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Bed Slope Effects on River Tides

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Tidal rivers are conceptually seen as narrow channels along which the cross-section geometry remains constant and the bed is horizontal. When a tidal wave propagates upriver, it decrease exponentially in height. It decreases the more rapid the stronger the river flow. Near the sea, the tidally averaged width and depth of a river changes little throughout the year, even if the discharge varies strongly between the seasons. However, farther upstream, the water depth seasonally varies strongly with the river discharge. Recent observations from the Kapuas River, Indonesia, show that the water surface forms a backwater profile when the river flow is low so that the depth converges, i.e. gradually decreases between the river mouth and the point where the bed reaches sea level. This distinctly influences the propagation of the tide so that the amplitude does not decrease exponentially any more. A theoretical analysis of this phenomenon reveals several so far overlooked aspects of river tides. These are in particular relevant for periods of low river flow. Along the downstream part of the tidal river, depth-convergence counteracts frictional damping so that the tidal range is higher than expected. Along the upstream parts of the tidal river, the shallow depth increases the damping so that the tide more rapidly attenuates. The point where the bed reaches sea level effectively limits the tidal intrusion.