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Measures for environmental conservation in enclosed coastal seas

Akio Tomita *, Yoshio Nakura, Takuya Ishikawa

Ministry of the Environment, Japan

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ABSTRACT

With putting a focus on the balance among the nutrient salts such as nitrogen and phosphorus, the Ministry of the Environment (MOE) developed the Action Plan for Healthy Material Circulation in Ocean (just called the Healthy Plan). The plan aims to facilitate the healthy and smooth circulation of the nutrients with an integrated management over land and sea as a package in respective sea areas. The Healthy Plan is now in a pilot phase and is to be implemented for some selected model regions.

Meanwhile, devastating tsunamis caused by the Great East Japan Earthquake on March 11th, 2011 severely damaged the natural environments in the affected regions. In the affected bays, seaweed beds and spawning grounds disappeared in a blink. MOE has launched on the recovery activities of Zostera (eelgrass) beds, using the concepts and the methods used in the "Sato-umi Creation" activity which is a purposeful environmental recovery project.

1. Introduction

For the environmental conservation in the enclosed coastal seas, Japan has implemented such measures as effluent regulations to achieve "clean seas." But some areas such as the Seto Inland Sea where the water quality has comparatively improved have entered into a new phase of environmental conservation, and the new goal is set to bring about a "beautiful, bio-diverse, bustling-with-people and bountiful ocean."

In this context, we are working on the Environmental Quality Standards for the bottom-layer dissolved oxygen, which is one of the important elements for inhabitation of aquatic creatures, and water transparency, a factor which positively contributes to the growth of aquatic creatures and the people's accessibility and familiarity with waters.

Some enclosed coastal sea areas in our country still suffer from frequent generation of algae blooms and oxygen deficient water masses due to eutrophication. In other areas, meanwhile, the reduction of nutrient loads, as hindering smooth circulation of nutrients to organisms of higher trophic levels in food chain, is considered to have changed the natural balance of ecosystem and have caused a decline in fishery resources. For such areas, it is necessary to rebalance the circulation of nutrients through an integrated management of the environmental cycle from land to sea areas.

To deal with these issues, efficient and effective management policies for a smooth circulation of nutrients between land and sea areas should be specifically established for the respective coastal sea areas. For this purpose, the Ministry of the Environment (MOE) developed "Action Plan for Healthy Material Circulation in Ocean" for three years starting out in 2010. The plan, by integrating management of land and sea areas for a smooth material circulation, aims to improve not only water quality but also biodiversity and biological productivity and to conserve habitats of aquatic creatures. This will bring about richer and healthier oceans in the future. The plans were drawn up per region selected as model, and the plans are being implemented one by one upon completion.

In the meantime, MOE supports the restoration efforts by the regions affected by the Great East Japan Earthquake on March 11th, 2011. The environments of such areas were severely damaged by landform changes in coastal lines and sea bottoms as well as disappearance of seaweed beds. We assist those regions for environmental recovery, using the methods and the know-hows of Sato-umi Creation. Sato-umi is defined as a coastal zone where the livelihood of people and the blessings of nature coexist harmoniously with coastal area eco-systems. We apply this approach to the disaster-affected sea areas in hope of accelerating the recovery and promoting Sato-umi Creation.

The details of the Healthy Plan and Sato-umi Creation are described in the following sections.

2. Action plan for healthy material circulation in ocean

Nutrient salts such as nitrogen and phosphorus circulate in the physical, chemical and biological mechanisms through land and sea. Nutrient salts are vital for aquatic animals and plants. However, the redundant inflow of nutrients, the social and economic activities in and around the sea and the change of natural condition and biota have jointly hindered the balancing of nutrients in the sea, causing red tides, oxygen

* Corresponding author.
E-mail addresses: AKIO_TOMITA@env.go.jp (A. Tomita), YOSHIO_NAKURA@env.go.jp (Y. Nakura), TAKUYA_ISHIKAWA@env.go.jp (T. Ishikawa).

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deficient water masses, discoloration of seaweeds and other fishery damages in some sea areas.

Appropriate measures to control the concentration or amount of nutrients in the sea and surrounding land or catchment area naturally differ depending on the geographic, topographic and the social and economic uses/activities in the respective areas.

Therefore, the management measures of nutrients should be carefully planned and delivered to correspond to the conditions of respective sea areas in order to conserve the healthy, rich and bio-diverse sea.

We categorized the enclosed coastal seas in Japan into two types by 1) Smoothness of Material Circulation and 2) Stability of Ecosystem, and selected three areas as model of either-type. They are Mikawa Bay, North-Western Coast of Harima-Nada and Mitsu Bay.

