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Regional debris-flow chronology reconstructed through dendrogeomorphic methods in Calimani Mountains (Eastern Carpathians, Romania)

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Debris flows (DFs) are widespread geomorphic processes in the high areas of Carpathians, being highly efficient sediment transfer processes from slopes to channel network. They often damage the transportation infrastructures, inhabited areas and threaten the recreational and other human activities. To minimize the negative impact of DF activity, it is crucial to understand the role of various conditions and factors which lead in the past to debris flow triggering. In this context, information on long-term DF activity needs to be known, to understand the DFs behavior and to predict the future trends of this potential natural hazard in the context of documented climate change. However, in Carpathians, as in most of the mountain areas worldwide, the lack of historical records about past hydrogeomorphic process activity in term of temporal frequency and spatial extent hampers the possibility to have a good knowledge of the past DF activity. Indirect reconstructing methods, e.g., dendrogeomorphic methods can be used to reconstruct past DF activity in forested mountain areas. When DFs along their paths cross the forests, they disturb the trees leaving in their growth rings distinct signs of the past DF events. Dendrogeomorphic approaches are based on the analysis of growth anomalies caused by the mechanical disturbance of DFs on trees and recorded in their rings, allowing to reconstruct with annual and even seasonal resolution past geomorphic activity. Dendrogeomorphology became in the last decades an established technique applied to reconstruct past geomorphic process activity, helping to understand dynamics of various geomorphic processes. Dendrogeomorphic methods have been extensively applied to reconstruct DF activity in various mountain regions, while in Romanian Carpathians DF activity has been rarely reconstructed through these methods, and if available the reconstructed activity has focused only on individual case studies at a local scale. The aim of this study is to investigate past DF activity at a regional scale through dendrogeomorphic methods. In this sense, study sites which includes multiple tracks of both natural and anthropogenically-influenced DFs crossing the forested slopes were chosen in Calimani Mountains (Eastern Carpathians). In each investigated site, growth anomalies identified in the rings of disturbed trees sampled allowed to reconstruct DF event chronologies. Analysis of rainfall data recorded at the weather station located close to the study sites revealed that local DF processes may be the result of extreme rainfall events occurring mainly during summer seasons. An increase in DF event frequency in the anthropogenically-influenced areas compared with the DF event frequency in natural areas was observed, suggesting that sediment availability possibly represent another factor for varying DF activity. The dendrogeomorphic reconstructions realized here represents a first attempt to assess the regional patterns of DF activity in Romanian Carpathians, with promising perspectives to extend similar dendrogeomorphic investigations in other regions of the Carpathian Range.

