



LAND SUBSIDENCE: A REVIEW ON ENVIRONMENTAL CONCERN OF JOSHIMATH

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Abstract:

Land Subsidence in Joshimath (also known as Jyotirmath) is situated in seismic zone 5 and is bordered by the Vaikrita and Muniari regional thrusts. The area is prone to earthquakes, as the quakes in 1991 and 1999 showed. Joshimath and the adjoining regions have been sinking at an average pace of 6.5 cm (2.5 inches) each year, based to study done on the basis of satellite data from July 2020 to March 2022 by scientists from the Indian Institute of Remote Sensing, Dehradun. Their findings are in line with the Joshimath slope's base erosion along the Alaknanda river. The ground subsidence, or sinking of land that has been occurring in this area has recently made headlines. Houses, businesses, and roads all have cracks, and hundreds have been moved to safer locations. The goal of the paper is to draw attention to the issue of environmental concern of Joshimath.

Keywords: eco- sensitive zone, environmental concern, landslides, land subsidence, sinking land

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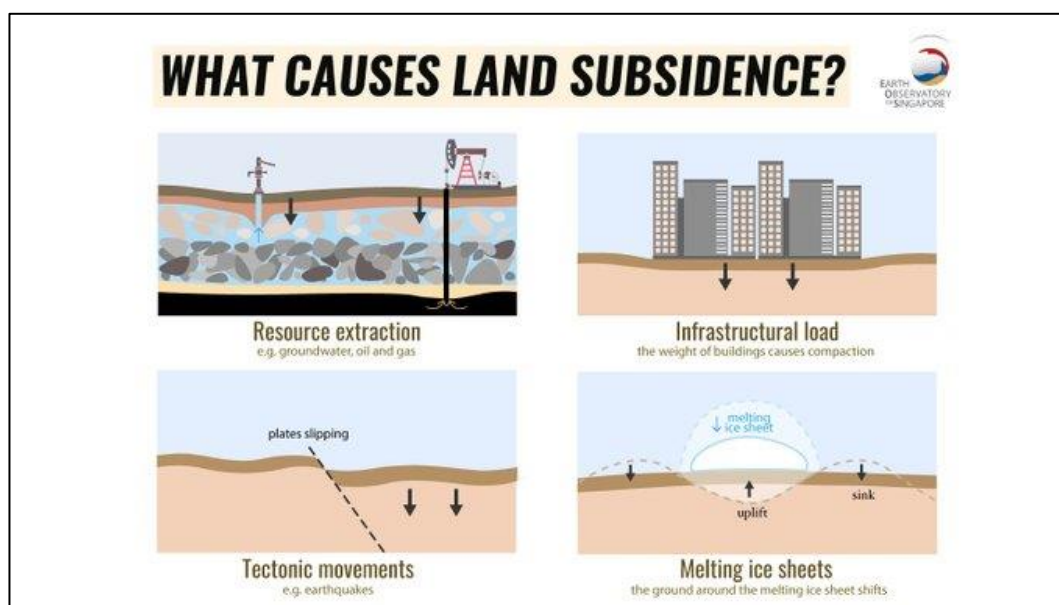
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INTRODUCTION:

Land subsidence is the sinking of the earth as a result of underlying material movement. Subsidence can be triggered by either progressive settlement or abrupt sinking of the Earth's surface, according to the National Oceanic and Atmospheric Administration (NOAA, USA). "Land subsidence" is the term for the gradual sinking or speedy sinking of the ground's surface that results from the removal or shifting of elements under the ground. Earthquakes, glacial isostatic adjustment, soil compaction, erosion, the development of sinkholes, and other factors can cause land to sag. Oil, water, minerals, natural gas,

and other resources are extracted from the soil by mining, fracking, or other methods. As a result of infrastructure building, the infrastructure load exceeds the soil's bearing capacity. Subsidence usually comes due to resource extraction, ranging from pumping, drilling, mineral extraction, or any other way of cutting off water, oil, or gas from the ground. Natural causes of subsidence include things like tremors, compacting of soil, glacial isostatic adjustment, weathering, the formation of holes in the ground, and the addition of water to fine soils. Heavy loads that outstrip the carrying capacity of the underlying soil include infrastructure loads.



