



## Sinking Joshimath in Chamoli: An Insight from Uttarakhand

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**Abstract:** This paper aims to explore the theoretical causal factors of subsidence in Joshimath, with particular emphasis on geophysical, climatic, and urbanisation factors, alongside establishing the NTPC Tapovan Vishnugad Hydroelectric Power Plant. Using secondary data in interviews, questionnaires, and expert opinions, it outlines significant subsidence episodes and their amplification by developmental processes. To identify the causes of this shift, the study examines how both natural and human factors have contributed to landslides in the region. It reveals that poor drainage systems and inadequate planning and expansion of urbanisation around this area have compounded the problem. This research concludes that damaging projects must be halted, drainage systems should be improved, and future research should be expanded.

**Keywords:** Tapovan Vishnugad Hydroelectric Power Plant • NTPC • Joshimath • land subsidence • climate change • GSI • NDMA

### Introduction

Joshimath, or ‘*Jyotirmath*’, is a municipal town of 2,458 sq. km. with a 16,709 population in the Chamoli district, now grown to an estimated 23,500 across nine wards acquired importance as a military town after the war with China over Barahoti in 1962 (Census India, 2011). It is 8 km off the Rishikesh-Badrinath National Highway (NH-7) at 1875 mts at Vishnuprayag, “the confluence of the Alaknanda and Dhauliganga rivers” (Testbook.com, n.d.). Trekking trails, mountaineering, and skiing are available at the skiing resort for both Hindus and Sikhs, and Badrinath and Hemkund Sahib can be accessed (WanderSky, n.d.). ‘*Adi Shankaracharya*’ set up the Jyotirmath monastery in the eighth or ninth century. The town is also well-known as a place of many temples and the winter abode of ‘*Badri*’, where the deity ‘*Badri Narayan*’ is moved to the Narsimha temple for the winter (Bikat Adventures, n.d.).

In Joshimath, “hotels, Indian army units, Indo-Tibetan Border Police (ITBP), Border Roads Organisation (BRO), and Jaypee Hydro camp are also near the Valley of Flowers National Park, a renowned United Nations Educational, Scientific and Cultural Organization’s (UNESCO) World Heritage site. “ (Uttarakhand Tourism, n.d.). Besides its cultural, religious, and strategic importance, Joshimath has significant climate change and human intervention (Down To Earth, 2023). Being geologically unstable, it is one of the most endangered Himalayan regions susceptible to natural mishaps like landslides and building subsidence, particularly in rainy seasons, where large sinkages recorded in 2021, 2022, and 2023 require specialised treatment.

### Recent Events and Concerns

In July 2021, the famous Nanda Devi glacier partially melted in the Nanda Devi National Park, flooding the Rishiganga and Dhauliganga rivers in Uttarakhand. This occurrence inflicted severe damage to the



Rishiganga and Dhauliganga Dams, the Tapovan Vishnugad Hydropower Plant, and Rini village, causing at least 31 casualties and '60 to 165' individuals reported missing (Drishti IAS 2021). Fault lines appeared in roads, buildings, and temple walls. Despite concerns about subsidence and structural damage, attention and intervention were minimal. From April to November 2022, the Indian Space Research Organisation's (ISRO) National Remote Sensing Centre recorded a slow subsidence of 8.9 cm in Joshimath, exacerbating infrastructure cracks and heightening concerns (Singh 2023). On January 2, 2023, significant subsidence caused a 5.4 centimetre (cm) sinking between 'December 27, 2022, and January 8, 2023,' leading to severe structural damage. By January 6, cracks in 500 buildings prompted rapid evacuations (Singh 2023). On January 9, the Prime Minister's Office directed the district administration to relocate residents to safer areas; 478 houses and two hotels were declared unsafe, and 81 families were relocated. Moreover, the number of cracked houses increased from 723 to 863 by January 23, highlighting the need for immediate mitigation (Times of India, 2023; The Hindu, 2023).

