CHARACTERISTIC OF CURRENT VELOCITY IN MITOGUCHI CHANNEL, LAKE JUSAN

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1. INTRODUCTION

Lake Jusan, located in Aomori prefecture, is a brackish, shallow and wide lake. Three rivers flow to the lake; Toriya, Iwaki and Yamada River, but based on the catchment's area, Iwaki River is the dominant one. The lake is connected to the Japan Sea by Mitoguchi channel, which is man made and 180 m wide (Sasaki and Sato, 2006) (**Fig. 1**). This lake is a habitat of Shijimi (*Corbicula japonica*), a species of bivalve that is very important fisheries resource in Japan.

The population of bivalve fluctuates yearly, but the parameters responsible for it have not been clearly understood. The population density does not spread uniformly in the lake.

Hydrodynamic behavior plays dominant aspect on clam population (Spillman et al, 2009). For Shijimi, it affects not only on supplying food and serve an appropriate water quality, but also on their fertilization, spreading (Nakamura, 1997). A three dimensional hydrodynamic model is sufficient to simulate the circulation structure in the lake, a set of accurate boundary condition data is required in order to obtain precise results. One of it is velocity distribution in Mitoguchi channel.

The objective of this study is to measure the characteristics of flow velocity in Mitoguchi channel that will be used as one of boundary condition data for hydrodynamic numerical simulations.

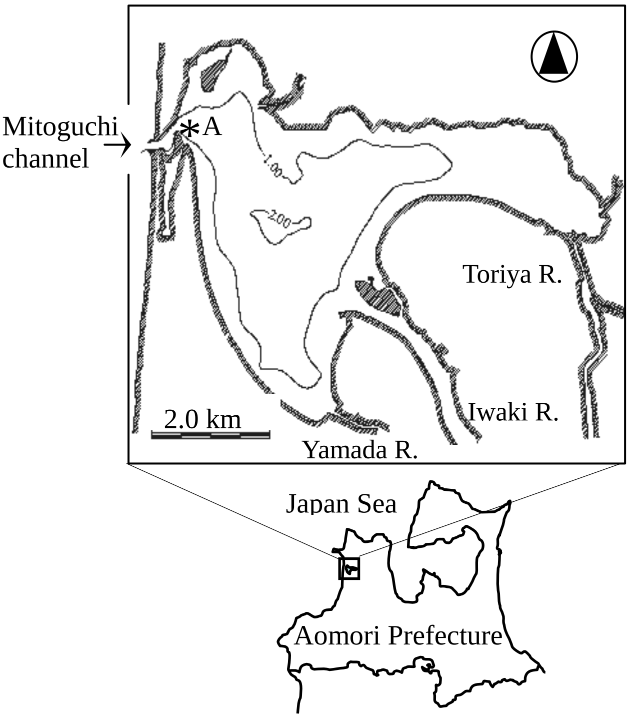

Fig.1 Location of Lake Jusan and Mitoguchi channel

2. FIELD OBSERVATION

Two kinds of observations, continuous and spatial measurements, were done to figure out the velocity distribution in Mitoguchi channel. For continuous measurements, two current meters (ECM, Alec Electronics Co. Ltd) were deployed at point A (**Fig. 1**), positioned at 0.5 and 1.5 meter above bottom (mab) to catch the vertical distribution of velocity. The observations started from 10 July and finished on 25 October 2009, and were set to record the data at 10 minute interval.

Spatial measurements were performed by using ADCP (Acoustic Doppler Current Profiler, RD Instrument) to clarify the vertical distribution of velocity in the channel. Measurements were carried out at several tracks in the cross line and along the center line of the channel. Measurements were carried out several times, but to compare the extreme differences during flood and low river discharge, two events were chosen, the 10 July and 26 September 2009 events.

On July 10th 2009, it was stormy with high intensity of rain and strong wind. In Mitoguchi channel, it was clearly observed that water flew from lake to the sea. The discharge of Iwaki River at Goshogawara was 425.8 m^3/s. The contrast condition happened on the second measurement: it was calm and sunny day, and the discharge was only 23.1 m^3/s.

3. RESULTS AND DISCUSSIONS

3.1. Velocity profile

Comparing the data obtained from ADCP and continuous measurement, shows that continuous data caught the vertical variability of velocity (**Fig. 2**), therefore based on continuous data is sufficient to predict vertical velocity distribution using continuous data is reasonable.

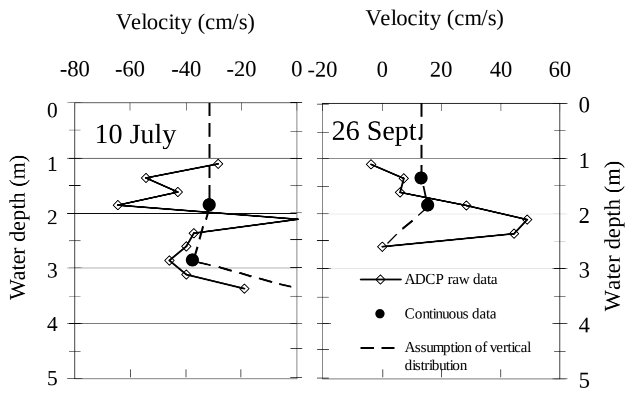

Fig. 2 Comparison between ADCP and continuous point measurement data. The dot line is proposed method to approximate vertical velocity distribution.

