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Applying dendrogeomorphological analysis for measuring medium-term sheet erosion: a case study of sand slope gullies at central Iberia

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The assessment of gully erosion is a challenge due to the complexity and connectivity of the geomorphic processes involved. In general, eroded materials by weathering processes are transported from slopes to gully bottoms by mean different hydric processes. Next, fluvial processes yield these sediments to the nearby fluvial networks. As consequence, fluvial ecosystem as well as the operability of hydraulic infrastructures placed downstream could be affected, such as their quantification is very important. This work is focused on the quantification of sheet erosion rates in a set of slope gullies located at the northern piedmont of the Guadarrama Mountains (Spanish Central System) characterized by ancient human quarrying activities, which initiated intense erosive processes at the regional slopes. To this end we have applied an approach based on application of dendrogeomorphological analysis of exposed root from existing trees at same Hydrologic/Erosion Response Units (HRUs/ERUs).
For that, microtopography measured as well as the identification of the first year of root exposure by erosion from anatomical criteria has been critical. Estimation of averaged erosion rate was based on the anatomical and crossdated analysis of 29 samples from Pinus pinaster Ait. and Pinus sylvestris L. Following the root exposure, anatomical changes showed a reduction in the area of the lumen area of earlywoods tracheids, as well as a slight increase in growth rings in most cases. Moreover, at the end of the ring several rows of thick-walled tracheids define latewood tissue and visible annual borders very clearly. In addition, the application of the dendrochronological principle of cross-dating has been aimed for dating the first year of exposure fixed using anatomical criteria. From the findings derived of this quantitative analysis, a non-parametric test was used to objectify the determination of the first year of exposure. Estimates of sheet erosion were obtained dividing the height of eroded soil between the numbers of years that each root remained exposed. Next, statistical inference was implemented in order to determinate the mean value of soil erosion for the entire study site. The procedure allowed to obtain a range of sheet erosion rates between 2.8–4.1 mm/year (56.6-82.8 t ha-1 year-1) for the dominant HRU of these gullies of Central Iberia: open woodland on silica sand hillslopes which averaged slopes of 24º. Based on our experience, we can affirm that the combined use of HRU and dendrogeomorphology has demonstrated their utility in the studies of medium term sheet erosion dynamics, what constitutes an important advantage with regard to common measuring devices producing data after costly installations.

Keywords: Hydrologic/erosion Response Units; Dendrogeomorphology; sheet wash/erosion, wood anatomy; Pinus pinasterAit.; Spanish Central System