The Emerging Threats to the Himalayan Environment

C P Rajendran*

The Himalayas form a dynamic, changing landscape. The writer Bill Aitken, who travelled extensively in the Himalayas, has remarked that "the art of beholding the Himalayas lies in accepting the paradox of aesthetic wealth alongside economic poverty, of reconciling the glory of aliveness with the evenly poised mischance of death." The roles of contrasting forces of tectonism and climate in the making of the Himalayas are evident. A product of millions of years of crustal shortening, the Himalayas bear immense tectonic stresses and occasional temblors. Four great earthquakes have struck the Himalayas during the last 200 years and the central Himalayas are considered ripe for yet another great temblor. Although the Himalayas resulted from huge tectonic forces generated by the collision of Indian and Eurasian tectonic plates, their growth is tempered by erosional forces unleashed by the annual monsoons. There exists a dynamic balance between the forces that support it and the opposing erosional forces that wear it down.

Earthquakes, avalanches, and floods are usually considered part of natural processes, which can turn into natural disasters for humans who live on the fringes of the Himalayas. The last couple of years have seen an unprecedented spate of cloudbursts, flash floods and attendant hazards over various parts of the Himalayas. The current increase in such phenomena reveals that human interferences in the name of massive infrastructural projects, which include the construction of wide freeways, railways, tunnels, and hydro-projects beyond the carrying capacity of the terrain are the root cause of many of the disasters like hike in landslides, flash floods and cave-ins leading to loss of human lives and environmental degradation.

In this article, I intend to list and discuss some disasters that have happened in the Himalayan region which should be seen as the emerging threats to the Himalayan environment brought about by the government's enthusiasm for massive infrastructural projects on an unrealistic assumption that this sort of developmental paradigm, unsuitable to the mountainous terrain that is already reeling under the impact of climate change, would lead to an economic boom. Many experts have cautioned that such unscientific infrastructural expansion will have disastrous environmental consequences and huge economic losses in the long run.

Pilgrim Tourism and Pollution

India's annual high-altitude pilgrimage to the Himalayan shrines during this period met with several hazardous events ending with heavy loss of human life. One single

*Prof. Rajendran is an Adjunct Professor at the National Institute of Advanced Studies, Bengaluru. The author has used parts of his earlier articles and the inputs provided by Mallika Bhanot, who works with Ganga Ahvaan, a citizens' forum based in Uttarkashi, Uttarakhand.

major incident that stands out occurred on 8 July 2022 in the Lidder Valley, en route to the 3,880-metre-high Amarnath cave, killing at least 16 people and several people going missing due to a flash flood triggered by a cloudburst. The Char Dham connectivity roads in the Uttarakhand Himalaya, on the other hand, have been impacted by a greater number of landslides this time resulting in the deaths of several and forcing the roads to be closed. These incidents show that such encroachments of the Himalayan ecosystem by road expansion and other construction activities will not bring any relief for the pilgrims, but will only imperil their safety and security. Every year the potential number of pilgrims is expected to increase in number, as can be seen in the current trend of increment in the number of pilgrims each year. The Amarnath pilgrims in 2009 were close to 4 lakhs, which rose to 6.21 lakhs in 2012. The cap on the number of pilgrims to the shrines in Kedarnath, Badrinath, Gangotri and Yamunotri — the Char Dham pilgrim route — is also being increased every year. In the Char Dham Yatra this year, over 30 lakh pilgrims have visited Char Dham and more than 10 lakh pilgrims have visited Kedarnath.