3. Selected area 1: Mikawa Bay area, Aichi prefecture

3.1. Issues

In Mikawa Bay area, as the rich habitats in the shallow sea somewhat disappeared, the biological productivity declined. This led the detritus food chain to surpass the ecological chain and resulted in oxygen-deficient water. In other words, the biological productivity and material circulation in the shallow sea can determine the scale of oxygen-deficient water masses in the deep sea. The reduction of seaweed beds, tidal flats and shallow sea areas can degrade biological network and productivity in the coastal areas and this is the issue that needs to be addressed to recover the smooth material circulation.

One of the typical issues is a large amount of nutrients flowing into the sea bottom beyond its decomposing capacity. They accumulate at the sea bottom, causing oxygen-deficient water masses.

3.2. Measures

1. Conservation and recovery of natural habitats

Seaweed beds, tidal flats and shallow sea areas are habitats for organisms of higher trophic levels in food chain and thus for biological diversity. We need to expand these areas and activate the ecological chain so that the ecological chain can surpass the detritus food chain.

2. Reform of geography that is causing oxygen-deficient water masses

We need to enhance the temporary storage function of nutrients on the coast and expand the tolerant areas of oxygen-deficient water masses by expanding seaweed beds, tidal flats and shallow sea areas. They also need to abate the accumulation of nutrients and the occurrences of oxygen-deficient water masses by reducing the remains of deep moats dug for gravel and other highly geographically enclosed sea areas.

3. Activate the ecological chain

We need to activate the ecological food chain so that the consumption capacity of nutrients is enhanced and the amount of nutrients flowing down to the sea bottom is reduced.

4. Support programs

We need to facilitate and support the local initiatives and projects to re-recognize the importance of the bountiful sea.

4. Selected area 2: north-western coast of Harima-Nada area, Hyogo prefecture

4.1. Issues

The north-western coast of Harima-nada area is considered to be in low productivity since the concentration of Dissolved Inorganic Nitrogen (DIN) declines in the coast and offshore in winter and this decline causes the discoloration of seaweeds. In the port sections, on the other hand, the area is in deficient of oxygen in the sea bottom layer in summer caused by eutrophication since the sea water exchange is little in addition to large quantity of water discharge effluents is released from sewage facilities and factories/business establishments along the coast. The issue in the area is this mal-distribution of DIN.

Despite the continued supply of DIN from land, it stays in the port sections and circulates neither to the coast and offshore. However, DIN loads in water discharge effluents from various sources are controllable. Thus the key to address these issues is the efficient use of water discharge effluents as well as the facilitation of the sea water exchange from the port throughout the coast and offshore areas.

4.2. Measures

1. Nitrogen effluent increase operation at sewage facilities

One prefectural and five municipal sewage facilities are in pilot operations that increase the concentration of nitrogen in treated water discharge effluents below the regulation standard requirement.

Site investigations confirmed some increase of nitrogen concentration in the water channels where water discharge effluents are released from sewage facilities and factories/business establishments. Simulations demonstrated that, compared to the normal operation, the amount of total nitrogen that reached to seaweed beds increased by 0.05 mg/L and the amount of DIN transportation from the water channels increased by 8.1%.

2. Facilitating the seawater exchange in the river

In some water channels, the concentration of DIN is higher than other areas due to water discharge effluents from sewage facilities and factories/business establishments. In order to decrease the concentration of DIN in the water channels, we examined the effect of facilitating the estuarine circulation in the water channels by increasing the water mass flow from the coast and offshore where the concentration of DIN is low to the water channels where the concentration of it is high. The methodology is the shift of the water discharge points from the surface of the river to the bottom of the water channels. Simulations confirmed the concentration of DIN decreased in the water channels and increased in the coast and offshore areas, and it was so calculated that the transportation of DIN from the water channels increased by 5.6%.

3. Constructing breakwaters that facilitate seawater exchange

In the port areas, the seawater exchange is generally less active and stagnant, so the concentration of DIN is relatively higher as compared to the coast and offshore areas. Thus we need to facilitate the flow throughout in and outside the port areas, as well as from the surface to the bottom and the other way around in the areas. We examined the effects of constructing breakwaters at the port estuary with function of generating the flow out of the port by wave.

The simulation calculated the maximum effect of the breakwater, and demonstrated the result that the accumulation and concentration of DIN decreased in the port compared to the breakwater without the function, and expected that the supply of DIN from the port to the coast and offshore areas especially on the surface layer would become activated. The effect of DIN supply was also confirmed by the increase