Check Dams: Solution to the Increasing Water Crisis in Ladakh

Colonel Vijay Kumar Goyat[@]

Abstract

Ladakh, a high-altitude desert with extremely low precipitation, a popular tourist destination and a unique geographical heritage. It is also at the centre of Indo–China boundary dispute. The challenges of water management in the region are low rainfall, high influx of tourists, increasing infrastructure, and heavy dependence on groundwater without adequate replenishment. Thus, water storage is essential and certain eco-friendly methods such as artificial glaciers or ice stupas have been tried. These methods are manpower intensive, less efficient and need recurring annual effort. Very small-scale check dams on various streams can be an effective means to store water and will automatically freeze in winter. The check dams are fairly easy to construct with a simple design and low water height along with adequate pondage. These check dams will help meet water requirements in an efficient and eco-friendly manner as well as facilitate groundwater recharge, besides being suitable sites for winter skiing and potential tourist spots. The approximate cost of one such check dam is likely to be INR 8.10 Cr.

[@]**Colonel Vijay Kumar Goyat**, an alumnus of the National Defence Academy, Khadakwasla. He was commissioned into the Corps of Engineers in Dec 1997. Besides being a BTech (Civil-Engineering), the officer is a postgraduate in Defence Technology and has completed his MBA in Operational Research. He has vast military experience in varied terrain across India besides serving as a Military Observer in Ivory Coast in 2009-10. He commanded an Engineer Regiment both in the desert as well as Northeast Sector besides commanding the Engineer Stores Depot at Delhi. The Officer has a rich experience in the construction of strategic infrastructure especially in Northeast India and Eastern Ladakh. His interests include sustainability and military technology.

Journal of the United Service Institution of India, Vol. CLIV, No. 636, April-June 2024.

Introduction

Ladakh lies in a high-altitude desert with extremely low precipitation and scanty vegetation. This has led to a unique climate and geomorphological evolution. The vast and barren landscape, interspersed with turquoise blue rivers and pristine lakes, blessed by the Llamas and their various monasteries is the new haven for tourists from India and abroad alike. The region is home to around four lakh people[1], but it now hosts approximately one lakh people as tourists on an annual basis.[2] That figure is likely to grow, as movies make the picturesque Nubra Valley and Pangong Tso more popular and the Indian middle class has more money to splurge. Most of the SUV buyers head to Ladakh immediately on buying and a selfie on a motorbike on roads along the Indus is fast becoming much desired.

In addition, the situation on the Line of Actual Control has mandated an increase in the deployment of security forces in the region. While the security forces always had a role to play in the region, the numbers have only gone up in the last two years.[3]

Increasing Water Shortage in Ladakh

While the increasing number of tourists is a good and welcome sign for the local economy, it has put a severe strain on the water resources in this cold desert. The average precipitation in Ladakh is less than 100 millimetres (mm) and in several places, it is less than 50 mm. The monthly mean of rainfall is shown below.[4]

The per capita consumption of water by a tourist is generally higher than a local Ladakhi and the numbers make the demand for water an alarming issue.[5] Hence, there is an acute shortage of water for various daily needs, and it becomes even more critical as tourism increases. The increased groundwater requirement is being met by the various borewells that have sprung up in Leh and nearby areas. These borewells are pumping water from aquifers that have been recharged over hundreds and thousands of years but are depleting fast.

