Behavior of Suspended Material in Lake Biwa

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1. Introduction

Investigation of the behavior of suspended material is very important to clarify the water quality formation and metabolism as well as the ecosystem in the lake. The river water controls the lake water quality by the transportation of both dissolved and suspended materials into the lake. Therefore, continuous observations were carried out to reveal the seasonal variation of the river water transportation into the lake. We have an attention on the River Yasu whose watershed area is largest among all rivers in Lake Biwa basin. In this article, we describe the dispersion of river water, and transportation of suspended materials in the lake.

2. Observation

Since 1996 we have carried out the observation of water temperature, turbidity, electric conductivity and chlorophyll-a both in the south basin and the north basin of Lake Biwa almost every month. The TCT profiler was used for measuring the vertical profiles of water quality. At every station, transparency and wind were also measured. The positioning of the stations were made by GPS. Figure 1 shows the arrangement of the observation stations. Water samplings have also been made occasionally at some stations. By filtering the sampled water, we analyzed the concentration of suspended substance (SS), ignition loss and concentrations of chemical elements of Al, Si, Ti, Fe, Ca, K, P, S and Mn by X-ray fluorescence spectrometry.

Automatic current meters, turbidity meters and thermistor chain have been set in these area to obtain the continuous records of current, turbidity and water temperature. Water temperature of River Yasu has also been continuously monitored using a thermometer.

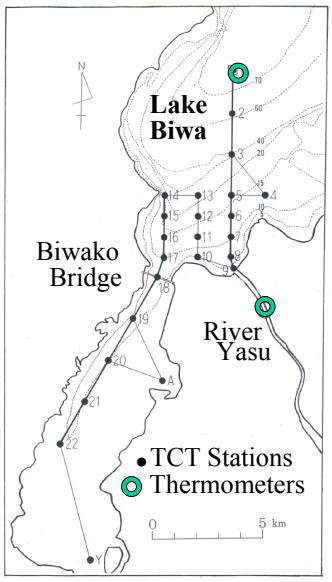

Fig. 1 Observation stations

3. Dispersion of river water

Figure 2 shows the seasonal changes of water temperature in River Yasu and Lake Biwa. It shows that water temperature of River Yasu is lower than lake temperature from autumn to spring, whereas it is higher from spring to early summer. On the basis of these temperature changes, we conclude the seasonal change of the river dispersion. In winter, river water sinks at the river mouth and flow along the lake bottom partially mixed by the strong wind. In early spring, river water spreads out in the lake surface. During May and August, river water flows into the surface layer of the lake in the daytime because its temperature is warmer than lake water, but sinks in the nighttime by cooling of river water. In late summer and autumn, river water intrudes into the thermocline. Figure 3 shows an example of this phenomenon which was obtained just after heavy rainfall.

From the comprehensive analysis by using the water temperature data of the river and every 5m-depth in the lake, we estimate the seasonal change of inflowing depth of the river water. The result is shown in Figure 4. From these analyses, we estimated the exchanging rate of the lake water to be about 13.1%/year, which is faster than that estimated by former analyses.

4. Benthic nepheloid layer

The benthic nepheloid layer (BNL), which means the layer just above the lake bottom with

high turbidity, developed in the seasons of thermal stratification (Fig. 5), and is not detectable in the non-stratification period (winter). The BNL is maintained by the organic matter sinking such as phytoplankton under decomposition. However, the turbidity in the nepheloid layer was much affected by the turbid water from rivers after heavy rainfall. In this case, the major component of the suspended substance in the nepheloid layer was inorganic soil. The particulate P concentration, which is originated from phytoplankton, also increased after a rainfall. This suggests that phytoplankton in the surface layer sinks with clay and silt coming through rivers. From summer to the early winter, another kind of turbidity appeared in the bottom layer. This is caused by the chemical reaction of manganese under the anoxic condition. The resuspension of bottom sediment by strong currents also occurred, but it is not a major process for maintaining the BNL.

