

## CHAPTER 254

# Present Situation of Sea-Sand Mining in Kyushu Island, Japan and Its Influence on Coastal Environment

M. Hashida<sup>1</sup>, N. Matsunaga<sup>2</sup> and T. Komatsu<sup>3</sup>

### Abstract

The sea-sand mining has been carried out in the coast of western part of Japan since the early 1970's. Mined sea-sand is mainly used as fine aggregate of concrete structures. Mining a large amount of sea-sand near the coast induces the possibility of beach erosion and devastation of fishing grounds. In order to evaluate its influence on coastal environment, the present situation of sea-sand mining has been investigated in seven prefectures of Kyushu Island in Japan. The sea-sand mining in Kyushu Island is classified into two types. One is the mining in the sea areas where sea-sand reserves are limited. In these areas, the compatibility between the sea-sand mining and the protection of coastal environment will become very important in future. The other is the type that sea-sand has been supplied constantly from rivers or other sea areas. In this case, it will be the most important to keep the balance between the amount of mined sea-sand and that of supplied one.

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- 1 Professor, Department of Civil Engineering, Nippon Bunri University, Oita 870-03, Japan.
  - 2 Associate Professor, Department of Earth System Science and Technology, Kyushu University, Kasuga 816, Japan.
  - 3 Professor, Department of Civil Engineering, Hydraulics and Soil Mechanics, Kyushu University, Fukuoka 812, Japan.

### Introduction

The dependence of fine aggregate of concrete structures on sea sand increases in the western part of Japan. On the other hand, many dams and gates have been constructed across rivers with the object of flood control, water utilization, etc. Both the sea-sand mining and the decrease of sand supply from the rivers may accelerate beach erosion and devastate the coastal



(a)



(b)

Photo 1. Field work of sea-sand mining. These photos were offered by Japan Broadcasting Corporation.

(a) Sea-sand being gathered in cargo space.

(b) Drainage of sea water including mud.

environment. Actually, remarkable beach erosion was observed along the coast of the northern part of Kyushu Island, after the sea-sand mining was approved by prefectural governments. The change of longshore current due to man-made coastal structures, the decrease of sand supply from rivers, the frequent occurrence of storms, the sea-sand mining, etc. have been examined as causes of this erosion. However, what are the most essential causes still has not revealed.

Photos 1(a) and (b) show sea-sand being gathered in the cargo space of a barge ship and the state of drainage of sea water including mud, respectively. The environmental problem that the diffusion and sediment of the mud devastate fishing grounds occurs sometimes.

The purposes of this study are to investigate the present situation of sea-sand mining in seven prefectures of Kyushu Island and to examine its influence on the coastal environment.

### Sea-sand mining in Kyushu Island

Figure 1 shows the control system of sea-sand mining in Japan. The sea-sand mining has been performed under the approval of each prefectural government. The Ministry of International Trade and Industry leads for the control system of each prefectural government. The prefectural government gives the approval for the volume of mined sand to sea-sand mining companies. The companies must report the total volume of sea-sand which they mined actually, to the prefectural government every year. The prefectural government must report the total volume of the mined sea-sand to the Ministry of International Trade and Industry. It also negotiates with Fishermen's Union about compensation for devastation of fishing grounds. The standards of the approval or the compensation for the Fishermen's Unions are different in each prefecture. At the present time, there are even prefectures which do not establish any standards.

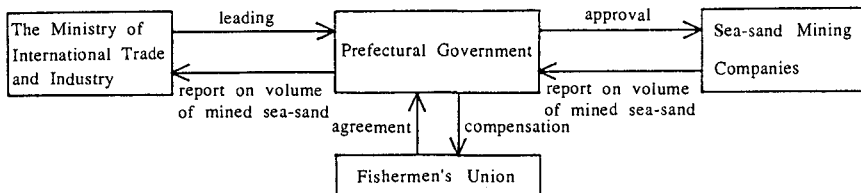


Figure 1. Control system of sea-sand mining in Japan.

