Hypolimnetic oxygen depletion rate of 8 Japanese mesotrophic lakes in 2021

*TAKAAKI ITAI[1], Hiroki Ishimizu[1]

1. Department of Earth and Planetary Science, The University of Tokyo

Hypolimnetic oxygen depletion rate is important variable to estimate net supply of primary production in lake system. We evaluated areal hypolimnetic oxygen depletion rate (AHOD) from 8 Japanese lakes through dissolved oxygen (DO) monitoring by Winkler method 3-4 time in a year 2021 to provide benchmark data of Japanese mesotrophic lakes. Lake water samples from multiple depths were collected in March/April, June, August, and October 2021 at Fuji lakes [Lake Yamanaka (YMN), Lake Kawaguchi (KWG), Lake Sai (SAI), and Lake Shoji (SHJ)], Nishina lakes [Lake Nakatsuna (NKT), and Lake Kizaki (KZK)], and Urabandai Lakes [Lake Hibara (HBR), and Lake Onogawa (ONG)]. Lake bathymetry data was obtained from the database provided by Geospatial Information Authority of Japan. The variables that characterize thermal stratification structure of lakes, such as the boundary depth of epilimnion/hypolimnion, and thickness of metalimnion were analyzed after establishing interpolation scheme of discrete data of temperature with depth using a cubic spline function of R script. The average P levels in the circulation period (March/April) was defined as TP_{mix} regarded as the representative P levels of each lake. The TP_{mix} was 132-249 nmol L^{-1} in Fuji lakes, 101-117 nmol L^{-1} in Nishina lakes, and 75.4-80.7 nmol L^{-1} in Urabandai lakes. The relatively high TP_{mix} in Fuji lakes was plausibly attributed to the elevated P level in surrounding soil originated from the weathering of basaltic rocks with high P concentration. In Nishina lakes and Urabandai lakes, internal loading of P during the stratification period was notable. Hypolimnetic phosphorus accumulation values were in the rage of 1.55-12.6 mmol m^{-2} day^{-1}. The AHOD were in the range of 2.22-15.6 mmol m^{-2} day^{-1}, and tended to increase with increasing the mean hypolimnion thickness (Z_H). There is strong positive correlation between TP_{mix} (nmol L^{-1}) and AHOD (mmol m^{-2} day^{-1}) (AHOD = $0.121TP_{mix}$ + 0.0073, R=0.9868) when considering lakes having Schmidt stability index (SSI) during summer >12 (i.e., SZAI, KZK, HBR, ONG). Different trend of lakes showing low SSI (i.e., YMN, KWG, SHJ, and NKT) is probably due to significant supply of DO from epilimnion during stratification. As far as we know, this is the first report of AHOD which is systematically determined from multiple mesotrophic lakes in Japan.

Keywords: lake, oxygen depletion, phosphorus, Japan