The study delves into Joshimath's leading causes of subsidence, including geophysical effects, climate change, faulty urbanisation, and projects like the NTPC Tapovan Vishnugad Hydroelectric Power Plant. It appraises the outcomes of recent disasters, such as glacier-triggered floods and building failures, on the town's stability. It examines how developmental activities, such as road construction and hydroelectric projects, have exacerbated the crisis. The study assesses the effectiveness of responses from government and private entities, including evacuation, financial support, and construction bans, and recommends halting harmful projects, improving drainage, and initiating repairs. Further research on satellite monitoring,

development impacts, and integrating disaster risk reduction with geological and socio-economic analysis is recommended.

### Research Methodology

This descriptive study is based on narratives collected from grey literature as part of secondary sources and synthesised through qualitative research. Grey literature has been used to provide up-to-date information on sinking Joshimath. Data or insights into emerging trends are not available elsewhere. Self-generated secondary data from interviews, surveys, and direct observations by academicians and journalists were used to assess the level and localisation of the sinking in Joshimath through site visits. Additional information includes famous newspaper articles (*The Hindu*, *Times of India*, *Indian Today*, *Economic Times*), online articles, blogs, national and international government reports, and opinions, as well as satellite images and ground views from the Chamoli District Administration, "Uttarakhand State Disaster Management Authority (USDMA), Geological Survey of India (GSI), National Disaster Management Authority (NDMA), Indian Space Research Organisation (ISRO), National Oceanic and Atmospheric Administration (NOAA), Press Trust of India (PTI), National Institute of Hydrology (NIH), National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), and the Mishra Committee Report (1976)" since very few research papers available that cover Joshimath studies. The study employed interpretative and thematic analysis using NVIVO software, with codes developed under various themes to understand the sinking Joshimath. The interpretative analysis aims to understand the context of the gathered data and then identify recurring patterns, themes and concepts. To identify the themes, coding of the data and a group of similar ideas are required. Then, the data was analysed to



draw conclusions and develop insights. To ensure validity and reliability, findings are cross-checked with other data sources. Here, different secondary sources cross-checked with each other to prove the reliability and validity of the findings.

## Observations And Discussion

### Causes of Sinking Joshimath

**Land Subsidence:** Dr Sudhakar M, a senior scientist at ISRO, reported that satellite imagery showed Joshimath experienced 4 to 4.25 cm of land subsidence daily between December 27, 2022, and January 8, 2023, a total of 4 cm over 12 days (Sharma 2023). Land subsidence, the ground sinking due to factors like subsurface fluid removal or soil compaction, can be caused by natural and human-induced factors (NOAA 2021). Natural causes include earthquakes, erosion, and glacial adjustments, while human activities involve water withdrawal and resource extraction.

ISRO's National Remote Sensing Centre analysis indicated a slight decrease in the sinking rate to 8.9 cm between April and November 2023. Significant subsidence was also observed near the Joshimath-Auli highway at 2,180 meters altitude (The Hindu 2023).

Cracks in Joshimath's road surfaces have been noted since the early 1970s. A government committee led by M. C. Mishra, a Garhwal Commissioner in 1976, has determined factors leading to subsidence, such as deforestation, unplanned construction, and drainage issues (Saha, 2023; Pandey, 2023). Joshimath DM Himanshu Khurana confirmed the area as a landslide-subsidence zone with issues documented since the 1970s (Pannu 2023).

**Seismic V Zone and Fragile Ecology:** Joshimath stands in Zone V, capable of earthquakes, landslides, flash floods, and erosion (Awasthi et al 2024). The Mishra Committee Report 1976 indicated that

Joshimath was constructed on a sedimentary layer of sand and stone over an ancient landslide. It recommended prohibitions against the extensive construction of buildings and deforestation (Gora & Anand, 2023). Y. P. Sundriyal at Hemvati Nandan Bahuguna Garhwal University (HNBGU), expressed concern, stating, "The government has not adequately learned from the 2013 Kedarnath floods and the recent Rishi Ganga flash floods, which has worsened the challenges. Joshimath faces a significant risk of earthquakes, being situated in Seismic Zone IV or V." (Shankar IAS Academy, n.d.).

**Tapovan Vishnugad Hydroelectric Power Plant:** "NTPC's Tapovan Vishnugad Hydroelectric Power Plant of 520 megawatt (MW) responsible for landslides." Residents said it necessitates the creation of a 12 km tunnel beneath the hills, which ranges from 12 to 25 km away from Joshimath (Thakkar 2023).

