ABSTRACT

CLIMATE VARIATIONS AND SNOWCOVER IN THE ITALIAN ALPS

M. Valt, P. Cianfarra

The V AR5 study of the working group of the Stockholm IPCC panel confirmed that the snowcover extent in the Northern Hemisphere has been gradually decreasing, and that in March and April high correlation exists between such decrease and anomalous temperature values. Recent works have already proved that in the Italian Alps, too (6.6-13.7 E and 47.1-44.1 N) the snowcover extent and the amount of fresh snow have been gradually reducing, especially in March and April, at heights ranging between 800 and 1,500 m. The present work analyzes temperature data, snowfall and snowcover duration with more than 30 cm thickness (skiable snow) in the 1930-2013 period.

The analyses carried out highlighted, in the 1987-1988 period, a variation of regime for all the three parameters analyzed. Furthermore, in the 1991-2000 period, the largest deficit was observed in the last 10 years. In the 2004-2013 period a lower temperature rise was observed in December-February compared with the 1961-1990 average, alongside almost standard snowfalls. Temperature ranges in March-April have been instead steadily increasing, with a major snow deficit (approximately -30%) especially at low altitudes, and resulting lower snowcover duration.

As for the snow reliability line (LAN), altitude rose by over 300 m following a seasonal temperature rise of 0.7 °C, amounting to a much higher value than that recorded in other studies, i.e. 150 m for 1.0 °C.

Last but not least, in the 1961-2013 period, high correlation was observed between temperature trends in spring, fresh snow accumulation (R=0.81) and duration of snowcover with more than 30 cm thickness (R=0.90).

EVOLUTION OF DOLOMITE GLACIERS IN THE LAST 100 YEARS AND RECENT MASS BALANCES IN THREE GLACIAL SYSTEMS

A. Crepaz, G. De Luca, A. Cagnati

The aim of this work is to provide quantitative data on changes occurred in the little Dolomite glaciers in the past century and show the recent mass balance data of three glacier systems, among the largest ones in the Dolomites.

Today there are approximately 75 glacier systems in the Dolomites; they are generally of little size, often in form of névé, and some of them were unknown in the past. Owing to that, a sample of 27 glacier systems was taken, for which historical data is available. Furthermore, the mass balance was calculated for Marmolada, Antelao Superiore and Fradusta glaciers, where GPR and GPS measures were taken in 2004 followed by Lidar survey from helicopter in 2009. These surveys show an average surface loss of 4.48 km2 in 100 years, amounting to -49%, of which approximately 30% in the last 30 years. Calculation of mass balance, in the 2004/2009 period, showed an average annual loss of respectively 1,05 m w.e a-1 for Antelao Superiore, 1,16 m w.e a-1 for Fradusta and 1,01 m w.e a-1 for the Marmolada Glacier.

CRYOSPHERE OF FRIULI VENEZIA GIULIA: THE CASE STUDY OF MONTE CANIN (JULIAN ALPS)

R.R. Colucci e, E. Forte

In the last years, glaciological research in Friuli Venezia Giulia has been experiencing a period of renewed interest, especially thanks to new technologies like Terrestrial and Airborne Laser Scanning (LiDAR), more powerful Ground Penetrating Radar (GPR) systems and widespread diffusion of Automatic

Weather Stations (AWS) located at high elevation. These techniques and facilities were used in the Canin area (Julian Alps) to better understand the present state of glacial remnants, from both a glaciological and a climatological point of view, and to deal with the study of underground ice, which represents a new approach to paleoclimatological studies in mountain areas.
In this work we present some case studies and some preliminary results about the use of geophysics in glacierized areas.

VOLUMETRIC ESTIMATE OF THE SOUTHERN ALP GLACIER THROUGH GROUND PENETRATING RADAR MEASUREMENTS AND GNSS SURVEYS

M. Rossi, M. Belò, M. Fioletti, L. Bonetti

The Southern Alp Glacier is a Lombard Glacier system located in the Valfurva area in the Sondrio province, on the Monte Sobretta massif (3,296 m a.s.l.).
On this glacier, technicals of Centro Nivometeorologico of ARPA Lombardia, regulary carried out high-accuracy measurement campaigns. Study and monitoring activities include a series of surveys performed in winter and summertime.
All the information on mass variations, usually obtained by means of differential measurements on stakes, is supported by accurate GNSS (Global Navigation Satellite Sistems) surface measurements. However, this type of measurements does not take into account the basal surface of ice, thus not allowing for the implementation of forecasting models aimed at estimating the availability of immediately available water resources. To this aim, a campaign of Georadar surveys was carried out in September 2011 concurrently with GNSS survey of the glacier surface and reading of ablatometric stakes. The bedrock surface, which makes up the sedimentary-rocky substratum, was reconstructed by processing Georadar profiles, which were taken using 100 MHz antennas and were homogenously distributed over the whole glacier surface. The basal surface, once reconstructed in its tridimensionality, produces a digital model of the terrain that is then taken as a benchmark for the analysis of volumetric variations with time. Also, thanks to the availability of GNSS surface surveys since 1997 to date, it is possible to evaluate any space variation of ice thickness throughout the years. This allows scientists to know what ablation dynamics are and to find out any possible differential ablation process. Being able to understand the complex differential ablation and accumulation processes allows us to improve our knowledge of glaciological dynamics, while bringing around essential information to create accurate models and reliable predictions about the availability of water resources from glaciers.

