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Vol. 1

Himalayan Bulletin

A Peer Reviewed Journal

Geographical Society of Central Himalaya

www.gsch.co.in

Editor: Prof. Vishwambhar Prasad Sati

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Cover Design and Setting: Vishwambhar Prasad Sati

Dedicated to

Dr. Nityanand

Geographical Society of Central Himalaya

Geographical Society of Central Himalaya (GSCH) was established on 23 March 2021 under the Societies Registration Act No. XXI of 1860, with its headquarters at 51 Nalapani Road, Dehradun. It was founded by Dr. Kamlesh Kumar, a renowned former Professor of Geography at HNB Garhwal University, Srinagar Garhwal. Subsequently, many geographers from the region became its founding members. There are three categories of membership: Fellows, Life Members, and Annual Members.

The Society aims to provide a platform for geography-centered academic interactions among faculty members, scholars, development stakeholders, and government representatives on relevant issues. Since most educational institutions in Uttarakhand are supported by public funds, it is expected that they contribute to society in return. The Society also seeks to improve the academic environment with a strong commitment to Geography as a discipline, while striving for practical applications such as advising the government on issues related to development and environmental conservation.

The Society is publishing a Himalayan Bulletin (this is the first issue). The articles and reports are related to various Himalayan aspects, ranging from sustainable resource management and sustainable development to climate change, disaster management, and culture-based studies.

Since its inception, the Society has been organizing significant national and international events each year, such as World Environment Day, National Tourism Day, Himalaya Day, GIS Day, and International Mountain Day. In addition, at the college level, it conducts activities such as essay competitions and quiz contests.

About the Himalayan Bulletin

One of the foremost objectives of the Geographical Society of Central Himalaya has been to bring into focus the hidden treasures and unexplored dimensions of the Himalayan region through scholarly communication. To achieve this, the Society initiated the publication of a quarterly Himalayan Bulletin, envisioned as a vibrant platform for disseminating knowledge, fostering dialogue, and connecting diverse groups of stakeholders. The Himalaya, often described as the "abode of snow," is not only a geographical marvel but also a repository of rich cultural traditions, biodiversity, natural resources, and unique socio-economic practices. However, much of this wealth remains either undocumented or only partially understood. Many aspects of the Himalayan environment, its communities, and its cultural and natural heritage have yet to be explored in depth. It is here that the Newsletter plays a pivotal role.

The primary aim of this publication is to highlight the lesser-known facts and dimensions of the Himalaya so that they may reach a wider audience—academicians, students, research scholars, policy-makers, and the general public alike. By publishing insightful articles, field reports, reviews, and updates, the Bulletin serves as a bridge between academic research and community knowledge, making information accessible not only to specialists but also to those who have a keen interest in the region. It encourages young researchers and students to contribute their observations, thus nurturing the next generation of Himalayan scholars.

In essence, the bi-annually Bulletin of the Geographical Society of Central Himalaya is not merely a bulletin of information; it is a forum for dialogue, discovery, and dissemination. By unearthing unknown gems—be they cultural practices, ecological insights, or geographical findings—it strengthens the collective understanding of the Himalaya. Ultimately, it aspires to cultivate a sense of shared responsibility among all who are connected with this magnificent mountain system, ensuring that knowledge about it continues to inspire, educate, and guide generations to come.

This Bulletin contains two types of write-ups: articles and reports. The articles are more analytical and explanatory, while the reports provide information on various events, including geo-hydrological phenomena and other issues in the Himalayan region. In this issue, nine articles and six reports are presented by scholars working in the Himalayan region. The articles cover a wide range of themes, from climate change and extreme events to culture, traditional knowledge systems, and agriculture in the Himalaya. Similarly, the reports describe significant events, resources, and policy-related matters.

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Increased Human Interventions under Climate Change is Intensifying Extreme Events in Uttarakhand Himalaya

Surajit Banerjee, Research Scholar, Department of Geography and Resource Management, Mizoram University, Aizawl – 796004, Bharat

Introduction

The Uttarakhand Himalaya, lying in the central part of the Himalayas, is one of the most ecologically sensitive regions, experiencing rapid warming. The situation is worsening by increased anthropogenic interventions and the unsustainable race of profit maximization through development. Consequently, the region is witnessing an increase in the frequency of extreme weather events such as cloudbursts, flash floods, Glacial Lake Outburst Floods (GLOF), and intensifying frequent landslides. Despite their different origins, these two issues are interconnected and have compounded effects on the geomorphology, structural stability, ecosystems, human lives, and livelihoods of local communities. This convergence makes the region even more fragile to the adverse impacts of climate change.

Uttarakhand is witnessing a rapid increase in the frequency and magnitude of flash floods like the Kedarnath disaster (2013), glacial lake outburst floods like Chamoli (2021), the Rishi Ganga cloudburst (2024), and numerous landslides. The most recent addition is the Dharali flash flood on 5th August 2025, claiming 145 lives and the livelihoods of thousands. Primarily these incidents were considered as the result of cloudbursts and warming-induced failure of moraine dams of glacial lakes. The intensity of warming is as high as an increase of 2°C in mean temperature in a few places of highlands within the last 40 years (Kumar et al., 2024). Glacial retreat is especially severe in human-impacted regions such as Gangotri (34 meters per year) and Pindar (16 meters per year) (Kumar & Khanduri, 2024). These changes are disrupting regional hydrology and significantly increasing the risk of Glacial Lake Outburst Floods (GLOFs). Additionally, the intensifying monsoon, with increased precipitation during summer, contributes more to ablation than snow accumulation, thus accelerating glacier melt. Altered rainfall patterns and early peak flows in rivers are shifting the flood season earlier and making it more unpredictable. In this situation monitoring extreme events are important and understanding their anthropogenic link become necessary. Therefore, this article try assess the link between this two.

Study Area

The Uttarakhand Himalaya lies between 28°43' N and 31°27' N and 77°34' E and 81°02' E, covering a 53,485 sq. km. area, of which 86% is mountainous (Sati, 2020). The mighty Greater Himalaya stands in the northern part of the study area, followed by the Lesser and Siwalik Himalayas in the southward area. The highest summits, including Nanda Devi (7816 meters), Kamet (7756 meters), Trishul (7120 meters), Dunagiri (7066 meters), etc., are covered by a dense layer of ice. Major glaciers like Gangotri, Yamunotri, Pindari, Milam, and Bandar Punch glaciers produce important rivers like the Ganga, Yamuna, Koshi, Ramganga, Alaknanda, Pindar, Gomti, and Tons, respectively, in this part of the Central Himalayas (Fig. 1). The diverse physiography ranges from bright snow-clad peaks to precipitous mountains, picturesque valleys, small hills, doons, river valleys, and plain lands. There are four different climatic zones as per Kappen's climate classification: tundra, humid continental with a severe winter, tropical upland with a short warm summer, and subtropical monsoon from north to south, respectively. The mean annual precipitation ranges from 97 to 177 cm (Banerjee et al.,

2024). The maximum temperature of the area varies from 0°C in the north to 30°C in the south in May and from -4°C in the north to 24°C in the south in January, while the minimum temperature of the area lies between 0°C in the north and 24°C in the south in May and -8°C in the north and 8°C in the south in January. However, nowadays, a warming trend and high variation in temperature are taking place, triggering a significant amount of snow melting at higher altitudes.

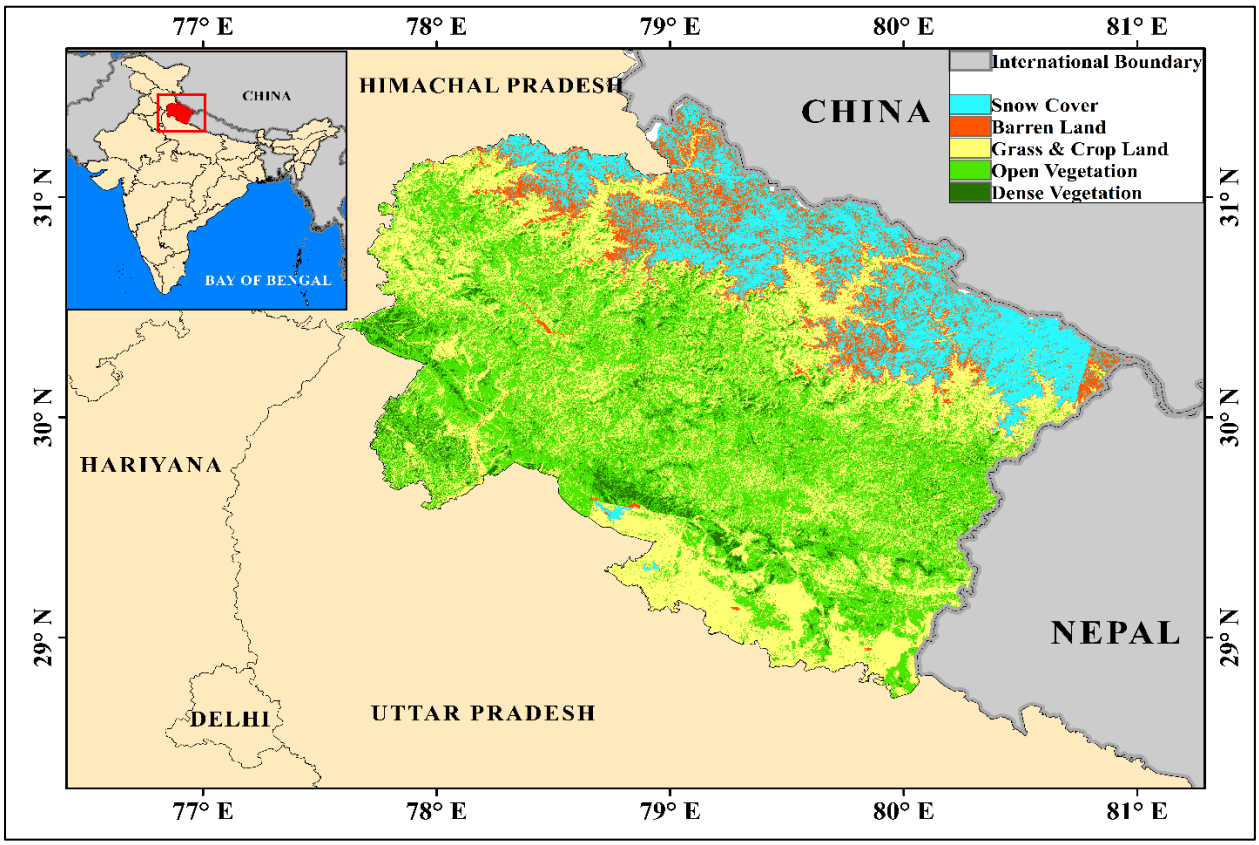

Fig. 1. Location of the study area.

Methodology

Climatic data were collected from the terra-climate monthly weather data, and landslide data were extracted from NAS global landslide inventories. Landslide data was extracted from landslide archives of NASA, and data on highways were extracted from Open Street maps. Temperature and precipitation trend was calculated in Google Earth Engine platform by comparing 1980 and 2024 values. Landslide hotspot and susceptibility layer were downloaded from Geological Survey of India.

Result

The analysis reveals that temperature changes in Uttarakhand display a marked altitudinal variation. In higher elevations, warming is more rapid compared to the lower elevations (Fig. 2a). Particularly, the cryosphere has experienced the highest mean temperature increase (1.5°C) between 1980 and 2020. Overall, the entire state has experienced an average warming, yet the rate of temperature rise is much slower in the lowlands. Specifically, in high-altitude zones, the rising temperatures coupled with reduced snowfall are accelerating glacier melt, thereby altering the seasonal flow regimes of Himalayan rivers. Precipitation trends

further accentuate this vulnerability. In higher altitudes, total annual rainfall deficit is negligible to moderate (up to 50 mm in 40 years); however, middle altitudes and lowlands experience a massive decrease in total annual precipitation (up to 400 mm between 1980 and 2020). Rainfall has been stagnant in river valleys in the middle altitudes and central parts of the state, particularly within river valleys (Fig. 2b). However, despite the rain deficit, in most of the areas, extreme rain within a short period of time is being observed, accelerating the irregularity of rain. Consequently, after a dry spell, when massive cloudburst rain occurs, the already fragile geomorphology of the region triggers slope instability. The shift from snowfall to rainfall at higher elevations and rain deficit in lower areas amplify soil saturation and reduce snowpack accumulation, thereby exacerbating both flood hazards and long-term water insecurity in the dry season.

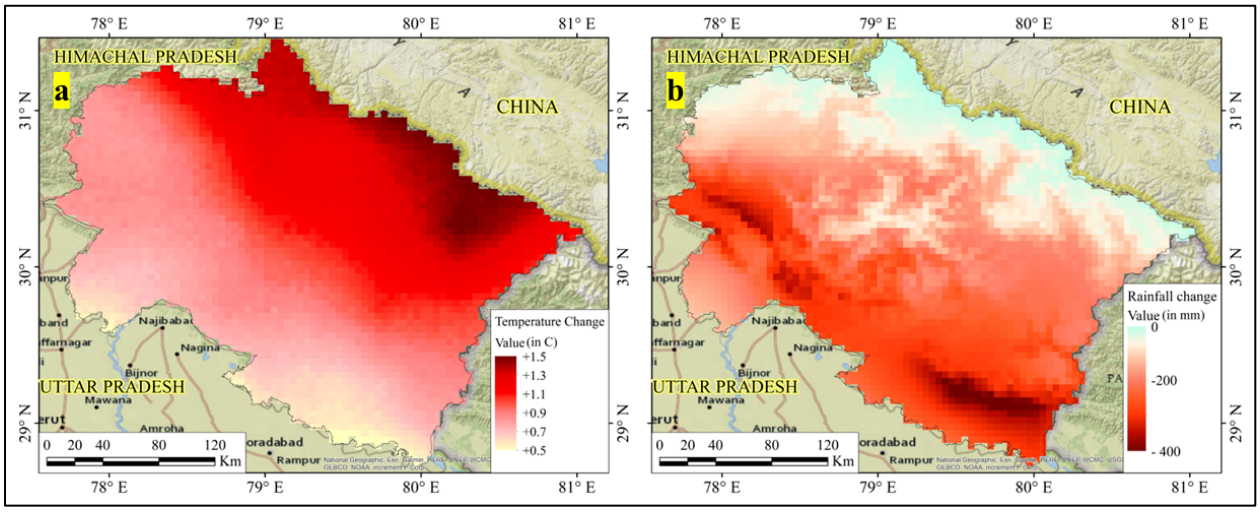

Fig.2. (a) Change in mean temperature between 1980 to 2020, (b) Change in total annual precipitation between 1980 and 2020.

Landslide susceptibility mapping highlights river valleys are experiencing the highest number of slope failures. Ironically, at the cost of environmental stability, infrastructure projects like the Char Dham highway have been constructed in such landslide-prone areas, accelerating the intensity and frequency of the hazard (Fig. 3). Despite high landslide susceptibility, during construction, many places recorded slope cutting at more than an 80° angle, exceeding geological safety concerns. Consequently, the interaction of climatic drivers with anthropogenic pressures has amplified the frequency and severity of landslide events. The combined outcome is an increasingly fragile mountain system where climate-induced changes and human interventions reinforce each other, raising serious concerns for sustainable development and disaster resilience in Uttarakhand.

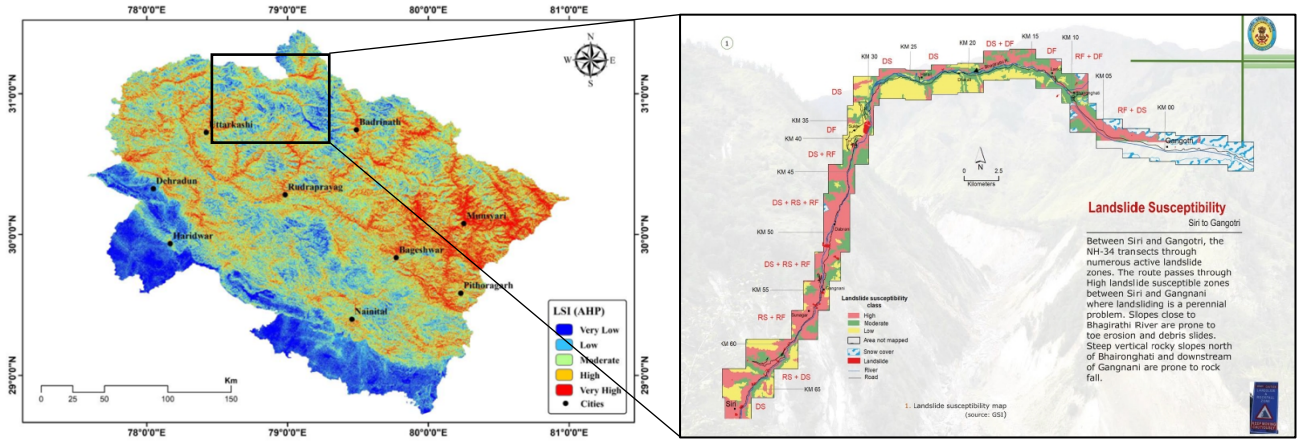

Fig. 3. (a) Landslide susceptibility map of Uttarakhand, (b) Landslide susceptibility in Char Dham highway route from Siri to Gangotri. (Source: Geological Survey of India).

