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Spatio-temporal analysis of channel wall erosion in ephemeral torrents - an example from the Patagonian Andes

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Absolute ages for flash floods and related sediment entrainment in headwater catchments are required to construct a spatio-temporal framework of events and to decipher process dynamics and the localization of hotspots of gully wall erosion. In ephemeral torrents, lateral roots of riparian woody vegetation can increase bank stability. At the same time, if partially exposed, these lateral roots may also be used for the dating of past erosion pulses through assessment of growth anomalies in their increment-ring series. We explore and illustrate the potential of increment rings of exposed roots to assess channel wall erosion and sediment entrainment in space and time. Cross sections of roots of Austrocedrus chilensis, Nothofagus dombeyi and Pseudotsuga menziesii that have been exposed by flash floods were collected from very steep (70–90°), but shallow (<1.7 m) channel walls. A total of 64 root samples was used to (i) establish the species' suitability to document evidence of past erosion events; (ii) identify new, previously undocumented erosion signals in roots; and to (iii) recognize and map erosional zones that became sediment sources activated by past events. In addition, we explored potential triggers of erosive flash floods and the possibilities and limitations of using roots to assess and quantify past erosion pulses in ephemeral drainage basins. The case-study is the Los Cipreses torrent in the Patagonian Andes (Neuquén Province, Argentina, 40°56'00"S, 71°24'45"W). The watershed area is ∼7.5 km2, with a channel length of 4.9 km and a vertical range of almost 1.2 km between the highest crests (1958 m asl) and the point where the torrent enters the Brazo Huemul section of Lago Nahuel Huapi (768 m asl). Based on the analysis of growth anomalies in the increment records of partially exposed roots we document time series of channel wall erosion and successfully dated 22 erosive flash floods since AD 1870. Results demonstrate the potential of root-ring analyses for the spatio-temporal determination of hotspots of sediment entrainment. In addition, we show that the position of damage within the root ring allows inferences about the seasonal timing of impact and thus an assessment of possible meteorological triggers of erosive events (presumably short intense storms) occurring primarily in austral fall and late winter in the present case. The approach presented adds significantly to the understanding of sediment entrainment and the identification of areas of rapid erosion in small, remote headwater catchments with ephemeral flash flood activity.