Artificial Glacier: A High Altitude Cold Desert Water Conservation Technique

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Since times immemorial, the melting water from the glaciers has been the only source of irrigation for 80 percent of the villagers in Ladakh. However, in recent times Ladakhis have observed decreased and untimely snowfall, retreating glaciers which have an impact on water supply both for irrigation purposes and domestic use. This is due changing climate conditions (decreasing precipitation and increasing winter temperature). Winters are getting shorter and with less precipitation and whatever little snowfall is received melt s away quickly much before it can be put to use in the barley fields in the sowing season.

Besides, due to short summer season they are able to cultivate only one crop per year and this need to be sown in the crucial month of April or May. If it is not sown at this time the crop cannot be fully matured which result in low yielding crops. However, at that time of the year there is not sufficient water in the streams as the natural glaciers are located at a higher altitude and further from the village and this start to melt only in the month of June which is too late for sowing.

Keeping the above facts and requirements in mind, locals have devised a unique system of water harvesting / conservation technique to augment water supply for irrigation.

The artificial glaciers have been innovated and located as far as possible closer to the village and at lower altitude so that it starts to melt much earlier as compared to a natural glacier i.e. in the month of April – May so as to supplement with additional irrigation water. During the winter months of November – December, the channel is built which divert/ guide the runoff water to the shady side of the mountain where it can slow down and freeze. At each dip /slope in the terrain, retaining walls (something like a mini dam) is built which further slows down the water and facilitates the freezing of water in a form of steps , all along the slope into to an "artificial glacier". All efforts are made to tap every drop of water, even the ones flowing below the frozen ice which would add to the surface run off that they are harvestings. This artificial glacier then melt in April and supplies water to the fields of the few villages just in time when the barley need to first water (locally know as *Thachus*).

Activity – Technology:

Some of its salient feature pertaining to the technology is:

1. The design for head work of diversion channel need to be down in such a way that in the lean period i.e. in the month of November (when the discharge of the nalla reduces to the minimum level) it can enter the diversion channel simply by opening the head regulator gate, without blocking the main stream as shown in the figure 2. Like wise, in summer season when the velocity of the water I the stream is at its highest the head regulator gate should be kept closed so that the diversion channel as well as other structure may not get damaged.

2. The bed grade of the diversion channel should be steep enough as compared to normal channel bed grade. Through this arrangement the water does not block by freezing. First the water enters into the silting tank and after the silt settles down, the clean water will follow into the distribution chamber. In the distributing chamber pipes have been fixed interval of 5ft so that a smooth distribution water and be obtained. As soon as the water comes out from the pipe it starts to freeze. The number of pipes is dependent on the total volumes of water available for the particular stream.

3. Since the terrain in Ladakh is undulated and uneven, it is not possible to calculate the amount of water using the usual formula. The ice retaining bunds, stone masonry dry in the crate wire in the depression area are needed to be constructed. The melting water from the ice easily passes through the pores of the dry walls without destroying/ damaging the structure.

4. As far as possible, it is essential to ensure that the water flows in small quantity with less velocity by spreading it over the entire area of the artificial glacier, so that it freezes instantly. If the water flows in one place, the volume and velocity of the water can be increased by forming bunds. On the other hand the terrain being very steep, the velocity of the waters to be very high with the result that instead of forming ice, it distorted the already formed ice. As such, regular monitoring of the water velocity/ formation of the ice is required.

Target Group:

Since the artificial glaciers are constructed close to the villages, its benefits are equally distributed amongst all the villagers. Hence, the entire population of each village located close to an artificial glacier is the target group of this particular intervention. The community on the other hand contributes towards the maintenance of the artificial glacier and monitoring.

Implementation Methodology:

Prior to the construction of the artificial glaciers, a lot of preliminary work in a step wise, systematic manner is done pertaining to :

(i) Community mobilization and participation

Since the village communities are the main stakeholders and know the area and it's dynamic thoroughly, the first step is to mobilize them and to hold intensive discussions with them regarding:

1. Water availability in the stream during peak winter time.

2. Presence of shady area along the course of stream.

3. Timing of sunrise and sunset.

4. Village history regarding water availability.

Apart from the discussion, the villagers are oriented about the innovated technique of artificial glacier and a comprehensive irrigation management system is developed.