I Fig : Source:Earth Observatory of Singapore
https://twitter.com/EOS_SG/status/1552970187829280768?s=20

The tool for identifying and mapping land-surface movement is interferometric synthetic aperture radar (InSAR). The utilisation of repeat-pass radar pictures from Earth-orbiting satellites by InSAR allows for incredibly detailed monitoring of subsidence and uplift. Assessments of the InSAR data can be made to better our understanding of the subsidence mechanisms after subsidence has been recognised and mapped. The subsidence brought on by the use of our water and land resources can be reduced by scientific understanding and careful management of natural resources (United States Geological Survey, 2019).

A landslide is a type of mass wasting that occurs when a large amount of rock, soil, or debris moves down a slope due to the force of gravity. Landslides are further classified into five types based on their movement, including collapses, tilts, slips, spreads, and flows. These types are categorized into bedrock, debris, and earth depending on the type of

geological material involved. Debris flows are also called mudflows or mudslides, while rock falls are common forms of landslides. This information is from the United States Geological Survey.

The Himalayas, the world's tallest mountain range, are located in India. They were created when the Indian and Eurasian plates collided. As the Indian plate moves northward towards China, it continuously stresses the rocks, making them weak, friable, and vulnerable to earthquakes and landslides. Natural disasters are said to be caused by the Indian crust's sluggish motion, which accumulates tension at a rate of roughly 5 cm each year. Some landslides cause unmatched and singular calamities. Together with avalanches and landslides are most occurring disasters in this region and considered among primary hydro-geological hazards that have a substantial impact on large areas of India. These mountain ranges, representing for around 15% of the continent, comprise the Himalayas, the, the Western Ghats,

the Nilgiris, the Eastern Ghats, Northeastern hill ranges and the Vindhya. Only the Himalayas can claim to have experienced landslides of every kind—large and small, swift and slow, old and recent. Landslide issues of an astounding variety are a serious problem in the Northeastern region. Landslides continue to be a major issue in several states of India, including Sikkim, Mizoram, Tripura, Meghalaya, Assam, Nagaland, and Arunachal Pradesh, as well as the Darjeeling region in West Bengal. To address the issue of landslides, measures need to be taken for reducing their impact and effectively dealing with them. This involves identifying hazard zones, stabilizing and managing unstable slopes, and implementing monitoring and early warning systems in specific areas. (Uttarakhand State Disaster Management Authority, n.d.)¹

Yaspal Sundrial et al. (2023) studied the sinking land in two towns in Uttarakhand, India, due to various factors like seismic stress, domestic discharge, building load, and rainfall.

Jurgen Mey et al. (2023) focused on landslides that obstruct the National Highway (NH-7) between Rishikesh and Joshimath in Uttarakhand, India, by mapping the areas where landslides occur and identifying the environmental factors that influence their occurrence.

Abdullah Tabish Ahmed et al. (2017) provided an overview of the types of disasters that affect India and the geographical locations that are prone to them, along with an analysis of India's paradigm change in disaster management.

Hines, R.I. (2007) explored the gender issues related to the 2004 Indian Ocean Tsunami and its disproportionate impact on women in India, highlighting the challenges they faced during and after the disaster.

R. A. Houze Jr et al. (2017) focused on the conditions that led to the catastrophic flooding in Uttarakhand and found that the deep convection event had little to do with the rainfall that caused the floods.

G. Erkens et al. (2015) studied the sinking land in coastal and delta cities and found that excessive extraction of groundwater coupled with urbanization and population growth was one of the main causes of land subsidence, which increased vulnerability to floods.

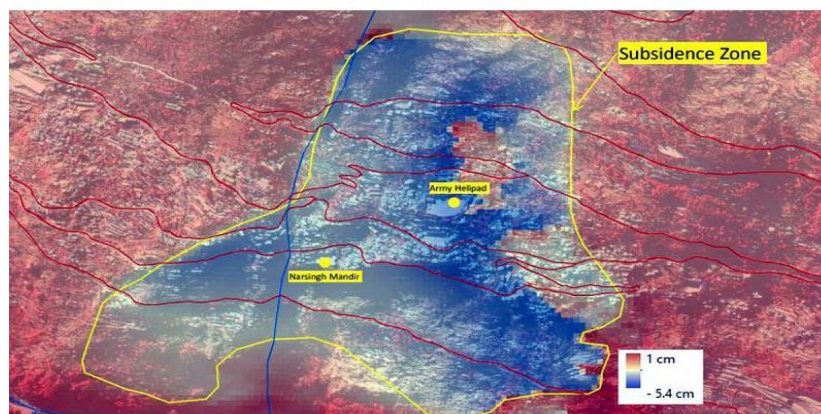
Michael Douglass (2010) studied the correlation between the spatial growth pattern of Jakarta and the quality of its environment, especially water flow and flooding, and emphasized the need for urban planning to minimize environmental shocks and risks in the face of economic and demographic growth.



