decreased 20% from 1987 to 2005; overall water quality conditions have been degraded by pollutants deposited by or discharged from inland as well; and massive harmful algal blooms (HABs) would lead to low oxygen levels in the water, fish kills, and economic losses. These coastal environmental issues resulted in raising public awareness on marine environmental protection.

To address coastal pollution issues, especially those of water quality, Korean governments initiated the National Clean Water Action Plan in 1995; with 4 billion USD investments, 205 wastewater treatment facilities were built in coastal area. And the National Plan for Marine Environmental Conservation was launched since 1996, providing national comprehensive framework for managing coastal environment systematically. Total pollution load management system (TPLMS), same as Total Maximum Daily Loads Program in USA, was introduced in the Masan Bay Special Management Area in 2008.

Recently Korean governments try to expand their management capacities to restore coastal ecosystems by enactment or amendment of relevant laws: Law on the Conservation and Management of Marine Ecosystem, Public Waters Reclamation Act, Coastal Management Act, and Marine Environment Management Act, etc.

The eighth EMCES International Conference
October 27-30, 2008 Shanghi, China

The National Initiative on Environmental Management of Coastal Area of Korea

CHANG, Won Keun
Korea Maritime Institute

Contents

I. Summary of Coastal and Marine Environment Protection

Coastal and Marine Features in RO KOREA

- Geographic features
  - coastal area : 3,220 km2
  - coastline : 11,914 km (6,228 main)
  - tidal mudflats : 2,550 km2(2.5% of land), 20% loss sine 1987
  - no. of islands : 3,167 (uninhabitated : 2,675)
  - No. of sea dikes: 1,601
- Coastal Population
  - 13 mil. (27% of total population)
  - decreasing(esp. rapid decrease in islands)
- Fisheries
  - Production: 2.7 mil. M/T
  - No of nat'l fishing ports: 105
  - Fisheries right/boat: 9,190/91,608
  - increasing aquaculture proportion
- Shipping & Transport
  - 1.1 bil. M/T & 17 mil TEU
  - No. of Commercial Ports: 51
- Socio-economic activities
  - 92% of nat'l industrial complex on coastal area(68 sites, 457 km2)
  - ocean related industry : 30 billion USD (8% of national GDP)
  - Fisheries household income : 70% of national average

History of Marine Environmental Protection

Better Ocean & Future

(modified from Nam and Kang, 2003)

Episodic Management
- MOE
- Agenda 21 Ch. 17
- Survey & Research
- Red tides, Oil spills
- Wetlands loss

Emergence of New Concepts
- MOMAF
- Introduction of ICM
- New laws & Policies
- Investment expansion
- Int'l cooperation

Formulation of Institutions
- TPLMS introduction in river basins
- Coastal & marine protected areas
- CEMAs
  -Watershed management

Watershed-based approach
- **TPLMS in Masan Bay**
- MPAs
- **NPA(GPA)**
  - Nutrients

Ecosystem-based approach

1992 **1996** **2001** **2006**

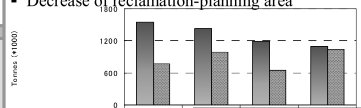
End-of-Pipe → **Front-of-Pipe**

Major Achievements since 2001

- Establishment & revision of legal and institutional mechanisms
- Raised awareness on rational use of coastal resources and environment
- ICM at local governments' level (08.6)

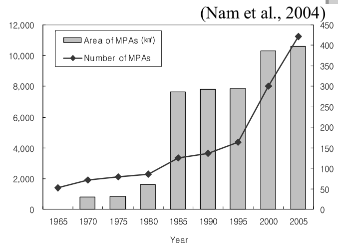
  Completed: 50, under review : 8, under establishment: 17
- Expansion of budget & organization for marine envrn. protection & coastal mgmt.
- Improvement of overall water quality in coastal waters since 2003
- Increase of COMPAS
- Decrease of reclamation-planning area

- Marine ECHO (2006~2010)
- Investment of 6.4 billion USD
  - Ecosystem protection & restoration
  - Pollution prevention from land and marine activities
  - Policy infrastructure enhancement



	1990	1995	2000	2005
Capture Production	1542	1425	1189	1097
Aquaculture Production	773	997	653	1041

(Nam et al., 2004)

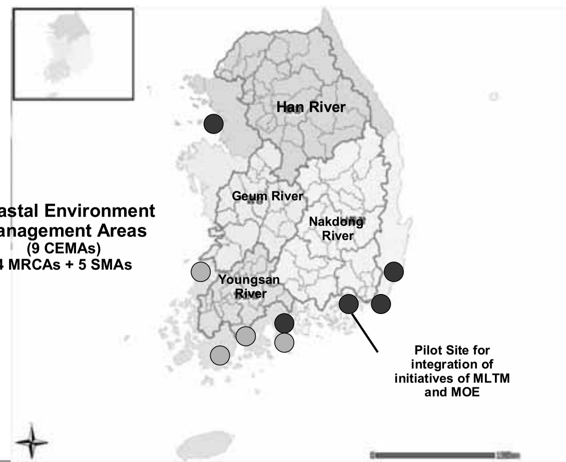


II. National Program of Action

for the Protection of the Marine Environment from the Land-based Activities

Focusing on SMA & MRCA before NPA

❖ Protection of entire Coastal area : ICM under the CMA(1999)



NPA Priority and Budgets

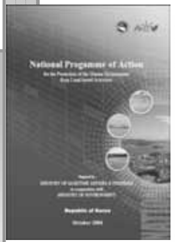


Table 3-2 Priority ranking of the GPA issues

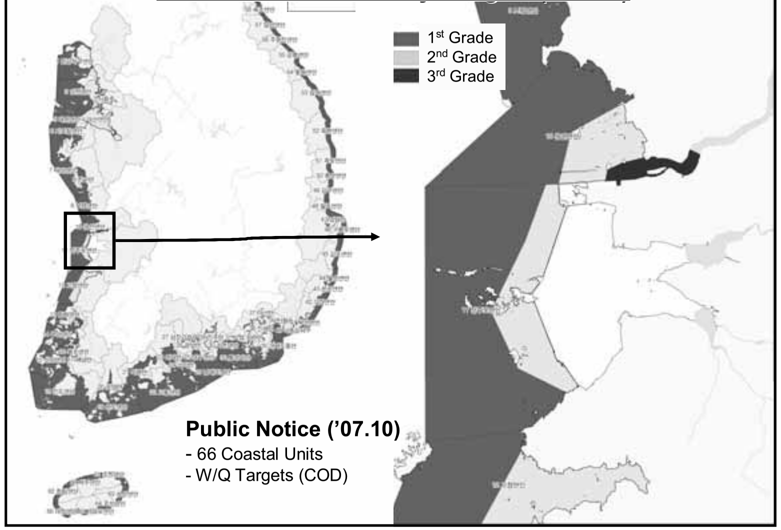
Rank of Priority	Management Issues	Rationale
High	Sewage POPs Heavy Metals	Severe, existing and potential impacts; Moderate or severe areas affected; Insufficient legal framework
Medium	Physical Alteration Oil/Hydrocarbons Nutrients Litter	Moderate or small, existing and potential impacts; Moderate or small areas affected; Sufficient legal framework
Low	Radioactive Substances Contaminated Sediments	Small, existing and potential impacts; Small areas affected; Sufficient legal framework

Table 4-1 NPA related government budget USD 6.4 bill. for 5 years

Unit: USD 1,000

Categories	2006	2007	2008	2009	2010
Ecosystem Protection and Restoration	64,533	54,533	60,022	65,800	73,689
Pollution Prevention from Land-based Activities	1,082,461	1,296,505	1,169,166	1,170,975	1,106,038
Infrastructure Enchancement for NPA Implementation	44,637	48,226	56,155	59,337	57,006
Total	1,191,631	1,399,264	1,285,343	1,296,112	1,236,733

Coastal Water Quality Targets('07.10)



Assessment of W/Q

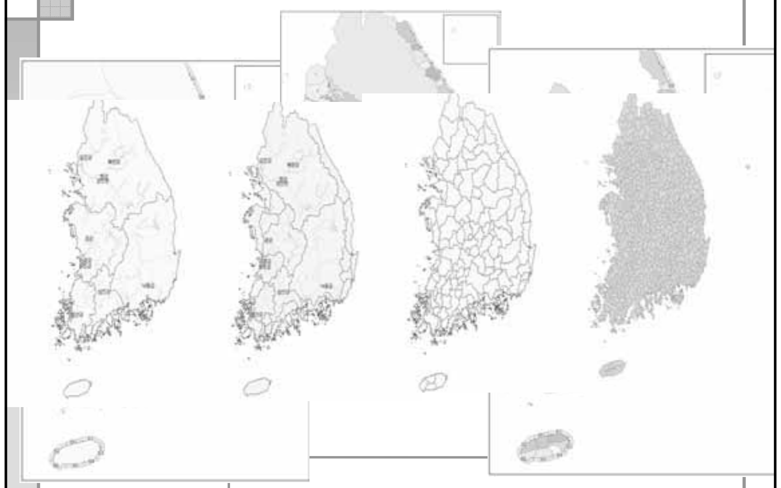
❖ List of Organic Contaminations ('07)

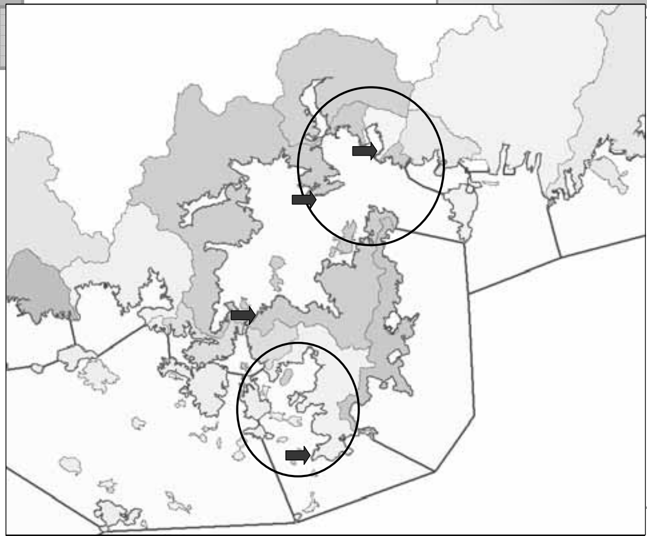
Unit No.	COD	TN	TP	Sum	Rank	Name of Unit
3	0.933	0.761	0.907	2.601	1	시화호
10	0.829	0.836	0.861	2.526	2	군산연안
13	0.556	0.926	0.948	2.430	3	함평만
51	0.164	0.107	0.239	0.510	61	후포연안
50	0.187	0.109	0.185	0.481	62	축산연안
49	0.160	0.079	0.207	0.446	63	강구연안
48	0.191	0.069	0.131	0.391	64	원포연안

	KCWQA (mg/L)	% of					
		'02	'03	'04	'05	'06	'07
COD	92.83	81.6	104.6	96.3	82.5	74.5	73.3
	Achievement (%)	67.7	87.1	79.7	62.5	53.1	48.4
TN	14.567	185.8	184.0	173.5	214.7	192.4	229.7
TP	1.313	240.6	207.6	223.0	224.1	224.3	215.5

- **Kwang-Yang(26), Ulsan(32), Busan(41), Nakdong River Estuary(42),**
- **Kamak(31), Deokryang(24), Wando-Doam(20)**

Re-Delineation of Coastal Watersheds

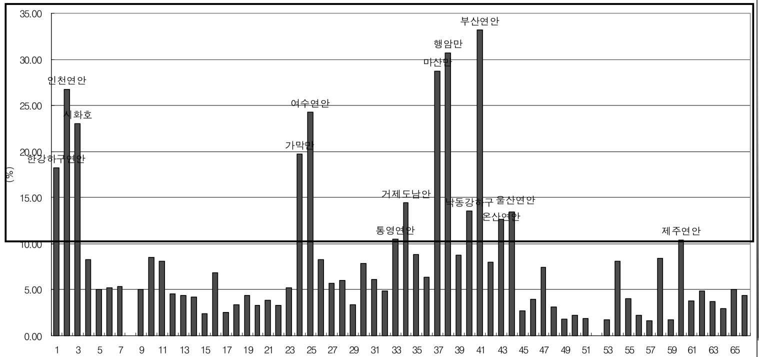




Imperviousness of Coastal Watersheds

❖ Impervious Coastal Areas (more than 10 % of Imperv.)

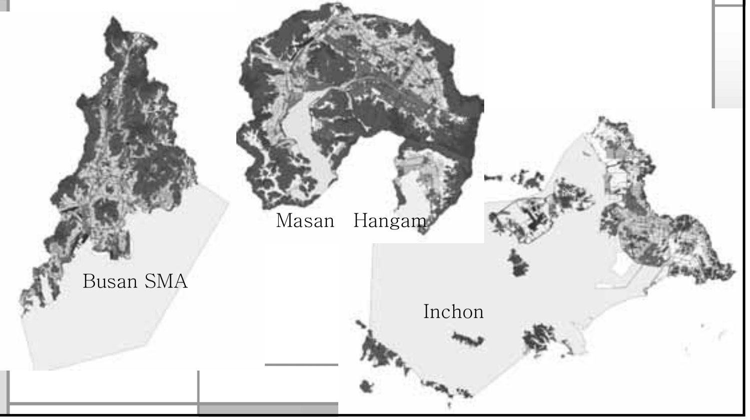
: Han River Estuary, Inchon, Shiwha, Gamak, Yeosoo, Tongyoung, Gaejae, Masan, Hangam, Nakdong River Estuary, Busan, Onsan, Ulsan, Jaeju Is. Etc.



Imperviousness of Coastal Watersheds

❖ Highly Impervious Areas

Busan (33.18%), Hang-am (30.71%), Masan (28.76%), Inchon (26.71%)



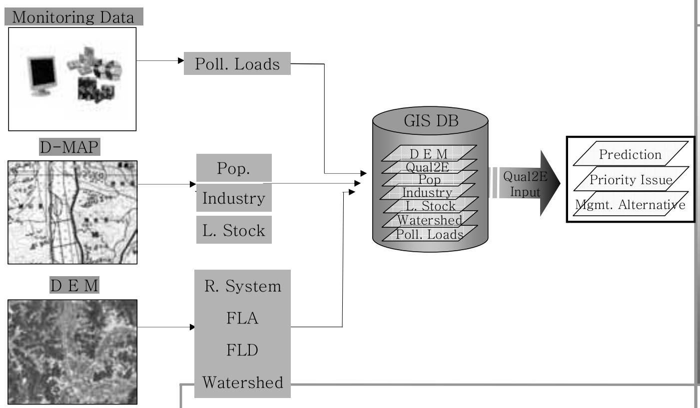
Effectiveness of Monitoring Systems

❖ Location of Monitoring Station of Rivers, Streams, and Effluents

구분		유역 내 수질측정망 합계	하천수	호소수	농업용수	도시관류	공단배수	유역 내 하천말단부 측정지점
28	진주만	3		7			10	
29	남해도 남안			1			1	
30	사천연안			3			3	
31	고성·자란만	2		2			4	
32	통영외안			2			2	
33	통영연안						-	
34	거제도남안			1			1	
35	거제도동안						-	
36	진해만	4	3	3			10	구천댐(호소수)
37	마산만	3				2	5	창원천(하천수), 마산공단(공단배수)
38	행암만						-	
39	신항					1	1	진해마천주물공단(공단배수)
40	낙동강하구	16	3		11	4	34	낙동강하구언1/2(하천수) 낙동강하구언2/2(호소수) 신평,장림공단처리장(공단배수) 장림유수지(농업용수)
41	부산연안	2		1	10		13	수영강5(하천수), 춘천(도시관류), 우동천(도시관류), 동천3(도시관류)
42	기장연안			2			2	
43	온산연안	3	2	2		5	12	회야강(하천수) 온산공단(공단배수) 온산공단2(공단배수)
44	울산연안	25	6	2	2	2	37	울산공단2(공단배수) 울산공단3(공단배수)
45	감포연안	1					1	
46	구룡포연안						-	
47	영일만	11	3	13	1	2	30	냉천(하천수), 형산강4(하천수)
48	월포연안			3			3	
49	강구연안	1		1			2	영덕(하천수)
50	축산연안						-	
51	후포연안	1		2			3	영덕송천(하천수)
52	죽변연안	1		1			2	왕피천(하천수)
총합계		73	17	46	24	16	176	

National GIS system (CEMA IS)

❖ System Architecture – Web GIS(2004)

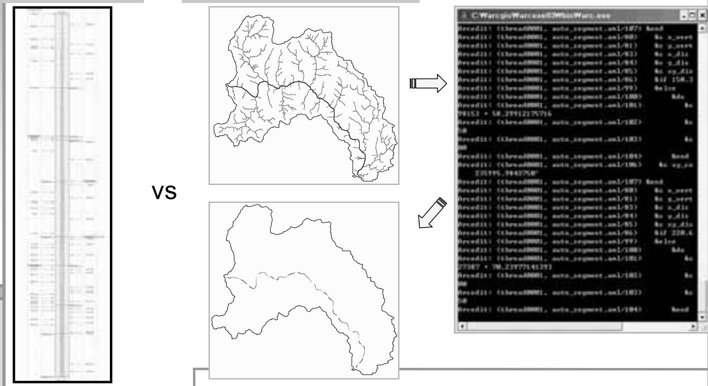


National GIS system (CEMA IS)

Element Allocation

GIS-based Element Allocation

VS

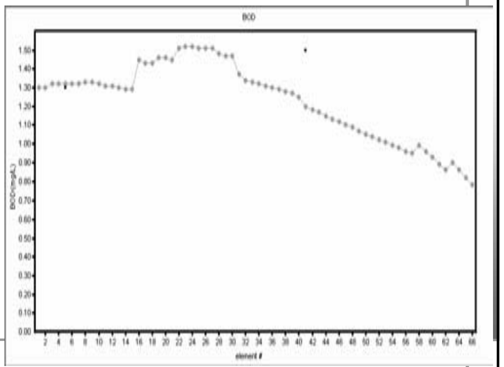


National GIS system (CEMA IS)

❖ Application – Prediction of Water Quality

Current Status of Pollutant load → Water Quality

Sources	Loads(kg/d)	
	Point	Non-Point
Population	3,079.9	5.0
Living Stocks	13.2	463.8
Industries	15.8	0.0
Reclamation	0.0	0.0
Aquaculture	880.9	0.0
Land	10.0	652.7
Swage Treatment Facilities	32.1	0.0
New Development	0.0	0.0

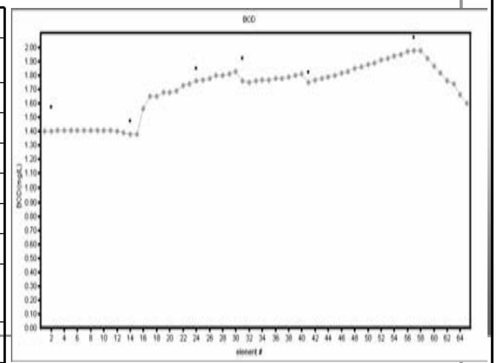


National GIS system (CEMA IS)

❖ Application – Prediction of Water Quality

Changes in Pollution Loads → Water Quality Prediction

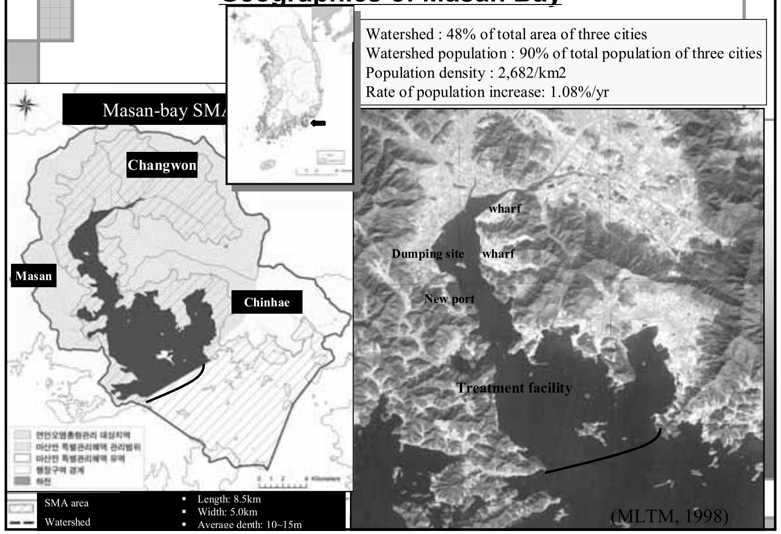
Sources	Loads	
	Point	Non-Point
Population	-59.8 %	199.7 %
Living Stocks	47.6 %	24.5 %
Industries	109.1 %	0.0 %
Reclamation	0.0 %	0.0 %
Aquaculture	0.0 %	0.0 %
Land	-33.7 %	-22.8 %
Swage Treatment Facilities	-15.2 %	0.0 %
New Development	154.5 %	270.2 %



III. Total Pollutant Load Mgmt. System
in Masan Bay

Geographics of Masan Bay

Watershed : 48% of total area of three cities
Watershed population : 90% of total population of three cities
Population density : 2,682/km2
Rate of population increase: 1.08%/yr



(MLTM, 1998)

Turning into National Concern(since '70s)

❖ The public did not realize the impairment of The Bay until late 70s.

Tidal Current get slow due to reclamation
© MBC('90s)

Massive sewage discharge into the bay (91% of total BOD load)

Sewage discharge and loss of Oxygen (hypoxia)

© KBS

Water Quality of Masan Bay SMA

❖ Chemical Oxygen Deamand (COD)

- NFRDI reported the water quality of Masan Bay,
  - 10-year average of COD in Masan Bay, 2.4㎎/L, is twice higher than that of the nation, 1.15 ㎎/L. (**3rd Grade**)

		Median	'97	'98	'99	'00	'01	'02	'03	'04	'05
COD (㎎/L)	Masan Bay	2.40	2.72	2.40	2.48	2.65	2.40	2.13	2.44	2.23	2.20
	National	1.15	1.02	1.19	1.11	1.10	1.16	1.05	1.39	1.22	1.10

  - Water Quality in summer is worse than other seasons.

		Median	Feb.	May	Aug.	Nov.
COD (㎎/L)	Masan Bay	2.40	2.36	2.54	2.65	2.08
	National	1.15	1.12	1.13	1.27	1.06

Water Quality of Masan Bay SMA

❖ Dissolved Oxygen Conc. (*Bottom Layer*)

- DO concentration of bottom water maintains in 2nd grade since 1997(average 6.19 ㎎/L)

		Mean	'97	'98	'99	'00	'01	'02	'03	'04	'05
DO (Bottom) (㎎/L)	Masan Bay	6.19	4.74	5.50	7.08	4.93	7.27	5.16	8.72	6.50	6.92

- Occurrence of Hypoxia (below 2㎎/L) amounts to 27% of the national total.

		1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Less than 2mg/L	National	9	2	2	4	-	3	4	6	7	37
	Masan	1	2	1	2	-	2	-	-	3	11
	%	11.1	100.0	50.0	50.0	-	66.7	-	-	28.6	27.0

Water Quality of Masan Bay SMA

❖ Red Tide Occurrence

- Red Tides in Masan Bay occur 52 times, amounting to 14.2% of the national total (2000 ~ 2005).
- The '79-'81 massive Red-Tide was reported in Masan Bay(1st case in Korea)

		Total	2000	2001	2002	2003	2004	2005
Red Tide (Occurrence)	Masan	51	9	6	10	8	9	9
	National	358	85	59	59	48	69	38
	%	14.2	10.6	10.2	16.9	16.7	13.0	23.7

Timelines of Evrn. Mgmt. of Masan Bay

USD 500 million until 2004
USD 400 mil. to be invested from 2005

1970s~1982

Perception of coastal environment degradation

✓ Massive Reclamation('70s)
✓ Kapo Beach Closure('75)
✓ Prohibition of Shellfish gathering('79)
✓ Large-scale red-tide('79~'81)
→ Special Management Area dsgn.('82)

1984~1999

Implementation of Management Measures

✓ Treatment plant construction('93)
✓ Environmental dredging(90-94)
✓ Monitoring and surveys
✓ Increased public awareness

2000~

Watershed-based & integrated approach

✓ SMA extended to Watershed('00)
✓ Sewage Treatment Plant upgraded('03
✓ Coastal Environment Management Plan(04): Masan SMA Plan
✓ **TPLMS introduced (05~)**
- TPLMS Master Plan('08.2)
- Implementation Plans ('08.10)
- Conflicts in the Reclamation Projects

(modified from Kang and Nam, 2003)

Management Constrains before TPLMS

❖ Land Use Planning without considering the Carrying Capacity of Masan Bay
- ➢ 42 coastal development projects still planned
- ➢ Conflict between Masan city, MLTM, and local NGOs, on the selection and management of a dumping site for dredged material

❖ Weak integrated management system
- ➢ Lack of comprehensive approach to various pollution sources and input pathways
- ➢ Lack of coordination between economic vision and environment management goals
- ➢ Conflict between ministries on jurisdiction → lack of cooperation

❖ Lack of systematic strategic action plan
- ➢ Implementation of environment management measures without priority, shared vision and goals, and social consensus

ex) Limited effect of dredging without effective control of land-based pollution sources

❖ No integrated and partnership-based management entity
- ➢ Coastal Environment Management Plan of the Masna-bay SMA established through cooperation among related ministries and local governments
- ➢ But, no integrated management entity with participatory planning and implementation mechanisms yet

Strategies for establishing TPLMS

❖ Strategy 1 : *Ensuring incremental and sustainable management based on* ***management priority***

- ➢ Based on the long-term vision

Management Priority

High ⟷ Low

Pollutants	COD	TP	TN	Heavy metals, Hazardous materials
Sub-management areas	Innermost area (Ok-kye)		Inner area (Hang-am bay)	Outer area
Investment	Land-based Point-sources	Ecosystem restoration	Dredging	River & Non-point sources

Strategies for establishing TPLMS

❖ Strategy 2 : *Application of the* ***precautionary approach*** *and establishment of a* ***integrated watershed management system***

- ➢ Introduction and implementation of total pollutant load management system (TPLMS)
- ➢ Coastal development taking into account the carrying capacity of the bay
- ➢ Formulation of a management council for the Masan-bay SMA

❖ Strategy 3 : *Establishment of* ***firm scientific platform*** *to support decision-making Process*

- ➢ Assessment of coastal environmental carrying capacity
- ➢ Assessment of optimum development density
- ➢ Identification of various input pathways of pollutants
- ➢ Establishment of web-based GIS

❖ Strategy 4 : *Encouraging* ***participation*** *of, and* ***cooperation*** *with, local stakeholders*

- ➢ From "ancient-regime" (command & control) to a new regime of governance
- ➢ Institutionalization of participation in planning and implementation processes

Appling Science for establishing TPLMS

COD
N, P

Estimation of Loads

Monitoring Program
17 rivers + 2 swage plants

Marine Ecosystem Model

↓ ← Determination of target level **(2.4 or 2.5)**

Estimation of Max. Allowable Loads

↓ ← Verification of MoS, and other parameters

Determination of Pollution Load Reduction Target

↓ ← Determination of Allocation Principles

1st National TPLMS Master Plan

Implementation Plan

Determination of Loads of Municipalities

↓

Development of New Reduction Plan

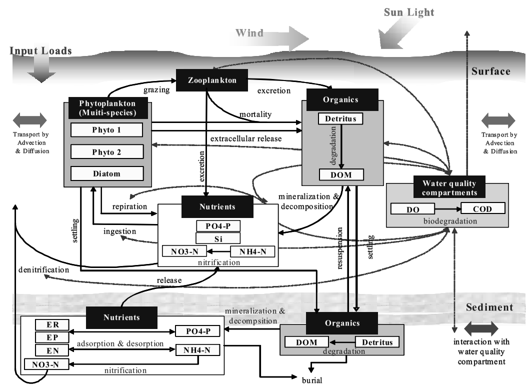
↓

Assessment

Adaptation of Implementation Plans

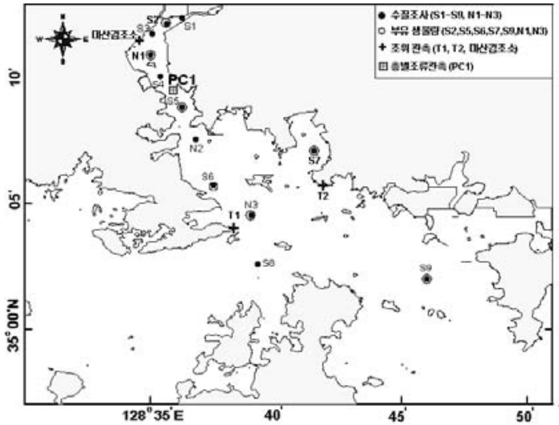
Appling Science for establishing TPLMS

❖ Masan Marine Ecosystem Model



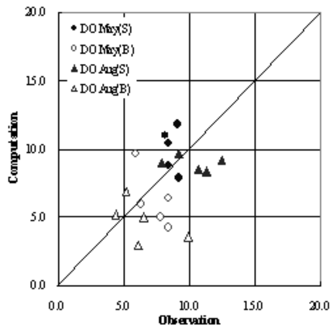
Appling Science for establishing TPLMS

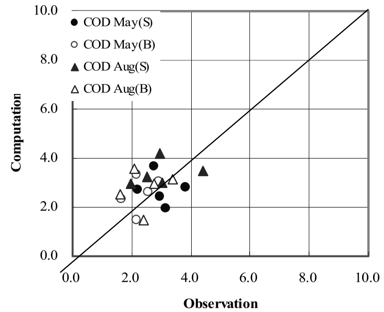
❖ Masan Marine Ecosystem Model (12 Monitoring Stations)



Appling Science for establishing TPLMS

❖ Masan Marine Ecosystem Model (Calibration & Verification)





Appling Science for establishing TPLMS

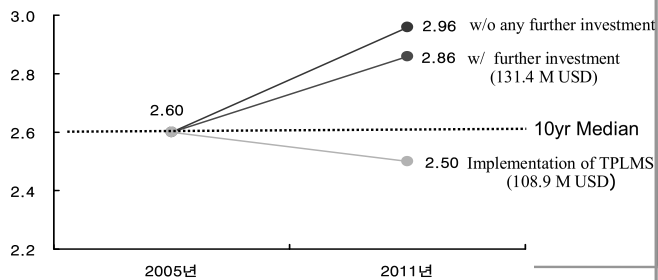
❖ Masan Marine Ecosystem Model (Changes in W/Q following Loads cut-down)

Reduction of Loads (COD only)	Change in Conc. (COD)	Reduction of Loads (COD + Nutrient)	Change in Conc. (COD)
0%	2.60	0%	2.60
-10%	2.59	-9%	2.50
-20%	2.54	-10%	2.49
-26%	2.50	-20%	2.44
-30%	2.48	-30%	2.40
-40%	2.42	-40%	2.33
-43%	2.40	-50%	2.26
-50%	2.36		
-60%	2.30		
-70%	2.24		
-80%	2.18		
-90%	2.12		

