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Exploring the 4D scales of vegetation-morphological interactions along a river corridor using repeat UAV Laser Scanning (ULS), multispectral imagery, and a functional traits framework.

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Interactions between riparian vegetation and river morphology are complex as they are often co-dependent, highly dynamic, and vary across both space and time. Vegetation diversity can be partially attributed to factors such as flood regimes and morphology, whilst simultaneously influencing the flow of water and sediment, ultimately impacting morphology and floodplain connectivity. As such, the importance of vegetation within the river corridor is well recognised and has been the subject of a considerable volume of research. However, within ecogeomorphology, most studies to date have been scale invariant, focusing either on characterisation of fine scale hydraulic roughness (e.g. using Terrestrial Laser Scanning; TLS) or on >reach scale patterns of riparian vegetation (using airborne or satellite imagery). Similarly, less attention has been paid to the temporal dynamics of vegetation beyond some appreciation of seasonality in controlling flow dynamics. This leaves a number of unresolved questions relating to the nested spatial and temporal (i.e. 4-dimensional; 4D) interactions of riparian vegetation and river flow.

In this study we seek to establish the temporal and spatial scales of riparian vegetation interaction within a river corridor using a traits based framework. Traits based research characterises plants with similar functional traits into guilds (groups) as opposed to by species or types, and as such provides a more useful basis to group vegetation according to the potential geomorphic impact that they exhibit. Traits based research for ecogeomorphic processes is relatively new in fluvial geomorphology, but has shown promise in its applicability, albeit existing applications are yet to investigate the temporal changes in vegetation. The need for extensive ground survey currently limits the application of traits based methods at reach scale and greater, highlighting the requirement for an approach that is able to classify a range of vegetation sizes and types into appropriate guilds.

Using a novel ULS and multispectral imaging systems, we have collected repeat high resolution (~1000 points per m^3) surveys over a 1 km reach of the River Teme, UK, which has a wide variety of seasonally dynamic riparian vegetation. For each survey we use the point cloud data and multispectral imagery to classify vegetation into guilds. We use these in conjunction with the morphological data from the survey to create spatially varying surfaces of ecogeomorphic interactions, allowing us to establish links between guild coverage and morphological evolution

across the reach throughout the year. The results show that vegetation-morphological co-evolution exists across scales and that high resolution survey methods are highly beneficial for resolving such interactions. The methods are designed to be transferable to other eco-geomorphic domains in any morpho-climatic regions, highlighting the flexibility and potential of a high resolution 4D traits based approach.