The artificial ice pyramids saving India's mountain villages

Priti Gupta, Technology Reporter, Mumbai

How to read this document: Difficult English words are followed by a small Urdu meaning and an English synonym in brackets, then the sentence continues normally.

At an altitude اونچائی (elevation) of almost 4,000m (13,000ft) and receiving almost no rainfall, the Himalayan village of Sakti is a hostile ناموافق (unfriendly) place to be a farmer.

> “Ladakh has a brutal سفاکانہ (harsh), single-cultivation کاشتکاری (farming) season,” says Gelak Gutme, who has been growing wheat, peas and potatoes there for most of his 65 years.
>
> “It is a desert with an extreme climate,” he says.

Conditions have become worse in his lifetime. Global warming means that the smaller, low altitude glaciers they relied انحصار کیا (depended) on to water their crops have disappeared غائب ہو گئے (vanished).

> “Now there is scarcity قلت (shortage) of water. Last year I lost everything - my entire field got dried due of lack of water,” Gutme says.

“For generations, small glaciers sitting right above the valleys acted like frozen water towers, holding onto water all winter and releasing it right when spring farming began,” explains Lobzang Fardod, who is a member of a local water management committee in Ladakh.

> “Now that those lower glaciers have completely vanished into a desert of dry rock, there is nothing left at the top to melt,” he says.

The mountain summer is short, so farmers have to plant their crops by May, otherwise the crops will not be ready before the winter hits again.

A reliable قابل اعتماد (dependable) source of water in early spring is crucial اہم (vital) for them.

To secure حاصل کرنا (obtain) that vital ضروری (essential) resource وسیلہ (asset), in the early 2010s some Ladakh villages attempted to create their own reservoirs ذخائر (tanks) of ice.

The system involved piping پائپ لگانا (channeling) water from higher up in the mountains during the winter and spraying it into the air, where it would freeze, and over time form large towers of ice, called ice stupas.

They successfully supplied melt water in the spring, but were a "nightmare ڈراؤنا خواب (ordeal)" to manage under harsh سخت (severe) winter conditions, says Fardod.

If temperatures dropped quickly below minus 20C, or sometimes minus 30C, the water in the pipes was liable ممکن (prone) to freeze, cracking دراڑیں پڑنا (splitting) the pipes and ruining تباہ کرنا (destroying) the whole system.

To guard against that, during the winter teams of four or five farmers would camp high-up, near the water source, rushing to any potential blockages رکاوٹیں (obstructions) with boiling water, often during the night when temperature drops were most likely.

But enduring برداشت کرنا (withstanding) those freezing, winter nights high in the mountains could be phased out بتدریج ختم (eliminated).

"Because traditional water systems are failing, Leh-Ladakh has become a hub for innovative اختراعی (inventive), grassroots عوامی سطح (local-level) hydraulic آبی طاقت کا (water-powered) engineering," says Murtaza Ali, executive engineer in the Irrigation and Flood Control Division, at the Ladakh Autonomous Hill Development Council.

Leh is the capital of Ladakh, a disputed متنازعہ (contested) region in Indian-administered Kashmir that is sandwiched گھرا ہوا (squeezed) between China to the east and Pakistan to the west.

As well as the potential for cracked pipes, the ice stupa system was not very efficient موثر (effective), says Ali.

Because water flowed constantly, on warmer days fresh water would melt the ice that had already formed.

But over the last couple of years that method has undergone a tech upgrade.

In partnership with private company Acres of Ice, a new system has been developed which precisely ٹھیک ٹھیک (exactly) controls ice production.

Called an Automated Ice Reservoir (AIR), the process also involves piping water down from higher up in the mountains.

The water arrives at the valley floor under pressure and shoots out of a vertical nozzle like a “massive fountain”, says Dr Suryanarayanan Balasubramanian, the founder of Acres of Ice.

That flow is computer controlled from a weatherproof موسم سے محفوظ (weather-resistant) control box, powered by solar panels and a battery.

The control system is connected to a weather station, which monitors نگرانی کرتا ہے (observes) environmental conditions, including the water temperature inside the pipe.

If the sensors detect that the air temperature is dropping too fast, or the water temperature inside the pipe approaches a dangerous threshold حد (limit), the control system takes action.

It shuts off the valve at the top of the stream and opens a valve at the bottom to completely drain the standing water out of the pipe.