Appling Science for establishing TPLMS

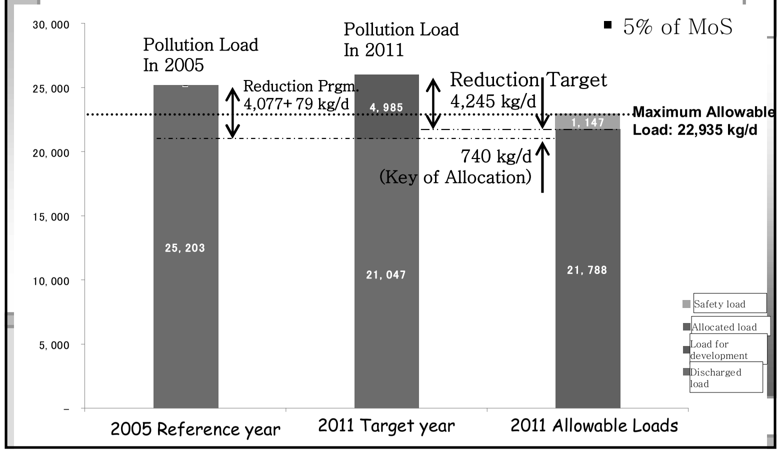
❖ Masan Marine Ecosystem Model forecasts the changes in the Future Water Quality of Masan Bay,

- By 2011, COD level of Masan Bay would reach 2.86 ~ 2.96 ㎎/L without adopting TPLMS Program



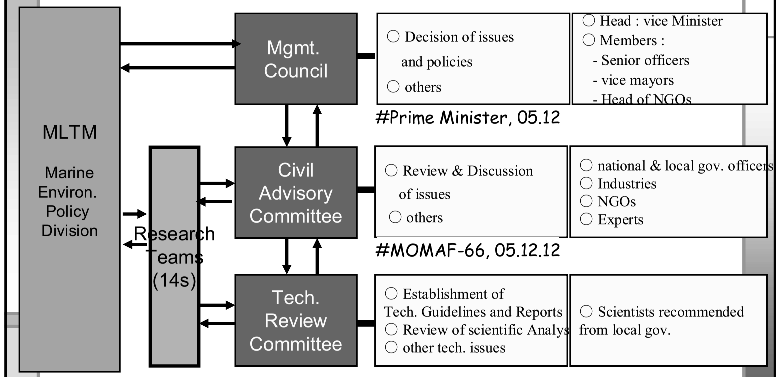
Appling Science for establishing TPLMS

❖ TPLMS Target : COD 2.5 mg/L, Summer Median)



Public Participations

❖ Institutional Framework (Public Notice)



Public Participations

❖ TRC Review, CAS Masan Decides, and Mgmt. Council Approves

❖ Summary

Unit: kg/day

Municipality	Pollution Loads (2011)	Allocation Load	Reduction Target
Masan	9,698	7,689	2,009
Changwon	12,875	10,899	1,976
Jinhae	3,460	3,200	260
Sum	26,033	21,788	4,245

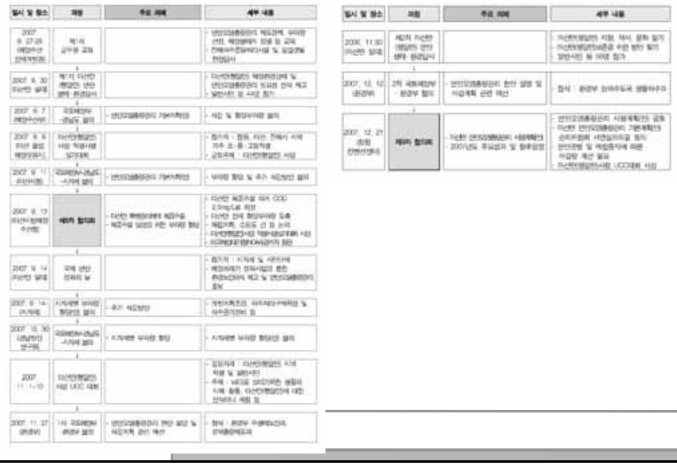
Municipality	Pollution Loads (2005)	Changes in pop.etc.	Reduction Programs	Development	Pollution Loads in 2011
Masan	8,908	-176	1,407	2,373	9,698
Changwon	12,025	-95	1,284	2,229	12,875
Jinhae	4,270	193	1,386	383	3,460
Sum	25,203	-78	4,077	4,985	26,033

Public Participations

❖Major Public Hearings of 1st TPLMS Plan

Public Participations

❖Major Public Hearings of 1st TPLMS Plan



Public Participations

❖Public Education and Relation Program '07 (Summary, as of Set. 07)

		Date	Site	Status
TPLMS Workshop For gov. officials	1st	8.27~8.28	MAFHI	Done
	2nd	Late Dec.	GSND Hall	In progress
Masan Bay Eco-environment Touring	1st	8.30	The Bay and Watershed	Done
	2nd	11.23		In Progress
UCC Festival	Time line	7.30~10.31	www.GNCIES.re.kr	In progress
		11.1~11.10		
		11.10~11.14		
		late Nov.		
Sketch & Drawing Festival		9.8	Dot Is. (in the Bay)	Done
PR Materials - Book, etc.				In Printing
ICC		9.14	Around the Bay	Done

GNCIES(경남시민환경연구소)

Public Participations

❖Public Education and Relation Program '07

The 1st TPLMS Workshop for local gov. officials

1st Eco-environment Touring

Public Participations

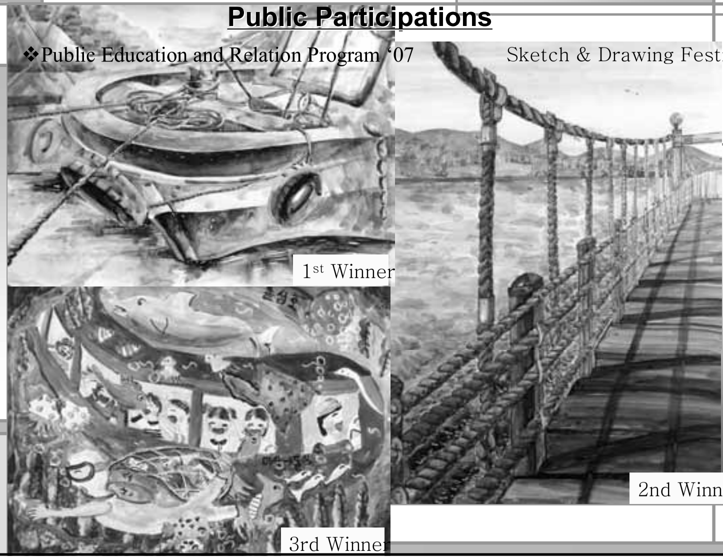
❖Public Education and Relation Program '07

Sketch & Drawing Festival

Public Participations

❖Public Education and Relation Program '07

Sketch & Drawing Festival



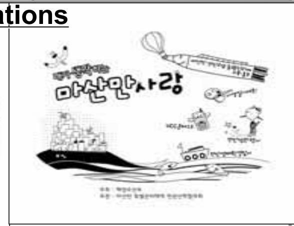
1st Winner

2nd Winner

3rd Winner

Public Participations

❖Public Education and Relation Program '07



PR Materials:
Book, Handkerchief and Others

Future of Masan TPLMS

❖ Basic Principles for determining the Structure of Action plan of three municipalities

- Each Municipalities ***does decide*** all Implementation plans *for itself* in compliance with the 1st National TPLMS Plan of Masan Bay (**approved on 8 Oct. 2008**)
- National govs. focus on **strengthening** permit requirements of discharges from two swage plants, and **reallocating** relevant budget for upgrading the plants.
- National and local govs. cooperatively try to develop necessary programs to **improve ecological health** (i.e. Carrying Capacity) of rivers and the Bay.

	Total	Masan City	Changwon City	Jinhae City	Cost estimated (M $)
Target (Amount to be reduced)	4,245	2,009	1,976	260	
Canceling or postponing Developments	2,456	1,159	1,193	104	0
POTWs	1,750	968	683	140	43.116
Other (River management)	217	-	182	35	65.762
Total (planned as of 2008.2)	4,464	2,127	2,058	279	108.9

Future of Masan TPLMS

❖ ***Expected*** **Achievements**

Unit : kg/Day

Action Plans	2007	2008	2009	2010	2011	Sum
1. Sewage Coverage					285	285
2. River Management				182	35	217
3. Improvement of Sewage Treatment Facility				768		768
4. Effluents Management	738					738
5. Canceling or postponing Developments	2,456					2,456
Total	3,194	3,194	3,194	4,144	4,464	4,464

100%

93%

72%

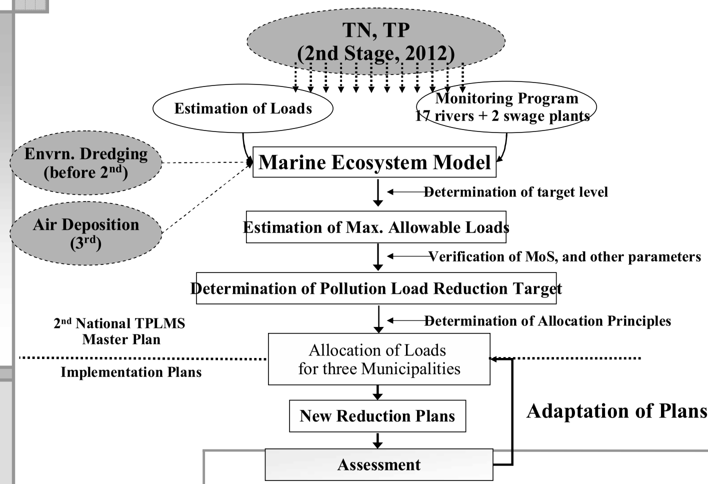
0%

Future of Masan TPLMS

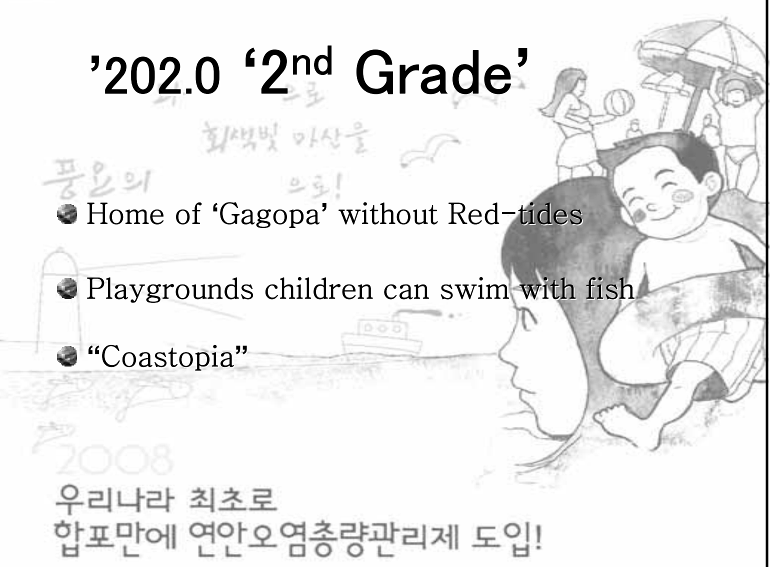
❖ Science vs. Policy (Loads Allocation on 22 small watersheds)

- Research Team determined reduction-targets based on each watershed in 2007.
- But, The targets were settled according to the jurisdictional boundaries considering the flexibility in TPLMS implementation.

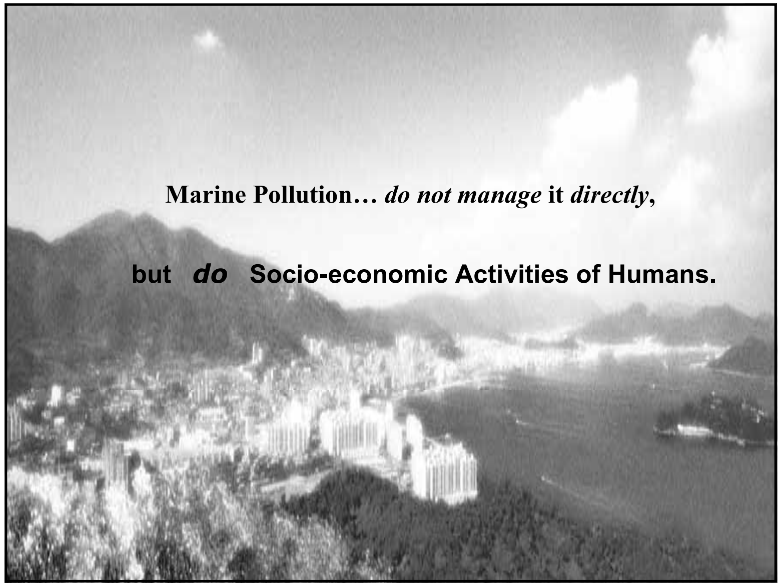
Future of Masan TPLMS



'202.0 '2nd Grade'



- Home of 'Gagopa' without Red-tides
- Playgrounds children can swim with fish
- "Coastopia"



Silvo-aquaculture: an ecosystem based management for sustainable coastal aquaculture in Thailand

Putth SONGSANGJINDA
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Mangrove forests in Southeast Asia have declined significantly over the past four decades due to many of human activities i.e. population pressure, wood extraction, conversion to agriculture and salt production, tin mining, coastal industrialization and urbanization including the conversion to coastal aquaculture. Silvo-aquaculture is an ecosystem based management for the sustainable used of coastal area for aquaculture that integrates mangrove and aquaculture for produce seafood in coastal areas especially shrimp farm. The large scale of silvo-aquaculture, an integrated 116 ha of shrimp farms with 160 ha mangrove, has been demonstrated at Kung Krabaen Bay, Chantaburi, Thailand. A number of 113 small scale farmers and community were educated in farm management practices based on ecosystem approached including with water irrigation, environmental protection, mangrove sea replantation, seaweeds conservation and fish stock enhancement in the bay. The annual shrimp production from this area was about 11.2 ton/ha/year while mangrove forest has been slowly increased at a rate 1.3 ha/year by natural reproduction and replantation. The study of water quality and nitrogen budget indicated that treatment system and the bay played it role on trapping and utilization of the nutrients from intensive shrimp farm.

The small scale silvo-aquaculture pond (5.2ha) was demonstrated in the mangrove (Rhizophora apiculata) replanted natural shrimp pond (density about 11 tree/ha or 2,614 kg/ha) located in Nakhonsrithammarat, Thailand. Mud crab (Scylla serrata) and black tiger shrimp (Penaeus monodon) were stocked to supplement the natural recruitment. Little amount of fresh fish was supplemented as feed to enhance growth of crab. The result suggested that the biomass of mangrove was increased about 10% or about 29-74.49 mgC/m2/d or 0.15-0.37 mgN/m2/d, while the rate of litter fall was about 6.7-32.3 mgC/m2/d or 0.06-0.29 mgN/m2/d. The contribution of the mangrove tree to the production of culture species is comparatively low comparing to the other processors. This is probably due to slow degradation of the litter fall from mangrove tree. In addition, the result from nitrogen budget suggests that mud crab and shrimp are suitable for the silvo-aquaculture pond because they are benthic detritus feeders. The addition management techniques are probably needed in order to utilize/transfer nutrients to the culture species.

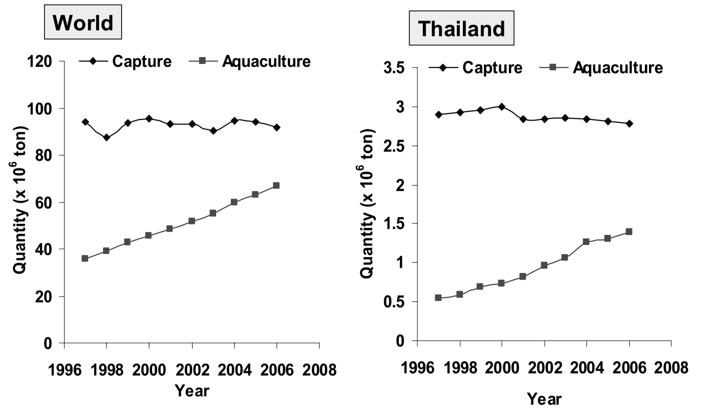
Silvo-Aquaculture:
an Ecosystem Based Management for Sustainable Coastal Aquaculture in Thailand

Putth Songsangjinda

Coastal Aquaculture Research Institute,
Department of Fisheries, Thailand

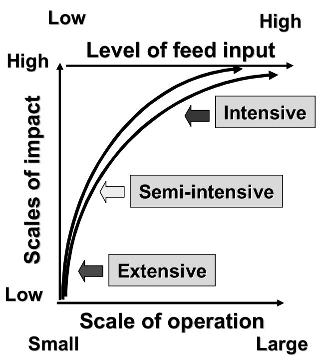
EMECS 2008 Conference:
27-30 October 2008. Shanghai, China

Status of Fishery Production During 1997-2006



FAO, 2007

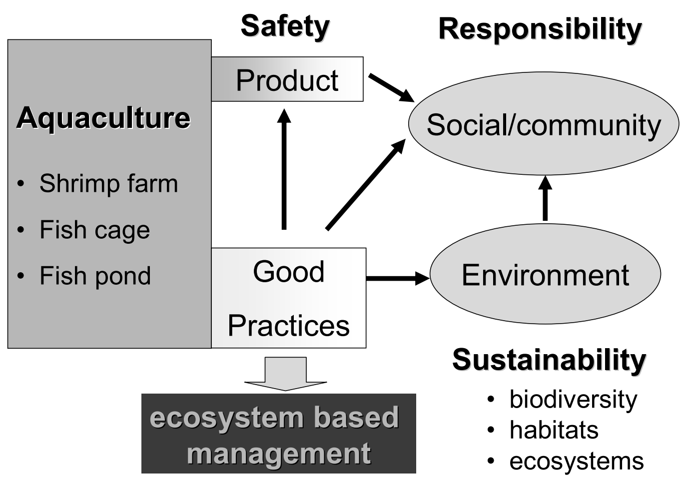
Environmental Impact from Aquaculture



Intensive : (production 5-10 ton/ha/yr)
- High technology
- No demand for mangrove / wetland

Extensive : (production < 1 ton/ha/yr)
- Low technology
- High demand for mangrove / wetland

Scope of Sustainable Aquaculture



Silvo- Aquaculture : An integrated aquaculture system with mangrove

Large Scale Management ( )
Royal Initiative Demonstration project

at
Chantaburi
Eastern,Thailand

Small Scale silvo-aquaculture pond (5 ha)

at
Nakornsrithammarat
Southern. Thailand

Krungkrabaen bay : Before the project

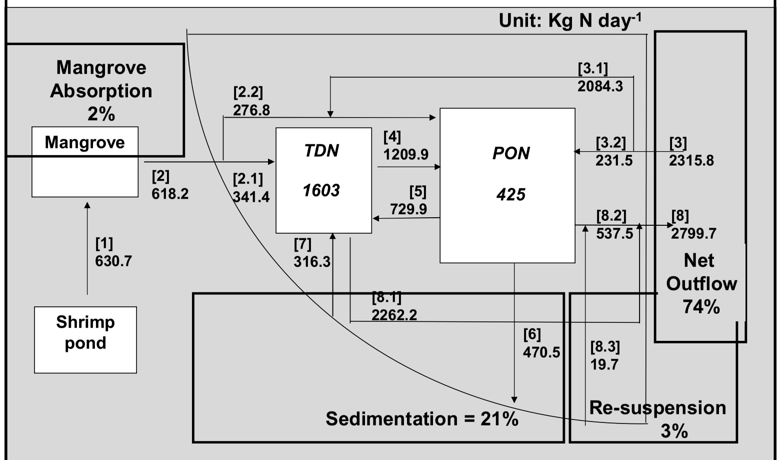
Causes of
Mangrove Destruction

Construction of Shrimp Farm

Agriculture conversion

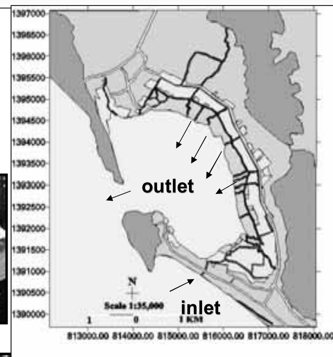
Human settlement

Budget of nitrogen loaded from shrimp farm into Kungkrabaen Bay



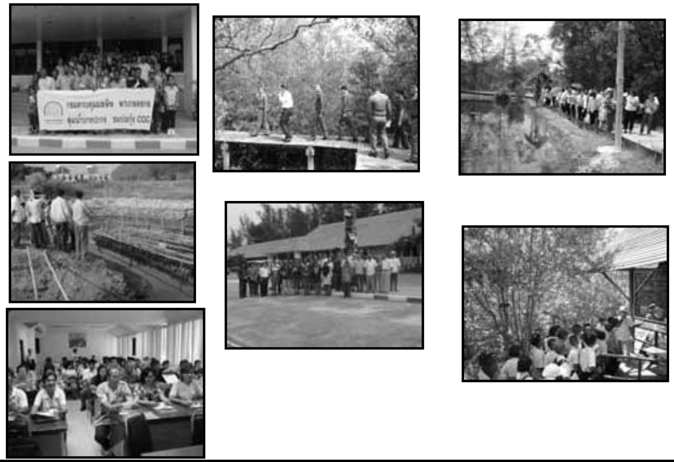
Songsangjinda et al. (2000)

Practices Within 8 Years of Demonstration



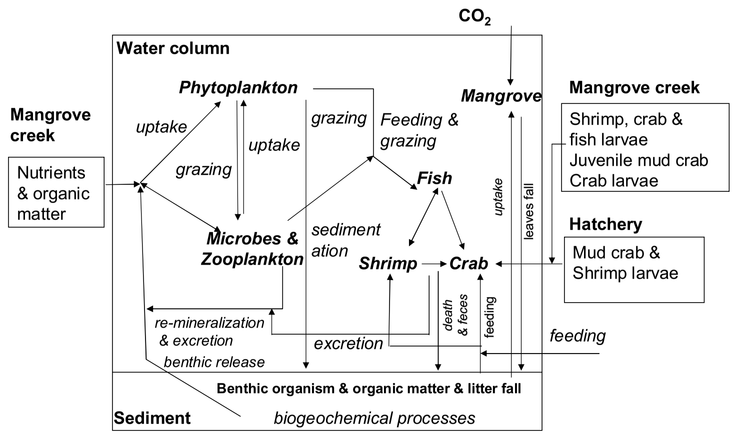
Results After 8 Years of Demonstration

Kungkrabaen Bay : Becoming a Study Area for silvo-aquaculture An Ecosystem based management

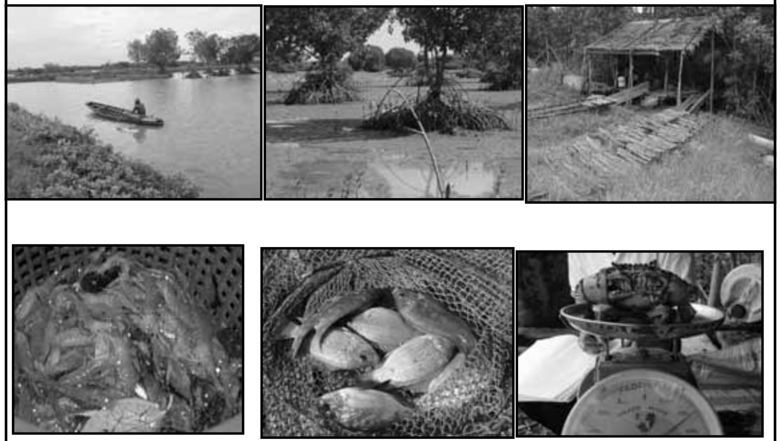


Small scale Silvo- Aquaculture Demonstration: Mud crab, Shrimp, Fish and Wood Production PakNakorn Nakornsrithammarat

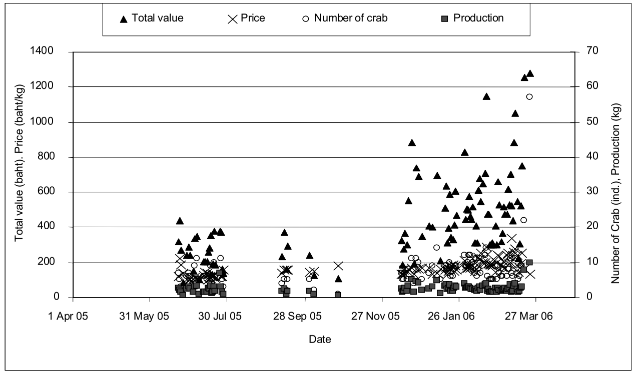
Concept in Small Scale Silvo-Aquaculture Study



Some Pictures of the Small Scale Silvo-Aquaculture Study

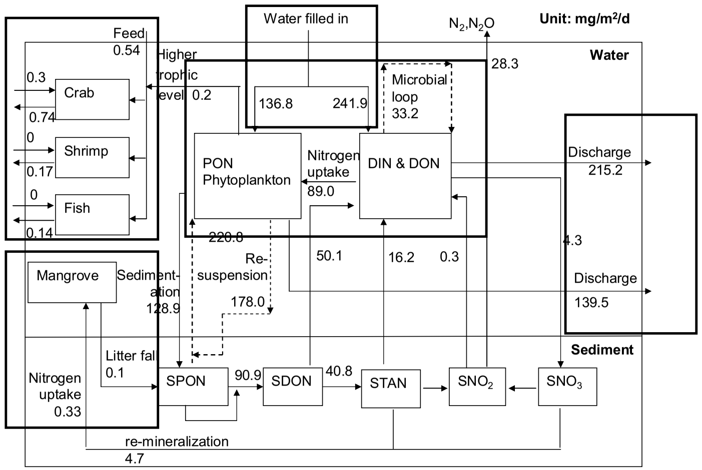


Data of mud crab (*Scylla serrata*) harvested from the silvo-aquaculture pond



273 days of culture

Nitrogen Budget in Small Scale Silvo-Aquaculture Demonstration



Songsangjinda, 2007

Silvo-Aquaculture:
an Ecosystem Based Management for Sustainable Coastal Aquaculture in Thailand

Putth Songsangjinda
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Thank you for your attention

Coastal Aquaculture Research Institute, Department of Fisheries, Thailand

EMECS 2008 Conference:
27-30 October 2008. Shanghai, China

Resolving Oyster Conflicts in the Chesapeake Bay: The Concept of Sato-Umi

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Since the nineteenth century the oyster fishery in the Chesapeake Bay has seen intense periods of conflict. The fishery has evolved in three phases. The first phase witnessed almost unrestricted harvesting of the Bay's rich oyster reefs. The second phase pitted regulators and the oyster police against oyster fishermen unaccustomed to government control. A third phase established a complicated set of laws and restrictions meant to prevent overharvesting of an abused resource. During this phase the two Bay states of Maryland and Virginia took very different paths, the first favoring a common resource approach, the latter favoring the leasing of private oyster grounds.

For much of the twentieth century the oyster fishery continued to operate under a range of restrictions, many of which prevented the use of modern harvesting equipment in an effort to control fishing pressure. Aquaculture, though advocated by some, failed to develop to any significant degree. Then as the 1950s ended, oyster disease struck. The oyster parasite Haplosporidium nelsoni, known at the time simply as "multi-nucleated sphere unknown," or MSX, devastated the Bay's oyster grounds, especially in Virginia's more saline waters. Much of the Virginia oyster industry soon collapsed.

Annual Baywide harvests continued to hover around 3-4 million bushels (see Figure 1), until the mid-1980s. Then drought conditions drove a salt wedge up the Chesapeake estuary, allowing disease to spread well into Maryland. Since that time the Chesapeake oyster fishery has struggled, with harvests only a small fraction of even mid-twentieth century catches.

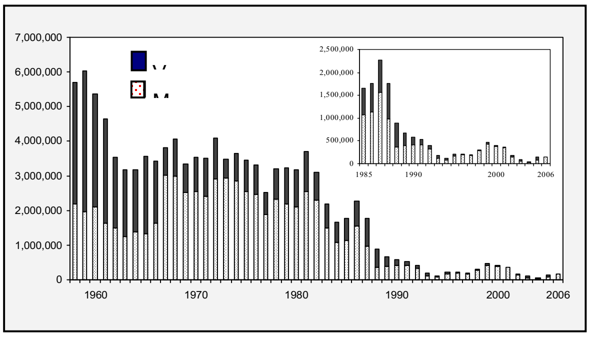

Figure 1: Oyster Harvests in Virginia (V) and Maryland (M) (in bushels). Source: NOAA Ches. Bay Office.

The Chesapeake Bay oyster fishery is now poised to enter a fourth phase that relies on aquaculture and careful management, but serious disagreements continue. Some are calling for a complete moratorium on oyster harvests to allow the overfished and disease-ridden native stocks to recover. Others, especially those in the seafood industry, are calling for the introduction of a non-native oyster, Crassostrea ariakensis, to supplement the failing native oyster. To date concerns over economically stressed fishing communities have prevented a harvest moratorium, and worries over unexpected impacts from a nonindigenous introduction have prevented the planting of a new oyster in the Bay. Commissions and studies are now underway to attempt to address these issues.

Underlying conflicts over Bay oysters is a fundamental disagreement over the nature and purpose of oyster reefs. Traditional watermen see the reefs as their livelihood. Environmentalists see the reefs as natural habitat essential for restoring the ecological health of the Chesapeake Bay.

The Chesapeake needs a new paradigm that will allow for the coexistence of protected oyster reefs, managed oyster fishing grounds, and intensive aquaculture areas. The concept of Sato-Umi provides such a paradigm. Intensive aquaculture areas would be like forest monocultures planted explicitly for wood production. Protected reefs would be analogous to protected forests in Japan, or Chinjyu-no-Mori, “where the gods live.” Managed oyster grounds would be like managed forests, Sato-Yama, meant for human use but still valued for their ecosystem services (e.g., filtering function). This approach would go beyond “marine zoning,” since it would offer a philosophical underpinning, with an emphasis on balanced use. Experiments would track to what degree protected areas or managed (worked) areas provide the greatest biodiversity. Research to date (e.g., Rodney and Paynter 2006) suggests that protected reefs will result in greater biodiversity, since they provide valuable vertical structure in the water column.

References

Maryland Oyster Advisory Commission. 2007. Interim Report. Accessed April 1, 2008. http://www.dnr.state.md.us/fisheries/oysters/

Rodney, W.S. and K.T. Paynter. 2006. Comparisons of macrofaunal assemblages on restored and non-restored oyster reefs in mesohaline regions of Chesapeake Bay in Maryland. J. Exp. Mar. Biol Ecol. 335:39-51.

Wennersten J.R. 1981. The Oyster Wars of Chesapeake Bay. Centreville, MD: Tidewater Publishers.

Resolving Oyster Conflicts in Chesapeake Bay: The Concept of Sato-Umi

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Special Thanks to
Professor Yanagi, author of *Sato Umi*
The Environmental Ministry of Japan
The International EMECS Center

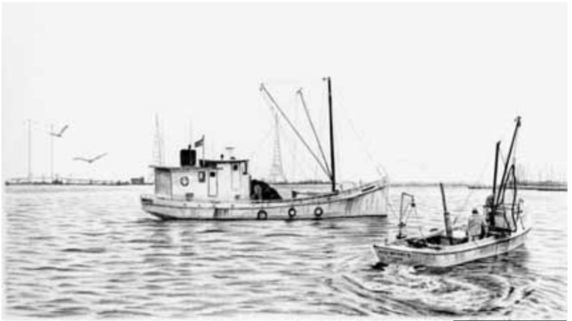
And in memory of Professor Bengt-Owe Jansson (1931-2007), who believed in addressing "the whole system," which includes the ecosystem, the economy, and people's lives.

