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Recent enrichment of nutrient and heavy metal deposition in Japanese mountain lakes due to anthropogenic dust

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Recent studies revealed that nutrient inputs such as nitrogen and phosphorus through atmospheric deposition to aquatic ecosystems have been increasing (Elser et al. 2009; Neff et al. 2008). In addition to nutrients, large emissions of heavy metals such as antimony (Sb) and indium (In) to the atmosphere is expected to be extensive (Filella et al., 2002; Tian et al., 2012; White and Hemond, 2012). East Asia plays an important role in global anthropogenic emissions, but little is known about the effects of nutrient emissions on terrestrial ecosystems and changes in the extent of the metal pollution during its rapid economic growth in recent decades. In this study, we examined fossil pigments and zooplankton remains in dated sediments taken from high mountain lakes at some Japanese National Parks in Hokkaido and Honshu area, to uncover the historical changes of plankton community over the past 100 years. Simultaneously, we measured the geochemical variables such as heavy metals, nitrogen and lead stable isotope to uncover the historical changes of metal deposition, and to identify causal factors including dust source regions. Sedimentary results showed that the fluxes of heavy elements of Sb and In increased at Lake Hachiman-Numa and Hourai-Numa in recent years (Kuwae et al. 2013). Furthermore, the fluxes of phytoplankton abundance in Lake Hourai-Numa (Tsugeki et al. 2012) and Lake Mikurigaike and Niseko-Onuma drastically increased since around 1990 when N stable isotope ratios in sediments decreased, probably due to expanding atmospheric N deposition. In parallel with this, *Daphnia*, a keystone herbivore, increased. During this period, there seems not to be expanding human activities in the watershed around these lakes, suggesting that the increases in nutrients and heavy metals were not resulted from inputs from watershed. Alternatively, Pb stable isotope data in Lake Hachiman-Numa and Hourai-Numa showed that dust deposition with nutrient and metal substances originated from the Asian continent were increasingly transported to study lakes in recent years (Tsugeki et al. 2012; Kuwae et al. 2013). These results imply that long-range transports of anthropogenic dusts have promoted not only Sb and In deposition but also eutrophication in a wide range of Japanese lakes even far from direct human disturbance.

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