An attendant problem of the hike in footfall is the generation of huge amounts of waste including plastics and horse and donkey excreta that are disposed of by the side of the walking trails. This will have serious implications for the local ecosystems. Ground reports also say that plastic waste is being collected and dumped on the sides of the pilgrim's routes in large or small pits, and the cleaning operations resort to open burning which is highly hazardous. Like the route to Amarnath, the Char Dham routes have also witnessed this growing mound of garbage since the beginning of the pilgrimage season. Unregulated human activities during the pilgrimage season are most likely to impact the quality of water and air in these regions. Many of these higher altitude areas, especially in the Uttarakhand Himalaya, host rare medicinal plants which are facing serious extinction threats. Changing patterns of climate coupled with the dumping of waste poses serious challenges to the survival of such rare plants. In the enthusiasm to promote pilgrim tourism, the authorities cannot afford to ignore the pressure of increased footfall on the fragile ecology of the mountain systems, which are already reeling under the effects of climate change. Many of the Himalayan Hindu shrines, whether in Jammu-Kashmir or Uttarakhand, are located close to the areas that host glaciers — a source of water for the Himalayan rivers. As a result of human breath and refuse, experts have also warned that the heavy pilgrim traffic could result in the melting of glaciers and environmental degradation with a serious impact on biodiversity.

Does the fear of God motivate people to protect environmental resources? The lessons I learnt from my journey across Himachal Pradesh a few years ago taught me that religious beliefs and environmental consciousness have a negative correlation in India. Such locations considered holy in the Hindu religious traditions are no exception. For example, Manikaran, located in the Kullu District of Himachal Pradesh in the Parvati River Valley, northeast of Bhuntar is no exception. It is endowed not only with a Hindu temple but also a gurdwara. As is usual with such places, businessmen have developed a market for religious tourism centred on them. The pilgrims who visit Manikaran leave behind a train of organic and inorganic waste along a majestic stream that snakes its way through from the snowy peaks of the

Himalayas. But why is a place considered holy by two religions treated so badly by the people who visit the shrines? The people who would insist on maintaining clean spaces within the devotional centres don't see it fit to extend the same civil courtesy to the world at large, and we see the effects of this throughout the country. It is possible to make a similar complaint about the ineffective management of waste generated during massive religious festivals such as the famous Kumbh Mela.

But what is comical is to read a report published under the theme 'environment' by NITI Aayog, which makes a ridiculous statement: "The Sustainable Plastic Waste Management Plan is an innovative and simple yet highly effective solution that has not only alerted the community about the menace of plastic and the need for sustained waste management practices but also sets up a robust mechanism for its achievement." What you see in the areas around the Hindu shrines in the Himalayas makes a pathetic commentary of this 'effective plastic waste management', and is yet another example of governments agencies' fondness for hunky-dory reports that have no relation to ground realities.

Role of hydro projects in aggravating the risks

Recurrent disasters in the last decade in the State of Uttarakhand indicate that the increasing anthropogenic pressure in this area is a direct or indirect contributor. The one recent example is the Rishi-Ganga Valley disaster in February 2021 which claimed over 200 lives as the river turned into a flood carrying a heavy load of silt and debris and demolishing hydropower projects along its course. While science and logic tell us to press on with conservation and protection in these sensitive areas, our government has decided to go in the dangerous and opposite direction.

The affidavit filed recently by the Ministry of Environment, Forest and Climate Change (MoEFCC) in an ongoing matter in the Supreme Court of India has recommended the construction of seven partially constructed hydroelectric projects in the Uttarakhand Himalaya. This essentially goes against the core mandate of the Ministry, which is to conserve the country's natural environment, and one of the prominent electoral promises of the Government, the rejuvenation of one of the country's major rivers, the Ganga. After the Kedarnath tragedy of 2013, in suo motu cognisance by the Supreme Court, an expert body (EB-I) was constituted to investigate whether the 'mushrooming of hydro-power projects' in the State of Uttarakhand was linked to the disaster. In its findings, EB-I said there was a 'direct and indirect impact' of these dams in aggravating the disaster. Paving the way for the projects, the Ministry formed committee after committee until it got approval for these projects with some design changes.