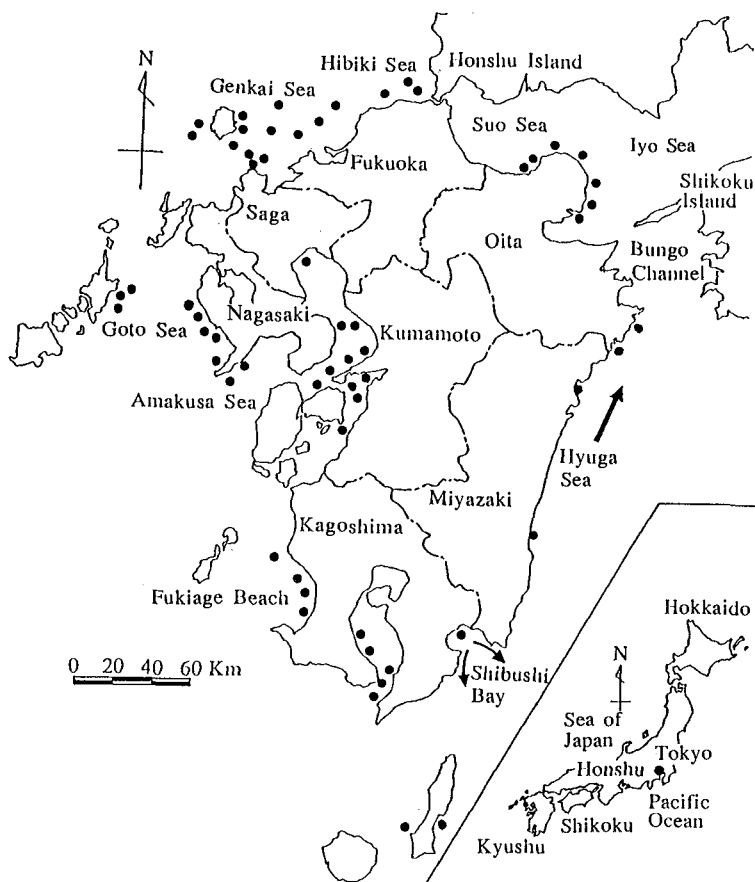


Figure 2. Sites of sea-sand mining in seven prefectures of Kyushu Island.

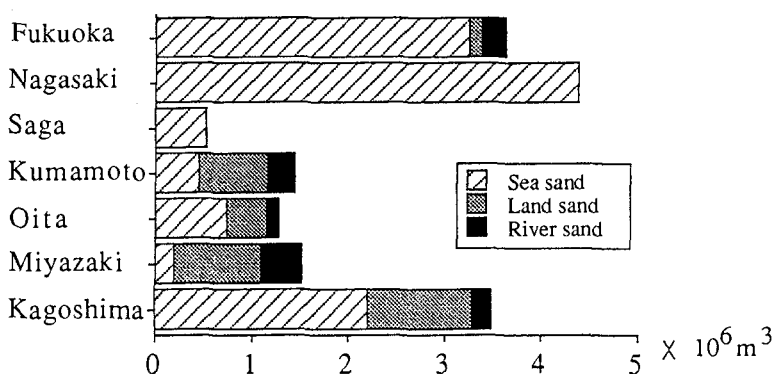


Figure 3. Volume of sand mined in seven prefectures in 1988.

In figure 2, the sites of sea-sand mining in Kyushu Island are shown. Kyushu Island consists of seven prefectures, i. e., Fukuoka, Nagasaki, Saga, Kumamoto, Oita, Miyazaki and Kagoshima Prefectures. The dash-dot lines indicate the border between the seven prefectures. The black circles show the superior direction of sediment transport. It is seen that many sites exist along the coast of Kyushu Island.

Figure 3 shows the volume of sand mined in the seven prefectures in 1988. The mining of both river sand and land sand has been restricted from the standpoint of the prevention of disaster. Therefore, sea-sand above 70 percent of total sand has been mined in Kyushu Island. Sea-sand mined in Fukuoka, Nagasaki and Kagoshima Prefectures is very large in comparison with that in the other four prefectures. The rate of the volume of sea-sand to that of the total sand shows a yearly increase.

