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DENDROCHRONOLOGICAL INVESTIGATIONS ON THE FREQUENCY OF DEBRIS FLOWS IN THE ITALIAN ALPS (**)

Abstract: STRUNK H., *Dendrochronological investigations on the frequency of debris flows in the Italian Alps.*

With the help of the example of the Kaserbach debris flow cone in the Dolomites of Prags/southern Alps, the analysis of debris flow frequencies by dendrochronological methods is demonstrated. Episodic burying of trees causes sprouting of secondary root systems at the top of each of those aggradations. By age determination of such layers of adventitious roots, as well as of the time of drastic decline in annual increment of the stem (suppression) due to aggradation, and by dating deaths of trees resulting from deep aggradation on the one hand, also by age determination of trees and shrubs growing upon debris flow cones on the other hand, a stratigraphic division comprising, in the study area, the last 246 years can be constructed, which permits sufficiently accurate conclusions on the frequency of episodic debris flows. The methods applied will be presented in detail, their problems and limits being discussed in conclusion.

KEY WORDS: Debris flows, Frequency analysis, Adventitious roots, Southern Alps.

Riassunto: STRUNK H., *Ricerche dendrocronologiche sulla frequenza dei debris flows nelle Alpi Italiane.*

Sulla base di studi condotti nella zona di Kaserbach nelle Dolomiti viene esposta e dimostrata la frequenza dei fenomeni di *debris flows* con metodi dendrocronologici. L'episodica caduta di alberi genera un nuovo sistema di radici avventizie alla sommità di ognuno degli accumuli. Dall'età di questi letti di radici secondarie, così come dal tempo del netto declino nell'incremento annuale del tronco dovuto al ricoprimento e dall'età della morte degli alberi ad ogni successiva aggradazione detritica, così come dall'età degli alberi ed arbusti cresciuti sopra i coni dei *debris flows*, è stata stilata per gli ultimi 246 anni una colonna stratigrafica che permette una sufficientemente accurata frequenza dei *debris flows*; il metodo e i suoi limiti nonché i problemi che ne conseguono sono esposti nelle conclusioni.

TERMINI CHIAVE: Debris flows, Analisi di frequenza, Dendrocronologia, Alpi Meridionali.

INTRODUCTION

Mountainous areas of high potential energy are permanently exposed to geomorphological hazards such as landslides, rockfalls, snow- and ice avalanches, disastrous floods, or debris flows. Due to their great intensity, these powerful episodic events may cause greater changes within a few hours than decades or centuries of continual or even periodic geomorphological activity (e.g. SCHICK & MAGID, 1978). Consequently, at a relatively early stage, geoscientists like HEIM (1932, cfr. HSÜ, 1978) and STINY (1910, 1931 cfr. MÜLLER, 1979) investigated the causes of low frequency geomorphological mass movements of high magnitude, which, from time to time, damage productive areas and infrastructural installations. Nowadays, the Alps have become Europe's playground all year round and are being made accessible for larger numbers of people by touristic installations which have penetrated into greater and greater altitudes and more and more unsuitable regions — considering their potential natural hazards. In consequence such natural geomorphological processes of high magnitude, which have always occured in these areas, are now considered disasters. This situation led to efforts to picture the natural hazards of a region in a cartographic survey intended to help those institutions concerned with spatial and architectural planning (e.g. KIENHOLZ, 1978; KIENHOLZ & *alii*, 1983). Now, as ever, the greatest problem consists in the investigation of magnitude-frequency relationships of extreme geomorphological events with low or very low frequencies over long periods of time (STRUNK, 1986). A great number of recent processes are accessible, the easier the more regulary they occur (WOLMAN & MILLER, 1960). Hitherto, the fluvial morphodynamics of small catchments has been most frequently examined (e.g. BURT & WALLING, 1984), an almost traditional field of research for English geomorphologists. The greatest problem in frequency research of episodic processes is the poor probability of their recurrence. In view of a given frequency of several years or even several dozens of years, usual geomorphological process measurements do not make sense and, considering the long periods of geomorphological stability, the expenditure for field measurement equipment can hardly be justified. If due to the poor proba-

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