Map of Chesapeake Bay

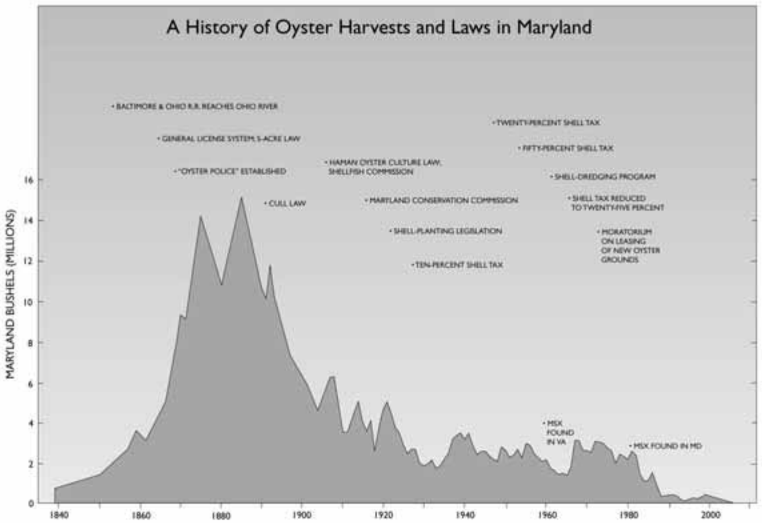
The Chesapeake oyster fishery lies at the center of a long tradition and a sense of place.

A way of life tied to the natural world, in a world where this is increasingly rare.

But because they are tied to the natural world, these oyster fisheries depend on the health of the ecosystem.



Watermen themselves have been called an “endangered species.”



A colorful history, but in the end a <u>lack of balance</u> among fishing, stewardship, and ecological preservation.

Public versus Private

- Public grounds in Maryland = 200,000 acres/809 km^2 (though one current model suggests that viable oyster habitat has dropped by over half since 1980).

- Private leases in Maryland = 9,000 acres/36 km^2 (but have also dropped to around 7,500 acres/30 km^2).

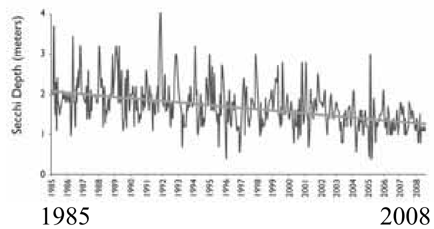
- In Virginia, private leases = 92,964 acres/376 km^2.

Public
Oyster
Bottom in
Maryland

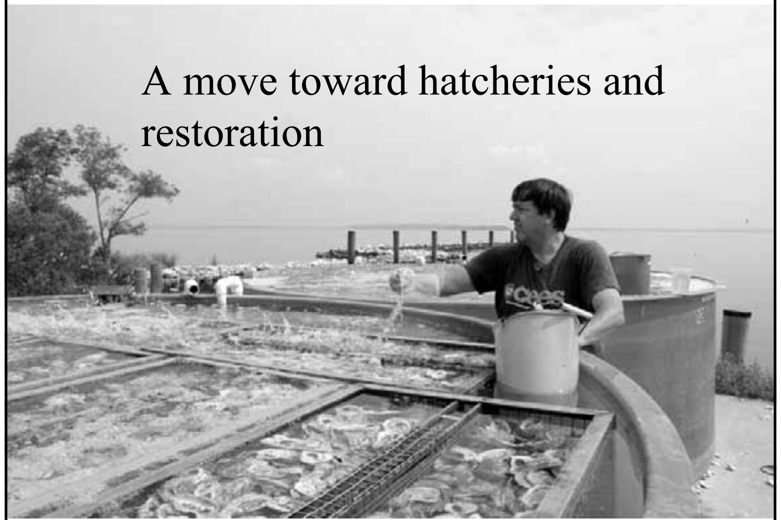
Privately
Leased
Oyster
Bottom in
Maryland

At the same time: Ecological Decline

Secchi disk measurements, mid-Bay



A move toward hatcheries and restoration

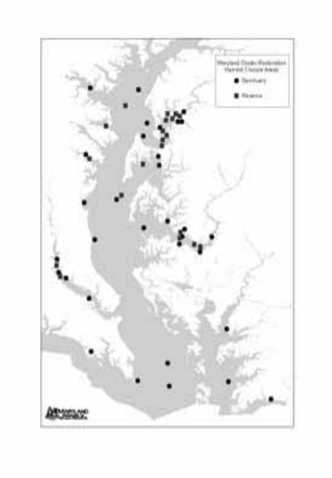


Oysters are being planted in order to restore reefs

Citizens and schools are also getting involved to help bring back the Bay’s oysters.

But unless in a protected area, oysters can still be legally harvested … and sometimes they may be taken even from a protected area.

Protected
Oyster
Sanctuaries in
Maryland



Public
Oyster
Bottom in
Maryland

Restored Reefs =
High Biodiversity

"One could argue that the most important role for the oyster is making the structure for other animals to settle on."
— Kennedy Paynter,
U of MD

<u>Biodiversity</u>: Restored oyster reefs Versus adjacent non-restored areas
(relative density)

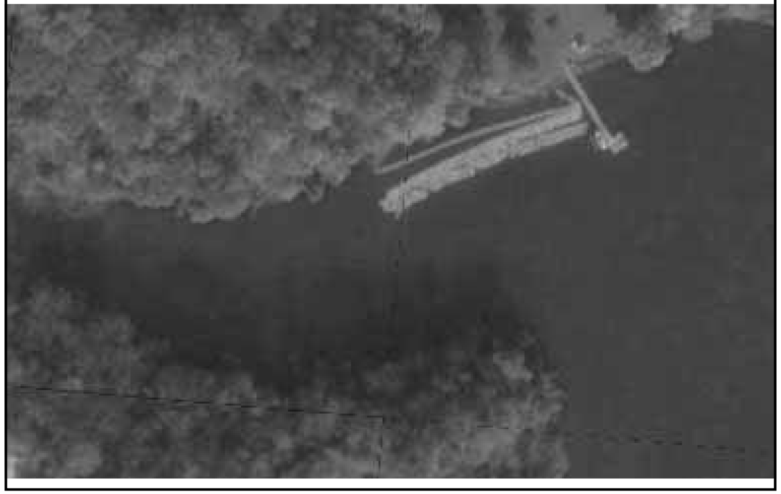
- Macrofauna an <u>order of magnitude</u> higher
- Epifauna more than <u>twice</u> as high
- Sessile macrofauna <u>two orders of magnitude</u> higher

William S. Rodney and Kenndey T. Paynter,
"Comparisons of macrofaunal assemblages on restored and non-restored oyster reefs in mesohaline regions of Chesapeake Bay in Maryland"
Journal of Experimental Marine Biology and Ecology

Rise of Private Aquaculture In both Maryland and Virginia

- Growth of commercial oyster and clam culture in the Bay
- Emergence of private entrepreneurs
- Intensive, fast grow-out in floats
- Aiming for high-end markets

Satellite View of Private Oyster Float Operation



Private Floating "Reef" in Saint Thomas Creek, Maryland

Conflicts

- Between home owners, boaters, and aquaculturists
- Between traditional oystermen and environmentalists
- Between aquaculturists and traditional oystermen

We Need New Thinking

- In the Chesapeake Bay we have lacked a sense of <u>balance</u> from the start.
- <u>Conflicts</u> have kept us at odds, among the public fishery, private aquaculture and ecological restoration.
- We need a <u>new mindset</u>.

The Concept of Sato Umi

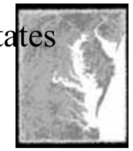
- The intensive forest = aquaculture
  - High productivity
- The managed forest = “managed reserves,” shell planting
  - Productivity & harvest
- Temple forest = sanctuary reefs
  - “Where the gods live”

Implications for Biodiversity in the Chesapeake Bay

- Intensive aquaculture = high productivity/<u>some biodiversity</u>
- Managed reserves = some productivity/<u>some biodiversity</u>
- Protected sanctuaries = no (commercial) productivity/<u>high biodiversity</u>

New Plans on the Horizon

New initiatives just taking shape:
- Blue Ribbon Panel in Virginia
- Oyster Advisory Commission in Maryland
- An Environmental Impact Statement by the Federal government & the states



New Considerations

- Update old regulations (many of which hindered aquaculture)
- Place new emphasis on ecological restoration.
- Balance possible introductions with potential risk (e.g. *Crassostrea ariakensis*)

The Concept of Sato Umi What Has to Change

Everyone agrees that we need better and tougher enforcement, <u>but</u>

- We need a change in attitude.
- We need to move from a habit of antagonism toward a mutual respect for all uses of the oyster (intensive culture, managed harvest, and ecological restoration).

The Concept of Sato Umi What Has to Change

- We need a <u>new ethic</u> that respects biological sanctuaries.
- <u>These must be seen as “where the gods live,”</u>
- Or where God’s creation is,
- Or where Nature dwells,
- Or where biodiversity thrives.

"God is going to make provisions . . . the Bay has always been generous.”

— Deal Island waterman

Sasi Laut: History and its role of marine coastal resource management in Maluku archipelago

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Indonesia is an archipelagic state within which Maluku province is one of the seven archipelagic provinces and has been recognized for its abundant of marine resources covering fish, mollusks, crustaceans, seaweeds and many others. These great diversities are supported by the fact that Maluku province, situated in the Eastern part of Indonesia has such vast sea area of 527,191km2 (90%) compared to land area which is only 54,185km2 (10%) of the overall size of 581,376km2. Historically, the resources including various kinds reef fishes, small pelagic fishes, mollusks and seaweed have been long exploited for the need of people throughout villages around Maluku. Along with such activities there have been also a local knowledge practiced by the communities in terms of regulating harvesting the resources. In principal, this knowledge has its counterparts with those practicing in numbers of other coastal island communities worldwide and in particular for the people of Maluku it is called Sasi Laut (marine protection). Numbers of studies have been done however the exact time of its implementation remains unclear although 1600 and 1921 has been indicated as the earliest. Terminologically, Sasi does not just mean prohibit to take but also invitation to solve problems of illegal practice. This community based management of the local resources usage has been practice to close particular coastal areas inhabited by the resources as well as close season within the year. Coastal areas that are closed include estuarine, bays, lagoons and platform of coral reefs. Meanwhile the resources include various kinds of reef fishes like Lutjanids, Lethrinids and Seranids, small pelagic species involve Trisina baelama, mollusk like top shell (Throchus niloticus), green snail (Turbo marmoratus) and seaweed (Eucheuma spinosum). Interestingly, yet the practice is merely based upon the local community knowledge, closed season is also implemented correspond with the areas for as long as 6 to 12 months periods. In numbers of coastal villages around Maluku archipelago, Sasi remains as part of their traditional way of managing their marine resources. Up to now this tradition has resulted not just social coherent among the villagers but also economic benefit and biologically support the sustainability of the resources. Despite its current practice, further study is critically required to assess the trend and possibility of its integration with modern science based knowledge on fisheries management. The reason is due to the fact that yet Sasi remains in

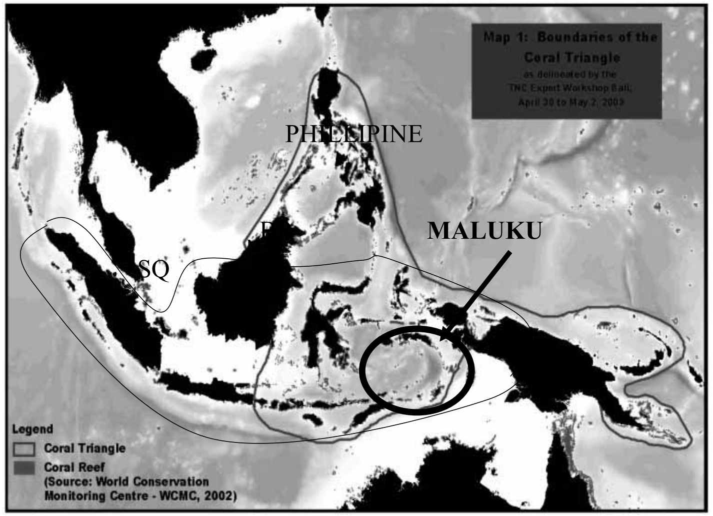
place, biological characteristics of the resources begun to show significant changes. Up until 1980, production of top shell harvest in the island of Dawelor (South West Maluku) after Sasi was 7-8 ton per season. Currently however, the production has been dropped significantly to only 1 to 1,5 ton per season. It is argued that this approach should be adopted given the fact that local communities living closed by the resources. Thus by empowering our local communities, sustainability usage of coastal resources can be expected.

SASI LAUT: HISTORY AND ITS ROLE OF MARNE COASTAL RESOURCE MANAGEMENT IN THE DISTRICT OF SOUTH WEST MALUKU, INDONESIA

Jacobus W.Mosse and B.G.Hutubessy
Department of Marine Resource Management, Faculty of Fisheries and Marine Science, University of Pattimura Ambon, Maluku Indonesia

Presented at EMECS-8 Conference
Shanghai, China October 28 – 31 2008.

WHERE ABOUT MALUKU PROVINCE IN INDONESIA



MOLLUCAS PROVINCE IN DETAIL

Area : 581.376km^2

Sea: 527.191km^2

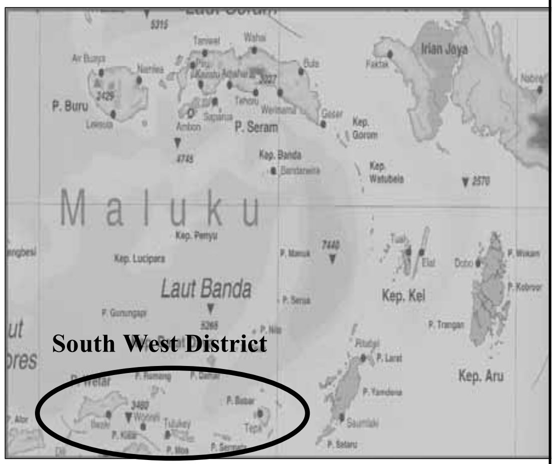
Land: 54.185km^2

Islands : 527

Villages : 842

Coastal vill. 85%

Population : 1,5million



TERMINOLOGY

- ❑SASI IS A LOCAL LANGUAGE MEANS: **FORBIDEN**
  1. PROHIBIT TO TAKE THE RESOURCES
  2. MANAGEMENT CONFLICT (Invitation to resolve matter, within village)
- ❑LAUT IS INDONESIAN LANGUANGE (BAHASA): SEA
  - ❑SASI LAUT : A TRADITIONAL CONCEPT AND METHOD OF THE VILLAGERS IN MALUKU TO MANAGE MARINE COASTAL RESOURCES COVERING:
    - ❑ *Closed area*
    - ❑ *Closed season (6 months ~ 3 years)*

FISHERIES RESOURCES MANAGEMENT AND MARINE SASI WITHIN NATIONAL PERSPECTIVE

- Fisheries resources in Indonesia has its owner (ada pemiliknya); *res communes*
- Considered as state property (Constitutional Act, 1945) Thus responsible for management:
- Management according to the decentralization Law No.32, 2004 by:
  - Central government (EEZ and territorial sea > 12 miles)
  - Provincial government (territorial sea of up to 12 miles)
  - District/ municipal town (territorial sea up to 12 miles)

FISHERIES RESOURCES AND SASI LAUT WITHIN NATIONAL PERSPECTIVE (*continued*)

- Certain regions with strong customary law (HUKUM ADAT) have territorial use right (hak ulayat laut) and indigeneous right (hak asli?).
  - ➢ **SASI LAUT (MARINE SASI)**
  - ❖ ***Counterparts :***
    - » Banu and Lulin West Timor (Land crops, Sea cucumber, inshore reef fishes)
    - » Badu, East Flores (varieties of estuarine fish)
    - » Kamande (rabitfishes)

Rabitfishes concentrated in the cod end of the set net (Photo. TNC_KFO)

OBJECTIVES OF MARINE SASI

- ✓ Maintain continuity of tradition and culture
  - ❖ Relation
  - ❖ Coherent
- ✓ Achieve better quantity and quality of the products
- ✓ Protection of the environment
- ✓ Maintain economic gain for
  - ❖ Village
  - ❖ Family members

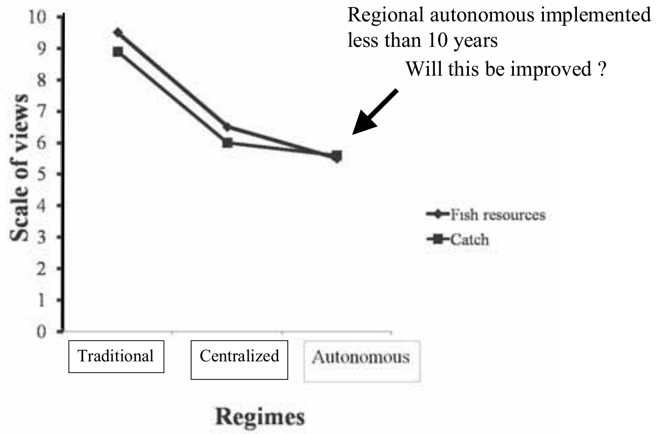
HISTORY

- TIME
  - ❑ Discrepancies of time remain
  - ❑ Present documents suggest that 1600 was indicated as the earliest (Lokolo, 1986)
- SASI WITHIN DIFFERENT TIME REGIMES (of fisheries resources) IN MALUKU:
  - ❑ Traditional (Adat) rregime
  - ❑ Centralized regime
  - ❑ Autonomous regime

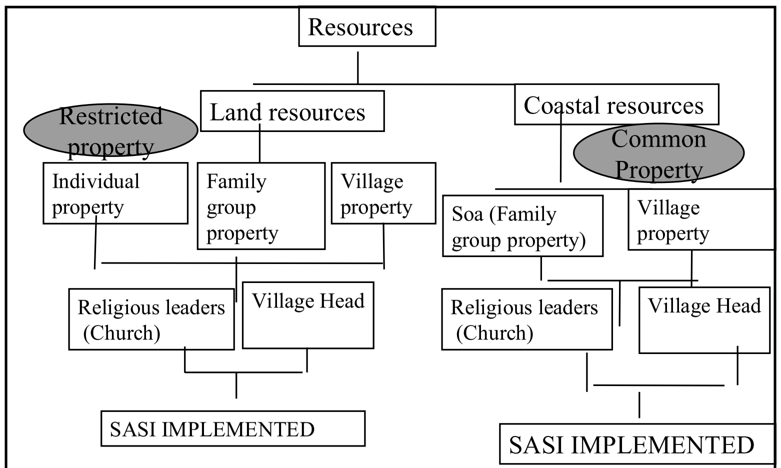
Characteristics of the management and sustainability of fisheries resources

Traditional harvest of Palolo worm (*Eunice viridis*) in Babar and Sermata Islands (Doc. de Jong, 1991)

- Traditional regime :
  - Resources more healthy
  - Better environment
  - Less pollutant to the waters
  - Lower fishing technology
- Centralized regime
  - Significant deployment of fishing efforts to increase catch
  - The resources dropped significantly
- Autonomous regime
  - Remnant of centralized management remain (unhealthy resources)
  - Revitalization of customary law (Sasi)



Perception of the villagers on biological sustainability of fisheries resources under different regimes of authority system (Redrawn with permission from Pical, 2007)



Roadmap towards implementing Sasi

RESOURCES UNDER SASI

Depend on the availability and characteristics of the region and resources :

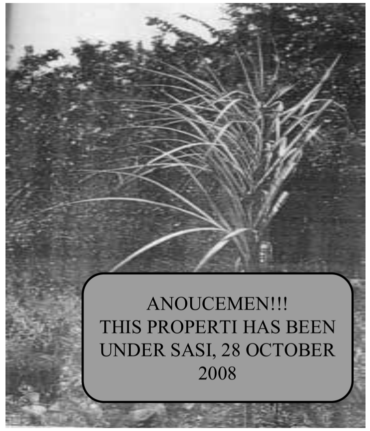
✓Land vegetation, crops and valuable trees (for housing and other purposes)

✓Coastal areas and organisms

THE RESOURCES (*Continued*)

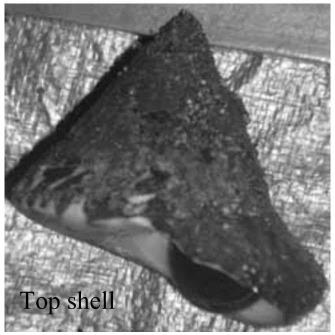
- ❖Land vegetation and crops: Forest, Coconuts, jack fruits, bread fruits, mangoes, and high quality trees for timber
- ❖Coastal vegetation and organisms:
  - ➢Mangroves
  - ➢Reefs areas (Known as Sasi Meti): NO TAKE ZONE: fish, mollusks, seaweeds and sea cucumbers
- ❖Fish: main reef species as; Groupers, Snappers, Emperors, Scarids, Wrasse, Siganids and Clupeid (*Trisina baelama*)
- ❖Mollusks; top shell (*Trochus niloticus*) and green snail (*Turbo marmoratus*)

Bays and mangroves under sasi



Symbol of Sasi with young coconut leaves (Kissya, 1993)

Top shell (*Trochus niloticus*) and Green snail (*Turbo marmoratus*)



Photo, Nony Uneputty

Forest Dept.

Top shell (Lola) of Nolloth Village with varieties of sizes harvested after sasi

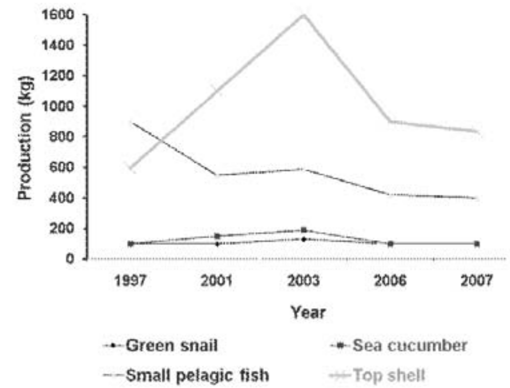
Sasi and coherent of community

Villagers area gathering on the coast on the day of lifting the Sasi = Lulin

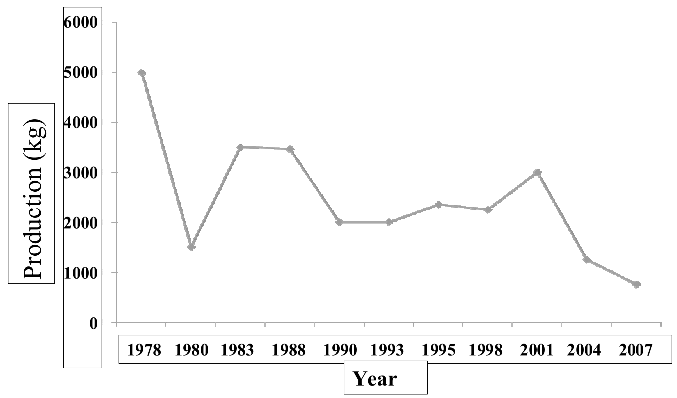
Helped by Policeman for order, a man contributes his share to the village head (25-50cent US).

Trend of selected fisheries commodities at selected sites after sasi

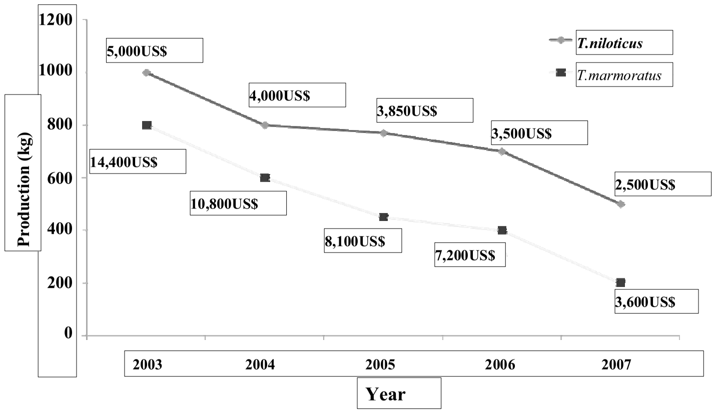
- District of Central Maluku (*Saparua and Haruku Isl.*)
  - Small pelagic fish (Clupeoidae, *Trisina baelama*), Declining
  - Sea cucumber ; Relatively stable
  - Green snail (*Turbo marmoratus*) ; Relatively stable
  - Top shell (*T.niloticus*) ; Fluctuate
- District of South West Maluku (*Babar, Sermata, Luang Isl.)*
  - Top shell (*Trochus niloticus*) ; Declining
  - Green snail (*Turbo marmoratus*) ; Declining



Annual production of top shell (*Throchus niloticus*) and other commodities in the island of Nusa Laut, Saparua island Central Mollucas (Redrawn with permission, Pical, 2008)



Top shell (*Trochus niloticus*) harvested in Noloth village of Saparua Island, Central District of Maluku (redrawn with permission from Uneputty, 2008)



Annual harvest of top shell (*Trochus niloticus*) and green snail (*Turbo marmoratus*) in Babar sub-district, South West District of Maluku (Present study)

POSSIBLE CAUSES OF DECLINING

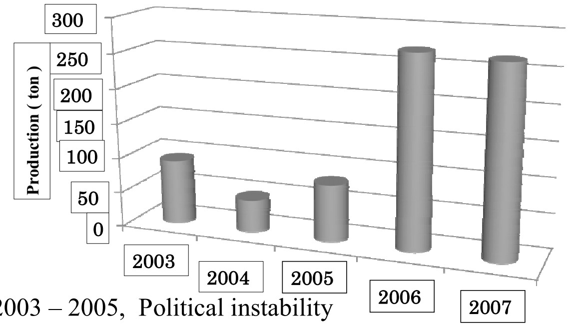
- External factors:
  - Pouching
  - The use of destructive fishing methods by outsiders (cyanide, etc.) to catch fish affecting their habitats
  - Economic pressure
    - ➢ *Harvest earlier (<2 years)*
    - ➢ *Include wide range of sizes (larger and smaller sizes)*
    - ➢ *Introduction of modern diving gear*

POSSIBLE CAUSES OF DECLINING (*Continued*)

Rabitfishes in full gonad

- Internal factors:
  - Human population increase
  - Lack of knowledge on the biological aspects of the resources
  - Inconsistency policy of the community leaders towards harvesting the resources
- Biological factors:
  - ➢ Harvest within reproductive season (Like Rabitfishes case)
  - ➢ Size limit of about 6cm of basal diameter very often violated
  - ➢ Recruitment failure

Overall production of top shell in Maluku



Period 2003 – 2005, Political instability
Period 2006 – 2007, Stable condition

CONCLUSION

- Marine Sasi could be considered as a good concept and model of CBM to manage coastal and marine resources (especially less mobile organisms, sedentary)
  - ✓ Have played a significant role in implementing management principles (i.e. compliance to the existing written and unwritten rules)
  - ✓ Maintain the continuity of the existing resources to be harvested
  - ✓ Protection and maintain good and healthy habitats
- Maintain social and community compactness
  - Maintain the existing custom and culture (potential conflict management)
- Has its strength
  - ➢ Implement fundamental management model (open and closed seasons)

Conclusion *(Continued)*

- ➢ The models are internally formulated suggesting:
- ➢ Local responsibility and policing on the resources
- ➢ The role of traditional law (adat) , gained its momentum via new coastal zone management law No.32 year 2008
- ➢ Play critical role towards establishing co-management structure
- ➢ Sasi has been ingrained as part of culture across Maluku archipelago

- Has its weakness
  - Limited in logistical support to overcome offenders
  - Lack of communication facility to help enhance information about the characteristics of organisms
  - Unwritten documents raise concern that young generation may forget the concept
- Unavoidable threats (externally and internally)

What is next

- Revitalization of sasi is a need, must and unavoidable
  - Realization of the government responsibility to support the system and practice (New law of coastal zone management, No.32 Year 2008).
    - » Developing more solid concept of co-management
    - » Incorporating new knowledge about the resources
    - » Developing a more attractive incentive for the community to support their social and economic requirements
    - » Establish a permanent coastal and marine conservation at village level (kawasan konservasi laut desa)
    - » Empowerment villages to reduce offenders
    - » Establishing catch limit (TAC)

THANK YOU

Managing eutrophication in megatidal estuaries in North-Western Europe through Integrated Coastal Zone Management (ICZM)

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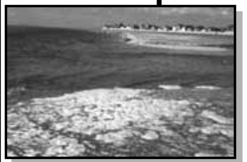
Coastal ecosystems, and estuaries in particular, are under strong influence of their watershed. Estuaries are semi-enclosed basins receiving water directly from a riverine basin. They are permanently connected to the sea whose waters are diluted by fresh water drainage and run-off. Estuaries maintain exceptionally high levels of biological productivity and play important ecological roles, including water purification, 'exporting' nutrients and organic materials to outside waters through tidal circulation; providing habitats for a number of species. In megatidal estuaries, differential degrees of sediment mobility have shown crucial effects on the zonation of the tidal flat macrofauna. Particle fluxes to mid water depths in the adjacent sea are mainly controlled by fluvial discharge and primary production. Fluvial discharge could be responsible for the higher lithogenic flux during autumn and winter, while high primary production could play a key role in generating biogenic particles during spring and summer. The benthic fauna responds to changes in particulate fluxes of mineral and organic matter from the photic layer. In turn, changes in the secondary production due to estuarine benthos have an impact on food chains, in particular shellfish and fish.

The concept of Sato-Umi has recently been developed in Japan in response to problems in managing eutrophic enclosed coastal seas such as the Seto Inland Sea. In Europe, similar organic enrichment exists (in the Baltic Sea, North Sea estuaries and the Mediterranean) and has led to the establishment of new legal instruments, notably directives, emanating from the European Union. Meanwhile, a new school of thought has emerged and proposed a new approach, known as Integrated Coastal Zone Management (ICZM).

This paper aims at drawing a parallel between Sato-Umi and ICZM in Europe, compare them and put differences and similarities into light. Based on case-studies, the presentation will focus on cycling of nutrients in selected coastal areas: quantities of chemicals which are loaded from the coast and how production (primary, secondary and tertiary) is affected. Measures taken to resolve eutrophication problems in Europe will be introduced and their effects analyzed in terms of biodiversity in relation to changed production.



THE UNIVERSITY OF HULL

Institute of Estuarine & Coastal Studies (IECS)

Managing eutrophication in megatidal estuaries in North-Western Europe through ICZM

EMECS 8 International Conference ***Shanghai, October 27 – 30, 2008***

Jean-Paul Ducrotoy

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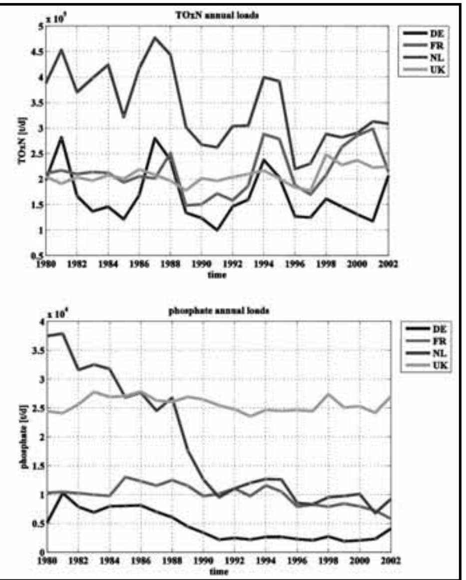
Reader Emeritus
The University of Hull

OSPAR Commission, 2008: Nutrient Reduction Scenarios for the North Sea

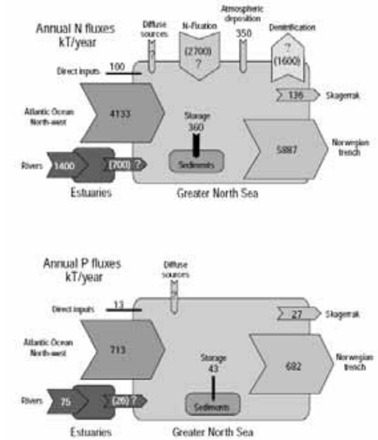
- Available annual loads of TOxN (NO3+NO2) by country.
- Available annual loads of PO4 by country.