Keywords: Mitoguchi channel, velocity distribution, discharge estimation
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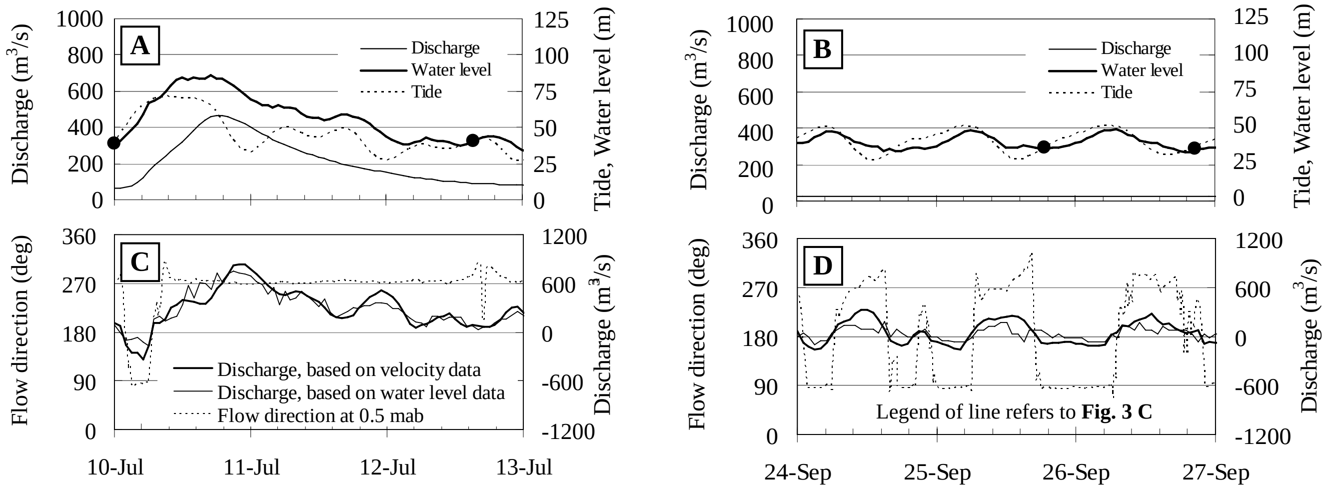

Fig. 3 Estimation of discharge flowing Mitoguchi channel by using velocity and water level data; during flood (A) and low discharge (B). The two dots in every case indicate the time frame of water balance calculation. Estimated discharge correlated to flow direction for both cases (C and D). The flow direction starts from the North, and clockwise. The negative discharge means water flowing from the sea into the lake

3.2. Calculation of discharge in Mitoguchi Channel

Estimation of discharge trough the channel is crucial to achieve precise results on numerical simulation. An equation to calculate flow discharge by using water level change ($\frac{dh}{dt}$) in the lakeis as follow:

$$Q_{out} = Q_{in} - A\frac{dh}{dt},$$

where A is surface area and Q_{in} is inflowing discharge. Correlating to velocity data, calculation by using above formula sometime generates a problem that the discharge and velocity were not in the same direction.

To avoid that problem, calculation of discharge was performed by using velocity data. Some assumptions were applied. Velocity at the bottom is set to zero and in the surface is equal to the velocity at 1.5 mab, therefore four points velocity data are available. Velocity between two point's data will be interpolated linearly. Average velocity will be obtained by dividing the total velocity by water depth. The cross section of the channel assumed as rectangular, and the channel width was estimated from the bottom track data of the ADCP, but should be checked by water balance calculation.

Water balance is calculated by comparing the total inflow from the river and the net outflow from the lake within the same duration. The duration starts when water level in the lake meets tide elevation and finish when they meet again at the same elevation. During this duration, the volume of water inflow should be the same with the net of water outflow.

The both estimations above were conducted for the two cases: Case 1, during flood (10 July, 00:00 to 13 July, 05:00) and Case 2 during low river discharge (25 Sept., 17:00 to 26 Sept., 18:00), and the results are shown on **Fig.3** and **Table 1**. During the flood, there is a clear difference on the water level change, therefore calculation based on water level gives a better result. On the other hand, during low river discharge, water level change is not so clear, then the error getting bigger. Moreover, problem of unsynchronized direction between velocity and discharge appear (**Fig. 3B**)

Table 1. Comparison of water balance calculation by using water level and velocity data.

	V_{in} (10^6 m^3)	V_{out} (10^6 m^3)			
		Based on elev.		Based on vel.	
Case 1	78.04	77.70	Error 0.4 %	77.09	Error 1.2 %
Case 2	2.98	3.50	Error 17.4 %	3.03	Error 1.8 %

4. CONCLUSION

Field observations were conducted in Mitoguchi Channel, Lake Jusan to investigate the velocity characteristics in the channel. Vertical velocity distribution was captured and was used to calculate the discharge flowing the channel. Calculation of outflow discharge by using velocity data gives more realistic result than using water level data, especially on avoiding problem of unsynchronized direction between velocity and discharge.

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