After the start of the project in December 2009 by a tunnel boring machine, other mishaps ensued, including striking an aquifer. In February 2021, a devastating flash flood claimed over 200 lives, primarily among dam site workers. A glacier in the Chamoli district induced several avalanches and the collapse of hydropower structures in the Alaknanda River (Shrestha et al 2021). The same year, it brought down a 90-meter Reinforced Cement Concrete (RCC bridge) on the Joshimath-Malari road approximately 2 km upstream from the Tapovan project site. The number of fatalities has been estimated to be more than 70, while 134 persons have been listed as injured and missing. Nevertheless, its ecological vulnerability and several run-of-the-river type hydropower projects have been stepped up: the Supreme Court constituted a Ravi Chopra committee on widening roads in the Uttarakhand Chardham, where these projects were shown to have compounded catastrophes such as



floods. Intergovernmental Panel on Climate Change's Anjal Prakash said it has no option but to remind people about the irreversible loss due to such projects through examples like Joshimath (Drishti IAS n.d.).

**Climate Change and Development Projects:** Experts attribute the catastrophe to climate change, exacerbated by dam and development projects. On January 5, the state government saw houses with emerging cracks and suspended the Tapovan-Vishnugad project and the Border Roads Organisation's (BRO) road extension undertakings.

The same concern towards the NTPC project was highlighted by Bisht and Rautela (2010). The Bureau of Indian Standards' seismic hazard maps indicate that nearly 59% of India is prone to earthquakes, with varying levels of risk across different zones (PTI, 2023). Explosions during the Helang-Marwari bypass construction and erosion from the Char Dham Pariyojana worsened conditions after the February 2021 flood (HT Correspondent 2023). Eyewitnesses reported a 20-meter rise in water levels before they receded. Severe erosion likely increased soil creep, causing cracks in Joshimath's buildings by November 2021 (Azad & Talwar 2023).

**Unplanned Urbanisation and Developmental Constructions:** Unplanned urbanisation and unauthorised construction have obstructed the natural flow of river water and led to structures being built without adequate load-bearing capacity. The current crisis is primarily attributed to human activities, including a sharp increase in population and tourism, resulting in unchecked infrastructure development. Hydropower tunnel construction involves blasting, which causes local tremors and structural cracks (Jha 2024).

High tourism demand has led to extensive road and infrastructure projects, such as the 'Helang-Marwari bypass, part of the Char

Dham highway expansion by the BRO.' This has destabilised local slopes, with unscientific slope-cutting triggering numerous landslides. A 1978 report by Garhwal Commissioner Mahesh Chandra Mishra recommended avoiding major construction in Joshimath, Niti, and Mana valleys due to their location on moraines (The Processor 2023).

**Inadequate Drainage and Wastewater Disposal:** The lack of proper drainage and wastewater disposal systems exacerbates subsidence in Joshimath (Perinchery 2023). Approximately 85% of buildings rely on soak pits rather than a sewerage system. The Mishra Committee report 1976 cautioned that these pits could form cavities between soil and boulders, leading to landslides (Officers Pulse n.d.).

#### **Other Ongoing Projects**

Despite previous lessons, several development projects around Joshimath, such as the 'Vishnuprayag dam, Vishnugad Pipalkoti hydroelectric projects, Jhelum Tamak, Malari Jhelum, Lata Tapovan, Tapovan, Rishi Ganga Power Project, and the Char Dham road from Helang to Marwari' persist. Vimlendu Jha, an environmentalist, has condemned engineers for failing to conduct thorough environmental impact assessments and not addressing local ecological concerns (Jain 2021).

#### **Impact on Residents**

**Protest and Panic:** Residents began protesting in late 2022 as signs of cracking and sinking emerged (Mahtolia 2023). By late December, affected individuals accused the administration of inaction. Protests, roadshows, and dharnas continued into early 2023 due to growing panic (PTI 2023).

**Mental Health Issues:** Joshimath, with 3,900 residences and 400 commercial structures, including 195 built under the 'Pradhan Mantri Awas Yojana,' faces severe landslides and road cracks (Ara 2023).



