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Case Study

Joshimath: Consequence of Human Disaster: A Case Study

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Abstract

The town of Joshimath in Uttarakhand is currently experiencing a severe geophysical and environmental crisis marked by land subsidence, structural damage, and mass displacement. This case study investigates the human-induced factors behind the disaster, primarily focusing on unregulated construction, hydroelectric projects, poor drainage systems, and unsustainable tourism in a geologically unstable region. Drawing on geological surveys, scientific reports, and historical data, the study reveals that Joshimath's location on ancient landslide debris and its proximity to seismic fault lines have been aggravated by government negligence, infrastructure overload, and unauthorized development. Despite early warnings from scientific committees, such as the Mishra Committee Report (1976), repeated disregard for environmental and structural safety measures has led to the current crisis. The paper calls for immediate and long-term mitigation strategies including relocation of residents, re-evaluation of development plans, ecological restoration, and strict enforcement of construction norms. The Joshimath disaster exemplifies the catastrophic consequences of ignoring environmental thresholds in fragile Himalayan ecosystems.

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INTRODUCTION

In Uttarakhand, the town of Joshimath is going through an unparalleled catastrophe. Roads and the town's many homes, businesses, and structures all now have large cracks in them. The occupants of numerous buildings have been notified that they are unsafe and requested to leave. Joshimath has been designated a region affected by landslides and subsidence by the authorities. The entire town is submerging. Although the town is located in a geologically unstable area, the main cause of the sinking is thought to be due to extensive construction projects being carried out in the area. The government and its agencies have taken a variety of steps to address the situation, but they have come under fire for a long time for disobeying warnings from environmentalists and geologists about the unchecked growth taking place in the area.

About Joshimath

Joshimath is a town in Uttarakhand's Chamoli District. It is situated at an elevation of about 1875 meters in the Middle Himalayas. Joshimath is a sacred site and a popular tourist destination that is close to Badrinath, one of Uttarakhand's Char Dhams. It is also close to Shri Hemkund Sahib, a sacred Sikhism temple, and Valley of Flowers National Park.

The Town is located in Seismic Zone V, an area of unstable geology. It is located close to the Tapovan Fault, north of the Main Central Thrust (of the Himalayas). Joshimath is close to the Vaikrita and Panduksehwar thrusts. One of the things that make it prone to subsidence is its proximity to a fault.