I. Fig ; source: Satellite image of land subsidence in Joshimath released by ISRO (IANS)<https://weather.com/en-IN/india/news/news/2023-01-13-isro-images-reports-show-how-entire-joshimath-could-collapse>

¹ kumar, S. (2021, November 08). An Explained Typology of Natural Disasters in the State of Uttarakhand, India: Preparedness and Response Mechanism. Retrieved from *Eur. Chem. Bull.* **2023**, 12(Special Issue 5), 5867 - 5877

<https://www.omicsonline.org/open-access/an-explained-typology-of-natural-disasters-in-the-state-of-uttarakhand-india-preparedness-and-response-mechanism-117809.html>



II. Fig; source:Satellite images of land subsidence in Joshimath released by ISRO (IANS)
https://ianslive.in/news/isro_report_shows_entire_joshimath_may_sink-937303/NATION/1

Satellite photographs captured by the Cartosat-2S satellite and issued by the National Remote Sensing Centre (NRSC) of the Indian Space Research Organisation (ISRO) have revealed that Dehradun Joshimath may soon face complete submersion due to land subsidence. The images, which show sinking regions of the town, have been made public by the Hyderabad-based NRSC, designating the entire town as a sensitive zone, including the Army's helipad and the Narasimha temple. As a result of ISRO's preliminary report, According to a report from the Indian news agency IANS on January 13th, the government of Uttarakhand is undertaking rescue operations in high-risk areas and evacuating residents to safer locations as quickly as possible. (Bureau, n.d.).² According to satellite images, the soil subsidence is causing the Joshimath-Auli road to also collapse. The results from ISRO's preliminary report are concerning, as they are still investigating the cracks that emerged in buildings and roads due to the sinking of the town's ground.³

MATERIAL AND METHOD:

The present evaluation project is based on analysing qualitative data from secondary sources, mainly reports from organizations such as the

Geological Survey of India, United States Geological Survey, Uttarakhand State Disaster Management Authority, and Newspaper Articles. The primary aim of this research is to investigate the root cause of the crisis and assess the ecological implications of Joshimath. Through this study, we can comprehend the factors responsible for land subsidence and determine how geographical knowledge can be implemented to undertake both immediate and long-term actions. The central goal of this paper is to scrutinize the outcomes of human interventions and appraise environmental concerns in Uttarakhand, with a particular emphasis on Joshimath.

DISCUSSION AND ANALYSIS:

On the NH-7, which connects Rishikesh and Badrinath, Joshi math stands a well-known hill station in Uttarakhand and a significant pilgrimage site. Joshimath is situated in the Chamoli district at a height of 6150 feet. It serves as a gateway to significant Hindu holy places including Hikind Sahib and one of the four char dhams, Badrinath. Joshimath, which stands homebased to one of the military's most important encampments, is also vital from a strategic perspective for the Indian Military. (Wahid Bhat, January 7, 2023).⁴

² Bureau, B. O. (n.d.). Joshimath Sinking Crisis: ISRO Releases Images And Introductory Report. BW Businessworld. <http://businessworld.inhttps://www.businessworld.in/article/Joshimath-Sinking-Crisis-ISRO-Releases-Images-And-Introductory-Report/13-01-2023-461631>

³ Joshimath sank by 5.4 cm in 12 days, says ISRO report. (2023, January 13). Joshimath Sank by 5.4 Cm in 12 Days, Says ISRO Report - the Hindu.

