Delta channel network complexity for quantitative delta classification and vulnerability assessment

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Deltas are landforms that deliver sediment, water and nutrients from upstream basins to the shoreline through interconnected pathways of channels that self-organize to a variety of stunning and complex patterns. The question as to what information about the forming processes (river, tide, and wave energy, vegetation, sediment properties, flow characteristics, etc.) might these patterns encode is fundamental to developing a quantitative approach to delta classification and advancing the still-in-use qualitative approach of *Galloway* [1975] and *Orton and Reading* [1993]. In our recent work [*Tejedor et al.*, 2015a,b] we introduced a graph theoretic framework for analyzing delta channel network complexity from a topologic (channel connectivity) and dynamic (flux exchange) perspective and proposed a TopoDynamic complexity space where deltas can be uniquely positioned. Here we examine the potential of this framework, together with field, numerical and experimental deltas towards a systematic approach to delta classification and inference. Specifically, we show that sediment parameters (grain size and cohesiveness; acting also as surrogates for vegetation) leave a distinct signature on the channel structure in river-dominated deltas simulated by a morphodynamic model (Delft3D) -- deltas with coarser incoming sediment tend to be more complex topologically (increased number of looped pathways) but simpler dynamically (reduced flux exchange between subnetworks), giving hope for classification. This is encouraging and calls for further analysis of simulated and field deltas and possible expansion of the dimension of the TopoDynamic complexity space to introduce additional discriminatory metrics. Comparison of the “delta width function” (channels at a radial distance from the apex) with the time-evolving shoreline of simulated deltas provides insightful new information about delta formation. Finally, entropy-based metrics of delta complexity are analyzed for both field and simulated deltas to examine how complexity might relate to delta vulnerability (where vulnerability here is defined by the relative effect of upstream flux perturbations to the shoreline) and an inverse relationship is reported.

Keywords: Delta Classification , Graph Theory, Complexity , Vulnerability

