

ANNA RAMPINI (\*), FRANCESCO ROTA NODARI (\*),  
ROSSANA SERANDREI BARBERO (\*\*\*) & PIETRO ALESSANDRO BRIVIO (\*)

## RETREAT OF AURINE AND PUSTERESI ALPS GLACIERS IN THE LAST DECADES FROM A LANDSAT TM IMAGE ON 2003 AND PREVIOUS RESULTS

**ABSTRACT:** RAMPINI A., ROTA NODARI F., SERANDREI BARBERO R. & BRIVIO P.A., *Retreat of Aurine and Pusteresi Alps Glaciers in the last decades from a Landsat TM image on 2003 and previous results.* (IT ISSN 1724-4757, 2005).

This paper presents the results obtained from the analysis of one recent Landsat TM image for the study of the status of some glaciers on Eastern Italian Alps. Then these results are compared with a set of multi-temporal Landsat images from the Eighties. A fuzzy set based classification technique permitted to quantify snow and exposed ice extents in glaciated areas. Integration with topographic information allowed to derive the elevation of glacier terminus, although the result is overestimated due to some problems with digital elevation data and frontal debris coverage. A comparison of front altitude changes data derived from satellite image processing with elevation measured during field surveys supports the knowledge of the size of glacier reduction of the last decades. On Aurine and Pusteresi Alps glaciers, the changes in the last twenty years result to be a reduction corresponding to the 40% of the glaciated surface in the '80s, but a lot of the glaciers are now characterized by a new extent debris coverage in the frontal zones.

**KEY WORDS:** Glacier retreat, Aurine and Pusteresi Alps, Remote Sensing, Debris cover.

**RIASSUNTO:** RAMPINI A., ROTA NODARI F., SERANDREI BARBERO R. & BRIVIO P.A., *Il ritiro dei ghiacciai delle Alpi Aurine e Pusteresi delle ultime decadi dedotto da un'immagine Landsat TM del 2003 e da risultati precedenti.* (IT ISSN 1724-4757, 2005).

Questo articolo presenta i risultati ottenuti dall'analisi di una recente immagine Landsat TM per lo studio dello stato di alcuni ghiacciai delle Alpi Italiane Orientali. Tali risultati sono stati poi confrontati con un set multitemporale di immagini Landsat degli anni '80. Una classificazione di tipo fuzzy ha permesso di quantificare le estensioni di neve e ghiaccio scoperto relative alle aree glacializzate. L'integrazione con le informazioni topografiche ancillari ha permesso di ottenere la quota delle fronti, anche se il risultato è soggetto sovrastima per problematiche legate al modello di elevazione del terreno e alla recente copertura detritica delle fronti. La riduzione areale dei ghiacciai in esame nelle ultime decadi viene confer-

mata dal confronto effettuato tra le variazioni di quota stimate da satellite e le misure effettuate durante le campagne al suolo. Negli ultimi vent'anni, le Alpi Aurine e Pusteresi hanno subito una apparente riduzione delle superfici glacializzate del 40% rispetto al valore del 1980, ma molti dei ghiacciai considerati sono caratterizzati da una recente copertura detritica che maschera interamente larghi tratti del settore frontale.

**TERMINI CHIAVE:** Ritiro dei ghiacciai, Alpi Aurine e Pusteresi, Telerilevamento, Copertura detritica.

### INTRODUCTION

Mountain glaciers are highly sensitive, large scale and representative indicators for the energy balance at the earth's surface in high altitude areas. Glacier signals from mountain areas are key element of early detection strategies for dealing with possible man-induced climate change (Becker & Bugmann, 2001). Except for too short advances in the Twenties and in the Seventies of the last century, glaciers in the Alps are retreating since their last Holocene maximum extent (around 1860). Mountain glaciers are linked to the atmosphere through mass and energy exchange which determine accumulation (gain of mass) and ablation (loss of mass) throughout the year (Paul, 2002). Thus, glaciers integrate atmospheric conditions over some years and are able to convert a gain of snow of a few metres thick to a change in length. Therefore, glaciers are considered as sensitive climatic indicators (Haeberli, 1995).

In order to better understand changes, world glaciology and global change communities, need a long term monitoring program, aimed at establishing a uniform baseline of the status and dynamics of the world's glaciers. This long term monitoring program requires spatially based information, which are intrinsically geographically homogeneous. The availability of long time series of high resolution satellite imagery as Landsat and SPOT is of invaluable importance in building a consistent database.

(\*) IREA - CNR, via Bassini 15 - 20133 Milano.

(\*\*) ISMAR - CNR, 1364 San Polo - 30125 Venezia.