This affidavit, dated 17 August 2021, reveals that the government is inclined towards the construction of 26 other projects, as per the recommendation of the expert body (EB-II; B.P. Das Committee). The conclusions of the first expert body (EB-I), chaired by Ravi Chopra, that had flagged the incalculable environmental risks of such structures, have been conveniently sidelined and overwritten by EB-II, whose mandate has been to pave the way for all projects through some design change modifications. Politicians in cahoots with private developers are bent on going ahead with such projects for short-term monetary gains despite the dire warnings of climate change threats and environmental challenges. It must be noted that the reports of the Intergovernmental Panel on

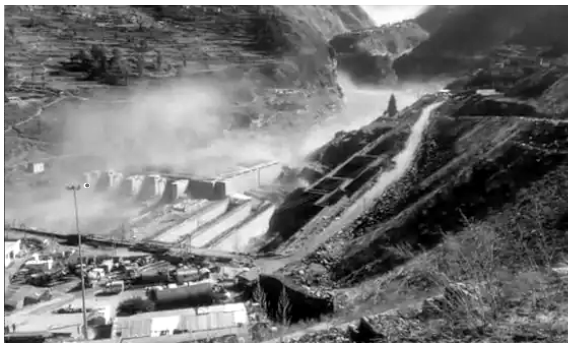

Figure 1: The Tapovan Vishnugad power plant — a 520 MW run-of-river project constructed on Dhauliganaga River in Chamoli District of Uttarakhand was hit by a massive glacial debris flow on 7 February 2021.

Climate Change have made special mention of fragile mountainous ecological regimes in the background of global warming.

The affidavit submitted by the MoEFCC conceals the Ministry's observations and admissions given in its earlier affidavit dated May 5, 2014, which admitted that hydroelectric projects had aggravated the 2013 Kedarnath flood. The Ministry's December 5, 2014, affidavit states: "It is pertinent to conclude that there has been a direct and an indirect impact of the [hydroelectric projects] in the aggravation of the flood of 2013".

Interestingly, the subsequent affidavit also conceals the minutes of the meeting and the decision taken by the Prime Minister's Office (PMO) on 2 February 2019 in this regard. The minutes of this meeting make the policy decision of there being 'no new hydropower projects' on the Ganga along with the cancellation of those that have not reached 50% of its construction. This is a bizarre demarcation because on one hand there is an acceptance of the devastating impact of the dams (and the decision not to have more) while on the other, there is a push still to pursue them on an unfounded logic of money having been spent on them. Should we continue with a mistake made or make amends?

The sustainability of the dams in the long term is highly questionable as hydropower solely relies on the excess availability of water. Climate change models are clear about the cascading impacts of global warming trends on the glaciers of the Himalayas — the main source of water in the region that sustains the drainage network within the mountain chain. Temperatures across the region are projected to rise by about 1°C to 2°C on average by 2050. Retreating glaciers and the alternating phases of floods and drought will impact the seasonal flows of rivers.

The most crucial aspect is the existence of sediment hotspot paraglacial zones, which at the time of a cloud burst, contribute huge amounts of debris and silt in the river, thereby increasing the river volume and the devastation downstream. The flash floods in these Himalayan valleys do not carry water alone; they also carry a massive quantity of debris. This was pointed out by EB-II alongside its recommendation not to build any projects beyond 2,000 metres or North of the MCT, or the Main Central Thrust (it is a major geological fault). The existing fully commissioned dams in the region are already indicative of the fact that these high-capital-intensive ventures have negatively impacted local communities and their livelihoods. It is high time the MoEFCC formulated a written position on climate change adaptation concerning the hydropower sector, after a thorough public discourse.

Amelie Huber, a political ecologist who has conducted extensive research on the hydropower development in Northeast India, says that the dams in the mountainous regions that are exposed to earthquakes, floods, extreme rainfall,

avalanches, and landslides, are 'risk-laden artefacts'. The dominantly cliché discourses on hydropower as a renewable source of green energy promoted by the dam lobby, deliberately ignore the contentious externalities such as social displacement, ecological impacts, and environmental and technological risks.