OSPAR Commission

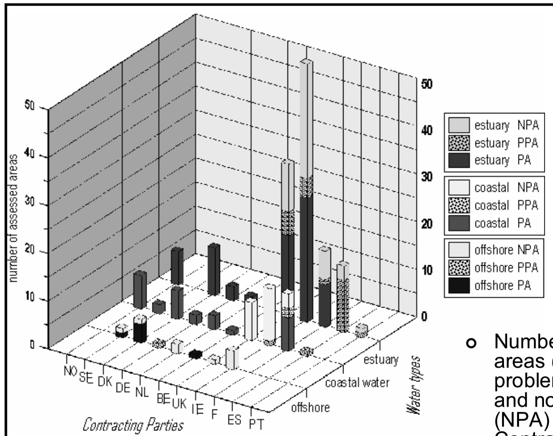


Annual nitrogen and phosphorus fluxes within the Greater North Sea area.

Source of data
- *sewage and riverine input data: OSPAR (1998b);*
- *atmospheric input data: OSPAR (1998c)*
- *estuarine inputs calculated according to Nixon et al. (1996)*
- *Atlantic ocean inputs and sediment storage: Radach and Lenhart (1995)*
- *N-fixation: Capone and Carpenter (1982)*
- *Denitrification value: Seitzinger and Giblin (1996)*
- *output calculations to Norwegian Trench and Baltic Sea: budgeting to satisfy steady state conditions (inputs = outputs)*



OSPAR Commission



OSPAR Commission

Eutrophication in the North Sea

- Number of problem areas (PA), potential problem areas (PPA) and non-problem areas (NPA) identified by each Contracting Party per assessed water type in the second application of the Comprehensive Procedure

Estuaries remain the most problematic in the Greater North Sea region in relation to the extension of identified problem areas

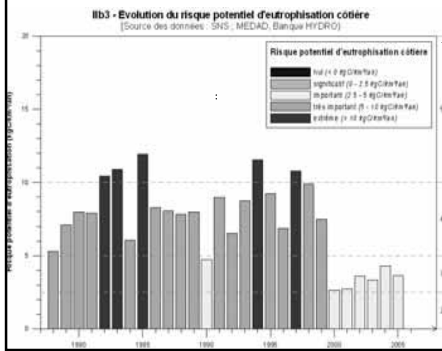
Major Problems Facing Esstuaries in North Western Europe

2 primary issues

- increased nutrient loading to the estuary, resulting in wholesale decline in estuarine health from shifting land-use
- bacterial contamination resulting in shellfish bed closure

Sampling by Seine Aval
Group in the Interest of the Public

Several estuaries and coastal areas in NW Europe have increased nitrogen (N) and phosphorus (P) concentrations, elevated concentrations of chlorophyll *a* and changes in algal community composition and abundance



$$\frac{C_N}{C_P} > 16$$

$$ICEP = \left[\frac{F_N}{(Mm_N \times RR_N)} - \frac{F_{Si}}{(Mm_{Si} \times RR_{Si})}\right] \times (Mm_C \times RR_C)$$

$$\frac{C_N}{C_P} \leq 16$$

$$ICEP = \left[\frac{F_P}{(Mm_P \times RR_P)} - \frac{F_{Si}}{(Mm_{Si} \times RR_{Si})}\right] \times (Mm_C \times RR_C)$$

Avec : ICEP : potentiel d'eutrophisation côtière (kgC/ km²/jour)
C_X : concentration en X (mg/ l)
F_X : flux de X (kg/ km²/jour)
Mm_X = masse atomique de l'élément X (C/N/P/Si : 12/14/31/28 g/ moles)
RR_X = rapport de Redfield pour l'élément X (C/N/P/Si : 106/16/1/20 moles)
X : N=Azote global ; P=Phosphore total ; Si=Silice

Eutrophication manifestations in estuaries

- Organic enrichment exists (in the Baltic Sea, North Sea estuaries)
- Increased inputs of nutrients to estuaries can lead to undesirable effects associated with eutrophication, including algal blooms, changes in species composition and bottom anoxia

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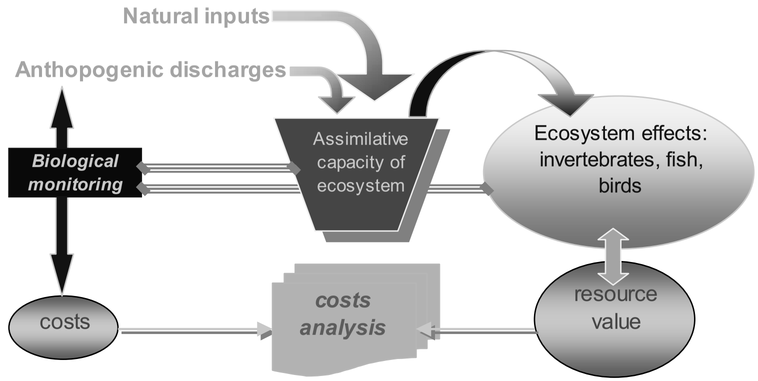
Assimilative capacity



Watershed N Loading to Estuary

- **Watershed N Load to estuary = N Sources - N Sinks + N Storage**
  - **Sources:** wastewater, fertilizers, agriculture, impermeable surfaces, etc.
  - **Sinks:** denitrification within wetlands, aquifer transport, surface water ecosystems, well withdrawals
- **Storage:** sorption, aquifer transport, biomass accumulation, etc.

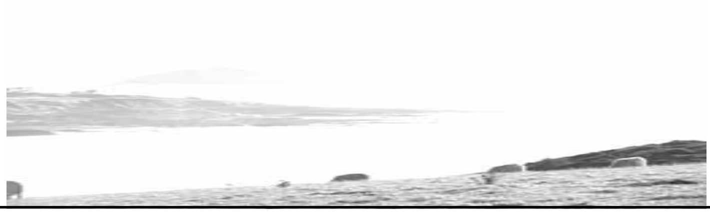
The Seine estuary, France

A strategy for restoration: Nitrogen Management Options for Estuaries

- Nitrogen source reductions
  - Fertilizer education
- Hydrodynamic options
  - Tidal flushing/circulation enhancement & management
    - ***Analyse habitats fragmentation in the estuary***
    - ***Compile information on historic changes***
- Natural attenuation options
  - Nitrogen source location to maximize natural attenuation
  - Wetland/riparian zone restoration to increase attenuation
  - Pond restoration to create zones of natural attenuation
    - ***Evaluate the location of potential aquatic restoration sites relative to ability to intercept watershed N sources***
    - ***Evaluate potential source relocation***

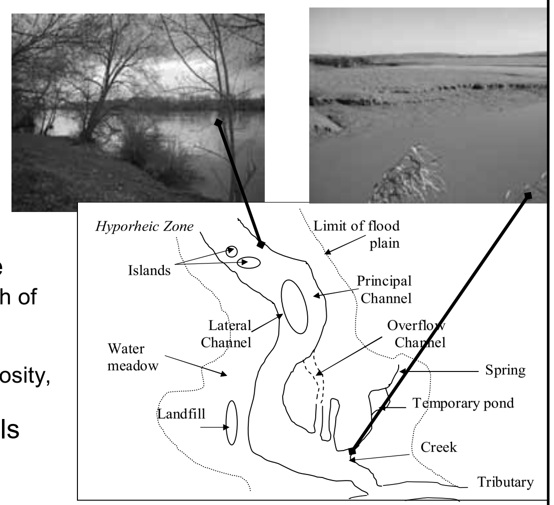
- Use of wetlands/pond/river restoration to
  - To enhance natural nitrogen removal processes for restoring nitrogen impaired estuaries.
- Result in
  - Lower costs for watershed nitrogen management
  - Impetus for environmental restoration

The Camel Estuary, UK



Connectivity between river and flood plain

- Main factors affecting the hyporheic zone
  - Width and depth of river bed
  - River flow
  - Sediments: porosity, volumes…
  - ➔ Use of models



Experimental sites

The Seine estuary, France

- Developing scientific knowledge (field experiments and surveys, modelling…) on hydrodynamics, sedimentology et <u>biocenotics</u>,…
- Acquiring technical skills (ecological engineering)
  - ➔ Review of available **technologies**
  - ➔ Launch **full scale pilots** adapted to local conditions using new protocols

ICZM in Europe

The Somme estuary

- New legal instruments, notably directives, emanating from the European Union.
- A new school of thought and a new approach, known as **Integrated Coastal Zone Management (ICZM)**.

OSPAR Commission

Specific EcoQOs for eutrophication, as agreed for the North Sea pilot project

- a. Winter DIN and/or DIP should remain below a justified salinity-related and/or area-specific % deviation from background not exceeding 50%;
- b. Maximum and mean chlorophyll *a* concentrations during the growing season should remain below a justified area-specific % deviation from background not exceeding 50%;
- c. Region/area-specific phytoplankton eutrophication indicator species should remain below respective nuisance and/or toxic elevated levels (and there should be no increase in the duration of blooms);
- d. Oxygen concentration, decreased as an indirect effect of nutrient enrichment, should remain above areaspecific oxygen assessment levels, ranging from 4-6 mg oxygen per litre;
- e. There should be no kills in benthic animal species as a result of oxygen deficiency and/or toxic phytoplankton species.

Aim of the Water Framework Directive (WFD)

- For surface waters the overall aim is that Member States should achieve "good ecological and chemical status" in all bodies of surface water by 2015
- Surface water means inland waters (e.g. rivers, lakes), transitional waters (e.g. estuaries) and coastal waters (up to 1 nautical mile from baseline)

Reacting against destructive developments and… Promoting an ecological perspective

the ecosytemic approach

Conclusion

1. Acquire and compile scientific knowledge on **biotopes** and their ecological potential
2. Establish ecological references from **historical knowledge** on estuarine habitats
3. **Calibrate proposed plans** for restoration and preservation
4. Propose a **virtual image** of the possible future estuary ("utopian perspective")
5. Set up a **restoration strategy** to attain the above
6. Prioritise restoration and preservation in consideration to **local environmental features and a holistic approach**

Phytoremediation of organically enriched sediment – evaluation by a numerical model

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Evaluation of results from field experiments was made by a numerical model. The field experiments were those to remediate shallow enriched sediment by replanting mass-cultured benthic microalgae, Nitzschia sp. The observation results have already reported elsewhere, in which organic content of the sediment was significantly decreased and inorganic nutrient concentration was increased. However, the processes which may have occurred in the surface sediment were not clear with only stock data. Then we tried to evaluate how much amount of biophilic elements were cycled in the surface sediments. The model constructed in the present study is consist of 9 compartments; dissolved inorganic phosphorus (DIP), dissolved organic phosphorus (DOP), particulate phosphorus (PP), adsorped phosphorus (EP), benthic microalgal phosphorus (BMA), Nitzschia phosphorus (Nsp), detritus feeder phosphorus (DEB), filter feeder phosphorus (FIB), and dissolved oxygen (DO). A marked characteristic of the model is that the thickness of the oxic layer of the surface sediment was variable depending on DO concentration in the overlying water. The model outputs reproduced well the observed results with minimum tunings. In comparison of phosphorus flow in the experimental site and control site, most processes showed large values in the experimental site, indicating phosphorus cycle in the sediments was enhanced by replanting BMA. Particularly, decomposition of PP and release of DOP from the sediment to the overlying water were markedly enhanced. Although DO production was obviously increased by photosynthesis of the replanted BMA, DO flux to the overlying water did not increase due to consumption for decomposition of PP in the sediment. To evaluate the superior points of replantation method of mass-cultured BMA for remediation of organically enriched sediments, a several sensitivity analyses were carried out. In one of them, same amount of PP was inputted onto the sediment surface in the model, then compared the results to those of replanted experimental site. In the results from the replanted experimental site, replanted Nitzschia sp. was fed by benthic animals while such an enhancement of feeding activity was not found in the PP addition. From these numerical calculations, it was concluded that decrease of organic matter in the surface sediment by replantation of BMA was explained by substantial enhancement of material cycle through food web.

Adaptive cooperative management of tidal flat by citizens - governments - researchers in the Yamaguchi Bay

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In the Yamaguchi Bay, which is located at the mouth of the Fushino River, fishery resources have been decreased quickly. The local government established a "committee of developing a healthy river basin" in 2002, and selected the basin of the Fishino River as a model field. In 2003, the natural environmental restoration law has been established. Based on this law, a "council of the river mouse and tidal flat restoration in the Fishino River" has been launched in 2004. The members of the council were consisted of thirty individuals and citizen groups, eighteen local and national governmental organizations, and nine researchers.

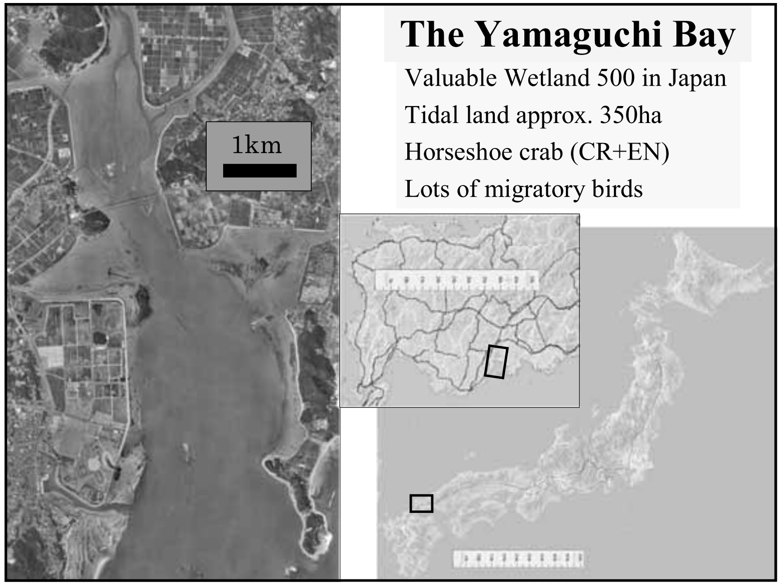
There are a lot of living organisms which should be conserved in the bay, which include short-necked clam, eel grass, houseshoe crab, waterfowls, etc. Among them, short-necked clam and eel grass were in the most serious situation. In the past, there were 700 ha eel grass bed in this area, which decreased down to 32 ha in 2002. The council members have planted young plant of eel grass, and the eel grass bed has increased to 153 ha in 2005. Our researches of finding the suitable habitat for eel grass would have helped the activity.

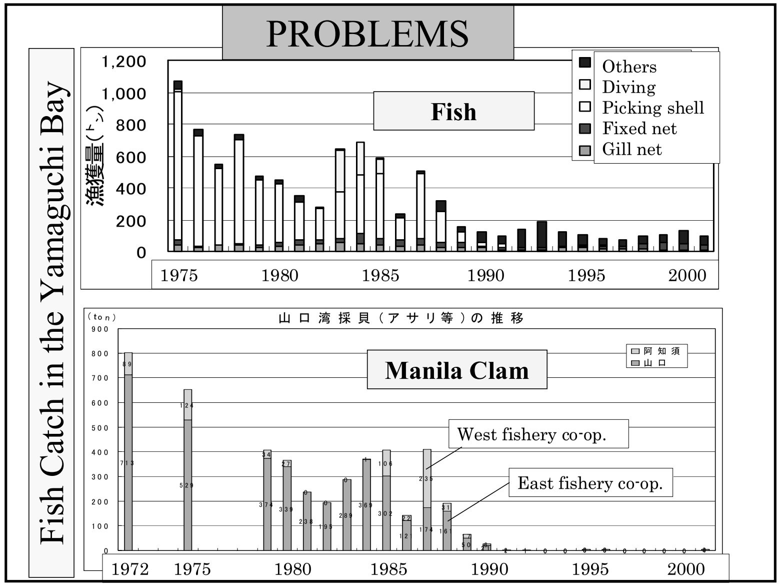
About short-necked clam, the situation was more complicated. Fishery catch of short-necked clam was 653 ton in 1975, which is sharply down to zero ton in 1991. Although there are a lot of possible reasons for this problem: 1. High mud content on the bottom sediment, 2. Low nutrient in the water, 3. Toxic substances in the water, 4. Over fishing, 5. Predation, etc., we could not reach a concrete conclusion about the cause. The council needed to start from possible countermeasures together with monitoring and researches. Since the clearest change of the environment was rise of mud content, the local government conducted sand covering works at first. The council members also conducted tidal flat cultivation at the place where the sand became hard. Low nutrient, toxic substances and predation were left unknown. We conducted researches to know the effects of these unchecked factors. Our research revealed that predation had a huge influence on short-necked clam biomass, and protecting by nets is essential in this bay. We also showed the appropriate location of spawning based on current simulations.

Recently the council has set up protecting nets at some places in the bay based on our proposal. We will continue this cooperative activity until we successfully restore this area in the near future.

Adaptive cooperative management of tidal flat by citizens - governments - researchers in the Yamaguchi Bay

Yamaguchi University
Department of Civil and Environmental Engineering
Masahiko SEKINE





Framework of the Yamaguchi Bay restoration

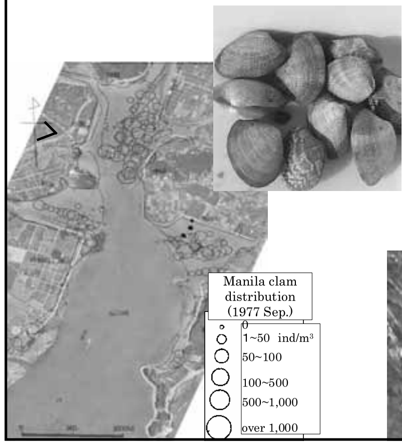
- Natural Environmental Restoration Law (2003)
- ***"Council of the river mouse and tidal flat restoration in the Fushino River"*** (2004)

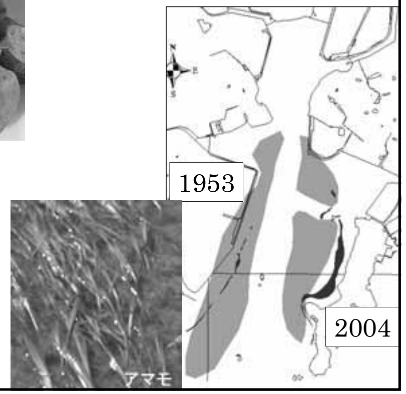
Cooperative council of
citizens - governments – researchers

15 ind. and 18 groups — 15 local and national governmental org. — 9 researchers

Two restoration target species

Manila clam **Eelgrass**





Two restoration target species

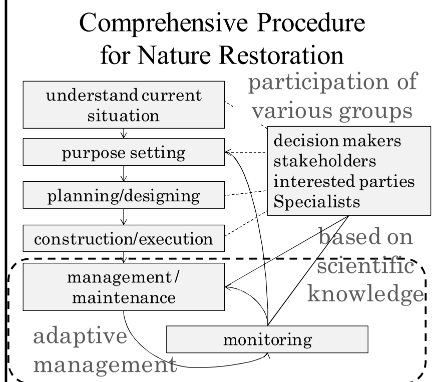
Manila clam **Eelgrass**

But…

We didn't know the cause why they had decreased.

We needed to start something, but it might not be an optimum solution.

An "adaptive management" was required.



Clearly visible change

- Mud content has increased.
- Covered by oyster shell.
- Sand has became hard and low organic matter included.
- Very few floating larva

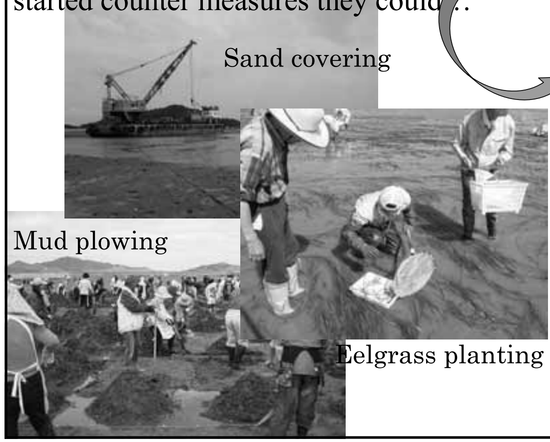
Other suspected causes

- Low nutrient in the water caused by sewage treatment.
- Toxic substances in the water from industrial wastes.
- Over fishing.
- Predation.

Why the problems had happened?

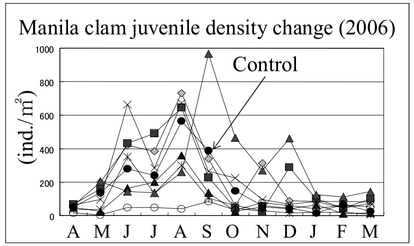
Adaptive cooperative management

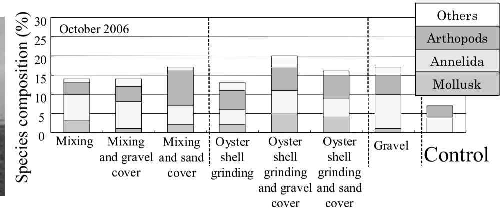
Citizenes and governments
started counter measures they could….



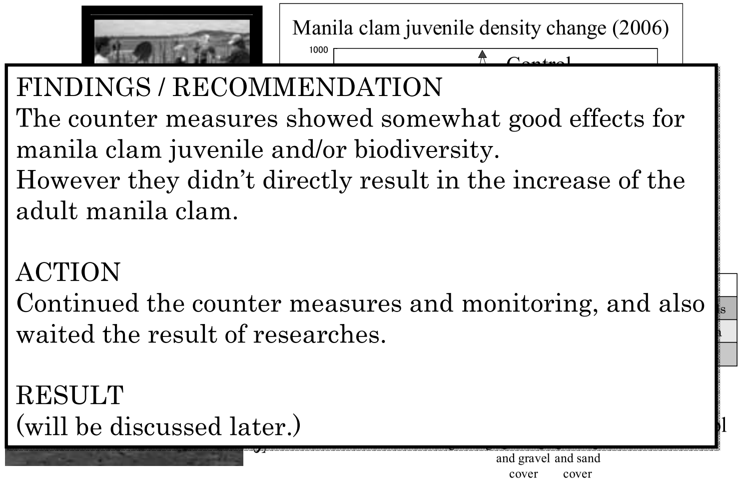
Researchers
started researches on deciding the essential cause of the decrease and the effectiveness of the counter measures

Results of the counter measures by the local government and citizens





Results of the counter measures by the local government and citizens

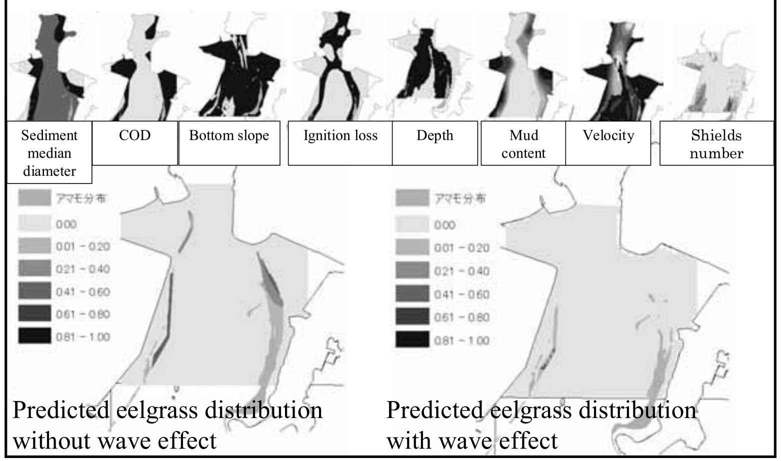


FINDINGS / RECOMMENDATION
The counter measures showed somewhat good effects for manila clam juvenile and/or biodiversity.
However they didn't directly result in the increase of the adult manila clam.

ACTION
Continued the counter measures and monitoring, and also waited the result of researches.

RESULT
(will be discussed later.)

Research 1
Eelgrass habitat evaluation(2004)



Predicted eelgrass distribution without wave effect

Predicted eelgrass distribution with wave effect

Research 1
Eelgrass habitat evaluation(2004)

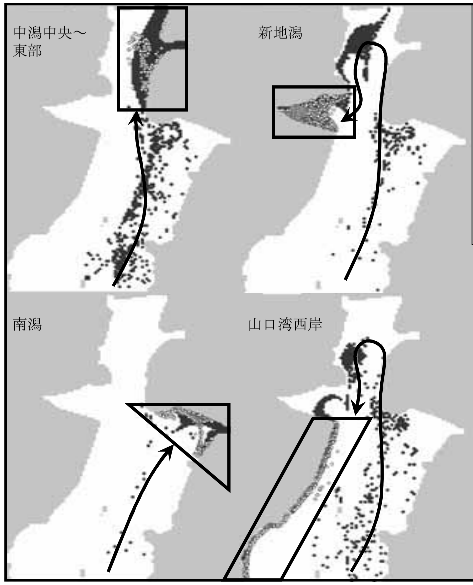
RECOMMENDATION
Eelgrass habitat can be extended toward north.
However, when a big typhoon hits, it can be destroyed.

ACTION
Local government chose a wave tolerable planting method such as fabric sheet with seeds.

RESULT
Eelgrass bed is spreading toward north.
Government evaluated that the restoration is success.
(It is also true that big typhoons have not hit us during recent three years. Continuous monitoring is needed.)

without wave effect　　with wave effect

Research 2
Finding appropriate location for clam spawning bed



● : Initial location of a particle
○ : Calculated location after 2 weeks

Research 2
Finding

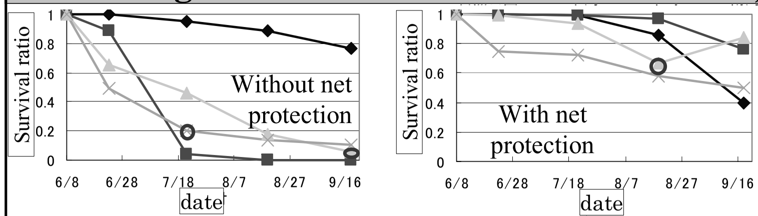
FINDINGS / RECOMMENDATION from research 2
If we can build a spawning bed at the central tideland, larva will be supplied to the central and western tideland in the bay.
Eastern tideland is isolated. Its own spawning bed will be needed.

ACTION
(will be discussed later.)

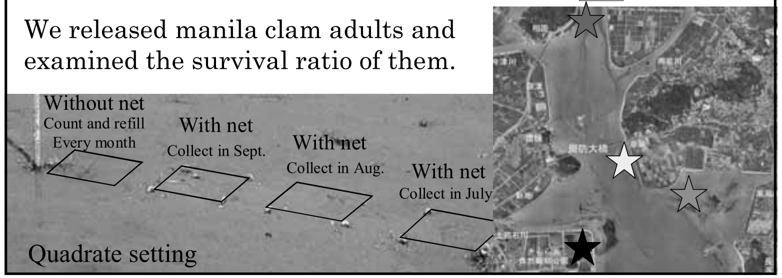
RESULT
(will be discussed later.)

○ : Calculated location after 2 weeks

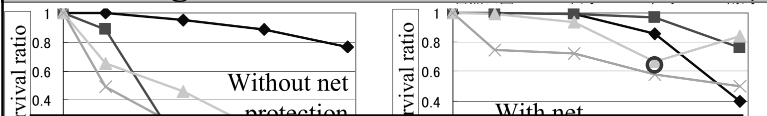
Research 3
Examining other reasons of extinction（2005)



We released manila clam adults and examined the survival ratio of them.



Research 3
Examining other reasons of extinction（2005）

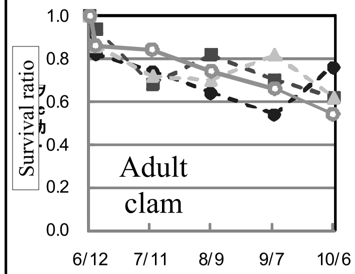


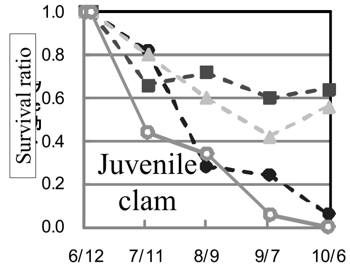
FINDINGS / RECOMMENDATION from research 3
Water quality seems OK.
Predation and/or disturbance might be the major problem.

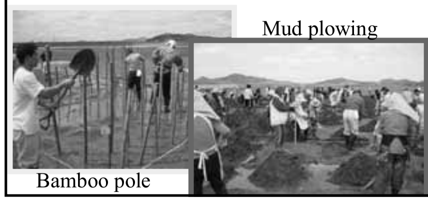
ACTION
Small test net (2x8m) was set at the eastern tideland (2006).

RESULT
Larger amount of settled larva was observed.

Research 4
Effects of counter measures (2006)







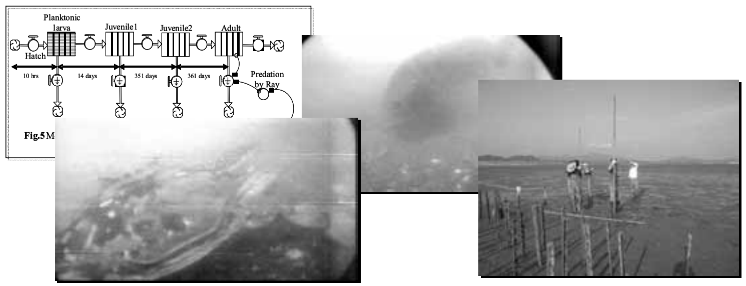
Control at the same ground level

Control at a higher ground level

FINDINGS / RECOMMENDATION from research 4
Existing counter measures seem somewhat effective for survival of larva. But the total effects seem smaller than net covering.
ACTION from Research 2, 3, 4
Larger test nets (10 x 10 m) were set to the central and the eastern tidelands (2006 - 2007).
RESULT
Considerably large amount of manila clam adults (approx. 800 ind. / m^2) were observed (2008).

Currently we are researching…

- The reason why the mud content had become higher.
- To identify the predator.
- The ecosystem model of the bay.



What we have learned from these experiences

- Small area and small group allow us to act promptly.
- Quickness is more important than preciseness in research activity.
- Plainness is more important than detailedness in expressing the research results.

- ➢ How to feedback the merit of the project to the citizen participants is a question we need to solve in the near future.

Seasonal retention and release of phosphorus in Shinkawa-Kasugagawa Estuary, the western Japan

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2 Faculty of Agriculture, Kagawa University, Ikenobe, Miki, Kita, Kagawa 761-0795, Japan

Estimation of mass balance of biophilic elements, such as nitrogen or phosphorus, is very important to understand the dynamics of these materials in coastal ecosystems. Phosphorus plays as one of the most effective material for the growth of primary producer or the eutrophication including occurrence of noxious red tides in the coastal sea. Phosphorus, discharged from a river, is varied in quality and quantity in estuary ecosystem, and then flow out to the coastal sea. We carried out 10-12 hours surveys during a high-low tidal cycle in May, August and November in 2006. Our objective is to estimate the phosphorus balance in Shinkawa-Kasugagawa estuary and to demonstrate the function of intertidal zone to coastal environment.

