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Landscape response to high-episodic precipitation (ENSO); Piura area, northern Peru

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We quantitatively illustrate that El Niño Southern Oscillations (ENSOs) have had a strong impact on sediment flux and the topographic development of the Piura drainage basin, Northern Peru. Topographic data show that the Piura drainage basin is made up of two segments. The lowermost area comprises the flat Sechura desert that extends from the Pacific coast to the border of the cordillera over a distance of ca. 110 km. The headwaters comprise the cordillera where the elevation of topography increases from 150 m to ca. 3600 m above sea level over a lateral distance of 35 km.

Pluviometric data reveal that ENSOs strongly disturb the precipitation pattern. In a 'normal' year precipitation only falls in the cordillera as easterlies bring the moisture from the Atlantic across the Amazone basin. In this case, the westerlies derived from the Pacific are a negligible source of precipitation. During these 'normal' periods the Sea Surface Temperature (SST) in the Pacific is 17˚C at the coast, and precipitation rates ca. 30 mm/yr in the Sechura desert. During ENSO events (e.g., 1983, 1998), however, the SST rises up to 27-29˚C along the coast, disturbing the equilibrium of the atmospheric cell configuration. As a result, precipitation rates increase to 4000 mm/yr in the Sechura desert. In the cordillera at ca. 2000 m above sea level, however, ENSOs cause a three fold increase in precipitation rates (ca. 3000 mm/yr).

Gauging stations measured a tremendous increase in water and sediment discharge due to ENSOs. During a 'normal' year, water discharge is ca. 15 m^3/s in Piura (located in the Sechura desert), and sediment discharge measures ca. 179 kt/yr. ENSOs, however, have resulted in a ca. 24 and 807 fold increase in water and sediment discharge, respectively. Hence, denudation rates rise up to ca. 8.8 mm/yr during ENSO

events. This tremendous increase in sediment discharge and erosion rates must be visible in the topography. Indeed, at 2000 m above sea level (which is the highest region in the cordillera that has been significantly affected by ENSOs) the morphometric properties change from high topographic roughness in the lower portions to smooth landscapes in the uppermost part. This change reflects the predominant controls of episodic precipitation (ENSO) on the landscape evolution in the lower regions, and the strong influence of seasonal 'normal' precipitation in the headwaters.