GLACIER-RELATED RISKS IN VALLE D'AOSTA: MONITORING AND APPLIED RESEARCH

D. Bertolo, M. Curtaz, C. Lucianaz, M. Vagliasindi

Glacier-related phenomena represent a major source of risk in mountain areas and particularly the Alps.
The risk originates from the interaction of glacial dynamics, which are very active and in rapid evolution also – but not only – due to climate changes and anthropic presence, which has been strongly expanding in the alpine areas in the past century. The main glacial risks are linked to the fall of seracs, the failure of tempered glaciers or the sudden release of water accumulated inside glaciers themselves.
The Valle d'Aosta territory, for its characteristics, is particularly subject to such risks. For this reason the regional government, through Fondazione montagna sicura (Safe mountain foundation), has implemented a specific monitoring plan for glacial risks. This plan provides for different initiatives, targeted to territory, as a whole, and monitoring of specific cases alike.

SUMMARY AND PRELIMINARY RESULTS OF STUDIES BY ARPA PIEMONTE ON PERIGLACIAL ENVIRONMENT AND PERMAFROST IN PIEDMONT ALPS

L. Paro and M. Guglielmin

In the last few years, some gravitational and debris flow phenomena occurred in Piemonte that originated from high elevation areas, sometimes evolving in critical events, as they involved distal and anthropised valley areas.
Due to these paroxysmal events, the necessity aroused to widen, to higher altitudes, the area until now surveyed through weather-climate monitoring stations, in order to highlight all possible interrelations between climate changes, periglacial environment and degradation of alpine permafrost that may lead to increased geological risks in large mountain areas.
To this aim, ARPA Piemonte (in collaboration with Università dell'Insubria) from 2006 started a series of projects aimed at improving knowledge about these issues, also creating a monitoring network of permafrost distributed on the whole regional alpine range.
These activities, which benefited from strong support on the occasion of the European project Alpine Space "PermaNet" (Permafrost long-term monitoring Network) in the 2008÷2011 3-year period, have now become an integral part of the Agency's institutional targets.2
The main results achieved so far include the regional land register updated with permafrost morphological indicators, maps and models of the potential alpine permafrost distribution, temperature monitoring stations and surface monitoring sites; furthermore, BTS (Bottom Temperature of the Snow Cover) measurement campaigns have been carried out, alongside geophysical surveys and detailed studies aimed at evaluating relations between atmosphere, geosphere, cryosphere and biosphere.

PILOT EXPERIMENTS AIMED AT REDUCING SNOW AND ICE MELT AT THE PRESENA GLACIER (TRENTO, ITALY): PRELIMINARY RESULTS ON THE APPLICATION OF ARTIFICIAL COVERS FEATURING DIFFERENT CHEMICAL COMPOSITION

A. Senese, R. Azzoni, D. Maragno, B. Mosconi, C. Smiraglia, G. Diolaiuti, A. Trenti

Since summer 2008 a research project aimed at reducing snow and ice ablation has been going on at the Presena Glacier (Adamello Group, Trentino), where skiing activities are performed in winter, spring and part of the summer season. To reduce magnitude and rates of snow and ice melting during summertime 2008, 2009 and 2010, several artificial covers were positioned on the glacier surface from July to September and the result of such experiments was actual reduced ablation. In summer 2012, a new experiment was performed to test the effectiveness of the different artificial materials in reducing melting. Five different artificial covers (COVERTESS ICE) were analyzed. These were characterized by different chemical composition (i.e. polypropylene, polyester and polylactic acid), mass per area (i.e. from 340 to 500 g/m^2) and thickness (i.e. from 3.00 to 4.40 mm at 2kPa). The 500 polypropylene cover (with 3.70 mm of thickness) turned out to have maximum efficacy (it reduced snow ablation by 73%) and also witnessed the highest albedo values and lowest temperatures. This may seem due to the higher mass per area, which makes surface reflectivity more stable. We also evaluated the effectiveness of old covers in reducing ice and snow melting (i.e.: covers used twice on two different summer seasons, the first time in 2011 and the second time in 2012). These covers featured lower albedo values and thus more intense melting rates: for this reason, they should be used only at high altitude areas where ablation generally takes place at lower rates.