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Is there a self-organization principle of river deltas?

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River deltas are known to possess a complex topological and flux-partitioning structure which has recently been quantified using spectral graph theory [Tejedor et al., 2015a,b]. By analysis of real and simulated deltas it has also been shown that there is promise in formalizing relationships between this topo-dynamic delta structure and the underlying delta forming processes [e.g., Tejedor et al., 2016]. The question we pose here is whether there exists a first order organizational principle behind the self-organization of river deltas and whether this principle can be unraveled from the co-evolving topo-dynamic structure encoded in the delta planform. To answer this question, we introduce a new metric, the nonlocal Entropy Rate (nER) that captures the information content of a delta network in terms of the degree of uncertainty in delivering fluxes from any point of the network to the shoreline. We hypothesize that if the "guiding principle" of undisturbed deltas is to efficiently and robustly build land by increasing the diversity of their flux pathways over the delta plane, then they would exhibit maximum nonlocal Entropy Rate at states at which geometry and flux dynamics are at equilibrium. At the same time, their nER would be non-optimal at transient states, such as before and after major avulsions during which topology and dynamics adjust to each other to reach a new equilibrium state. We will present our results for field and simulated deltas, which confirm this hypothesis and open up new ways of thinking about self-organization, complexity and robustness in river deltas. One particular connection of interest might have important implications since entropy rate and resilience are related by the fluctuation theorem [Demetrius and Manke, 2005], and therefore our results suggest that deltas might in fact self-organize to maximize their resilience to structural and dynamic perturbations.

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