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Moving beyond the Galloway diagrams for delta classification: A graph-theoretic approach.

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Delta channel networks self-organize to a variety of stunning and complex patterns in response to different forcings (e.g., river, tides and waves) and the physical properties of their sediment (e.g., particle size, cohesiveness). Understanding and quantifying properties of these patterns is an essential step to solve the inverse problem of inferring process from form. A recently introduced framework based on spectral graph theory allows us to assess delta channel network complexity from a topologic (channel connectivity) and dynamic (flux exchange) perspective [Tejedor et al., 2015a,b]. We demonstrate the potential of this framework, together with numerical and experimental deltas, wherein different delta properties can be varied individually, to replace the qualitative approach still in use today [Galloway, 1975; Orton and Reading, 1993]. Specifically, in this work we have examined the effect of sediment parameters (grain size, cohesiveness) on the channel structure of river dominated deltas generated by a morphodynamic model (Delft3D). Our analysis shows that deltas with coarser incoming sediment are more complex topologically (increased number of looped pathways) but simpler dynamically (reduced flux exchange between subnetworks). We capitalize on the combined approach of controlled simulation (with known drivers) and quantitative comparison by positioning field and simulated deltas in the so-called TopoDynamic space to open up a path to provide valuable information towards a refined classification and inference scheme of delta morphology. Furthermore, numerical deltas allow us to explore the delta channel structure not only in a spatially explicit manner but also temporally, since the complete temporal record of delta evolution is available