### 1. Fukuoka Prefecture

Figure 4 shows the frequency of storm wind, whose mean velocity is larger than 10 m/s, in Fukuoka Prefecture. During 15 years from 1947 to 1961, a remarkable beach erosion was observed along the coast of the Genkai Sea and the Hibiki Sea. The recession of the shoreline averaged 45 m, and 85 m recession was recorded as a maximum value during the 15 years. The Fukuoka Prefectural Govrnment concluded that extraordinary frequent storms induced this erosion (Kojima, H. et al., 1986). Sea-sand mining started in 1972. Though the

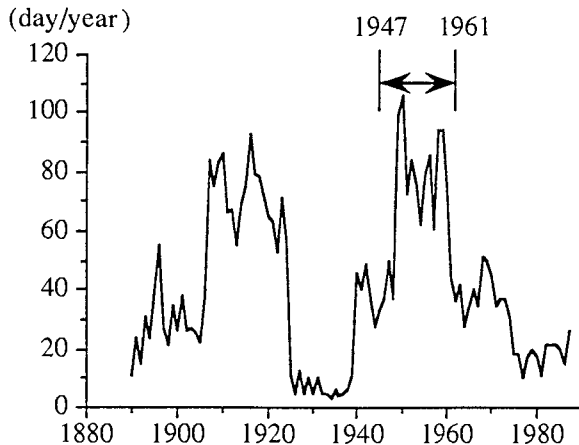


Figure 4. Frequency of storm winds in Fukuoka Prefecture.

frequency of storm decreased after the onset of the sea-sand mining, the progression of beach erosion continued to be seen along some areas of the coast. In Fukuoka Prefecture, a large amount of sea-sand was mined at sea areas shallower than 20 m from 1972 to 1981. When the prefectural government began to investigate the change of shoreline, i. e., in 1981, it also established a restriction on the sea-sand mining. The restriction was that the sea-sand mining has to be performed in principle at sea areas deeper than 40 m after 1981. Generally speaking, a remarkable beach recession has not been observed since 1981's restriction. Therefore, which was the essential cause for this erosion has not still been made clear.

Figure 5 shows the sites of sea-sand mining in the Genkai Sea and the Hibiki Sea of Fukuoka Prefecture. The black triangles indicate the sites shallower than 20 m, and the black circles indicate ones at the water depth over 40 m. Fukuoka Prefectural Government has carried out the level survey along the coast of the Genkai Sea since 1981. The stations are shown by numbered black-rectangles.

Figure 6 shows the correlations between the volume of mined sea-sand and beach elevation at stations 4 and 6 in the Genkai Sea. The open and solid marks indicate the results of level survey and the volume of mined sea-sand, respectively. At the stations, the sea-sand mining was performed at sea areas shallower than 20 m until 1986, but it has been mined only at sea areas deeper than 40 m since 1987. The mining was repeated about twenty times from 1985 to 1986 at Ainoshima and Tsuyazaki. The total volume reached about  $6.0 \times 10^5 \text{ m}^3$ . As shown in this figure, a remarkable erosion was observed at that time. After the sea-sand mining at Ainoshima and Tsuyazaki was stopped in 1987, the beach at station 4 began to recover and reach nearly an equilibrium state. At station 6, the influence of sea-sand mining on the beach elevation did not appear obviously because a small amount of sea-sand was mined at Nogita. The sea-sand mining at Oshima and Nishinoura was continued to 1986. Its influence on beach erosion was not recognized. It may mean that the restriction established by the Fukuoka Prefectural Government was valid. The field investigation on the volume of sea-sand reserved in the Genkai Sea was made by the Ministry of International Trade and Industry. According to its report, sea-sand suitable for the fine aggregate distributes over an area of about  $1.75 \times 10^2 \text{ km}^2$ .

