

Estimation of lake water circulation mechanism in Lake Tazawa based on Physico-chemical characteristics

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Lake Tazawa, located in Akita Prefecture, is the deepest lake in Japan. The elevation of the lake surface is around 249 m and the maximum depth of the lake is 423.4 m. Acidic water of Tama-River has been introduced to the lake since 1940 for electricity development. As the result, the rapid acidification of the whole lake water had progressed and most kinds of fish had been killed by the acidification. After that, a neutralization treatment of acidic river water began in 1991 and the neutralized river water has been introduced to the lake. According to Akita Prefectural Government (2015), the water qualities of the shallower and deeper layers of the lake were different from 1991 to the beginning of 2000s, and they became almost uniform since around 2003. This fact suggests the possibility that the circulation mechanism of lake water has been changed and the turnover has occurred since around 2003 (Boehrer et al., 2008; Ishiyama et al., 2013). However, the circulation mechanism of the large amount of lake water in the lake has not been clarified. Considering the results of previous studies, the two possibilities of the circulation mechanism of lake water are considered. First possibility is an inflow of the river water having heavier density due to high concentration of dissolved components especially metals. If the river water has the heavier density than the lake water, the river water may affect the circulation of lake water by the heavier density flow. Second possibility is the circulation of the lake water by strong wind under the conditions of almost uniform temperature and density of lake water. Considering these points, we study on the circulation mechanism of the lake water based on the physico-chemical characteristics and water quality of the lake water. This study will contribute to predict the circulation variation in the future and the efficiency of the water quality improvement in the lake.

The water samples of Lake Tazawa were collected at five locations in the lake and at some depths at each point. The samplings were carried out between June and October in 2019. Water temperature, pH, EC, Eh, density, specific gravity, quantity of suspended solids, and major dissolved ions were analyzed. Water temperature was different between shallower and deeper layers and the water temperature in deep layer was almost constant around 4°C from June to October. So, the thermocline existed through this period. On the other hand, values of pH and concentrations of major dissolved elements of the lake water were similar between all the sampling points and the depths. This result showed the water quality as the whole lake was almost uniform. In addition, the specific gravity and the quantity of suspended solids of lake water and river water of Tama-River were similar. The existence of thermocline and the results of specific gravity and suspended solids of lake water and river water showed that the difference of water density based on the water temperature is much larger than that based on the water quality. Thus, the first possibility was denied. On the other hand, if the shallower water is sufficiently cooled and the water temperature from bottom to surface becomes around 4°C in winter, the difference of the density of lake water between the shallower and deeper layer will become small. Then, strong winds in this season are considered to cause the turnover of the lake water. The results of this study suggest that the future environment change such as the global warming and climate change may affect the circulation of lake water and the ecosystem of the lake.

Keywords: Lake Tazawa, Water quality, Circulation, Turnover, Thermocline, Wind

