

Beyond short-term pilot projects

By Kenneth Hewitt

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water crisis
Agriculture

MOST of these tongues are heavily blanketed in erosional debris known as supra-glacial moraine. It is generally so thick it protects the ice from melting by the sun. Dusting would have no effect. Where the ice is bare, there is so much natural dust blowing around and melting out of the ice that surfaces are already very dirty, and dusting will have little added effect.

Finally, however, there are times when the monsoon fails and drought occurs over the summer months, and the most extensive areas of glacier are available for melting. Moreover, if additional large reservoirs, mooted for the main Indus, were built, the need and the capacity to hold back most or all high flows from the mountains would change the picture. Suppose then, that we accepted these increased incentives for dusting of clean ice. What would be required?

Additional melting will only occur for as long as sunny conditions prevail. In warm sunny weather a surface layer of the ice becomes pitted and porous. Any dust is held and collects in the pits where it will enhance melting. However, if there is a cloudy day, this pitted layer is quickly degraded and a smooth ice surface develops. The dust washes away. If a storm comes in, at lower elevations rain will wash the dust away. At higher ones snow will cover it up. Each time this happens, a new layer will have to be applied.

In my experience of the glacier zone, there are a great many cloudy days and multiple storm episodes in most summers — especially those in which poor melt yields would increase the incentive for artificial melting. A run of more than a week of clear weather is unusual and when it happens, vast quantities of melt water are released naturally. Huge budgetary demands and fluctuations will hinge on weather events. Meanwhile, the melt waters generated would take many days or weeks to reach the

more wasted glaciers? Increased melting without increased ice flow will likely bring more turbid water and declining water quality. What if the dust being used contained some unrecognized contaminant? If artificial melting on a useful scale were possible, these are the issues that become serious. I believe enough is already known to reject such schemes on grounds of safety and environmental impacts, as well as of cost and reliability. However, the fact that we are still discussing these ideas seriously is testament to how limited awareness and understanding is of the glacial zone.

Over the years, my own work in the Northern Areas became involved with water resource issues thanks to a few perceptive individuals in the universities, WAPDA and other agencies. They recognized the growing economic and strategic significance of snow and ice for

Unfortunately, only rather localized, short-term pilot projects have so far investigated the high-altitude conditions. There is no on-going monitoring of the Upper Indus glaciers, or high altitude snow packs. There are no stations directly measuring the climatic conditions that govern them. How existing weather stations and stream gauging might relate to conditions on the glaciers remains uncertain.

Pakistan's survival — and the risks associated with lack of knowledge and monitoring of them. But these voices have not been widely heard. The question is generally buried except in times of crisis. Why is this so? In part, it is a carryover from before independence and some time after, when snow and ice was not as important. In part, it is also a problem of 'out of sight, out of mind'. When the rains come they immediately signal their own importance for the main settled regions.

Upper Indus glaciers, or high altitude snow packs. There are no stations directly measuring the climatic conditions that govern them. How existing weather stations and stream gauging might relate to conditions on the glaciers remains uncertain. Very few persons are trained in snow and ice hydrology, or for working in the glacial environment. One final point will help reinforce the seriousness of these questions.

Most of the world's mountain glaciers are in decline. It has been widely reported that the glaciers of the Himalaya are 'disappearing'. Global climate warming is generally blamed. It is generally seen as a severe crisis for water supply in basins dependent on snow and ice. People I have spoken to seem to think the same is happening in the Upper Indus Basin. It is not.

At least, in recent visits and from inspection of satellite imagery, I have found that a major glacier expansion is occurring in the highest parts of the Karakoram Range. Along eight of the largest glaciers, there has been 5-20 metres of thickening over substantial areas between 3,500 and 5,500 metres, compared to the late 1980s. Seven glaciers are known to be advancing. Ice margin areas known to have been ice-free for fifty years or longer are being overridden by zones of elevated ice. Thus, the Karakoram is one of just three areas in the world where mountain glaciers are increasing. The others are in Norway and New Zealand — much smaller in size and much less vital for surrounding populations. As far as I am aware only a few shepherds in the Northern Areas and this visitor from Canada have recognized the glacier expansion.

If Pakistan's glaciers are growing, it seems like good news. The ice and snow resources of the Upper Indus Basin are being sustained, for the moment at least. Evidently, more moisture is being carried into the region, offsetting other possible consequences of global warming. However, this need not, and probably will not, translate directly into increased water supplies. The added mass repre-

areas of need in the plains. Its benefits could be compromised by intervening weather conditions suddenly increasing or decreasing yields from elsewhere. So there are great uncertainties as to how, and how effectively, artificial treatments can be applied. The greater the need, the more costly the water they would generate.

But now suppose we are very determined, and do find ways to significantly enhance melting. How can the system pay for itself if only used for a few days or weeks in unusual years? If it works, there will be incentives to use it as fully and often as possible. Demand for the added water will likely grow. Soon, the ice will be used up faster than it is replaced. The glaciers will thin, retreat or stagnate, no less than if the climate itself had changed. The resource will become unsustainable; and eventually create an even worse, artificially created water crisis.

What of potential environmental and ecological damage? What effect will the added dust have on the farmers, shepherds and wild life of the high valleys? How often will we hear bad stories of dust missing the target and blowing into vulnerable areas? Will the tourist industry be affected by such practices, and dirtier,

But the role of snow and ice melt is not directly perceived, even in the months and on the rivers where it is decisive. Also, the highest yields from the glaciers tend to coincide with, and be masked by, monsoonal rains. It is not widely appreciated that for the same reason, snow and glaciers partly protect Pakistan against late, poor or failed summer rains. Indeed, usually the glaciers will yield more water in a poor monsoon year, and for longer, because it usually brings sunnier weather to the mountains.

Meanwhile, effective use and development of snow and ice resources involves a different understanding from rain-fed conditions, and different skills. For reasons sketched earlier, the glaciers of Upper Indus Basin differ from those in better-known places like Switzerland, Iceland, or Western Canada, where there have been long and concerted efforts to monitor and understand snow and ice. They need their own investigations as well as assessments in terms of Pakistan's needs and development.

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sents water not going into the rivers. Periods of highest water yields on the Upper Indus in the past century coincided with glacier recession. Moreover, growing and advancing glaciers can bring other hazards for water resource systems and downstream populations.

Recent years are also singled out by an exceptional number of glacier surges. Six were confirmed in the period 1986-1996, and four other rapid advances may be surges — the greatest numbers recognized in any decade since the 1830s. There have been renewed problems with threatened and actual glacier dams, though no serious floods have resulted. Villagers report many more problems with debris flows and avalanches.

The full extent of the glacier expansion, and what is causing it, cannot be adequately substantiated. There is no monitoring system or research investigations in the glacial zone. No agency, actively engaged in climate or water resource questions, is equipped for, or committed to, adequately addressing the state of the glaciers and high-altitude snow fields. But rather wild schemes for melting the glaciers continue to have a ready audience.

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