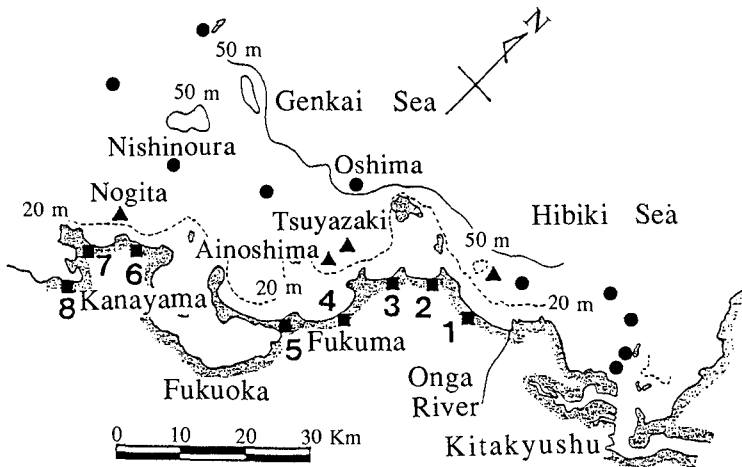


Figure 5. Sites of sea-sand mining ( ● and ▲ ) in the Genkai Sea and the Hibiki Sea, and survey stations ( ■ ).

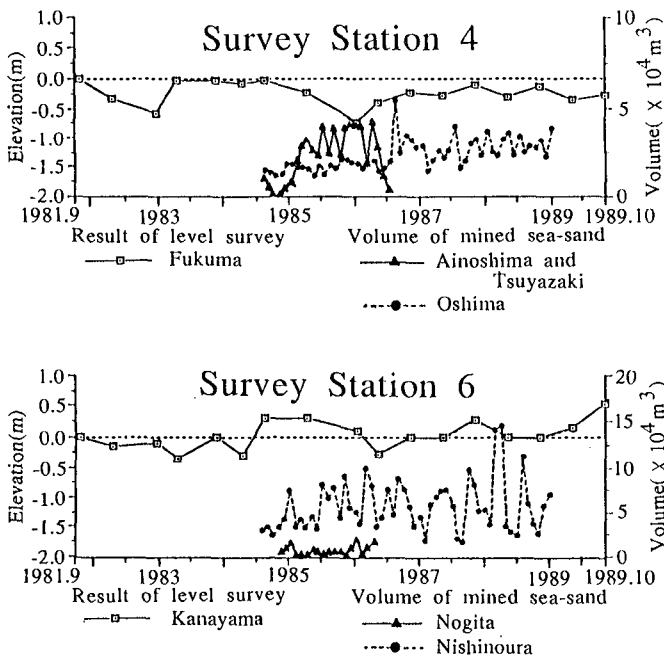


Figure 6. Correlations between volume of mined sea-sand and beach elevation in the Genkai Sea.

## 2. Nagasaki Prefecture

The sites of sea-sand mining in Nagasaki Prefecture are shown in figure 7. The black circles indicate the sites of sea-sand mining. The investigation about the reserves of sea-sand was made in the dotted area by the Ministry of International Trade and Industry. This prefecture is mining the largest amount of sea-sand in Kyushu Island. However, there are few wide, long rivers. Therefore, it seems that the sand supply from river to coast is very little. The Nagasaki Prefectural Government has approved the sea-sand mining in the sea areas where the water depth ranges from 30 m to 70 m. This means that Nagasaki Prefecture is also obliged to seek offshoreward sites. The sea areas have been a good fishing ground for a long time. Surface layer of the region contains a lot of lime composed of shells and dead planktons. Therefore, suitable sea-sand for fine aggregate is very little.

According to this investigation, however, it can be expected that sea-sand of good quality distributes in deeper layer. Its distribution is over about  $19.4 \text{ km}^2$ . Recently, a new environmental problem, i. e., the devastation of fishing grounds, is also occurring in this region. The Nagasaki Prefectural Government is looking for countermeasures to realize both sea-sand mining and preservation of nearshore environments.

