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Distributary Channel Evolution in Two Phases: Increased Asymmetry during Floods, Multiple Channel Extension during Low Flow

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River mouth bifurcations are an important feature on many river deltas. However, the processes that control their evolution remain unclear due to a lack of repeat surveys defining the evolution of these channels. We have collected such a data set on the Wax Lake Delta (WLD) in southern Louisiana. The survey site at the downstream end of a major distributary channel documents its transition into four terminal channels over a distance of roughly 500 m. Repeat surveys at the site reveal two important and distinct channel behaviors; a phase where channels volume is conserved during river flood and a phase of channel extension during a period of low river flow. The flood of 2011 produced no systematic channel extension and the total volume for the channels in the survey area decreased by 1.2×10^3 m^3 as channel volume increased in two channels and reduced in the remaining two. Channel bifurcation asymmetry (measured as the width of the wider channel divided by the width of the narrower one) increased from a mean value of 1.29 before to 2.80 after the flood. During the 8 month period of low flow preceding the 2011 flood, each of the four surveyed channels extended basinward distances between 150 and 500 m and channel beds incised up to 0.80 m or 160% of their previous depths. Increased channel length and incision produced a gain in total channel volume of 2.3×10^5 m^3, with individual channel contributions ranging from 15-35%. The channel bifurcation asymmetry was small and showed little change (1.27-1.29). We conclude that channel dynamics on the front of the Wax Lake Delta are unsteady and depend on both the river hydrograph and open bay conditions. During flood flow some channels grow at the expense of others, increasing bifurcation asymmetry and providing a potential explanation for the many asymmetrical bifurcations observed on the sub-aerially exposed WLD. During low flow, multiple channels can simultaneously extend and deepen. We posit that bifurcations are most likely to occur during times of low discharge when bay-driven processes combine with river flow to rework flood-deposited sand allowing multiple distributary channels to extend and incise on the delta front.

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