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Sprouting and resistance to uprooting of wood logs on alluvial sediments at the laboratory scale

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The dynamics of wood logs involves the processes of transport, deposition and possible remobilization on and from river gravel bars. Wood logs may be mobilized by floods and deposited on elevated regions of alluvial sediments. Here, they can sprout roots and grow, thus favouring the formation of early island nuclei, which contribute to the hydrogeomorphic evolution of the whole river ecosystem. Much research today has been devoted to wood logs recruitment without yet focusing on the evolution of their local biomechanical properties. Whether wood logs become resilient enough to successive flooding events depends on the interplay between the inter-arrival time of floods and the ability of wood logs to take root efficiently and withstand flow drag forces. In this work we move the first steps in the direction of quantifying the resistance to static uprooting of wood logs that have possibly resprouted and rooted while lying on alluvial deposits. For the time being, we answer basic questions concerning how the resistance to uprooting depends on the biomechanical and geometrical properties of wood logs after initial resprouting. In particular, we run laboratory pull-out tests in order to assess the uprooting resistance of small-scale wood cuttings (Salix species) which serve as a surrogate for wood logs. We tested cuttings of different lengths and at different growing phases. Salix cuttings were laid down horizontally with half-portion embedded in a fully saturated medium and were allowed to develop roots. Then, cuttings were pulled up by direct traction by means of a computer-controlled motor-encoder and load cell system. The architectural parameters of below- (e.g., root length) and above-ground biomass (e.g., size of branches) were obtained. Our results show how root biomass depends on cutting size (diameter and length) and how it affects the resistance to uprooting. From the uprooting force-displacement curves we obtain information about the maximum uprooting force, energy and load redistribution among roots as revealed by force vertical drops. Normalized cumulative sums of below-ground biomass show overall a uniform distribution of root biomass over the length of the cuttings independently of their sizes, which may be useful to advance upscaling rules.