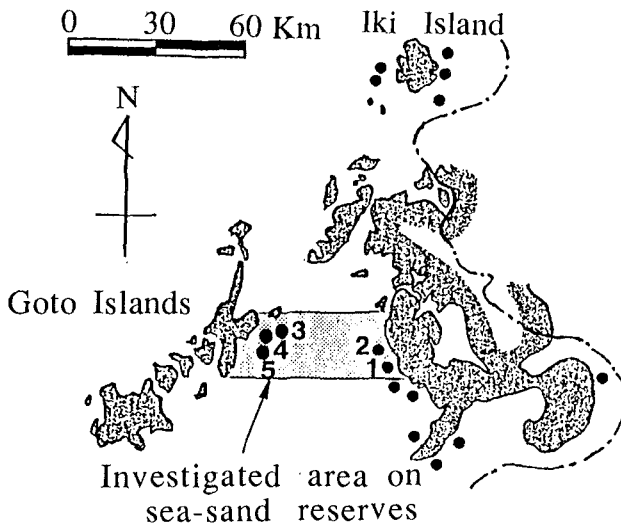


Figure 7. Sites of sea-sand mining in Nagasaki Prefecture.



### 3. Kumamoto Prefecture

Figure 8 shows the sites of sea-sand mining in Kumamoto Prefecture.

The volume of sand mined in this prefecture was  $1.50 \times 10^6 \text{ m}^3$  in 1989.

The volume tends to increase during the last five years. Sea-sand occupies from 30 % to 40 % of the total volume of mined sand.

The sea-sand mining has been carried out at the Ariake Sea, of which the sites are indicated by the black-circles numbered from 1 to 7.

The sites at the Yatsushiro Sea are shown by the black circles numbered from 8 to 11.

Sandy beach remains only along the numbered coast.

The other coasts are either tidal flat or gravel coast. The source of sand supply to the sea area is only inflow from the rivers.

In the case when sea-sand is mined in these seas, therefore, it is necessary to consider the balance between the volume of sea-sand mining and the volume of sand supply from the rivers.

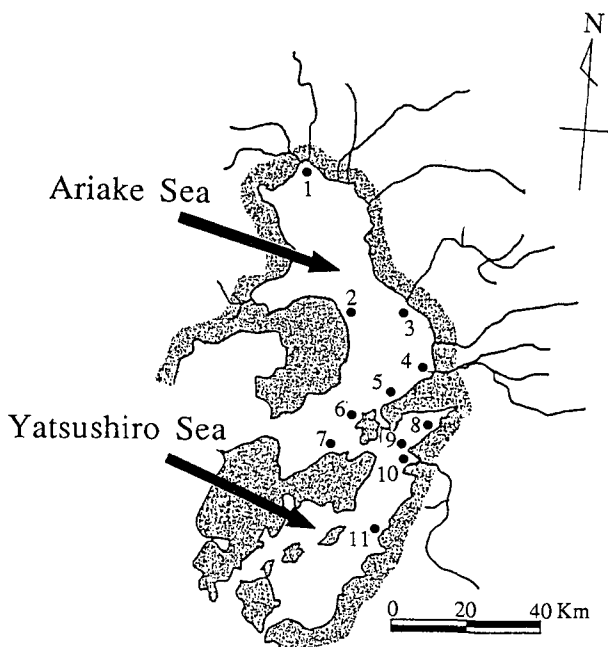


Figure 8. Sites of sea-sand mining in the Ariake Sea and the Yatsushiro Sea.

4. Oita Prefecture

Figure 9 shows the sites of sea-sand mining in Oita Prefecture. According to the statistical report on coast, which is presented by the River Office of the Ministry of Construction, the yearly mean expense of public utility enterprise for beach erosion was 40 million yen over the four years from 1984 to 1987. This is very high next to Nagasaki and Miyazaki Prefectures. The ratio of sea-sand to the total sand is from 60 % to 65 %. The sea-sand mining has been carried out mainly at both the northern part and the southern part. Oita Prefecture mined sea-sand of  $6.55 \times 10^6 \text{ m}^3$  during six years from 1984 to 1989. This volume is nearly equivalent to the volume mined over 14 years from 1970 to 1983. It shows the rapid increase of sea-sand demand. During last six years, a large amount of sea-sand has been mined at Jiromaru Coast (number 5), Morie Port (number 7) and Nishinoura Coast (number 8). At Jiromaru Coast, the sea-sand mining has been carried out because of the accumulation of sea-sand. The sand supply from Jiromaru River is very little and erosive coasts have been observed along the northern part of Jiromaru Coast. Therefore, it is necessary to make clear the source of the sand supply to Jiromaru Coast. Morie Port has a tendency to be buried due to sediment from Yasaka and Takayama Rivers. The volume of

