

Kinematic waves and supraglacial tree responses on Miage Glacier (Western Italian Alps)

Manuela PELFINI*, Maurizio SANTILLI, Giovanni LEONELLI, Mauro BOZZONI

“A. Desio” Department of Earth Sciences, University of Milan, Italy

*manuela.pelfini@unimi.it

The Miage Glacier (Aosta Valley, Italy) is the most important debris-covered glacier in the Italian Alps. In the lower part of its tongue the debris cover is thick enough to allow colonisation of trees (mainly European larch), shrubs and herbaceous vegetation. Supraglacial trees react to glacier pushing and to vertical movements related to freezing and melting processes assuming characteristic shapes. Debris cover instability due to the ice sliding down-valley, to the transmission of kinematic waves and to glacio-karst phenomena, is recorded in the annual tree rings by trees moving down valley following the glacier movement.

Fifty-two larches were sampled on the northern and southern lobes and three reference tree-ring chronologies based on undisturbed larches growing outside the glacier were constructed for comparison with tree-ring data from supraglacial trees. In order to identify the temporal distribution of the growth disturbances (event years, pointer years, compression wood and abrupt growth changes) in supraglacial trees, samples were visually analyzed by means of skeleton plots and a time series analysis was performed on ring-width measurements. Different growth anomalies were located and dated. Also the yearly spatial distribution of the event years of the supraglacial trees was assessed for the period 1960-2003.

Tree distribution on the glacier surface show that areas characterised by more stable debris show a larger number of specimens, while the most unstable areas are not colonised, even if the debris thickness is similar. The oldest sampled trees colonised the glacier surface just before 1960. The presence of very young trees near their upper limit of distribution can be related to the shallowness of the debris layer and to the higher instability of the supraglacial debris.

In the southern lobe, the cambial age of the trees tends to increase down-valley, even if the difference of altitude between the glacier front and the origin of the southern lobe is only about 200 m. The results show a time lag between the concentration of indicators of surface movement: in the northern lobe they mainly occur in the period 1989-1993 (5 years), while in the southern lobe in the period 1984-1990 (7 years). Miage Glacier mass change due to the passage of a kinematic wave in this period is well documented. Substrate movements due to the tongue deformation cause tilting of trees and the consequent presence of growth disturbances. According to the dendrochronological results, the glacier kinematic wave could have reached firstly the southern lobe and few years later the northern lobe. The time lag and the time span suggest that the kinematic wave which crossed the glacier tongue in the 1980's seems to have been slower and weaker on the northern lobe.

References

- Giardino, M., Mortara, G. and Bonetto, F., 2001. *Proposta per la realizzazione di un catalogo aerofotografico dei ghiacciai italiani*. Suppl. Geogr. Fis. Dinam. Quat., V, 89-98.
- Pelfini, M., Bozzoni, M. and Santilli, M., 2005. *Il Ghiacciaio del Miage, un geosito dalla peculiare valenza ecologica*. S.L.M., 23, 8-16.
- Pelfini, M., Santilli, M., Leonelli, G. and Bozzoni, M., (2007 in press) - *Investigating surface movements of debris-covered Miage Glacier (Western Italian Alps) using dendroglaciological analysis*. Journal of Glaciology, vol 53.
- Thompson, M.H., Kirkbride, M.P. and Brock, B.W., 2000. *Twentieth century surface elevation change of the Miage Glacier, Italian Alps*. Nakawo M., C. F. Raymond and A. Fountain, eds. *Debris-Covered Glaciers*, Wallingford, IAHS Publ., 264, 219-225.