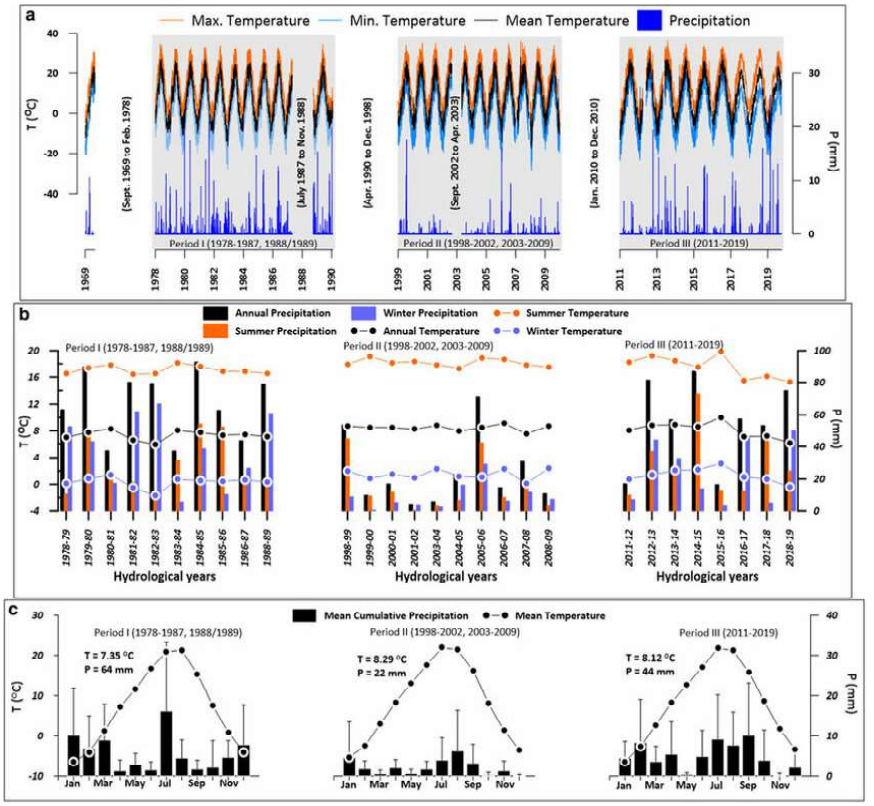

Figure 1

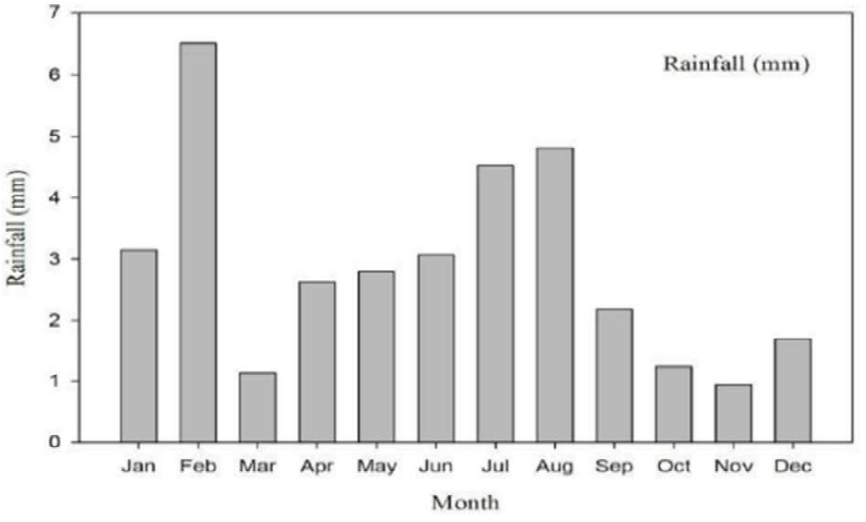

Figure 2: Monthly mean of rainfall during 2000-2013

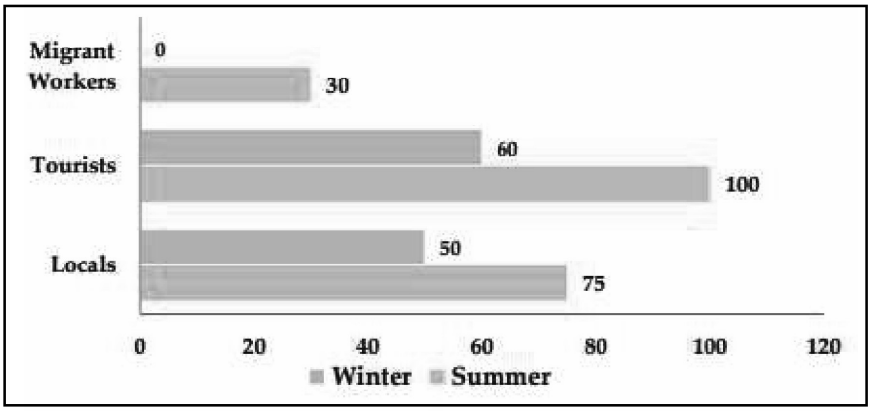

Figure 3: Comparison of Water Usage in Ladakh Across Users and Seasons (Source: Niti Ayog[5])

At the same time, it is a stated government goal to provide tap water to every citizen across India, including Ladakh. Water is the essence of life. Thus, water management in Ladakh becomes a priority to ensure that this precious resource is optimally utilised and does not lead to over-exploitation of the groundwater while meeting the aspirations of the locals as well as the tourists who throng this beautiful place.

The challenges of water management in Leh can be summarised as low rainfall, high influx of tourists, increasing hotels and other infrastructure, and heavy dependence on groundwater without adequate replenishment.

The region gets water in the form of snowfall in the winter seasons and the snow-melted water is the source of water in the summers. Since it does not rain for a very large part of the year, water storage is essential.