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<https://www.thehindu.com/sci-tech/energy-and-environment/isro-releases-satellite-images-showing-rise-in-joshimath-land-subsidence/article66373138.ece>

⁴ (Bhat, Ground Report, 2023)

Bhat, W. (2023, January 7). Ground Report. Retrieved from What geographical survey report of Joshimath reveals?:

<https://groundreport.in/what-geographical-survey-report-of-joshimath-reveals/>

Joshimath has a rich history and is significant from a social, spiritual, and strategic standpoint. Among all the four "maths" introduced by Shri Adi Shankaracharya was situated there from the eighth century. It facilitated as the Katyuri dynasty's capital in the seventh century CE. It now serves as a rest stop for traveller's and pilgrims heading on religious pilgrimages to the important Hindu and the Sikh tombs of the Badrinath and Hemkund Sahib, along with trampers and skiers heading towards the Valley of Flowers and the Auli. Joshimath is also served as one of the stops on a marketable route connecting India and Tibet until 1962. Later the Indo-China Warfare, the trade terminated, in addition large tracts of property in Joshimath were bought to line the Indo-Tibetan Border Police and large army brigade headquarters. To accommodate the rising number of tourists, Joshimath was also hampered throughout the years through a spike in development activities that was well in excess of its carrying capacity. After the state of Uttarakhand was created in 2000, tourism grew steadily, reaching 10 lakhs by 2012. From the point of view of municipality ward, representative Mr. Sameer Dimri, according to him, about 19 lakhs of visitors, travelling towards Badrinath had arrived in Joshimath in the year of 2022. To accommodate this foot traffic, for more than 150 guesthouses and also many lodging places have built in the Joshimath over the years, covering an area of 2.5 square kilometres, which worsens traffic there. (Shruti Jain, Feb 01, 2023)⁵

The rivers Dhauliganga, Alaknanda, Karmanasa, and Dhaknala surround Joshimath on each side of the town's center-slope location.

Numerous communities are situated in the lower and middle slopes in addition to Joshimath. The Chamoli district, where the town is situated, has an elevation range of 1440 to 3797 m above sea level, or about 6,000 feet. Around 18,000 people live in these settlements as a whole. The area's springs and streams are kept perpetual by the groundwater recharge brought on by the winter's significant snowfall in the upper reaches. Joshimath, which is

located close to important tectonic discontinuities, has been exhibiting signals of distress as a result of the mounting pressure from anthropogenic activity. According to "The Mishra Commission," Joshimath is sinking because it is built on an old landslip zone. The area is purportedly showing evidence of persistent ground subsidence. In the vicinity of Joshimath, substantial construction should be prohibited, according to the assessment. (M.P.S. Bisht Piyooosh Rautela, vol. 98, NO.10, 25 MAY 2010).⁶

Professionals from 'Wadia Institute of Himalayan Geology' under 'Department of the Science and Technology', Dehradun (Adobe of Drona) conducted one survey in 2022, and they found that these gneissic rocks are highly eroded, have a low cohesive value, and are vulnerable to high pore pressure when wet, especially during the monsoon season. Fundamentally, the soil beneath Joshimath has a poor ability to hold itself together, especially when weighed down by further development. Joshimath is situated in the earthquake-prone seismic zone V. Additionally, weathering and water seepage are problems in this location (Wahid Bhat, January 7, 2023)⁷.

Joshimath was not suitable for a township, according to one of the famous 'Mishra Committee' report, because it was placed on top of sediments of gravel and pebble rather than on the main rock or stable land. Blasting noises, excessive traffic, etc., will cause vibrations that will disturb the equilibrium of natural forces. (Mansi Jaswal, 17 Jan 2023)⁸

On the report of a precursory estimation, out on 12 January by ISRO (Indian Space Research Organisation), the town, Joshimath dropped around 9 cm amid April and November, 2022. Later from December 27, 2022, to the January 8,

⁵ (Jain, Greed sank Joshimath. I saw it happen, 2023)

Jain, S. (2023, February 1). Greed sank Joshimath. I saw it happen. Retrieved from <https://scroll.in/article/1042961/greed-sank-joshimath-i-saw-it-happen>

⁶ (Rautela, 2010) Rautela, P. (2010, May 25). Disaster looms large over Joshimath . Retrieved from https://www.researchgate.net/publication/242766157_Disaster_looms_large_over_Joshimath

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⁷ (Bhat, Ground Report, 2023)

Bhat, W. (2023, January 7). Ground Report. Retrieved from What geographical survey report of Joshimath reveals?: <https://groundreport.in/what-geographical-survey-report-of-joshimath-reveals/>