Discussion and Conclusions

The findings reveal a complex interplay of climate change and human interventions in the Uttarakhand Himalaya. Rising temperatures at higher altitudes, declining snowfall, and glacier retreat are reshaping hydrological systems, while rain deficit yet occurrence of extreme events at middle altitudes heightens landslide risks. These climatic shifts, compounded by unregulated development transforming natural hazards into recurrent disasters. The convergence of warming and anthropogenic stress underscores the urgent need for integrated, scientific policies, environment friendly, and sustainable policy formation.

References

Banerjee, S., Sati, V. P., Almazroui, M., & Chakraborty, S. (2024). Spatio-Temporal assessment of areal fragmentation and volume of snow cover in the central himalaya. *Earth Systems and Environment*, *8*(4), 1639-1656.

Kumar, P., Patel, A., Rai, J., & Kumar, P. (2024). Environmental challenges and concurrent trend of weather extremes over Uttarakhand Himalaya. *Theoretical and Applied Climatology*, *155*(2), 1217-1246.

Kumar, S., & Khanduri, V. P. (2024). Impact of climate change on the Himalayan alpine tree line vegetation. *Heliyon*, *10*(23).

Sati, V. P. (2020). *Himalaya on the threshold of change*. Springer, Springer Nature, Switzerland.

Article

Extreme Weather Events and Out-Migration in the Indian Himalayan Region: Evidence from the 2025 Monsoon

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Introduction

The Himalaya, often referred to as the "Third Pole and water tower of Asia," is among the most ecologically fragile and disaster-prone mountain systems in the world. Recently, the region is witnessing a marked rise in extreme weather events such as cloudbursts, debris flows, flash floods, landslides and GLOFs (Kumar et al., 2023; Vargas-Burgos et al., 2025). These disasters not only cause the loss of lives but also destroy critical infrastructure, farmlands, orchards, livestock, and livelihoods, thereby disrupting the socio-economic stability of mountain communities (Gautam & Andersen, 2016). The impacts extend beyond immediate physical damage, as recurrent exposure creates cumulative risks that affect the long-term sustainability of settlement patterns and human habitation (Banerjee, 2017).

In the Indian Himalayan Region (IHR), the states of Jammu & Kashmir (UT), Himachal Pradesh, Uttarakhand, and Sikkim have emerged as hotspots. The steep topography, fragile geology, and intense monsoon rainfall make them highly vulnerable to water-related disasters during the monsoon (Sati & Kumar, 2022). Over the past decade, as climate change intensifies, the frequency and intensity of these disasters have increased, raising concerns about climate variability and anthropogenic pressures (Kumar et al., 2023). While direct impacts are reported in terms of death tolls and economic losses, their indirect role in influencing migration and depopulation of mountain villages has received less attention (Gioli et al., 2014).

Therefore, this paper examines the nexus between extreme weather events and out-migration in the Himalayan context, using the 2025 monsoon season (June–August) as a case study. It specifically focuses on deaths, injuries, missing persons, destruction of livelihoods, economic losses, and psychosocial impacts. By situating these findings within the broader climate change and migration discourse, the study seeks to contribute to a better understanding of how climate-induced disasters are reshaping migration and mobility in the Himalayan region (Vargas-Burgos et al., 2025).

Study Area

The study focuses on the states of Jammu & Kashmir (UT), Himachal Pradesh, Uttarakhand, and Sikkim, located in the Indian Himalayan Region (IHR). This region is a hotspot for disasters, characterized by steep topography, fragile geology, and high seismicity, making it extremely vulnerable to water-related hazards during the monsoon. Intense rainfall, cloudbursts, flash floods, landslides, and GLOFs frequently occur, disrupting both ecosystems and human settlements. The dependence of local communities on climate-sensitive sectors such as agriculture, horticulture, livestock, forests, and tourism further heightens their vulnerability. These combined vulnerabilities make the selected Himalayan states critical sites to examine the nexus between extreme weather events, livelihood disruption, and out-migration.

Methodology

This study relies on secondary data collected from State Disaster Management Authority (SDMA) reports of the Himalayan States, government press releases, and verified

media reports covering the 2025 monsoon season from June to August. Information on deaths, injuries, missing persons, and other losses was compiled and cross-checked to ensure the accuracy. The additional details on environmental damages, livelihood disruptions, and psychosocial impacts were drawn from institutional updates and news reports. The data were organized into three thematic categories—destruction of lives and livelihoods, environmental and economic impacts, and psychological and social impacts—to analyze how extreme weather events contribute to out-migration in the Indian Himalayan region.

Results

Destruction of Lives and Livelihoods

The 2025 monsoon season (June–August) caused widespread devastation across the Himalayan states. Till August, Himachal Pradesh witnessed the highest toll with 312 deaths, 199 injuries, and 37 missing (Table 1). Uttarakhand reported 70 deaths, 94 injuries, and over 100 missing due to cloudbursts and flash floods. In the Jammu region, 78 deaths, 400 injuries, and 200 missing were reported, while Sikkim recorded 3 deaths, 4 injuries, and 3 missing. These figures reflect not only immediate human loss but also severe damage to livelihoods. Thousands of acres of farmland, orchards, and livestock were destroyed, disrupting agriculture, horticulture, and tourism. For many, sudden disasters and the collapse of livelihoods leave migration as the only survival option when settlements become uninhabitable.

Table 1: Destruction of lives and livelihoods

State/Region	Deaths	Injured	Missing
Uttarakhand	70	94	100+
Himachal Pradesh	312	369	38
Jammu & Kashmir	78	400	200+
Sikkim	3	4	3

Source: SDMA and Media Reports (June-August, 2025)

Environmental and Economic Impacts

Each monsoon underscores the environmental fragility and economic vulnerability of the Himalayan region. Flash floods and cloudbursts destabilize mountain slopes, triggering landslides, soil erosion, and riverbank collapse, damaging farmlands, forests, and water resources (Fig. 1). These events also lead to the land degradation that reduces productivity and hampers recovery. Economically, households face repeated rebuilding of homes and restoration of fields. Tourism, a major income source, also suffers as damaged infrastructure and perceptions of risk deter visitors. These combined shocks and limited livelihood alternatives push communities toward out-migration.

Psychological and Social Impacts

These disasters leave lasting psychological and social impacts. Families exposed to repeated disasters live under constant fear, insecurity, and trauma, especially those who lose families and relatives. Younger generations increasingly view migration as the pathway to safety and stability. Social dynamics reinforce this: once some households migrate, others follow, creating chain migration. This process weakens community cohesion and accelerates depopulation of mountain villages.

Discussion and Conclusions

Our findings highlight how extreme weather events in the Himalayas are emerging as a significant driver of human migration in the region. The reported destructions of lives and livelihood demonstrate not only the immediate loss but also the structural vulnerability and fragility of the mountains and the local communities (Vargas-Burgos et al., 2025). The results clearly show that Himachal Pradesh has borne the highest human toll, while Jammu region has reported the largest number of missing persons. Such regional variation indicates that exposure, preparedness, and coping capacity differs significantly across the region (Kumar et al., 2023). The destruction of critical infrastructure, farmland, orchards, livestock, forests and water resources demonstrates that extreme weather events in the Himalaya are not isolated disasters but a recurring phenomenon with long-term implications for environmental sustainability, economic resilience, and human habitation (Banerjee, 2017).

Fig.1. Large scale destruction due to disasters

The study reveals that these events not only have physical impacts such as loss of lives and livelihood, environmental and economic damages, but also profoundly affect the social and psychological wellbeing of the people. Post-disaster trauma and social disruption play a decisive role in shaping migration decisions (Gioli et al., 2014). The fear of recurrence, compounded by lack of alternative livelihoods, drives households to view migration as a survival strategy (Gautam & Andersen, 2016). Such chain migration can weaken community cohesion, reinforcing the cycle of out-migration and depopulation of villages (Banerjee, 2017). Addressing these problems requires immediate policy measures. Strengthening disaster preparedness, resilient infrastructure, and sustainable livelihoods are important to reduce the impact of these disasters on forced out-migration. Unless integrated environmental and social protection measures are adopted, the combined pressure of fragility, economic loss, and social distress is likely to accelerate the pace of out-migration from these ecologically sensitive regions (Vargas-Burgos et al., 2025).

References

Banerjee, S. (2017). *Understanding the effects of labour migration on vulnerability to extreme events in Hindu Kush Himalayas: Case studies from Upper Assam and Baoshan County* [Doctoral dissertation, ICIMOD].

Gautam, M. R., & Andersen, P. (2016). Climate change and rural out-migration in the Himalaya. *Environmental Drivers of Migration*.

Kumar, P., Patel, A. K., Rai, J., & Kumar, P. (2023). Environmental challenges and concurrent trends of weather extremes over Uttarakhand Himalaya. *Environmental Research Communications*. https://doi.org/10.21203/rs.3.rs-2509943/v1

Sati, V.P. & Kumar, G (2022). Environmental and economic impact of cloudburst-triggered debris flows and flash floods in Uttarakhand Himalaya: a case study. Geoenvironmental Disasters. 9 (5): 1-11, https://doi.org/10.1186/s40677-022-00208-3, 2197-8670

TOI City Desk. (2025, August 28). *Himachal Pradesh monsoon mayhem: Toll climbs to 310 — 158 rain deaths, 152 in road mishaps; losses top Rs 2,623 crore*. *The Times of India*. Retrieved from https://timesofindia.indiatimes.com/city/chandigarh/himachal-pradesh-monsoon-mayhem-toll-climbs-to-310-158-rain-deaths-152-in-road-mishaps-losses-top-rs-2623-crore/articleshow/123558500.cms

Vargas-Burgos, A., Malik, R., & Ford, J. D. (2025). Climate change in the Himalayan region: Susceptible impacts on environment and human settlements. *Frontiers in Environmental Science, 13*, 1550843. https://doi.org/10.3389/fenvs.2025.1550843

Article

Massive Dharali Disaster in the Bhagirathi Valley, Garhwal Himalaya

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Introduction

The Garhwal Himalaya has a well-documented history of frequent and spatially clustered geomorphic hazards. The present study area—Dharali—is historically associated with high-magnitude glacial and paraglacial debris flow events, which have exhibited catastrophic geomorphic impacts on valley floors, river terraces, and human settlements. The Garhwal Himalaya has witnessed several catastrophic geomorphic events triggered by a combination of glacial, fluvial, and slope processes. Prominent examples include: The great Bhagirathi catastrophe of 1750; Gohna Tal Outburst, Birahi Ganga Source (26 August 1894); Alaknanda Flood due to breach of Birahi Tal (20 July 1970); Kanodia Gad cloud burst 1978 in Bhagirathi valley; Phata–Byung Landslide, Rudraprayag District (15 July 2001); Phata–Byung Landslide, Rudraprayag District (15 July 2001); Ukhimath Cloudburst (4 September 2012); Kedarnath Disaster (16–17 June 2013); Raunthi Gad (Rishi Ganga) hanging Glacier Collapse (February 2021); Maldevta–Song–Baldi River Flash Flood (August 2022); Dharali flash flood in BHairathi valley (5 August 2025).

Study Area

Dharali is a mountain village situated at the confluence of the Bhagirathi River and its third-order tributary, the Kheerganga, in Uttarkashi district, Uttarakhand. The Dharali lies roughly between 31.00–31.12° N latitude and 78.70–78.82° E longitude within the Higher Himalaya, extending from the headwaters north of Srikantha peak to the confluence at Dharali. The Kheerganga originates on the northern slope of Srikantha Peak (6,133 m) and debouches into the Bhagirathi at Dharali at 2,650m. The average basin elevation is ~4,100 m, and the source area remains snow-covered year-round. The climate is temperate to subalpine; based on the nearby Harsil station, annual precipitation is on the order of ~800–900 mm (with August (240mm) the wettest month) and driest month November (5mm), while lower-elevation Uttarkashi town records ~1,900 mm. The warmest month (with the highest average high temperature) is June (32.8°C). The month with the lowest average high temperature is January (15.9°C).

According to the 2011 Census**,** Dharali village recorded a total population of 505 individuals accommodated in 137 households. The areal extent of the settlement is approximately 3.27 km², yielding an average population density of 178 persons/km²**.** Males constitute 52% of the total population, while females account for 48%**,** with a corresponding sex ratio of 899 females per 1,000 males. In terms of social composition, Scheduled Tribes (STs) comprise 87% and Scheduled Castes (SCs) 9% of the total population. The overall literacy rate is 71%**.**

The Kheerganga catchment falls within the glaciated zone**,** which comprises **five** cirque-type glaciers**,** three small, debris-covered slope glaciers**,** and one prominent valley glacier. The northern face of the Srikantha Peak is characterized by steep, jointed quartzite cliffs. In the cirque glacial surface there are transverse, longitudinal and diagonal crevasses**.** The glacio-geomorphic assemblage includes well-developed lateral and terminal moraine ridges, numerous avalanche chutes, and a wide array of erosional and depositional landforms associated with active and relict glacial processes. The valley flanks are also characterized by

talus cones**,** avalanche chutes**,** active landslide scars, and a thick cover of coarse detritus composed of angular to sub-angular rock fragments embedded in a silt–sand matrix. Downstream of the glaciated sector, the Kheerganga incises a deep, high-gradient V-shaped valley. At its confluence with the Bhagirathi River, the stream has developed a prominent debris-fan (alluvial/debris fan) formed by the deposition of coarse colluvial and fluvial materials.

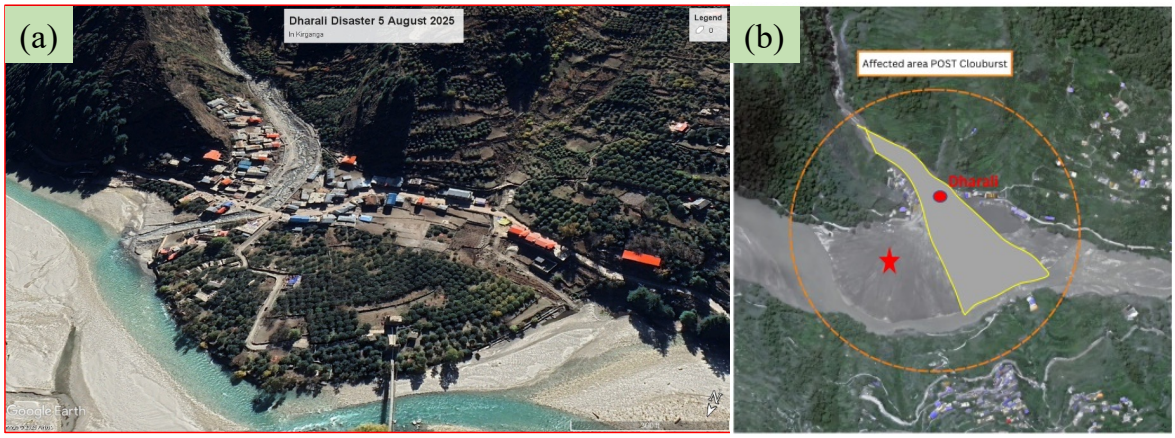

Fig. 1: Dharali Village (a) before August 5, 2025 (b) after August 5, 2025; Google Earth Imagery

On 5 August 2025, the village experienced a high-magnitude flash flood event, characterized by extreme peak discharges and hyper concentrated sediment flows. The flood wave destroyed residential buildings, hotels, homestays, sections of the motorable road, terraced agricultural fields, and commercial apple orchards. Field evidence suggests the event comprised a debris flow–flood hybrid, with a water-sediment mixture transporting large boulders (>1 m in diameter), cobbles, pebbles, and massive volumes of fine sediments. The momentum of the flow was sufficient to induce structural scour**,** displacement of building foundations, and rapid burial of single-story structures under several meters of debris

Preliminary geospatial analysis and rapid post-event assessment estimate that approximately 3.6×10^8 m³ (Nick Lagon: CBC News, 9August 2025) of debris and water were mobilized, with the entire surge reaching the settlement in 34 seconds. The estimated peak discharge likely exceeded 10,000 m³/s, placing this event in the extreme range for Himalayan Mountain catchments. Casualties include six confirmed fatalities, with at least 50 individuals **missing.** The total economic damage has been provisionally assessed at ₹500 crore**.**

Causes and Consequences

The source area of the Khirganga glacier exhibits close morpho dynamic similarity with the Chorabari (Kedarnath) glacier. The terminal moraine complex attains a maximum relative height of ~500 m, indicating a phase of intense glacial activity in the past. Notably, the longitudinal gradient of the Srikantha valley glacier is significantly steeper compared to that of the untidily glacier, enhancing its transport and erosive capacity. The lower ablation zone is extensively mantled by mega-boulders, angular detritus and coarse rock fragments, which are chaotically strewn across the valley floor and adjacent slopes because of recurrent glacial disintegration and gravity-driven mass-wasting processes.

