Formation of Ilsands on Deltas from Radially Symmetric Flow Expansion

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The creation of islands on delta tops is a primary means of coastal land generation and a critical process for interpreting the stratigraphy of ancient deltas. To-date, models of island creation have been largely based in sediment laden jet-theory and its application to river mouths. Inspired by a suite of laboratory experiments and collection of planform data from modern deltas, we propose another model for island formation that is based on topographic flow expansion. Consistent behaviour was observed in 9 new and 5 previously published delta experiments that began as wall-bounded, planar turbulent jets. Initial deposition occurred as predicted by jet theory produced elongate deposits followed by lunate bars. The lunate bars did not immediately evolve into islands. Instead the lunate bars first transitioned into topographic flow expansions that were stable to topographic perturbations. These deposits prograded and maintained a uniform, characteristic flow depth until island formation and channel bifurcation occurred. The islands appeared to form at a consistent distance from the center of the spreading flow. The experimental deltas all developed radially symmetric deposits and flow patterns (i.e. where flow width increases uniformly with radius). We hypothesize that the islands on these deltas form at the distance from the center of spreading, Ψ_m, where flow per unit width drops below that which provides critical stress to move the median grain size. To test this hypothesis, we analyzed channelization and island formation for the 14 experiment and 4 field scale deltas gathered from the literature. Distances to the position of channelization, Ψ_d, were measured and compared to predictions of distance, Ψ_m. Experimental and field data are predicted with a root-mean-square error of 17%, and the best-fit model offers only a modest improvement in explanatory power over a 1:1 line model (i.e. $\Psi_d = \Psi_m$). This new model predicts island formation on delta tops where radially symmetric flow patterns develop from sediment-laden jets before prograding until flow conditions drop below the threshold of motion through radial expansion. This model explains well a set of experimental and natural deltas. The model predicts that the distance to the first channel bifurcation scales with water discharge, scales inversely with flow depth over the apron, and scales with the inverse square-root of median grain diameter.

Keywords: delta, bifurcation, island, jet, flow expansion

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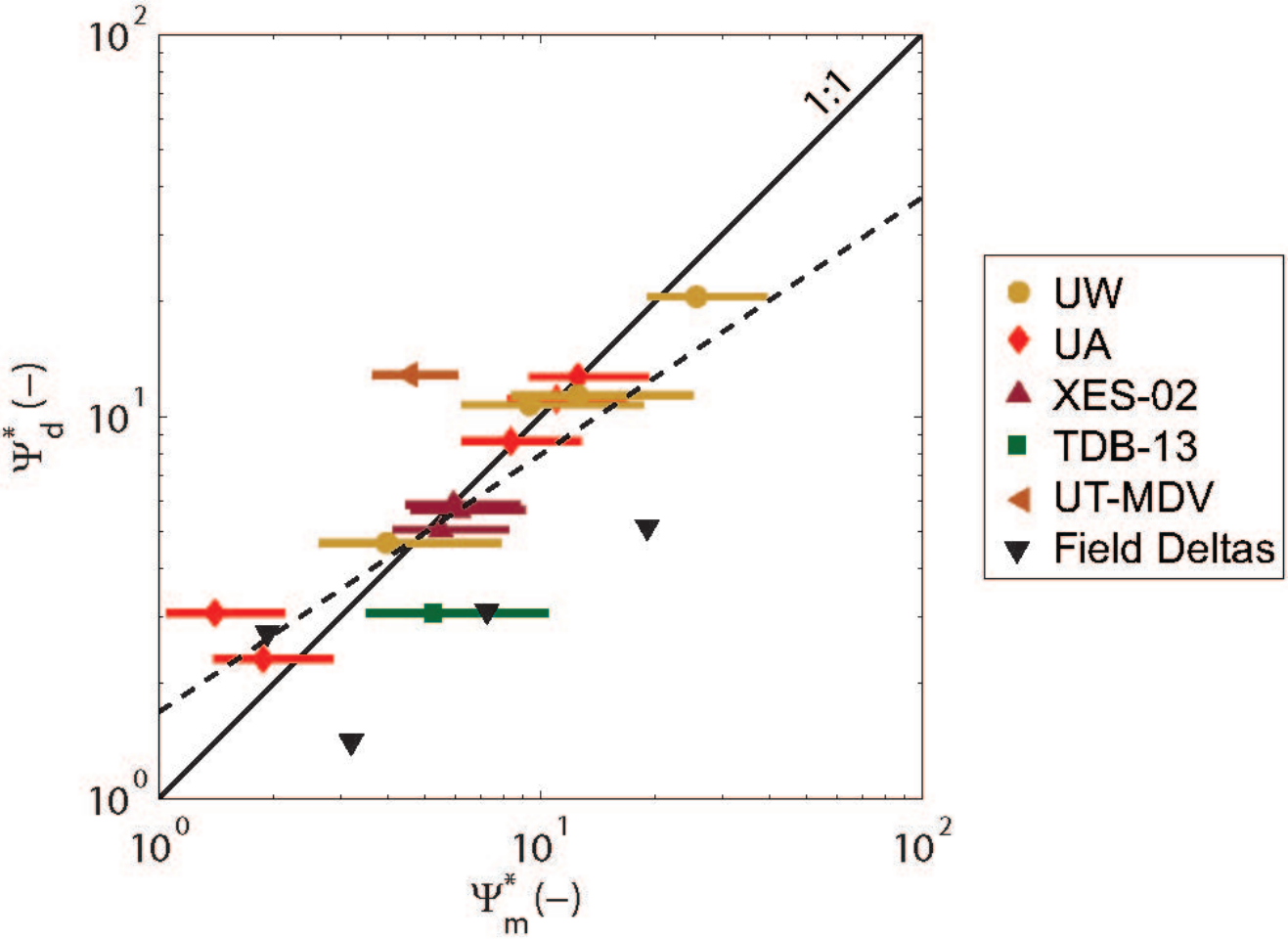

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