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Spatial aspects of tree ring-based reconstruction of past landslides behaviour: where to sample?

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Knowledge of the spatial distribution of landslides is essential for forestry, landscape planning or hazard assessment. In fact, dendrogeomorphic approaches are a useful tool to construct past landslide behaviour due to the known location of the sampled trees. The position of trees on the landslide surface can influence the detection of spatial patterns of landslide reactivation and significantly affect the amount and intensity of recorded landslide signals within a series of tree rings. This is due to the presence of different morphological zones with different movement mechanisms that generate landslide bodies. In this study, data from 1030 tree-ring series originating from 515 trees occupying ten different complex landslide sites in the Outer Western Carpathians were used to test the spatial distribution of landslide signals during reactivation events and to investigate the specific influence of six different landslide morphological zones on tree growth, with the aim of revealing the most valuable sites for future sampling at the landslide surface. Spatial patterns of landslide reactivation were tested using the Moran index. Signals from tree rings generally do not tend to cluster spatially. Thus, the analysis of spatial patterns can be used as a very stringent condition for verifying landslide events in the case of a limited number of tree-ring signals. Moreover, this analysis is only suitable for block-type landslides (not for flow-type landslides). Furthermore, this research presents a general model of the influence of movement mechanism on tree growth in the different morphological zones forming complex landslide areas. Finally, recommendations for future sampling strategies regarding tree location within specific morphological zones are made based on the results obtained. In general, trees on subhorizontal landslide blocks or in the plastic shallow movement zone should be preferred as opposed to trees on steep landslide sections or in the source zone, which should be avoided.