The disaster that occurred at Dharali at 1:30 pm on 5 August lasted only 25–30 seconds. This raises the question of how such a huge volume of water was generated in such a short time to mobilize the sediments. A detailed field investigation and visual analysis of high-resolution historical Google imagery were carried out to identify the possible causative factors behind this

specific event. In close proximity to the source area, no glacial lake, pond, or any other large water body that might have breached was observed.

As far as cloud burst is concerned, historical cloud-burst occurrences have predominantly been documented on the south-facing slopes of the Himalayan ranges. Since the Kheerganga catchment lies on the north-facing aspect of the Srikanta peak, the likelihood of cloud-burst occurrence in this area is comparatively low due to the prevailing topographic and orographic conditions

Although continuous rainfall had been recorded since 3 August**,** there was no evidence of a cloudburst, as the total rainfall measured at the Harshil IMD Station was only 80 mm 5th August. According to IMD officials that Kheerganga did not overflow due to excessive rainfall or cloud burst. More studies are needed to know the real reasons beyond speculations.

For a cloudburst to occur, at least 100 cm of rainfall is generally required. Secondly, under high-intensity rainfall, stream discharge normally remains elevated for a relatively long time; however, such discharge was not observed in this case. The possibility of a landslide-dammed lake forming is also very low in a high-gradient stream**,** and no evidence of such lake formation was observed.

Another plausible scenario for the initiation of the observed event involves the mechanical failure of an ice mass originating from a transverse crevasse near the threshold zone of the Srikantha cirque glacier. A large detached ice block may have collapsed onto the underlying glacier surface, resulting in a substantial pulse of dynamic loading on the main glacier body over approximately 1 km distance. This sudden loading could have triggered a rapid downslope displacement of snow and ice, ultimately impacting the 500 m high terminal moraine wall.

The failure of the moraine—analogous to the 2013 Kedarnath event—would have resulted in a sudden release of ice, sediment and meltwater stored behind or within the moraine small water pits. Concurrently, high-intensity rainfall and enhanced melt rates due to elevated air temperatures could have augmented the water volume and mobilized a large quantity of unconsolidated and weakly consolidated materials located on the steep gradient of the Ksheer Ganga Channel.

The rapid release of this combined mass of water, snow, ice and debris produced a high-energy debris flow, characterized by elevated velocity and discharge. According to SSP Pradhan, IIT Roorkee estimated that approximately 3 million cubic meters of debris were mobilized in the Ksheer Ganga. The flow propagated downslope and, within approximately 30 seconds, expended most of its energy upon reaching the lower gradient reach at the valley base, leading to rapid deposition of entrained sediments and a sudden cessation of the event.

Given the event's rapid onset, high sediment load, and geomorphic transformation of the channel, the Dharali disaster may be classified as a high-intensity, short-duration mass-wasting, rainfall and glacio-fluvial hazard typical of unstable Higher Himalayan headwater environments. Investigations are exploring deep causes such as cloudburst, landslide lake breach, glacier-related events, or a multi-hazard chain.

Mitigation Measures

The Bhagirathi Valley in the Garhwal Himalaya represents one of the most sensitive regions in terms of tectonic activity, geomorphic processes, geology, topography and the incidence of natural hazards. In high-mountain environments, natural processes operate continuously and cannot be halted. Such events have occurred throughout the geological history of the Himalaya and will continue to occur in the future. The pertinent question, therefore, is how disaster risk and associated losses to life, livelihoods and infrastructure can be reduced. In this regard, planners and administrators are expected to adopt and implement

the Sendai Framework for Disaster Risk Reduction (2015–2030) with the objective of minimizing existing disaster risks. Based on the current scenario and past experience of mountain hazards and disasters, the following mitigation measures are proposed as:

Identify disaster-prone areas where any type of natural hazard – particularly climate-related events – is likely to occur in the future, as most disasters take place during the monsoon season. Assess the existing landforms to determine which are safe and suitable for human activities and which are not. For example, Dharali township is situated at the river mouth, which is a highly vulnerable landform. Likewise, floodplains, riverbanks, toes of old landslides, snow-avalanche tracks, rockfall zones, and valley slopes whose catchments include hanging glaciers are extremely hazardous locations for any type of construction. If rural service centers, villages, tourist facilities (such as resorts and home-stays), offices, vehicle stands, etc., are located in hazardous areas along pilgrimage routes, they should be formally advised to relocate. If they refuse to shift, the administration should immediately evacuate them from these dangerous locations. Government departments should also relocate army camps, police stations, block and tehsil headquarters, guest houses, schools, colleges or any other infrastructure from probable hazard sites, since residents often begin to carry out activities in those areas under the perceived protection of government structures**.** Improve regional connectivity by strengthening roads, helipad services, ropeways and other communication networks. Unplanned urbanization has become a serious issue across the Himalayan region. Inhabitants are increasingly settling near service centers and towns in search of better facilities, often encroaching upon riverbanks, floodplains, stream mouths and landslide toes. These areas later become disaster-prone zones. It is therefore necessary to regulate and clearly demarcate permissible areas for construction. Tourist and pilgrim inflow should be controlled according to the carrying capacity of the Dhams. Proper management of these religious sites is essential. Numerous recommendations have been proposed by government agencies, researchers, environmentalists and geologists after previous disasters. Unfortunately, most of these remain academic exercises and are not implemented in practice. Ultimately, self-initiated safety and preparedness become the only means of protection.

Conclusions

The Dharali disaster highlights the urgent need for proactive landform assessment, careful planning, and strict enforcement of regulations in the fragile Himalayan region. Settlements and infrastructure should never be located on vulnerable landforms such as river mouths, floodplains, old landslide toes, or avalanche and rockfall zones—even if they appear stable under normal conditions. At the same time, public awareness of the natural processes and inherent risks of high-mountain environments must be strengthened. Ultimately, sustainable development that respects geomorphic and climatic realities is vital to minimizing future loss of life and property.

Article

Lepchas of Darjeeling Himalaya: A Brief View on Native People of Kalimpong

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Introduction

Lepchas are born naturalists who live in relative isolation from the outside world with their own traditional practices and beliefs. They are mainly found in the Eastern Himalayan Region namely Sikkim, West Bengal, Nepal and in some pockets of Bhutan. They often called themselves as *Rong or Rongkup* as children of God. The Lepchas migrated from Sikkim to Darjeeling region under religious influence. The Darjeeling Hills initially was under Sikkim and later under British rule came under West Bengal. The neighboring Hindus never considered Lepchas as their own community as from racial, social, cultural, geographical they are different. Unstable political situation, lack of infrastructural facilities, absence of basic services as well as cultural mixing, acculturation process has created a threat to this Lepcha community and considerably they are termed as 'vanishing people'. The Kalimpong region of Darjeeling Himalaya suffered mostly from politically volatile situations and infrastructural development and community protection from state and local level. The Lepchas have their own social, cultural and environmental realms. The study focuses on these aspects of Lepcha tribes of Kalimpong, Darjeeling Himalaya and how their unique and individual traits will help to promote sustainable livelihood. From the available census data (2011,2021) for West Bengal. It is known that there are three types of indigenous people living in this region namely Lepcha, Bhutia and Gorkha.

Study Area

Darjeeling Himalaya belongs to the Eastern Himalayan range and also a part of Lesser Himalaya. The Darjeeling district (26°31′ to 27°13′ N and 87°59′ to 88°59′ E) except Siliguri Subdivision and the Kalimpong District (26°51′ N to 27°12′ N and 88°24′ E to 88°53′ E) come under this region. (Fig.1.). The two main rivers of this region are the Teesta and the great Rangit. As per census 2011, total Lepcha population in Sikkim is 42909 and the northern part of West Bengal (Darjeeling and Kalimpong districts) is 76,871. From the available census data (2011,2021) for Kalimpong, Darjeeling Districts, West Bengal it is known Kalimpong municipality comprises of 23 wards and Tehsils like Kalimpong I, Kalimpong II, Lava, Pedong and Gorubathan with 42 village panchayats covering 128 villages. Kalimpong is termed as 'Land of Lepchas'.

Methodology

An extensive form of web search has given information about the Lepchas of this region. Existing literature on this domain has been studied to understand various social, cultural and environmental aspects of Lepcha people. Information has been collected from secondary sources like journals, published articles, published reports on Lepchas. The study attempts to synthesize various aspects of Lepchas and conclusions are made on the basis of information available to represent a general view of Lepcha eco-centric living.

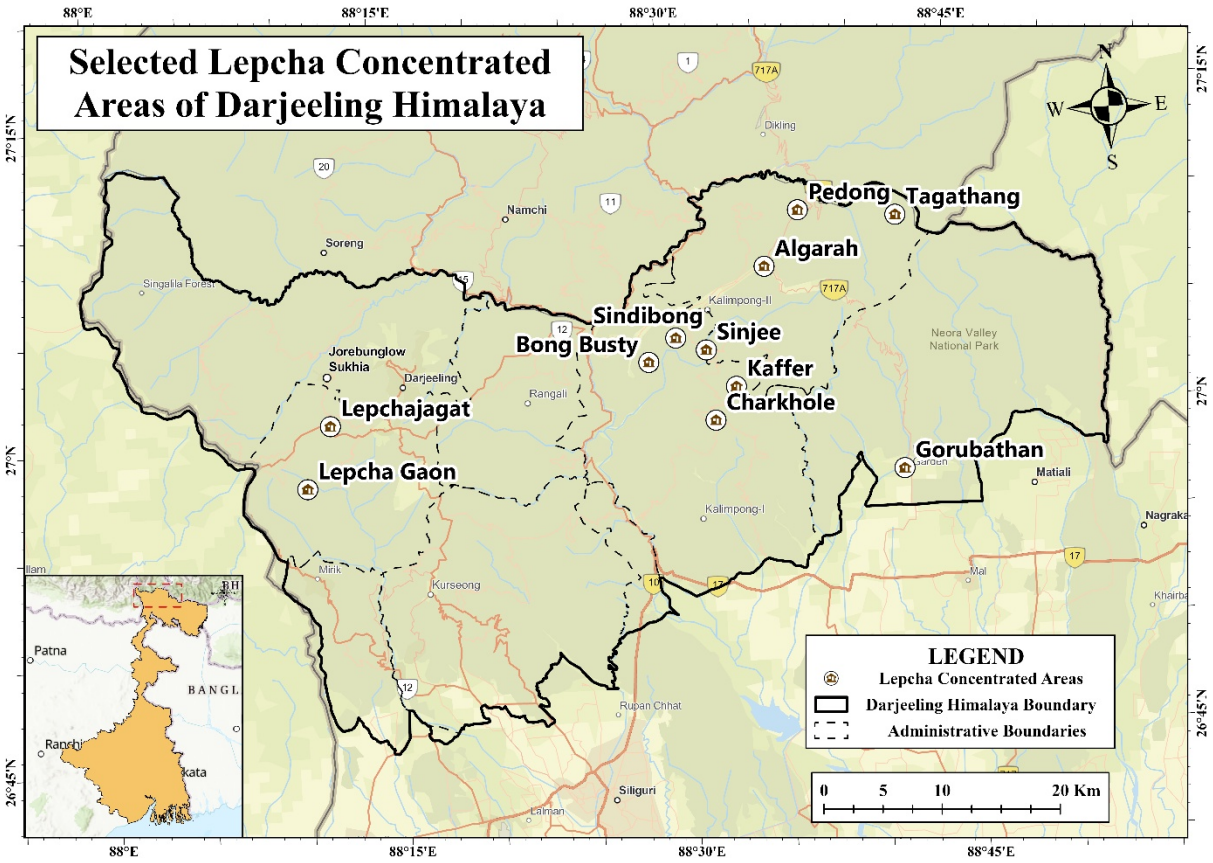

Fig. 1. Selected Lepcha Concentrated Areas of Darjeeling Himalaya

Results

Social Conditions

Among the hill-settlements, in Kalimpong Districts, minority Lepchas are virtually unnoticed and they have started living in the outskirts of the towns creating small hamlets in the valleys and gorges, protected by the forests and the mountains faced with a bleak and uncertain future. The members of the community who belong to the urban areas have almost lost their Lepcha identity. Their society was organized on the basis of sharing and equality. Living with other groups they still follow some of their traditional rituals as they consider themselves as descendants of Kanchenjunga, as their guardian deity. Their social aspects are an integral part of this region fostering the growth of this region with sustainable livelihood approaches. All the domains of social demographic aspects are covered under six parameters: family, income, education, health, households and population.

Cultural Aspects

This domain sheds light on the traditional foods and food habits of the Lepcha community. It highlights the cultural importance of the traditional drink (chi), prepared from finger millet which is a part of every ritual and ceremony. Chi is not only a delicious and nutritious or ceremonial drink but proper marketing will give economic benefit to the community. The recent trend of shifting to Buddhism and Christianity is an important aspect of changing Lepcha identity. However, from a linguistic perspective this community is losing all its individuality by shifting to different languages instead of rooted to their native language. Sharma & Karolia (2024) stated that it is believed the Lepchas are nature worshippers, adhering

to the traditional polytheistic, animistic and syncretic religion centred around *Mun* and *Bongthing* (Fig.2.). The various cultural traits are known through cultural economy, heritage, language, religion gender specific participation and social cohesion. These are reflections of their present situation and need some protective measures.

Fig.2.Lepcha Male Priests named as Bongthings

Environmental Perspectives

It is primarily addressed through bioresource utilisation by the Lepcha community in their day-to-day lives. It is known for agricultural and horticultural crops cultivation commonly grown by the community. All Lepcha folk literatures, including folklores and proverbs mention the bio-resources such as trees, flowers, fruits, climbers, wild edibles, various types of bamboo, etc. (Jana & Chauhan, 2000). Furthermore, the study explains traditional conservation practices of nature and natural entities. It covers preserving water bodies, rocks, forests, and forest patches as abodes of deities and mentions related legends and folklore. Lepchas believe to protect cultural and ecological purity (Purkayastha, 2013) cultural values and practices need to be protected. The idea of ethics and morality, agricultural wisdom, livelihood, ethno-habitat helps to understand the present situation of Lepchas of Kalimpong, Darjeeling Himalaya.

Table 1. Various Aspects to understand Lepchas present situation in Kalimpong Region

Aspects	Indicators
Social	Family Conditions, Occupation, Education, Health, Households, Population Composition
Cultural	Cultural Economy, Heritage, Language, Religion, Gender Specific Participation, Social Cohesion

Environmental	Idea of Ethics and Morality, Agricultural wisdom, Livelihood, Ethno-habitat

Discussion and Conclusions

Lepcha traditional knowledge is environment based and all aspects of their lives are surrounded by the natural environment and natural entity. The knowledge, culture, traditions are transmitted from older generation to younger generation. As they worship nature and follow traditional Buddhism all Lepcha scripts are the identity of Lepcha culture. Lepcha society follows substantive bamboo-based economy and its part of their cultural identity too. Lepcha festivals are also celebrated to respect natural elements and their contributions towards Lepcha living. Lepcha live within nature and they believe protecting nature is essential to preserve Lepcha identity. However, acknowledging the Lepcha view of the environment is essential to address all climate related changes and changes due to modernization in Darjeeling region. Due to the impact of modernisation and continuous influx of people in Kalimpong Darjeeling the Lepchas are facing threats to preserve their identity. Younger generations are influenced by the acculturation process and traditional knowledge are not properly transmitted to them. Lack of infrastructural facilities, absence of basic services as well as cultural mixing has created a threat to this Lepcha community and considerably, they are called as vanishing people. To improve the Lepcha community's socio-economic status and to protect cultural traits from vanishing sustainable livelihood practices, cultural revival is needed in this part of Himalayan region.

References

Census of India 2011, 2021.

Jana, S. K. & Chauhan, A. S. (2000) Ethnobiological studies on Lepchas of Dzongu, North Sikkim, India. *Annals of Forestry*, 8(1),131–144.

Purkayastha, S. (2013) Hydro power development and the Lepchas: A case study of the Dzongu in Sikkim, India. *International Research journal of Social Sciences,*2(8),19-24.

Sharma, G. & Karolia, A. (2024) Lepchas and their Languishing craft-design culture. *Journal of Visual and Performing Arts*, 5(1), 97–108. DOI 10.29121/shodhkosh. v5.i1.2024.112 2

Article

The Role of Traditional Ecological Knowledge in Forest conservation Practices: A Study of the Shertukpen Tribe in Arunachal Himalaya

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Introduction

Traditional Ecological Knowledge (TEK) represents experience acquired over thousands of years of direct human contact with the environment (Berkes, 1993). Traditional ecological knowledge has been found to have significant management relevance, particularly in relation to the sustainable use of renewable resources (McCay & Acheson, 1987). Traditional Ecological Knowledge (TEK) refers to the knowledge and belief systems developed by Indigenous peoples through their intimate interactions with nature and the environment. The Shertukpen community of West Kameng District in the Arunachal Himalayas has inherited indigenous knowledge of a cordial relationship with the environment through various conservation services. They are well known for endorsing Indigenous knowledge and its application in numerous conservation efforts. The primary objectives of the study are to explore and understand the Indigenous belief systems and how such belief systems are helping in environmental conservation practices.