⁸ Jaswal, M. (2023, January 17). Before Joshimath crisis, govt ignored two similar tragedies in adjoining areas. Retrieved from <https://www.livemint.com/news/india/ground-report-joshimath-crisis-from-chaien-gaon-to-2021-chhawani-bazaar-tragedy-uttarakhand-govt-ignored-two-crucial-threats-11673934752209.html>

2023, it drowned even more, roughly around 5.4 cm. (Shruti Jain, Feb 01, 2023)⁹

Disasters have occurred in the area between Chamoli and Joshimath. The 2013 Uttarakhand floods and the more recent rock and ice avalanche calamity in Chamoli are indicators of the area's ecological vulnerability. Years prior, the warnings had been issued. Geologists and other scientists have often warned about how unstable the zone is. But regrettably, none of the various administrations paid attention to these warnings. They prioritised an unbalanced and unplanned growth because it came with a vote bank reward. In 1978, a panel headed by Garhwal Commissioner Mahesh Chandra Mishra produced a report in which it was advised against carrying out significant development projects in the city because it is built on deposits of sand and stone rather than a rock. In the vicinity of Joshimath, substantial construction should be prohibited, according to the report's recommendation.

In a commentary published in Current Science in 2010, two researchers from Garhwal University and the Disaster Mitigation Management Centre also raised awareness of the ecological peril the region was experiencing. However, the government still pressed through with road building and approved hydroelectric projects in spite of all the warnings. (Vanita Srivastava, Jan 15, 2023)¹⁰. Numerous hydroelectric projects have been approved in Joshimath and Tapovan despite the region's geological and environmental sensitivity. One such programme is the Vishnugad HE Project. It is noteworthy that National Thermal Power Corporation (NTPC) chose a commercial business over the Geological Survey of India to carry out the project-related geological research. These investigations ignored previous geological research that had been conducted in the area and made no attempt to determine the depth of overburden along the tunnel alignment. The 400

MW Vishnuprayag Hydro-electric Plan was completed by Jaypee Group in November 2006, while NTPC started work on the 520 MW Tapovan Vishnugad project in the same month. (Mansi Jaswal, 17 Jan 2023)¹¹.

According to a geologist, the Tapovan Vishnugad Hydropower Project Joshimath of the National Thermal Power Corporation (NTPC) will be destroyed if a nearby NTPC project that is now being built is not stopped. The 520 MW run-of-river Tapovan Vishnugad Hydropower Plant is being built in India's Uttarakhand district along the Chamoli River. The facility must annually produce more than 2.5 TWh of energy.

Another justification is the 6 km long road being built between Helong and Marwari Bye Pass. This is a section of the 800-kilometer Char Dham Project, which was officially inaugurated by P.M. Modi in 2016 and cost roughly Rs 20 billion. Geologist Navin Joyal, a member chosen by the Supreme Court to serve on the High-Power Committee, noted that some members had suggested that the road not be built until a study was completed, but that our recommendations had been completely disregarded and the road allowed to be built. The High-Power Committee was reviewing the Char Dham Project at the time. (Gungun Agrawal, Pravin Gandhi College of Law, Mumbai)¹².

Due to soil subsidence, hundreds of homes in Joshimath have developed fractures recently. Large fissures have formed in homes, roads, and fields, including the neighbouring interstates and border roads. Shailendra Pawar, the chairman of the Joshimath Municipal Corporation, claims that water seeping from the ground caused significant cracks to form in the homes in the Marwadi ward. Around 200 individuals have been evacuated, and 600 houses have been impacted in varied degrees.

⁹ (Jain, Greed sank Joshimath. I saw it happen, 2023)

Jain, S. (2023, February 1). Greed sank Joshimath. I saw it happen. Retrieved from <https://scroll.in/article/1042961/greed-sank-joshimath-i-saw-it-happen>

¹⁰ (Srivastava, 2023)

Srivastava, V. (2023, January 15). Joshimath havoc: Ignoring warnings culminates into deep environmental, economic crises. Retrieved from <https://www.cnbcvt18.com/views/joshimath-ecological-havoc-ignoring-repeated-warnings-culminates-into-deep-environmental-economic-crises-15671481.htm>

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¹¹ (Jaswal, 2023)

Jaswal, M. (2023, January 17). Before Joshimath crisis, govt ignored two similar tragedies in adjoining areas. Retrieved from <https://www.livemint.com/news/india/ground-report-joshimath-crisis-from-chaien-gaon-to-2021-chhawani-bazaar-tragedy-uttarakhand-govt-ignored-two-crucial-threats-11673934752209.html>

¹² (Agrawal, n.d.)