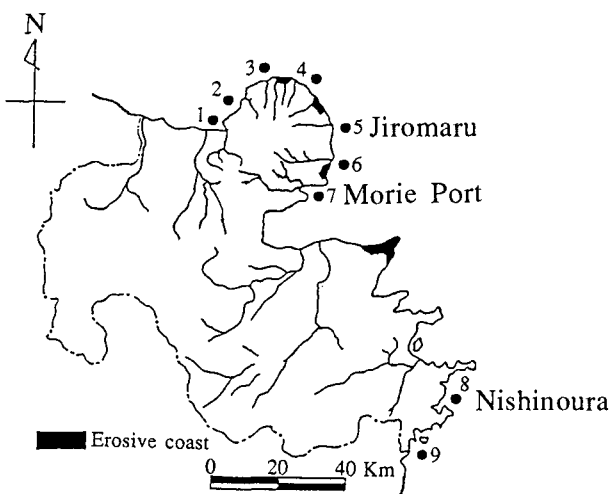


Figure 9. Sites of sea-sand mining in Oita Prefecture.

sea-sand mined in Morie Port is nearly balanced to that of the sediment yield from the rivers. Therefore, the environmental devastation due to the sea-sand mining does not appear in Morie Port. In spite of no rivers along Nishinoura Coast, a large amount of sea-sand has been mined with the object of keeping ship courses and arranging fishing grounds. However, no influence on coastal environment due to the sea-sand mining has been observed for the last 20 years. Therefore, understanding how the sediment transport occurs along Nishinoura Coast is the most important.

### 5. Saga, Miyazaki and Kagoshima Prefectures

Saga Prefecture is mining the smallest amount of sand in Kyushu Island. The total volume of sand is less than about  $8.0 \times 10^5 \text{ m}^3/\text{year}$ , of which most depends on sea-sand. The sea-sand mining has been carried out at four sites. One of them is in the Ariake Sea. The other sites locate in the Genkai Sea. The total volume of mined sea-sand per year is very little. The sea-sand mining in the Genkai Sea has been made at sea areas deeper than 20 m. From these reasons, the influence on coastal environment has not been come to the front.

Miyazaki Prefecture faces the Hyuga Sea. The coast is an erosive large-scale beach. Therefore, the sand mining in sea and river has been prohibited in principle. However, sand and gravel deposited in dams has been dredged to keep up their function. Small volume of sea-sand has been dredged with the object of keeping ship course in Miyazaki Port and Nobeoka Port. It has been used as fine aggregate. The year-mean volume of river sand is about  $4.0 \times 10^5 \text{ m}^3$ , that of sea-sand  $2.5 \times 10^5 \text{ m}^3$ , and that of land sand  $8.5 \times 10^5 \text{ m}^3$ . The total volume is  $1.5 \times 10^6 \text{ m}^3$  per year.

Though Kagoshima Prefecture does not open detailed data about the volume and sites of the sea-sand mining. The year-mean volume of mined sea-sand was about  $2.34 \times 10^6 \text{ m}^3$  during three years from 1987 to 1989. This volume is the third next to Nagasaki and Fukuoka Prefectures.

### Conclusions

In this study, the present situation was investigated about the sea-sand mining in all seven prefectures of Kyushu Island, Japan. Though there are a few prefectures in which the

detailed data on sea-sand mining could not be obtained, we reached the following conclusions.

- (1) Sea-sand reserves of the Genkai, Hibiki and Goto Seas are limited. Therefore, how the sea-sand mining compatible with the protection of coastal environments should be carried out in these seas will become very important in future.
- (2) Sea-sand of the Ariake, Yatsushiro and southern part of Oita Prefecture has been supplied constantly from rivers or seas. In these seas, it is necessary to take into account the balance between the volume of mined sea-sand and the volume of supplied sand .

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#### REFERENCE

- Kojima, H., T. Ijima and T. Nakamura (1986). Impact of offshore dredging on beaches along the Genkai Sea, Japan, Proc. 20th Coastal Eng. Cong., ASCE, 1281-1295.