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Experimental investigations of natural diatomaceous biofilm behaviour and sediment stabilizing capacity

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Microbial assemblages ('biofilms') preferentially develop at water-sediment interfaces and are known to have a considerable influence on sediment stability and erodibility. There is potential for significant impacts on sediment transport and morphodynamics and, hence, on the longer-term evolution of coastal and fluvial environments, but the biostabilization effects remain poorly understood and quantified due to the inherent complexity of biofilms and the large spatial and temporal (i.e. seasonality) variations involved. Here, we use experimental river channels to systematically quantify the effect of biofilm colonisation over time for a range of sediment substrates. We find that the diatomaceous biofilm more rapidly colonises finer sand with an earlier onset for a flat-bed morphology compared to the bedform-dominated reaches. Sediment entrainment tests show a higher sediment transport threshold for biostabilized beds in both fine as well as coarse substrates, which is confirmed by quantitative cohesive strength meter (CSM) tests. Auxiliary spectrometer tests, soil sampling for extracellular polymeric substances (EPS), and microscope investigations indicate that chlorophyll-a, EPS content, and the biofilm community are dynamic and spatially diverse. These findings will help improve bio-physical modelling efforts in fluvial and coastal environments and provide much-needed quantification to improve predictions of the influence of biostabilization on sediment transport and morphodynamics.