Traditional and Current Water Storage Methods

Traditionally, water requirements have been met by the populace of Ladakh from the natural streams, *nalas* (streams) and rivers. Thus, most of the habitation has come up along these areas. As the population grew, and alongside the water demand, various measures have been taken by the locals to preserve water. A unique method in Hunder Village is separating the drinking water stream from the other water streams and ensuring its hygiene and free flow almost throughout the year. There are various signboards

along this stream that advise locals on its utility and the need to protect the stream.

Also, certain eco-friendly methods of water conservation, such as artificial glaciers or ice stupas have been propagated in the region.[6] Artificial glaciers are a remarkable innovation to address water scarcity in the region. These artificial glaciers are created using a simple yet effective technique. The process involves diverting water from streams into shaded areas, typically valleys or depressions, where it freezes during the winter months. By controlling the flow of water and strategically designing the location and shape of these ice structures, water is stored in the form of ice during the winter, which gradually melts during the spring and summer months, providing a vital water source for irrigation and drinking water.

This ingenious solution has helped alleviate water shortages in the Leh region, particularly during the critical agricultural season, when water is in high demand. Additionally, it reduces reliance on unpredictable glacier melt water and provides a sustainable alternative for water storage and management in the region. Hence, these methods have their own utility.

However, there are certain drawbacks. These artificial glaciers or ice stupas need to be made from the natural snow on a yearly basis. Artificial glaciers can only provide water to areas located within their vicinity. This means they may not address water scarcity issues in regions far from their location. This activity needs to be done on a large enough scale to merit due benefits of water storage. Also, the activity has to be done in winter per force and needs manual effort. There is a need to look for better solutions to manage water and its storage on a recurring basis in Ladakh.

Check Dams as a Water Storage Solution: A Permanent Water Stupa

One such solution can be the construction of very small-scale check dams on the various streams and *nalas*. Currently, these *nalas* run at full capacity during summers but dry up in winter. Once check dams are made in phases, water can be stored for use around the year. These check dams can store water and will automatically freeze in winter and act as a reservoir and there will be no need to create artificial glaciers or ice stupas. In addition,

due to the peculiarity of the terrain, there is a need to construct these check dams at various heights along one stream. This height difference between various check dams will ensure that the highest one will freeze first in winter and melt last in summer. It will, therefore, ensure a perennial supply of water in these *nalas*.

Another advantage of constructing these check dams will be to boost tourism. Leh is renowned for its stunning landscapes and adventurous activities. However, due to its high altitude and relatively warmer climate in the summer months, finding ice skating sites directly in Leh can be challenging. During the winter months when temperatures drop significantly, natural frozen lakes and ponds offer opportunities for ice skating. Currently, a small pond along the Leh Kargil route along the Indus River is used by locals for ice skating. Also, this site is used by Ice Hockey teams of the army and locals to practice. There is no other suitable site in the town of Leh for ice skating. A series of check dams along a *nala* will provide a suitable location for ice skating in winter and a photogenic background to tourists in summer.

The check dams are fairly easy to construct. A simple design that ensures no leakages and low water height along with adequate pondage at the selected site will meet the requirement. The design will have to factor in the seismic threat in the region and hence, it is deliberately kept at a low height. Also, the construction, operation and maintenance of these will also provide job opportunities to the locals. The operation of the check dams will involve maintenance of sluice gates and de-silting on a required basis, mostly annually in the lean season.

Case Study: Check Dams in Leh Town

The methodology of construction of these check dams can be easily implemented in various places, however, to understand the concept a case study of Leh is being presented here. The natural water source for Leh is the Khardung *Nala* which streams down from the snowcapped Khardungla range. This water source freezes during winter and is a gushing stream for a few days in summer. In 2023, this *nala* overflowed and led to a minor flood situation due to a cloud burst. It is proposed that a series of check dams be made on this *nala* at different elevations to better manage the flow of this water.

