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Landward migration of backwater-mediated delta avulsion sites in response to increase in seasonal lake level: Qaidam Basin, China

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River deltas grow through episodic channel-jumping events, called avulsions, which have caused some of the deadliest floods in human history. Climate change is threatening to drown river deltas through a global increase in sea level; however, it is unclear how sea-level rise may affect the location of avulsion sites. Theory and experiments indicate that the avulsion sites on lowland deltas emerge within the backwater zone of coastal rivers because of the morphodynamic feedbacks arising from natural flood discharge variability and the nonuniform flows caused by the standing water level in the receiving basin. Under this backwater hypothesis, marine transgression should cause the landward-migration of lobe-scale avulsion locations; however, we currently lack field evidence for this theoretical prediction. Here, we analyze the location of river avulsions on the Sulengguole River that drains into the North Hubusun Lake, Qaidam Basin, China. Using analysis of time-series satellite imagery, we identified 7 lobe-scale avulsions that occurred in the distal portions of the Sulengguole River during the observation period of 1985 to 2010 CE. Satellite imagery revealed that the areal extent of the seasonal water in the lake increased at a rate of 1.89±0.80 km^2/yr, likely as a result of increase in extreme precipitation rates. The increase in seasonal lake water areas caused the river mouth of the Sulengguole River to translate landward at a rate of 0.36±0.17 km/yr. We show that the avulsion sites also migrated landward at a commensurate rate of 0.24±0.07 km/yr during this period, consistent with the rate of landward migration of the river mouth. Finally, we show that all 7 avulsions had an avulsion length—streamwise distance of the avulsion site to the river mouth—that scales with the estimated backwater lengthscale (mean of 0.50±0.14 times the backwater lengthscale), consistent with the global compilation of avulsion lengths on large, low-gradient deltas. Our work demonstrates, for the first time, that landward migration of river mouth that would result from relative sea-level rise will cause the avulsion locations to migrate inland in a predictable manner, with implications for the sustainable management of the future of deltas and mitigating flood hazards.