Study Area

The study area is the West Kameng district of Arunachal Pradesh, Northeast India. The Shertukpens are mainly settled in Rupa, Shergaon, and Kamengbari-Doimara circles, consisting of 15 villages, namely Birpur (Joon Pam), Brokpublang (Lin-cho), Chillipam, Dikshipam, Doimara, Gorbow, Jigaon, Kamengbari, Lingbaktang, Musakshing, Membachur, Mukhuthing, Shergaon, Rupa, and Thongre. The term 'Shertukpen' is a combination of the dual vocabulary 'Sher' and 'Tukpen', where 'Sher' denotes those people who live in Shergaon village and 'Tukpen' denotes those people who inhabit Rupa and its adjoining villages. Generally, they are polytheist by religion, embracing both Animism and Buddhism.

Methodology

A primary survey was conducted in various villages inhabited by the community. Three subdivisions or circles were selected, and a total of fifteen villages were surveyed using simple random sampling, with the help of structured questionnaires. Questions were asked about their belief systems and traditional practices. The population is small; therefore, the sample size was determined to be 50% of the total households present in the village.

Results

The Shertukpen community, nestled in the verdant landscapes of Arunachal Pradesh, India, upholds a time-honored legacy of sustainable conservation, deeply rooted in their rich indigenous knowledge, which has evolved into an invaluable intangible cultural heritage (Table 1.1). This heritage is reflected in their profound reverence for specific tree species, which they regard as sacred embodiments of deities and spiritual forces integral to their beliefs. Central to their honor are trees of the Cypress and Pine, which hold immense traditional and spiritual significance, symbolizing resilience, eternity, and divine protection within their cultural ethos.

Additionally, the vibrant Rhododendron, with its vivid blooms, is cherished as a sacred emblem, its presence in their rituals and folklore underscoring its role as a spiritual and ecological keystone in the community's worldview. These species are not merely botanical elements but are considered living deities, woven into the Shertukpen's rituals, festivals, and oral traditions, which guide their sustainable practices to protect the forests and maintain ecological harmony (Fig. 1). Consequently, the community enforces stringent customary laws to safeguard these sacred groves, prohibiting any form of exploitation or disturbance, such as cutting, pruning, or encroaching upon their habitats, to preserve their spiritual sanctity and environmental balance.

Fig. 1. Local saman or Zizi offering prayers; Source: Pema Dorjee Megeji

The local community holds these trees in high esteem, attributing profound cultural and spiritual significance to them, deeply rooted in their indigenous belief systems. Consequently, any actions that might disturb, damage, or encroach upon their natural habitat are strictly forbidden to preserve their sanctity. Individuals who violate these sacred boundaries by tampering with the trees face severe repercussions, including punitive measures and social ostracism enforced by the village council and its members.

Table 1. Information about the tree species

Sl. No	Common name	Scientific name	Local name
1	Blue Pine	Pinus wallichiana	Bichi-Zaemat
2	Chir Pine	Pinus roxburghii	Bichi
3	Chinese Weeping Cypress	Cupressus funebris	Wangchhin
4	Leyland Cypress	Cupressus x leylandii	Wongmu
5	Bhutan Cypress	Cupressus cashmeriana	Shikmu or Poshi
6	Rhododendron	Rhododendron arboreum	Khandak

The figures depict the prayers and offerings made by the local samans (*Zizi in local dialect*) to the local deities known as '*Phu'*. The offerings are performed to appease the forest deities for the well-being of the people and to continue to provide forest resources to the villagers. Moreover, these rituals are performed to appease the spirits of the forest, ensuring

the community's health, harmony, and prosperity while safeguarding the abundant resources the forest provides to the villagers.

Discussion and Conclusions

Conservation is essential, whether it be through innovations or traditional practices. The study reveals that their belief systems and traditional practices are an effective measure of conserving the environment, particularly the forest. The study also found that certain tree species, although not botanically important, hold traditional and spiritual significance. Ultimately, such a belief limits human encroachment and indirectly helps in the conservation of trees, in particular, and the forest as a whole. Such conservation practices have immense significance both traditionally and environmentally, and profound conservation practices. A similar study has been conducted by Thongdok & Sati (2023), their study deliberated that Shertukpen is well known for its ecological conservation practices through endorsing indigenous knowledge systems and practices. Besides, the manifestation of the sustainable conservation of not only forests, although water resources, such as sustainable practices, is long long-inherited culture of the community.

The study can be concluded that the tribal communities have co-existed with nature since time immemorial through sustainable interactions. One such example is the Shertukpen community, profoundly practising nature worship or animism. In the wake of climate change and environmental destruction through urbanization, conservation practices have become important and an integral part of conservation measures. Environmental conservation can not only be done through technological innovations, but it can also be effectively achieved through traditional and indigenous conservation practices. Hence, it is evident that the traditional belief systems are effective measures of forest conservation as particularly for and environment as a whole.

References

Berkes, F. (1993). Traditional ecological knowledge in perspective. *Traditional ecological knowledge: Concepts and cases*, *1*, 1-9.

McCay, B.J. and J. Acheson (1987). The Question of the Commons. Tucson: University of Arizona Press.

Thongdok, N. J., Nimasow, G., & Dai Nimasow, O. (2022). Ran-thok and Ling-chhom: indigenous grinding stones of Shertukpen tribes of Arunachal Pradesh, India. *Journal of lithic studies*, *9*(1), 17-p.

Thongdok, N. J. & Sati, V. P. (2023). Conservation of Water Resource through Traditional Ecological Knowledge: A Case Study of Shertukpen tribe, West Kameng District, Arunachal Pradesh (India), *Unveiling the Mystique Diversity in Geography of North-East India*, Notion Press, pp. 64-71.

Article

Impact of Pine (Chir) Expansion on Forest Ecology in Uttarakhand

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Introduction

Conservation of biodiversity is the most burning issue of today. Global warming and climate change, along with human activities, have been affecting biodiversity since time immemorial. Despite adequate environmental awareness in Uttarakhand, pine is becoming a major problem for biodiversity. *Pinus roxburghii* (pine), the three-needled Indian pine and the most flammable species (Sati, 2023), is a native of the Himalayas and widely spread over India, Nepal, Pakistan and Afghanistan at an altitude of 500 m to 2,200 m. It is a tree with a long evergreen crown and may attain a height of 50 m. It has been reported that 16.36% of the forest area in Uttarakhand at an elevation of 1000 m to 1800 m above sea level is covered by pine forests (Bargali et al., 2020). Despite the ban on pine plantations, pine trees are spreading naturally. The expansion of pine in the forests of Uttarakhand is posing serious ecological challenges, threatening the ecosystem and biodiversity. This study investigates the multidimensional aspects and impacts of history of pine expansion in Uttarakhand, focusing on its effects on floral diversity, fire frequency, hydrological impacts, man-animal conflict and ecosystem services. Historically a natural component of the Himalayan ecosystem, pine has become an increasingly dominant species, invading the areas traditionally dominated by broadleaf forests, especially mid-elevation oak forests, due to its invasive nature, anthropogenic disturbances and frequent forest fires (Chowdhary et al., 2025).

Study Area

Uttarakhand, the 27th state of India, has a geographical area of 53,483.36 km^2 of which 93% is mountainous mainland and 65% is forest covered (Negi & Kumar, 2016). The state extends with Geographical Coordinates, from Latitude 28° 43' N to 31° 28' N to Longitude 77° 34' E to 81° 03' E. Average Population Density of Uttarakhand is 189 per km^2 (India state of forest report, 2023).

Methodology

Methodology includes extensive review of literature and research articles. Our study also used field observations and historical data to compare areas with high pine densities to areas with native broadleaf trees. The present article has been divided into four sections including history, responsible factors, impacts and control measures for expanding pine forest.

Results

In Uttarakhand, five species of pine has been reported to grow in wild conditions (Table 1). Preliminary findings suggest that dense pine trees lead to heavy accumulations of highly flammable resin-rich leaf litter (pirul), increasing the risk and intensity of forest fires.

Table 1. List of Pine species found in Uttarakhand

Pine species	**Common name**
Pinus roxburghii	Pine (Chir as local name)
Pinus wallichiana	Blue pine
Pinus gerardiana	Chilgoza pine
Pinus kesia	Khasi pine
Pinus bhutanica	Bhutan white pine

This positive feedback cycle, induced by fire, further increases the dominance of fire-adapted pines over less tolerant species, leading to a reduction in native floral diversity and changes in species richness. Forest fires result into increased frequency of human-animal conflict. In addition, the specific pine litter chemistry alters soil nutrient cycling, which can cause soils to become acidic and impede regeneration of native species. Expanding pine trees in place of diverse broadleaf forests also affects important ecosystem services, such as water retention, carbon absorption and availability of non-timber forest products for local communities. This study aims to quantify these ecological changes and provide a comprehensive understanding of the mechanisms driving pine expansion. The results will contribute to the development of sustainable forest management strategies that will reduce the negative ecological impacts of pine and help to conserve the rich forest biodiversity of Uttarakhand.

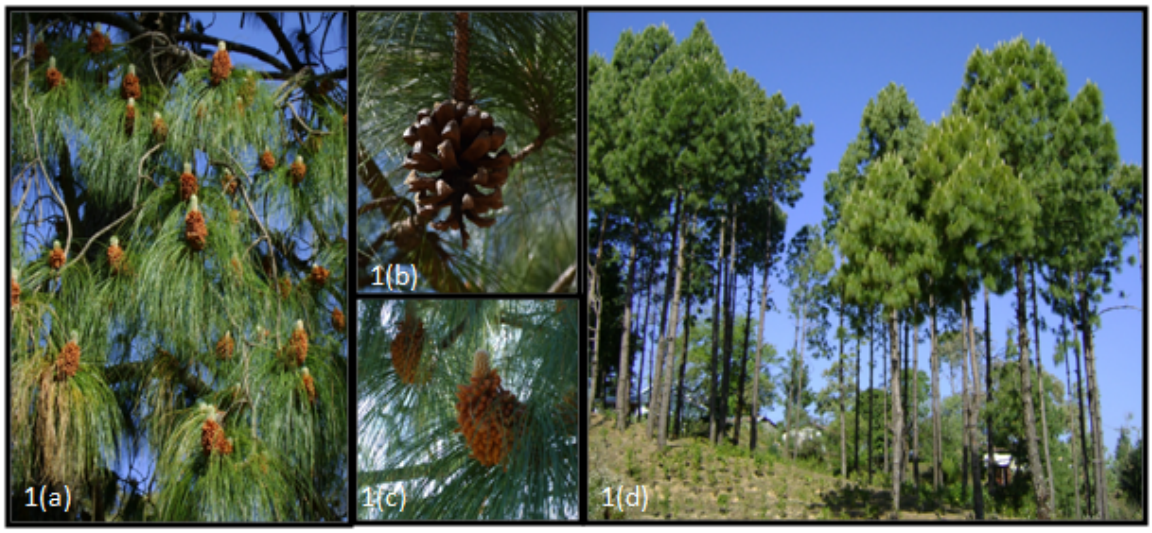

Fig.1. Pinus roxburghii, (a) Tree with several male cones, (b) Female cone, (c) Male cones, (d) Pine monoculture

Discussion

Although pine trees are native to Uttarakhand, the British colonial administration promoted the spread of pine trees to replace broadleaf trees such as oak for economic gain, particularly for resin extraction and timber. This led to the dominance of pine trees in the region, which increased the incidence of forest fires due to their flammable needles and cones. The British commercial interest in the resin called linseed led to the establishment of the first industry in the Himalayas, but the fast-growing nature of pines and large-scale felling of oak forests allowed pine trees to spread rapidly in the central mountain regions. After the Treaty of Sugauli (1815-16) the British sought to reap economic benefits from the forests of the region. Pine resin was valuable for industries such as soap, paint and turpentine, and its wood was used for construction and other purposes. The British distributed pine seeds among village headmen and encouraged them to plant them in upland areas. The fast-growing nature of pine helped it

spread easily and spontaneously. The colonial practice of clearing oak forests to make coal and charcoal created a favourable environment for the faster-growing and more resilient pine trees.

Impact of Pine expansion includes Increased Forest Fire Risk, Altered Forest Structure, Impact on Water Resources, Socio-Economic Consequences and Vulnerability to Climate Change. Pine forests are highly vulnerable to forest fires due to the accumulation of highly flammable, resinous pine needles on the forest floor, a process that is further aggravated by anthropogenic activities. The dominance of pines, which cover a significant portion of Uttarakhand's forest area, leads to changes in the overall forest structure and composition, thereby affecting biodiversity. Although not explicitly detailed in all studies, pine forest fires have been linked to water scarcity and drought conditions, suggesting an indirect impact on local water availability (Naudiyal & Schmerbeck, 2017). Frequent fires in pine forests cause significant damage to the environment and economy of the region. Climate change exerts further pressure on these pine forests, negatively impacting their natural structure and function (Chauhan et al., 2018).

Conclusions

The inference drawn from the study of all these points is that preventing the spread of pine forests and planting broadleaved native flora in their place will be beneficial for the ecology of the region. Forest fires result into loss of biodiversity and adversely affect tourism due to environmental pollution. Conservation of fauna can also be accelerated by developing mixed forests replacing the pine forests. Hence, by controlling the expansion of Pine forest a holistic ecosystem management may be accomplished.

References

Bargali, H., Singh, P., & Bhatt, D. (2020). Role of chir pine (pinus roxburghii sarg.) in the forest fire of Uttarakhand Himalaya. *ENVIS Bull. Himalayan Ecol*, *28*, 82-85.

Chauhan, J. S., Gautam, A. S., & Negi, R. S. (2018). Natural and anthropogenic impacts on forest structure: a case study of Uttarakhand state. *The Open Environmental Research Journal*, *11*(1).

Chowdhary, M. A., Sharma, V., Gadri, H. S., Roy, S., & Bhardwaj, P. (2025). Spatio-temporal mapping and climate change impact on current and future expansion of P. roxburghii in the Himalayan Biodiversity Hotspot. *Environmental Monitoring and Assessment*, *197*(3), 1-20.

India state of forest report -Vol. II (2023).Forest Survey of India, Dehradun.

Naudiyal, N., & Schmerbeck, J. (2017). The changing Himalayan landscape: pine-oak forest dynamics and the supply of ecosystem services. *Journal of Forestry Research*, *28*(3), 431-443.

Negi, M. S., & Kumar, A. (2016). Assessment of increasing threat of forest fires in Uttarakhand, using remote sensing and GIS techniques. *Global Journal of Advanced Research*, *3*(6), 457-468.

Sati, V. P. 2023. *Sustainable Forest Management in the Himalaya*, Springer Nature, Cham, Switzerland, ISBN: 978-3-031-21935-1.

Article

Article

Changing Geo-economic Structure of Uttarakhand State

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Uttarakhand state has entered in the 25thyear of its formation and this length of time could be considered sufficient for setting the direction of development and its eligibility to cross the threshold of development as per its resource base, challenging problems in the framework of India's development scenario i.e. demand, supply, import and export requirements of the day. Prof. S.C. Kharkwal has published book entitled Uttarakhand -25 Years of Development" and it carries the whole range of statistical information relating to its primary resources, agriculture, horticulture, industry, infrastructure, health, education and income structure. In the formative years of state two types of sign boards were visible along state national highways- 1. Energy state (Urja Pradesh) 2. Tourism State (Paryatan Pradesh) 3. Clean State (Swachh Pradesh).

In addition to above two, the third one is the basic requirement of Tourism development. Hydro-electricity production in 2011-12 was 5261.8 MU and it is reported to be 5433.0 MU in 2022-23. Similarly gross tourist was. Tourism has immense potential and capable of playing a lead role in income generation and creating employment opportunities. It is very difficult to decipher the direction of economic development. Level of infrastructural development is terribly good realizing the impact of monsoon rains, recurring landslides, flash floods etc. Construction and operation of Railway Line, four- Lane pilgrim road and air strips- Helipads etc. are going to maintain satisfactory level of mobility in the near future. State has launched a number of economic development programs such as, fruit belts and government orchards with required infrastructure, Ram Bans project, herb culture project, tea garden project, homestay programme

There may be some more initiatives and all these demand evaluations by professionals not by government machinery. In this issue of Society's research News Bulletin, we are starting with the Primary resource base of Uttarakhand. Table 2 exhibits the status of primary resources on district unit. Uttarakhand carries 45.4 (India 21.8). percent forest cover (SFR 2023) while forest area as per reported area is 63.5 percent. On account of three-dimensional relief, reported area of Uttarakhand is 12.2 percent larger than the geographical area and its keeps on changing. On the basis this area discrepancy, the average slope of reported area is $9{\cdot}6^0$ and it ranges between 18.5 ^{o} in the Tehri district to 10.5^o in Rudraprayag district. Distribution of forest area into very dense, dense and open categories make comparison of total forest area on District unit problematic. In order to overcome this handicap Weighed Forest Area has been computed giving 1.0, 0.5 and 0.3 multiple for the respective categories and the result are given here.