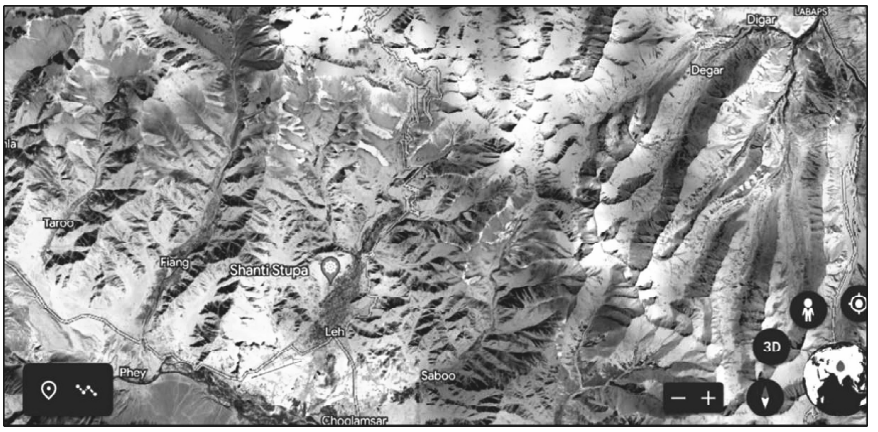

Image 1: Leh Valley Between Zanskar and Ladakh Range

Water Requirements v/s Availability for Leh Town.

Leh, the largest town in the Ladakh region of the Union Territory of Ladakh, experiences very low annual precipitation due to its high-altitude desert climate. The annual rainfall is typically less than 100 mm (around 4 inches). The bulk of the rainfall occurs during the summer months, from Jun to Aug, although even during this time, rainfall is minimal compared to other regions. The rainfall can vary from year to year, with some years experiencing even less precipitation than others. Leh's climate is characterised by cold winters and mild summers, with most of its precipitation falling as snow during the winter months. The snowfall in Leh typically occurs from late Nov to early Mar, with the peak of the snowfall usually happening in Dec and Jan.

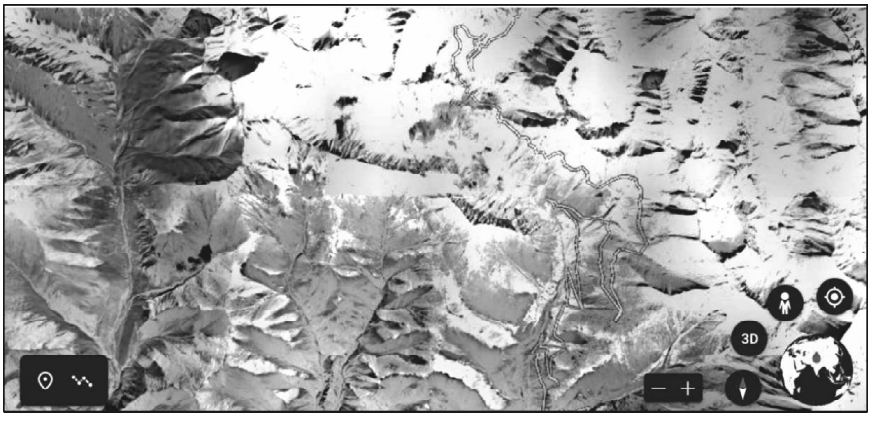

Image 2: Catchment Area for Leh Town

The average annual precipitation in Leh is 100 mm as per data provided by the Defence Institute of High-Altitude Research. The catchment area north of Leh town is approximately 60 sq km, which lies on the ridge line to South Pullu.

One mm of rainfall provides approximately one litre of water per square meter. Out of this, approximately 50 per cent will be available for storage in check dams. Hence, the total volume available annually is likely to be 30 lakh Kilolitres (Kl). Leh has a local population of approximately 45,000. In addition, about 5,000 government servants and approximately 5,000 tourists (on a daily maximum basis in summer) are also located in Leh. Hence, the peak water requirement of Leh town (@100 litre per person) is 5,500 Kl/day. The annual availability in the check dams is likely to be 30 Lakh Kl against a requirement of 20 Lakh Kl.

Proposed Solution for Leh.

Proper storage and use of surface runoff can meet the water requirements of Leh in an efficient and eco-friendly manner. One of the efficient storage options is multiple small check dams constructed at various elevations across the Khardung *Nala*. These small check dams will freeze sequentially in winter and allow better stage-wise storage. In summer, the thawing will also be sequential and gradual based on altitude and hence, will meet the requirements of the users downstream, one check dam at a time. As one check dam melts, the water will be available for use while the check dam which is at a higher altitude will remain frozen and act as a reservoir for a later date. Thus, 8 to 10 small check dams can meet the total requirements for a sustained flow.

To achieve 30 Lakh Kl storage, an average height of 3 m, an average span of 300 m and a pondage of 333 m may be considered. However, a detailed ground survey will be required for detailed and adequate design. The construction can be carried out in phases based on the success of one check dam. The dimensions are only for preliminary planning purposes based on the author's visit to the site.

Within Leh Town, a near perennial *nala* runs from north to south. Steps should be created in this *nala* using local stones. This will help to slow down surface runoff, beautify the place and increase water availability as well as better groundwater recharge.