Agrawal, G. (n.d.). JOSHIMATH CRISIS: CHOOSING ECONOMY OVER ECOLOGY. Retrieved from <https://jlrjs.com/joshimath-crisis-choosing-economy-over-ecology/>

Locals have protested the situation and called for relocating as well as a full stop to any ongoing infrastructure development in the area (Anwasha Mitra, January 7, 2023). According to State Disaster Management Secretary Ranjit Sinha, the Joshimath ground collapse in Uttarakhand has caused 900 members of 29 families to be displaced. (Ranjit Sinha, January 20, 2023).¹³

ENVIRONMENTAL CONCERN :

The Collins Dictionary defines "environmental concern" as being concerned with the preservation of the land, sea, air, and animal kingdoms. Van Liere and Dunlap (1980: 188), described it as "perceiving environmental problems as serious, supporting efforts by government to protect environmental quality," and "engaging in behaviors aimed at improving environmental quality."

Natural disasters, which involve deaths, property damage, and environmental devastation, is more frequent in recent years. The danger level is increasing for the majority of people who live in developing countries with high poverty rates, leaving them more at risk of natural disasters (Living with risk, 2002). Mountainous areas are more vulnerable to earthquakes, landslides, flash floods, and avalanches. Due to the uneven ground structure, low soil coverage, and presence of livestock grazing, this region is more susceptible than the others. The District Census Handbook states that vulnerability may be used to relate the vulnerability of at-risk foundations to how much the hazardous process is impacting them (2011 to 2014).

India's greatest rate of fatal flash floods occurs in Uttarakhand. The most frequent flash flood months are June through September. The bulk of the highland communities in Uttarakhand have experienced flash flooding this year. In steep locations where there has been human activity, flash floods are a cause for concern. The disaster is the result of human intervention, poor construction methods, and environmental change (CWC, 2016). The Nanda Devi Sanctuary in Uttarakhand saw a rapid landslide on 7 February at approximately 10 a.m. This caused a flash torrent of mud and other debris to fall down the steep slopes, killing at least 56 people and ruining two hydroelectric generating plants. Mismanagement of the environment and people led to this catastrophe. One of the projects

was already underway, while the other was nearly complete. At a height of 5,000 metres, ten kilometres from the confluence of the Rishi Ganga and Dhauliganga rivers, a sizable rock block was pushed together with snow and ice. A field 300 metres long and 80 metres broad was impacted by the slide (WIHG).

The waters of the Dhau Ganga approached and carried away this project in a matter of seconds. The Tapovan Vishnugad project's barrage, which is located close to Joshimath town in Uttarakhand's Chamoli district, around 8 kilometers (km) downstream. There are 450 hydroelectric projects in the mountains of Uttarakhand, and the locals did not want them to be built so close to their homes in the first place. They are aware of the negative effects that the massive explosive blasting used by the construction companies, extensive deforestation, and the muck they dump along riverbanks have on the environment. However, many of them were forced to give up their agricultural and forest lands when these projects were imposed upon them, and many felt compelled to accept temporary employment creating the tunnels and barrages of these projects or to carry out other menial "favours". Their lives have unavoidably been linked with these plans despite their fear of and hostility to such an incursion, which they regard as growth. They have been reduced to working as laborers on projects that have actually rattled the foundations of their homes, forcing many of them to flee in search of stable employment. On February 7, 2021, (Jain, 22 March, 2021) workers were washed away or buried under the muck as a result of these very same initiatives.

The 520 MW "Tapovan Vishnugad project's", barrage was damaged by the February 2021 fluvial ash flood. The project was being built 14–15 kilometers uphill from Joshimath, close to the villages of Tapovan and Dhaak. It filled the tunnels where hundreds of laborers were working with debris. Plans for counting the exact number of personnel, setting up alarm systems to notify them of danger, or ensuring their safety were all missing from the organisation.

