Self-organization of valley width preserved in fluvial terrace sequences

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Fluvial terraces are striking geometric features present along many streams. Terrace surfaces are abandoned floodplains that preserve geometries of past channel systems over hundreds to thousands of years. Fluvial terraces are one of the most commonly used markers to investigate the impact of past climate and tectonics on river catchments. The formation of terraces is linked to recurrent changes between lateral widening of the floodplain and vertical river incision. The generation of a paired terrace sequence requires periodic changes in bed elevation, combined with a progressive reduction in floodplain width. Periodic changes in bed elevation can be induced by fluctuations in water discharge or sediment supply, or by downstream base level variations, all of which are oftentimes related to climatic cycles. To date, however, it is unclear why a periodic climate with constant amplitude would produce the narrowing floodplains required for the preservation of paired terrace sequences. Here, we demonstrate a globally uniform linear scaling between floodplain width and valley depth¬ in sixteen terrace sequences. The observed relationship cannot be explained by a preservation bias. Instead, we propose a model that explains progressive valley-narrowing by a competition between the sediment supplied from valley walls and the river’s capacity to rework sediment. This model predicts valley width from parameters that are measurable in the field. Such predictions are currently lacking in landscape evolution models and help to understand how landscapes respond to changes in climatic or tectonic boundary conditions.

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