



Artificial glacier

a unique high altitude water harvesting
and conservation technique from the
cold desert of Ladakh, Indian Himalayas



Context

The cold desert region of Ladakh is an isolated, inhospitable terrain that lies in the western Himalayas sandwiched between Pakistan and China at an altitude of 3,000-5,000 meter above sea level. The region is characterized by extreme seasonal temperatures ranging from +40 to -40 degree Celsius, meager annual rainfall (50-100mm). In this region literally each village has a small glacier above it which plays a very important role in the sustenance of life as they are the only source of water, be it for domestic use or for irrigation. Agriculture is completely dependent on gravity irrigation; there is no rain fed agriculture.

Over the last few years, impacts of global climate change have been increasingly visible in Ladakh. Rainfall and snowfall patterns have been changing; small glaciers and permanent snow fields are melting affecting water runoff in the streams, and rise in temperature and

humidity inducing favorable conditions for the invasion of insects and pests. Two villages, Shun Shadey and Kunic, have already been relocated due to water shortage and are examples of climate refugees. Data clearly indicates that snowfall has decreased by 50 percent over the past 30 years. Likewise, there is an increase in temperature by nearly 1°C for all the winter months and nearly 0.5°C for summer months since 1973.

Besides, due to the short summer season cultivation, only one crop per year is possible which needs to be sown in April/ May. If it is not sown at this time the crop cannot be fully matured, resulting in low yielding crops. However, at that time of the year there is not sufficient water in the streams as the natural glaciers melt only in June.

Keeping the above facts and requirements in mind, locals had devised a unique system of water harvesting to augment irrigation water. The system of "Artificial Glaciers" was then revived by Mr. Norphel; currently working with Leh Nutrition Project (LNP).



Environmental, economic and social benefits



By providing timely and adequate irrigation water to the crop fields there is an overall rise in agricultural productivity and hence an increased cash income.



Because of the availability of water at early spring time, farmers are able to harvest two crops in a year which generates additional income. Eg. Alfalfa

Technology

The artificial glacier is an intricate network of water channels and dams along the upper slope of a valley. In November-December, water is diverted to the shady side of a mountain where it can slow down and freeze. At each dip /slope in the terrain, retaining walls (something like a mini dam) are built which further slows down the water and facilitates the freezing of water in form of steps, all along the slope into an "artificial glacier". All efforts are made to tap every drop of water in winters which otherwise goes waste.

The artificial glacier is located between the village and the natural glacier at different altitudes so as to ensure melting at different times. The artificial glacier located closest to the village/lowest altitude melts first and provides irrigation water at the crucial sowing time in April May. As the temperature increases the next glacier which is located at a higher altitude then melts and the process of melting at different times continues to provide assured irrigation to the fields below.

Therefore the step-wise procedure for freezing of artificial glacier:

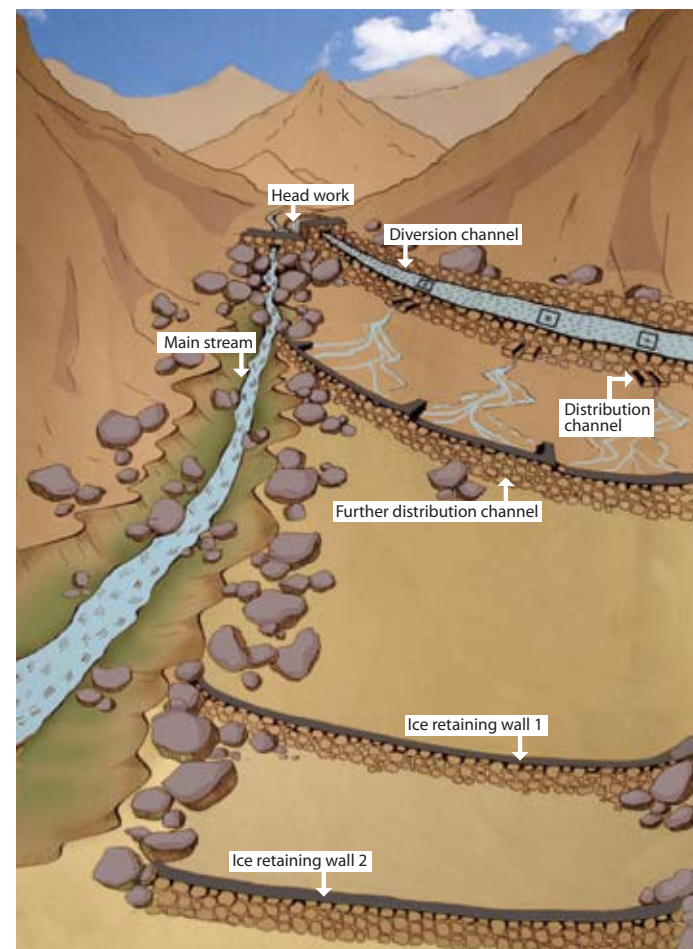
- ✓ Stream water at different altitude is diverted to shaded area of the hill, facing north side, where winter sun is blocked by a ridge or a mountain slope.