(ii) Technical aspects:

Under the technical requirement, priority is given to various aspect such as direction of the village, water availability in the stream during peak winters, location, etc.

1. Direction of the village

All villages where a artificial glacier will be constructed should be south facing villages (on the south of the Indus river) so as to ensure proper formation of winters and its timely melting during the spring season. E.g. Saboo, Igoo, Sakti, ect.

2. Location/ proximity to the village

The location of the artificial glacier must be as close as possible to the village so that the artificial glacier melts quickly as compared to the natural glaciers and reaches the adjoining village at the crucial time i.e. sowing period in April/ May.

Financing:

Till date the Government watershed Department, Department Science and Technology GoI and the Sadhbavhana the philanthropic wing of the Indian Army have been financing artificial glacier project in Ladakh.

Impact of artificial glacier:

The project on artificial glacier has been operating in the region since the last four years and farmers in particulars have given some positive feedback regarding its impacts. These can be classified into three.

Economic benefits:

1. By providing timely and adequate irrigation water to the barley and wheat fields and some other cash crop, there is overall rise in agricultural productivity which contributes to increased cash income for farmers.

2. Besides, because of the availability of water at early spring time, farmers are able to harvest two crops in a year as compared to traditional single harvest per year. This double harvest again enables farmers to generate additional income, e.g. Alfa Alfa.

3. Due to the additional water made available by the artificial glacier, villagers are able increases the number of tree plantation. Trees are a major source of income as the twigs / branches and the main truck is mainly used in constructing houses (roof and window floor) as building materials.

4. Increased availability of water also leads to pasture development in the village and this creates conducive condition for cattle rearing, hence an additional source of income from dairy products like milk, curd etc.

Environmental benefits:

The artificial glaciers have range of benefits which directly impact the environment in a positive manner. This includes:

1. Channels that are diverted in shady are to slow down the water, helps to reduce the surface runoff thereby recharging underground aquifers and increasing the underground water table. Water discharge from natural springs (locally known as ('chumiks') has increased as a result of the increased water table.

2. Because of the artificial glaciers, the total agriculture land holdings have significantly increased thereby increasing the green belt cover.

3. The simple technique of the artificial glaciers also contributes in soil moisture plantation and agriculture.

4. An increase in cattle population leads to increased use of manure on agricultural fields rather than chemical fertilizer.

Social Impacts:

Ladakh is essentially a peaceful region where different communities co-exist inspite of different religions, cast, etc. However traditionally and even up to date one main source of dispute arises from use and distribution of water resources which is the most scare and valuable natural resources.

One evident impact of the artificial glacier on the social life and be perceived in the from of reduced water disputes amongst neighbors and families because of the additional water generated by the artificial glacier.

Lesson learned:

In the past four- five years some of the lesson learnt were:

1. During the crucial period of construction / formation of artificial glacier i.e. November-February it is extremely difficult to find and retain labourers either for construction or maintenances as the temperature goes below zero degrees.

2. As such to increase the efficiency and to enable the smooth formation of glacier during these harsh conditions, it is required and suggested to mechanize the operation of the head work and the distribution chambers. This will reduce the use of manual labours and the regular monitoring work which is required to ensure the proper formation of the glacier.

Replicability:

The technique of the artificial glacier is a winter/ spring technique which is easy and simple and can be replicated in similar geo- climate regions as Ladakh such as Spiti (in H.P) and some central Asian countries like Kazakhstan, Krgystan, etc. these can be replicated in areas which have the following features:

1. 14,000 to 16,000 ft altitude

2. Temperature as low as minus – 15to -20 degree Celsius during peak winter

3. Longer winter period of 4-5 months minimum to ensure longer expansion / formation of glaciers.

4. Villages that are primarily dependent on glaciers or snow melt water for irrigation purpose.