

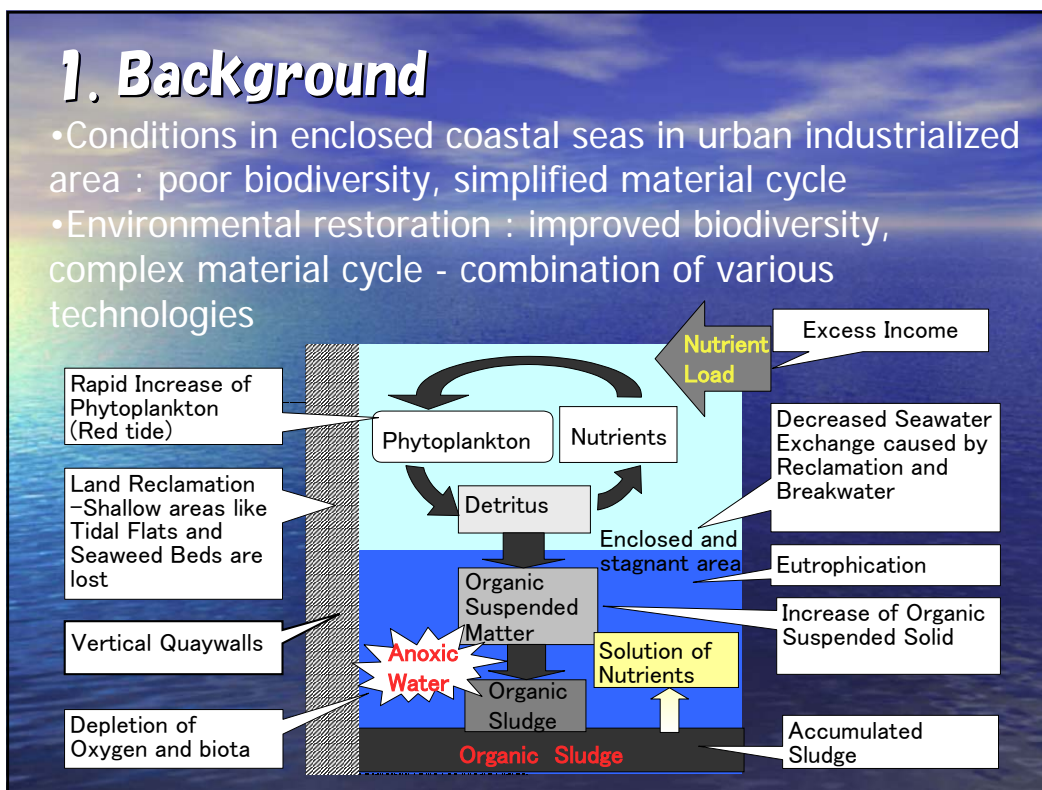
**Project aimed at packaging  
Optimal environmental  
restoration  
technologies**



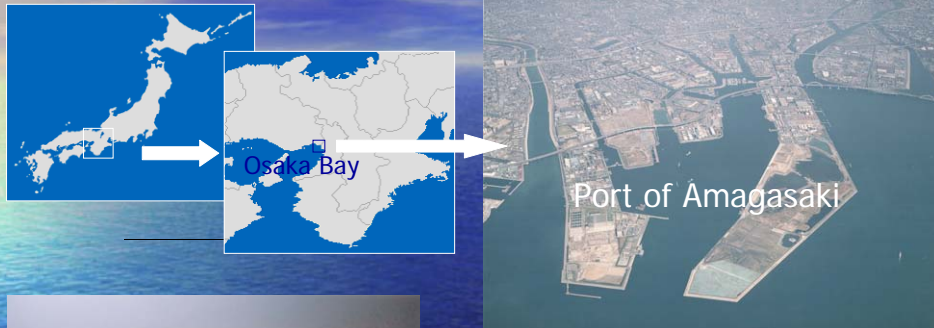

**An overview**



International EMECS Center



## 2. Background (continued)



Surrounded by vertical quaywall and reclaimed land



Sea bottom in Port of Amagasaki  
4-5 m underwater, September 2002  
oxygen-poor condition

