The significance of tidal flats for environmental preservation

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Introduction

The convection on wetlands of international importance as waterfowl habitat was established in Ramsar in 1971, and Japan became a member in 1980. Wetlands, which have particular ecosystems and are important for wildlife and fisheries, are divided into two types: one is fresh water marsh and the other is salt marsh in which tidal flat is included.

There used to be many shallow areas such as tidal flats and seaweed beds because our country has long coastal lines. However, the shallow coastal areas were buried on a large scale during rapid industrialization after the 2nd world war. About 50% of 32,000 Km, total coastal lines in Japan, have been changed from natural to artificial concrete and semi-concrete cover.

Except for the importance for aquatic ecosystems and waterfowl, tidal flats have different functions and values: they have socioeconomic values, such as fishery resources, recreation and aesthetics, and also have purification functions against water pollution through the metabolism by bacteria or macrobenthos, etc.

On the other hand, artificial tidal flats began to be created recently for the cultivation of juvenile clams and oysters. The purpose of this research is to investigate the differences in sediment characteristics and metabolizing abilities against organic materials between natural and artificial tidal flats and to estimate how they contribute to purify the organic pollution by land loadings in Hiroshima Bay, a typical enclosed and eutrophic bay, located in western part of the Seto Inland Sea, Japan.

Materials and methods

There are only 19 tidal flats larger than 5 ha and the largest one 29 ha in northern Hiroshima bay. Hiroshima city with a population of 1.1 million is located at the inner part and industrial cities like Kure, Ohtake and Iwakuni at the surrounding areas.

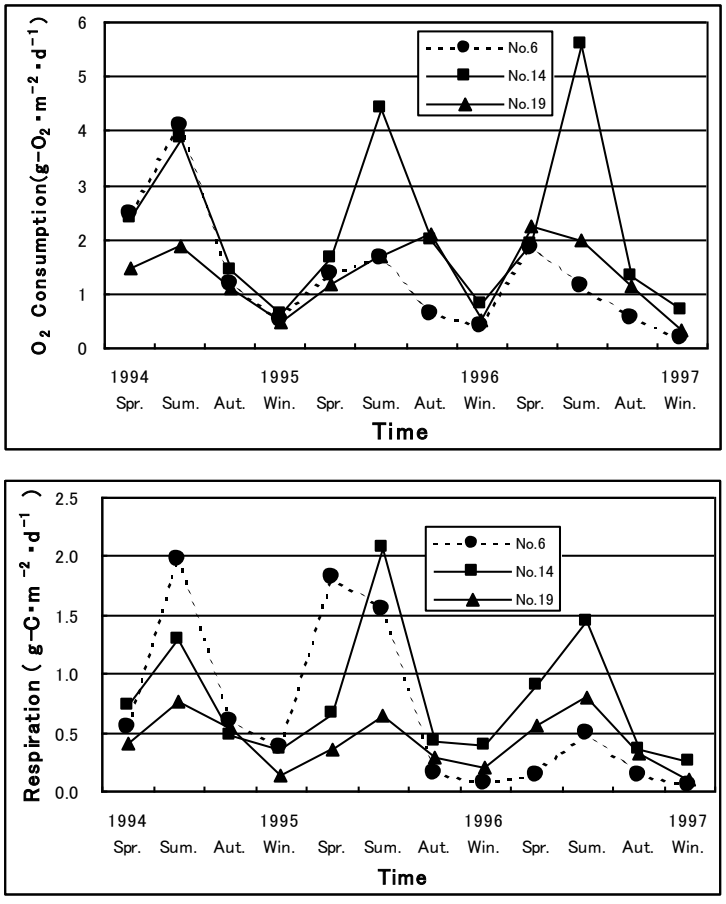
No.6 is an artificial tidal flat expanded by sea sand to cultivate clam in 1987. No.14 is a semi-natural one where the natural muddy sediment surface was covered with sand about 30 cm thick in 1990, in order to enhance the beauty scenery; it is located in front of Itsukushima shrine. No.19 is a natural one used for juvenile oyster cultivation.

Decomposition rates of organic material in tidal flats were estimated both from the rates of oxygen consumption and carbon dioxide production using undisturbed sediment cores in a laboratory. Physico-chemical characteristics (Particle diameter, IL, TOC,T-N,T-P) and biological characteristics (Bacteria, Macrobenthos) in tidal flat sediments were also examined.

Results and discussion

Most of artificial tidal flats are created by filling sand inside a bank constructed under the water. Some are created without a bank by expanding the natural beach through sand dumping. On the other hand, natural tidal flats are formed gradually over long periods by sand or mud carried from river. Therefore, basic difference between natural and artificial tidal flats is that the former is made of organic-rich sediment with more fine particles and the latter consist of comparatively homogeneous, sandy sediment. Total number of bacteria is almost one order less in artificial tidal flats, reflecting less organic matter content in sediments. However, it is difficult to indicate the differences in macrobenthos biomass in simple terms because they are strongly affected by artificial shellfish cultivation.

The seasonal changes in de-composition rates for organic materials of three tidal flats are shown in Fig.1. The rates in No.6, 14, 19 were in the ranges of 0.046 ～ 1.98, 0.247 ～ 2.08, 0.105 ～ 0.804 g-C・m^{-2}・day^{-1},respectively. These values are almost one order lager than those in coastal sea sediments. The decomposition rates indicated maximum value in summer and minimum in winter. The main reason for the increase in summer was due to intensified metabolic activity of bacteria and macrobenthos, a result of higher temperatures, because there is no seasonal change in bacterial numbers and macrobenthos biomass. Although the number of bacteria in natural tidal flats (No.19) were 2～3×10^9 cells・g^{-1}, one order larger than 3～4 ×10^8 cells・g^{-1} in artificial tidal flat (No.6), natural tidal flat (No.19) showed lower metabolic activities than those of No.6, which is due to active metabolism by macrobenthos originated from artificial clam cultivation in No.6. However, the rates in No.6 in 1996 were less than No.19 because the clam cultivation was stopped in 1996.



Land loadings for organic materials in the northern Hiroshima bay are 28.8 ton-C・day^{-1}. On the other hand, the decomposition rates of organic materials by tidal flats are estimated to be 1.2 ton-C・day^{-1} from the annual mean decomposition rate of 0.623 g-C・m^{-2}・day^{-1} and cumulative areas of 190 ha, which corresponded to 4.2 % of the land loadings.