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Changes in Bottom Sediment Caused by Construction of the Airport Island in Ise Bay, Japan.

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ABSTRACT: In order to investigate the impact on the marine environment from the construction of the Chubu International Airport Island in Ise Bay, Japan; a careful observation was made to clarify the bottom sediment condition and the composition of benthic fauna at some stations located from east to south of the airport island. Grain size compartment, moisture percentage, ignition loss, carbon, nitrogen, phosphorus and sulfur were measured. The ignition loss values in surface sediment in 2003 averaged 150% times higher than that of data in 2007. The benthic fauna revealed the species and number of individuals were very few. Organic matter increased, the species structure of the benthos was made poor. The average number of individuals and species compared before and after the Airport construction clearly showed a remarkable decrease after the construction. This phenomenon might reflect the ongoing progress of eutrophication and oxygen depletion around the airport island sea.

Keywords: Bottom sediment, Airport Island construction, Carbon, Nitrogen

1. INTRODUCTION

The Chubu International Airport Island was constructed along the east coast of Ise Bay where fishing grounds have been especially excellent. However, the Oceanographic Soiety of Japanese Environmental Issues Commission warned that this sea area environment would be negatively impacted by constructing the airport island [1]. On the other hand, the Central Japan International airport Co., Ltd. and Aichi prefecture reported that an environmental assessment in connection with the airport island construction revealed minor damage to fishing grounds [2]. After the airport island (580 ha) was built, the other side area (130 ha) of the airport island was developed. After the airport opening in 2005, the investigation near the airport island has been continually carried out every year by Aichi Prefecture and the Central international airport Co., Ltd. [3]-[5]. Originally, the Tokomane sea area was the fishing place that was good because seawater mixed with fresh water of Kisosansen River which was rich in the nutrient salt. However, after the construction, seawater tends to stagnate on the south side in the Chubu International Airport Island.

When diving fishermen who have been engaged in fishing in these sea areas, were asked why the shellfishing decreased so sharply recently, they agreed to cooperate with the present study by assisting with the core sampling of the bottom sediments. The purpose of our study is to clarify the effect of large structure of the coastal zone on the nearby
sea area environment for water quality, bottom sediments and the benthos.

2. METHODS

2.1 Study site

The study site was located on the Ise Bay sea area between the Chubu International Airport Island and Chita Peninsula. Seven sampling points were selected: very shallow sea area; A1 (4 m depth), A2 (3 m depth), A3 (5 m depth), A4 (7 m depth) and shallow area; B1 (11 m depth), B2 (11 m depth), B3 (13 m depth), where water quality and sea sediment were examined. Observations were conducted twice a year (2002, 2004, 2005, 2006 and 2007) and three times in 2003, respectively.

2.2 Sampling and analysis

Sediment core samples, three acrylic pipes (5 cm in diameter and 50 cm in length), were taken from the each location with two divers, and two core samples of three cores were subdivided into 1 to 2.5 cm-thick sections with a knife by extruding sediment core vertically.

Ignition loss (I.L.: 650℃), total nitrogen (TN), total organic carbon (TOC) and total sulfur (TS) were analyzed with a CHNS analyzer (Perkin Elmer CHNS/O analyzer 2400). The grain size was analyzed using the test method for particle size distribution of soils (JIS A 1204) and was fractionated to six (75 μm or less, 75 to 125 μm, 125 to 250 μm, 250 to 500 μm, 500 to 2 mm, 2 to 4 mm).

Bottom sedimentation rate was estimated by applying the ^{210}Pb method using the bottom sediment cores sample in 2004 and was 0.5 cm y^{-1} in the surrounding area [7]. Furthermore, 0.06～0.76 g cm^{-2} y^{-1} of the sedimentation rates were reported by the applying ^{210}Pb method of ten stations in Ise Bay [8].

Therefore, it was necessary to analyze sediment sample in 1-cm to 2.5-cm-thick sections vertically in order to clarify the environmental change around the airport island.
Macro benthos was collected by the quadrat method (25 cm square, 25 cm depth), and the sediment was separated by a sieve (φ1 mm). The kind and number of the mollusks were obtained.

