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Climate-driven changes of dissolved organic carbon and metal bioavailability in the Arctic

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Many open questions remain regarding the potentially large impacts of climate change on the carbon cycling, hydrology and water quality in the Arctic. Notably, permafrost thaw may increase dissolved organic carbon (DOC) concentrations in rivers that discharge into the Arctic Ocean, which also can alter the bioavailability of metals carried by the rivers, by impacting metal speciation. We use the geochemical equilibrium speciation model Visual MINTEQ to investigate how sensitive concentrations of the relatively bioavailable dissolved metal phase would be to changes in DOC concentrations. In particular we model metal spreading from a large mining source zone within the Lake Baikal drainage basin (located in Russia and Mongolia), which is connected to the Arctic Ocean through the Yenisey River. Results showed that, under prevailing high-pH conditions (up to 9.6), metal-organic complexation had a large impact on the speciation of Pb and Zn. These metals were predicted to form soluble complexes with DOC, on average governing their speciation by 50 % and 30 %, respectively. With a hypothetical 50 % increase in DOC concentrations, an increased dissolved fraction of all metals were predicted, with the greatest impacts on Fe, Pb and Zn solubility, on average increasing by 65 %, 40 % and 30 % respectively. At certain locations, over 80 % increase were predicted for these metals. This may have important implications for Arctic ecosystems, including the status of species endemic to Lake Baikal.