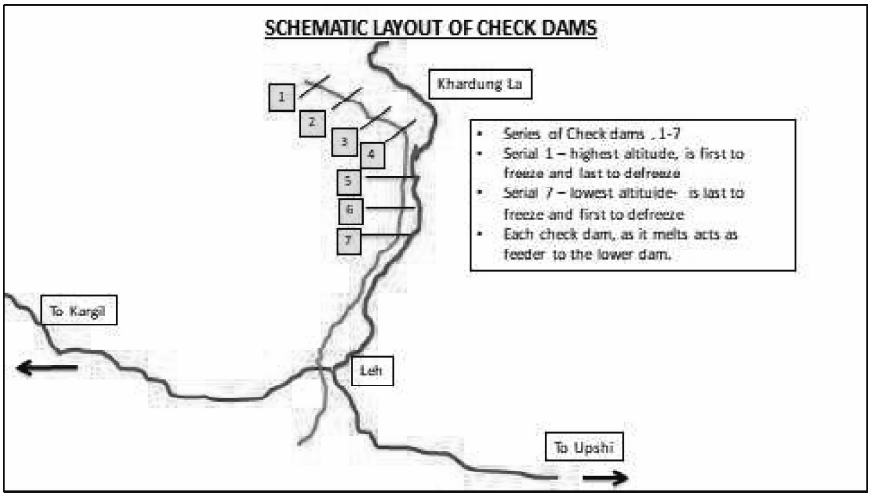

Figure 4

These check dams will help meet water requirements in an efficient and eco-friendly manner as well as facilitate groundwater recharge. If properly planned, these can become suitable sites for winter skiing and potential tourist spots and generate local employment. These can also act as short-duration storage in case of cloud bursts, thus, acting as trip wires for early information. There will be a boost to ice skating and these sites can act as micro-tourism sites.

Past experiences with various types of water storage mechanisms employed in Ladakh show that check dams could be the real solution. One such system is functional in Nang Village.[7] The system was built with funds from Tata Trust. However, suitable design modifications need to be carried out as per site requirements and geological conditions. In flow artificial glaciers have also been made at Alchi, Phuksey, Igu, and Nang. A better design with a more comprehensive approach is likely to be an effective solution. The efficacy of the entire check dam-based solution lies in comprehensive planning, sound design and the involvement of various stakeholders including locals, the water and tourism departments, etc.

Image 3: Improvised check dams at Nang Village

(Image courtesy @Sierra Gladfelter Fulbright-Nehru Student Research Scholar[7])

Recommended Way Ahead

Preliminary estimates suggest that the approximate cost of one such check dam is likely to be INR 8.10 cr. However, a detailed project report can be made before implementing the project in Leh. If the pilot project is successful, it will pave the way for large-scale implementation of these small check dams and will go a long way in mitigating the water shortage in Ladakh. Other government organisations and security forces may adopt a similar model on a smaller scale for various detachments spread along the vast landscape of the union territory.

The check dam project has the potential to benefit the locals in terms of water availability as well as job creation, both during construction and later as a tourist site. It can also actively boost ice skating sports in the region. If implemented and maintained properly, this simple solution can prove to be an eco-friendly solution to the water crisis in Ladakh. It will also ensure that awareness is raised about the need to conserve water among locals and tourists.

Endnotes

[1] Leh Ladakh Town Population Census 2011–2024.
https://www. census2011.co.in/data/town/800047-leh-ladakh-jammu-and-kashmir.html

[2] Administration of UT of Ladakh Tourism.
https://ladakh.nic.in/tourism

[3] Rehul Bedi, "Indian Army's Increased Deployment Along LAC Likely to Become a Permanent Fixture", The Wire, 21 May 2021.
https://thewire.in/security/indian-armys-increased deployment-along-lac-likely-to-become-a-permanent-fixture.

[4] https://www.researchgate.net/figure/a-Entire-temperature-and-precipitation-record-available-at-Leh-station-3500-m-asl_fig2_341460980

[5] Carbon Neutral Resource Efficient Strategy for Ladakh UT.pdf, page 31, Niti Aayog.
https://www.niti.gov.in/sites/default/files/2023-03/Carbon%20Neutral%20Resource%20Efficient%20Strategy%20for%20Ladakh %20UT.pdf

[6] The Ice Stupa Project.
http://icestupa.org/

[7] Ladakh's Artificial Glaciers, Ice Stupas, and Human-made Ice Reserves.
https://sierragladfelterblog.files.wordpress.com/2018/07/gladfelter_artificialglaciersofladakh_reflectionsandtakeaways_compressed.pdf