## 3. Background (continued)

- Port of Amagasaki : one of the worst in environmental condition – model case
- Amagasaki Nijuisseiki-no-mori (the Amagasaki century 21<sup>st</sup> Forest Project):  
On-going project by the prefectural government for environmental restoration in the land area around Port of Amagasaki



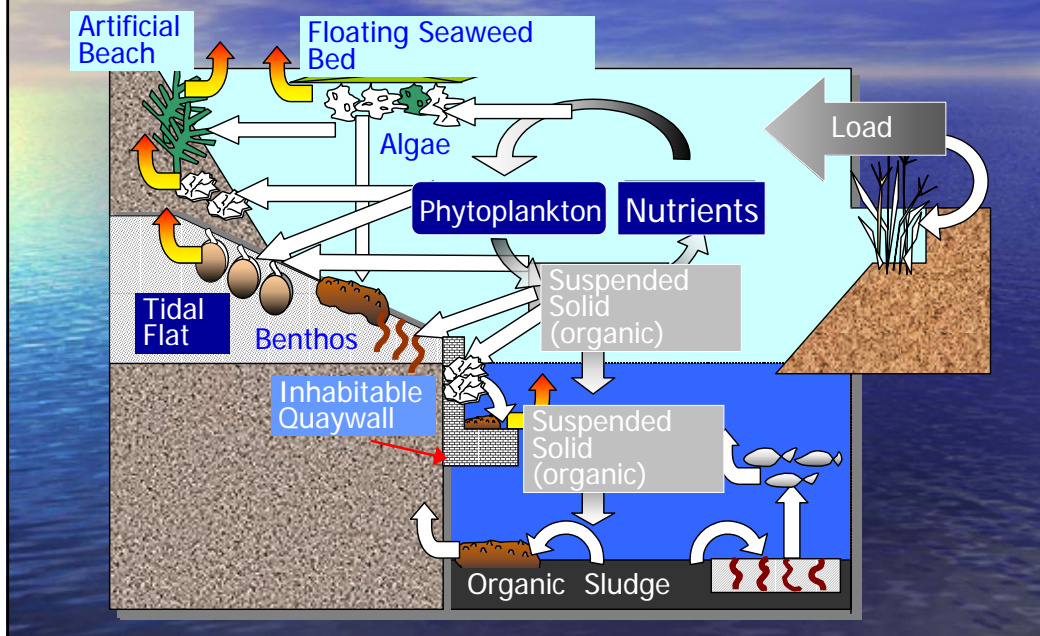


## 4. Objectives

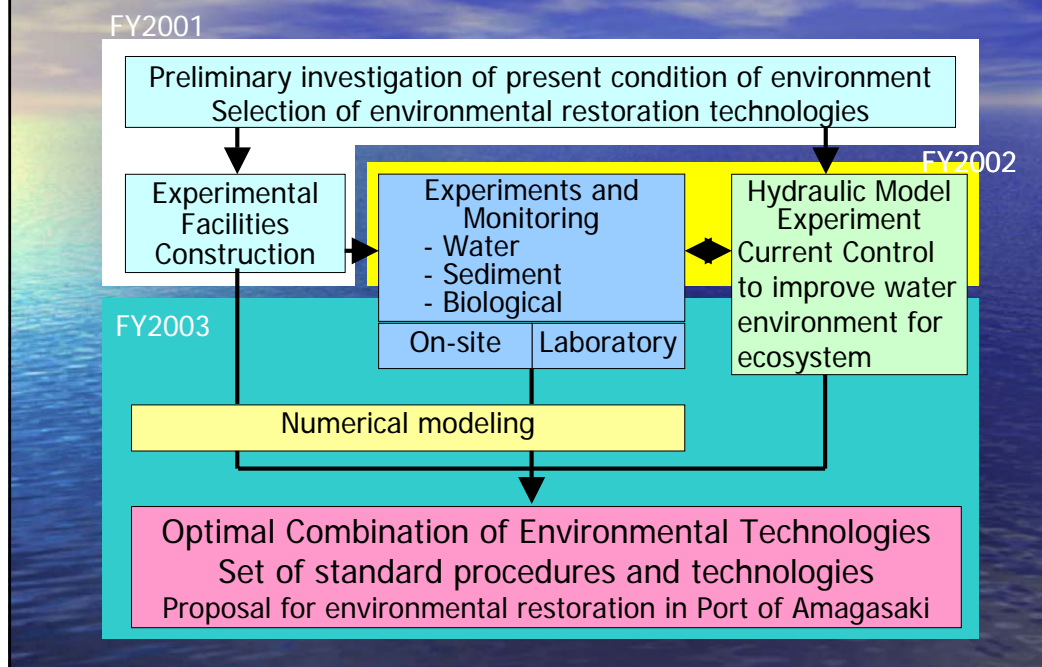
1. Optimal combination of environmental restoration technologies : **the best mix**
2. Proposal for environmental restoration in sea area of Port of Amagasaki
3. Set of standard procedure and technologies for planning of environmental restoration for future application in other sea areas : **"packaging"** environmental restoration technologies

## 5. Expected Effect

(Formation of Desirable Material Cycle)



## 6. Flow diagram of the project



## 7. Experiments - chosen technologies

- Artificial tidal flat (open-type)** : water purification by benthic ecosystem including bivalves (Short-neck clam), nutrients fixation by reed, maintenance of artificial tidal flat