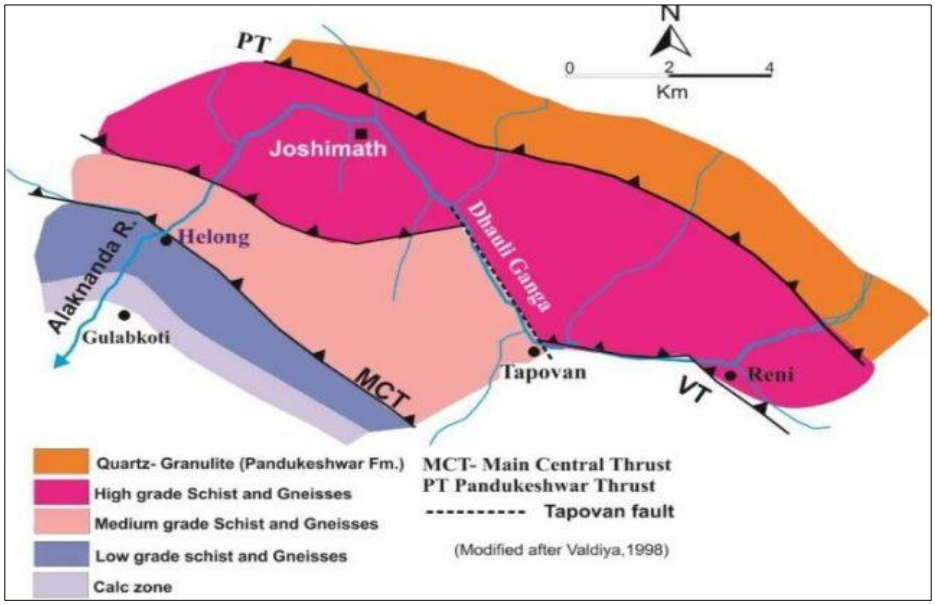

Figure 1: Geological Map of Joshimath and Surrounding Areas

Land Subsidence

The National Oceanic and Atmospheric Administration (NOAA) define land subsidence as the sinking of the ground as a result of the movement of subsurface materials. The Earth's surface may gradually settle or suddenly begin to sink, which causes subsidence. In general, resource extraction—the process of pumping, cracking, mining, or otherwise removing water, oil, natural gas, or mineral resources from the ground—causes subsidence; Natural causes include things like earthquakes, soil compaction, glacial isocratic adjustment, erosion, the formation of sinkholes, and the addition of water to fine soils. Infrastructure loads include heavy loads that are more than what the underlying soil can support.

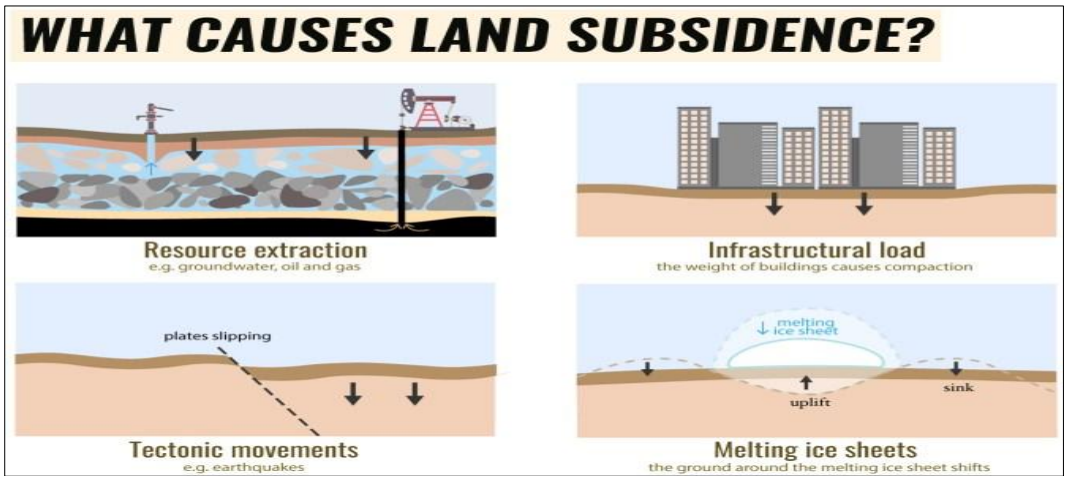

Figure 2: Causes of Land Subsidence

Reasons for Joshimath crisis

Government Development Projects: A number of development projects are being carried out close to the region that is sinking. These include the widening of highways under the Char Dham Project and the 520 MW Tapovan-Vishnugad Hydro Power Project by NTPC. Although NTPC has denied the power project's involvement in the current issue, past incidents connected to the project raise the likelihood that it might. In 2009, an aquifer in Joshimath was breached by a tunnel being dug beneath the town of Auli, causing extensive seepage and the depletion of nearby water supplies. In various spots during the current crisis.

Tourism: For visitors and pilgrims traveling to Badrinath, Shri Hemkund Sahib, or the Valley of Flowers, Joshimath has become a popular overnight stop. The local ski resort of Auli is situated. As a result, the town has seen a significant increase in hotels. The underlying soil might not be able to support the weight of the increasing infrastructure.

Illegal Construction: The majority of buildings were erected without doing adequate soil analyses.

Withdrawing of Water: When significant volumes of groundwater are removed from particular types of rocks, including fine-grained sediments, subsidence occurs. Because water helps to keep the ground in place, the rock compacts. The rocks collapse in on themselves once the water has been removed. Tourism-related population growth may have led to increased water withdrawal, which may have contributed to the sinking.