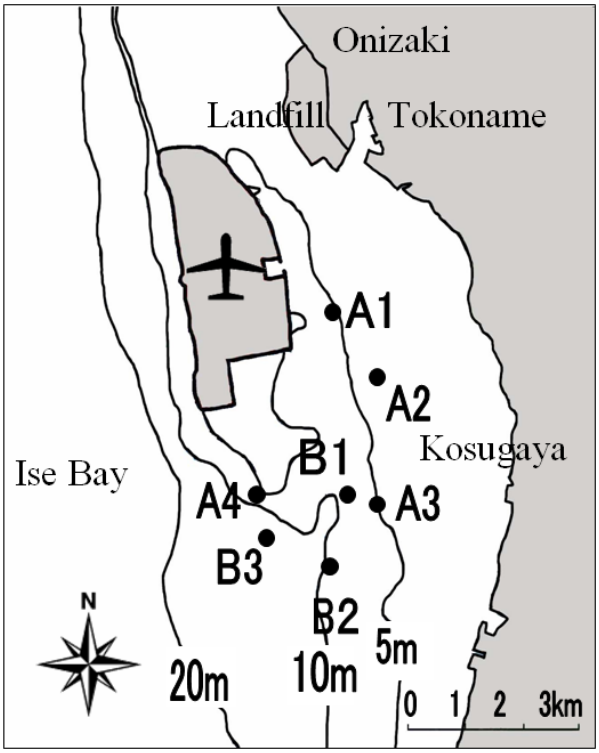

Fig.1 Study site

3 RESULTS AND DISCUSSION

3.1 Particle size distribution.

Organic matter contents of in B1, B2 and B3 were high ratio of silt-clay fraction (75 μm>) and those of B1, B2 and B3 were 24-30%, 18-38% and 13-16%, respectively (Table 1). About ratio of the silt-clay fraction (75 μm>), it was clearly that 0-1 cm layer in the very surface sediment was higher than deeper layer in B1, B2 and B3.
In spite of shallow A1, the silt-clay fraction was relatively large with 4-6 % and then it was indicated that the sea water was stagnated.

3.2 Ignition loss, carbon, nitrogen, phosphate, sulfur

The mean of the ratio of carbon and nitrogen (C/N) in the very surface layer (0-1cm) of September 2004 and October 2005 was calculated. As a result, the stations more than 10 were B2 (C/N:11), B3 (13), A4 (16) .And the stations less than 7 were A2 (C/N:7), A1 (6). Under natural environments, as for the decomposition rate of nitrogen and carbon, nitrogen is faster. Therefore, there were old sediments that organic matter decomposition was progressed in these stations (B2, B3 and A4). On the other hand, there were new sediments that organic matter decomposition was progressed in these stations (A2 and A1).
About the value of the C/N value of September 2004 and October 2005, the very surface layer was the smallest value, and the difference with the layer except it became clear.
The C/N value had become smaller, suggesting that, under autochthonous production, the sediment seemed to immediately deposit on this very surface, causing at least a temporary disturbance with a typhoon. The sites where the stratified structure was clearly recognized were B1, B2, B3, A3 and A4, and A1 and A2 estimated that the disturbing (about 0～7cm) of sedimentary layer occurs in the shallow site coastal from the vertical distribution of C/N.
In order to show the poor oxygen condition of the bottom sediments, the total sulfur was determined.
The ignition losses for B1, B2 and B3 with great depth were high concentrates and the total sulfur was also high with the maximum value of 1～5 mg g^{-1} (Fig. 2). The total sulfur of the surface in the pole surface of 0～2 cm layer tended to be high. Furthermore, the value total sulfur of about 0.3~0.7 mg g^{-1}, of total sulfur was measured in the relatively shallow sea area of A4, where bottom mud evidenced a hydrogen sulfide smell.