These discourses assume great significance in the Himalayan terrains as these projects exacerbate ecological vulnerability, in a region that is already in a precarious state. The intense anthropogenic activities associated with the proliferation of hydroelectric projects in these precarious regions accelerate the intensity of flash floods, avalanches, and landslides. The additional element of climate change makes these scenarios much worse. About 15% of the great earthquakes (of magnitudes greater than 8) of the 20th century took place in the Himalayas. Many of its segments are likely to see a period of intense earthquake activity in the future, as studies show. The 2015 Nepal earthquake is a case in point. Several dams were damaged in that event destroying a third of Nepal's hydropower.

The events such as the Rishi Ganga tragedy and the flash flood disasters of 2012 and 2013 are examples of how hydroelectric projects which come in the way of high-velocity flows aggravate a disaster and should be treated as a warning against such projects in disaster-prone Uttarakhand River valleys.

Sikkim Disaster

The proliferation of dams is not restricted to Uttarakhand. Cut to October 4, 2023. The disaster that struck Sikkim in the early hours of Wednesday, October 4, ended up killing at least 40 people and many more are reported to be missing, according to currently available reports. The surge of floodwaters flowing into the Teesta River in Lachen Valley was so intense that it washed away several bridges and roads and it rammed the biggest hydroelectric project, the Teesta-III Dam in Chungthang in Sikkim, causing part of it to give away. According to a statement issued by the National Disaster Management Authority, the flash flood was the result of a cloudburst causing the Lhonak glacial lake, located at 5,200 metres above sea level, to overflow the impounding moraine, eventually eroding it to form an outlet. The recent dam break in Sikkim is another costly reminder of how a dam aggravated the impact of a flash flood.

A glacial lake outburst flood, or GLOF as it is known in scientific literature, usually results in more damage and destruction than a flood caused by excess rainfall alone. It is worth remembering that on February 7, 2021, a similar catastrophic mass flow descended along the Rishiganga and Dhauliganga Valleys in Chamoli, Uttarakhand, killing more than 200 people and damaging two hydropower projects. The 2013 Kedarnath disaster was another devastating example of GLOF caused by the overflowing glacial lake up in the mountain, resulting in 6,000 fatalities.

The Sikkim disaster appears to be a repeat of events like the one that happened at Kedarnath in 2013 and Chamoli in 2021 — a sequence of events that marks the increasing risk caused by the upward trend in global warming and sustained melting of mountain glaciers. Combined with unregulated constructions, hydroelectric projects and anthropogenic activities, these events evolve into massive disasters.

The Geological Survey of India (GSI) reports about 9,575 glaciers in the Indian part of the Himalayas. The annual rate of retreat of glaciers in this part ranges between 5 and 20 m per year. Based on satellite-based observations, it is estimated

Over 50 Organisations Sign Declaration to Draw Attention to Climate Disasters in Himalayas

More than 50 social and environmental organisations mostly from India's Himalayan states have signed the 'People for Himalaya' declaration, highlighting the vulnerability of the mountain range to climate disasters.
Recent climate disasters are 'political, economic and social and not just environmental' and cannot be called 'natural disasters', held the declaration, signed in late February by organisations.
"We understand that those who are the least responsible for these disasters are in fact the worst impacted by these disasters—and have been further rendered powerless and resourceless in the process of disaster-making. These include marginal farmers, landless Dalits, forest dwellers, adivasis, women, migrant workers, pastoralists, minorities, persons with disabilities and those living in conflict zones," the declaration said.
The declaration condemned the 'repression' and the tags of 'anti-national' and 'anti-development' being labelled on people who have questioned the dilution of existing environmental laws and the non-implementation of progressive laws such as the Forest Rights Act.
The signatories vowed to work towards the 'well-being and sustenance' of the natural heritage of the Himalayas and support the sustainability-oriented decentralised governance—backed by science and indigenous knowledge—of the Himalayas.

that the Himalayas lost 13% of its glacier area between 1960 and 2000; that is about 0.3% per year. Himalayan glaciers are losing mass at the rate of 6.6 ± 1 Gt per annum, which is nearly 0.2% per year. (1 Gt = 1 Gigaton = 10^{12} kilograms)

In a study published in the journal *Science Advances* in June 2019, around 650 glaciers across India, China, Nepal and Bhutan show confirmed signs of retreat. The study identifies global warming as the cause of the melting and loss of glacial ice over a large area confirming the role of global warming. The studies also indicate that the average temperature in the Himalayas has risen by 0.66◦C since 1991 — an increase much higher than the global average. The higher Himalayas became even warmer on average in the same period. The winters in the Himalayas have been getting warmer and wetter over the last 25 years. The unprecedented extreme rainfall events as seen in Himachal Pradesh during this year's monsoon season are attributable to climate shifts.

