PHOSPHOROUS FROM AGRICULTURAL RUN-OFF: NEW INSIGHTS FROM MONITORING & MODELLING

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The management of phosphorous (P) in agricultural run-off currently focuses on trapping P-bearing sediment in riparian zones or settlement ponds. This is based on the common assumption that P is almost entirely bound to suspended particulate material (SPM) in the run-off and immediate receiving waters. In this study, this assumption has been held up to scrutiny, using existing monitoring data for dissolved reactive P (DRP) and total P in the Te Waihora/Lake Ellesmere and Wairewa/Lake Forsyth catchments, and a geochemical modelling approach.

Long term monitoring data for the lakes[1] confirms that P has indeed been predominantly bound to SPM in the water column (DRP averaged <10% of total P) over the monitoring period. However, in the tributaries there has been considerably more variability in the fractionation of P, and a higher proportion of DRP. In the Selwyn River, for example, DRP has made up (on average) 50% of the total P concentrations (38 yrs of monthly monitoring data[1]). In the LII River, DRP has made up 67% of the total P concentrations (19 years of monthly monitoring data[1]). In the smaller tributaries of Te Waihora, DRP has ranged from 34% (an average for creeks and streams) to 50% (an average for farm drains) of total P, over the 18 years that monitoring data has been collected by students of Lincoln and Canterbury universities[2,3]. Similar results have been observed in a recent 10 month survey of the tributaries of Wairewa, in which DRP averaged 30-60% of total P. During flood events the P fractionation has changed to favour a greater percentage of SPM-bound P in all tributaries monitored.

Using water chemistry and SPM compositions typical of these lake and tributary environments, the geochemical model PHREEQC has been used to determine principal controls on P binding to SPM. A sensitivity analysis approach was used to establish the role of variables such as the iron oxide content of the SPM, redox conditions, pH and the concentrations of competing ions such as SO_4. The potential precipitation of P-phases such as Ca-, Fe- and Mn-phosphates was also considered. While the uptake of P by phytoplankton could not be represented in the geochemical model, the correlation between in total P and chlorophyll-a observed in the long term monitoring data from both lakes[1] could be used, together with a mass balance approach, to predict the effect of phytoplankton growth on P fractionation.

It is proposed that this modelling approach can be used to predict the optimal conditions for P-binding to SPM, and therefore help identify the best options for retention and immobilisation of P, before it reaches important water features in a catchment.

References

1. Monitoring data kindly provided to the Waterways Centre by Environment Canterbury
2. Markham-Short R. (2012) A Compilation of Lincoln University Water Quality Monitoring Data for Lake Ellesmere/Te Waihora Catchment: 1993-2011. *WCFM Technical Report 2012-001*.
3. Mitchell H.L. (2014) A comparative study of riparian drain management and its effects on phosphate and sediment inputs to Te Waihora/Lake Ellesmere. *Unpublished Master of Water Resource Management thesis. University of Canterbury.*