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A typology of catchment-level effects on rivers to inform catchment management

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Both natural and anthropogenic catchment-level effects alter the functioning of fluvial systems, which in-turn impacts river habitats. Catchment management aims to reduce impacts of land use practises on reach-scale river habitats. However, the coupling of anthropogenic and natural catchment-level effects often makes it difficult to distinguish the dominant control and therefore may hinder identification of appropriate management actions. Rather than separate anthropogenic and natural processes, we explore their interconnectivity by assessing similarity of catchments across the highly modified landscapes of England and Wales. We applied the self-organised map technique – an artificial neural network – to group 4485 catchments based on their ecohydrological features, hydromorphological features and habitat quality score under statutory assessment.

This approach identified seven 'catchment types' with distinct distributions of stream power, sediment size, flow velocity and aquatic macrophyte diversity; each critical components of physical habitats. The feature distributions show catchment types across an energy gradient from high energy, upland catchments with coarse sediments and fast flow velocities, to low energy, lowland catchments with fine sediment and slow flows. This reflects natural changes in morphometry, rainfall, geology and land cover. However, anthropogenic modification caused departures from this expected natural gradient. For example, lowland catchment types with extensive arable land had significantly finer sediment than other lowland classes; likely due to fine sediment eroded from agricultural fields being deposited in rivers. Catchment types with the highest arable and urban coverage had the lowest habitat quality scores, slowest flow velocities and highest macrophyte diversity; but these hydromorphological features also lend themselves to naturally occurring low energy environments. This finding indicates that the location of anthropogenic pressures may exacerbate the underlying natural energy gradient, demonstrating the interconnectedness of natural and anthropogenic catchment-level effects.

Our typology of catchment-level effects delivers an effective method of conceptualising the holistic impacts of catchments upon river reach ecohydrology and hydromorphology, providing a useful tool to inform strategic catchment management plans at a national level. The success of the self-organising maps approach for catchment classification in England and Wales could usefully be applied with national-level datasets across Europe to enable the effective management of catchments at a national scale and beyond.