About 200 families have been evacuated, leaving others in fear. Mental health issues such as anxiety and insomnia are prevalent among residents, exacerbated by the economic toll on businesses and displacement. Atul Sati of the Joshimath Bachao Sangharsh Samiti and Dr Jyotsana Naithwal note that stigma around mental health prevents many from seeking help (Economic Times 2023).

### **NTPC's and Government Response**

The Uttarakhand Chief Minister announced financial aid and planned evacuations for Joshimath. In 2023, efforts included monitoring the situation, relocating families, and mitigating damage. The government banned construction in affected areas and provided dry ration kits and other aid. Expert committees are investigating and advising on mitigation measures. Both the State and Central governments have faced criticism for their delayed response.

PK Mishra, Principal Secretary to the Prime Minister, conducted a review meeting and was informed that central institutions and advisors are aiding the state administration in designing short-, medium---, and long-term plans. NDRF and SDRF teams have arrived in Joshimath, where land subsidence and structural damage are prompting concern. Experts from NDMA, the Geological Survey of India, IIT Roorkee, the Wadia Institute of Himalayan Geology, the National Institute of Hydrology, and the Central Building Research Institute assessed the situation and offered suggestions. Chief Minister of the state, Mr Pushkar Singh Dhama, also travelled to Joshimath for a site visit, directed the evacuation of around 600 families and highlighted the area's cultural, religious, and tourism significance, including its role as a gateway to Badrinath, Hemkund Sahib, and Auli.

NTPC refutes claims that its head race tunnel has disrupted Joshimath. The company states the tunnel is 0.85 to 1.2 km

horizontally from the town and 0.65 to 1.1 km deep. It did not pass under Joshimath and was constructed using a boring machine for 8.5 km within the 12 km tunnel without blasting. The government's response has been criticised for its delay and lack of clarity, with speculation that it might be downplaying the situation to protect Char Dham yatra tourism.

At the ITBP base camp, Chief Minister Dhama emphasised safe and sensitive relocation. He suggested that the landslides are a natural tragedy, not caused by human activities. He cited a Times of India article that argued that blaming NTPC without scientific evidence is akin to blaming divine forces for flash floods. The article also noted similar subsidence in Karanprayag, which is unrelated to the NTPC project. Dhama referenced Shimla's subsidence in 1972-1973, attributed to inadequate sewage and drainage, not tunnelling. He suggested that similar issues might be affecting Joshimath, as predicted by MC Mishra in 1976. NTPC maintains that its tunnel does not pass under Joshimath, and both state and central governments are managing relocation and compensation.

### **Recent Findings, Expert Reports and Local Opinions**

Residents are demanding that NTPC exit Joshimath. The causes of land subsidence in Joshimath remain unclear. According to the Mishra Committee Report, Joshimath is founded on sand and stone deposits. Much of the town is built on Landslide remnants of smooth, weathered rocks and loose soil. Minor triggers can destabilise such slopes, making them unsuitable for construction. The report further suggests that subsidence could be connected to the reactivation of a geographic fault where the Indian Plate is pushed beneath the Eurasian Plate along the Himalayas. Additionally, erosion induced by the Alaknanda and Dhauliganga rivers also leads to landslides in the area."





A strategic conference with state government representatives, the NDMA, the GSI, and the NIH classified the region as an area affected by landslides and subsidence. Experts blame rapid construction, including the Char Dham Yatra road widening and National Highway 7, which runs through Joshimath. Dr Bahadur Singh Kotila of Kumaon University noted that the road should have been seven metres wide but was widened to 12 metres,(m) exacerbating the risk of landslides by clearing more hills.

Atul Sati, the Struggle to 'Save Joshimath Committee coordinator,' highlighted that inhabitants had repeatedly alerted the government about the cracks emerging in their homes. He recommended that there should be a high-level State Committee that includes local entities, regional collaboration and an immediate cessation of large-scale construction. Despite a year passing, there has been little action or acknowledgement. However, the issue has had minimal response or recognition even after a year.

Experts recommend halting construction and hydroelectric projects in the region. Construction of the NTPC Hydro Power plant and the Helang Bypass has been paused until further notice. Measures such as plantation at vulnerable sites and development of the drainage system are needed. Scientific studies specific to Joshimath's issues should be conducted. These incidents highlight the urgency of addressing the situation and prompt significant intervention from both local and central authorities. Three authors, Heim, Arnold, and August Gansser, mentioned that Joshimath is situated on landslide debris in the book Central Himalaya. In 1971, reports of cracks in homes led to recommendations for tree conservation and avoiding disturbance of boulders under the town, but these measures were not implemented.