That avoids the ruinous تباہ کن (destructive) problem of cracked pipes, but the system is also more efficient at creating ice. Instead of continuously spraying water, AIR fires a burst of mist, coating پرت چڑھانا (layering) the existing ice, and then shuts off.

“The system waits precisely long enough for that layer of water droplets قطرے (drops) to freeze solid based on current wind and humidity نمی (moisture), then fires the spray again,” explains Balasubramanian.

He says that AIR converts almost all of the diverted موڑا گیا (redirected) water into ice.

The whole system runs automatically and uses a local wireless network to connect the control box and the various valves. But the villagers do have a manual override دستی کنٹرول (bypass), if needed.

It all appears to be making a difference to village life.

“When we speak to the villagers, they are saying the groundwater is getting recharged دوبارہ بھرنا (replenished) and spring sources are getting revived بحال (restored). They are getting water in time. We are also planning a scientific study now to see exactly what impact it has made,” says Ali.

During the winter of 2025, Acres of Ice and the local government ran 10 AIR projects across Ladakh.

“Our biggest challenge right now is to push the envelope in the technology to see how we can multiply بڑھانا (increase) the number of ice reservoirs we are building. With the same system that previously used to build only one ice reservoir, can we build a dozen?,” says Balasubramanian.

Back in Sakti, farmer Gutme is more optimistic پرامید (hopeful) about the future. The single AIR system has created a more reliable water source and he hopes the village will build at least two more of the artificial glaciers.

> “I am a farmer, land is all that I have to survive on. I don’t know the technology, all that I know today is that I have water to grow my crops.
>
> “We live in harsh climate that makes our life difficult and lack of water was creating more issues. Many of the youths in the village wanted to go to cities to work. That would have been a disaster تباہی (catastrophe).”

Summary

High in the Himalayas, the village of Sakti in Ladakh faces a harsh, dry climate where farmers depend on glacier melt-water for their short single growing season. As global warming has caused smaller glaciers to vanish, spring water shortages have threatened crops. To cope, villagers first built hand-managed “ice stupas” that froze winter water into towers of ice, but the system was risky, inefficient and required farmers to camp out in freezing conditions to stop pipes cracking. A new technology called the Automated Ice Reservoir (AIR), developed with the company Acres of Ice, now uses sensors, a solar-powered control box and a wireless network to spray water in carefully timed bursts, freezing it efficiently and protecting the pipes automatically. Ten AIR projects ran across Ladakh during the winter of 2025, and engineers hope to multiply their numbers further. For farmers like Gutme, the system has already made water supplies more reliable, reducing the pressure that was pushing young people in the village to leave for the cities.

Word Bank (in order of appearance)

altitude — اونچائی — elevation

hostile — ناموافق — unfriendly

brutal — سفاکانہ — harsh

cultivation — کاشتکاری — farming

relied — انحصار کیا — depended

disappeared — غائب ہو گئے — vanished

scarcity — قلت — shortage

crucial — اہم — vital

secure — حاصل کرنا — obtain

vital — ضروری — essential

resource — وسیلہ — asset

reservoirs — ذخائر — tanks

piping — پائپ لگانا — channeling

nightmare — ڈراؤنا خواب — ordeal

harsh — سخت — severe

liable — ممکن — prone

cracking — دراڑیں پڑنا — splitting

ruining — تباہ کرنا — destroying

blockages — رکاوٹیں — obstructions

enduring — برداشت کرنا — withstanding

phased out — بتدریج ختم — eliminated

innovative — اختراعی — inventive

grassroots — عوامی سطح — local-level

hydraulic — آبی طاقت کا — water-powered

disputed — متنازعہ — contested

sandwiched — گھرا ہوا — squeezed

efficient — موثر — effective

precisely — ٹھیک ٹھیک — exactly

weatherproof — موسم سے محفوظ — weather-resistant

monitors — نگرانی کرتا ہے — observes

threshold — حد — limit

ruinous — تباہ کن — destructive

coating — پرت چڑھانا — layering

droplets — قطرے — drops

humidity — نمی — moisture

diverted — موڑا گیا — redirected

override — دستی کنٹرول — bypass

recharged — دوبارہ بھرنا — replenished

revived — بحال — restored

multiply — بڑھانا — increase

optimistic — پرامید — hopeful

reliable — قابلِ اعتماد — dependable

disaster — تباہی — catastrophe