Science focuses on snow

Snow plays a central role in Switzerland's capacity to provide water for downstream users as a water tower. As climate change will have far-reaching consequences for snow conditions, so to will it affect Switzerland's capacity to export water in the future. Research into climate impacts on the availability and use of water is an important part of the National Research Foundation programme no. 61, which will start this autumn.

Urs Fitze

Engadine at Christmas 2098: there is hardly any snow on the lower slopes of the valley. They are white only above about 2200 m. Snow on the valley floor has become a rare phenomenon at this time of year. Winter is two to three months shorter than it was 100 years ago. Even at an altitude of 3700 m the snow no longer remains through the summer. The snow-melt reaches a peak at the beginning of May and is more or less over by June.

This scenario is based on calculations from a model devised by the Swiss Federal Institute for Snow and Avalanche Research (SLF) in Davos. For Tobias Jonas, Head of the Snow-Hydrology Research Group at the SLF, just how closely it resembles the future is but one of many unanswered questions concerning the effects of climate change in the Alps. "If the currently available climate scenarios are accurate, our calculations will on the whole be correct."

All the scientists who attended the meeting "Alpine Hydrology – Snow Hydrology", organised in Davos in mid-August by the Swiss Hydrological Commission, were unanimous: snow plays a central role in the hydrology of Alpine catchments. Snow has a far greater effect on runoff from the Alps than does the ice stored in glaciers. In Switzerland, between 40 and 90% of precipitation above 1500 m falls in the form of snow, and in the summer months up to 80% of the runoff from the Alps is melted snow. Future changes in snowpack will have major impacts on downstream users.

We need a great deal of detailed knowledge

According to Prof. Dr. Rolf Weingartner, President of the Swiss Hydrological Commission of the Swiss Academy of Sciences, current knowledge indicates that in the Alps not only temperatures but also precipitation will change in the future. Most models indicate that there will be less precipitation in summer but slightly more in winter.

The challenge facing hydrologists today is to downscale these general predictions to a regional or even local context. Hydrologists are in something of a dilemma, because their models are based on those devised by climatologists. This dependence means that the approximations of the climate models are transferred to hydrological models, which are, of necessity, of much finer scale.

The difficulties involved in downscaling are easily seen. In the area immediately around a glacier snow transport by wind is central to the fate of glacier, since wherever the snow accumulates the ice will melt away more slowly. This feature can be seen on the Arolla glacier:

Thanks to this drifted snow more ice has been able to survive on the flanks of the glacier. This accumulation of snow may explain the persistence of this glacier in a site where, according to theories, it should not exist at all.

In a computer model, a jagged mountain summit often becomes a rounded peak as computer capacity cannot allow for a greater degree of topographic precision. This approximation is adequate for general predictions of snow behaviour in a mountain area because opposing effects cancel each other out. But, for a precise picture of what happens at the summit, much more detailed rendering is needed.

Forest is also challenging for hydrology researchers, since snow that falls on a forest behaves quite differently from that which falls on non-forested land. Part of it will remain in the forest canopy, from where it will eventually either evaporate or fall to the ground. Furthermore, the canopy protects the snow from solar radiation during the day. So far researchers have been only moderately successful in transferring these factors to a numerical model.

Despite less snow, recurring good winters

The degree of change in the Alps can be seen from a survey of the past 100 years. If we look more closely, the recent "100-year winter" of 2007/2008, which brought tourist resorts and transport companies record earnings, was only an average winter in terms of the historical record. This perception shows how limited our temporal viewpoint has become. Statistics on total snow depth and depth of new snow evaluated by SLF researcher Christoph Marty show a marked change at the end of the 1980s. Since then both snow depths and volumes of new snow have decreased considerably. In Marty's opinion it is too early to talk of a trend; "We need to have data series from at least three decades to do statistically sound analyses. However, similar changes in the snow cover have been observed not only in Switzerland but in the whole of the Alps, however."

What will be the consequences? Carmen de Jong of the Savoy University Mountain Institute has already observed a growing conflict of interests concerning water in the French Alps, an area considered to have a plentiful supply. For example, following the summer heat-waves in 2003, a number of springs in limestone areas dried up. Farmers had to fetch water for their cattle from the valley by tractor. At the same time, the tourist sector was using an increasing amount of water to create artificial snow to ensure a good cover for skiers. This water was stored in basins and consequently was not available in the valleys. As far as the resort companies were concerned, snow-making was and is an economic necessity, since in 50 years' time only ski resorts above 1500-1800 m asl. will have sufficient snow throughout the season. For this reason, the SLF is also studying the development of artificial snow makers, especially those machines which are able to run without using energy from other sources.

A new National Research Programme

These issues are among those raised in the context of National Research Programme no. 61, entitled "Sustainable supply and use of water". If the Federal Council gives its approval, this programme will start this autumn. For Christian Leibundgut, head of the NRP 61 management group, this programme must address not only climate change but also social and economic issues, since conflicting interests are apparent in many aspects of water use. "So far the whole hydrological system in Switzerland has been able to meet all these demands. Whether this will be the case in the future, with the new global challenges, remains to be seen. With NRP 61 we hope to be able to supply an answer to this question." The priority for this project will therefore be multidisciplinary team work – a challenge for hydrologists too.

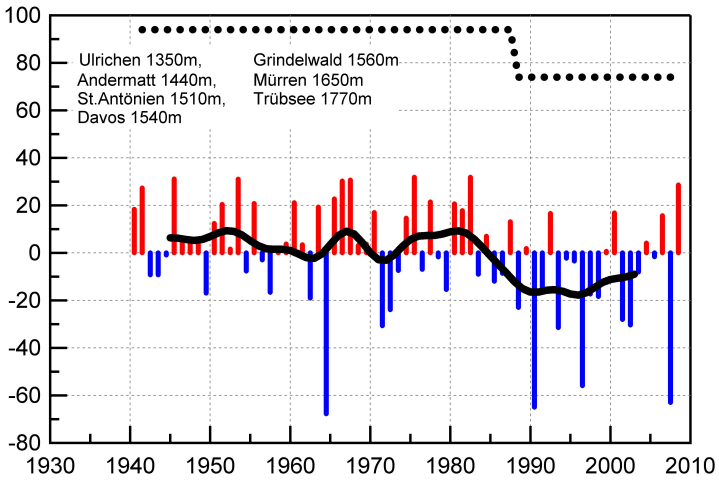

Fig. 1 Annual deviation in the duration of snow cover from the long-term mean for 1961 to 1990 and the resulting trend (black line). The change at the end of the 1980s, which has so far not been followed by a come-back, can be clearly seen.
(Christoph Marty, SLF)

Fig. 2 Guaranteed snow (here the ski pistes in Samnaun) is extremely important for winter sports. Snow also plays a central role in Alpine hydrology, however.