The studies published in 2019 in the *PNAS* (Proceedings of the National Academy of Sciences) journal show that the sustained glacier melt has produced more than 5,000 glacier lakes in the Himalayas, dammed by potentially unstable moraines, the loose debris transported by glaciers. These lakes are prone to outbursts triggered by ice or debris falls, earthquake or overtopping waves generated by intense rainfall. The erosion of impounding barriers takes place within minutes or hours, releasing sediment-laden water rushing downstream, and destroying everything in its wake. The studies also indicate that glacier lakes are much larger in number and have occurred in clusters in the Central and Eastern Himalayas since 1990, compared to the other parts of the mountain range.

The analyses of satellite-borne remote sensing data carried out in 2013 by the Centre for Development of Advanced Computing (CDAC) in Pune jointly with the Sikkim State Council of Science and Technology had shown that many glacial lakes in Sikkim Himalaya have expanded their spatial extent, accompanied by the retreat of glaciers from 1965 to 2010. The expansion of Lhonak and South Lhonak glacial lakes in 45 years was also found to be

significant and both have been flagged as potential GLOF sources.

The Sikkim event was forecast by later studies too, led by the researchers in the Divecha Centre for Climate Change, Indian Institute of Science. A December 2021 paper in the journal *Geomorphology* discusses the outburst potential of South Lhonak glacial lake in detail. The studies highlight that the length of the glacier that is feeding the lake over the last 29 years has been reduced from 6.4 km to5.1 km, while the overall glacier shrank by 0.96 sq km. In line with the glacier retreat, the lake has been exhibiting significant growth over the years as it grew from 0.42 sq km in 1990 to 1.35 sq km in 2019. This is a substantial growth in its area.

The Sikkim disaster shows that repeated warnings from individual research groups that have been communicated through scientific reports and papers in the past were ignored and the contingency plans were put on the back burner. The written replies from the national agencies on potentially dangerous glacial lakes that were published in the 23rd report of March 2023, submitted by the Parliamentary Committee, do not mention the potentially hazardous ones located in the Sikkim Himalaya. The Union and state governments are hand in glove in building up dams in the Himalayan states to tap the hydroelectric power. The Teesta Dam mishap is yet another warning to reconsider the efficacy and sustainability of such projects constructed within the dynamic environmental settings of the Himalayas.

These projects, often partnered with private companies with minimal accountability or experience have been approved by the Government with no science backing them but with several scientific truths demanding their cancellation. A preposterous amount of money is being wasted in the

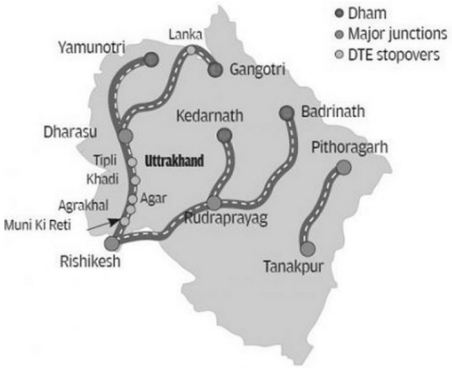

Figure 2: A map of the Char Dham road project

construction of these dams that will always function much below their efficiency, cause the loss of water and forests, and render the area fragile. By the time they are constructed, the cost of electricity generated will also be phenomenally high and will have no buyers. The Government should refrain from the economically challenged rapacious construction of hydroelectric projects and declare the upper reaches of all the headstreams of the Himalayas as eco-sensitive zones. It must allow the river to flow unfettered and free.

