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Effect of Sea Level Rise on River Deltas:Application to the Fly-Strickland River System, Papua New Guinea

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A consequence of the current global warming is rising sea level as polar ice melts. The future effect of such sea level rise on shorelines, river deltas and river long profiles is not well known. The problem may be understood by studying the consequences of Holocene sea level rise after the last glaciation. The melting of the Pleistocene glaciers caused a sea level rise of ˜120 m, mostly in a period of 12,000 years.

Under conditions of constant base level of standing water deltas can be expected to gradually prograde outward, so that the delta shoreline regresses seaward. Rising base level such as that which prevailed in the ocean at the end of the last glaciation, however, can not only slow this progradation, but reverse it, so that the shoreline migrates landward, or transgresses. An extreme limit of this case is one of shoreline starvation, for which the supply of sediment at the shoreline drops to zero and the delta goes into transgressive autoretreat. In this study, a 1D morphodynamic model of delta response including backwater effects is developed to understand the effect of rising sea level on river deltas for the Fly-Strickland River System, Papua New Guinea. The effect of river size on delta response to sea level rise is also studied for three rivers, of which initial river lengths are 400km, 600km and 800km, respectively. Both cases are conducted for the Holocene sea level rise after the last glaciation, in which sea level is -120 m for the first 3000 years, rises at 10mm/year for 12000 years to an elevation of 0 m, and is subsequently constant for 6000 years. In the numerical calculation for the Fly-Strickland River System, two types of sea level rise, which are constant rate of sea level rise (10mm/year) and punctuated sea level rise in the period of 12,000 years, were employed for comparison.

The result of numerical calculation for the Fly-Strickland River System suggests that (1) this river delta experienced the autoretreat phenomenon during the sea-level rise, (2) the effect of the sea-level rise has extended to the far upstream reaches of the river delta, (3) the present Fly-Strickland estuary represents the traces and on-going processes of the recovery (formation of new delta) from the effect of the past rapid sea-level rise, and (4) the predicted final position of shoreline at the present day in the case of the punctuated sea level rise is approximately same in the case that sea level constantly rises at the rate of 10 mm/year. The comparison of the three rivers indicates that the shorelines in all rivers transgress about 200 km by the time sea level stabilizes at high stand, but the prograding speeds of new deltas depend on the feed rate from upstream and therefore the delta of the large river recovers more rapidly than that of the small river.