

## **Geology to unplanned construction: Decoding why Joshimath is sinking**

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Joshimath, at an altitude of 1890 metres is a town in the Garwhal himalayas , and an important waystation on both the pilgrim and trekking circuits.



Cracks appear in the houses and on the roads due to landslides at the Joshimath of Chamoli district of Uttarakhand. (PTI)

[Neeraj Santoshi](#)

On Thursday, the Uttarakhand [government banned construction work in and around Joshimath over land subsidence](#) that has resulted in cracks in 561 homes there leading to protests by panicked locals.

Joshimath, at an altitude of 1890 metres is a town in the Garwhal himalayas , and an important waystation on both the pilgrim and trekking circuits. But the town of over 20,000 population is also on a fragile mountain slope rendered even more fragile by unplanned and indiscriminate development.

Here's the science behind the subsidence.

### **1. Location, topography, and extreme weather events**

Joshimath is situated in the middle slopes of a hill bounded by the Karmanasa and Dhaknala streams on the west and the east and the Dhauliganga and Alaknanda rivers on the south and the north. According to a study by Uttarakhand State Disaster Management Authority (USDMA), the town is located in an area prone to landslides and the first instance of subsidence in it was reported way back in 1976 Mishra Commission report.

"The area around Joshimath town is covered with thick layer of overburden material. Large boulders of gneisses and fragments of basics and schistose rocks are embedded in grey-coloured, silty-sandy matrix. This makes the town highly vulnerable to sinking," said Piyush Rautela, executive director USDMA.

The USDMA study said that the perennial streams, appreciable snow in the upper reaches, and highly weathered gneissic rocks with low cohesive characteristics makes the area prone to landslides.

"Flood events of June 2013 and February 2021 had adverse impact on the landslide zone with toe erosion and sliding along Ravigram Nala and the Nau Ganga Nala having increased since the February 7, 2021, flooding of Rishi Ganga," the study said. Its reference is to the glacial lake burst that caused a flood, resulting in the loss of 204 lives, mostly migrants working on a hydropower project.

The landslide zone was further weakened when Joshimath recorded 190 mm of rainfall in 24 hours on October 17, 2021.

The impact of extreme rainfall events is visible in latest satellite data, which shows that mountain streams have expanded their channels and changed course, thereby inducing more slope instability in an already fragile belt. "Huge volume of debris-laden water brought down by the Dhauliganga during a previous flood event (February 2021) has also aggravated the toe erosion along the left bank of the Alaknanda, downstream of its confluence with the Dhauliganga river at Vishnuprayag. This adversely impacted the stability of the slope on which Joshimath town is situated," the USDMA report said.

## **2. Geology**

The study also pointed out that eco-tectonic and geomorphic factors coupled with meteorological characteristics render Joshimath region highly vulnerable to subsidence. Joshimath is in Chamoli district which falls in Zone V of the Seismic Zonation Map and has witnessed several earthquakes of magnitude of less than 5 on the Richter scale.

Joshimath almost sits on the Vaikrita Thrust (VT), a tectonic fault line. The town is also very close to main geological fault lines, Main Central Thrust (MCT), and Pandukeshwar Thrust (PT). MCT passes below Helang, a little south of Joshimath Town, and juxtaposes with the rocks of Garhwal Group (Joshimath Formation), thereby bringing the town under the impact zone of any tectonic activity on MCT.

"Joshimath being on a fault line and close to another two makes it highly vulnerable to sinking because of tectonic activity," said a scientist with Dehradun based geological institute who asked not to be named.

At Helang, the Border Roads Organisation (BRO) is building Helang bypass that will reduce the distance to Badrinath shrine by about 30 km, using heavy machinery. Experts said this below the "earth tectonic activity" could induce more landslides. The Mishra Commission report (headed by MC Mishra then a top bureaucrat in Uttar Pradesh) in 1976 had recommended ban on heavy construction in the area around Joshimath.

## **3. Unplanned construction**

Hemant Dhyani, environmentalist and member of Supreme Court appointed High Powered committee (HPC) on the Char Dham Project said despite being fully aware of the geological vulnerability of the area, hydroelectric schemes have been sanctioned around Joshimath and Tapovan, including the Vishnugad HE Project.

"The head race tunnel of the project traverses all through the geologically fragile area below Joshimath. A tunnel boring machine (TBM) was employed for excavating the tunnel. On December 24, 2009, it punctured a water-bearing strata some 3 km inward the left bank of Alaknanda near Shelong village. Over a decade back, experts had warned that this sudden and large-scale dewatering of the strata had the potential of initiating ground subsidence in the region. No remedial measures were taken so it is not surprising that the town is sinking," he explained.

Locals say that in the past decade or so, several new multi-storey buildings have come up in and around Joshimath town. One such building tilted due to subsidence recently. Kailash Joshwal, a resident of Joshimath blamed the construction work on the hydropower project run by National Thermal Power Corporation for the worsening situation with water from the power tunnels seeping into the houses resulting in the widening of the cracks. "Many new buildings came up on the landslide prone zone by building retaining walls. This has created additional pressure on the fragile slope," added the scientist with the Dehradun based geological institute.

Unplanned developmental activities without due regard to bearing capacity have contributed in aggravating slope instability-related issues in Joshimath, according to the USDMA survey report in August 2022.

#### **4. Improper water drainage**

Experts and USDMA pointed out reasons for increase in ground seepage of water from surface, a probable cause for subsidence. First, on-surface anthropogenic activities have blocked natural water drainage systems, forcing water to find new drainage routes. Second, Joshimath town does not have sewage and wastewater disposal system. "The seepage reduces the shear strength of the overburden soil," said Dhyani. This is visible around Sunil village in Joshimath, where the impact of subsidence is visible on the water pipes, which have bent out of shape.

#### Original article

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