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# Changes of snow avalanche regime over the last century in Pirin Mountains (Bulgaria)

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Snow avalanches represent a widespread phenomenon in the Pirin Mountains (SW Bulgaria), damaging forests, properties, infrastructures and causing fatalities, especially in the central part of the massif. There, recreational winter sport activities have increased over the last few decades. Snow avalanche activity in this mountain area is poorly documented in historical archives: very little is known on the past frequency and spatial extent of such phenomenon. However, the slopes are forested, and trees repeatedly disturbed by snow avalanches record in their annual rings evidence of past events. The aim of the present study is to analyze tree-ring records to reconstruct the frequency and spatial extent of past avalanche activity along three avalanche paths located on slopes in the Banderitsa valley. Samples collected from Norway spruces (Picea abies (L.) Karst.), Bosnian pines (Pinus heldreichii Christ.) and Macedonian pines (Pinus peuce) heavily disturbed by snow avalanches have been analyzed. Growth anomalies related to mechanical impact (e.g. scars, callus tissues, the onset sequences of tangential rows of traumatic resin ducts, compression wood, growth suppression and release sequences) have been identified within tree rings. The type, amount and intensity of growth anomalies found within the tree rings served to date past avalanche events, back to late 19th century. A minimum frequency of snow avalanches has been determined and served to define the return periods within each of the runout areas of the paths investigated. Dendrogeomorphic methods provided the most consistent avalanche event chronology within the study area. It contributes significantly to an accurate avalanche hazard zonation in the study area.

This study represents a contribution to the project ZONAGEOTOUR « Zonage des aléas géomorphologiques dans les espaces touristiques des massifs du Parâng (Roumanie) et du Pirin (Bulgarie) » (Geomorphic hazard zonation in tourism-frequented areas of Parâng Mts., Romania and Pirin Mts., Bulgaria), funded by the Agence Universitaire de la Francophonie (AUF) and Fonds de Recherche Scientifique (FRS) de Bulgarie.

Keywords: snow avalanches; tree rings; event frequency; return periods; Pirin Mountains (SW Bulgaria).