

Abstract

Avalanche effects on endemic pine forests in the Pirin Mountains in Bulgaria

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Abstract: Pirin Mountains in Bulgaria are refuge of endemic *Pinus peuce* and *Pinus heldreichii* forests.

Due to the steep and long slopes the forests are affected by avalanches and many trees keep record of past avalanche activity in their tree rings. In our study we use combination of dendrochronology, satellite images and historical aerophotos to study the effects of avalanches on forests in the Bunderitsa valley. Our findings show that avalanches are the main shaping factor for the structure of forests in the valley followed by fires. Past avalanche activity is responsible for opened long-lasting avalanche tracks in the forests. About 60% of the potential forests (i.e. territories below treeline, outside of avalanche couloirs, streams, rock formations and screes) are strongly affected by avalanches. Of them almost 40% are in avalanche runout zones, 12% are in avalanche tracks in the forests and 48% are forests, which are periodically strongly affected by bigger avalanches. Comparisons of newer satellite images with older aerophotos showed that in the 1970s there were larger openings in the forests due to high frequency of avalanches in the very snowy 1950s and 1960s. Although recent avalanche activity has decreased, there are still years with larger avalanches, which affect forests. In addition, tourist development in vicinity has increased risk for human health and life due to avalanche accidents, including in forests. Tree-ring analysis allowed reconstructing past avalanches that affected certain areas. The big couloirs are affected by smaller avalanches almost annually, while bigger avalanches have hit the neighboring forests almost every decade. Our findings demonstrate that avalanches in the valley are of high importance and require more attention by authorities both as risk factor for human health and life and as natural disturbance shaping the forest structure and dynamics.

Keywords: tree-ring analysis; dendrochronology; avalanches; Pirin; *Pinus peuce*; *Pinus heldreichii*

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