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Phosphorus geochemical cycling inferences from high frequency lake monitoring

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Freshwater bodies in Europe are required to return to good water quality status under the Water Framework Directive by 2015. A small inter-drumlin lake in the northeast of Ireland has been susceptible to eutrophic episodes and the presence of algal blooms during summer since annual monitoring began in 2002. While agricultural practice has been controlled by the implementation of the Nitrates Directive in 2006, the lake is failing to recover to good water quality status to meet with the Water Framework Directive objectives.

Freshwaters in Ireland are regarded, in the main, as phosphorus (P) limited so identifying the sources of P possibly fuelling the algal blooms may provide an insight into how to improve water quality conditions. In a lake, these sources are divided between external catchment driven loads, as a result of farming and point sources, and P released from sediments made available to photic waters through internal lake mechanisms.

High frequency sensors on data-sondes, installed on the lake in three locations, have provided chlorophyll a, redox potential, dissolved oxygen, temperature, pH, conductivity and turbidity data since March 2010. A data-sonde was installed in the hypolimnion to observe the change in lake conditions as P is released from lake sediments as a result of geochemical cycling with iron during anoxic periods. As compact high frequency sampling equipment for P analysis is still in its infancy for freshwaters, a proxy measurement of geochemical cycling in lakes would be useful to determine fully the extent of P contribution from sediments to the overall P load.

Phosphorus was analysed once per month along with a number of other parameters and initial analysis of the high frequency data has shown changes in readings when known P release from lake sediments has occurred. Importantly, these data have shown when these P enriched hypolimnetic waters may be re-introduced to shallower waters in the photic zone, by changes in dissolved oxygen saturation when thermocline-breakdown occurs, possibly fuelling algal growth and possibly lengthening the time to recovery from reduced external loads.

Further analysis of the P measurements and high frequency pH and conductivity measurements showed a breakdown in the weak relationship observed between these parameters during mixed conditions, when anoxic conditions prevailed in the deep water. High frequency data has therefore provided the opportunity to identify the period of P release without the requirement of intensive P sampling.