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Assessing the spatio-temporal variability in the small tributaries of the River Wyre

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We are investigating transport variability in the small streams and rivers draining the forest of Bowland and feeding the River Wyre in Lancashire, UK. Sampling in the main channel of the river Wyre (at Garstang) has established that the main river water quality and sediment load is similar to that of larger rivers (Lune, Ribble) draining the same area, and co-varies with them seasonally (DOM) and in response to rainfall (discharge, TSS). However, this landscape/region scale "averaging" conceals considerable local variability in discharge, sediment load, sediment sources and DOM. Understanding this local variability is critical to developing a clear understanding of the impacts of current human activities and the process of post-glacial "recovery" that the river is still undertaking.

Our approach uses a mixture of in-situ sensor networks, monthly water sampling (multiparameter sonde, UV-fluorometer and UV-vis spectrometer), and b̃iannual morphological surveys (using photogrammetry and LIDAR). The investigation has run for one year, and is intended to run for a further four at least. For example, the headwaters of one branch (the Tarnbrook Wyre) consist of three streams. The Hare Syke has a relatively large (3 sq km peat) catchment, a near zero base flow, and a large peak flow (reflected in the channel morphology). The second un-named stream is dominated by a spring close to Hare Syke (Ward Stone aquifer) and has a small run-off catchment. The third stream (Brown Syke) has significant groundwater input (Bowland shales) with Carbonate content, and ĩ sq km runoff catchment. At this site we have installed a network of sensors (3 pressure gauges, 3 Turbidity meters, 6 temperature loggers, 6 tilt based (HOBO-G) flow and level estimators, an automated weather station (Vaisala) and 3 soil moisture detectors), and have a regular programme of site visits. The sensors are all logging at 10 minute intervals and can thus capture rapid changes. The sampling is a reasonable match to the streams dynamic response to rainfall events (a minimum observed rise time of 30 mins), and does not fill the logger memories too quickly.

Unsurprisingly, we have found that patchiness in rainfall accross the Wyre catchment can lead to some feeder streams flooding whilst others are near base flow. More interesting is the observation that local flood events often do not correlate with TSS. This appears to be because some locations are starved of sediment that can be moved by the current stream, whilst other locations are well supplied with unconsolidated deposits from the LGM, but the main mechanism of sediment delivery at sites observably exporting sediment is bank collapse which often occurs late in the flood or during a subsequent smaller flood. At those locations dominated by pastoral farmland, TSS relates most strongly to soil saturation, and correlates with high discharge events that result from several days of rain, but not with those caused by a convective storm at the end of a dry period, and thus is likely to relate to soil loss. Supply of DOM is also very variable reaching seasonal peaks at different months in streams draining upland peat, coniferous forestry, deciduous woodland and pastoral farmland, and again having a complex relation with local discharge. The DOM from each of these areas has a characteristic spectrum (indicating variation in composition) that is reproducible within each stream, but does not correlate straightforwardly between streams draining areas with similar land usage. We aim to explore the reasons for both in stream and inter stream DOM content variation by adding more detailed ecological assessment techniques to our observation strategy, and collecting data through several seasons. Ultimately we hope our approach will deliver sufficient data to motivate the development of complex process models that can predict local impacts more reliably than current tools.

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