Impacts of Climate on Long-term Variation in the Abundance of Different Chemical Fractions of Phosphorus in Finnish Archipelago Sea Sediments

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Phosphorus is a factor that controls the growth of organisms in marine systems. However, excessive phosphorus input triggers eutrophication and hypoxia (Schindler 1977), which have deteriorated especially the environmental status of inner Finnish Archipelago Sea (Jokinen et al. 2018). Though external phosphorus load has diminished, the problems caused by eutrophication have not been conquered (Andersen et al. 2009, HELCOM 2011, McCrackin et al. 2018). Previous studies have also shown the significance of internal load of phosphorus that hinders the recovery of Archipelago Sea (Puttonen et al. 2014, 2016). However, the accumulation, preservation, and long-term variations in the burial of phosphorus within the sediment is not fully known. Thus, we trace long-term variations in chemical forms and contents of sediment phosphorus in detail to reveal the importance of different processes on phosphorus deposition, burial, and release.

We investigate variations in the abundance of different chemical fractions of phosphorus (i.e. different binding and solubility forms of phosphorus) during the last 60 years with seasonal resolution from varved sediments of Halikonlahti Bay sediments in inner Finnish Archipelago Sea. We compare abundances of phosphorus fractions to hydro-climate parameters to study how variations in the conditions, such as occurrence and timing of precipitation or snow and ice cover, control the washout of phosphorus from the catchment. In addition, we investigate if the changes in enhanced leaching of phosphorus are directly mediated to sediment deposits. According to our knowledge, varved marine sediments have not been earlier used to study long-term variations in chemical phosphorus fractions with sub-annual resolution. The importance of this study lies within high temporal resolution allowing to assess the response of phosphorus burial to past hydro-climate conditions. This can further improve our understanding on internal loading and hence the use of rehabilitation actions and target them better spatially and temporally.

References

Andersen, J. H., Laamanen, M., Aigars, J., Axe, P., Blomqvist, M., Carstensen, J., ... & Villnäs, A., 2009: Eutrophication in the Baltic Sea–An integrated thematic assessment of the effects of nutrient enrichment and eutrophication in the Baltic Sea region. *Baltic Sea Environment Proceedings ed. Baltic Sea Environment Proceedings. Helsinki Commission*.

Helcom, 2011: The Fifth Baltic Sea Pollution Load Compilation (PLC-5). *Baltic Sea Environment Proceedings 128*, pp. 1–217.

Jokinen, S. A., Virtasalo, J. J., Jilbert, T., Kaiser, J., Dellwig, O., Arz, H. W., ... & Saarinen, T., 2018: A 1500-year multiproxy record of coastal hypoxia from the northern Baltic Sea indicates unprecedented deoxygenation over the 20th century. *Biogeosciences 15*, 3975-4001.

McCrackin, M. L., Muller-Karulis, B., Gustafsson, B. G., Howarth, R. W., Humborg, C., Svanbäck, A., & Swaney, D. P., 2018: A century of legacy phosphorus dynamics in a large drainage basin. *Global Biogeochemical Cycles 32*, 1107–1122.

Puttonen, I., Mattila, J., Jonsson, P., Karlsson, O. M., Kohonen, T., Kotilainen, A., ... & Rydin, E., 2014: Distribution and estimated release of sediment phosphorus in the northern Baltic Sea archipelagos. *Estuarine, Coastal and Shelf Science 145*, 9–21.

Puttonen, I., Kohonen, T., & Mattila, J., 2016: Factors controlling phosphorus release from sediments in coastal archipelago areas. *Marine Pollution Bulletin 108*, 77–86.

Schindler, D.W. 1977: Evolution in Phosphorus Limitation in Lakes. *Science 195*, 260–262.