- Closed-type artificial tidal flat** : water purification by pores bed contact and sessile organism, comparison in ecosystem and biomass of sessile algae, seaweed and benthos with those at open-type artificial tidal flat
- Inhabitable quaywall** : improvement of material cycle on vertical quaywall and elimination of organic suspended material to sea bottom by sessile organisms and benthos
- Floating seaweed bed** : fixation of nutrients by algae, formation of seaweed beds in area with poor transparency



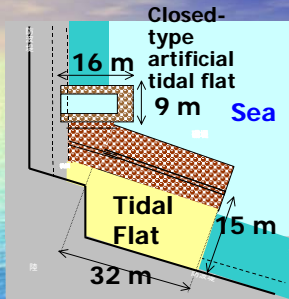
## 8. Experiments (continued)

5. **Hydraulic control (hydraulic model experiment)** : design of current control in the Bay, improvement of sea water exchange
6. **Seaweed biomass utilization (gasification)** : effective utilization of seaweed produced by creating shallow water area

## 9. On-site Experiments in Amagasaki Port - Location



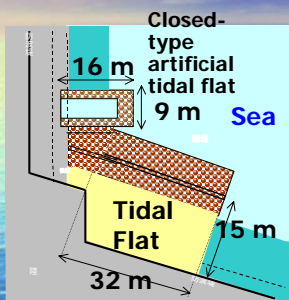
## 10. On-site Experiments in Amagasaki Port - Artificial tidal flat



Bivalves raising test (Short-neck clam)