Char Dham: A Road to Disaster

The National Environment Policy 2006 envisages several measures to conserve mountain ecosystems. The proposals include appropriate land-use planning, watershed management, farming methods and promotion of eco-friendly and sustainable tourism. Perhaps most importantly, it advocates 'best practice' norms for infrastructure construction in mountain regions to minimise or avoid damage to sensitive ecosystems and despoiling of mountain landscapes.

The present government seems to have completely ignored its own document while trying to implement the Char Dham road

project, touted as an all-weather, faster road link for pilgrims intending to visit some much-promoted Himalayan Hindu shrines in Uttarakhand. It is being constructed by the Ministry of Road Transport and Highways and includes work to widen about 900 km of highways connecting Yamunotri, Gangotri, Kedarnath, Badrinath and the Tanakpur-Pithoragarh.

The current project seeks to convert the existing narrow mountain road into an eight-metre wide highway to ease motorized travel. In its enthusiasm to promote unrestrained tourism and local employment, the Union government turns a blind eye to the danger that this project is going to unleash on Himalayan ecosystems. The project has not even cleared an environmental impact assessment, as this combined 900-km stretch has been presented in segmented bits each less than 100 km long to escape the rule — a classic case of the fence eating the crops.

The Himalayas, the highest mountain range in the world and a transcontinental majesty, are facing some of the worst environmental threats, with huge implications for the survival of one-third of all humans. The home of the largest volume of snow and ice outside the polar regions, this range is also known as the 'third pole' and is the source of some of Asia's major rivers. A key driver in regulating the Asian climate, it is now in grave danger of losing its original splendour and power as a major climatic regulating force thanks to human-induced climate change and global warming.

Temperatures across this mountainous region are projected to increase by several degrees. One consequence will be increased melting of glaciers, which will hamper rivers and trigger massive seasonal flooding followed by dry spells. More recent projections indicate that the region, including Uttarakhand, is likely to lose 70-99% of glaciers by 2100. Before the world can overhaul energy consumption and generation, as a major first step to control global warming, there are many smaller strides that we can take at local levels to strengthen the sustainability of ecosystems.

We must remember that the unique Himalayan landscape — with steep slopes and sharp gradients — is not inherently amenable to human engineering. They are dynamically heterogeneous and change in their properties, in terms of climatic variables, hydrological processes and biodiversity, at every turn. Any human-induced changes to these local ecological parameters will have their overall impact on stream run-offs and erosional or depositional processes. Considering the vulnerability of the biological and physical features of the Himalayan ecosystems, we must think of how we can reduce the scale of human-induced disturbances at the community and local levels. The Char Dham project goes against just such an environmental outlook and ethos.

Realizing the nuances of Himalayan ecology, the mission document on sustaining the Himalayan ecosystem, released by the Ministry of Science and Technology in June 2010, highlights some caveats under the heading 'Green Road Construction'. While accepting the fact that the roads are the lifeline of remote and inaccessible regions in the mountains' interiors, it says that the construction of roads must fully consider the region?s environmental fragility.

It also states that the concerned state governments should consider promulgating, as soon as possible, the following guidelines for road construction in hilly areas: (1) Environmental impact assessment to be made mandatory for the construction of all state and national roads and expressways of more than 5 km length, including in the extension and widening of existing

roads and excluding inter-village roads; (2) Road construction should provide for the treatment of hill-slope instabilities resulting from road-cutting, cross-drainage work and culverts, using bio-engineering and other appropriate technologies.

It must be noted that the Char Dham project has made room for neither. When geologists of a panel set up by the Supreme Court to investigate environmental aspects of the project say excavations are being done in an unscientific way, we need to take their complaints seriously. When the chairperson of the panel says implementing agencies are not doing a proper job of identifying vulnerable slopes and are engaged in hill-cutting without making proper arrangements for dumping the muck, building footpaths and planting trees along the roads, it is time to raise a red flag. The expert members of the panel have said the construction work is destabilizing the entire valley — a valley already prone to landslides, cloudbursts, and earthquakes.