Lack of Water Drainage System: This causes landslides. The formation of cavities between the soil and the boulders is caused by the presence of soak pits, which let water slowly seep into the earth. This causes soil erosion and water seepage.

Scientific Factors

1. Joshimath is in seismic zone V, which makes it more vulnerable to earthquakes in addition to slow weathering and water percolation that over time weaken the cohesive strength of the rocks.
2. Joshimath is positioned atop a sand and stone deposit, according to the Mishra Committee Report. The majority of the town was built on landslide debris, leaving the area covered with smooth, worn rocks and loose soil. Even small triggers can cause these slopes to become unstable. Therefore, a township cannot be built on such slopes.
3. According to the Mishra Committee Report, the subsidence at Joshimath may have been brought on by the reactivation of a fault line where the Indian Plate has pushed beneath the Eurasian Plate near the Himalayas.
4. Landslides in the area are also a result of the Alaknanda and Dhauliganga river currents undercutting the terrain.

History

Background

1. The first reports of cracks in walls and structures were made in 2021 as the Chamoli area of Uttarakhand frequently faced landslides and flooding.
2. According to reports, a 2022 expert panel appointed by the Uttarakhand government discovered that Joshimath is "sinking" in some places as a result of both man-made and natural reasons.
3. It was discovered that practically all of the wards of the city have structural flaws and damage as a result of the earth's surface sinking gradually or suddenly as a result of the loss or relocation of underlying materials.

Reasons

1. **Site of an Ancient Landslide:** Joshimath is not on the main rock; rather, it is situated on a layer of sand and stone, according to the 1976 Mishra Committee report. It is situated on an old landslide. According to the report, the Alaknanda and Dhauliganga rivers' undercutting currents also contribute to the occurrence of landslides.
2. Heavy construction activities, blasting or excavating to remove rocks for road repairs and other works, and tree cutting had been restricted, according to the committee's recommendations.
3. Geographically, the area's dispersed rocks are covered in low-bearing boulders, gneissic rocks, and loose soil from previous landslides. When saturated with water, especially during monsoons, these gneissic rocks tend to have high pore pressure due to their high weathering, low cohesive value, and low cohesive value.
4. **Construction Activities:** Increased construction, hydroelectric projects, and the widening of the NH have made the slopes highly unstable in the last couple of decades. Land Erosion: Due to the running streams from Vishnuprayag and sliding along the natural streams are the other reasons behind the city's fate.

Impact

At least 66 families have fled the town while 561 houses have reported cracks. A government official said that over 3000 people have been affected so far.

LITERATURE REVIEW

Government Negligence

Roads in Joshimath started to show fissures and cracks as early as the 1970s. A government team led by Garhwal Commissioner M.C. Mishra conducted an investigation into the causes of land sinking in 1976 and made recommendations for corrective action. As the primary reasons of ground subsidence, it listed deforestation, haphazard building development, explosive road construction, poor domestic wastewater drainage, and erosion at the base of Joshimath brought on by the Dhauliganga and Alaknanda rivers (Pahari 2005).

The committee suggested undertaking a survey to identify regions that are stable and unstable, prohibiting tree removal

and major building in these places, and allowing only minimal construction in safe areas. Additionally, it suggested safeguarding the hill slopes' toes from river scouring. These suggestions were disregarded.

Local residents warned the President of India and the Governor of Uttarakhand in a letter sent in December 2003 that blasting for the Tapovan-Vishnugad head race tunnel will destroy their homes and farms. They demanded guarantees that their issues will be taken care of (Sati 2023) [1]. The NTPC was asked by the President's office to allay public concerns, but the company made no reply.

The JBSS again appealed to the President of India in 2007 after the Tapovan-Vishnugad tunnel got environmental approval, noting instances of slope destabilization at other nearby tunnels and asking for a high-powered committee to assess the NTPC project.