Table 1: Population (2011) Per Sq. Km. Area of Forest (2023) in Uttarakhand State

Persons (2011/ km2) Total Forest Area	Districts	Persons (2011/ km2) Weighed Forest Area	Districts
Below 500	Uttarkashi, Chamoli, Tehri, Pauri, Champawat, Rudraprayag	Below 700	Uttarkashi, Chamoli, Pauri, Champawat
500-750	Pithoragarh, Bageshwar, Nainital	700-1100	Tehri, Rudraprayag, Pithoragarh, Bageshwar, Nainital
750-1500	Almora, Dehradun	1100-2000	Almora
Above 1500	U.S. Nagar, Haridwar	2000-5000	Dehradun
		Above 5000	U.S. Nagar, Haridwar

Source : India State of Forest Report,2023

Table 2: Primary Resources of Uttarakhand (Figures in percentage geographical area of Uttarakhand State 2011)

District	Geographical area	Forest Area %	Forest Area Sq. Km.	Dense Forest	weighted forest area	NSA	Horticulture	Infrastructure	Person 2011
Uttarkashi	15.2	37.9	3036.2	618.6	1686.5	6.27	0.74	1686.5	477.8
Chamoli	15.3	33.8	2710.1	443.1	1441.2	6.86	1.96	1441.2	550.4
Tehri Garhwal	6.95	56.7	2064.4	272.9	1027.2	10.74	0.26	1027.2	994.0
Pauri Garhwal	10.1	63.7	3396.7	576.6	1804.0	9.69	2.62	1804..0	678.3
Dehradun	5.9	52.2	1611	663.3	1069.8	13.19	6.45	1067.8	20139.7
Rudraprayag	3.8	57.6	1142.3	251.9	519.4	1.57	2.42	519.4	750.2
Pithoragarh	13.5	29.4	2080.8	505.5	1172.6	8.01	1.55	1172.6	1026.6
Almora	6.2	54.7	1719.8	199.1	822.3	10.82	2.73	822.3	1836.3
Nainital	8.5	71.6	3044..5	772.9	1802.9	12.81	3.20	1802.9	1060.5
Bageshwar	4.2	56.3	1262.7	161.6	645.2	2.03	2.36	645.2	1116.9
Champawat	1.8	69.3	1224.2	366.9	743.5	5.71	1.99	743.5	637.3
Mountainous Ds	90.8	48.0	23293.1	4832.4	6.38	44.50	2.23	130281.3	493.0
U.S. Nagar	4.8	16.8	428.1	148.2	270.1	5.12	12.50	270.1	8821.3
Haridwar	4.4	20.6	1012.0	222.9	552.6	7.20	14.10	552.6	7442.5
Plain district	9.2	19.56	959.0	234.6	47.85	6.81	12.43	591.2	5986.7
Uttarakhand State	100	45.4	24303.8	5266.6	13.38	5.26	4.00	13281.3	759.4

Source: 1. Dr S.C. Khrkwal: Uttarakhand 25 years of Development (Hindi) Winser Pub. Dehradun (Based on Statistical Dairies of Uttarakhand), Page 96-99.

Table 3: Main Forest produce in Uttarakhand(Figures in 000 units)

Year	Timber Cubic metres Logs	Fuelwood Cubic metres Bundles	Lisa (resin) Quintals
2000-01	212.55	40.68	111.52
2007-08	310.58	68.58	192.58
2014-15	239.52	171.27	144.15
2018-19	222.51	65.12	96.50

Source : Dr S.C. Kharkwal: Uttarakhand 25 years of Development (Hindi) Winser Pub.Dehradun (Based on Statistical Dairies of Uttarakhand),Page 96-99.

Table 4: Changing Land Use Pattern in Uttarakhand State 2021-22 (In percentage of reported area)

District	Forest	Barren etc.	Scrubs, Garden	Other than Ag.	Net Sown Area	% Changes in N. S. A		
						2003-10	2010-15	2015-22
Uttarkashi	88.8	5.04	0.53	0.74	3.47	-1.51	-1.37	-0.04
Chamoli	59.41	10.66	16.86	1.96	3.56	-0.15	-0.1	0.21
Pauri Garhwal	66.23	1.19	0.98	2.62	4.46	0.49	-0.81	-2.28
Tehri Garhwal	57.56	5.47	4.12	0.26	8.97	-1.03	-5.04	-1.4
Dehradun	55.6	6.45	4.56	6.45	9.27	-0.97	-0.57	-2.82
Rudraprayag	76.82	3.59	6.1	2.42	7.83	0.26	0.16	-0.71
Pithoragarh	72.33	2.84	5.59	1.55	8.48	-0.69	-5.07	-1.02
Almora	50.8	5.25	8.5	2.73	12.48	-5.39	-3.98	-4.3
Nainital	73.08	0.22	5.36	3.2	9.51	-0.04	-1.09	-1.17
Bageshwar	52.98	3.22	13.86	2.36	9.98	1.29	-0.57	-1.96
Champawat	56.74	3.16	9.46	1.99	5.33	1.14	-1.49	-2.86
Mountainous.Ds	66.33	4.48	6.67	2.23	6.38	-0.95	-1.2	-4.74
U.s Nagar	33.53	0.39	0.25	12.5	47.65	-3.57	-0.34	-1.76
Haridwar	34.48	1.29	0.53	14.1	45.49	-2.28	-0.69	-3.97
Plain district	33.97	0.81	0.38	13.24	46.64	-3.30	-0.24	-2.97
Uttarakhand state	63.51	4.16	6.12	3.19	9.89	-1.38	-1.38	-1.79

Source : Dr S.C. Kharkwal: Uttarakhand 25 years of Development (Hindi) Winser Pub. Dehradun (Based on Statical Dairies of Uttarakhand),Page 96-99.

Agricultural Land (Net Sown Area) shows wide variation (3.47% Uttarkashi – 12.48% Almora) and six districts (Rudraprayag, Tehri Garhwal, Dehradun, Nainital, Bageshwar, Almora) carry 7.5-10.0 percent NSA. On the other hand, plain districts have almost identical (45.5-47.65%) Net Sown Area. Mountainous districts of Uttarakhand have recorded 4.74 decrease in NSA due to increasing fallow land under influence of population shift from interiors to low lands (foot hill piedmont zone) while plain districts owe this change due to urbanization which is reflected in the land use category 4 denoting land put to use other than agriculture. We may refer it to cultural- infrastructural use carrying water bodies settlement, roads, water and electricity networks.

Horticultural land use is significant to mountain terrain accounting for 5.25 percent of REPORTED area and it is nearly constant since 2010-11. Among hill districts horticultural area is minimum of two percent in Rudraprayag, Bageshwar and maximum of 16.1 percent in Nainital, Dehradun (14.98) districts. Tehri, Pauri, Pithoragarh, Almora display area under fruit and vegetables above 10 percent. Yamuna Valley representing mountainous part of Dehradun, Western part of Uttarkashi district and Jaunpur Block of Tehri districts is the core of horticultural activities in Uttarakhand. Potato production during rainy season is a high demand commodity. Area under potatoes increased by 47.9 percent during 2005-22. Much more can be done in this area to harness its full potential. Transport problem during monsoon season, recurrence activity disrupt road mobility is very serious concern. This problem needs to be overcome by Crop Transport Insurance Policy or air lift or innovative rope-ways mechanism.

Table 5. Changes in Horticulture Area and Production(Percentage of Uttarakhand) 2010-11

District	Area	Production	Fruit Area	Vegetable Area	Percentage Changes +	Main Horticulture Crops		
					Year	Fruits	Vegetables	Potatoes (1m000 hectors)
Uttarkashi	6.27	7.37	8.72	14.29	2005-6	692.5	461.1	276.9
Chamoli	6.86	8.81	5.51	2.95	2010-11	792.8	606.5	424.3
Tehri Garhwal	10.74	6.58	11.66	11.36	2014-15	786.0	657.2	452.5
Pauri Garhwal	9.67	3.97	12.62	6.93	2021-22	648.9	656.6	367.3
Dehradun	13.19	12.37	14.98	16.45				
Rudraprayag	1.57	0.82	1.88	1.74				
Haridwar	7.20	11.54	8.86	6.08				
Garhwal region	55.50	57.26	68.71	59.69				
Pithoragarh	8.01	8.29	10.89	7.83				
Almora	10.82	15.86	13.43	6.38				
Bageshwar	2.03	2.01	2.04	2.17				
Champawat	5.71	2.51	4.60	4.42				
Nainital	12.81	12.90	16.09	8.12				
U.S. Nagar	5.12	7.67	4.22	11.50				
Kumaon region	44.50	48.74	31.29	40.31				
Uttarakhand	100	100	100	100				

Source: Dr S.C. Kharkwal,Page 148.150,152

The contribution of primary sector in the economy of Uttarakhand is 10% (2023-24) but the critical question is relative contribution of primary sector of mountainous area in the economy of state. The falling population (human& cattle) and increasing area of long fallow land, are the indirect markers of the multidimensional decline in the overall scenario. However bright spots of Agro-tourism oasis distributed randomly in the whole mountainous territory are symbol of hope for the vibrant future. We can't reverse rural-out migration from the state and within as well. This daydreaming must stop because it is universal phenomena and it must be viewed as by-product of the development gaps, urbanization and educational facilities as well as growing aspirations and market forces. Primary sector in Uttarakhand need reform in data collection procedure. Some suggestions are given here:

1. Standardization of Land use categories and reporting of factual (on ground) data. Land use categories of Scrubs- garden (category 3) shows unrealistic variation (Uttarkashi 0.53 – Chamoli 16.86%) while terrain and cultural history is same. Similar discrepancy is noticed increase of category 2 (barren etc.). It is advisable to assess area under first 3 categories by Remote Sensing methods using high resolution data. Similarly, horticulture related data procurement demands more precise information by skilled personnels. State Government must setup a self-sustaining agency to market the specialized agro-horticultural products, irrespective of their quantity.

2. It will help in creating demand for mountain (Uttarakhand) products in the mega cities of country.
3. Long standing open areas within Reserved Forests are required to be utilized for Tourism and recreation activities.

लेख

उत्तराखंड की व्यावसायिक कृषि में नवाचार का एक प्रयोग टिहरी जनपद में रोतों की -बेली का विशेष अध्ययन

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परिचय

भारत कृषि प्रधान देश ही रहेगा और इसके अनुरूप हिमालयी राज्यों में भी कृषि ,उद्यानकी, पशुपालन आदि प्राथमिक क्षेत्र का महत्व बना रहना चाहिए| पिछले दो-तीन दशकों में उत्तराखंड के पर्वतीय क्षेत्रों में कृषि उद्यानिकी पशुपालन क्षेत्र में लगातार ह्रासमान परिस्थितियां बन रही है| पौड़ी गढ़वाल जनपद, अलकनंदा भागीरथी घाटियों में आधुनिक कृषि व्यवसायिक कृषि विकास के लिए आवश्यक परिस्थितियां उपलब्ध नहीं हो पा रही है| न्यूनतम उत्पादकता और बाह्य प्रवास पोषित आजीविका के विकल्प उपलब्ध होना, साथ ही आंतरिक भागों से बाह्य हिमालय क्षेत्र में स्थायी निवास स्थानांतरण की बढ़ती प्रवृत्ति, अतीत में जीवन निर्वाह कृषि में प्रचलित कृषि व्यवस्था के लिए आवश्यक तात्कालिन प्रस्तुतियों का वर्तमान में न तो उपलब्ध हैं, न विकल्प हैं, और न प्रासंगिकता हैं | जनसंख्या घनत्व बढ़ने पर बाह्य प्रवास हुआ, शिक्षा के प्रति जागरूकता बढ़ी, पारिवारिक श्रम में कमी का प्रभाव कृषि- पशुपालन पर प्रतिकूल हुआ, इसके फलस्वरुप पारंपरिक कृषि व्यवस्था के प्रति उदासीनता का वातावरण बनता गया| गंगा घाटी के विपरीत यमुना घाटी में जहां कहीं भी भौगोलिक परिस्थितियां अनुकूल है, व्यावसायिक कृषि पशुपालन का विकास समुचित रूप में हुआ है| और कृषि आर्थिकी में आशा की किरण बन अन्य क्षेत्रों में जहां कहीं भी कृषि के लिए आदर्श परिस्थितियां हैं एक प्रेरणा का स्रोत है| प्रस्तुत विवरण आधुनिक डेयरी,बागवानी कृषि के व्यावसायिक स्वरूप का परिचायक है| यह विवरण नितांत प्राथमिक गुणात्मक सूचनाओं पर आधारित है| अलकनंदा भागीरथी नदियों की सहायक घाटियों में जहां सिंचाई के स्रोत हैं कृषि मरूद्यान मिलते हैं| कुछ नवाचार भी हो रहा है और उत्पादन भी समुचित है| इसका एक उदाहरण अगस्तमुनि विकासखंड में क्यूँजा, बाबई ग्राम है| अनुमानत:50 वर्ग किलोमीटर राजस्व क्षेत्र में ऐसा एक ग्राम मिलने की संभावना रहती है| टिहरी जनपद में सिंचित भूमि का प्रतिशत अधिक रहने के कारण कृषि मध्यम स्तरीय मानी जा सकती है| कृषि संबंधी शोध कार्यों का प्रचलन भी कम है। इन परिस्थितियों के रहते हुए यमुना जल प्रवाह क्षेत्र में विशेष रूप से कुछ स्थानों पर व्यावसायिक कृषि फलोंत्पादन द्वारा कृषि भूमि से उत्पादन का स्तर बढ़ता दिखाई दे रहा है, इसी श्रृंखला में जौनपुर विकासखंड के रोतों की -वेळी गांव को अध्ययन के लिए चयनित किया गया है।

ग्राम की स्थिति अवस्थिति - रोतों की- बेली गांव उत्तराखंड के टिहरी जनपद के जौनपुर विकासखंड में लघु हिमालय के बाह्य पृष्ठ क्षेत्र में 30 डिग्री 45 मिनट उत्तरी अक्षांश व 78 डिग्री 8 सेकंड पूर्वी देशांतर पर समुद्र तल से 1826 मीटर की ऊंचाई में मसूरी से 17 किलोमीटर उत्तर पूर्व में देहरादून उत्तरकाशी मार्ग पर 175.4 हेक्टेयर क्षेत्र में फैला हुआ है, जिसकी जनसंख्या 2011 में 1116 व्यक्ति थी, रोतों की- वेली गांव ने व्यावसायिक कृषि फसलों पशुपालन से डेयरी उत्पादन एवं पर्यटन विकास कर रोजगार के नये आयाम स्थापित कर उत्तराखंड में अपनी पहचान बनायी है|

भौगोलिक स्वरूप- लघु हिमालय में 1826 मीटर की ऊंचाई पर स्थित होने के कारण तीव्र ढाल होना स्वाभाविक है| गांव सूर्योनुखी ढाल पर स्थित है, इसके ऊपरी भाग में तीव्र ढाल तथा निचले भाग में ढाल मध्यम है|ऊंचाई अधिक होने के कारण शीत ऋतु कठोर व ग्रीष्म ऋतु सुहाबनी रहती है| ऊपरी भागों में शीतोष्ण कटिबंधीय सघन वनस्पति के कारण आद्रता पूरे वर्ष भर बनी रहती है, जिसका प्रभाव यहां के कृषि उत्पादन पर स्पष्ट दिखाई देता है| गांव की ऊपरी भाग में मिट्टी हल्की भूरी तथा दक्षिण भाग में गहरी

भूरी मिट्टी पाई जाती है| गांव के मध्य भाग में वनस्पति पर मानवीय अतिक्रमण अधिक होने के कारण सघनता कम मिलती है, लेकिन ऊपरी भागों में बांज, बुरांश,देवदार,चिल्दी, के वृक्षों में सघनता पाई जाती है| निचले भागों में चीड़ के वृक्ष भी सघन रूप में फैले हैं|

जनांनिकी संरचना - रोतों की बेली गांव में मुख्य रूप से रावत भंडारी राजपूतों व कुछ अनुसूचित जाति के परिवार निवास करते हैं| वर्तमान समय में परिवारों की संख्या 182 है| 2011में यहां की जनसंख्या 1116 है| जिसमें पुरुषों की संख्या 528 तथा महिलाओं की संख्या 588 थी| जनसंख्या का लिंगानुपात 1114 स्त्री प्रति हजार पुरुष तथा साक्षरता 81.4 थी, अनुसूचित जाति की जनसंख्या 57, क्रियाशील जनसंख्या 594, मुख्य कृषक 534 ,सीमांत श्रमिक 20, सीमांत कृषक 5, थे| कामकाजी महिलाएं 267, 0-6 आयु वर्ग के 161 बच्चे थे| इस ग्राम में स्थाई प्रवास का प्रतिशत अनुपस्थित है| रोजगार के लिए अल्प अवधि के लिए आवा-गमन होता रहता है|

