Use of multispectral aster images for mapping debris-covered glaciers within the GLIMS Project

Roberto RANZI, Giovanna GROSSI, Laura IACOVELLI, Stefan TASCHNER
Università di Brescia
Via Branze 38, 25123 Brescia - ITALIA
taschner@ing.unibs.it

One of the most ambitious ongoing research project in glacier monitoring is the GLIMS (Global Land Ice Monitoring from Space) Project, co-ordinated by the USGS. The main objective of this international project is to establish a new global inventory of land ice based on remote sensing data (mainly on ASTER images). The research team of the Department of Civil Engineering at the University of Brescia is involved in the project as being responsible for the co-ordination of mapping the glaciers in Italy (see http://civserv.ing.unibs.it/utenti/ranzi/glimsit/index.htm).

However monitoring glaciers using remote sensing techniques is difficult in those areas, where a large number of glaciers are partly covered by a debris layer that prevents an appropriate use of remote sensing data, especially in the visible range.

One of our test sites for studying the physics of those ‘black’ glaciers is the Belvedere Glacier (45.94° N; 7.91° E), located in the Anzasca watershed at the base of the Monte Rosa peak (4634 m asl) in the Italian Alps, close to the Swiss border. The overall glacierized area is 5.58 km² as reported in the World Glacier Inventory (WGI). The glacier’s terminus has an altitude of 1785 m asl., which is quite low and very unusual for the Southern side of the European Alps. Also of special interest is the Belvedere glacier from another point of view. Since 2001 every year a small endoglacial lake (Lago Effimero) developed on the flat glacier tongue. This lake however is a serious risk in terms of a possible outburst and formation of a flood wave and has therefore be also monitored.

In the frame of the GLIMS activities in summer 2003 a meteorological/energy balance station was installed at the end of July 2003 on the main glacier tongue of the Belvedere glacier at an altitude of 1930 m asl. and remained there till mid October. Besides standard meteorological measurements also the net radiation, the heat flux and the temperature of the debris surface as well as the temperature of the debris layer at 3 different depths was recorded. Additionally several field surveys studying the temperature of the debris were carried out due to ASTER satellite passages. Also an energy balance model was set up for the Anzasca river basin. The collected data at the meteorological/energy balance station enables to validate several results of the energy balance model. Moreover for the melt seasons 2002 and 2003 the melt rate upstream Lago Effimero was computed. The cumulated melt was in agreement with the volume of the lake measured after surveys.

The field measurements and the energy balance model results can be used for a better interpretation of remote sensing data particular for understanding the thermal signature. A GIS based classification algorithm for black glacier detection was developed including the thermal band of the ASTER sensor respectively the LANDSAT satellite. Good results were achieved for detecting the glacier outlines of the Belvedere glacier. To test the method the algorithm was also applied to the Maige Glacier, another debris-covered glacier in the Italian Alps located in the Mount Blanc group.