Hourly seawater samplings were conducted at boundary site between intertidal and subtidal area to estimate the abundance of phosphorus which flowed into or flowed out from intertidal zone. Collection of river water and measurement of flow rate of the river were also carried out to estimate the abundance of discharged phosphorus from the river. As a result, 40.9 kg of phosphorus (dissolved inorganic phosphorus + particle phosphorus) were discharged into intertidal zone from Shinkawa-Kasugagawa River, and 23.6 kg of phosphorus flowed out from intertidal zone to the sea in May. In August, 33.7 kg of phosphorus were discharged from the river and 12.4 kg of phosphorus flowed out to the sea. Therefore, 17.3 kg (42%) and 21.3 kg (63%) of discharged phosphorus from the river could be considered to trap in intertidal zone in May and August, respectively. On the contrary in November, only 2.6 kg of phosphorus were discharged from the river and 42.8 kg of phosphorus flowed out to the sea, showing 40.2 kg of phosphorus were released from intertidal zone.

Our results indicate that considerable phosphorus discharged from the river are trapped in intertidal zone during spring to summer, when various estuarine organisms are active, and are released drastically to the sea during autumn to winter.

Seasonal retention and release of phosphorus in Shinkawa-Kasugagawa Estuary, the western Japan

Kazuhiko ICHIMI & Kuninao TADA
Faculty of Agriculture, Kagawa University, JAPAN

Importance of Tidal Flat & Sea-grass Bed

(1) Spawning and nursery grounds for shells and fishes
(2) Fishing zone
(3) For recreation (going shellfish, landscape)
(4) Self-purification

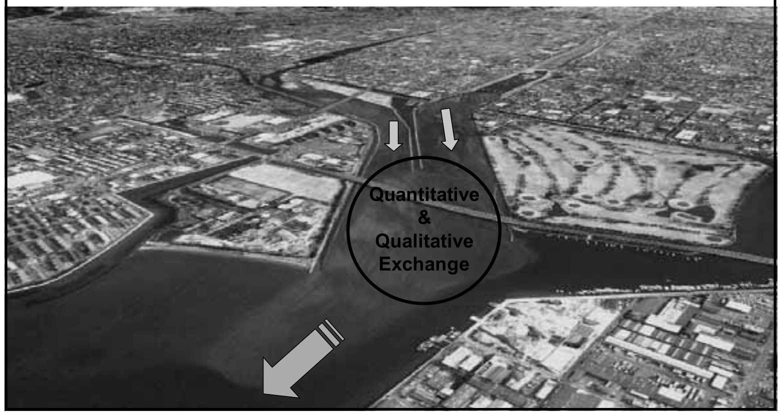

Juvenile rock fish

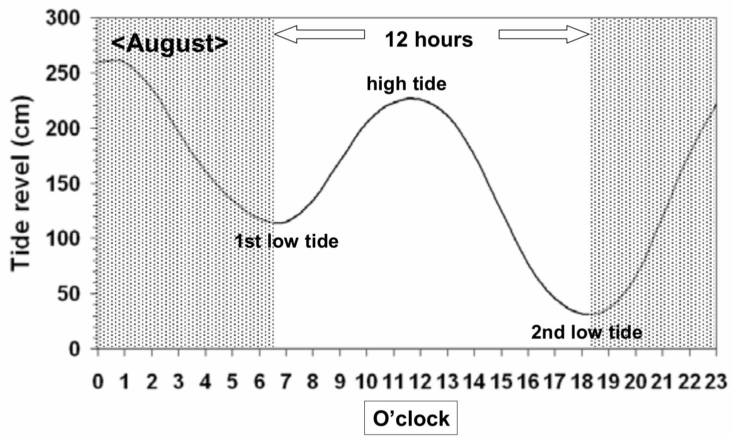

Eggs of cuttlefish

Going shellfish

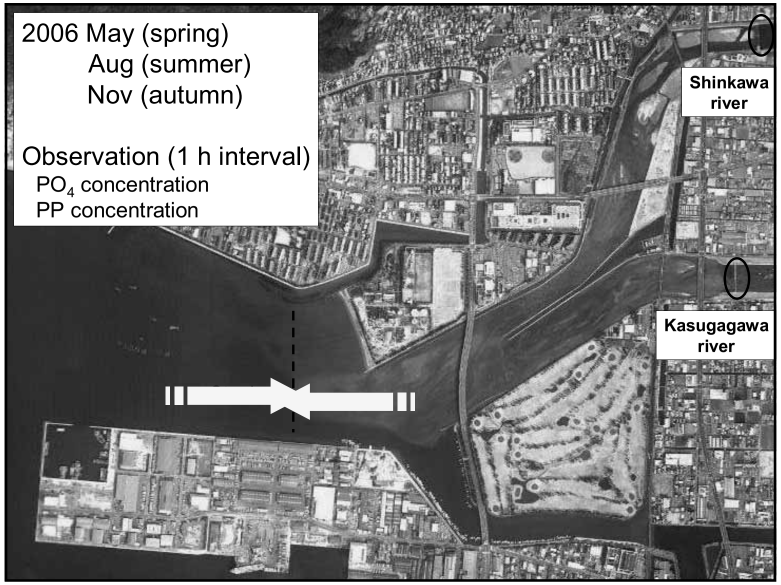

The function of intertidal zone

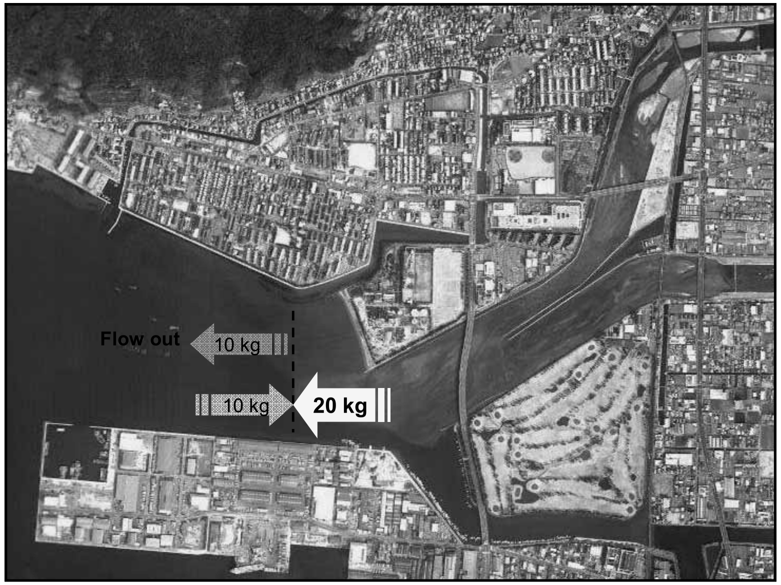
How do intertidal zone affect on the behavior of biophilic elements, such as Nitrogen or Phosphorus?

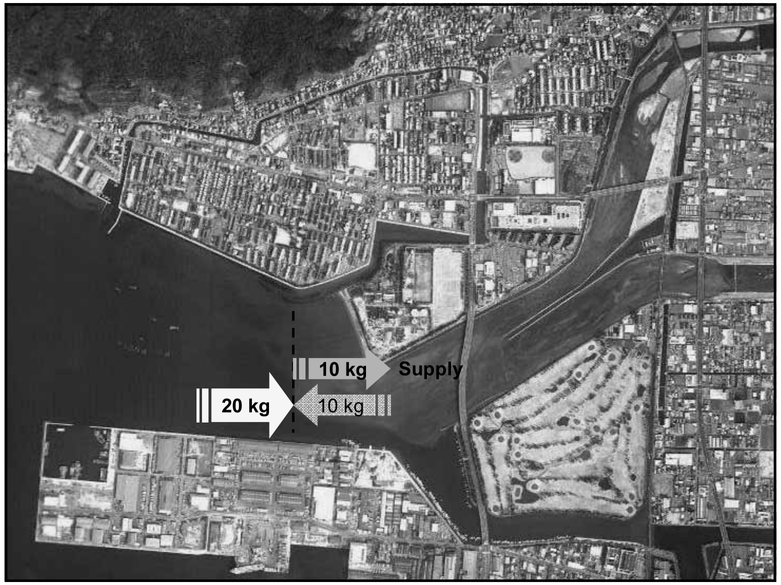




May: **11** hours
August: **12** hours
November: **10** hours







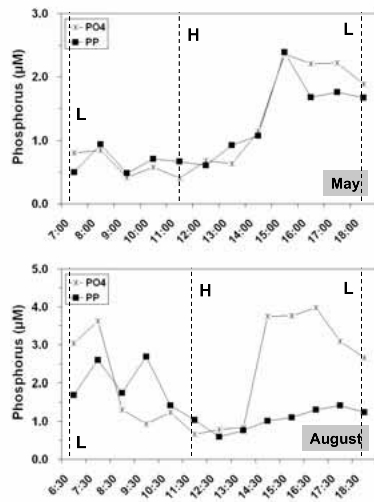
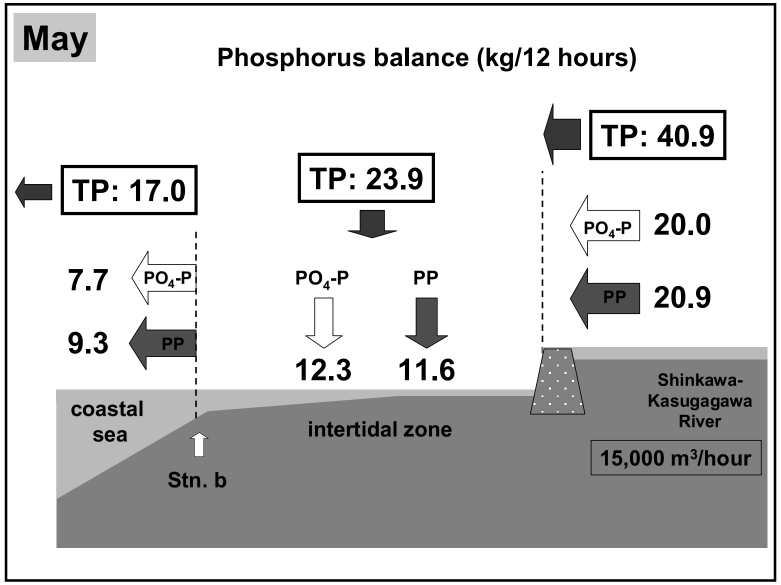
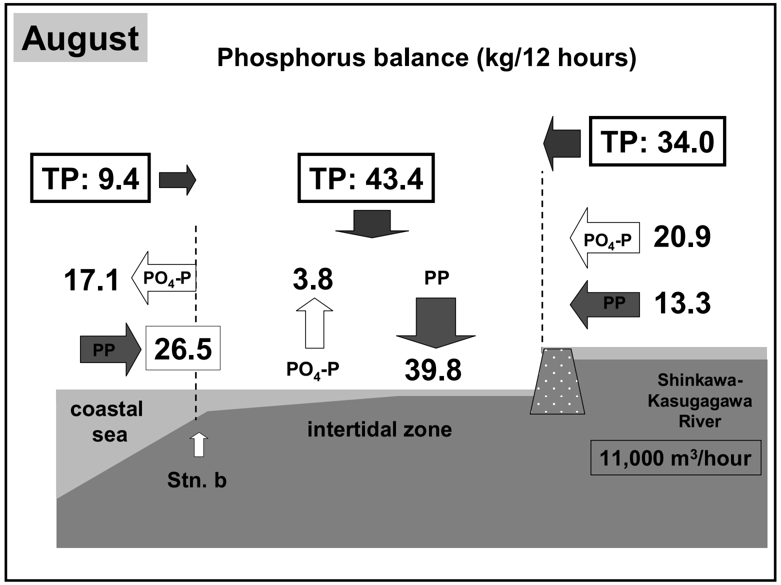
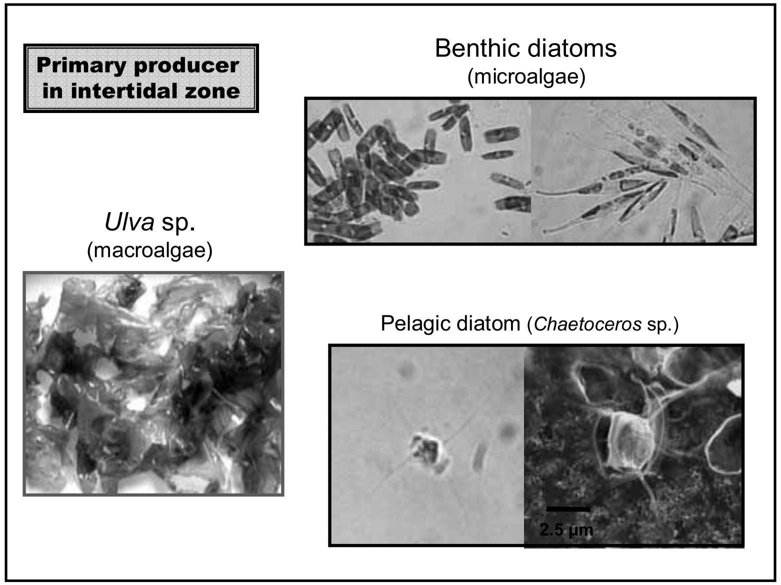


Fig. Temporal variations of PO_4 and PP at Stn. b







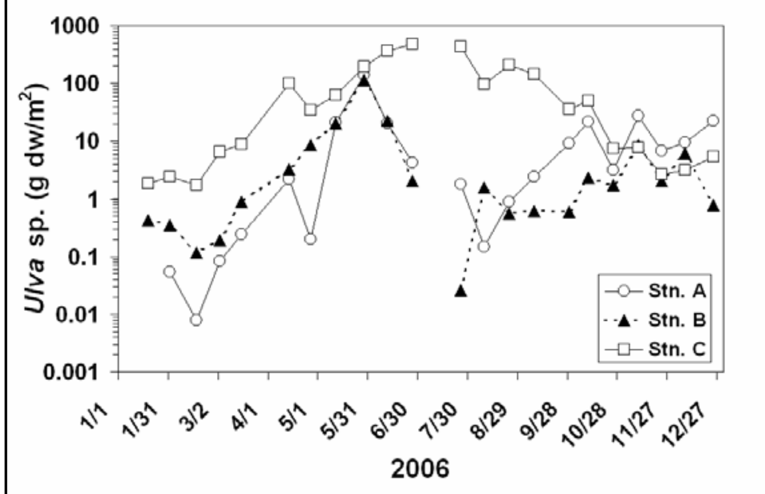
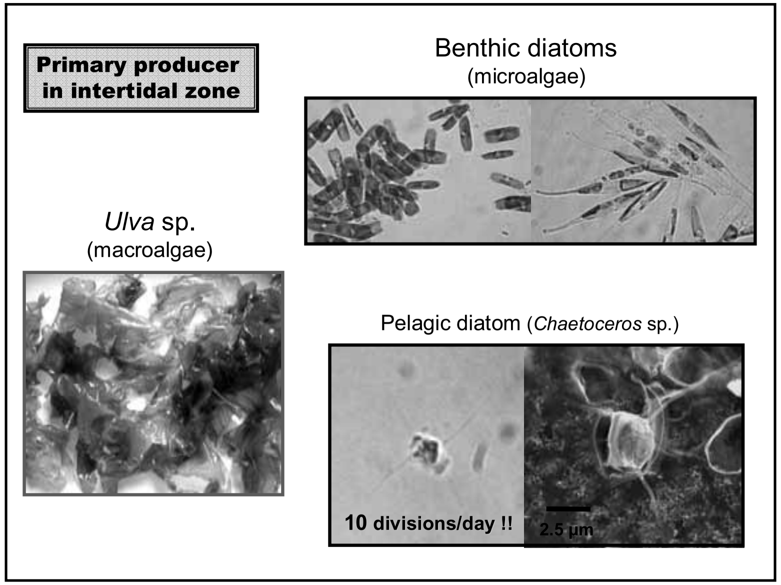
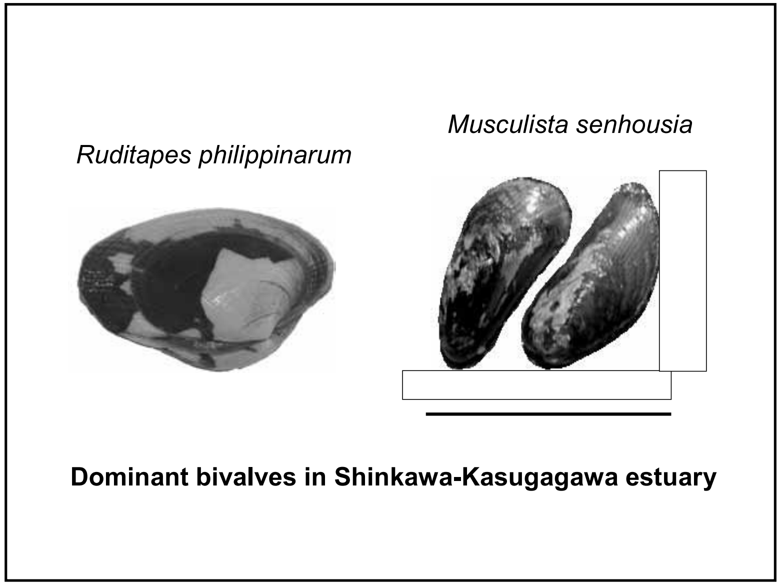
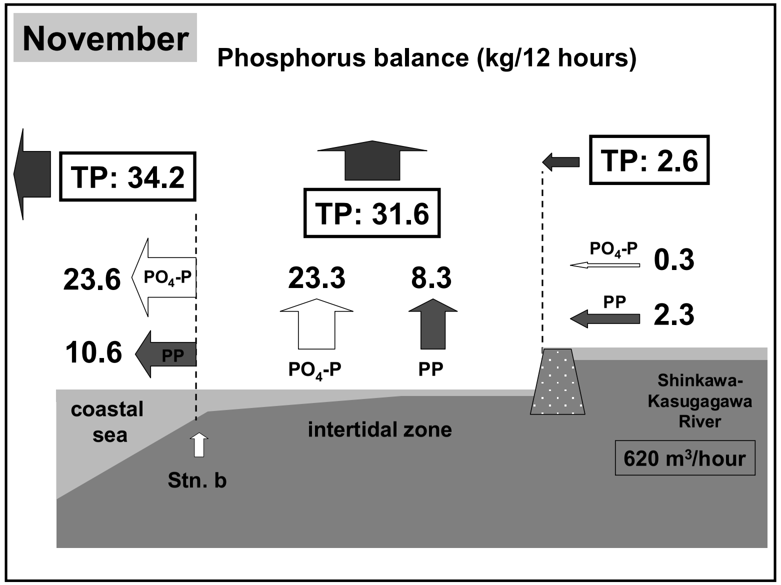


Fig. Annual standing stock of *Ulva* sp.







Phosphorus balance in Shinkawa-Kasugagawa Estuary (kg)

	Input from Rivers PO_4-P	PP		Output to coastal sea PO_4-P	PP	
May (spring)	20.0 +	20.9 =	$\boxed{40.9}$	7.7 +	9.3 =	$\boxed{17.0}$
Aug (summer)	20.9 +	13.3 =	$\boxed{34.2}$	17.1 -	26.5 =	$\boxed{-9.4}$
Nov (autumn)	0.3 +	2.3 =	$\boxed{2.6}$	23.6 +	10.6 =	$\boxed{34.2}$
winter			near 0			20～30
Total	41.2 +	36.5 =	$\boxed{77.7}$	48.4 -	6.6 =	$\boxed{41.8}$

River input 78　　Output to sea 62～72

Conclusion

(1) The annual abundance of phosphorus input from rivers and output to coastal sea were almost balanced, but phosphorus form flowed out to coastal sea was mainly PO_4.
This result shows tidal flat plays a role to purify river and coastal water. (Mineralization)

(2) Tidal flat retained phosphorus briefly in spring – summer, and released after autumn. Therefore, the abundance of phosphorus input from rivers and output to coastal sea were balanced, but did not synchronize.

Conclusion

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This result shows tidal flat plays a role to purify river and coastal water. (Mineralization)

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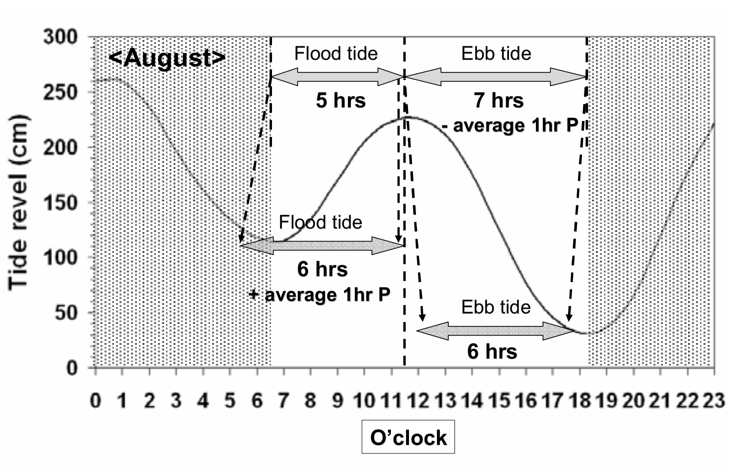


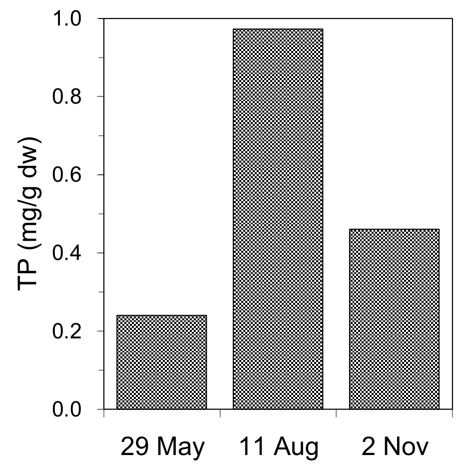
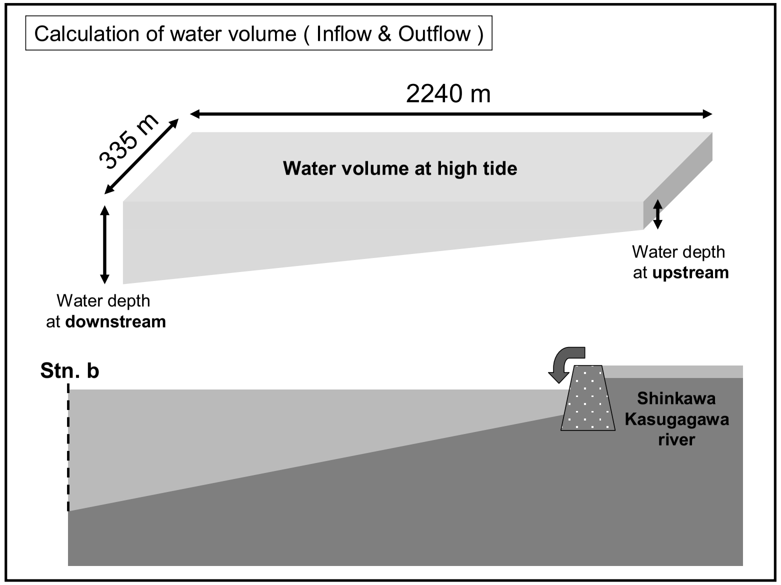


Fig. Phosphorus contents in the surface sediment collected at central part of the tidal flat



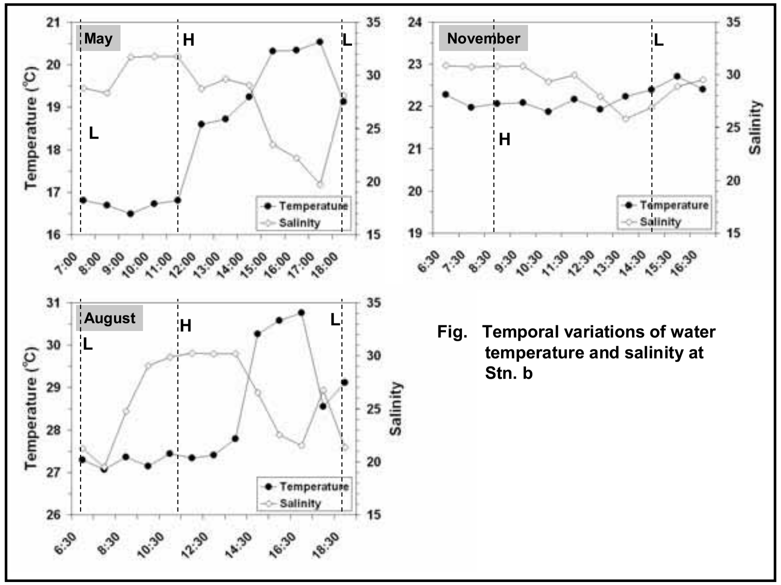


Fig. Temporal variations of water temperature and salinity at Stn. b

Isotopic evidence of seasonal variation in feeding niche of riverine and brackish gastropods

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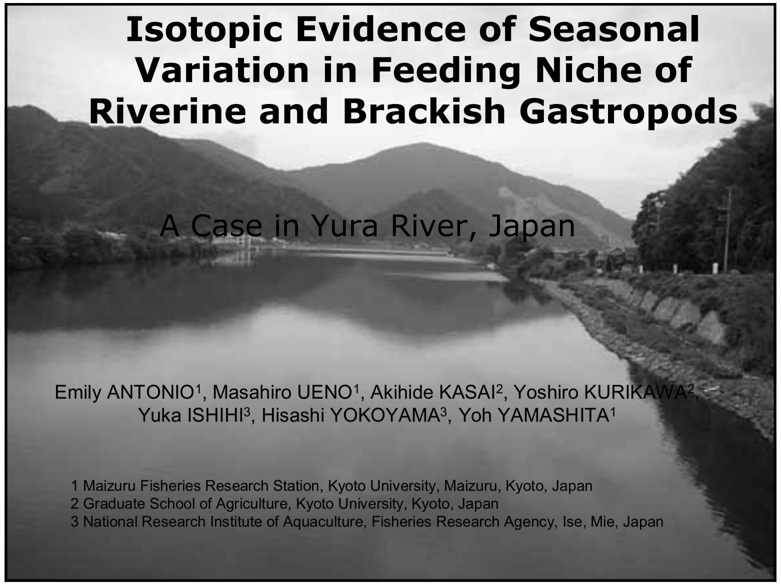
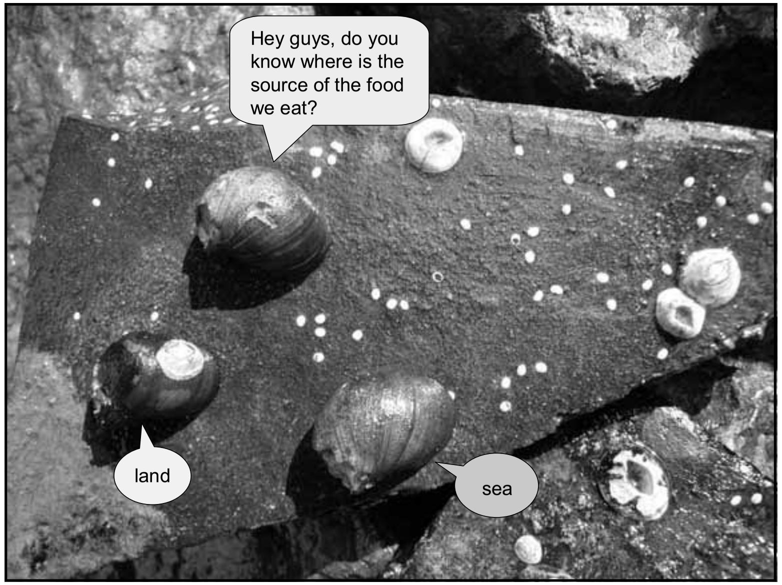
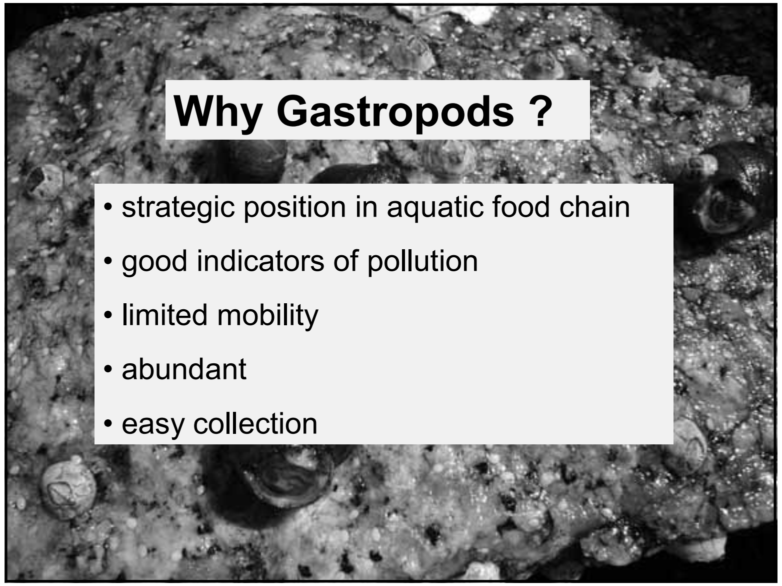
Dynamics of organism's feeding niche in response to environmental changes is of fundamental importance for understanding determinants of community structures and diversity. Feeding niche can be examined by stable isotope analysis. At a downstream bank of Yura River, Kyoto, Japan, feeding habit of three common gastropods and their possible food were studied using 13Carbon and 15Nitrogen stable isotopes. Anadromous gastropod Clithon retropictus depended mostly on benthic microalgae and marine POM as source of nutrition. It utilized about 65% benthic microalgae in spring and slightly decreased to 62% in summer while marine POM in its diet increased from 25% in spring to 30% in summer. Marine water enters Yura estuary and intrudes midstream from spring to summer, making oceanic phytoplankton available as part of the diet of C. retropictus. Cipangopaludina japonica and Semisulcospira libertina which are both freshwater gastropods change diet from spring to summer. In spring, C. japonica consumed about 67% from organic matter of the sediment but shifts its diet to river POM (68%) in summer. A wider food spectrum is consumed by S. libertina in spring; about 27% river POM, 25% sediment POM, 24% estuary POM and 16% microalgae. In summer, it shifts its diet to mostly river POM (71%).