विकास के अनुकूल कारक - रोतों की- बेली गांव की स्थिति देहरादून मसूरी धनोल्टी के समीप रहने एवं स्वास्थ्यवर्धक जलवायु के कारण यहां पर विकास के लिए अनुकूल दशाएं विद्यमान हैं| शीतोष्ण कटिबंधीय क्षेत्र में होने के कारण ग्रीष्म ऋतु में मौसमी सब्जियों का अच्छा उत्पादन होता है, इनमें गोभी, मूली, बीन्स, मटर,आलू मुख्य हैं| ऊपरी भाग में बन्य संसाधनों की पर्याप्तता का प्रभाव यहां के पशुपालन पर स्पष्ट दिखाई देता है| वर्तमान समय में प्रत्येक परिवार ने दुधारू पशुओं के दुग्ध से पनीर का उत्पादन कर व्यवसायीकरण की दिशा में अच्छी पहल की है|

पनीर उत्पादन -रोतों की -बेली गांव ने स्वरोजगार के संसाधनों में पशुपालन से पनीर उत्पादन का कार्य कर उत्तराखंड में अपनी अलग पहचान बनायी है, यहां का पनीर अत्यधिक स्वादिष्ट एवं शुद्ध होने के कारण मसूरी तथा उसके समीप पर्यटक केन्द्रो में अपनी मांग बना चुका है| 1975- 76 में सड़क निर्माण के बाद पशुपालन से उपलब्ध दुग्ध का व्यवसाय मसूरी -देहरादून क्षेत्र के लिए किया जाता था, तत्पश्चात 1980 में यहां के विकासखंड प्रमुख के द्वारा सबसे पहले पनीर उत्पादन का कार्य प्रारंभ किया गया। दूध की अपेक्षा पनीर के मूल्य में अधिक तथा लंबे समय तक सुरक्षित रहने की सुविधा हो जाती है, इस दृष्टि से धीरे-धीरे अन्य लोगों ने भी पनीर उत्पादन को अपनाया और वर्तमान में पनीर इस गांव की पहचान बन चुका है| इसके फलस्वरुप आज यह गांव पनीर गांव के नाम से जाना जाता है| प्रारंभिक समय में पनीर 25रू प्रति किलो के मूल्य से बिकता था, वर्तमान में इसका मूल्य 300रू प्रति किलो है| प्रारंभ में 30 से 35 परिवार ही पनीर उत्पादन करते थे, परंतु वर्तमान समय में रोतों की बेली सड़क मार्ग का उत्तरकाशी नगुण मार्ग से जुड़ने के कारण अब 90% परिवार पनीर का उत्पादन कर 15 से 35 हजार रुपए प्रतिमाह अर्जित करते हैं| यहां पर उत्पादित पनीर उत्तरकाशी -मसूरी -देहरादून के बाजारों तक पहुंचता है| गांव ने दूध के सुगम- सुलभ व्यावसायिक प्रसंस्करण द्वारा पनीर निर्माण से पश्चिमी गढ़वाल में अपनी पहचान बना ली है| ऑर्गेनिक उत्पादन के रूप में इसकी मांग बड़े नगरों में आसानी से हो सकती है| पशुपालन के लिए चारा- चारागाह ऊपरी घाटियों में भी सुलभ होते हैं, जहां पर पनीर का उत्पादन कर सहकारी समितियों के माध्यम से विपणन किया जा सकता है| यह कृषि की अपेक्षा वन्यजीवों के हानी से सुरक्षित है| आवश्यक है कि उत्पादन अनुकूल सभी क्षेत्रों में बढ़ाया जाए, इसके लिए सरकार द्वारा प्रचार प्रसार तथा समर्थन आवश्यक है| पनीर उत्पादन द्वारा उत्तराखंड अपनी एक विशिष्ट पहचान बना सकता है|

साग सब्जी व नगदी फल फसलें- रोतों की -बेली गांव में नगदी फसलों एवं फल उत्पादन व्यवसाय भी बहुत तीव्रता से बढ़ रहा है, जिसमें आलू, गोभी, मटर, शिमला मिर्च, मूली राई आदि सब्जियों का व्यापार उत्तरकाशी, देहरादून के नगरों के लिए किया जाता है| नगदी फसलों का उत्पादन लगभग गांव के सभी परिवार करते हैं| कृषि भूमि पर जनसंख्या का दबाव अधिक होने के कारण लोगों के पास कृषि भूमि बहुत

कम है, जिसका सीधा प्रभाव उत्पादन पर पड़ता है| सर्वेक्षण में 50 परिवारों के उत्पादन को निम्न तालिका द्वारा प्रस्तुत किया गया है|

तालिका 1: रोतों की बेली ग्राम में नगदी फसलों का उत्पादन (प्रति परिवार) कुंतल

परिवारों की संख्या	आलू	मटर	गोभी	हरी सब्जीयां
2 से नीचे	12	34	5	15
2-4	20	10	22	11
4-6	14	5	16	11
6- से ऊपर	4	1	7	13

श्रोत- प्राथमिक

फलों के उत्पादन में खुमानी,आडू, पलम, कीबी का उत्पादन भी किया जाता है| पशुपालन में कठिनाइयों के कारण पनीर का उत्पादन कुछ लोग कर पाते हैं|

पर्यटन की संभावना एवं विकास- रोतों की -वेली गांव का प्राकृतिक सौंदर्य अत्यधिक मनमोहक है, जो चारों तरफ से ही पर्वत श्रृंखलाओं से घिरा हुआ अवतल ढाल पर मध्यम ढाल लिए हुए पूर्व से पश्चिम की तरफ फैला हुआ है। इसके ऊपरी भाग में बांज, बुरांस व देवदार के जंगल सैलानियों को अपनी और आकर्षित करते हैं। मध्य भाग में मध्यम ढाल पर लहलहाती हुई सब्जियां, सेव, पलम, खुमानी के लदे हुए वृक्ष अत्यधिक सुंदर लगते हैं। मार्च अप्रैल में चारों तरफ बुराँस के लकदक वृक्ष इस क्षेत्र की नैसर्गिक छटा को और भी निखारते हैं। शीतोष्ण कटिबंधीय क्षेत्र में स्थित होने के कारण हमेशा जलवायु अनुकूल रहती है, जिसका प्रभाव यहां के पर्यटन पर भी दिखाई दे रहा है।

मसूरी धनोल्टी के निकट स्थित होने तथा अत्यधिक सुंदर प्राकृतिक दृश्य व स्वास्थ्यवर्धक जलवायु होने के कारण वर्तमान समय में पर्यटन का विकास भी यहां पर तीव्र गति से हो रहा है| उत्तराखंड सरकार की होमस्टे योजना का भी यहां पर विकास दिखाई दे रहा है| यहां पर मुख्य रूप से होटल, होमस्टे काफी विकसित अवस्था में है| तीन बड़े होटल, 5 से 6 रेस्टोरेंट, तथा एक एप्पल गार्डन होमस्टे है, जिसमें 6 कॉटेज बने हुए हैं| होटल में प्रति कमरा किराया 3000से 4000रु तथा होम स्टे में किराया 1000 से 2000रु तक रहता है, जो यात्रा सीजन में बढ़ जाता है|

निष्कर्ष -इस क्षेत्र की स्थानीय जनता ने अपने अथक प्रयास से स्वरोजगार के तहत पनीर उत्पादन,नगदी फसलों का उत्पादन, तथा पर्यटन विकास को अपनी आर्थिकी का मुख्य आधार बनाया है, जिसे भविष्य में और भी अधिक विकसित करके इस क्षेत्र के विकास को और अधिक बढ़ाया जा सकता है|

लेख

भागीरथी बेसिन के परिस्थितिकी तंत्र पर टिहरी जलाशय का प्रभाव

मंजू भंडारी, असिस्टेंट प्रोफेसर, राजकीय स्नातकोत्तर महाविद्यालय, देहरादून शहर, देहरादून, भारत

परिचय

पृथ्वी का पर्यावरण गतिक संतुलन (डायनामिक इक्यूलिब्रियम)अवस्था में है क्योंकि परिवर्तन निरंतर चल रहा है। पर्यावरण का प्रत्येक घटक भी शाश्वत परिवर्तन के समायोजन -अनुकूलन की प्रक्रिया में अपनी भागीदारी सुनिश्चित करता आया है। यह आवश्यक है कि भूगर्भिक काल क्रम में पर्यावरण के विभिन्न घटकों की अनुपातिक भागीदारी में सामयिक परिवर्तन होता रहता है। क्रिटेशियस,जुरासिक, टर्शियरी तथा क्वार्टरनरी कालों में भिन्न-भिन्न प्रक्रमों की बदलती सक्रियता सतत बदलाव की साक्षी है। हमारी बौद्धिक चिंता 2-4-10 दशकों में हुये बदलाव पर रहती है। अवसंरचनात्मक विकास जिसमें 4 लेन सडकें,अन्य सड़कें, कर्णप्रयाग रेल लाइन,हवाई अड्डे आदि ने पर्यावरणीय स्वरूप पर अपनी छाप छोड़ी है। जल विद्युत परियोजनाओं पर 6 दशकों से कार्य चल रहा है। बांधों,बैराजों द्वारा निर्मित उत्तराखंड में छोटे-बड़े10 -15 जलाशय हो सकते हैं ।जल क्षेत्र का आवरण बढ़ने से स्थानीय पर्यावरण में सूक्ष्म स्तरीय परिवर्तन हो रहे हैं । इन परिवर्तनों में आर्दता,वर्षा की अवधि एवं मात्रा ताप परिसर धुंध,कोहरा,दृश्यता,वायुदाब न्यूनाधिक मात्रा में सम्मिलित है। इनका सम्मिलित प्रभाव वनस्पति कृषि स्वास्थ्य(मानव पशु) पशु -पक्षी -कीट आदि के माध्यम से स्थानीय परिवेश में सूक्ष्मस्तरीय परिवर्तन होना स्वाभाविक है। इस परिवर्तन का लाभ हम पर्यटन विकास के माध्यम से कर सकते हैं।

टिहरी बांध मध्यवर्ती भागीरथी घाटी में भिलंगना तथा भागीरथी के संगम पर 602 मी. की ऊचाई पर स्थित है। यह नदी गार्ज से होकर बहती है। बांध के ऊपरी भाग में भागीरथी नदी के दाये किनारे पर उपजाऊ कृषि भूमि नदी वेदिकाओं और सीढीनुमा खेतों (Terraced farming)के रूप में मिलती है जिसके आस पास पारम्परिक अधिवास व सांस्कृतिक स्वरुप का विकास हुआ। इस भाग में नदी की चौडाई बढ़ जाती है और उसके किनारे छाम, चिन्यालीसौर, आदि प्रमुख ग्रामीण अधिवास मिलते हैं। इस भाग में टिहरी नदी में बांध के समीप समुद्री तल 602मी. है, और धारासू में इसकी ऊचाई 1324 मी. है।

टिहरी जलाशय का प्रभाव

यह क्षेत्र जैव विविधता से समृद्ध है। टिहरी बांध निर्माण के बाद यह सम्पूर्ण भूआकृतिक स्वरुप जलमग्न हो गया। वर्तमान झील निर्माण के फलस्वरूप हो गया है। नयी भौगोलिक पारिस्थितिकीय निर्मित हुई है इसमे बांध की कंकरीट संरचना, जलमग्न पुराना शहर, आस पास ग्रामीण अधिवास देखने को मिलते हैं। इसी परिपेक्ष में टिहरी झील निर्माण के फलस्वरूप स्थानीय (लगभग 250 वर्ग किलोमीटर) क्षेत्र में हो रहे पर्यावरण परिवर्तन का गुणात्मक विवरण दिया जा रहा है। यह परिवर्तन 5-10 -15 किलोमीटर पर भिन्न अवयवों पर भिन्न भिन्न रूप से हो रहा हैं।

टिहरी बांध निर्माण के फलस्वरुप 42 वर्ग किलोमीटर क्षेत्र का जलाशय निर्मित हुआ जिसमें जल भरने की शुरुआत 2006 में हुई और जलाशय का वर्तमान आकार 830-35 मीटर में प्राप्त किया गया है। जलाशय का उच्चतम स्तर सितम्बर माह में कभी कभी 835 मी.तक पहुंचता है तथा न्यूनतम जल स्तर 740 मी. अप्रैल माह में चिन्यालीसौड़ के पास मिलता है। इस प्रकार जलाशय के जलस्तर में 90-95 मी. का वार्षिक अंतर मिलता है। इस प्रकार जलाशय के बढ़ते-घटते जलस्तर के फलस्वरुप यह एक संक्रमण क्षेत्र निर्मित होता है, जिसमें सूक्ष्म स्तरीय भूआकृतिक, जीव-जंतु,कीट आदि का एक अस्थाई पारिस्थितिकीय तंत्र निर्मित हो जाता है जिसकी छाप यहां के भौगोलिक परिवेश पर स्पष्ट दिखाई देती है (*आकृति 1*)। कही कहीं पर भूभाग की चौडाई 250 मीटर तक है। और घाटी के निर्माण के स्वरुप के अनुरूप ऊपरी भाग कम होती जाती है।

इस संक्रमण भूभाग के निर्माण की प्रक्रिया डेल्टा जैसी है। क्योंकि नदी का आधार तल अब जलाशय के ऊपरी तल से निर्धारित हो रहा है। नदी की अवस्था के अनुरूप इसमें अवसाद निक्षेपित है। एक मीटर आकार तक के बोल्डर्स, ग्रेवल, शिल्ट और रेत आदि के कण निचले जलाशय की ओर क्रमशः छोटे आकार के होते चले जाते हैं, जिनके ऊपर नदी सर्पिल आकार में बहती हैं, इससे समीपवर्ती पेटी में स्थित ग्राम अप्रत्यक्ष रूप से प्रभावित हुए हैं। झील से प्रभावित होने वाला परिस्थितिकीय तंत्र लगभग 150 वर्ग किलोमीटर क्षेत्र में फैला हुआ है।

आकृति 1. चिन्याली सौड़ में झील के पानी घट जाने के बाद बाढ़ के मैदान के समान का दृश्य

चिन्यालीसौड लघु हिमालय में नदी वेदिका पर स्थित है। भागीरथी नदी उत्तर से दक्षिण की ओर उत्तरकाशी, चिन्यालीसौड़ से होते हुए टिहरी की ओर बहती है। ये नदी धारा चिन्यालीसौड में अपेक्षाकृत चौड़ी घाटी में बहती है। यहाँ से नदी टिहरी बांध परियोजना से जुडी हुई है।यहां पर जलाशय का जलस्तर जब घट जाता है तब यहां चौड़ा रेतीला मैदान बन जाता है जो बाढ़ का मैदान जैसा प्रतीत होता है (*आकृति 2)*।

इस निक्षेपजनित बाढ़ के मैदान में मई-जून माह में सौर्यिक विकिरण तथा परावर्तन के फलस्वरुप ऊर्जा का अवशोषण समीपवर्ती क्षेत्रों में होता है। इसके फलस्वरुप ग्रीष्मकालीन तापक्रम में वृद्धि हो रही है तथा झील के जल के आवरण के प्रभाव से शीतकालीन तापक्रम में कमी आने से जलवायु विषम होती जा रही है। जलाशय के प्रभाव में वर्षा की प्रकृति भी समुचित रूप से प्रभावित हुई है। संवाहनिक वर्षा की भागीदारी बढ़ती जा रही है। यहां उष्णकटिबंधीय और उपोष्णकटिबन्धीय वनस्पतियां पाई जाती हैं।

आकृति 2. टिहरी उच्च बाँध के आसपास के क्षेत्र में ग्रामीण बस्तियाँ और कृषि क्षेत्र

जिसमें साल,चीड़, भीमल, हल्दू,आदि निचली घाटी में देवदार, ओक, बुरांश, उच्च -मध्यवर्ती घाटी में पाये जाते हैं। जलागम क्षेत्रों में 3000 मीo के आस -पास हिमानी अपरदित ढालों में तालाब मिलते हैं जिनमें साहस्त्रताल तथा मसरताल के आस पास क्षेत्रों में अल्पाइन वनस्पति का आवरण मिलता है। ब्रामी, अश्वगंधा आदि जड़ी बूटीयां प्रचुर मात्रा में पायी जाते हैं। फसलों में मूंगफली, तिल,मक्का,रामदानाआदि के क्षेत्र में अप्रत्याशित कमी आई है। इसके विपरीत झंगोरा, तोर तथा मुख्य रूप से आलू के क्षेत्र में बहुत अधिक वृद्धि हुई है ।खरीफ की फसलें पहले की तुलना में 15-20 दिन पहले तैयार हो जाती हैं और रबी की फसले 15 - 20 दिन देरी से पकती हैं। अपेक्षा की जाती है की फसलों की उत्पादकता में वृद्धि होनी चाहिए तथा बागवानी के लिए