According to a survey published in 2006 by the Dehradun-based Wadia Institute of Himalayan Geology (WIHG), Joshimath, the town, and the villages of Kamet and Sema, were sliding 1 centimeter year. The notice stated, "Some households in the Ravigram ward have already relocated. Three to four families must still be relocated quickly.A newspaper reported this month that the WIHG's Swapnamita Choudhury team had discovered an 8 cm per year soil creep rate in the Ravigram ward. Sunil and Ravigram wards experienced a higher rate of creep than the others.

The abrupt and widespread dewatering of the stratum has the potential to start ground subsidence in the area, noted Garhwal University geologists looking into the catastrophe after the boring machine became caught inside the tunnel for the first time in December 2009. According to them, the event's long-term effects "were sure to be serious" (Bisht and Rautela 2010) [10]. Later, Bisht led the Uttarakhand Space Applications Centre (USAC), and Rautela led the Disaster Management and Mitigation Centre (DMMC).

The NTPC was obliged to agree to insure all homes in Joshimath against damage and to guarantee a steady supply of water for people affected by the drying up of their spring sources as a result of a protracted campaign by the JBSS against the corporation and an intervention by the union Power minister. The guarantees were not kept. After the JBSS ordered a review of the Tapovan-Vishnugad project, a powerful committee was established, but it was never convened. According to Atul Sati, "This cast doubt on Joshimath's future."

No hydroelectric projects should be built in the paraglacial zone, north of the MCT, according to a 2014 expert body report commissioned by the Union Ministry of Environment and Forest (MoEF) (Ministry of Environment, Forest, and Climate Change 2014). The MoEF initially agreed with all of the body's recommendations in its report, but then changed its mind.

Disaster struck on February 7, 2021. 217 people were killed when the tunnel was inundated, the Rishi Ganga hydropower project's barrage, and the Tapovan- Vishnugad project's defenses were damaged. This catastrophe would not have happened if the expert body's proposal had been followed.

A survey of the state's disaster risk was commissioned by the Uttarakhand government in 2016. For sites that are seriously at risk, like Joshimath, the final report advised creating strategic disaster mitigation strategies (DRA JV Team 2019) [9]. However, the state did nothing about it.

The Indian government chose to resume building at seven hydropower projects in Uttarakhand in 2021. Six of them, including the Tapovan-Vishnugad project, were in the paraglacial zone. In two letters to the Prime Minister, more than 60 Indian scientists and other distinguished individuals pleaded with him to halt all seven hydroelectric projects (Koshy 2021) [11]. The choice was left alone.

The JBSS warned the Prime Minister in a letter dated October 3, 2022, that the currently ongoing building of the Helang-Marwari bypass would exacerbate the unrest already present in Joshimath. The signatories requested that he put an end to the project and instead improve the well-established road through Joshimath. However, large explosions persisted night after night.

Disaster Spurs Government Response

Since November 2021, the number of soil creeps and land subsidence incidents has increased. Joshimath's predicament was regularly brought up to the district administration and the state government, and the JBSS demanded a thorough scientific investigation of the places where land had subsided.

The JBSS obtained assistance from several well-known independent scientists who carried out their own survey after receiving no answer from the government. In July 2022, they provided an official report to the JBSS and the residents of Joshimath that listed all the aforementioned unstable elements (Sati et al. 2022) [3].

To inspect the area and create a report, the state was compelled by this to assemble a formal committee of scientists. The Mishra Committee's findings from 1976 were essentially restated in its report from September 2022, which also suggested that the occupants of critically damaged homes be evacuated. Both studies advised stopping all future construction (Rautela et al. 2022) [4].

Despite the state government's lack of concern, building fissures started to show more frequently. Hundreds of homes had split walls and floors by the beginning of December 2022. Many families began using wooden poles to support their roofs. Others completely departed Joshimath out of fear.

Fig 3: Cracks In A House In Joshimath

More than 2,000 people participated in a torchlight protest march on December 24 after a significant hotel building started to tilt menacingly. They demanded the rapid resettlement of those whose homes had been irreparably destroyed. In response, the Disaster Management Department scheduled a meeting for January 15th.

