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Alluvial archives of land use histories in small drainage basins of the Mexican highlands

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The highlands of southern and central Mexico have been farmed by sedentary populations for more than 3000 years. The imprint of agriculture on local hydrology is thus very early and exceptionally strong. Highland streams have a flash-flood regime and narrow floodplains confined between vertical walls of unconsolidated sediment. Their small scale allows for brief response times to changes in land use. Their alluvial records, although fragmentary, often have a good resolution. As a result, they can be tied to changes inferred from settlement patterns and other archaeological parameters measured on timescales of the order of centuries. Examples borrowed from recent field research in the states of Tlaxcala and Oaxaca illustrate this approach.

In Tlaxcala alluvial records can be correlated on lithologic grounds from one drainage to the next until about 1000BC. Stream behaviour until that date seems to be driven mostly by region-wide climate change, with minor perturbations introduced by volcanic activity and internal feedbacks of the fluvial system. In the 1st millennium BC, as farmers settle Tlaxcala, the evolution of each stream begins to diverge. By the 4th century BC sediment transfers attain rates unprecedented in the Holocene. Valley fills in excess of ten meters accumulate in the matter of a few centuries. Many contain a high concentration of charcoal, in some instances forming discrete laminae of near-annual recurrence. At several settlements abandoned between 350BC and AD100 erosional unconformities cutting through archaeological features attest to the removal of both A and B horizons of pre-settlement soils and the formation of impermeable silica-indurated duripans. The farming practices responsible probably involved a form of swidden cultivation of unterraced slopes. After AD100 Tlaxcala experiences a region-wide population decline, but in many drainages the same extensive farming practices maintain high rates of sediment delivery to streams. In contrast, valley fills contemporaneous with the demographic explosion of the Aztec period (ca. AD1200-1520) are virtually non-existent. This period coincides with widespread reclamation of previously eroded surfaces by means of hillside terraces. In the 16th century diseases introduced form Europe kill three-quarters of the population, and much of the vacant farmland is turned over to grazing. As unmaintained terraces collapse a thick colluvial mantle develops over much of the landscape, but it is unclear how much sediment is actually delivered to streams. The complex local land use histories reconstructed do not fit the model previously advanced for the region by Klaus Heine that correlated periods of rapid aggradation with those of high population pressure and intensive agriculture.

In the Nochixtlan valley of Oaxaca high rates of alluviation can be documented from the early Holocene onwards, aided by the extremely erodible shale substrate. Still, the arrival of sedentary farmers at ca. 1500BC marks a threshold after which the frequency of cut-and-fill cycles seems to increase. Prehispanic agriculture affected stream behaviour not only by altering the rates of runoff and sediment delivery from slopes, but also through direct and deliberate floodplain management. Stone walls were placed across floodplains and used to trap sediment to build up artificial planting surfaces. With time the walls rose to heights of several meters and blocked off completely many smaller streams, transforming them into long flights of cross-channel terraces. The system is thought to have attained its climax just before Conquest, but remains of breached terrace walls exposed in stream cutbanks allow us to reconstruct its earlier history. The oldest currently known specimen dates to ca. 1000BC. Terrace construction in headwater reaches must have oversteepened the longitudinal profiles of many streams, and produced rapid pulses of localized aggradation when they failed.