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The recent variations of a debris-covered glacier (Brenva Glacier) in the Italian Alps monitored with comparison of maps and digital ortophotos

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Debris-covered glaciers are widespread in the mountains chains of Asia, such as the Karakoram, the Himalaya (Moribayashi and Higuchi, 1977) and the Tien Shan. They are also particularly common in New Zealand (Kirkbride and Warren, 1999), in the Andes, in Alaska. Despite their relatively common occurrence, debris-covered glaciers have not been well studied (Nakawo and others, 2000). The debris cover that masks partially or completely their ablation zone significantly influences the surface energy fluxes, the ablation rate and the discharge of the meltwater streams; at the end the debris cover by reducing ablation produces an alteration of the response of this kind of glaciers to climate changes. It is then important, with the aim of understanding how persistent debris cover influences the magnitude of terminus fluctuations, to collect quantitative information on length and thickness variations. On the Alps there are only few examples of such glaciers. Miage and Brenva, which drain the south slope of Mont Blanc in Valle d'Aosta (western Italian Alps) are two of the best known. Brenva Glacier (8 km2 wide and 7 km long) originates on the East side of Mont Blanc (Monte Bianco, 4810 m) and descends steeply to the floor of Val Veny where it terminates at an altitude of 1415 m, the lowest glacier front of all the Italian Alps and the closest one to a permanent inhabited place (the village of Entreves and the Mont Blanc tunnel's entrance are 1 km far). The terminal zone is extensively mantled with granitic debris, mainly deriving from large rockfalls that were deposited in November 1920. Until that event its terminus fluctuations were comparable with other Mont Blanc clean glaciers, such as Argentière or Mer de Glace (Orombelli and Porter, 1982). After the rock falls Brenva Glacier departs from the general trend and while most of Alpine glaciers retreating, it continued to advance reaching in the 1940 almost the limit of the 1818.

After that period it began to recede. A renewed advance was detected between 1965 and 1967 continuing with a new maximum in 1991 (Cerutti, 1992). Up to date, the last measurements of terminal variations show a new reduction phase (Deline, 2002). In spite of the often detected short terms terminus fluctuations of the Brenva glacier, its tongue thickness and volume variations are rather poorly known. The work deals with the processing and comparison of large scale maps and aerial imagery of the glacier supported by GIS-based metodology. By using GIS software the maps and ortophotos were managed after digitalisation. Digital Elevation Models were produced and their comparison allowed: 1) to quantify surface, volume and thickness variations of the Brenva tongue in the second half of the 20th century; 2) to elaborate thematic maps about ice thickness variations; 3) to elaborate longitudinal and cross profiles to underline thickness variations (Fox and Nuttall, 1997; Kääb and Vollmer, 2000; Kääb, 2001). The preliminary results obtained from differential analysis show that: 1) from 1959 to 1971 the glacier tongue increased in volume of about 15.3 milions m3 of ice with an estimated increasing rate of about 2m/y; 2) an increase of the Brenva tongue has been observed also from 1971 to 1983: 17.8 milions m3 in volume that corresponds to an increasing rate of the same size than the previous period 3) from 1983 to 1991, on the contrary, a volume loss (8.2 milions m3) and a thickness reduction (more than 1m/y) were observed; 4) the glacier shrinkage has continued from 1991 to 1997, period that has seen a volume reduction of 9.3 milions m3, that corresponds to a thickness lowering rate of about 2m/y. Again it must be pointed out that the 1997 aerial photograph was acquired in October. In January 1997, a big landslide flowed down from the upper basin of the Brenva and covered all the tongue; the granitic deposit thickness was about 1 m (Deline, 2002), which was superimposed upon the former debris cover. Therefore the above mentioned volume and thickness reductions could be subject to a little underestimating. In summarizing, during the second half of the 20th century (1959-1997) a net increase in volumetric change of 15.6 milions m3 and in thickness change of about 20 m occurred. This pattern of thickness change contrasts with recorded fluctuations of uncovered Italian glaciers. For instance, Lys (Monte Rosa group) and Forni (Ortles group), two of the widest glaciers of the south side of the Alpine chain, experienced strong thickness reduction of their tongues: Lys from 1953 to 1994 lost about 18 m (Rota and others, 2001) and Forni from 1953 to 1998 lost about 23 m (Merli and others, 2001).

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