## Conclusion

The subsidence crisis in Joshimath exemplifies the complex interplay between natural and anthropogenic factors leading to geohazards. Key contributors to the adverse effects in Joshimath include unregulated expansion and development, infrastructural growth, and climate change, all of which exacerbate land subsidence and structural damage. Satellite imagery and expert analyses confirm that the ground sinking is significant and ongoing. Thus, an integrated approach to addressing these issues is urgently needed. The current situation continues deteriorating, highlighting that structural and environmental problems remain unresolved amid ongoing developmental pressures.

## Future Aspects

Future research should focus on assessing subsidence through advanced satellite imagery and frequent levelling surveys. It is also essential to evaluate the impact of various developmental projects on the region's stability. Disaster management strategies must integrate geological, environmental, and socio-economic factors, necessitating a comprehensive model with practical early warning tools and effective response protocols.

Addressing panic and other issues among vulnerable residents requires raising public awareness through large-scale campaigns that inform about risks and preventive measures. Additionally, future development in geo-hazardous zones should adhere to environmental regulations and incorporate sustainable practices to mitigate subsidence risks.

## Limitations of The Study

This study relies primarily on secondary and historical data, which may not account for recent developments or changes in the subsidence situation. A notable constraint is a concentration on Joshimath and its surrounding environs, which could restrict



the generalisability of the results to other regions with comparable features but distinct geological and climatic circumstances. The overlapping characteristics of geological, environmental, and socioeconomic aspects present additional difficulties for the investigation, as they can result in divergent conclusions and recommendations from various fields. Additionally, resolving the issues discussed may be prolonged due to delays in governmental responses and project implementations.

### Implications of The Study

The findings reveal the role of geology in urban environments and underscore the need for its inclusion in planning and policy analysis. Geology should be integrated into future development projects, particularly in areas prone to geological instability. This study demonstrates the importance of applying insights from previous research to current and future disaster management practices, reiterating earlier recommendations.

Comprehending the socio-economic standing of inhabitants is imperative in formulating efficacious assistance systems for impacted groups and expediting their immediate and extended recuperation. The study highlights the significance of disaster mitigation and environmental preservation, providing insightful insights for creating resilient and environmentally sound models.

### Recommendations

Strengthening historical recommendations is another crucial step. The 1976 Mishra Committee Report suggested controlling construction and conserving natural resources to address the region's vulnerability. These measures must be reinforced and adapted to current conditions to ensure their effectiveness. Forming a high-powered state committee can further enhance the response to the crisis. This committee should include regional

representatives, scholars, and members of the state administration to address the issue comprehensively and coordinate practical actions.

Finally, initiating replantation and environmental restoration projects is critical. New planting initiatives must be launched to restore vegetation in regions vulnerable to soil erosion. Restoring vegetation will strengthen the area's resilience to upcoming environmental pressures, stabilise the soil, and reduce erosion. These coordinated efforts will resolve Joshimath's subsidence issues more quickly and efficiently.

### References

- Ara I (2023 January 26). Joshimath crisis: A story of criminal neglect. *Frontline*. <https://frontline.thehindu.com/environment/ground-report-at-the-fault-lines-why-joshimath-crisis-is-a-story-of-criminal-neglect/article66408>
- Awasthi S, Jain K, Sahoo S, Kumar R, Goswami A, Joshi G C, Kulkarni A V and Srivastava D C (2024 May 13). Analysing Joshimath's sinking: Causes, consequences, and prospects with remote sensing techniques. *Scientific Reports*, 14(1), 10876.
- Azad S and Talwar G (2023 January 9). Parts of Joshimath 'sinking 1 cm/year', 2006 report warned. *The Times of India*. <https://timesofindia.indiatimes.com/city/dehradun/17-year-old-survey-said-parts-of-joshimath-sinking-residents-need-to-be-shifted/ar>
- Bikat Adventures ( 2017 March 29). Joshimath: The gateway to heaven. *Bikat Adventures*. <https://www.bikatadventures.com/home/blog/Joshimath--The-Gateway-to-Heaven>
- Bisht M P S and Rautela P (2010). Disaster looms large over Joshimath. *Current Science (Bangalore)*, 98(10), 1271



