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Soil organic phosphorus flows to water via critical and non-critical hydrological source areas

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Critical source areas (CSAs) are zones in the landscape where easily connected hydrology coincides with a phosphorus (P) sources in the soil. The P export risks in CSAs are hypothesised to be higher compared with non-critical source areas (Non-CSAs) and specifically that the magnitudes of P forms in CSA areas were higher than Non-CSAs. Past research on CSAs has often neglected forms of organic P, such as DNA and phospholipids which are among the most potentially biodegradable organic P compounds. The objectives of this study were i) to quantify the magnitude of organic P compounds in agricultural soils and specifically determine whether these magnitudes differed significantly between CSAs and Non-CSAs; ii) determine the variation of P magnitude between and within individual fields; iii) identify the P delivery concentrations in soil solution after raining events in CSAs. The study focussed on soils collected from the Morland sub-catchment of the River Eden catchment in Cumbria, northern England. CSA and Non-CSA pairs were identified using the SCIMAP modelling and field assessment providing five CSA – Non-CSA pairs in total. The results showed that there are significant differences in the total P (TP) concentrations, the proportions of DNA-P, WETP (water extractable total P), WERP (water extractable reactive P) and WEUP (water extractable unreactive P) between CSA and Non-CSA. We also found that the concentrations of all the P forms showed distribution variation between fields or even within the same field. Liable organic P such as DNA-P and PLD-P was presented considerable proportions of total P in soil, especially DNA-P which had a good correlation with TP. DNA-P in the ten areas accounted for a considerable proportion of soil TP (4.9 to 16.6%). Given the potential lability and bioavailability of DNA and phospholipids, our data demonstrate that these soil organic P could be a potential pool to support plant nutrition and a potential contributor to water pollution problems. Furthermore, For a number of soil samples, comparisons were made between extraction of P within phospholipids and DNA and the results of 31 PNMR analyses, to provide further characterisation of the organic P fractions within these soils.Data of this study will also be presented concerning the forms and magnitudes of P fractions in runoff pathways across an agricultural catchment, including the prevalence of organic P in these pathways.
Keywords: Organic P; Soil; CSA; DNA; Phospholipids