उपयुक्त परिस्थितियां निर्मित हो रही है ।यह क्षेत्र अपने प्राकृतिक सौंदर्य, कृषि एवं पशुपालन गतिविधियों के लिए जाना जाता है जो यहां के निवासियों की परिवारिक आय का मुख्य स्रोत रहा है। यहां पर गाय, भैंस,बकरी,भेड़,मुर्गी पालन किया जाता है। कई ग्रामीण दूध सहकारी समितियां से जुड़े हुए हैं ।जिसमें दूध उत्पादन दही,घी,मक्खन आदि का स्थानीय बाजार में व्यापार होता है। उत्तराखंड सरकार की कई योजनाएं हैं जो पशुपालकों सब्सिडी प्रशिक्षण और चिकित्सा सुविधा देती है। पर्वतीय क्षेत्रों में जैविक पशुपालन और स्थानीय नस्लों को बढ़ावा देने की बड़ी संभावनाएं हैं। वर्तमान में होमस्टे के द्वारा पर्यटकों को घर का भोजन जिसमें दूध से बने व्यनजनों, घी, दही, मट्ठा आदि से पर्यटकों के माध्यम से बिक्री को बढ़वा दिया जा रहा है।

भागीरथी जलाशय टिहरी से चिन्यालीसौड़ मत्स्य पालन एक महत्वपूर्ण आर्थिक आजीविका का विकास हुआ है। जो यहां के जनसमुदाय को आय प्रदान करती है। जलाशय में रोहू,काटला, ग्रास कार्प, सिल्वर कार्प मछलियों के बीज डाले जाते हैं और उन्हें बड़े आकार तक बढ़ाया जाता है। मत्स्य पालन ग्रामीणों का एक प्रमुख आजीविका का साधन बन चुका है। यहां हर साल मछलियां पकड़ी जाती है और

बड़े स्तर पर व्यापार किया जाने लगा है। यहां 2021-22 मछलियों का उत्पादन 60 टन हुआ है। औसत उत्पादकता लगभग 18 किलोग्राम प्रति हेक्टेयर के लगभग रही है जिससे कुल वार्षिक आय 60 लाख 1.5 करोड़ रु० के बीच हो जाती है। उत्तराखंड मत्स्य विभाग द्वारा बीज वितरण,प्रशिक्षण और उपकरणों हेतु सहायता दी जाती है।

चिन्यालीसौड के आस पास के जलाशय में क्लोराइड और नाइट्रेट की उच्च सांद्रता देखी गई है, जो सीवेज और मानवजनित अपशिष्ट के कारण हो सकती है। चिन्यालीसौड़ में जल की क्षारीयता 58 लीटर पाई गई, जो गंगोत्री 24 लीटर की तुलना में अधिक है। जलाशय में नदीमार्ग के समीपवर्ती क्षेत्रों की चट्टानों से प्राप्त खनिजों की अधिकता का संकेत मिलता है। चिन्यालीसौड़ में जल का PH स्तर 7.25 पाया गया, जो जल को थोड़ा क्षारीय दर्शाता है। यहां के आसपास के क्षेत्रों में सीवेज और मानवजनित अपशिष्ट के कारण जल में क्लोराइड और नाइट्रेट की मात्रा बढ़ी है।

शीतकाल में नवंबर से मार्च के अंतराल, टिहरी और चिन्यालीसौड़ इस जलाशय में विभिन्न प्रवासी पक्षियों का आगमन होता है। ये पक्षी मुख्यत साइबेरिया, मंगोलिया, और मध्य एशिया से लंबी दूरी तय करके इस जलाशय में आते हैं। प्रमुख पक्षी बार-हेडेड गूज़(Bar-headed-Goose) हिमालय को पार करके टिहरी जलाशय में आते हैं जिन्हे टिहरी जलाशय में देखे जाते हैं। रड्डी शेलडक (Ruddy Shelduck): इन्हें स्थानीय रूप से सुरखाब कहा जाता है और ये चिन्यालीसौड़ जलाशय में सामान्यत: देखे जाते हैं ।रेड-क्रेस्टेड पोचार्ड(Red-crested Pochard)एक सुंदर जलपक्षी भी इन जलाशयों में प्रवास करते हैं। सैंडपाइपर (Sandpiper)प्लोवर (Plover), और मार्श हैरियर (Marsh Harrier)आदि ये पक्षी भी शीतकालीन में इस क्षेत्र में देखे जाते हैं।इन प्रवासी पक्षियों का आगमन न केवल जैव विविधता को बढ़ाता है, बल्कि स्थानीय पारिस्थितिकिय तंत्र की स्थिरता और स्वास्थ्य का भी संकेत देता है। ये पक्षी जलाशयों में मछलियों तथा अन्य जलीय जीवों की आबादी को संतुलित रखते हैं, जिससे पारिस्थितिक संतुलन बना रहता है।

उपसंहार

टिहरी बांध बनने के बाद बडे जालाशय ने पर्यटकों को आकर्षित किया है और जैसे जेट स्कीइंग,बोटिंग,कयाकिंग, राफ्टिंग, बनाना बोट राइड और वाटर स्कूटर आदि जल क्रीड़ाए की संभावनाएं बनी हैं। टिहरी जलाशय में तैरते हुए हट्स और हाउसबोट्स में ठहरने का अनुभव पर्यटकों को रोमांचित करता है। जलाशय के आर पार निर्मित डोबरा-चांठी पुल भारत का सबसे लंबा सिंगल-लेन मोटरेबल सस्पेंशन ब्रिज है, जो झील के ऊपर से गुजरता है और पर्यटकों के लिए एक प्रमुख आकर्षण का केंद्र है। भागीरथी नदी के किनारे स्थित यह स्थान पर्वतीय दृश्यों और शांत वातावरण के लिए जाना जाता है। चिन्यालीसौड़ में स्थित धारासू हवाई पट्टी भविष्य में पर्यटन सम्बधी उड़ानों के लिए उपयोगी सिद्ध होगी जिससे पर्यटन को बढ़ावा मिलेगा। प्रस्तुत विवरण लघु हिमालय पेटी में भागीरथी नदी पर निर्मित टिहरी बांध 2006 से ऊपरी भाग में 42 वर्ग किलोमीटर क्षेत्र पर विकसित जलाशय जीरो से 7 मीटर गहरी 250 मी चौड़े15 कमी लम्बे के फलस्वरुप विकासरत्त रूपांतरित पारिस्थितिकी तंत्र की एक झलक प्रस्तुत की गई है। पर्यावरण के विभिन्न अवयव (भूआकृतिक-नदी जलीय पार्श्ववर्तीय ढाल निक्षेपण, अपरदन, जलवायु, वनस्पति, कृषि,पशु- पक्षी- कीट, प्रवासी पक्षी आदि) रूपांतरण प्रक्रिया से गुजर रहे हैं। विवरण गुणात्मक है, व्यवस्थित अध्ययन हेतु एक रुचिकर विषयवस्तु प्रस्तुत करता है। ऐसे क्षेत्रों पर पर्यावरणीय सक्रीय परिस्थितिकी का धनात्मक रूपांतरण हो रहा है। किसाऊ बांध, आसन बैराज, मनेरी भाली, कालागढ़ बांध के अतिरिक्त उत्तराखंड हिमालय में 5-10 छोटे बड़े ऐसे स्थल विद्यामान हैं जिनका अध्यन किया जाना अपेक्षित है।

Report

Analysing the Land Use Land cover by using Multi–Spectral Remote Sensing Data in Tehri Garhwal, Uttarakhand

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Land use and land cover (LULC) changed drastically throughout the time frame, today there are various factors which is responsible for changes in agricultural land use, anthropogenic and natural factors both have reasons for it, anthropogenic factors like infrastructural development, agricultural activities, recreation activities play major role, natural factors like forest fires, climate change mainly responsible, The investigation studies in modifications in LULC, More than two decades, researcher prepared LULC maps with the assistance of multi-spectral remote sensing Landsat 5 series data used for preparing maps of 2001 and 2011. 2021 map created with Sentinel 2 series data, two decades maps of LULC gives picture about variations in land cover and use, 2001 taken as base year of study, LULC in mountainous regions of Tehri Garhwal different from plain regions, cropping pattern is different, agricultural productivity is different, Seven major LULC types (Crop land, Built Up Area, Forest cover, Water, Range land, Snow Cover and bare Grounds) built-up areas have steadily increased during the past 20 years, demonstrating substantial infrastructural development and urbanization, Crop land is consistently declining, snow cover continuing decline from 2001 to 2021 indicating signifies a move away from conventional agricultural uses, Planning for urbanization must integrate economic expansion with preservation of the environment., addressing the reduction in snow cover and its ripple consequences requires mitigation as well as adaptation measures, such as encouraging sustainable behaviours and renewable energy. *Table 1 shows land and land cover in the Tehri District.*

Land Use land Cover	2001		2011		2021	
	Area in Sq. KM.	Percentage (Total area)	Area in Sq. KM.	Percentage (Total area)	Area in Sq. KM.	Percentage (Total area)
Water Bodies	52.78	1.4%	62.06	1.7%	56.82	1.56%
Forest Cover	1928.64	52.95%	2004.5	55%	1948.2	53.49%
Crop land	106.74	2.93%	92	2.52%	89.25	2.45%
Built Up Area	108.82	2.98%	122.45	3.36%	134.8	3.70%
Bare Grounds	78.24	2.14%	68.5	1.8%	76.8	2.1%
Snow Cover	138.15	3.79%	118.26	3.24%	104	2.85%
Range Land	1228.63	33.73%	1174.18	32.23%	1222.2	33.55%
Total	3642	100	3642	100	3642	100

This examination of LULC over two decades in Tehri Garhwal district of Uttarakhand; the number of urban centers has been steadily rising, reflecting significant urbanization and infrastructure development over the past two decades. This growth suggests ongoing expansion of cities and towns, The consistent reduction in Crop Land indicates a shift away from traditional agricultural uses, he significant decrease in Snow Cover over the 20 years points to the impacts of climate change, with warmer temperatures likely reducing snow accumulation, The fluctuating trends in Forest Cover, Water bodies, and Range Land suggest dynamic changes in the environment, likely driven by a combination of human activities and natural factors. significant land use changes, driven by urbanization, environmental management, and climate factors.

Report

Rising Threat of Natural Disasters in Uttarakhand

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In recent years, Uttarakhand has been witnessing severe devastation caused by natural disasters. The fragile Himalayan state, already vulnerable due to its topography and climate, has experienced floods, landslides, and cloudbursts that have brought chaos from the mountains to the plains. The widespread impact is visible across several districts, with Chamoli, Uttarkashi, Rudraprayag (Fig. 1), Pauri, Tehri, Bageshwar, Almora, and Pithoragarh among the worst affected.

As the monsoon season reached its final phase this year, the frequency of rain-induced disasters increased dramatically. Cloudbursts, excessive rainfall, and massive landslides have caused severe loss of life and destruction of property, estimated in thousands of crores of rupees. The devastation has been particularly alarming in Chamoli and Uttarkashi districts.

Fig.1. Natural disasters in Rudraprayag District

Several tragic incidents highlight the extent of the damage. At the beginning of the monsoon, a disaster at Silai Band on the National Highway washed away nine workers, with only two bodies recovered. On August 5, a massive disaster struck Dharali in Uttarkashi, destroying the entire town—two bodies were recovered while 66 people remain missing. In Pauri district's Thalisain block, two sisters lost their lives, with homes and farmland also damaged. In Tharali (Chamoli), several lives were lost, and many houses and shops collapsed. In Yamunotri (Uttarkashi), two people died, while a cloudburst in Dewal block of Chamoli killed a couple and injured two others on August 29. The same night, Rudraprayag's

Basukedaar Chenagad village saw one death and eight people missing after a cloudburst, with heavy losses in the Badeth Dugar Tok area. On August 31, landslides in Rudraprayag buried several cattle, while the Niti motor bridge in Chamoli was swept away.

These repeated disasters have raised serious concerns among scientists and policymakers. While natural factors such as climate change, shifts in local air pressure, and monsoon variability are driving the rise in such extreme events, human-induced causes are equally significant. The expansion of roads under the Chardham project, large-scale deforestation, tunnel construction for railway projects, mining, and unchecked development in ecologically fragile zones have intensified the risks.

The Himalayan ecosystem is delicate, and unregulated development without consideration of ecological balance is proving disastrous. Climate change and global warming further amplify these vulnerabilities. The uncontrolled growth of towns and infrastructure in sensitive mountain areas is worsening the impact of natural events, causing greater loss of lives and property.

To mitigate future risks, the government must rethink its development strategies. Infrastructure and tourism projects in the hills should be carried out in harmony with nature, ensuring sustainable practices and disaster preparedness. Otherwise, continuing to tamper with the fragile ecology will only invite further havoc. Uttarakhand's experience serves as a warning for all Himalayan states: living in balance with nature is the only way forward.

Report

Om Parvat's Disappearing Snow: A Warning from the Himalaya

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High in the Vyas Valley of Pithoragarh district, Uttarakhand, stands Om Parvat, a mountain revered for its naturally formed snow pattern resembling the sacred "Om" symbol. Rising nearly 14,000 feet above sea level, it has long been a spiritual and natural attraction for pilgrims and trekkers (Fig. 1). But in 2024, the mountain drew attention for a troubling reason—the complete disappearance of its snow cover, something never before recorded in history.

Fig. 1. Om Pravat, changing snow-cover and landscape.

In January 2024, reports noted unusually fast melting of snow on Om Parvat. By August, the famous "Om" mark had vanished completely as the mountain turned bare. A later snowfall briefly restored the pattern, but the incident left locals and environmentalists deeply concerned about the health of the Himalayan ecosystem.

For residents of nearby villages, the sight was shocking. Villagers like Urmila Sanwal from Gunji said the mountain looked unrecognizable without its defining snowy symbol. Dhan Singh Bisht, who has been associated with the Adi Kailash Yatra base camp for more than two decades, admitted that he had never before seen Om Parvat without snow. Visitors too expressed disbelief, as the peak has always been thought of as "eternally snow-clad."

Experts believe the phenomenon was caused by several overlapping factors. The Himalayas are warming faster than the global average, and rising temperatures are accelerating snowmelt. Over the last five years, snowfall in the region has become irregular and insufficient, leaving thinner snow cover that melts quickly in summer. Growing tourism and development linked to pilgrimages to Adi Kailash and Om Parvat have also increased environmental

pressure. Frequent forest fires release black carbon, which settles on the snow and speeds up melting, while vehicular pollution in fragile valleys adds further stress. According to Sunil Nautiyal of the GB Pant Institute of Himalayan Environment, vehicular emissions and forest degradation are among the most damaging forces behind this imbalance.

The disappearance of snow on Om Parvat is more than just the loss of a sacred sight. The Himalayan cryosphere feeds major rivers that support millions of lives across northern India. A reduction in snow cover disrupts water flow, harms agriculture, and threatens biodiversity in high-altitude regions. It may also affect tourism, which is a vital source of income for local communities.

The event is a reminder of the urgent need for conservation. Tourism must be managed sustainably, visitor numbers regulated, and eco-friendly facilities encouraged. Fuel-driven vehicles should be restricted in sensitive areas, with greener alternatives promoted. Forest fires need to be prevented, and afforestation efforts expanded. Continuous scientific monitoring of snow patterns and climate conditions will also be crucial for timely action.

Although the “Om” pattern reappeared with fresh snowfall in 2025, the underlying causes remain unaddressed. The incident is not just about one mountain but about the future of the entire Himalayan region, whose water, culture, and livelihoods depend on the stability of its snow and glaciers. Protecting Om Parvat means protecting the greater Himalayan ecosystem. Without immediate steps, more of these rare and sacred landscapes may lose their natural identity, reminding us of the heavy cost of ignoring climate change.

Report

What should be a Development Model for Uttarakhand?

Vishwambhar Prasad Sati, Senior Professor, Department of Geography and Resource Management, Mizoram University, Aizawl – 796004, Bharat

The state of Uttarakhand is the home to abundant natural resources – forests with rich biodiversity and high economic value; water – numerous glacial-fed rivers, highland, and lowland lakes; panoramic landscape for responsible tourism development; the world-famous pilgrimages – river valleys and highlands; and rich agro-biodiversity (Fig. 1). It has a rich cultural heritage and it is a land of gods, goddesses, folk deities, fairs, and festivals. On the other hand, the Uttarakhand Himalaya is ecologically fragile, geologically sensitive, tectonically and seismically active, geographically remote, and economically underdeveloped. The entire Uttarakhand Himalaya is highly vulnerable to occurrences of geo-hydrological disasters including cloudbursts and glacier-bursts triggered debris flows, flash floods, landslides, and mass movement. The high variability and change in the climatic conditions have further accelerated the frequency and intensity of these natural calamities. Declining crop production and yield, lacking infrastructural facilities, and an exodus of outmigration from the rural areas to urban areas are the other dimensions of impediments that the rural people of Uttarakhand are facing. About 32 lakh people have left their houses and migrated to other parts of India from 3900 villages. Many of them have turned into ghost villages. This has changed the political geography of Uttarakhand.

