Nutrient silicon cycling and seasonal silicon limitation in a eutrophic coastal embayment

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Silicon (Si) is an essential nutrient for siliceous algae in aquatic ecosystems. The availability of reactive Si therefore impacts algal communities and water quality. Anthropogenic enrichment of water bodies with phosphorus (P) and nitrogen (N) alters nutrient ratios (P:N:Si) and may enhance stoichiometric Si limitation of siliceous algae. These conditions may favour the growth of non-siliceous algae, potentially causing nuisance and harmful algal blooms.

Here, we present a reactive Si mass balance model for Hamilton Harbour, a eutrophic embayment in Lake Ontario, Canada. Our objectives were to determine if the embayment is a net source or sink of Si, and if Si is stoichiometrically limiting with respect to P. Data on dissolved Si (DSi), reactive particulate Si (RPSi), and total dissolved P (TDP) were assembled from ongoing environmental monitoring, published literature, and field work carried out throughout 2016. The latter involved the collection of lake water, bottom sediments, and suspended sediment samples from Hamilton Harbour, and effluent from anthropogenic point sources. The model accounts for seasonal transformations between DSi and RPSi in the water column. Our results show that, in 2016, Hamilton Harbour was a net sink of reactive Si. The relative importance of external Si sources versus internal Si cycling varied as a function of the time of year. Hamilton Harbour was found to be seasonally Si limited with respect to P (Si:P < 16:1), which could be a factor contributing to the harmful algal bloom growth observed in the system.

While Hamilton Harbour is a freshwater embayment, these findings are likely relevant to coastal marine environments. The Laurentian Great Lakes are Earth's largest freshwater system and are comparable to oceans in terms of primary productivity [1]. In addition, seasonal Si limitation and the biogeochemical processes investigated herein are also encountered in nearshore marine environments. Thus, our research serves as a case study demonstrating the potential for Si limitation under eutrophic conditions, which can have important implications for primary productivity, ecological health and water quality.

[1] Phillips, McKinley, Bennington, Bootsma, Pilcher, Sterner & Urban (2015), *Oceanography* 28, 136–145