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Terminus and surface recent variations from a sample of glaciers on the Italian Alps. The case study of Verra Grande Glacier (Monte Rosa Group)

T. Carnielli (1), C. D'Agata (1,2), G. Diolaiuti (1,2), C. Smiraglia (1,2)

(1) Earth Sciences Department, University of Milan, Italy (teresa.carnielli@unimi.it / Fax: +39 02-50315494) (2) Italian Glaciological Committee

The study of terminus and surface recent variations of some Italian glaciers has been carried out by using glacier frontal variations data (by Italian Glaciological Committee - CGI), historical maps and geomorphological evidences; particular attention has been paid to these last ones, used to reconstruct the past glaciers extension during the Little Ice Age (LIA) and the 2^{nd} half of the 20^{th} century (called also Cold Episode by Pinna, 1996).

The contribution will focus on the main results obtained by the research applied on the whole sample (20 glaciers chosen for their type, shape, size, position, and aspect all over the Italian Alps) and will explain with more details the findings performed on Verra Grande Glacier (Monte Rosa Group).

The more recent glacier advancing phases (LIA and Cold Episode) had represented unique occasions for Alpine glaciologists to observe directly small glacier advance phases (small but not different from the bigger older ones which occurred in the ancient past) and their influences on mountain landscape building moraine ridges (the called respectively LIA moraines and newly formed moraines).

The youngest evidences, called newly formed moraines, located near the present glacier snout from 0 to 800 m far away, have been surveyed. These moraine complexes are characterized by 3 or more concentric ridges, each formed by a large number of segments. Moraine morphology, morphometry and sediment grain size analyses permitted to formulate interpretation on the origin of these moraines. Comparison between moraine morphological and vegetational features and frontal variation data

suggested that these morphologies are attributable to the more recent glacier advance occurred in the 2^{nd} half of the 20^{th} century. Two older moraine complexes were also present in all the sites we had analyzed, they were always located downvalley respect to the newly formed ones position. These geomorphological evidences are characterized by 2 or more concentric ridges. The first and lower moraines complex was ascribed to LIA; these moraines are the largest ones and they present an almost total vegetational cover and pedogenetical processes deeply started. The second and intermediate complexes are ascribed to the advancing phase of 1920; its moraines are less covered by vegetation than LIA ones and show less advanced pedogenetical processes.

By GPS technique it was possible, during the years 1999-2003, to map glacier terminus and moraines positions and by GIS software has been calculated the past glacier surface extensions. The field data have been also analyzed comparing them with the terminus variations data (collected by CGI from the beginning of the 20^{th} century up to now) and with surface and volume changes calculated by GIS comparisons of different historical maps (for some Italian glaciers they were available from the end of the 19^{th} century). For some glaciers we studied meteorological data, collected on Automatic Weather Stations (AWS) not far from the glacier location, were also available; in these cases we tried to compare glacier and climate trends.

Verra Grande Glacier represents the third largest glacier (7 $km^2$of area) on Monte Rosa Group. From 1914 to 2001 its terminus retreated 816 m, but some gaps in the data records excluding from this value a part of information about the glacier Cold Episode. In order to obtain data for that period, by correlations between Verra Glacier and Lys Glacier data, the gaps have been filled and the record so reconstructed was successfully compared with the surveyed ones available for other close Alpine glaciers. Two short advancing phases had been found: the first between 1914 and 1921 (+78 m) and the second between 1975 and 1985 (+16 m). The GIS comparisons of different historical maps allowed to calculate an area reduction of about 31% (respect to the LIA area) from the Little Ice Age to nowadays. This reduction was rather irregular during the whole period: in fact it resulted stronger from 1934 to 1956 (surface reduction rate: 21x10^3 m^2/y), lower in the period 1975 -1991 (surface reduction rate: 7.3x 10^3 m^2/y), at the end this process intensified (1991-2002, surface reduction rate: 24 x 10^3 m^2/y). Moreover some geomorphological evidences (moraine ridges) have been found allowing to determine the past (LIA and Cold Episode) glacier extensions resulted respectively equal to 9.86x 10^6 m^2 and 7.45x 10^6 m^2. By processing the data collected at the AWS of Lago Gabiet (2367 m asl), it was possible to underline an increasing in the yearly amount of precipitation between 1976 and 1979 of 244 mm (+44% respect to the yearly mean value calculated for the period 1928-1994); also a precipitation reduction (equal to -16% between 1952 and 1964) has been detected. As

regards the temperature variations, between 1973 and 1984 the summer temperatures reduced of –1˚C (respect the 1928-1994 mean summer temperature value). These data are according Litterature's findings (Wood, 1988; Patzel, 1985)

For Verra Grande Glacier the advance phase of the second half of the 20^{th} century can so be attributed to those climate variations.

The results obtained on the other glaciers we analyzed underline a common glacier trend all over the Italian Alps on the last 150 years (from the end of the LIA up to now) even if each glacier had modulated differently its answer to regional and global climate variations on the base on its local geographic features and on its size.

KEY WORDS: glacier recent variations, ongoing climate changes, Verra Grande Glacier, Monte Rosa, Italy

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