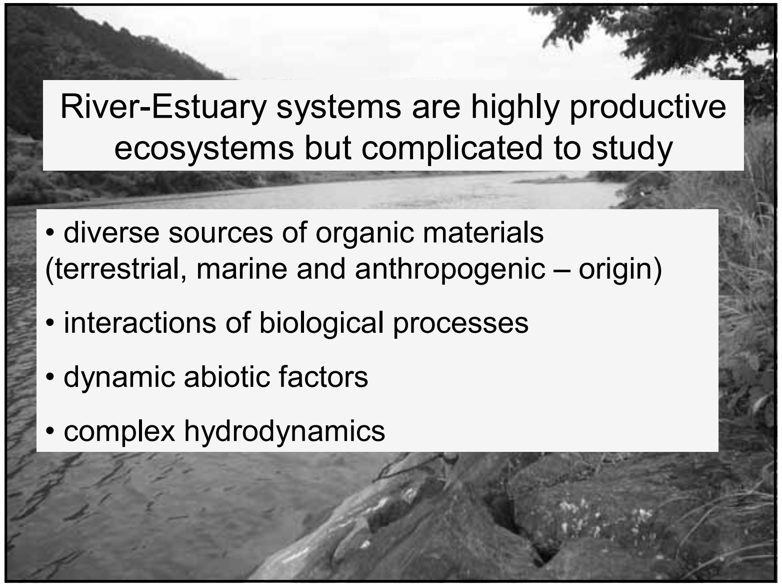
To understand the dynamics of feeding niches of the three river gastropods, we measured and analyzed stable Carbon isotope trends of the five possible food items in the study site. Stable isotope 13C of microalgae had enriched greatly from spring to summer, from -25‰ to -17‰ which indicated the presence of marine-origin epiphyton. The same trend was observed in sediment POM which increased from -26‰ to -22‰. River POM showed the opposite trend, 13C decreased from -24‰ to -27‰ from spring to summer which indicated more influence of terrestrial-origin materials in the river freshwater during summer. Marine and estuarine POM showed relatively constant 13C values in the two seasons (-22‰ and -24‰ respectively).

C. retropictus utilized marine POM aside from benthic microalgae. Although marine-origin materials are more available in summer due to marine water intrusion, C. japonica and S. libertina still selected terrestrial-origin materials either from river POM or sediment POM. Shift, expansion and overlapping of feeding niches were thought to be responses to food availability, competition and water dynamics in the estuary. River discharge and movement of marine water into the river may play an important role in the temporal change of feeding niches of the gastropod populations. This has implication on the diversity and management of river and estuary systems.

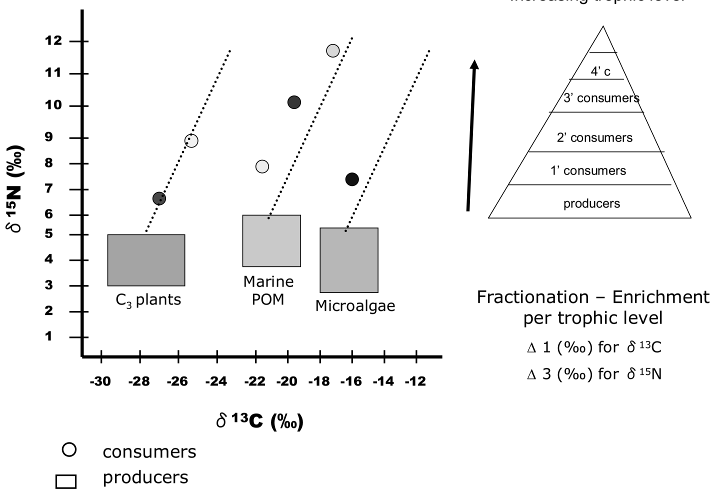

Isotopic Evidence of Seasonal Variation in Feeding Niche of Riverine and Brackish Gastropods
A Case in Yura River, Japan
Emily ANTONIO[1], Masahiro UENO[1], Akihide KASAI[2], Yoshiro KURIKAWA[2], Yuka ISHIHI[3], Hisashi YOKOYAMA[3], Yoh YAMASHITA[1]
1 Maizuru Fisheries Research Station, Kyoto University, Maizuru, Kyoto, Japan
2 Graduate School of Agriculture, Kyoto University, Kyoto, Japan
3 National Research Institute of Aquaculture, Fisheries Research Agency, Ise, Mie, Japan


Hey guys, do you know where is the source of the food we eat?
land
sea


Why Gastropods ?
• strategic position in aquatic food chain
• good indicators of pollution
• limited mobility
• abundant
• easy collection


River-Estuary systems are highly productive ecosystems but complicated to study
• diverse sources of organic materials (terrestrial, marine and anthropogenic – origin)
• interactions of biological processes
• dynamic abiotic factors
• complex hydrodynamics

CN Map

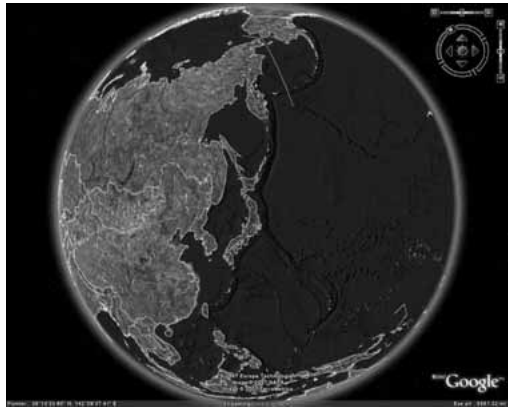


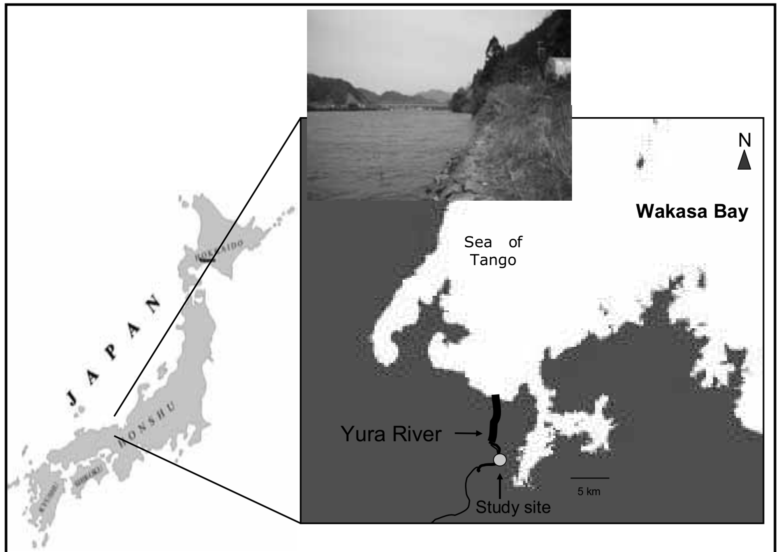
Fractionation – Enrichment per trophic level

Δ 1 (‰) for δ 13C

Δ 3 (‰) for δ 15N

Where on earth is Yura River ?



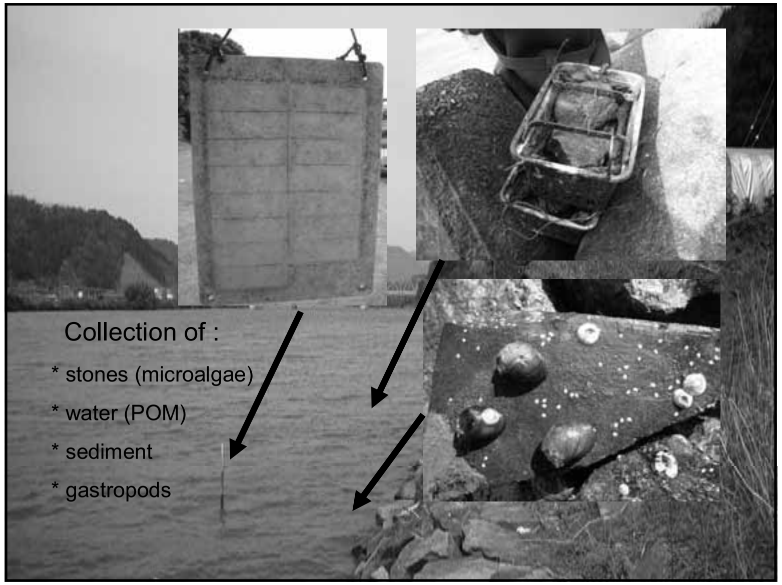


Objectives

a. To identify food sources of gastropods in Yura River.

b. To determine temporal variation in isotopic ratios of gastropods.

c. To assess the relative importance of potential sources of organic material as sources of energy among gastropod species in a river-estuary system



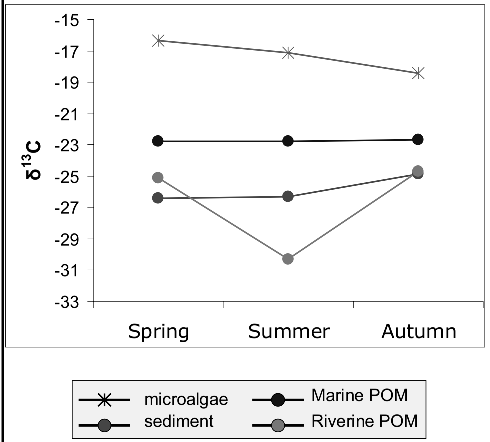
Three gastropod species used:

A. *Cipangopaludina japonica* (otanishi)

B. *Semisulcospira libertina* (kawanina)

C. *Clithon retropictus* (ishimakigai)

Seasonal δ^{13}C trend of possible food sources



- Possible food sources have distinct δ^{13}C signatures.

Microalgae (-19 to -16 ‰)

Marine POM (-23 to -22 ‰)

Riverine POM (-31 to -24 ‰)

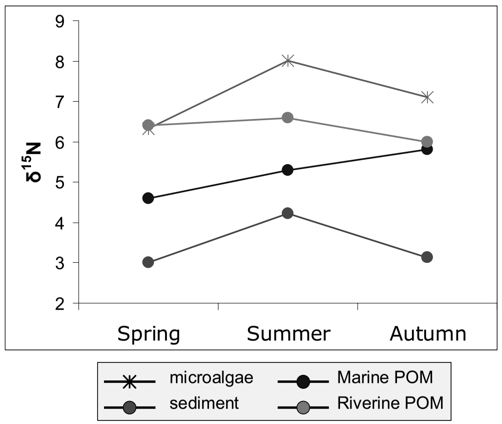
Sediment (-27 to -24‰)

- Change in δ^{13}C of epilithic microalgae might be due to species succession.

- C_3 plants (mean δ^{13}C = 28 ‰) largely constitute Riverine POM in summer.

-related to higher river discharge in summer

Seasonal δ^{15}N trend of possible food sources



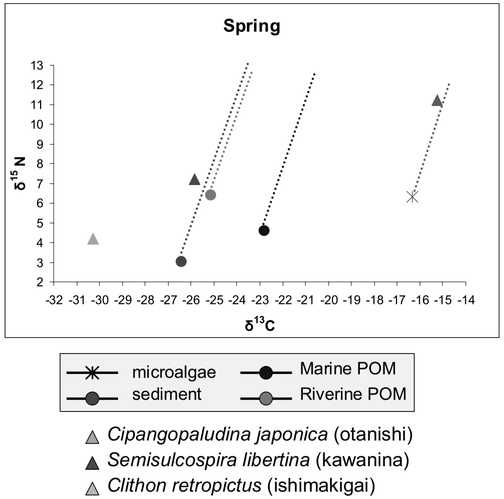
Possible food sources have enriched δ^{15}N in summer.

maybe due to

Higher river discharge in summer

Anthropogenic-origin OM has higher **δ^{15}**N (Kendall, 2001 and Martinetto, 2006)

Seasonal gastropod feeding niche

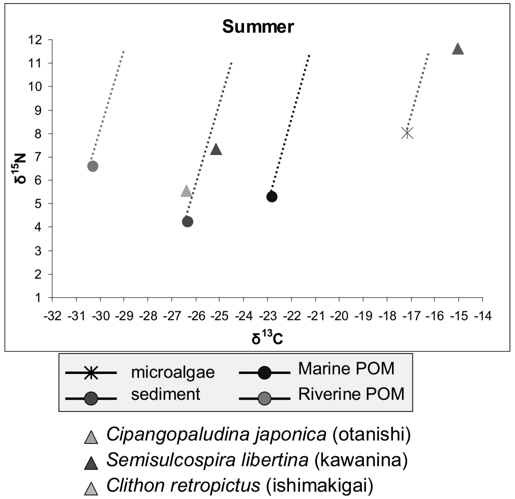


Semisulcospira libertina seemed to consume sediment and riverine POM.

Cipangopaludina japonica seemed to consume more depleted Carbon source – terrestrial C3 plants.

Clithon retropictus seemed to consume benthic microalgae

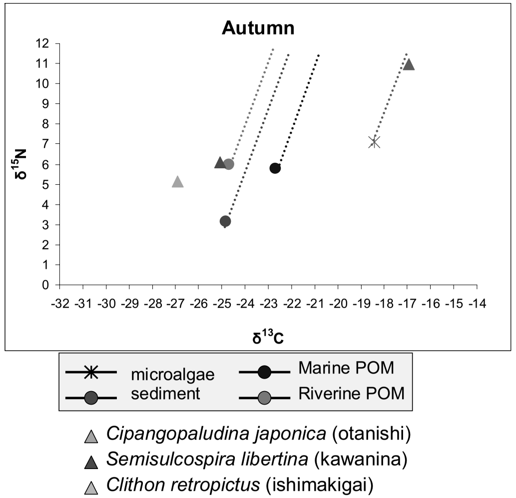
Seasonal gastropod feeding niche



Cipangopaludina japonica and *Semisulcospira libertina* seemed to be consumers of sedimentary organic matter in the river.

Clithon retropictus still consumed benthic microalgae

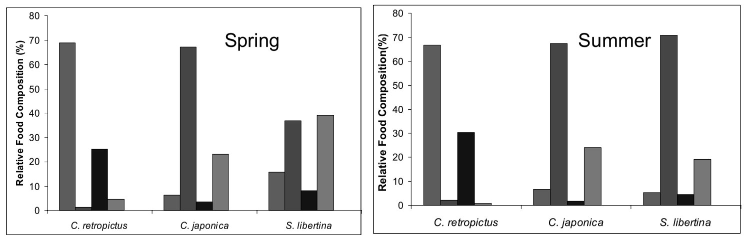
Seasonal gastropod feeding niche



Cipangopaludina japonica and *Semisulcospira libertina* seemed to consume both riverine and sedimentary POM.

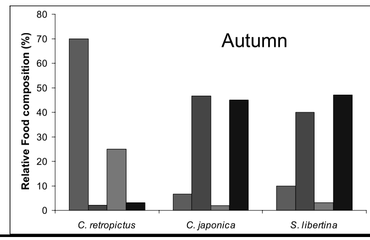
Clithon retropictus still consumed benthic microalgae

Relative percent composition of possible food items of the three gastropod species



Mixing Model

(Phillips 2003)



Fractionation – Enrichment per trophic level

Δ 1 (‰) for $\delta^{13}C$

Δ 3 (‰) for $\delta^{15}N$

Difference in Food consumption

- *Clithon retropictus* (ishimakigai) consistently depends mostly on microalgae and marine POM.
- *Cipangupaludina japonica* (otanishi) shifts diet from more of terrestrial C3 plants in spring, sediment POM in summer, and sediment and riverine POM in autumn.
- *Semisulcospira libertina* (kawanina) consume sedimentary and riverine POM in spring and autumn but more of sedimentary POM in summer.

Implications

❖Gastropod's feeding niche differs with

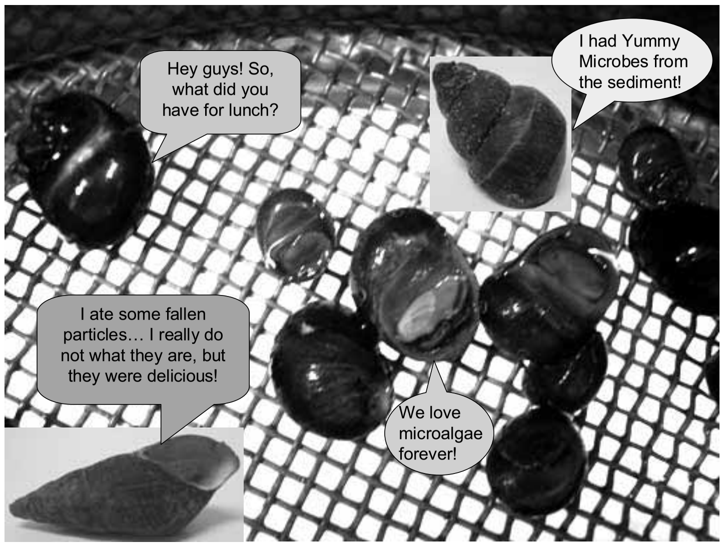
life history

Shift, expansion and overlapping of feeding niches were thought to be difference in species' responses to food availability

❖River discharge and marine water intrusion into the river play an important role in the temporal change of gastropod feeding niche.

❖Feeding niche of gastropods was influenced by anthropogenic Organic Matter in summer

❖Feeding Niche of benthos can be utilized for monitoring and management of river-estuary systems.



Paper sludge ashes as coagulant for treating contaminated dredged sediments and its applications for enhancement the coastal biodiversity in Ago Bay, Japan

Ahmed Dabwan[1], Kiyoyuki Egusa[1,2], Diazo Imai[2,3] Satoshi Kaneco[2], Hideyuki Katsumata[2], Tohru Suzuki[4], Tadaya Kato[1] and Kiyohisa Ohta[2]

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Restoration the environmental ecosystem quality in Ago Bay that has been deteriorated as a result of the continuation of pearl oyster culture for over 100 years became the first priorities for concern parties in the area. Cleaning pearl oyster shells generates organic matters furthermore it produces suspended particles, which increase the turbidity. Eventually sufficient amount of light cannot reach the submerged aquatic vegetation.

Dredging the accumulated sediments that is rich with organic matters is one of the important ways to restore the damaged ecosystem. Treatment of the sea bottom sediments was conducted using coagulant made mainly from paper sludge ashes (AGOCLEAN-P). The water content of the dredged sediments was reduced from 90% into 60% by weight after treatment with AGOCLEAN-P.

Usually contaminated dredged material is placed in confined disposal facilities (CDF), but as land development and acquisition costs continue to rise, emphasis is shifting towards utilizing these contaminants. The beneficial use of dredged sediments instead of depositing them could prevent depletion of resources in two ways: natural clay resources would be spared for a longer period of time and stock yards could be used for other productive purposes.

Our aim is to utilize the dredged sediments treated with coagulant made mainly from paper sludge ashes for beneficial applications such as:

- ◆ Replacing the removed natural tidal flats for reclamation purposes by making environmentally friendly artificial tidal flats.
- ◆ Making granular micro-habitat beads for microorganism in order to treat contaminated seawater and polluted sediments.
- ◆ Creating stable surface area rich with nutrients for culturing bivalves, seaweeds and seagrasses since seaweeds and seagrasses provide shelter and feeding grounds for a diverse assemblage of organisms.
- ◆ Manufacturing marine blocks that can be used as reefs in aqua-cultural industry, which can provide a vital habitat for different species.

Paper sludge ashes as coagulant for treating contaminated dredged sediments and its applications for enhancement the coastal biodiversity in Ago Bay, Japan

AAhmed H. A. Dabwan[1], Kiyoyuki Egusa[1,2], Daizo Imai[2,3], Tadaya Kato[1], Satoshi Kaneco[2], Hideyuki Katsumata[2], Tohru Suzuki[4], and Kiyohisa Ohta[2]

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EMECS-8 Shanghai Oct. 27-30, 2008

ARIER (株)あの津技研 *Anotsu Research Institute for Environmental Restoration*

Paper sludge wastes in Japan

- Annual paper and paper board production in Japan about 31 million tons
- Out of 31 million tons paper sludge produced is 1.5 million tons (~5%)
- During treatment about 0.6 million tons of incinerated products are formed (40% of paper sludge)
- Usual way to get rid of these wastes is disposal into the landfill or confined disposal facilities (CDF).
- Suitable methods to utilize this huge amount of paper sludge wastes

Paper sludge ashes → **Inorganic coagulant (AGOCLEAN-P)**

New coagulant and solidification agent

What is AGOCLEAN-P??
AGOCLEAN-P manly made from paper sludge ashes.
When AGOCLEAN-P reacts with water, a needle-like crystals (ettringite) are formed and rapid flocculation occurs for watery and muddy sediments.

Coagulant

Added

Before

After

Coagulant characteristics:
Safe
Cheap
Fast
Easy to apply in the field

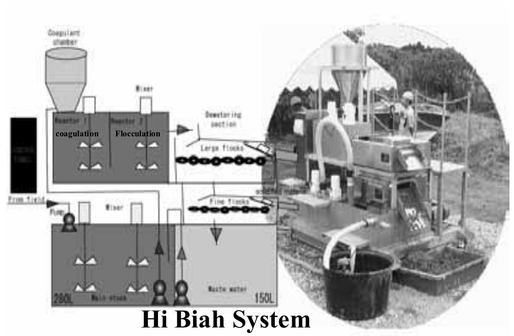
Chemical compositions(%)*

Component	Content (%)
CaO	44.2
SiO_2	26.9
Al_2O_3	12.7
SO_3	12.2
Fe_2O_3	1.2
MgO	1.2
TiO_2	0.8
K_2O	0.4
Others	0.4

*Average values

Dewatering and solidifying process

Separation of water from dredged sediment was carried out by Hi Biah System (HBS)



Hi Biah System (HBS)

Solidified material

Objectives of this work

a) Making artificial tidal flats

b) Creating stable surface areas for culturing seaweeds and sea grasses

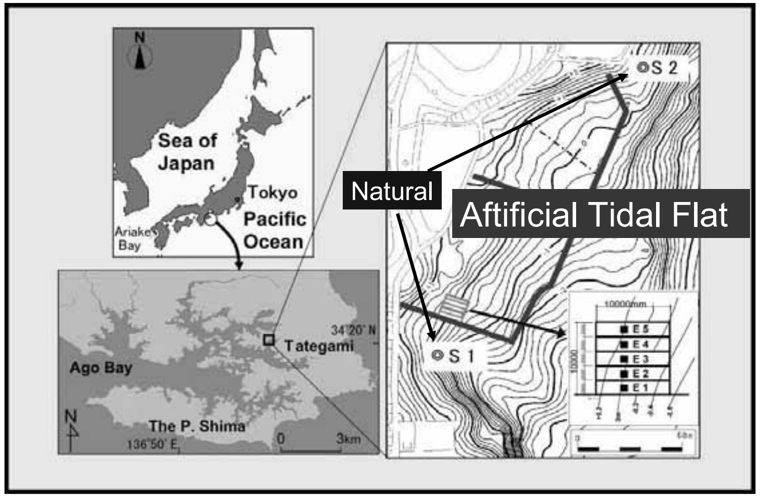
c)Manufacturing marine blocks

d)Making micro-habitat beads for treated contaminated sea bottom sediments

Objectives of this work

a) Making artificial tidal flats

Experimental area



Materials used in this work

Table ... Coagulant and/or hardeners used for preparation the artificial tidal flats in Tategami, Ago Bay, Japan

Dredged sed.	First stage treatment	Obtained materials	Second stage treatment	Flat material	Flat
90% W.C	HBS AGOCLEAN-P 1.5 %	60% WC	-	70% Natural sand 30% treated sediment	E1
	HBS AGOCLEAN-P 1.5%	60% WC	Pelletizer AGOCLEAN-P 20%	70% Natural sand 30% treated sediments (pellets)	E2
	-	-	-	100% Sand only	E3
	HBS GYPSANDER 5%	60% WC	-	70% Natural sand 30% treated sediment	E4
	PAC Filter press 2%	40 % WC	ECORTON 20%	70% Natural sand 30% treated sediment	E5

Physico-chemial parameters

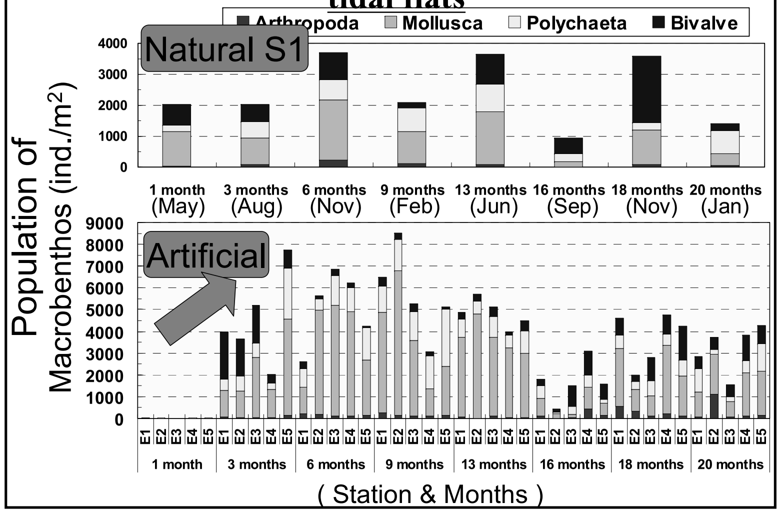
	WC (%)	AVS (mg/g)	LOI (%)	TOC (mg/g)	Muddy fraction <75μm(%)
E1	29.9	0.34	5.2	6.0	30.0
E2	29.6	0.66	4.9	4.5	30.7
E3	22.9	0.16	3.6	2.7	25.9
E4	26.5	0.26	4.8	4.5	24.0
E5	27.3	0.39	5.7	6.3	29.4
S1	45.0	0.47	6.5	8.0	48.6
S2	25.1	0.03	2.7	1.2	20.1

Artificial

Artificial

WC;Water content, AVS;Acid volatile sulphide, LOI;Loss on ignition, TOC;Total organic carbon

Benthos population in the natural and artificial tidal flats



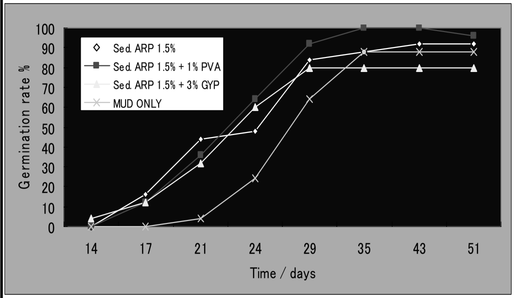
Objectives of this work

b) Creating stable surface areas for culturing seaweeds and sea grasses

Experimental conditions

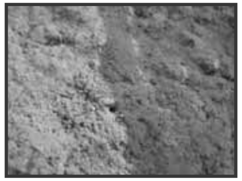
pH	: 8.18
Temperature	: 11.8 ~ 17.1 ^oC
Salinity	: 31.9 PSU
DO	: 10.59 mg/L
Turbidity	: 88 NTU
Concrete tank depth	: 45 ~ 51 cm
Number of seeds in each base	: 25
Light intensity (concrete tank) :	
Surface	1007 μ mole / m^2 / sec
Bottom (50cm)	1943 μ mole / m^2 / sec

b-1-Effect of different hardeners on *Z. marina* growth



Fig… Effect of the hardeners on germination rate

Sample : Dredged sediments treated with 1.5% AGOCLEAN-P



b-2) Filed scale

Dewatering technique (AGOCLEAN-P 1.5%)

Stable base

Treated bases with AGOCLEAN-P into the sea bottom

Results:

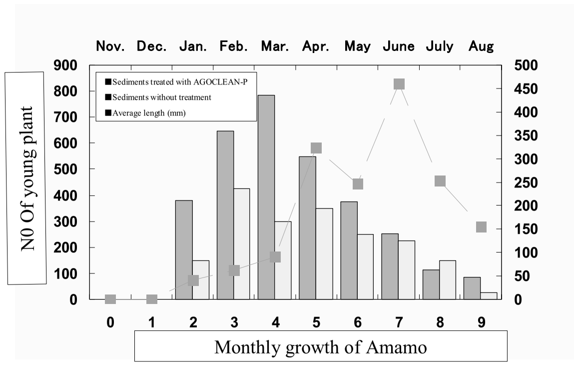


Fig... Monthly growth of *Z. marina* in the bases treated with HBS and natural sea bottom

Objectives of this work

c)Manufacturing marine blocks

Raw materials used for manufacturing marine blocks

No.	C[a]	Sediments	Water added	S[b]	G[c]	Total	Water in sediments[d]	Total water[e]	W/C[f]	AFK-2	EX-50	SSP-104
	Raw material components (kg/m³)									Additive agents (cm³/m³)		
1	420	0	168	759	1045	2392	0	168	0.40	2.8	552	-
2	420	50	168	640	1069	2347	30	198	0.47	2.8	552	-
3	420	100	168	519	1093	2300	60	198	0.53	2.8	552	-
4	420	200	168	248	1174	2210	120	288	0.69	3.3	656	-
5	500	954	0	0	300	1754	572	572	1.14	8.2	1640	-
6	500	1054	0	0	100	1654	632	632	1.26	0	1640	820

[a] cement, [b] fine sand aggregate, [c] coarse aggregate (crushed rocks), [d] water content 60 wt% in sediments, [e] sum of water added and water contained in sediments.
[f] ratio of water to cement by weight.

Table.. Standards experimental methods

Test	Method
Slump	JIS A 1101
Air content	JIS A 1128
Compressive strength	JIS A 1108
Drying shrinkage 20 °C, 60% R.H	JIS A 1129
Concrete temperature	Alcohol thermometer

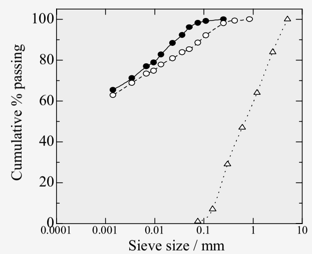
Table.. Materials

Material	Properties
Cement (C)	Ordinary Portland cement; Density: 3.16g/cm³
Water (W)	Density: 1g/cm³
Fine aggregate (S)	Sand: 2.6 g/cm³; F.M.: 2.78
Coarse aggregate (G)	Crushed stones; density: 2.68 g/cm³; Solid content in aggregate: 60%
Dredged sediment treated with 1.5% paper sludge ashes (ARP)	Density: 1.336 g/cm³; Water content: 60%
Chemical admixture	Water reducing agent: EX50
	Antifoaming agent: AFK-2
	High strength concrete and shrinkage reducing agent: SSP-104

Table.. Standards experimental methods

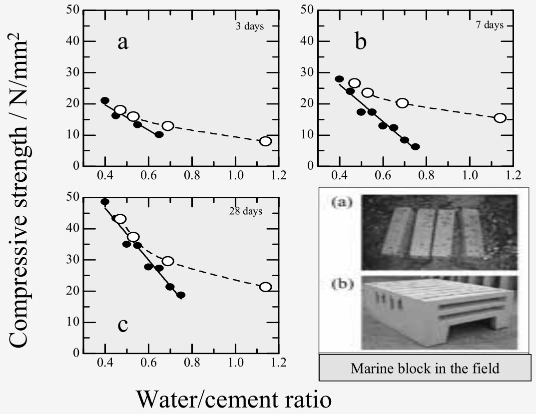
Test	Method
Slump	JIS A 1101
Air content	JIS A 1128
Compressive strength	JIS A 1108
Drying shrinkage 20 °C, 60% R.H	JIS A 1129
Concrete temperature	Alcohol thermometer

Marine block data



Fig…Gradation curves for the original sediments (●), sediments treated with Agoclean-P (○)and the fine sand aggregates for the concrete mixes according to the normal Japanese standard (△).

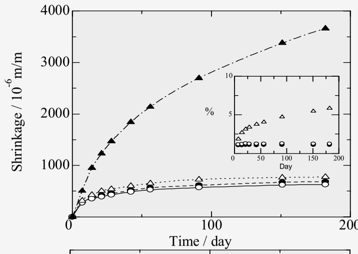
%



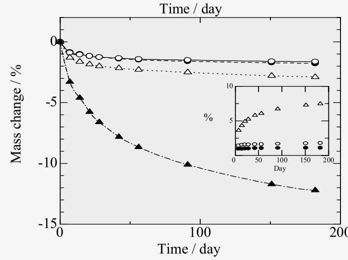
Marine block in the field

Fig…Effect of the ratio of water to cement on the compressive strength of the concrete products. ○; concrete materials with the sediments, ●; normal concrete products. Curing age; (a) 3, (b) 7, and (c) 28 days.

