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Factors of knickpoint migration on the moderately uplifted Ardennes Plateau, Western Europe

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In the last two decades, much research has been devoted to the development and refinement of numerical models of river incision. In settings of prevailing bedrock channel erosion, numerous studies used field data, notably knickpoint data, to calibrate the widely acknowledged stream power model of incision and to discuss the specific impact of various variables (e.g., sediment load, channel width) not appearing explicitly in the model's simplest form. However, most of these studies were conducted in areas of very active tectonics and high relief, thus displaying an exacerbated geomorphic response to the tectonic signal. Here, we analyze the traces left in the drainage network 0.7 My after the NE Ardennes region (western Europe) underwent a moderate 100-150 m uplift. We identify a set of knickpoints that have travelled far upstream in the Ourthe catchment. Because time becomes a more sensitive variable than distance near the headwaters, we fit the stream power model to the data by minimizing time residuals (i.e., the differences between 0.7 My and the modelled times for the knickpoints to reach their actual location) rather than distance residuals. Our best fit of the stream power model parameters yields m/n = 0.75 and K = 4.63 10^{-8} $m^{-0.5}y^{-1}$. We suggest that the discrepancy with the m/n value of $\sim$0.5 obtained from field and long profile data of the currently graded downstream part of the catchment's streams points to a narrowing of the bedrock channel at the passage of a knickpoint. Then, the time residuals of the model fit are regressed against quantitative expressions of bedrock resistance to erosion and junction crossing, showing that both variables significantly affect knickpoint migration. In particular, most of the small tributaries with highly delayed knickpoints display all features characteristic of hanging valleys. However, not all such small streams have developed hanging valleys, and further research is needed to unravel how other controls, e.g., amount and size of the tributary bed load, are determining for the creation of such valleys.