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.

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

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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 (5.2 ha) 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 $mgC/m^2/d$ or 0.15-0.37 $mgN/m^2/d$, while the rate of litter fall was about 6.7-32.3 $mgC/m^2/d$ or 0.06-0.29 $mgN/m^2/d$. 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.

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.

Definition of Sato－Umi

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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.

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Rehabilitation of Ariake Bay by oyster cultivation

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One of the typical semi-enclosed bays in Japan, Ariake Bay, in Kyushu Island, western Japan is 20 km wide, 100 km long, 20 m deep as average and 1700 km2 in area. Catches of finfish and shellfish have been decreasing since the late 1970’s. The cultivation of sea weed, “Nori” had been