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Winter snow melt events in the Eurasian Arctic: consequences analysed from scientific and indigenous knowledge

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Scientific analysis of changing snow conditions in the Arctic are dominated by measurements and projections of relatively few parameters such as snow depth, onset of snow cover, melt date and snow water equivalent. However, Indigenous Arctic Peoples have wide vocabularies for many different snow conditions dominated by terms related to movement of people and animals over the snow and access of semi-domesticated reindeer, to food plants beneath it. Observations of local peoples e.g. the Saami have been accumulated and central to their survival over generations. Collaboration with the Saami has led to a new understanding of the importance of climatic events that affect winter snow cover: their reading of the vertical snow profile and its consequences for reindeer grazing has focused scientific measurements of snow profiles and experiments to simulate extreme warming events in winter. Furthermore, natural events that have had severe implications for natural ecosystems and biodiversity have been recorded by scientists.

Of particular concern are the snow and ice conditions represented by hard crusts and ice encapsulation of vegetation that prevent access to food by reindeer and small rodents such as lemmings. These conditions might be created by animals compacting the snow, a situation called “Čiegargovvi”. They are also formed by warm events during winter that result in snow melt, and subsequent ice formation., “Bodneskárta”, “Bodnevihki” and “Skilži” occur when the ice layer is on the ground and underneath the snow when it returns, and “Gaskageardni” occur when the ice layer is in the middle of the snow pack (i.e. melt was incomplete).

At Abisko in Swedish Lapland, the number of observations with an “ice hard” snow layer at ground level have increased strikingly: more than twice as many occasions occurred in the period 1993-2009 than in the two periods 1961-1976 and 1977-1992. Experimental simulations of an extreme warming event at Abisko showed numerous effects on the sub-arctic ecosystem including plant shoot death and reduced berry production, probably because some plant species were triggered into spring-like development before temperatures returned to normal and because the plants were exposed to unnaturally low temperatures when the snow’s insulation was absent. In December 2007, a natural extreme winter warming event occurred during which satellite and ground based measurements showed that plant production in the following summer was decreased by 26% over an area of more that 1400 km2. Damaged vegetation affects grazing animals such as reindeer while the absence of snow exposes small rodents to predators and destroys their ability to breed. This then affects iconic predators such as snowy owls and arctic foxes. In November 1993, a rain on snow event on high Arctic Svalbard caused crashes in populations of reindeer and an introduced rodent species. Elsewhere, 20 000 musk oxen died probably because of rain on snow events while Peary’s reindeer in Canada’s Northwest Territories is experiencing a dramatic decline probably because of the same factor. In contrast, events in Russia when the basal ice layer was thicker than 5 mm over 10 consecutive days decreased by $\sim$5%/decade since 1966, mainly in response to a shorter and more intense snowmelt season.

In conclusion, winter warming can have dramatic negative effects on arctic ecosystems but these effects are due to events of just a few days. Although these events and their consequences are well known by arctic indigenous peoples, they remain a challenge for the scientific community to understand and predict. A new study, commissioned by the Arctic Council (the SWIPA report), will present in May 2011 a baseline study of observed and predicted changes in arctic snow conditions and their multiple consequences.