- ✓ At the start of winter (or November), the diverted water is made to flow onto sloping hill face, through appropriately designed distribution channels / outlets.

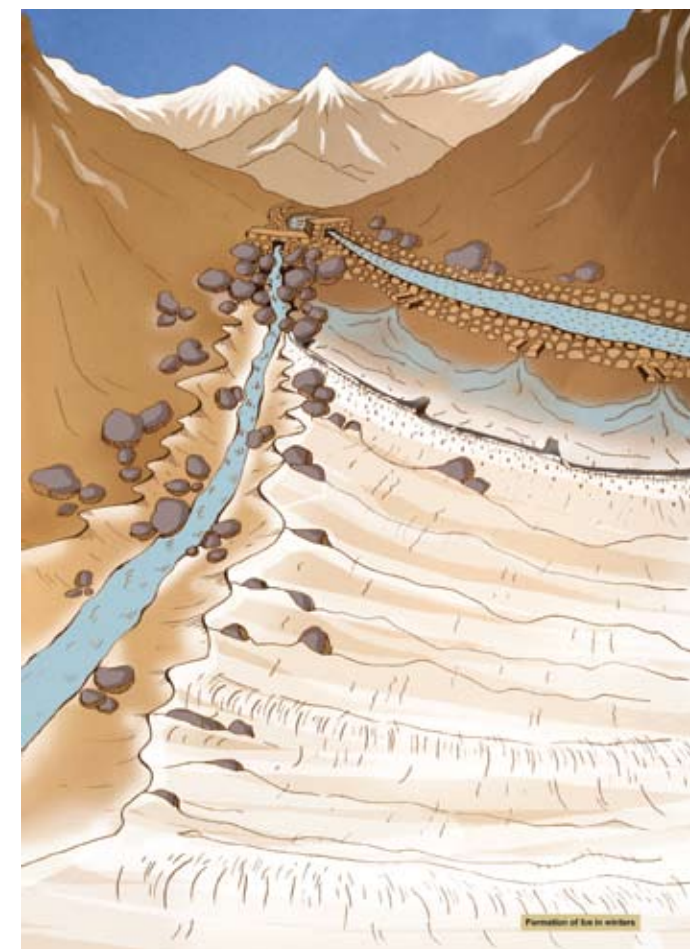
- ✓ At regular intervals stone embankments are built which impede the flow of water making shallow pools.

- ✓ The process of ice formation continues for 3-4 winter months and a huge reserve of ice accumulates on the mountain slope, aptly termed as 'artificial glacier'.

For the construction of the artificial glacier materials are mainly procured locally with some use of concrete and steel and unskilled labour. On an average 50,000 tons of water is required to be frozen into an artificial glacier and costs about 2,500 Euros and above (depending on its size and site). Since the last four years nine artificial glaciers have been constructed in Phuktse, Igoo, Shara, Sakti, Saboo and Stakmo.



Stone structure to create an artificial glacier



Artificial glacier formed in winter



Artificial glaciers also contribute in recharging of the underground aquifers and soil moisture conservation.



Ladakh is essentially a peaceful region where different communities co-exist. However, one main source of dispute is water which is the most scarce and valuable natural resource. One evident impact of the additional water generated by the artificial glaciers on the social life can be perceived in the form of reduced water disputes amongst neighbors.



Replicability

The technique of artificial glaciers is a winter/spring technique which is easy and simple and can be replicated in similar geo-climatic regions as Ladakh such as Spiti (in Himachal Pradesh) and some Asian countries like Kazakhstan, Kyrgyzstan, China (Tibet), Nepal, etc.

The artificial glacier can be replicated in areas that have the following features:

1. Temperature as low as minus -15 to -20 degrees Celsius during peak winter
2. Long winter period of 4-5 months minimum to ensure longer expansion of ice
3. Villages mainly dependent on glacier melt water for irrigation.

About the organizations

Leh Nutrition Project (LNP)

LNP was founded by Save the Children Fund (UK) in 1979 as a supplementary nutrition programme and is the first local NGO of Ladakh and became independent in 1991. Since its inception LNP has and continues to contribute to the region vis-à-vis education, health, women empowerment, children, livelihood improvement, rural development, etc.

Awards and honours to Mr. Norphel:

- Best Rural Engineer Award from the President of India
- Rural Engineer Award by Center for Science and Environment, New Delhi
- Asian Innovative Award of Hong Kong, Far Eastern Economic Review Magazine
- CNN-IBN 'Real Hero' Award, 2008

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GERES (Groupe Energies Renouvelables Environnement et Solidarités)

GERES, a French NGO was formed by a group of researchers and local development experts in the South of France in September 1976. Its headquarter is in France (Aubagne, close to Marseille) and is operational in twelve countries. GERES has been supporting local organizations on income generation activities, energy, environment and adaptation to climate change.

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