Almost 50,000 trees are to be felled for the Char Dham project. These include slow-growing, high-altitude trees like deodar (Himalayan cedar), birch and oak. The Indian Himalayan region hosts about 8,000 species of flowering plants, which is about 50% of all flowering plants in India. Of this, nearly 30% are endemic to the region. There are over 816 tree species, 675 edibles and nearly 1,740 species of medicinal value here. The Himalaya, with its vast green cover, is also a major sink of carbon dioxide. Annual carbon sequestration by the forests of western and northeastern Himalayas and protective cover for the catchments of the Bhagirathi, Alaknanda and Mandakini valleys — a first line of defence against erosion — are just two important ecosystem services rendered by Himalayan forests.

The exponential increase in the incidences of landslides in Uttarakhand and the tunnel collapses along the Char Dham route needs to be assessed in the background of the unscientific construction practices followed by the contractors. The tunnel construction failure on the Brahmakhal-Yamunotri road in Uttarkashi district is the most recent one in the trail of disasters we have witnessed in the Himalayas since massive road construction projects were started.The literature on the collapse of a tunnel is a rather complex problem because it is strongly influenced by the random variability of the mechanical properties of the rock in situ and the presence of cracks and fractures in the rock formations. When these disasters happen, the Government representatives have a tendency to call them 'geological surprises'. If you do such massive infrastructural projects in a tectonically dynamic and environmentally fragile landscape like that of the Himalayas with limited expertise, anything would be a 'surprise'. The same part of the Yamunotri tunnel is reported to have collapsed in 2019, but the scale of the cave-in was less severe and no workers got trapped. Previously such excavations in the mountains were carried out under the constant supervision of competent geologists, followed by recording rock mass properties and continuous tunnel logging among other precautionary measures.

An all-weather road in a terrain like the Himalayas is fundamentally a misnomer. This proposed eight-metre wide freeway will not withstand landslides, floods and earthquakes *set to happen in future*. The government must first refer to its guidelines prepared years ago for building roads in the Himalayan terrain. Two experts from the committee formed by the Supreme Court have also submitted a critical rejoinder on the Char Dham Project and defined this road construction work as an act of irresponsibility and disregard towards a highly

fragile ecology.

When the Char Dham case was heard in the Supreme Court, the government pleaded that with the construction of this road, it would be easier for the Indian Army to reach the border with tanks and weapons and would increase connectivity in the mountainous areas. Although the Yamunotri stretch of the road is exempted from widening, which follows the plan of an intermediate width of 5.5 metres of tarred surface, the Supreme Court had approved the widening of other parts of the Char Dham, saying it can't second-guess the infrastructural needs of the armed forces. It remains unclear how a disaster-prone road network can ease the army movement to the border areas or facilitate the pilgrims' progress.

Summary

The predictions on the disaster scenarios in the Himalayan states have come true. And, the ordinary people had to suffer for the mistakes of those occupying powerful positions. By opening doors to uncontrolled construction, be it widening roads or making long tunnels, the authorities allowed the overburdening of a fragile ecosystem beyond its carrying capacity. We are now witnessing the consequences of human interventions that have contributed to the intensity of disasters, impacting the lives and livelihoods of the people.

It is clear that both the Union and state governments have been following a flawed development model. Due to climate change, we have rising extreme weather events like cloudbursts, flash floods and torrential rain in the Himalayas. Avalanches and floods are part of recurrent natural processes, which can become major disasters in ecologically sensitive regions because of their impact on unplanned settlements. In vulnerable areas, the intensity of any calamity, a landslide or a massive flood, is proportional to the level of expansion of construction activities. The rise in tourism has led to a reckless construction boom in unsafe zones, such as river valleys, floodplains, and slopes vulnerable to landslides.

Engineering interventions like road expansion are being done with scant regard to the local geology and environment. The construction of highways and railway tracks has now become a prime cause of landslides, whose occurrences have doubled over the years.