Marine block data



Fig…Effect of the water/cement ratio on the total shrinkage of the concrete products (○); sample No. 1 with w/c 0.40, ●; sample No.2 with w/c 0.47, △; Sample No.4 with w/c 0.69and ▲; Sample No. 5 with w/c 1.15. The insert figure shows the ratio of the total shrinkage of the concrete materials with the sediments to the total shrinkage of the normal concrete (Sample No.1) In the insert figure, ●; Sample No. 2, ○; Sample No. 4 and △; Sample No.5.



Fig…Effect of the water/cement ratio on the mass change of the concrete products (○); sample No. 1 with w/c 0.40, ●; sample No.2 with w/c 0.47, △; Sample No.4 with w/c 0.69and ▲; Sample No. 5 with w/c 1.15. The insert figure shows the ratio of mass loss of the concrete materials with the sediments to the mass loss of the normal concrete (Sample No.1) In the insert figure, ●; Sample No. 2, ○; Sample No. 4 and △; Sample No.5.

In the field

Marine block with Solidified materials

(Nov. 2007, after 8 months)

- Many sea grasses were noticed in the surface.

Objectives of this work

d)Making micro-habitat beads for treated contaminated sea bottom sediments

Experimental conditions

Strain	: *Sc51*, CFU 10^9~10^{10} / g (denitrification strain)
Incubation temperature	: 25°C
pH	: 7.5
Culture media	: Polypeptone, extract yeast (dried)
Cultivation time	: 72 hrs
Sample solution	: 170 ml, seawater contained NO_3^--N
Carrier	: Dredged sediments; room temperature; 5g
Experiential time	: 48hrs
Instrument	: Continuous flow analyzer; Standard
colorimetric	techniques TRAACS-2000; Bran+Luebbe)

Micro-habitat pellets

Fig…Micro-habitat pellets made from dredged sediments treated with AGOCLEAN-P (1.5%)

Nitrogen concentration profiles (carriers without washing after media immobilized)

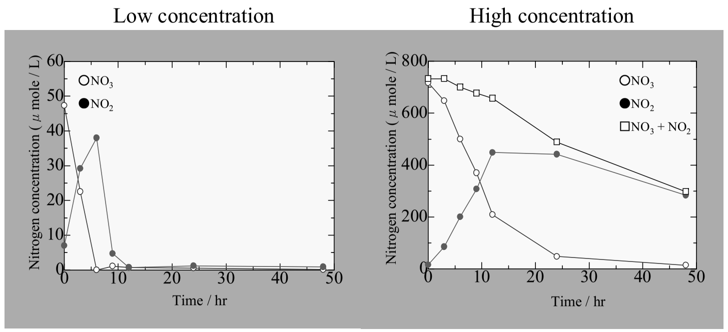


Fig.. Nitrogen concentration profile in the microbial denitrification.

sample : NO_3^- ion in seawater
Carrier : dredged sediments treated with AGOCLEAN-P 1.5%, natural drying

Denitrification mechanism

$$\boxed{NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2}$$

NO_3^- is used as a terminal e^- acceptor (or as oxygen source) and it is reduced to N_2 (through NO_2^-, NO and N_2O). This process is called denitrification. In order to perform this process a supply of organic matter and anaerobic conditions are needed, and it is temperature dependent.

Other prospective areas:

1. Food industry
2. Construction applications
3. Microelectronics
4. Paint industry

- Food processing in general produces wastes that is degradable and non-toxic. However, these wastes have high concentration of high bio-chemcial oxygen demand (BOD) and high level of dissolved and/or suspended solids that need months for complete settling.

Wastewater treatment technology

The technology related to different industrial wastes treatment could be divided into three general categories:

1. Physical Methods; Solid liquid separation techniques (filtration)
2. Chemical Methods, application of chemicals that either aid in the separation of contaminants from water, or assist in the destruction, or neutralization of harmful effects associated with contaminants(coagulation, etc. our target)
3. Energy Intensive Methods (sterilization).

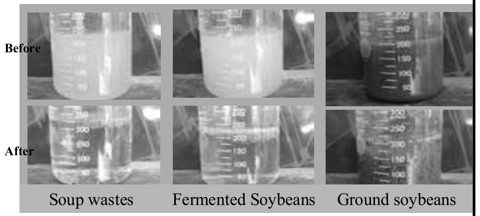
Treatment technology

Since the principal step in any treatment process is the concentration of tiny particles (nano-size level) followed by solid-liquid separation, fully automated, compact size, and efficient system called Hi Biah System (HBS) was developed in our institute to perform the following tasks;
(1) sludge concentration,
(2) sludge separation,
(3) sludge handling and disposal (beneficial applications).

Our aim is to introduce closed loop clean technology in order to achieve zero emission

Other prospective areas:

Food industry
a- Soup manufacturing wastes
b- Fermented soybeans (Natto)
c- Ground soybeans (toufu)



Results:

All units in mg/L (PPM), except pH.

Sample		*T.N*	*T.P*	*COD*	*BOD_5*	*SS*	*pH*
Soup	**Before**	**80**	**39**	**1100**	**600**	**-**	**4-5**
	After	**18**	**<1**	**120**	**16**	**<100**	**8.5**
Toufu	**Before**	**100**	**52**	**2100**	**1100**	**8000**	**4-5**
	After	**5**	**<1**	**170**	**92**	**<100**	**8.5**
Natto	**Before**	**30**	**27**	**1500**	**660**	**-**	**5-6**
	After	**19**	**2.6**	**180**	**100**	**-**	**8.5**

Other prospective areas:

Construction applications

600m^3 of dredged sediments

Ago-P ~5 %

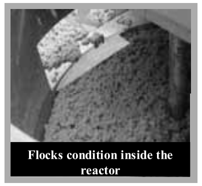
After treatment

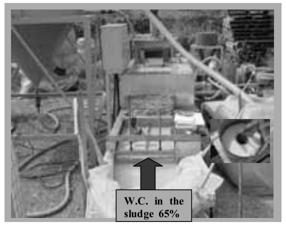
Results:

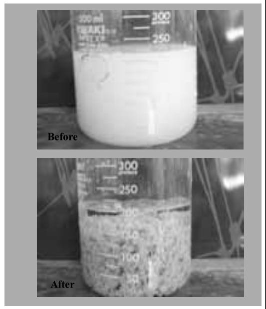
Sample		W.C(%)
Dredged sediment	Before	70-80
	After	40%

Other prospective areas:

Microelectronics







Results:

All units in mg/L (PPM), except pH.

Sample		T.N	T.P	COD	BOD	SS	pH
①	**Before**	**8**	**<1**	**<20**	**14**	**18,000**	**11-12**
	after	**8**	**<1**	**<20**	**12**	**<100**	**11-12**

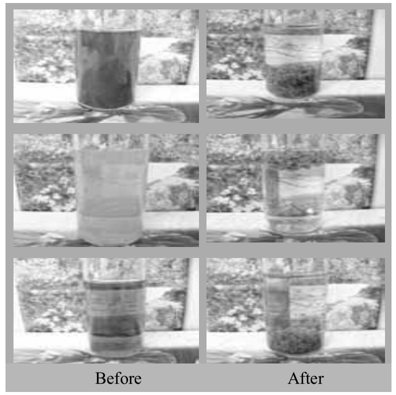
Other prospective areas:

Paint, ink & dye industries

Results:

All units in mg/L (PPM)

Sample		COD	S.S.
Paint	Before	>1000	Nano-size
	After	<100	<20
Ink	Before	>1000	Nano-size
	After	<100	<20
Dye	Before	>2000	Nano-size
	After	<100	<20



Conclusion

By using HI BIAH SYSTEM we could reduce the water content in the dredged sediments from 90% to 60% . Agoclean-P was used as coagulant.

The treated sediments were used for three main applications:

a) Bases for *Z. marina* germination

- Sediments treated with paper sludge wastes and mixed with different hardeners show higher and faster germination rate for *Z. marina* compared to the sediment only.
- Sand optimum ratio is 30%, since other ratios (10, 50 & 70%), give lower leaf areas.
- Although bases made from mud only show high germination rate, the times was delayed for almost one week.

Conclusion

b) Pellets as micro-habitat carrier

- Pellets made from dredged sediment treated with paper sludge ashes show its possibility to be used as a suitable carriers for bacterial immobilization
- SEM data clearly show that pellets cavities range between 1~5 µm, whereas bacteria size about 1µm which means suitable habitats for the Sc51 strain, therefore high removal efficiency was obtained.
- Over 80% removal efficiency was achieved for the pellets sintered at 300°C, presumably due to the cleavage of the chemical organic bonds (mainly humic substances).
- For the samples treated at 800°C removal efficiency was the lowest, this could be referred to the lack of carbon at high temperature. Organic carbon is needed for denitrification bacteria.

Conclusion

c) Marine block manufacturing

Based on the data obtained from this study, the following conclusions can be drawn:

- Since, dredged sediment contains high chloride content besides other organic matters, the applications could be directed towards making concrete to be used for marine blocks production rather than buildings and other reinforced concrete application. In aqua-cultural industry blocks are used as fishery habitats in large quantities.
- High W/C (>1) causes significant change in compressive strength, shrinkage and change in the mass values due to the extra water.
- Mixing was difficult when low content of coarse aggregate was added (run 6). So suitable amount of coarse aggregate is necessary in order to get reasonable strength.
- When W/C ratio was higher than 1, the air content was high by almost 2 times, the slump was lower than ordinary concrete therefore, mixing was difficult.

Restoration of eelgrass (Zostera marina L.) bed by filling up a borrow pit with natural sediment

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The objective of this study is to evaluate restoration technology of eelgrass (Zostera marina L.) bed by filling up borrow pit by the coast of Iwakuni, the Seto Inland Sea, Japan. We constructed eelgrass habitat at the edge of a previous borrow pit within eelgrass bed by filling up with natural sediment. We monitored sand movement, underwater irradiance and eelgrass shoot density at the constructed and natural habitats. Sand movement at the constructed habitat was from -8 cm to 9 cm showing little difference from that of natural habitats. The daily averaged underwater irradiance at the constructed habitat was more than 3 mol photons・m-2・day-1 necessary for eelgrass. Eelgrass disappeared after typhoon attacks in 2004-2006, whereas seedlings of eelgrass appeared both at the constructed and natural habitats every winter. These results suggest that restoration of eelgrass habitat by filling up borrow pit is a useful technique for eelgrass bed restoration.

5 Poster Session

Appendix

Proper management of fishery resources using a bivalve growth model which included fishery catch and feeding damage

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Ariake Bay, which is one of the most prominent fishing grounds, is located in southwest Japan. The area is about 1700 km2 with a tidal flat of about 190 km2. Since the 1980’s, fishery catch has decreased year by year. Among the suspected causes of the decrease, there are outbreaks of red tide, rise of water temperature, excessive fishery pressure and feeding damage by predators. Especially, as a cause of the feeding damage, it is reported that longheaded eagle rays (Aetobatus flagellum) have been seen in Ariake Bay since the 1990's, and prey on large amounts of bivalves. The eagle ray is more than 1 m in body width and 10 kg in weight. In Ariake Bay, a large number of rays appear in April and disappear in December. In this study, a simple numerical simulation model based on the bivalve growth considering fishery catch and feeding by the rays is developed and applied to assist with the proper management of fishery and extermination of predators.

The growth of bivalves is simulated as a function of water temperature. The quantity of natural resources of the bivalves is calculated by multipling recent population density by habitation area. The fishery catch is estimated by summing up values of monthly catch from statistical reports. Monthly catch amount is more than 500,000 tons in the big catch years and equal to or less than 10,000 tons in the poor catch years. The biomass of the ray is estimated to be more than 3,000 tons based on the amount of capture for extermination. The daily amount of predation on bivalves by the rays is calculated to be 1% of the biomass during the appearance period.

As a result of this simulation, the bivalve resources varied according to the biomass of the rays. It was indicated that the predation pressure by the rays could be a serious factor affecting bivalve resources. With the big catch amount of the past years, the bivalve biomass of recent years was entirely consumed causing the exhaustion of the bivalve. It clearly explains that the current bivalve resources cannot support the same amount of

fishing as in the past. Under the conditions of both predations of the ray and past fishery catch, bivalve resources were diminished. To maintain the resources with this predation and catch, a biomass 4 times larger than recent bivalve populations is required. Our simulation model has revealed that it is important to decrease the feeding damage and to manage the fishery catch properly to maintain the bivalve resources.

Monitoring of macrobenthos and bivalve for biologically productive artificial tidal flats, Ago Bay, Japan

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Ago Bay in Japan is a typical enclosed coastal sea, which is connected to the Pacific Ocean through a very narrow and shallow entrance. The bay has been extremely contaminated by the practice of culturing pearls, which has been ongoing for the past 110 years. Because sediment eutrophication, oxygen deficient water and harmful algal blooms have occurred in recent years, the pearl culture industries were damaged. To address this problem, many attempts are being tried in order to improve the natural self-cleaning capability in the bay region by forming artificial tidal flat, shallow water area and sea algae and/or sea-grass bed inside the bay. To clean up the dredged sediments accumulated at the bottom of the sea, where the contamination is progressive, we are exploring the technologies to decompose the organic materials. This new technology—the Hi-Biah-System (HBS)—was developed in 2005. This system could dewater muddy dredged sediments and coagulate them to the solidified sea bottom sediments for constructing an artificial tidal flat.

The purpose of this study was to evaluate the environmental conditions of the constructed tidal flat over two years after it was built. We monitored the biological characteristics (restoration of macrobenthos and growth of bivalve) and physico-chemical parameters (oxidation-reduction potential, acid volatile sulphide, loss on ignition, water content, total organic carbon, total nitrogen, chlorophyll a, and particle size) for five types of constructed tidal flats and a natural tidal flat. At the same tidal situation, the physico-chemical parameters were almost similar among the five constructed and natural tidal flats. However, the biomass and macrobenthic population in the constructed flats was higher compared to the natural one. Moreover, it was observed that the results for the young short-necked clam indicated remarkably larger growth in the artificial tidal flat relative to that obtained in the natural one. From this result, it was supported that the muddy solidified sea bottom sediments were very effective for the excellent growth of the young clams. These observations may be considered to be attributable to the minerals which were supplied from the solidified sea bottom sediments. These solidified materials would give the good ecological conditions to benthic animals. The muddy dredged sediments generated by the HBS could provide useful materials for enhancing the productivity of the tidal coast in order to create new environment.

The present study is a part of the Ago Bay Environmental Restoration Project under the program of Japan Science and Technology Agency.

Nutrients, organic carbon and oxygen budget in semi-enclosed Ago Bay, Japan

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Ago Bay is a small semi-enclosed coastal water body of Japan and is well known as the birth place of the pearl culture. The culture began about a century ago and the production reached a peak point about 40 years ago. Since then, the production has declined and the present production had fallen down to the one fifth of its peak point. The deterioration of the marine environment has become serious in recent years, but it is unclear whether the long usage of the water body by the culture is the cause. The sediment quality in terms of COD at the bay head area has increased and had exceeded far the local regulation limit. The settlement of hypoxic water mass in the bay head area continues during warm season, every year.

Mie Prefecture, which is the local government, had conducted the corresponding research project called CREATE for five years. The outline of the project was presented on the EMECS 7 conference1) to 4). This article reports a conclusive result for the material budget around the bay. Nutrients, organic carbon and oxygen are the materials of subject, since the cause of the environmental deterioration was presumed to relate to the change of organic matter pathway in the bay.

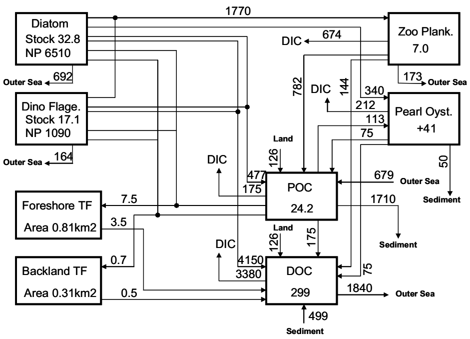
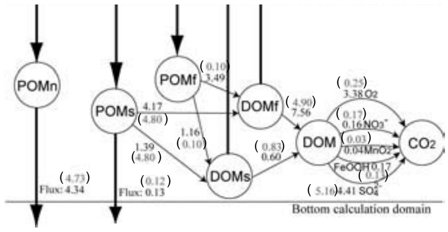


Fig.1 Yearly budget of organic carbon in the entire bay (ton year^{-1}); the data is the sum of the transport, production and consumption. TF means tidal flat

The data for standing stock, flux and reaction rate of regarding materials were gathered by the extensive observations and the laboratory experiments performed during the project. Then, these data were utilized to set up numerical models, which played a role to produce data for material budget. The models consist of the catchments area model, the hydrodynamic model of seawater, the pelagic water quality model and the sedimentation model. Many features of the material flow in the bay were disclosed through the analysis. An important result is that the contribution of organic matter load to the seabed by the pearl cultivation was quantified. Fig.1 shows the Particulate Organic Carbon (POC) depositioning flux from the pearl oyster is 50 ton yr-1 which corresponds to only 3% of total POC depositioning flux. This result, therefore, changes our view of the deterioration process of the sediment in the shell cultivating sea area. Fig.2 shows Organic Carbon (OC) budget in the sediment, which brought us the information about the degradation pathway for OC in the sediment at the different location in the bay. We will show comprehensive results for material budget of Ago Bay in the conference, including some results for evaluation of the future restoration activity.

Fig.2 Yearly budget of organic carbon in the sediment (mmol m^{-2} day^{-1}); the values with parenthesis are for the bay center area and those without parenthesis are for the bay head area, respectively



References for EMECS 7; 1) S.Chiba, Session 1-7, 2) Anggara Kasih, Session 1-8, 3) T.Kato, Session 3-4, 4) S.Chiba, Session 3-5

Evaluation of restoration effect in the coastal unused reclaimed area by promoting sea water exchange in Ago Bay, Mie Prefecture, Japan

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Ago Bay is located in Ise-Shima National Park, Mie prefecture, Central Japan. This bay is famous for cradle of the pearl culture and it has been continued for more than 100 years. However, harmful algal blooms and infectious diseases make the pearl oyster culture for whole year difficult. Furthermore, sediment eutrophication and frequent occurrence of oxygen-deficient water has caused the deterioration of benthic ecosystem and decrease of biological productivity in recent years. It is considered that one of the major causes of these phenomena is stagnation of the material circulation by reclamation of shallow coastal area including a tidal flat, sea glass and sea weed beds. The reclaimed coastal areas were made clear by the multi-spectrum aerial picture analysis. In detail, more than 50 years ago approximately 70% of tidal flats and shallow area were reclaimed for constructing rice fields in Ago Bay. But now these reclaimed areas are given up cultivation and changing the unused wetland. Therefore, for environmental restoration of Ago Bay, it is necessary to enhance the biological productivity and natural purification capacity which these areas provided, and to recover a smooth material circulation around the shallow area. Then in this study, attempts were made to enhance the biological productivity, by promoting water exchange between unused reclaimed area and outer sea using pumps, pipeline system was set up in an experimental reclaimed wetland. Improvements were evaluated by monitoring sediment quality, benthic abundance and species diversity every season.

1) Present state in unused reclaimed area

The total reclaimed areas are about 185 ha, however almost of these areas were given up cultivation and changed hypertrophic unused wetland in Ago Bay. Such areas add up to about 153 ha. The sediment of unused wetlands are too muddy and contain high organic matter, because the dykes which were constructing for reclamation, lead to accumulation of the nutrient and organic matter run off from the land. In these wetlands, the abundance and diversity of benthos are quite poor.

2) Seasonal changes of the sediment quality, abundance and species diversity of benthos in experimental field by promoting the water exchange

The sediment samples from experimental field with promoting water exchange and natural tidal flat in front of the reclaimed areas were measured for COD, TOC, TN, IL, AVS, particle size, chl.a and benthic abundance and species were counted every season for 2 years. Now these monitoring are continuing. Before water exchange, sediment was hypertrophic and anaerobic state. Capitella sp. and Chironomidae were dominant species, because wetland was brackish. And more both wet weight and diversity were quite small. After water exchange, the macrobenthos were changed from brackish to sea water. The diversity and wet weight were gradually increased and after two years they became same level of the natural tidal flat in front of the reclaimed area. The COD and AVS in sediment were decreased too. These results indicate that the sediment statuses in wetland were gradually changed to the aerobic condition by promoting the decomposition of the hypertrophic sediment under the water exchange. Continuous water exchange would provide enhancement of the biological productivity. This method would lead to wise use of the coastal environment and enhance the biological productivity around the unused reclaimed areas.

Approach to improve nutrient situation in the Seto Inland Sea, Japan

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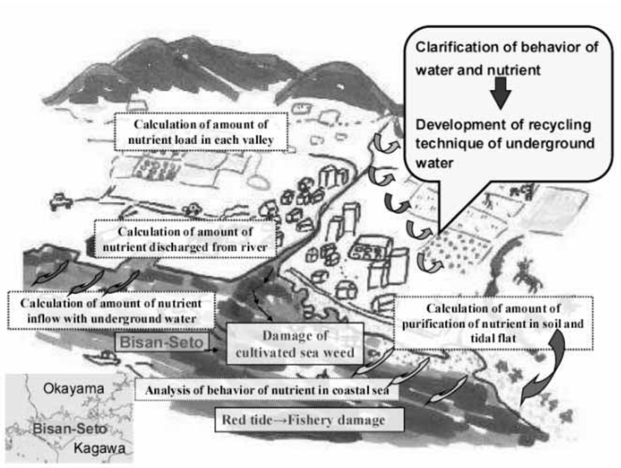
The nutrient load from the land influences the nutrient concentration in enclosed coastal sea. On the other hand, even if the fishery damage that the nutrient state relates is caused, it is difficult to solve such problems, because extent where the nutrient load from the land influences the sea area water quality is not revealed yet. Then, in Bisan-Seto (central area of the Seto Inland Sea), a research project is started to clarify the behavior of the nutrient from the source (land) to coastal sea consistently. In this project, we are trying to specify the region where the possibility that the fishery damage occurs is high. And, by recycling underground water, we are aiming at technological development to decrease the nutrient concentration of the underground water at the farmland that is the nutrient source. This time, the outline of this project and the characteristics of Bisan-Seto are explained.

1. Outline of this research

This study project is composed of the item chiefly shown as follows, and shows the image in Figure1.



1)Calculation of behavior of nutrient that discharged from river and underground.
2)Calculation of amount of nutrient purified in soil and tidal flat.
3)Presumption of behavior of nutrient in coastal sea.
4)Development of recycling technique of nutrient contained in underground water in farmland

2. Characteristic of Bisan-Seto

In order to clarify the characteristic of Bisan-Seto, we analyze the water quality data observed by Kagawa Prefecture and Okayama Prefecture. And using these data, numerical model experiments are carried out to calculate water flow field. As a result, the following fact was clarified.

1)The stratification doesn't develop enough even in summer, because tidal current is strong.
2)The nutrient concentration is usually low, except near the shore.
3)The nutrient concentration reaches the maximum value in autumn, though the cause cannot be clarified.
4)Because the stratification doesn't develop in summer, the seasonal variation of residual current is not found except around river mouth.

Nutrients transfer between the sea and artificially enclosed waters

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Ago-Bay has several enclosed water bodies surrounded by concrete dykes which were artificially constructed for rice cultivation, and almost of the nutrients from the land flow down to the sea through these enclosed waters. In order to estimate the amount of nutrients discharged into the sea, evaluation of the waters enacting on the nutrients flow is regarded very important. Therefore, the nutrients flowing into the Ishibuchi-pond and Tateishi-pond have investigated in this study.

Area of Ishibuchi-pond is estimated to be ca. 15000 m2, and the bottom sediments in this area are in extremely anaerobic condition. Tateishi-pond has no river flowing into them, and surrounded by natural forest. The total area of the Tateishi-pond is estimated to be 850 m2 at the low-tide (0 cm to 30 cm above sea level), and ca. 2000 m2 at the high-tide (higher than 30 cm above sea level). Few benthos and shells inhabit the area.

In investigation of Ishibuchi-pond, survey was conducted at the water gate of the dyke and the mouth of the river flowing into the pond (two points). Tateishi-pond, survey was also conducted at the water gate. The measurements were carried out during spring-tide 2 or 3 days consecutively.

Usually sea is alternating high-tide and low-tide twice in a day, however contrary to this, the water level in the pond was witnessed to have high-tide and low-tide only once a day. Furthermore, a time lag of ca. 3 h was recorded between the high tide in the pond and that observed in the outer sea. However, the time lag was only ca. 30 minutes in case of low tides in the pond and outer sea. It was considered that the water gate has a kind of structure of check valve, which is hindering the up-flow from the sea. The sea level fluctuates from spring tide to neap tide in two weeks. As may be expected, while moving from neap tide to the spring tide, usually sea water levels become higher at the high tide, and lower at the low-tide. Contrary to this, although water level in the pond on the same occasion becomes lower at the low-tide, it tends to remain/become lower at the high-tide as well. This phenomenon is regarded as an influence of the structure of the water gate which is hindering the water flow from the sea.

Regarding outflow and inflow of T-N and T-P between the outer sea and the waters, no significant difference was observed in Tateishi-pond, however, the outflow of T-N and

T-P to the sea in case of Ishibuchi–pond was bigger than the inflow from the sea. So far, it has been presumed that the amount of nitrogen and phosphorus will be reduced by the processes like sedimentation and/or de-nitrification in the pond, however, results from the present study do not support this hypothesis. However, survey time in our investigation was rather limited, and therefore, much more accumulation of the data over a longer period is require.

Possible bottom-up control of fisheries production in the Seto Inland Sea, Japan

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In recent decades, anthropogenic nutrient discharges into the Seto Inland Sea of Japan have reduced as a result of a set of measures for environmental conservation. On the other hand, several fish catches and/or stocks have collapsed in this area. Shifts in seawater quality and fisheries landings were accompanied by modifications in structure of marine communities. Alteration of resource availability represents a "bottom-up" effect on marine ecosystems, whereas removal of consumer biomass through fishing represents a "top-down" effect. Therefore, an understanding of how bottom-up and top-down processes influence the structure and dynamics of marine communities is necessary for effective management of fisheries production and marine ecosystems in the face of environmental variability and human impacts. In this study, we addressed the question of bottom-up versus top-down control of marine ecosystem trophic interactions by using long-term nutrients and phytoplankton biomass data and annual fish catch data (1973 – 2005) in Harima-Nada, located in the eastern part of the Seto Inland Sea of Japan. Linear regression model showed a significant relationship between dissolved inorganic nitrogen concentration and phytoplankton biomass (chlorophyll a concentration) for the period 1991 to 2005. A positive relationship was also found between mean annual phytoplankton biomass and annual yield of pelagic plankton feeders for the same period. These results demonstrate close linkages between nutrients (especially dissolved inorganic nitrogen), phytoplankton, and pelagic plankton-feeding fishes, suggesting that bottom-up control regulates fisheries production in Harima-Nada during recent decades. Our findings have

also an important bearing for ecosystem approaches to fisheries, particularly for the estimation of the carrying capacity with regard to sustainable exploitation.

Evaluation on Pb contamination in algae in Osaka Bay, Japan

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Heavy metal concentrations of the brown alga Undaria pinnatifida and the green alga Ulva sp. collected at 15 and 6 locations, respectively, from Osaka Bay are measured with inductively coupled plasma mass spectrometry (ICP-MS). The data are compared in order to evaluate the usefulness of a biomonitoring system for assessing the geographic distribution of heavy metals in coastal seawaters.

The ports of Osaka Bay are located on the N side coast (e.g., Kobe Port, Osaka Port) and the SE side coast (fishing ports). In contrast, Awaji Island, on the SW side of the bay has a natural coast. We believe the port areas receive contamination from anthropogenic sources such as shipping activities. Undaria from Kobe Port, a major industrial port, show extremely high Pb concentrations (3.5±0.27 ppm, dry weight) and those from the SE area are relatively high (0.43—1.4 ppm, dry weight), while those from the SW area are low (0.14—0.36 ppm, dry weight). Geographical variation in Pb concentrations of Ulva in the bay is different from that of Undaria. The Pb concentrations in Ulva from the SE area show a variance of between 0.29 and 1.71 ppm (dry weight). These concentrations are lower than those in the SW area (2.28—2.69 ppm, dry weight), although shipping activity in the latter is much less extensive. The sources of Pb contaminations in Undaria and Ulva are further investigated by Pb isotopic data and a factor analysis for heavy metal components (Cr, Mn, Cu, Zn, Cd, Pb) in Undaria.

Lead isotopic data for Undaria from two port localities, and two non-port localities and Ulva from one port locality and one non-port locality are acquired by thermal ionization mass spectrometry (TIMS). 206Pb/207Pb values in Undaria from non-port areas (Yura and Ikuho) are 1.1576 and 1.1638, respectively. These values are very similar to those in Ulva from port (Tarui) and non-port (Yura) areas: 1.1574 and 1.1649, respectively. However, Undaria from port areas (Kobe Port and Tarui) show 206Pb/207Pb ratios from 1.1372 to 1.1522, which are much lower ratios than those from non-port areas, suggesting that Undaria from port areas and non- port areas receive Pb from various sources and that Ulva and Undaria can maintain different Pb isotopic ratios in the same habitat. With the exception of one sample from Tarui, 206Pb/207Pb values in Undaria and Ulva (1.1486—1.1696) were similar to the ratios in the coastal seawater in Japan (Miyazaki and Reimer, 1993); however 208Pb/204Pb ratios in the latter are much lower (34.85—37.57) compared with the current report. Plots of 208Pb/206Pb versus 207Pb/206Pb ratios appeared to overlap with the field of airborne particulate in Osaka City (Osaka City, 2007) and those ratios in most specimens overlap with the field of road runoff in Osaka City (Osaka City, 2007).

Two significant factors accounting for about 77% of the variance were distinguished for the analyzed data. The first factor was characterized by high levels of Pb and Cu and the second factor was high level of Mn. Those scores of river water contaminated from road runoff (Osaka Pref, 2004) in the first and second factors differ greatly from those of Undaria. Those scores of Undaria from Amagasaki, where is near an abandoned industrial area and a sewage plant, corresponded closely to those from the SE area.

These observations suggest that 208Pb/206Pb and 207Pb/206Pb ratios in the algae from the areas affected by human activities in Osaka Bay are lower than those from the natural area and are controlled by mixing processes involving various components including sewage water and seawater rather than one source such as road runoff.

Durability of sand capping effect in the inner area of Ariake Bay

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The sand capping method appears to be useful for improving the environment of bottom sediment in the inner area of the Ariake Sea. It is usually thought that its effect becomes dull in only a few years. The present study investigates the secular change of the bottom sediment environment in sand capped sections, which were constructed by Saga Prefecture from 2001 to 2003. The relation between the habitation of benthos and the grain size distribution was investigated.

Sediment sampling was conducted in nine sand capped sections for evaluating the profile of sediment environment in 2005 and 2006 and in three sections for investigating benthos in 2007. Sediment column was taken with an acryl pipe. Three column samples were taken from each section, two samples were taken inside and one sample was taken outside a section. A sediment column was divided into pieces of 5 cm thick. The grain size distribution of each piece was examined with sieves. A surface sediment sample was taken using an Ekman-Birge type bottom sampler and put through a screen of 1mm meshes. The residue was fixed with 10 % formalin solution and benthic organisms were sorted, identified and weighed.

