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Suspended sediment export in five intensive agricultural river catchments with contrasting land use and soil drainage characteristics

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Soil erosion and sediment loss from land can have a negative impact on the chemical and ecological quality of freshwater resources. In catchments dominated by agriculture, prediction of soil erosion risk is complex due to the interaction of physical characteristics such as topography, soil erodibility, hydrological connectivity and climate. Robust measurement approaches facilitate the assessment of sediment loss magnitudes in relation to a range of agricultural settings. These approaches improve our understanding of critical sediment transfer periods and inform development of evidence-based and cost-effective management strategies. The aim of this study was to i) assess the efficacy of out-of-channel (ex-situ) suspended sediment measurement approaches, ii) to quantify the variability of sediment exported from five river catchments with varying hydrology and agricultural land uses over multiple years and iii) to investigate trends in relation to physical and land use characteristics when sediment data were compared between catchments.

Sediment data were collected in five intensive agricultural river catchments in Ireland (3-11 km^2) which featured contrasting land uses (predominantly intensive grassland or arable) and soil drainage classes (well, moderate and poor). High-resolution suspended sediment concentration data (SSC - using a calibrated turbidity proxy) were collected ex-situ and combined with in-stream discharge data measured at each catchment outlet to estimate suspended sediment yield (SSY – t km^{-2} yr^{-1}). In two catchments additional in-stream turbidity monitoring equipment replicated ex-situ measurements including site specific calibration of individual in-stream and ex-situ turbidity probes. Depth-integrated samples were collected to assess the accuracy of both approaches.

Method comparison results showed that true SSC values (from depth-integrated sampling) were predominantly within the 95% confidence interval of ex-situ predicted SSC consequently confirming the robust cross-validation of these results. Average annual SSCs and SSYs were higher in poorly drained catchments (17-27 t km^{-2} yr^{-1}) than those with well drained soils (8-10 t km^{-2} yr^{-1}). Catchments with both poorly-drained soils and land use dominated by tillage were most susceptible to field-scale soil erosion due to rapid establishment of overland flow pathways and periods of bare soils during cropping cycles. However results suggest that relatively high SSY may also occur in grassland catchments, particularly on poorly drained soils and with higher stocking densities and greater likelihood of channel bank erosion. Whilst the mean SSY rates are low by international standards, inter-annual variability was significant highlighting the spatial and temporal fluctuations in runoff and soil erosion risk. Such issues are of particular concern as Ireland pursues an agricultural policy of sustainable intensification. Effective soil erosion and sediment management should address catchment specific characteristics.