FIELD OBSERVATIONS ON SPRING-NEAP TIDE VARIATION OF TIDAL CURRENT AND DENSITY STRATIFICATION IN THE ARIAKE BAY

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The Ariake Bay, which is famous for a macrotidal estuary (tidal range is greater than 5m at the head of the bay at spring tides) and has the widest tidal flat (surface area: 207km^2) in Japan, is located in the western side of Kyushu Island, Japan. Its surface area is 1700km^2. The Ariake Bay has a branch called the Isahaya Bay in the northwestern side and its surface area is 75km^2. The head of the Isahaya Bay was reclaimed in "the Isahaya Bay reclamation project." The project started in 1990 by the Ministry of Agriculture, Forestry and Fishery of Japan in order to develop fine farmland and keep off flood in the lowland in the rear of the Isahaya Bay. In this project, a surface area of 36km^2, which is 2.1% of the total surface area of the Ariake Bay, is reclaimed at the head of the Isahaya Bay. The reclaimed area is divided by a 7-km long sea-dike constructed in 1997.

Water environment in the Ariake Bay changed drastically after construction of the Isahaya sea-dike. Both of frequency of occurrence and scales of time and space of red tide and oxygen depression tend to increase. In addition, fish catches of cultured laver, clams and fan-shells have decreased. These became serious social problems in Japan, because fishery, especially cultivation of laver, is one of the major industries around the Ariake Bay. Recently, it has been considered that information of tidal current at neap tide is very important to discuss oxygen depression and red tide because of stratification due to its weak current. In this paper, a result of tidal current and CTD observations that were carried out by using a Acoustic Doppler Current Profiler (ADCP) and a multi-factor profiler in order to investigate current and stratification structures correspond to the several tidal conditions (spring, middle and neap tide) was introduced.

Two shipboard ADCPs were used in the observation on tidal current on two sections: Line-C and Line-D. Vertical profiles of salinity and water temperature were measured by using multi-factor profilers at five points (only three points on 30 June) equally spaced on the Line-C and D.

Vectors of depth-averaged horizontal velocity on the Line-C at flood and ebb tide are shown in Fig. 1 and 2. We can see that the relatively strong flow appeared in the area of approximately 3 km from the Shimabara Peninsula at both spring and neap tide. Maximum velocities are 114.6cm/s at spring tide and 60.6cm/s at neap tide respectively. The ratio of them is equivalent to the ratio of tidal range at spring tide (431.5cm) to one at neap tide

(233.5cm). Thus, it implies that the horizontal distribution of velocity on the Line-C is caused by barotropic component.

It was clarified from CTD observations that stratification in the western side is more stable than that in the eastern side on the Line-D, while that in the eastern side is more stable than the western side on the Line-C. However, the density difference between surface and bottom was larger in the western side on the Line-C. It implies that stratification is weakened by strengthened vertical mixing due to the relatively strong flow in the area along the shore of the Shimabara Peninsula.

As a result of this research, we conclude that the current structure which has strong flow in the area close to the Shimabara Peninsula plays an important role of exchange of sea water in the northern Ariake Bay, because it affects vertical mixing and horizontal shear which bring about longitudinal dispersion of substance.

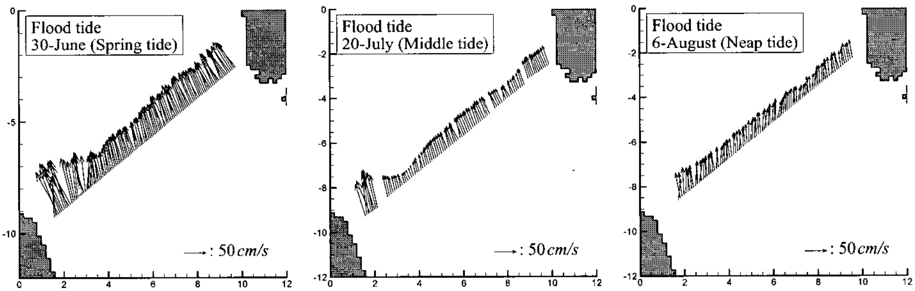

Fig. 1 Depth-averaged velocity vectors on the Line-C at flood tide (17:23-18:25 on 30 June, 8:55-10:14 on 20 July, and 10:53-12:27 on 6 August). (left: 30 June; center: 20 July; right: 6 August)

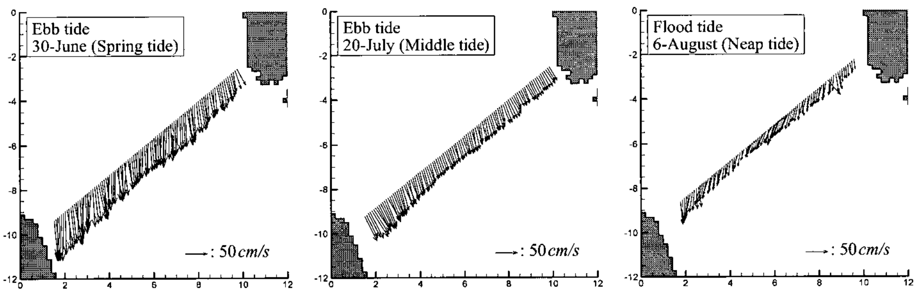

Fig. 2 Depth-averaged velocity vectors on the Line-C at ebb tide (11:26-12:26 on 30 June, 14:55-16:05 on 20 July, and 17:26-19:00 on 6 August). (left: 30 June; center: 20 July; right: 6 August)