The ratio of fine sand (0.075-0.25 mm) of the surface sediment (0-0.05 m) increased from 2005 to 2006 at most of sections. The apparent change in grain size distribution might be occurred owing to huge disturbance of sea water caused by the typhoon (T0514) which crossed the Ariake Sea on September 6 in 2005. The effect of sand capping on grain size distribution was recognized except for section SW01, in which the ratio of sand ranged 0.075-2 mm was larger from the surface to deeper layer for capped and non-capped point, i.e. outside the section. Species, population and weight of benthos at sand capped point were obviously larger than non-capped point in NE02 and NE03.

The improvement of the bay environment recorded in a sediment core at Asou Bay in the Tsushima Island, southwestern Japan

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The Tsushima Island is located between the Japanese Islands and the Korean Peninsula, eastern Asia. Asou Bay is present in the middle part of the Tsushima Island. The bay opens to the west and is connected to Miura Bay on the east through the Manzeki-seto Strait, which is an artificial strait and was constructed by the Imperial Japanese Navy in 1900. At that time, the strait was 40 m wide and 4.5 m deep. Afterward, it was extended and dredged in 1975 (width: 40m, depth: 4.5m). We collected a sediment core 18 cm thick in the inner part of Asou Bay (34° 18.069’ N, 129° 20.869’ E, 16 m in water depth). The core was sliced in 5 mm thick, and 36 samples were obtained. We conducted several analyses to reconstruct the temporal changes of depositional environments; gamma spectrometry (210Pb and 137Cs) analysis, CHN (total organic carbon (TOC) and total nitrogen (TN)) analysis, grain size analysis and meiobenthos (Crustacea: Ostracoda) analysis.

As a result, the sedimentation rate based on 210Pb and 137Cs dating was 0.11 cm/year. Therefore, the estimated age for 18 cm level is about 150 years. The C/N ratio is constant before the 1900s and afterward it has decreased up to the recent. Before the 1980s, grain size was constant, but it became coarser gradually after 1980s.

The result from the ostracode analysis reveals that the construction and extension of the Manzeki-seto Strait have influenced the distribution and composition of ostracode assemblages around the inner part of Asou Bay. Before the 1900s, Bicornucythere bisanensis, which lives in oxygen-poor bottoms, was abundant. On the other hand Nipponocythere bicarinata, which cannot tolerate anoxic or oxygen-poor bottoms, was rare. Between the 1900s and 1970s, B. bisanensis decreased although N. bicarinata increased gradually. Since the 1970s, there are no significant changes of the species composition of ostracode assemblages, but the total number of individuals has increased up to the present.

Thus, seasonal hypoxia was developed in the study site before the 1900s. The construction and extension of the Manzeki-seto Strait, however, have promoted the inflow of oxygen-rich waters from open seas and have improved the environment in the inner part of Asou Bay.

THE PROJECT FOR ESTABLISHMENT OF A MONITORING SYSTEM AND CONTINUAL UTILIZATION OF FISHING GROUND IN THE BAYS OF PARANA COASTAL AREA, BRAZIL

The team for the environmental technology exchange in Hyogo and Parana
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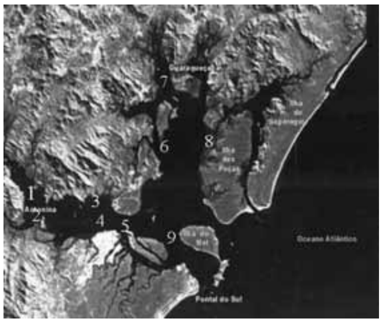

<u>Background to environmental technology exchange</u>

Paranagua Bay is located in Parana State in the south of Brazil. The bay covers an area of 612 km2 and is a classic shallow enclosed coastal sea that is prone to environmental degradation. The bay can be generally divided into two parts: a southern part with an international port city, and a northern part with a national nature preserve that marks the southernmost point of the Atlantic rain forest.

Mangrove forests also have a considerable area, there is a leading port, in one side which is also many citizens' resort, culture of a shrimp, a crab, an oyster, etc. is also carried out and various use is carried out in the inside of the bay. However, the common problem in enclosed coastal area is discovered, due to increased pollution load resulting from the centralization of population, development and so on in coastal zones in recent years and the loss of natural ecosystems and so on, environmental preservation in the bay has become a pressing issue.

1. Construction of the project by a JICA technical cooperation

JICA assistance was obtained in 2004 and 2006 - 2008 for these efforts as a grass-roots technical cooperation project aimed at building monitoring systems in Paranagua Bay. The project was conducted jointly by the Hyogo Environmental Advancement Association and relevant organizations in Brazil.

The program will be executed in cooperation by the following institutions from Brazil and Japan: Hyogo Environmental Advancement Association, Kobe University Research Center for Inland Seas, Hyogo Prefectural Technology Center for Agriculture, Forestry and Fishieries, Department of Marine Bioscience, Faculty of Biotechnology, Fukui Prefectural University, CEM/UFPR, IBAMA, IAP, SEMA and PUC/PR.

2. Composition of a project

The project framework can be generally divided into two parts. One is a long-term program in which trainees from Brazil are accepted and training is conducted by the Japanese side, primarily in ocean monitoring technologies. The other involves the dispatch of specialists from Japan to Brazil to work with related personnel on the Brazil side in studying the water quality in Paranagua Bay, the environment of fishing grounds, the approach to biological monitoring and the methods that should be used and so on.

3. Future sustainable efforts and approaches

Beginning in 2006 the Brazil side created an alliance of entities that would conduct monitoring, and also established a venue for coordination and pursued organizational efforts. Subsequently, the Brazil side personnel worked with the Japanese side to form monitoring teams in each area (water quality, fishing ground environments and biology), implement joint monitoring, create a website and so on. These model efforts were conducted on an autonomous and independent basis and were widely praised both at home and abroad.

This project has been conducted since FY 2006 with the goal of achieving long-term monitoring in Paranagua Bay, and in this final year the framework, personnel organization for promoting monitoring and construction of processes will be made even more robust to help preserve the environment of Paranagua Bay.

Up-to-date technology for treatment watery sediments

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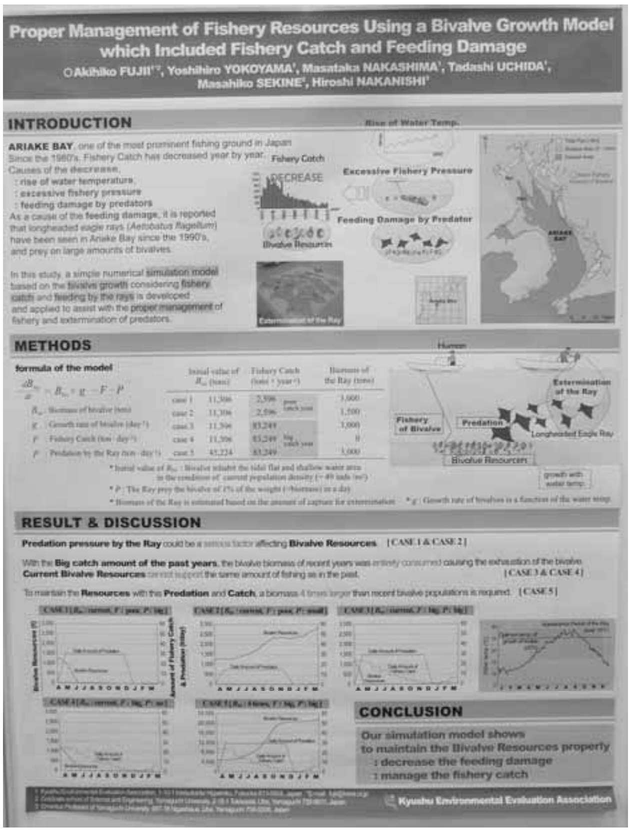
The Project of Environmental Restoration of Enclosed Coastal Seas in Agobay of Mie Prefecture in Japan was carried out by a group of collaborative researchers assigned by Japan Science and Technology Agency for five years since 2003. This project deals with efforts to clean up the deteriorated sediments that are accumulated at the bottom of the sea. Agobay is known as the starting bay on the culture of pearl oysters by Mr. Kokichi Mikimoto and has been contaminated in the continuation of pearl culture spanning 110 years. Attempts are in order to enhance the self-cleaning capability of the natural water in the bay by using the many kinds of artificial restoration technologies, that is, dredging engineering, re-forming artificial tidal lands and seaweed beds.

As one of the innovated investigation results, new technologies for dewatering and solidification of the dredged sediments were developed by the original coagulant, named ‘AGOCLEAN-P’, which was made of paper sludge ashes wastes and/or coal ashes as raw materials.

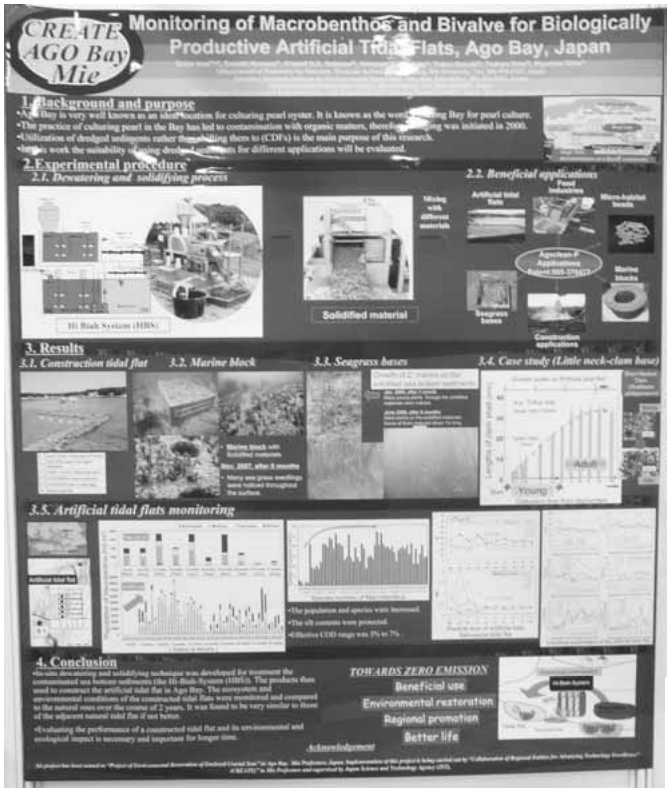
The coagulating mechanism of AGOCLEAN-P is explained that ettringite crystallites are firstly formed in the watery sediments when the powdered coagulant and wet sediments are mixed. The mixture reacts with water to make soil particles by cross-linkages of silicate networks. Soil particles are agglomerated to become diameter several 10 μm and does not disperse into water as silts. The separation between agglomerates and clear water is performed very well and sedimentation of agglomerates is happened very short time. After dewatering by press, treatment dredged mud can reuse for the raw materials of artificial tidal flats, granular micro-habitat beads for microorganism, seaweed beds, and marine blocks. This treatment will improve the turbidity of sea water in order to reach the sun light in the bottom of the sea.

This technique will be applied to the environmental cleaning about river catchment and estuary areas in Asia. Wetland restoration actions, in general, for lagoons, lakes, rivers, and reefs grow yearly on a point of view for global environmental problems.



Akihiko FUJII

Proper Management of Fishery Resources Using a Bivalve Growth Model which Included Fishery Catch and Feeding Damage

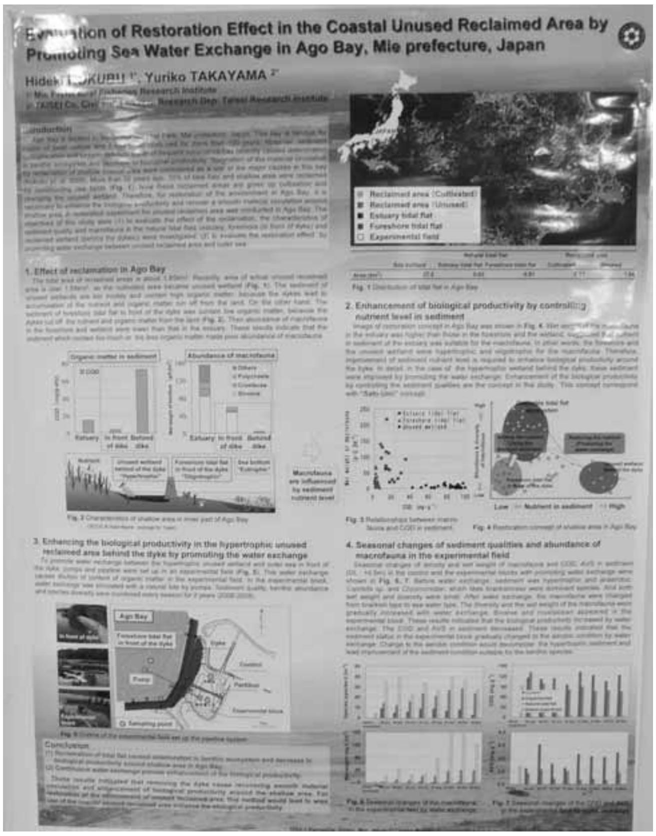


Daizo IMAI

Monitoring of Macrobenthos and Bivalve for Biologically Productive Artificial Tidal Flats, Ago Bay, Japan

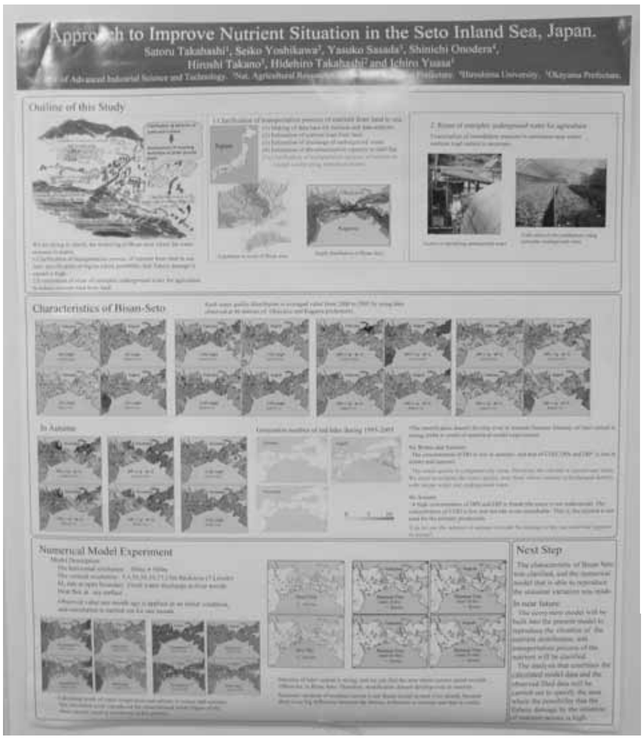
Satoshi CHIBA

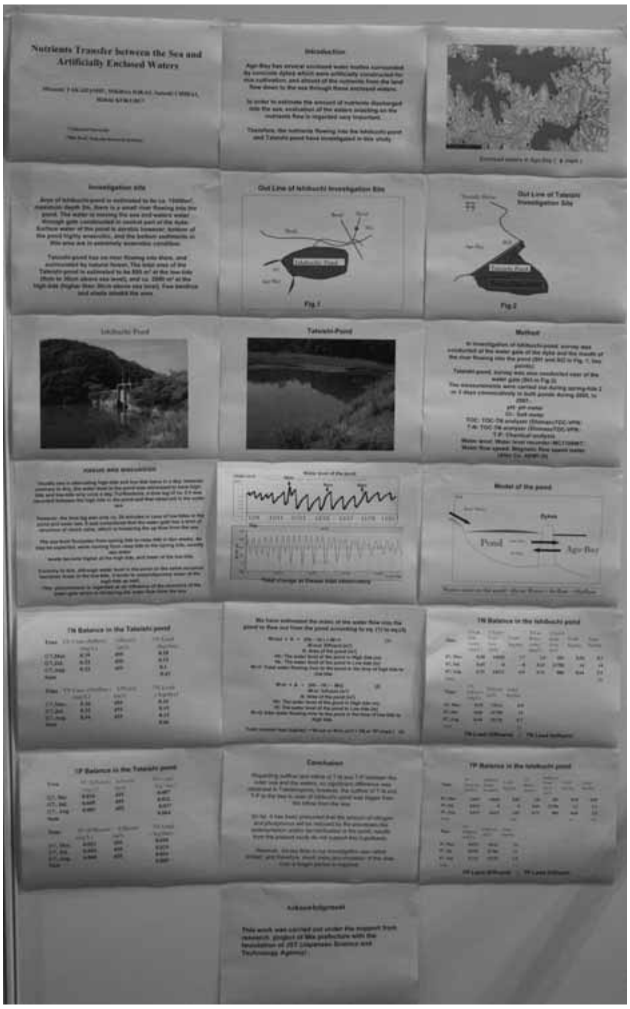
Nutrients, Organic Carbon and Oxygen Budget in Semi-Enclosed Ago Bay, Japan



Hideki KOKUBU

Evaluation of Restoration Effect in the Coastal Unused Reclaimed Area by Promoting Sea Water Exchange in Ago Bay, Mie Prefecture, Japan



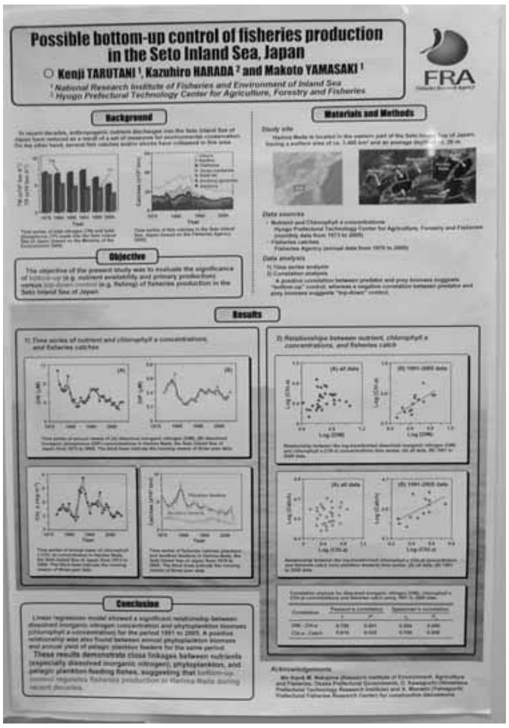


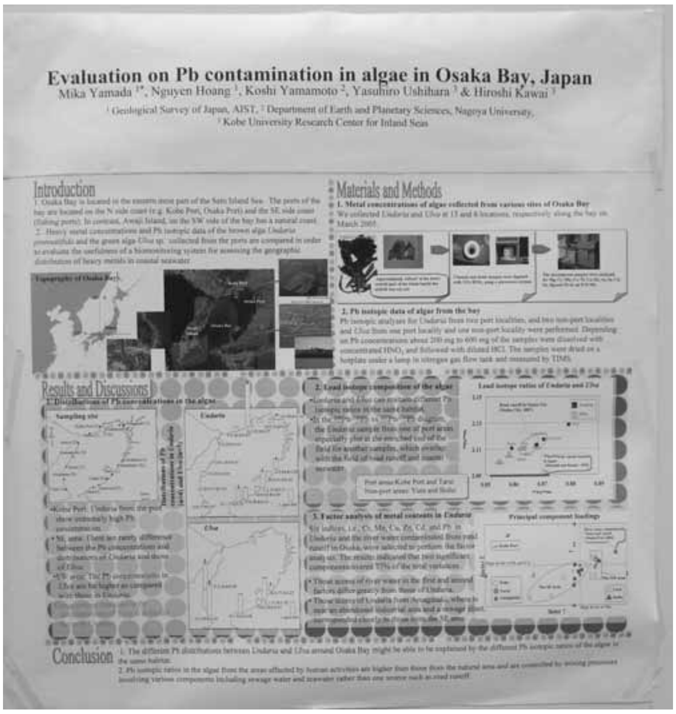
Satoru TAKAHASHI

Approach to Improve Nutrient Situation in the Seto Inland Sea, Japan

Masaaki TAKAHASHI

Nutrients Transfer between the Sea and Artificially Enclosed Waters/Feature of the Nutrient Flow in the Catchments Area in Ago-Bay



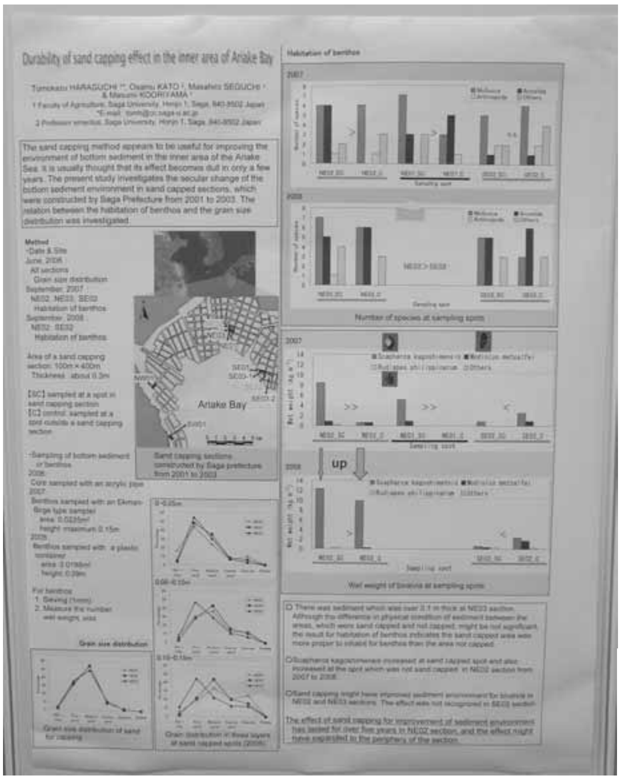


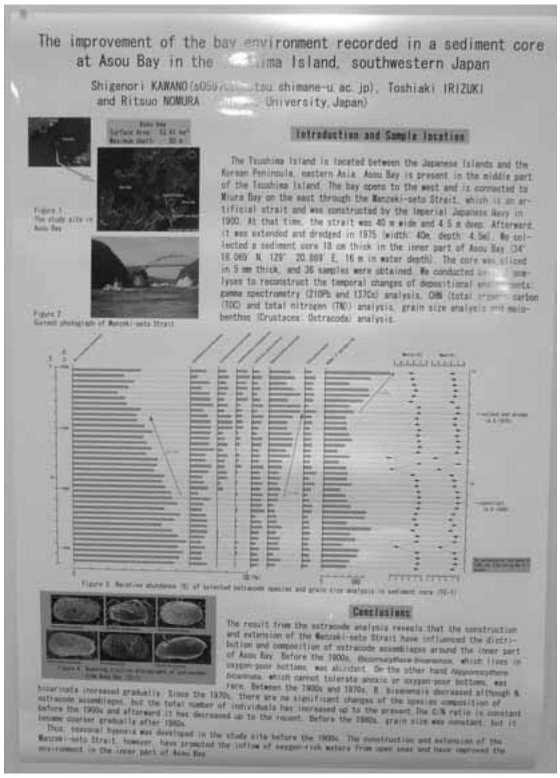
Kenji TARUTANI

Possible Bottom-up Control of Fisheries Production in the Seto Inland Sea, Japan

Mika YAMADA

Evaluation on Pb Contamination in Algae in Osaka Bay, Japan





Osamu KATO

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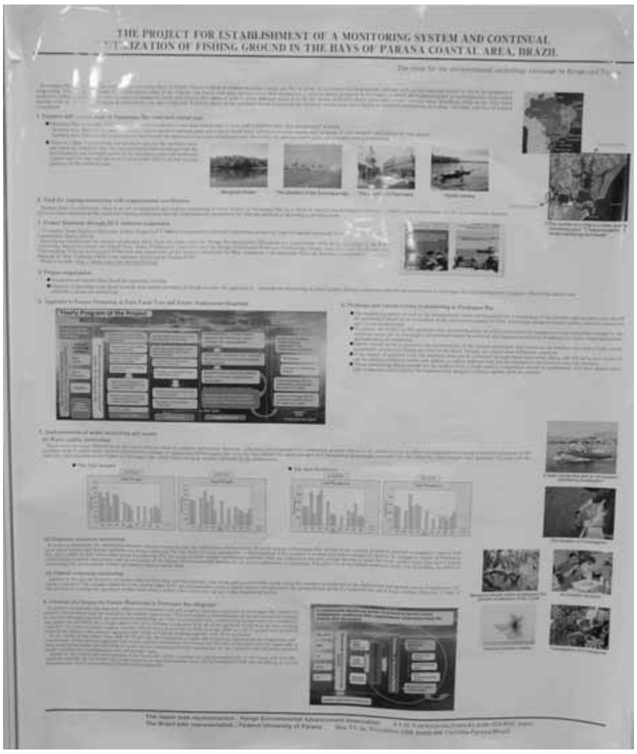
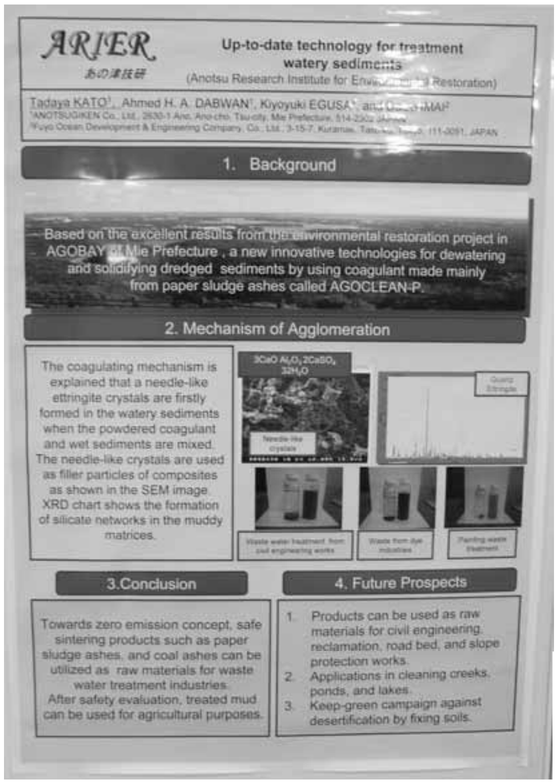
The Improvement of the Bay Environment Recorded in a Sediment Core at Asou Bay in the Tsushima Island, Southwestern Japan





Hiroshi KAWAI

The Project for Establishment of a Monitoring System and Continual Utilization of Fishing Ground in the Bays of Parana Coastal Area, Brazil

Tadaya KATO

Up-to-date Technology for Treatment Watery Sediments

THE SHANGHAI DECLARATION

Environmental Management of Enclosed Coastal Seas
EMECS 8
October 30, 2008

Staying the Course in Troubled Waters

We are more than 450 persons who participated in the 8th International Conference on Environmental Management of Enclosed Coastal Seas in Shanghai, China, under the theme of "Harmonizing River Catchment and Estuary." We are researchers, policy makers, educators, students, businesspersons, governmental officials, and members of non-governmental organizations. We have come from our workplaces, academic institutions, schools, and homes in China and 36 other countries near and far. We are here because we have a shared interest in a sustainable future for coastal seas around the world. This is our conference declaration.

We applaud the fact that restoration, conservation, and management programs are underway on most of the world's coastal seas. We have learned that many have been in place long enough to demonstrate some successes, among them reduction of the oxygen-depleted dead zone in the Black Sea, nutrient pollutant reduction in the Delaware Estuary, and increased public awareness as a result of environmental education for school children and citizens in every country represented at EMECS 8. We are delighted with the increasing levels of commitment and intergovernmental cooperation that our leaders have shown in addressing such critically important environmental matters.

Nevertheless, we recognize that we are navigating seriously troubled waters today. The recent economic growth that is so beautifully reflected in the gleaming new buildings of Shanghai gives us hope in our ability to accomplish great things. But we have seen in the past how economic development can neglect environmental concerns because they are viewed as being inconsequential to a country's well-being. In stark contrast is the world-wide economic turmoil within which EMECS 8 has taken place. This, too, draws attention away from environmental quality as governments search for immediate solutions to their economic problems. The consequences of both economic condition can be serious for our coastal seas: decreasing water quality, loss of resource productivity, and even complete ecosystem disruption.

We simply must not allow governments to neglect our coastal seas regardless of their economic condition. To do so would not only erase the successes many of us have worked so hard to achieve, but also threaten the environmental services that our coastal seas provide which are the foundation of the well-being and prosperity of coastal communities. Further, we have learned through experience that restoration of degraded coastal seas is far more expensive than the cost of implementing programs to prevent that degradation in the first place. Finally, coastal seas, like other ecosystems, are dynamic and changing. These changes have ecological, social, and political aspects, all of which are increasing in rapidity. They require monitoring and adaptive management programs that are only possible through continued vigilance. Global warming is an extreme aspect of this last concern. If effective responses are not implemented, global warming and its consequent effect on sea-level rise could subject our coastal seas to irreversible change with serious worldwide consequences.

We believe that advocacy for our coastal seas, no matter how vigorous and no matter how strongly supported by scientific research, cannot be assumed to compete successfully with perceived economic concerns for the attention and action of our political leaders. We must convince those leaders that healthy, productive, and sustainable coastal waters are vital to a country's economic well-being. We therefore encourage understanding and adoption of a perspective that correctly includes people as an integral part of the system of coastal sea after coastal sea around the world, in every country and within every political context. We identify the elements of this perspective as follows:

1. Coastal seas and their river catchments must be understood to be components of a single system so that harmonization between them from both environmental and policy making perspectives will benefit the entire system.

2. Similarly, the economics, cultural, and creative activities of coastal communities must be understood and harmonized as integral components of that same coastal system.

3. Consequently, degradation of any component of a coastal system has negative effects on all other components; activities that improve the condition of any component will improve the system as a whole.

Past EMECS conference declarations introduced the term "working landscape" to indicate the relationship between land, water, and human activity that generates sustainable economic return through activities such as fishing, farming, commerce, and recreation that can be passed as an economic and environmental asset from generation to generation. At EMECS 8 we learned an informative new concept, sato-umi, which signifies "high productivity and biodiversity of a coastal sea as a result of, and in harmony with, human activity." Both of these concepts speak to the economic value of a positive relationship between coastal communities and coastal seas. We understand that relationship to our potential benefit; we neglect it to our peril.

Sato-umi places increased emphasis on promoting positive interaction between humankind and our enclosed coastal seas. That interaction can take many forms. It may be realized through concerted, continuous environmental conservation programs. Sustainable economic return through ecosystem-based resource management and agricultural practices are other aspects of sato-umi. So are activities that bring people in contact with coastal systems through recreation and artistic creativity. Especially during these times of rapid economic and environmental change, governments, businesses, and philanthropic organizations alike need to invest significant financial and intellectual resources in programs that will have positive results according to sato-umi – projects that empower local communities to undertake activities to improve water quality and manage living resources with demonstrated success that will be sustainable into the future. Finally, sato-umi places a high premium on an education that connects young people with the natural world and provides them opportunity to learn through hands-on experiences how their sincere concern for the natural world relates to the well-being of their community, family, and themselves. We hear their collective voice in the EMECS 8 Student Declaration. We strongly endorse what they have written. We promise that they will not be disappointed with our response.

Our EMECS 8 Conference Declaration is simple: We must act on the principle that land, water, and people are integral components of the world's coastal seas. Economy and environment are intertwined with art and nature. All are bound together by education. This is the lesson of sato-umi. This will help us keep our course on today's troubled waters. This is what we wish to pass to the next and future generations. This is our commitment. This is our promise.

International Workshop

Sato-Umi

New Concept that Increases Biological Productivity and Biodiversity

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