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Research and Development in the Anthropogenic Cryosphere

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Much of todays cryosphere research is oriented towards the polar regions and is strongly supported by large associations and funding. On the other hand, funding and institutional support is still limited for mountains. In Europe, mountain research is mainly funded through Alpine Space Interregs, FP7, ESF and COST. However, there is growing global change pressure on mountain regions, particularly in the more fragile, higher altitudes such as between 1000 – 3200 m in the Alps. Although these zones are comparable to the Arctic in terms of climatic and physiographic conditions, they are not in terms of human pressures and atmospheric pollution released from surrounding agglomerations. A re-orientation of research into more applied projects that tackle present day problems is necessary. Not only is climate change rapidly changing the face of mountains, socio-economic multipliers are also acting fast. New problems such as conflicts over natural resources are evolving at a rapid rate, requiring research funding and projects to respond at according rates if timely and efficient solutions are to be proposed. Other problems include contamination of high altitude lakes and ecosystems through atmospheric precipitation of persistent organic pollutants and concentration of radio-active substances. The rapid melt of glacier ice is also releasing pollutants that have been captured for many decades. Many of the present day problems develop due to a miscomprehension of the cryosphere. Short-term economical reasoning outweighs the long-term ecological impacts that could be very counter-productive at the long term. Both the glaciological, snow, permafrost, geomorphological, ecological, hydrological and atmospheric conditions are increasingly heavily modified by human impacts. The effects include the alteration of the ice cover (by artificial covering of glaciers), production of artificial snow cover, snow and ground compaction, erosion, landsliding, change in vegetation cover and fauna, modification of local hydrological cycle and modification of local climate and atmospheric pollution. Research in mountains should balance the needs of scientists and stakeholders alike, but this requires re-orientation of mountain research into multi-disciplinary projects next to basic science. Unlike the polar regions (with exceptions like Longyearbyen, Spitzbergen), seasonal population pressure in mountains is intense, causing local problems such as water scarcity. Research in these areas therefore requires close collaboration with stakeholders.
Large-scale events such as Winter Olympics that have benefited from the classical mountain cryosphere in the past are now increasingly becoming internationally competitive and independent of the natural cryospheric conditions. New ski areas are developed world-wide in zones that do not offer natural climatological conditions for maintaining ski runs. Sub-zero temperatures are used as a basis for snow-making even in those regions that do not benefit from sufficient natural snow-fall. Large-scale landscape modification results in motorway like ski runs, large snow water reservoirs and extensive housing projects on vulnerable slopes. Due to steep and remote topography, transport is often dominated by cars and increases CO2 emissions intensively at local hot spots. In future, mountain slopes that have been heavily modified for winter tourism, may rapidly become neglected zones due to rapid snowline retreat. As the summer season extends, the modifications to the cryosphere will become more and more evident. Even with positive temperatures and snow-free ground, the vegetation season will not be extensive enough to enable rapid recovery, especially at altitudes above 2000 m a.s.l and north-facing aspects. Several decades of anthropogenic modification may require several centuries of recovery to provide new economical benefits.