- Census of India. (2011). Uttarakhand population data. *Office of the Registrar General & Census Commissioner, India*. <https://censusindia.gov.in/census.websit e/data/population-finder>
- Down To Earth (2023 January 11). Joshimath's tragedy again shows us how fragile Uttarakhand's Himalayas are. *Down To Earth*. <https://www.downtoearth.org.in/climate -change/joshimath-s-tragedy-again- shows-us-how-fragile-uttarakhand-s- himalayas-are-86982>
- Drishti IAS. (2021, February 9). Uttarakhand flash flood. *Drishti IAS*. [https://www.drishtiias.com/daily-news- analysis/uttarakhand-flash- flood/print\\_manually](https://www.drishtiias.com/daily-news- analysis/uttarakhand-flash- flood/print_manually)
- Drishti IAS. (2022, February 11). Ravi Chopra Committee. *Drishti IAS*. [https://www.drishtiias.com/state-pcs- current-affairs/ravi-chopra- committee/print\\_manually](https://www.drishtiias.com/state-pcs- current-affairs/ravi-chopra- committee/print_manually)
- Dutta S (2024 January 30). GSI: Joshimath highrises, not NTPC project, led to sinking. *The Times of India*. <https://timesofindia.indiatimes.com/city /dehradun/unbridled-infrastructure- buildup-not-ntpc-induced-joshima>
- Economic Times. (2023, January 15). Joshimath sinking: Mental health issues add to trauma of displaced. *The Economic Times*. <https://economictimes.indiatimes.com/n ews/india/joshimath-sinking-mental- health-issues-add-to-trauma-of- displaced/articleshow/978>
- Gora S and Anand V (2023, March 15). Joshimath: 1976 report warned that town was on ancient landslide, human activity poses danger. *CNBC TV18*. <https://www.cnbctv18.com/india/joshim ath-1976-report-warned-that-village- was-on-ancient-landslide-human- activity-poses-danger-15610021.ht>
- HT Correspondent. (2023, August 17). Helang-Marwari bypass project stuck in a limbo, awaits IIT report. *Hindustan Times*. <https://www.hindustantimes.com/cities/ dehradun-news/helangmarwari-bypass- project-stuck-in-a-limbo-awaits-iit- report-101679925198063.h>
- India Today. (2023, January 14). Joshimath sinking: ISRO-NRSC report on land subsidence mysteriously withdrawn. *India Today*. <https://www.indiatoday.in/india/story/jo shimath-sinking-isro-nrsc-report-land- subsidence-mysteriously-withdrawn- 2321410-2023-01-14>
- Jain S (2021). Construction of calamities in the Uttarakhand Himalaya. *Economic and Political Weekly*, 56(13), 43-48 [https://www.futuredams.org/wp- content/uploads/2021/03/PER\\_LVI\\_13 \\_Shruti](https://www.futuredams.org/wp- content/uploads/2021/03/PER_LVI_13 _Shruti)
- Jha R (2024 August 8). The enduring problem of illegal constructions in India's cities. *Observer Research Foundation*. <https://www.orfonline.org/research/the- enduring-problem-of-illegal- constructions-in-indias-cities>
- Mahtolia U (2023 May 18). People protest to draw attention to land subsidence in Joshimath, demand rehabilitation and compensation. *Land Conflict Watch*. <https://www.landconflictwatch.org/conf licts/people-protest-to-draw-attention- to-land-subsidence-in-joshimath- demand-rehabilitation-and-comp>
- National Disaster Management Authority. (n.d.). Home. *Government of India*. <https://www.ndma.gov.in/>
- National Ocean Service. (2021, October 6). What is land subsidence? *National Oceanic and Atmospheric Administration*. <https://oceanservice.noaa.gov/facts/subs idence.html>