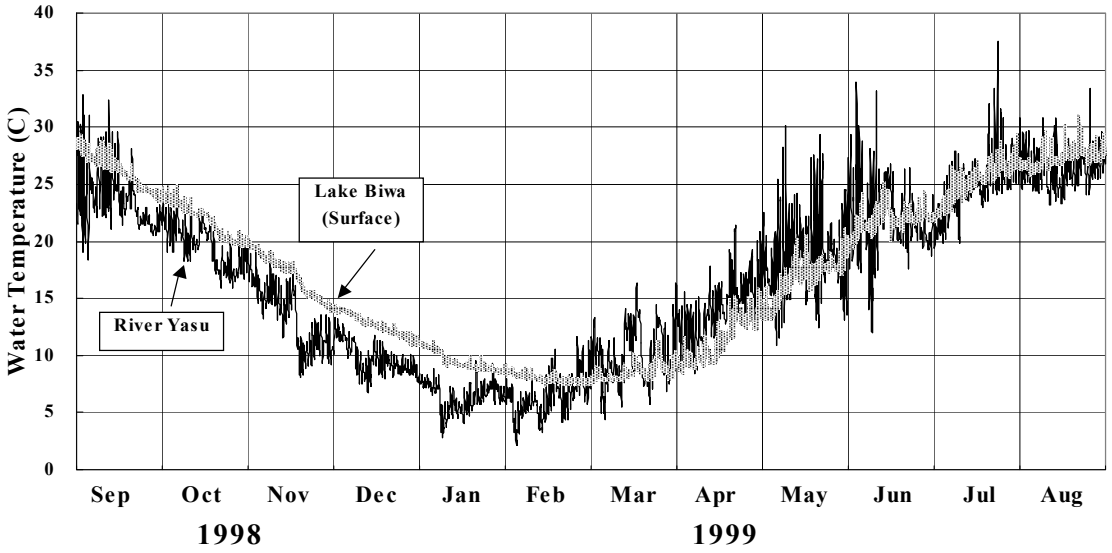

Fig. 2. Seasonal change of water temperature in River Yasu and Lake Biwa (surface).

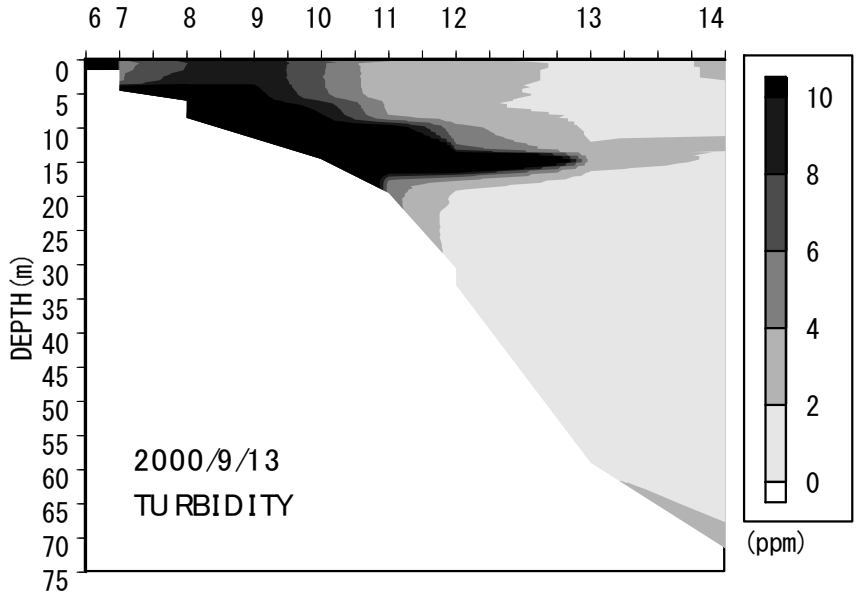

Fig. 3. Vertical section of turbidity off River Yasu on 13 September, 2000.

