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Disturbance, geomorphic processes and regeneration of wildfire slopes in North Tyrol

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Forest fire slopes are widespread in the northern Limestone Alps. On pure limestone surfaces, the organic soil layer can be widely destroyed by fire. Subsequent long-lasting deforestation causes considerably heightened geomorphic activity including rockfall, soil erosion, debris flows and avalanches. Regeneration of the ecosystem takes place very slowly. The significance of fires for geomorphological processes and related natural hazards can be understood only at a broader perspective and in the context of the long-term fire frequency.

Investigations are carried out in historical archives to assess the timing and spatial distribution of fires in the last centuries. For a deep-time perspective, we study charcoal and pollen in nearby mires, supplemented by dendrochronology and 14C dating of charcoal in soils. The geomorphological processes on the slopes are directly measured by means of sediment traps and by mapping debris on avalanche cones. Finally, we perform detailed vegetation mappings on burnt slopes of different age in order to clarify the patterns and timing of vegetation recovery.

According to our results, erosion is intensified after deforestation by 1-3 orders of magnitude. While relocation processes dominate on small fire slopes, avalanche scouring and fluvial dissection take place on larger slopes. We recently observed large debris flows which are probably supported by deforestation and enhanced overland flow more than 60 years after the fire. First results on fire frequency point to recurrence intervals of as low as 200-300 years in the last 2000 years on the very dry, south-exposed slopes near the Inn valley. In the moister areas closer to the northern edge of the Alps, fires appear to be much less frequent. Anthropogenic influence obviously heightens the fire frequency, as 80-95% of the historical fires are man-made; however, lightning fires also occur and probably affected large areas in the past. Vegetation mappings show that there are at least two general paths of regeneration depending upon the degree of soil destruction and geomorphological activity. The time span of the "window of disturbance" ranges from decades to several centuries depending on relief, geology and fire severity. The frequent disturbance events in the past impede soil development and may prevent the formation of a climax vegetation.

Many results point to increasing fire probability under the influence of climate change. However, efforts are currently undertaken to assess the spatial distribution of future fires and to improve quick fire fighting. Thus, total vegetation destruction and degradation of large slopes, as happened in the past, is likely to remain a rare exception.