- Officers Pulse. (2023, 19 January). Why is the land in Joshimath sinking? *Officers Pulse*. <https://officerspulse.com/why-is-the-land-in-joshimath-sinking/>
- Pandey K (2023 January 18). As cracks widen in Joshimath, reasons lay hidden underground. *Mongabay India*. <https://india.mongabay.com/2023/01/joshimath-amid-widening-cracks-truths-remain-hidden-in-hills/>
- Pannu A (2023, January 17). Joshimath declared land-subsidence zone: What does this mean? *The Quint*. <https://www.thequint.com/climate-change/joshimath-declared-landslide-subsidence-zone-uttarakhand-chamoli-sinking>
- Perinchery A (2023 January 11). Uncontrolled construction, ignored warnings: How Joshimath sank. *The Wire*. <https://thewire.in/environment/joshimath-himalayas-explainer-warnings-reports-construction-ntpc>
- Press Information Bureau. (2023, January 15). Government of India's comprehensive plan to tackle Joshimath land subsidence. *Press Information Bureau*. <https://pib.gov.in/PressReleasePage.aspx?PRID=1740656>
- PTI. (2023, January 28). Locals protest in Joshimath against slow pace of efforts to save town. *Deccan Herald*. <https://www.deccanherald.com/india/locals-protest-in-joshimath-against-slow-pace-of-efforts-to-save-town-1185389.html>
- Saha S (2023, January 8). Joshimath: An avoidable disaster. *The India Forum*. <https://www.theindiaforum.in/environment/joshimath-avoidable-disaster>
- Shankar IAS Academy. (2023, January 21). India's seismic zone maps. *Shankar IAS Academy*. <https://www.shankariasparliament.com/current-affairs/daily-news/indias-seismic-zone-maps>
- Sharma S (2023 January 12). Scary revelation by ISRO: Joshimath may sink entirely; see satellite images. *Business Today*. <https://www.businesstoday.in/latest/story/scary-revelation-by-isro-joshimath-may-sink-entirely-see-satellite-images-360001-2023-01-12>
- Singh S (2023 January 5). Joshimath: Satellite images from NRSC show land subsidence. *India Today*. <https://www.indiatoday.in/india/story/joshimath-satellite-images-national-remote-sensing-centre-nrsc-isro-joshimath-land-sub>
- Testbook.com. (2023, May 9). *The river Alaknanda meets which river at Vishnuprayag?* *Testbook*. <https://testbook.com/question-answer/the-river-alaknanda-meets-which-river-at-vishnuprayag-6068204d9c0b8e8ce6dabef8>
- Thakkar H (2023 January 26). Tapovan Vishnugad: NTPC project at the heart of Joshimath crisis. *Frontline*. <https://frontline.thehindu.com/environment/tapovan-vishnugad-hydropower-plant-ntpc-project-at-the-heart-of-joshimath-crisis/article66386>
- The Hindu. (2023, January 10). Explained: Why is the land sinking in Joshimath? *The Hindu*. <https://www.thehindu.com/sci-tech/science/explained-why-is-the-land-sinking-in-joshimath/article66364329.ece>
- The Hindu. (2023, January 13). ISRO releases satellite images showing rise in Joshimath land subsidence. *The Hindu*. <https://www.thehindu.com/sci-tech/energy-and-environment/isro-releases-satellite-images-showing-rise-in-joshimath-land-subsidence/article6637>



The Processor. (2023, August 10). Lessons from Joshimath subsidence. *The Processor*.

<https://theprocessor.in/policy-puzzles/lessons-from-joshimath-subsidence-3694225>

Times of India. (2023, January 6). PMO team visits Joshimath to submit findings to PM Narendra Modi. *The Times of India*.

<https://timesofindia.indiatimes.com/city/dehradun/pmo-team-visits-joshimath-to-submit-findings-to-pm-narendra-modi/articleshow/9701555>

Uttarakhand State Disaster Management Authority. (n.d.). Joshimath reports. *Government of Uttarakhand*.

<https://usdma.uk.gov.in/IEC/josimath-reports-1395.aspx>

Uttarakhand Tourism. (n.d.). Valley of Flowers. *Uttarakhand Tourism*.

<https://uttarakhandtourism.gov.in/destination/valley-of-flowers>

WanderSky. (2023, August 23). Joshimath travel guide. *WanderSky*.

<https://wandersky.in/joshimath-travel-guide/>