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Cryosphere – a CRY for our SPHERE ?

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Recently Schellnhuber (PIK/Tyndall) suggested that there are 12 tipping points or triggers that could further enhance global warming. Interestingly, 8 of these 12 tipping points concern the cryosphere, be it the north pole, south pole or mountains. These include the North Atlantic Current, Greenland Ice Sheet, Ozone Hole, Antarctic Circumpolar Current, Tibetan Plateau, Methane Clathrates locked in the Russian permafrost, Salinity Valves and West Antarctic Ice Sheet. Apart from these tipping points, there are also the so-called Canary Indicators concerning our mountains regions. Here mountains, which belong to one of the most sensitive environments of our globe, are taken as indicators of climate change. In future, the increasingly densely inhabited and touristically frequented mountain regions under the stress of climate change will have to become another prime focus of the cryosphere. For example, the economical significance of winter ski tourism, attracting 60-80 million tourists in the European Alps alone, remains unchallenged. The latest OECD report, to be published in February 2007, shows that a 1 ˚C warming in temperature could bring about such severe changes as reducing the natural snow cover by up to 60% in the Alps, with the German, French and Italian Alps to be hit strongest. Ski operators are adapting to the shorter winters and thinner snow covers with improved technology, mainly confined to artificial snow production. Over the last few years this has become common in practically all skiing areas, consuming large amounts of water and energy and causing effects to the cryosphere, such as increased evaporation and sublimation, yet to be quantified. With rising temperatures, the problem of snow deficit cannot be solved by mechanical solutions alone. Unfortunately, the natural and human alterations of snow cover has received little attention compared to the more impressive statistics of accelerated glacier retreat.

Since Rodda defined the concept of mountains as the water towers of our lowlands in Messerli and Ives (1997), it has been actively applied for mountains around the world.

However, it remains a blackbox concept with limited considerations of hydrological and other interactions. If the concept of water towers is to be analysed with greater precision in future, numerical models treating natural factors alone are insufficient. Mountain regions unite many human interests, but transparency on the different uses of the cryosphere, in particular water, is very low. Joint interests such as production of hydroelectricity, flood control and production of artificial snow are put forward without considering possible short and long term primary and secondary effects. The optimisation of e.g. snow use and tourism seem environmentally sustainable but if the different components are analysed closely many discrepancies are obvious. The optimal security related to hydropower is not obvious in the long term with melting glaciers, reduced snow cover and reservoir sedimentation. The apparent security of ski stations is not even obvious in the short term. With warmer winters, the absence of snow below 1500 m has transferred many skiing areas into hiking areas. Artificial snow is not unlimited: where snow is absent due to climatic factors it is difficult to sustain artificial snow.

Another major issue is the retreat of glaciers: with more water released from rapidly melting glaciers, an augmentation of slope instability and increased sediment transport in rivers can be anticipated. Processes of valley slope decompression will dominate in recently glaciated areas due to the loss of meachanical resistance, triggering more natural disasters such as mass movements and rock falls. Similarily, the melt of permafrost could cause major reorganisation of the surficial layers and facilitate slope erosion as well as rock falls. As permeability of the former impermeable frozen layers increases, new hydrogeological relations can develop, in particular in limestone regions or zones with intensive faulting.

Not to be neglected are the ecological aspects associated with the changing cryosphere. The altitudinal and latitudinal re-distribution of plants may not occur in simple linear trends but may tend to cluster. In high alpine zones, such changes will occur in adaptation to the geomorphological and geological setting and will heavily influence the alp economy.

There are many problems that the cryosphere community has to tackle and their reduction or solution will only succeed in interdisciplinary cooperation with other scientists. Thus, apart from the polar regions, the cryosphere should be actively extended to include the mountains regions. Mountains are of prime importance since they directly effect people living downstream and at their margins. The “Cry for our Sphere” requires Integrated Cryosphere Management (ICM), including not only the polar regions but also the continental mountain areas.