## 11. On-site Experiments in Amagasaki Port - Closed-type artificial tidal flat



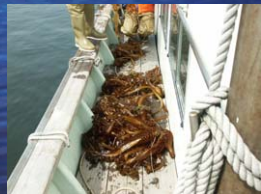
Cobble cages



## 12. On-site Experiments in Amagasaki Port - Floating seaweed bed (rafts)



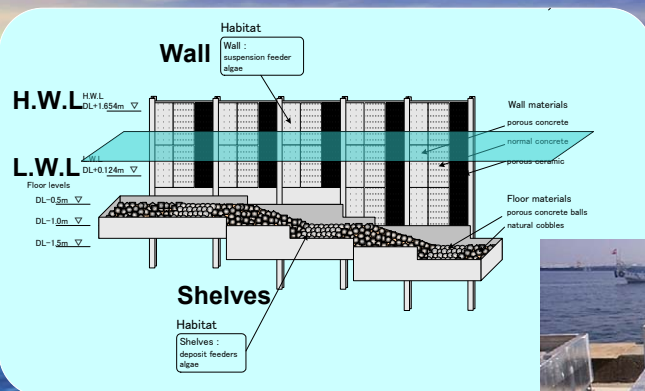
Planting Wakame seaweed (Undaria pinnatifida)



Grown-up Wakame seaweed

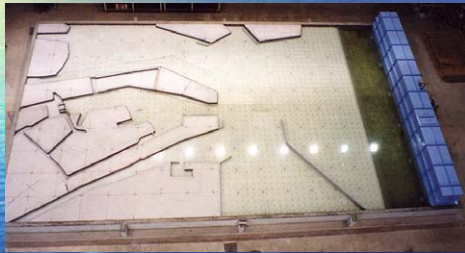


## 13. On-site Experiments in Amagasaki Port - Inhabitable quaywall



Shelf Porous concrete balls Natural cobbles

## 14. Hydraulic control and seaweed biomass utilization



Hydraulic control  
(hydraulic model experiment)  
Size : 18m × 10m  
Scale : 1/500 horizontal,  
1/63 vertical



Seaweed biomass utilization  
(anaerobic digestion to produce  
methane gas)

## 15. Examples of organisms found at experimental facilities

### Artificial Tidal Flat



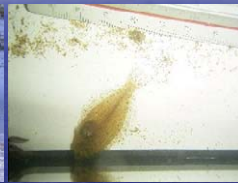
clams



lugworm



goby



Juvenile of flounder

### Closed-type artificial tidal flat



Algae covering cobble



sea anemone



## 16. Examples of organisms found at experimental facilities (continued)

### Floating Seaweed Bed



Sessile organisms on seaweed



Juvenile fish

### Inhabitable Quaywall



Mussels



Crabs



Octopus

## 17. Summary

- Experiments of 4 technologies combined together within the same water area in port of Amagasaki is being conducted to achieve the goal (end of FY2003)
  - Accumulated data is being evaluated to achieve the best mix
  - Proposal for environmental restoration in Port of Amagasaki to the Amagasaki century 21<sup>st</sup> forest project
  - “packaging” environmental restoration technologies will be conducted by studying and examining the flow and the result of this research

## Organization of project



## Working groups

Artificial tidal flat	Dr. Yoshiyuki NAKAMURA	The Port and Airport Research Institute
	Dr. Kunio KOHATA	National Institute for Environmental Studies
	Takatoshi TANIMOTO	Hyogo Prefectural Institute of Public Health and Environmental Sciences
Closed-type artificial tidal flat	Dr. Koji OTSUKA	Associate Professor, Osaka Prefecture University
	Dr. Hirokazu TSUJI	Obayashi Corporation
Inhabitable quaywall	Dr. Yasunori KOZUKI	Associate Professor, The University of Tokushima
Floating seaweed bed	Dr. Hiroshi KAWAI	Professor, Kobe University Research Center for Inland Seas
Biomass gasification	Dr. Koji OTSUKA	Associate Professor, Osaka Prefecture University
	Dr. Toru IDA	Kobe Steel, Ltd
Hydraulic control	Dr. Munehiro Yamasaki	National Institute of Advanced Industrial Science and Technology
Construction/maintenance	Dr. Hirokazu TSUJI	Obayashi Corporation
Monitoring	Dr. Takashi NAKANISHI	Sohgoh Kagaku Inc



## ***Environmental learning program for citizen at experimental site***



Observing crabs, sea hares etc. found on artificial tidal flat



Watching demonstration of water purification by bivalves



Water quality test (COD) at experimental site



Visit to experimental site