Table 1 The particle size distribution

station	depth (cm)	75 μm>	75–125 μm	125–500 μm	500 μm–2mm	2–4mm	>4mm
A1	0–1	4.52	5.89	87.50	2.10	0.00	0.00
	1–2	5.75	7.17	85.47	1.30	0.32	0.00
	2–3	6.34	4.81	85.64	2.82	0.39	0.00
A2	0–1	2.72	0.87	92.07	3.04	0.74	0.56
	1–2	3.11	0.88	90.72	3.36	0.37	1.57
	2–3	2.96	0.95	90.50	4.92	0.68	0.00
A3	0–1	3.13	2.11	79.92	14.84	0.00	0.00
	1–2	2.69	1.30	75.15	20.40	0.45	0.00
	2–3	2.95	1.37	72.91	20.92	1.86	0.00
A4	0–1	1.80	0.30	85.89	11.16	0.86	0.00
	1–2	1.76	0.00	83.18	13.93	0.54	0.59
	2–3	1.77	0.00	82.41	13.32	2.50	0.00
B1	0–1	30.21	9.06	44.80	8.30	3.59	4.05
	1–2	24.10	10.48	50.60	9.24	4.81	0.77
	2–3	26.97	13.73	45.55	6.66	3.43	3.66
B2	0–1	38.29	7.73	35.33	14.14	1.75	2.75
	1–2	22.66	12.11	49.92	12.80	1.96	0.55
	2–3	18.66	12.29	47.83	12.86	2.31	6.04
B3	0–1	16.87	11.88	66.76	3.43	0.73	0.33
	1–2	14.22	9.78	70.17	3.70	1.69	0.44
	2–3	13.94	6.40	73.72	3.22	1.63	1.09

In addition, red tide was appeared in the investigation sea areas in July 2005. All bottom core samples to the laboratory turned black within around 6 hours. It showed that a remarkable reduction condition had occurred in that bottom area.

3.3 IL Comparison around the airport construction

Ignition loss in 2003 and 2007 in the surface layer (at 0-2.5 cm depth) from the result of the dating which corresponds to about 5 years was compared at each point (Fig. 3). The 2003 value corresponds from 1999 to 2003, and the 2007 value to that from 2003 to 2007. This 5 cm thickness was equivalent to approximately 5 years from a result of the measurement of the sedimentation rate. At deep areas of B1, B2 and B3, the 2003 value was remarkably higher than in 2007, averaging 150%. 112% was obtained at A2, A3 and A4 site in very shallow sea. Beside, TS4 data showed the most remarkably changed value of 190% despite the shallow depth. It appeared at a place especially where the influence on the deep bottom sediments of the construction airport island started in November, 2000 was remarkable.

In this way, the progress of the bottom mud pollution clealy changed at A1 in very shallow sea and also at A4 where the sea bed had a convex shape.