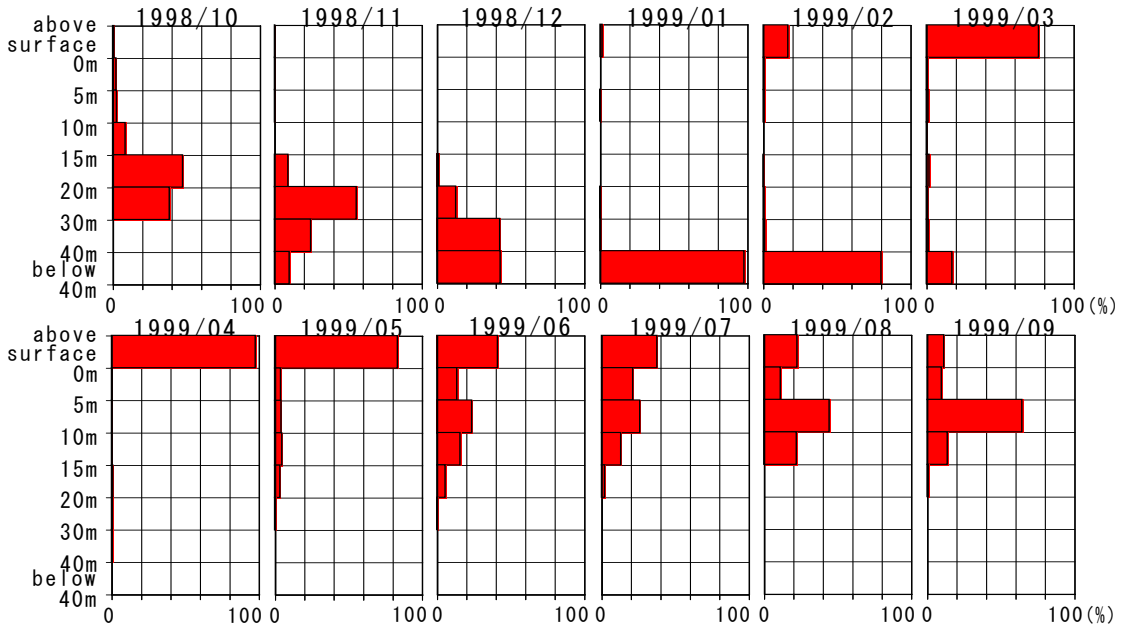

Fig. 4. Seasonal change of flowing depth of river water into Lake Biwa

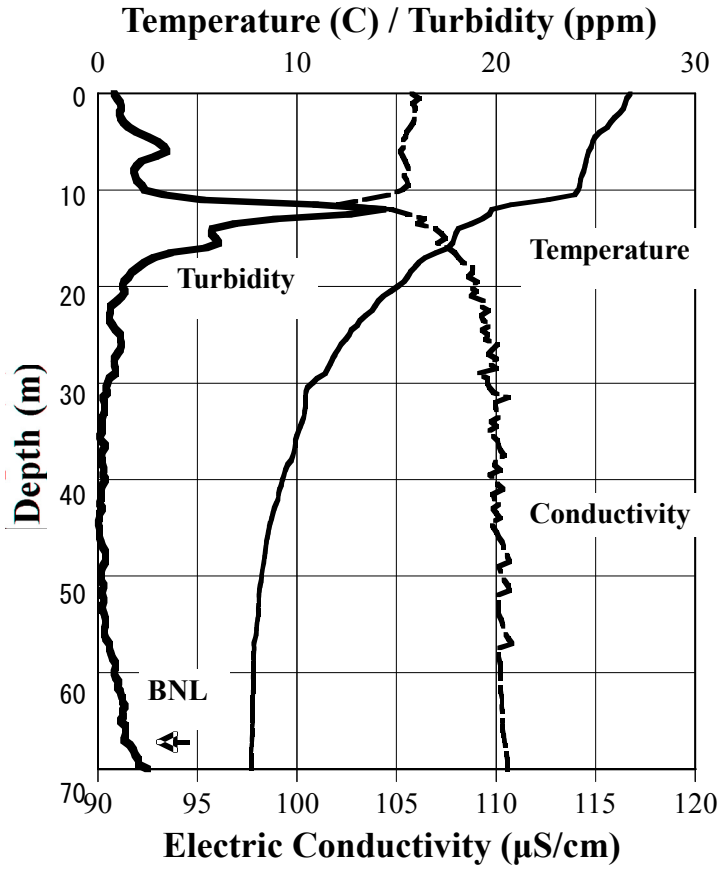

Fig. 5. Vertical profiles of water temperature, turbidity and electric conductivity