The NTPC, a thermal power corporation, has invested more than 15 years in the development of this hydroelectric project. Its actions have continued to be rather careless and exhibit a lack of

¹³ (Sinha, 2023)

Sinha, R. (2023, January 20). 900 members of 29 families displaced in Joshimath land subsidence, says State Disaster Management Secretary. Retrieved from
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<https://www.thehindu.com/news/national/other-states/900-members-of-29-families-displaced-in-joshimath-land-subsidence-says-state-disaster-management-secretary/article66413601.ece>

thoroughness in evaluating the region's geological characteristics. Additionally, it has hired many private organizations for a variety of tasks, including the construction of barrages and the excavation of tunnels, allowing it to delegate its obligations to these supporting actors. During the initial stage, a tunnel boring machine (TBM), which has been stuck at one end of the tunnel since 2009, was employed. After that, the workers started excavating the tunnel from the other side. It had drained water that must have collected over many years beneath the Auli oak woodlands, discharging "about 60-70 million litres daily, enough to sustain 2-3 million people" (Bisht and Rautela 2010: 1271). Its EIA report demonstrates how it arbitrarily disregarded professional viewpoints. After running into hot water springs while drilling, the Geological Survey of India (GSI) urged it to switch positions downstream, it was stated in the article. GSI was worried that while driving the tunnel, hot water springs may be encountered. According to the firm, following this advice would have resulted in a loss to the project of roughly 100 mega units (MU) (National Thermal Power Corporation Ltd. 2004). Numerous hydroelectric projects were nevertheless planned in the vicinity of Joshimath despite the region's geological and environmental sensitivity. According to Bisht and Rautela (2010), "the tunnel traverses all through the geologically fragile area below Joshimath" of the Tapovan Vishnugad project.

The region of Joshimath, located near significant geological discontinuities, is experiencing increasing anthropogenic pressure, leading to distress. Ongoing ground sinking has been reported in the region, which has been observed in the past. The Mishra Commission has identified Joshimath as a previous landslide zone that is sinking. The assessment recommends prohibiting substantial construction in the vicinity of Joshimath. Despite the geological and environmental sensitivity of the area, numerous hydroelectric projects, including the Vishnugad HE Project, have been approved and are currently underway. The head race tunnel of the Vishnugad HE Project passes through the geologically sensitive region beneath Joshimath. It is worth noting that instead of using the Geological Survey of India, the National Thermal Power Corporation (NTPC) chose a commercial business to carry out the geological research related to the project. Despite the sensitivity of the region, multiple hydroelectric projects have been approved in Joshimath and Tapovan, including the

Vishnugad HE Project, whose head race tunnel runs through the geologically fragile area beneath Joshimath. It is significant to note that the NTPC opted to outsource the geological study for the project rather than utilizing the Geological Survey of India.

While constructing the head race tunnel, a tunnel boring machine was utilized to bore through a layer of water on the left bank of the Alaknanda River, which was located approximately three kilometers from Shelong. The project management stated that the drilling site was situated over a kilometer below the surface, somewhere beneath Auli. As per estimates, the water flow from the layer amounted to 700 to 800 liters per second, resulting in the discharge of 60-70 million liters of water per day, which could have been sufficient to cater to the needs of 2-3 million individuals. However, the aquifer remained unharmed even after a passed, making this incident a lamentable squandering of a valuable resource.

The unexpected release of water from an aquifer will have a variety of repercussions, but it would be premature to think about them all at this time. The water flowing out via the tunnel would cause the neighbouring springs to dry up. Joshimath's neighbourhood would have a drinking water shortage throughout the summer. It's crucial to take note of the fact that spring discharge depletion and the early drying up of a few springs have already been recorded. The local population's problems might be made worse by ground subsidence in the region caused by the abrupt and extensive dewatering of the strata. Reduced agricultural output and biomass availability would result from a reduced ground moisture regime, which would be harmful to the strategy most people employ to support themselves. It would also have an impact on the variety of the animals and flora. Joshimath frequently sees a huge inflow of people due to its location at the gateway to the Badrinath and Hemkunt Sahib temples, making it challenging for the local government to provide water to both the visitors and the villagers.