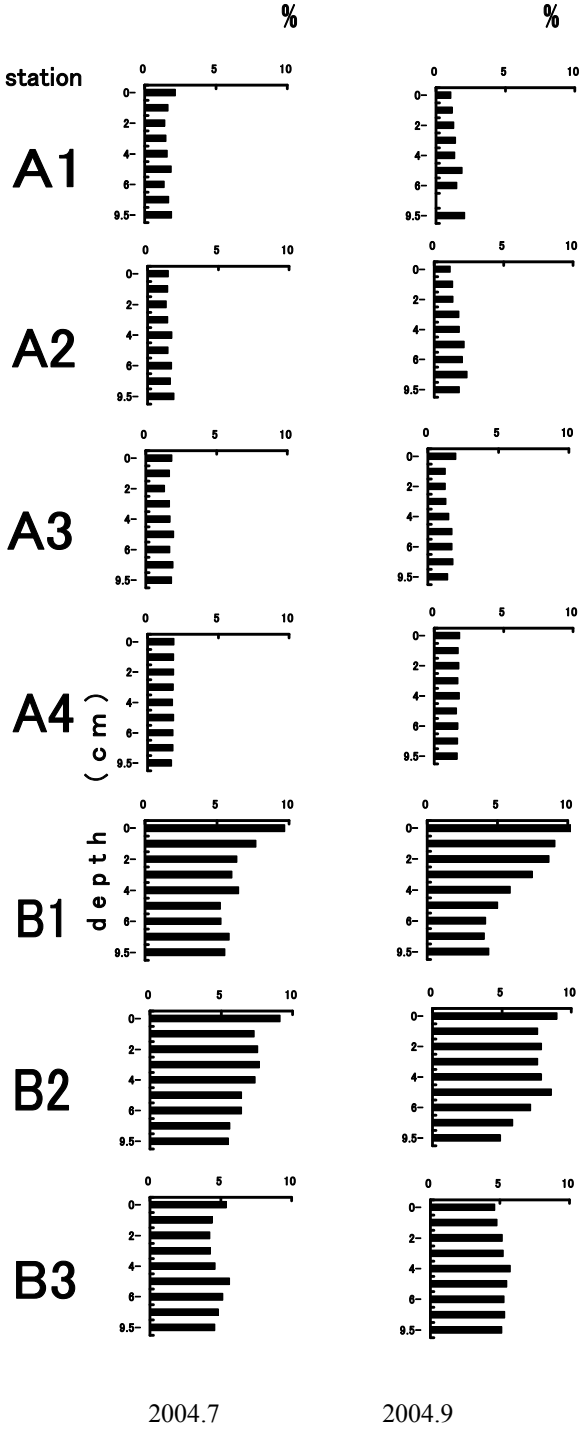

Fig.2 Ignition loss in vertical distribution

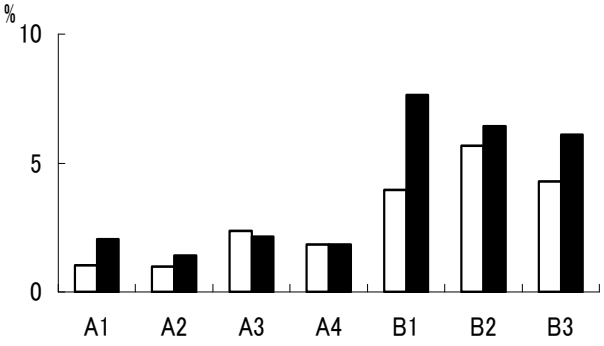

Fig.3 Ignition loss of surface layer (0-2.5 cm depth) in 2003 (white bar) and in 2007 (black bar)

4 CONCLUSION

The ignition loss values in surface sediment in 2003 averaged 150% times higher than that of data in 2007. The benthic fauna revealed the species and number of individuals were very few. Organic matter increased, the species structure of the benthos was made poor. The average number of individuals and species compared before and after the Airport construction clearly showed a remarkable decrease after the construction. This phenomenon might reflect the ongoing progress of eutrophication and oxygen depletion around the airport island sea.

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6 REFERENCES

[1] The oceanographic society of Japanese environmental issues commission, "For construction of artificial islands Central International Airport" (in Japanese), Journal of Oceanography, vol.8, 1999, pp. 349-357.

[2] Central Japan International Airport Co., Ltd. and Aichi prefecture, "The environment assessment's brief about the construction project of the Central Japan International Airport and the constructed project of the airport island area land for development (abstract)" (in Japanese) , 1998, 269pp.

[3] Central Japan International airport Co., Ltd. and Aichi prefecture, "Annual report of environmental monitoring results (2002) about the construction project of the Central Japan International Airport, the constructed project of the airport island area land for development and the constructed project of the other side of the airport island " (in Japanese), 2003, 442 pp.

[4] Central Japan International Airport Co., Ltd. and Aichi prefecture, "Annual report of environmental monitoring results (2003) about the construction project of the Central Japan International Airport, the constructed project of the airport island area land for development and the constructed project of the other side of the airport island" (in Japanese), 2004, 426 pp.

[5] Central Japan International Airport Co., Ltd. and Aichi prefecture, "Annual report of environmental monitoring results (2004) about the construction project of the Central Japan International Airport, the constructed project of the airport island area land for development and the constructed project of the other side of the airport island" (in Japanese), 2005, 464 pp.

[6] The Environmental Agency Water Quality Bureau, "Marine environmental monitoring guidelines", The ministry of the finance Printing beau, 1997, 136pp.

[7] Saijo Yatsuka, Hisayoshi Terai, Maki Umemura, Akihiko Yagi, Mariko Nagano, Yoshihisa Kato, Motohiro Kawase, Yasuo Matsukawa and Katsuyuki Sasaki, "Degradation of seawater and sediment quality and benthic fauna composition caused by construction of the Chubu international airport island in Ise bay, Japan" (in Japanese), 2008, Oceanography in Japan, 17(4), 281-295.

[8] Lu, X. and E. Matsumoto (2005): Recent sedimentation rates derived from ^{210}Pb and ^{137}Cs methods in Ise Bay, Japan. *Estuarine, Coast. Shelf Sci.*, 65, 83-93.

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