Fig 4: Family Moving Out of Joshimath Town

On December 28, the JBSS complained to the State Disaster Management Secretary that January 15 was already past due and requested quick resettlement of the populace in light of a Nagarpalika study of dangerous structures. Meetings with the state BJP chief and the chief minister in Dehradun on January 1 were attended by local residents, their MLA, and the leader of the Nagarpalika; however, only a vague promise of "looking into the matter" was made.

On the evening of January 2, a significant water discharge and subsidence within the JP Hydro colony prompted the state and federal governments to take action. 561 buildings had suffered major damage, the Chamoli district government reported on January 4th. Orders were given to the NTPC, BRO, and other contractors to stop all work after a chakka jam (road blockade) in the town on January 5 (Sethi 2023a) [5].

Fig 5: Fissures in boundary wall of J.P. block of hydro colony

On January 7, Chief Minister Pushkar Singh Dhami traveled to Joshimath and paid visits to a few affected families' homes. The Prime Minister's Office (PMO) gave eight central organizations a directive the following day to investigate the reasons of ground sinking in Joshimath and submit suggestions for corrective action within two weeks.

General Manoj Pande, the Chief of the Army Staff, declared on January 12 that more than 20 military facilities in Joshimath had suffered "medium to minor damage" and that troops had been transferred out of the area. The operational readiness of the Army would not be impacted, he emphasized

Government Response

Responses from the State and Central administrations to the current crisis in Joshimath have been slow, halting, deceptive, and timid. The government's approach to the problem in Joshimath is unclear. It's mystifying that it took so long to be acknowledged. Perhaps the administration was attempting to downplay the circumstance in order to protect the summer tourism industry, which is dependent on the Char Dham yatra.

Steps to Mitigate Its Sinking

1. The region's growth demands must be balanced with environmental preservation. The local ecology and

population must not be sacrificed for development. The first priority should be ensuring sustainability.
2. Any development strategy for the region should put the natural resources of the Himalayas, including biodiversity, regional ecology, and environmental balance, at its core.
3. Smaller initiatives that can assist in meeting the community's energy demands should receive priority rather than concentrating on the development of large dams.
4. The protection of people's safety should be given top priority right now. The State administration has to establish a constant and transparent line of communication with those who have been impacted.
5. All development projects should follow the advice of the Mishra Committee. On unstable slopes, no activity should be carried out until structural stability can be guaranteed.
6. Experts recommend a complete shutdown of development and hydroelectric projects in the region. But the urgent need is to relocate the residents to a safer place and then re-imagine the town's planning to accommodate the new variables and the changing geographical factors.
7. Drainage planning is one of the biggest factors that need to be studied and redeveloped. The city is suffering from poor drainage and sewer management as more and more waste is seeping into the soil, loosening it from within. The irrigation department has been asked by the state government to look into the issue and create a new plan for the drainage system.
8. Replanting has also been advocated by experts as a way to preserve soil capacity in the area, particularly in susceptible places. To save Joshimath, a coordinated effort between the government and civil organizations is required, assisted by military groups like the Border Roads Organisation (BRO).
9. The state currently has weather prediction technology that can alert citizens to local events, but its coverage has to be expanded.
10. Satellites and Doppler weather radars, which use electromagnetic energy to detect precipitation and pinpoint its location and intensity, are used in Uttarakhand to forecast the weather.
11. The state administration also has to be more serious about scientific investigations that clearly explain the causes of the current problem. The state won't stop its development binge till then.

CONCLUSION

The Joshimath Crisis highlights the negative effects of unrestrained growth in a location with unstable geology and sensitive environmental conditions. The region is currently experiencing various crises (Kedarnath 2013, Chamoli 2021) that call for a reexamination of the current development strategy. It is essential to make a change right away that prioritizes sustainability. If not, similar crises will happen more frequently and have terrible results.

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