The entire long-term effects of this tragedy cannot yet be predicted, but they will undoubtedly be grave. It seems obvious that the organization conducting the exploration in this sensitive zone acted negligently in this situation. It demands strict adherence to the preliminary investigations as well as severe sanctions for anyone who do not comply. (Rautela, 25 May, 2010)



III. Fig ; Source: The Times of India

<https://timesofindia.indiatimes.com/india/joshimath-sinking-town-in-indian-himalayas-spotlights-risks-of-development/articleshow/97018583.cms?from=mdr>

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RESULT AND RECOMMENDATION:

A platoon of experts from different associations, including the National Institute of Disaster Management, Geological Survey of India, IIT Roorkee, Wadia Institute of Himalayan Geology, National Institute of Hydrology, and Central Building Research Institute, are presently assessing the situation and immolation recommendations. Specifically, IIT Roorkee, the Geological Survey of India, and the Wadia Institute of Himalayan Geology are studying the issue of land subsidence in Joshimath. (APAC News Network, 2023)¹⁵

It is crucial to strike a balance between the region's growth demands and environmental conservation. The development should not come at the expense of the local ecology and population. Sustainability should be the top priority.

Any development plan for the area should prioritize the natural resources of the Himalayas, such as biodiversity, regional ecology, and

environmental equilibrium. Instead of focusing on constructing large dams, smaller initiatives that can help meet the community's energy needs should be given more attention.

At present, ensuring the safety of people should be the topmost priority. The state administration should establish a transparent and continuous line of communication with those affected. The recommendations of the Mishra Committee should be followed for all development projects. No activity should be carried out on unstable slopes until structural stability can be ensured.

IMPACT ASSESMENT:

The impact assessment highlights the importance of addressing the environmental concerns in Joshimath to ensure the sustainable development of the town. Efforts should be made to prevent deforestation, reduce the risk of landslides, and treat sewage and industrial waste to reduce water pollution. This will not only protect the town's ecology and economy but also ensure the safety and well-being of its residents.

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)

¹⁴ From "Disasters looms over Joshimath", by M. P. S. Bisht and Piyoosh Rautela, Current Science, VOL. 98, NO. 10, 25 MAY 2010, H.N.B. Garhwal University, Srinagar (Garhwal), Disaster Mitigation and Management Centre, Uttarakhand Secretariat, 4 Subash Road, Dehradun 248 001, India,

Source URL:

https://dmcc.uk.gov.in/files/pdf/Current_Science_Joshimath.pdf, accessed on 28/03/2023 12:45

¹⁵ IIT Roorkee, the Geological Survey of India and the Wadia Institute of Himalayan Geology review land subsidence in Joshimath | APAC News Network. (2023, January 9). APAC Digital News Network.

<https://apacnewsnetwork.com/2023/01/iit-roorkee-the-geological-survey-of-india-and-the-wadia-institute-of-himalayan-geology-review-land-subsidence-in-joshimath/>

that call for a reexamination of the current development strategy. It is essential to make a change right away that prioritises sustainability. If not, similar crises will happen more frequently and have terrible results. It is now evident that all cautions in the Mishra Committee report, which was published nearly 50 years ago, went unheeded in the rush that successive administrations have made to develop Joshimath since 2001. It was unmistakably stated that Joshimath Township is built on the rubble of previous landslides and will eventually slide. It should be top priority right now to take safeguards to safeguard people's safety. The State government should establish an open and ongoing line of communication with those who have been impacted. The Joshimath dilemma is a clear example of our disregard for the unique qualities of the Himalayan system in our quest for economic progress. The most recent incident might serve as a reminder of the value of sustainable development. The sinking is also having an impact on the town's infrastructure, such as high tension electricity lines. The local trees, especially apple trees, have begun to collapse. Following the event, the town's people have left their homes. Joshimath's instability has been mostly caused by anthropogenic activity. Thousands of lives are at risk due to such extensive infrastructure destruction. For example, the Joshimath subsidence endangered about 3,000 people.

People left their homes because they were afraid they may collapse, but they were left unsheltered outside during a winter storm. Right now, the government is doing what is best for the inhabitants' safety. The National Disaster Management Authority, the National Institute of Hydrology, and the Geological Survey of India have been tasked with creating a "risk-sensitive urban development plan" for the area. The future lies in good microzonation, advancements in building supplies and techniques, and humility in human interactions with nature.

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