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Spatial and seasonal variation in dissolved silica benthic fluxes in the shallow zones of the southern Baltic Sea

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Dissolved silica (DSi) is an important macronutrient in the marine environment, necessary for growth of many aquatic organisms. Yet, DSi marine cycle is still not fully recognized, especially in dynamic, coastal zones. Although DSi is mainly transported to the sea by rivers, benthic fluxes of DSi, which originate from dissolution of the siliceous remains in the sediments, can also represent an important source of bioavailable silicon in the ocean. Benthic DSi fluxes are mainly powered by diffusion, but their rates are strongly shaped by the benthic fauna. Still, the role of benthos in these processes is not fully recognized. The main goal of this study was to investigate how various environmental factors and benthic fauna may shape the coastal cycle of Si in coastal environments during different seasons.

Our study was conducted in the shallow coastal ecosystems of the southern Baltic Sea characterized by contrasting environmental conditions: shallow, brackish and enclosed Szczecin Lagoon (Oder river estuary), dynamic open waters near Łeba with relatively low anthropogenic influence, enclosed Puck Bay and Vistula prodelta. We investigated both shore ecosystems (app. 0.5 m depth) and deeper areas (from 6 up to 60 m depth). DSi concentrations in the bottom waters and environmental characteristics (T, S, O_2, sediment organic matter) were investigated at 6 stations, during three seasons (winter, spring and autumn) in years 2019-2020 with s/y Oceania (IOPAN) and directly from the shore. Additionally, samples from shore stations were collected during summer. DSi benthic fluxes were determined at each station by performing *ex situ* incubations of sediment cores (n = 4-5) with natural benthic assemblages. The benthic organisms in studied cores were collected, identified, counted, and weighed.

The lowest fluxes were measured at sandy stations while highest return fluxes were observed at muddy sites. High variability in DSi benthic fluxes along studied localities was observed, ranging from -1.11 mmol $d^{-1}m^{-2}$ in summer at shore station in the Puck Bay and up to 6.79 mmol $d^{-1}m^{-2}$ in Szczecin Lagoon in autumn. We used Gaussian Generalized Linear Models (GLMs) to estimate the role of environmental conditions, benthic fauna characteristics and interactions among them in the variability of DSi benthic flux across studied localities. The most important predictors for the fluxes were all pair-wise interactions of temperature, total organic carbon, the C/N molar ratio, and the density of benthic macrofauna. Both interaction terms that included C/N ratio, a measure of organic matter quality (i.e. low C/N ratio indicates higher quality), were associated with

increased DSi uptake by the sediment. Further, the interaction term between T and benthic marcofauna density was also linked to negative benthic fluxes of DSi. In contrast, the interaction of T and TOC caused a strong increase in DSi return fluxes.