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Enhanced sediment loading facilitates point bar growth and accelerates bank erosion along a modelled meander bend on the Sacramento River, USA

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Meandering channels provide a conduit through which sediment and water is routed from the uplands to the sea. Alluvial material is periodically stored and transported through the channel network as permitted by the prevailing hydrologic conditions. In the lowlands, this sediment often accumulates as point bar deposits attached to the inner banks of meander bends; previous research has highlighted the importance of these bedforms in facilitating the link between in-stream sediment supplies and channel dynamism. We use a 2D curvilinear hydrodynamic model (MIKE 21C) to perform a number of experiments in which we alter the sediment load to investigate how changes in alluvial material fluxes affect the development of point bars and the resultant patterns of bank erosion. We reveal that increasing the sediment load by up to two times the normal causes the point bar to grow both longitudinally and transversely; concurrently, near-bank shear stresses are elevated resulting in accelerated rates of bank retreat compared to normal sediment loads. Our results suggest that enhanced sediment loads (potentially the result of changes in land use or climate) can trigger enhanced rates of bank erosion and channel change through the sequestration of alluvial material on point bars, which then deflect high-velocity fluid towards the outer bank of the meander. These results have implications for the development of morphodynamic meander models which should consider the role of topographic flow accelerations induced by the presence of point bars more explicitly. Moreover, increased boundary shear stresses accelerate rates of bank retreat and therefore control rates of riparian habitat development as well as exchanges of sediment and nutrients between the channel and floodplain.