There was a peaceful agitation for a separate state, which lasted for almost five decades. In the incidences of Khatima and Muzaffarnagar, many innocent people were killed by the unlawful act of the state government. The main objective of the demand for a separate state as Uttarakhand was to bring this remote region into the mainstream of development. The policy for this mountainous region was framed and implemented by the planners sitting in Lucknow city, the state capital of Uttar Pradesh. In the meantime, the topography, terrain, and climate of Uttarakhand are quite different. With the limited knowledge of the planners about the mountainous region, it remained one of the backward regions of India for decades. The dream of the people came true with the existence of Uttarakhand as a new state of the Republic of India on 9th November 2000, carved out of Uttar Pradesh. This was a great moment for the people of Uttarakhand who were dreaming of the bright future of the state.

Now, the state is 22 years old. Within this short period, 16 chief ministers of both BJP and Congress Parties ruled the state. A few have completed their five years tenure. The dilemma was that there were two or more chief ministers of the same party replaced within five years. The planners, who plan for the development, are transferred immediately after a change in guard in the government. The policies one party launched, the other party declined, and as a result, the government did not decide on any development model for the state.

The situation is now very critical. The state does not have any concrete development model. Those development schemes are existing, do not foolproof. Corruption is deep-rooted in all spheres and many development schemes are closed before their completion. Agriculture, which is the main occupation and the major source of livelihood, is declining. Many rural settlements are inaccessible and many of them do not have electricity, proper schooling, and medical facilities. This means many villages are lacking basic infrastructural facilities.

Fig. 1. Abundance of forest and water and spectacular landscape for responsible tourism (Lanka); Photo: By Author

Out of a total of 1,147 posts sanctioned for medical doctors in the state, only 493 doctors are working. Further, the number of specialist doctors is significantly less. From educational institutions, students are decreasing. Less than 10 students are studying in about 10000 schools. Teaching staff in the educational institutions in the rural areas are less and in the plain region, they are excess. The remotely located rural areas are not properly connected by road networks and those are connected, buses are not running on the roads.

The natural calamities are increasing multifold and the local people facing tremendous problems. It shows that still, the state of Uttarakhand did not frame any concrete policy for these natural calamities. Broadening of roads along the fragile landscape, construction of multistoried buildings, and resorts along the fragile landscape are inviting future catastrophes. After the Kedarnath calamity, a high-level committee prepared a comprehensive report, which stated that the commencement of any development project needs rigorous suitability analysis. However, the findings of the reports are not taken into account, and the state government kept the report unused. In July and August 2022, 32 incidences of landslides, debris flows, flash floods, rock falls, and heavy rainfall were noticed, which killed many people and caused a huge loss of property. Figure 2 shows a flash flood in the Pindar River on June 16, 2013. About 16 shops, 1 km of road, and arable land were washed away.

Fig. 2: Flash flood in the Pindar River at Narayan Bagar service center; Photo: By Author

As per the state government report, about 400 villages are highly vulnerable to natural disasters; of which, only 233 villages of 13 districts were rehabilitated in safe areas and the remaining 167 villages are facing future catastrophes. This figure has increased to 308 after the 2013 natural calamity. The report says that the highest villages, which are highly vulnerable to disasters, are in the Pithoragarh district, followed by the Chamoli and Bageshwar districts. In plain districts, the situation is better. There are an increasing number of villages along the Tehri high dam, which are facing a submergence problem.

Under such a situation, now the question is raised what should be the development model for Uttarakhand? Uttarakhand is a mountainous state where about 70% of people live in rural areas. Practicing agriculture is the main occupation and the major source of income. Therefore, agricultural development is inevitable. In the recent past, the cultivation of traditional cereals has declined. Changing food habits, growing population, low production, and low yield from cereals are among the major drivers of declining agriculture. Owing to the climate change phenomenon, the agroecological zones have shifted to higher altitudes. Therefore, it is high time for re-delineation of agro-climatic zones and analysis of land suitability for growing different crops. Multi-cropping is quite better than mono-cropping. Adequate irrigation facilities, climate-smart agriculture, the system of rice intensification, value addition, construction of cold storage, and adequate market facilities are essential for future agricultural development in the state. Special subsidies should be given to marginal farmers during crop failure and other times. Forest-based small-scale village industries, imparting skilled education and community participation in framing development planning and their implementation are the other sectors of sustainable development. The creation of jobs for the youth of the region is an important task so that out-migration can be minimized. Institutional development may lead to employment generation. Strong primary level education, tourism development at the local level through homestay, and development of local handicrafts are some of the development models for the Uttarakhand state.

Rehabilitation of people, who are living in highly vulnerable villages, can be ensured for their safe future with sufficient rehabilitation packages. Before the construction of any development project, land suitability analysis should be carried out so that the future adverse consequences of these projects will be minimized. The development model should be area-specific, keeping the topography and climate of the area in mind. Monitoring of river channels is essential and constructing settlements alone on the fragile slopes and along the course of the river should be prohibited. The construction of roads along fragile slopes can be avoided. Road construction by constructing pillars is suitable for the fragile landscape. There are pieces of evidence of constructing roads through pillars in mountainous regions is successful. The other means of transportation can be ropeways. Technology intervention in infrastructural development will lead to overall economic development and environmental conservation of the state.

Report

Formation of Syanachatti Artificial Lake

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The Himalayan region is prone to natural hazards, one of which is the formation of artificial lakes in running rivers. This may occur due to several reasons, such as the sliding down of slopes into the river, the flow of debris, and the subsequent blockage of water. On August 21, 2025, debris from the Kupada Khad Gad entered the Yamuna River and blocked its flow at Syanachatti. This led to the formation of an artificial lake, causing inundation of many settlements located along the riverbanks. Debris and mud entered houses, shops, hotels, and even a school. Since the school and a total of 29 houses and institutions were submerged in the river, approximately 150 girl students were scattered in different locations. About 12 villages were disconnected due to the event, and the situation continued for three days. The inhabitants were asked to vacate their homes. Meanwhile, the affected people protested against the government for the slow pace of the rescue operation. Eventually, the administration blasted the artificial lake to release the water; however, only about one foot of water was successfully discharged.

Syanachatti is a service centre located on the Yamunotri highway, on the bank of the Yamuna River (Fig. 1). It provides essential services to tourists and pilgrims. Many settlements are situated close to the riverbed, and whenever the water level of the river rises, houses and business establishments become submerged.

Fig. 1. Syanachatti service centre sinking in the Bhagirathi River. Photo: Social media (open Source)

Most climate-related disasters in the Himalayan region occur due to the location of settlements close to river valleys and along streams. In recent times, the establishment of service centres along roads leading to highland pilgrimages has further accentuated the severity of these disasters. This region falls under the Main Central Thrust (MCT), and several artificial lakes have been formed in the past, such as Belakuchi in 1970 and Gona Lake in 1983.

रिपोर्ट

द्वितीय केदार मध्यमहेश्वर ट्रैक

राजेश भट्ट, असिस्टेंट प्रोफेसर, भूगोल विभाग, हिमवंत कवि चंद्रकुंवर बर्त्वाल राजकीय महाविद्यालय नागनाथ पोखरी, भारत

उत्तराखण्ड में पर्यटन एवं धार्मिक दृष्टि से पंचकेदार का महत्त्व बढता जा रहा है। वर्ष 2013 की आपदा के बाद केदारनाथ सौन्दर्यीकरण के पश्चात केदारनाथ में तीर्थयात्रियों का सैलाब उमड़ रहा है तथा लगातार तीर्थ यात्रियों की संख्या बढ़ रही है, जिससे की पंच केदार दर्शन हेतु भी तीर्थयात्रियों की संख्या बढ़ने लगी है। द्वितीय केदार के रूप में प्रसिद्ध मध्यमहेश्वर मंदिर रुद्रप्रयाग जिले में स्थित है और यह क्षेत्र केदारनाथ वन्यजीव अभयारण्य के अंतर्गत आता है तथा नंदादेवी बायोस्फीयर रिज़र्व से निकटता रखता है जो की स्वतंत्र संरक्षित क्षेत्र है। मान्यतानुसार महाभारत काल के पांडवों ने भगवान शिव को प्रसन्न करने के लिए पंच केदार की यात्रा की थी। माना जाता है कि शिव ने भैरव रूप लेकर उनसे छिपने की कोशिश की और अलग अलग अंग पंचकेदार के पांच स्थानों पर प्रकट हुए, जिसमें प्रथम केदारनाथ (पीठ भाग) द्वितीय मध्यमहेश्वर (नाभि) तृतीय तुंगनाथ (भुजाएं), चतुर्थ रूद्रनाथ (मुख), पंचम कल्पेश्वर (जटाएं) रही है।

मध्यमहेश्वर के लिए पर्यटक एवं तीर्थ यात्री ऋषिकेश से श्रीनगर गढ़वाल राष्ट्रीय राजमार्ग 7 से 110 किलोमीटर की दूरी लगभग 3 घंटे में सर्पीली, सुंदर अलकनंदा नदी के साथ तय करने के पश्चात् 35 किलोमीटर सड़क मार्ग 1 घंटे में तय कर लेते हैं तथा रुद्रप्रयाग पहुँचते हैं। कुछ पर्यटक एवं तीर्थ यात्री श्रीनगर से 16 किलोमीटर दूर स्थित अलकनंदा नदी के मध्य भाग में स्थित आधुनिक शैली से बने धारीदेवी मंदिर के दर्शन कर लेते है। रुद्रप्रयाग से उखीमठ 45 किलोमीटर पंचकेदार प्रशासनिक केंद्र से होते हुए 19 किलोमीटर रांसी गांव तक पहुंचते हैं। उखीमठ से रांसी गांव तक सड़क मार्ग काफी संकरा है तथा यहाँ पर सीमित गाड़ियों की सुविधाएं उपलब्ध हैं ।

रांसी गांव से मध्यमेश्वर ट्रैक का प्रारंभ बिंदु है। रांसी समुद्र तल से 1772 मीटर उचाई पर स्थित पर्वत श्रृंखलाओं से घिरा क्षेत्र है। यहाँ से गौंडार 1707 मीटर ऊँचाई, ढाल युक्त, संकरा 5 कि0मी0 पैदल मार्ग है। यह कच्चा मार्ग, साहसिक यात्रा, प्राकृतिक वनस्पति, जंगली जानवरों की नयी नयी सुंदर प्रजातियों से युक्त है जहां पर्यटक प्राकृतिक सुंदरता के छाया चित्र खींचते नजर आते हैं। गौंडार में मधु गंगा व मोरखंडा (स्थानीय नाम) नदियों का संगम स्थल पर थकान भरे पड़ाव में थोड़ा आराम करते हुए प्राकृतिक सौंदर्य का लुफ्त उठाते पर्यटक देखे जाते हैं। गोण्डार से वनतोली, खड्डुरा खाल (2079 मी), नानू (2306 मी), 9 किमी ट्रैक यात्रा करने के पश्चात मध्यमहेश्वर(3260 मी) 15 किलोमीटर ट्रैक करने के पश्चात् 5-6 घंटे में तीर्थ यात्री मध्यमहेश्वर पहुँच जाते हैं। हिमवंत कवि चंद्रकुंवर बर्त्वाल राजकीय महाविद्यालय नागनाथ पोखरी के भूगोल के छात्रों के साथ यह भौगोलिक भ्रमण सुबह 11 बजे रांसी से 4:00 बजे सायं मध्यमहेश्वर तक तय किया गया। यह ट्रैक तीर्थयात्री अपनी सुविधानुसार नानू, गोंडार में होमस्टे में रुककर दो दिन में भी करते हैं तथा कुछ तीर्थयात्री दो- तीन दिन रूक कर प्राकृतिक एकान्तता का आनंद लेते हुए भी यहाँ पर देखे जाते हैं।

मध्यमहेश्वर मंदिर के निकटवर्ती मुख्य आकर्षण

हिमाच्छादित शिखरों से घिरा मध्यमहेश्वर मंदिर अपनी धार्मिक महत्त्व के साथ प्राकृतिक सौंदर्य के लिए भी प्रसिद्ध है (Fig.1)। यह धार्मिक स्थल साहसिक पर्यटकों की विश्राम क्रीड़ा स्थल है। उतार चढ़ाव के इस धार्मिक स्थल में अनेक दृश्य बिंदु मिलते हैं जहाँ पर्यटक इन हिमाच्छादित पर्वत श्रृंखलाओं एवं घाटियों को अपने कैमरे में कैद करते हुए दिखाई देते हैं। पर्यटक मध्यमहेश्वर मंदिर में शाम- सुबह की पूजा अर्चना करने के पश्चात तीन किलोमीटर पर फैले धाती बुग्याल में क्रीड़ा का आनंद लेते हुए दिखाई देते हैं। यहाँ पर मंदिर के पीछे पांच पेड़ है। इन वृक्षों को पांच पांडवों के रूप में जाना जाता है। मध्यमहेश्वर मंदिर से धोला, यम्बीर, पांचार्णा, चौखंबा, नदी कुंड, सफेद बुरांस, पर्वत श्रृंखलाओं की ट्री लाइन, बुग्याल, मधुगंगा उद्गम स्थल, कांचली ताल , बेनाम ताल, पार्वती कुंड

के अलावा पितृ शीला (पांडवों के पूर्वज स्थापित है), धर्मशाला (गाय के खुर) जैसे आकर्षण स्थल पर्यटकों को मंत्रमुग्ध कर देते हैं। मध्यमहेश्वर में धाती बुग्याल पर्यटकों को एक स्वर्ग का अनुभव कराता है। यहाँ पर देवदार, ओक वृक्ष अधिक मात्रा में दिखाई देते हैं।

Fig.1. Madhyamaheshwar and Budha Madhyamaheshwar

बूढ़ा मध्यमहेश्वर: मध्यमहेश्वर मंदिर में दर्शन करने के पश्चात पर्यटक दो किलोमीटर ट्रैक करने के पश्चात सुबह 4-5 बजे सूर्य की प्रथम रौशनी देखने के लिए पहुंचते हैं। यहाँ पर सूर्य की प्रथम किरण नज़दीक से एवं एकदम सुबह होते हुए दिखाई देती है। यहाँ पर चौखंबा चोटियो का सबसे अच्छा दृश्य देखने को मिलता है और चौखंबा पर्वत हाथ से स्पर्श जैसे दूरी महसूस कराता है जोकि एक डरावना एवं अद्भुत सौंदर्य महसूस कराता है। हिमालय की श्वेत चादर व चौखंबा के प्रत्यक्ष दर्शन करने से मानव अपने जीवन के दुख दर्द को भूलकर प्रकृति का हिस्सा बन जाता है । बूढ़ाकेदार मंदिर के नजदीक एक जल का कुंड है, जो पर्वत श्रृंखलाओं को उनकी प्रतिबिंबता दर्शाते हैं, तथा मध्यमहेश्वर से बूढ़ाकेदार तक एक कुत्ता भी साथ आते जाते देखा जाता है, जो धार्मिक परंपराओं की अनुभूति कराता है।

मध्यमहेश्वर में पर्यटकों की आवाजाही मई -जून में सबसे अधिक होती है। मध्यमहेश्वर धाम में यात्रियों के आवागमन से स्थानीय उत्पादों की बिक्री में वृद्धि होने के साथ साथ यात्रियों के रहने के लिए आरामदायक धर्मशाला, टिनशेड कालोनी, टेंट में लगभग 200 यात्रियों के ठहरेने की व्यस्था है। यात्रियों के ठहरने हेतु स्थानीय कमिटी द्वारा क्रमवार आवासीय सुविधा उपलब्ध करायी जाती है जिससे आवासीय सुविधा ठहराव में प्रतिस्पर्धा नहीं हो। इन धर्मशालाओं को चलाने से स्थानीय युवाओं को नए रोजगार के अवसर मिलते हैं एवं इसमें रसोईघर, परिवहन सेवा, सफाई कर्मचारी के साथ- साथ स्थानीय उत्पाद जैसे छाछ, जूस, दूध, दही, घी, झंगोरा खीर आदि पकवान का स्वाद पर्यटकों को मंत्रमुग्ध कर देता है ।

मध्यमहेश्वर धाम अभी पूरी तरह से पर्यटकों की नजर से दूर है यहाँ पर ट्रैकिंग मार्ग ऊबड़ खाबड़ एवं साहसिक है, जो कुछ हद तक घाटी में असुरक्षित महसूस कराता है। यहाँ पर नंदादेवी बायोस्फीयर रिज़र्व होने के कारण टेंट कॉलोनी का ही विकास हुआ है तथा स्थानीय लोगों की निरंतर मांग रहती है कि सरकार द्वारा उन्हें प्रकृति की सुरक्षा के साथ आधुनिक टैंट आदि बनाने की अनुमति दी जाए, जिससे की तीर्थयात्रियों एवं पर्यटकों को आधुनिक सुविधा प्राप्त हो सके।

Photo: Panchachuli Mountain Peack, photo taken from Dantu village, the last village of the Darma Valley. Photo: By Vishwambhar Prasad Sati