As studies indicate, the massive road-building work — a 900 km all-weather Char Dham highway project — will have serious consequences for the Himalayan ecosystem, including the loss of forest lands. Vast quantities of muck generated are being pushed down into river valleys and choking river courses, leading to frequent flood situations.

The disregard for the environment is visible in other aspects as well. At the state government's request, the Environment Ministry wanted to amend the 2012 Bhagirathi Eco-Sensitive Zone, which restricts construction activities. Through this amendment, the Ministry also sought to redefine 'steep hill slopes' to allow construction on hill slopes while easing restrictions on riverbed mining to facilitate mining up to a depth of two metres. Our priorities look lopsided, and the Char Dham highway project is part of that lopsidedness.

A recent report by the Intergovernmental Panel on Climate Change (IPCC) projects that extreme precipitation will become more common and intensify over mountainous areas, increasing the risk of floods, landslides and glacial-lake outbursts. The report stressed the accelerating pace of glacial melting, leading to higher melt-water pressure on the moraines that serve as natural

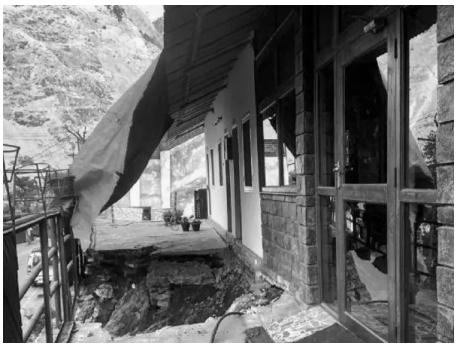

Figure 3: Ground subsidence in the Joshimath town

barriers against water rushing down slopes. If the moraines give way, floods will follow. But the Indian government continues to plan new hydroelectric projects for this area.

Infrastructure, like power projects, comes in the way of powerful natural forces. Put another way: high-velocity flows due to glacial bursts turn into disasters when they have to meditate with the built environment, like a dam, which stands in their way.

Subsurface structures like tunnels could result in gross damage to the environment, including concentrating pollutants from traffic exhaust, compounded in long-distance tunnels by a micro-environment with no sunlight and limited dispersion. Rail traffic may rely on electric locomotion, but constantly generated vibrations by train movements is another issue related to tunnels that will keep the mountain slopes eternally unstable and make them vulnerable to slide at the slightest trigger. Blasting to make these tunnels would often weaken rock formations, further leading to landslides, besides generating vast quantities of excavated rock waste.

The irreversible impact on groundwater, such as descending water levels, has also been observed in tunnel construction areas. Excavating a tunnel also induces stress changes, and consequent deformation within rock formations could also contribute to landslide vulnerability.

What we saw in Joshimath and other towns, which experienced land subsidence, is a warning of what lies in store for us unless we take precautions. Too much groundwater withdrawal or damage to aquifers that hold water, leading to leaks, can contribute to sinking or subsidence. There are reasons to believe that the road building activities and tunneling in the vicinity of Joshimath may have contributed to the land subsidence. Excess monsoons must have led to excessive water percolation through the already-formed fractures resulting in further land sinking. What is happening in Joshimath may occur in other places in the Himalayan states where such intrusive engineering activities are ongoing.

While despairing about the military infrastructure being built in fragile parts of the Himalayas by countries like India and China, which includes tens of thousands of kilometres of roads, Maharaj K. Pandit, a prominent Himalayan ecologist, wrote *"I dream instead of the Himalayan highlands transformed into a peaceful nature reserve, and that the huge public funds squandered on managing conflict are invested instead in infrastructure for health care, education, conservation and welfare".*

A recent paper authored by Katarzyna Nowak and others and published in the journal *Conservation Biology*, suggests that national security interests must not override conservation efforts in the context of the climate and biodiversity emergencies and laws and regulations should not become secondary to national security at the expense of protected areas like national parks, wilderness areas, and biosphere reserves. □